Bulletin 143
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DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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*UNIVERSITY OF PAPUA NEW GUINEA

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1974

DEPARTMENT OF MINERALS AND ENERGY

MINISTER: THE HON. R. F. X. CONNOR, M.P.

SECRETARY: SIR LENOX HEWITT, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: N. H. FISHER

ASSISTANT DIRECTOR, GEOLOGICAL BRANCH: J. N. CASEY

Published for The Bureau of Mineral Resources, Geology and Geophysics by The Australian Government Publishing Service

ISBN 0 642 00601 6

MANUSCRIPT RECEIVED: MARCH, 1972

REVISED MANUSCRIPT RECEIVED: DECEMBER, 1972

ISSUED: MARCH, 1974

Printed by Graphic Services Pty. Ltd., 60 Wyatt Street, Adelaide 5000.

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PART 1

SUBJECT CATEGORIES

INTRODUCTION

Since the first visits by European explorers nearly five hundred years ago, the islands of New Guinea have been visited by explorers and scientists from many nations, including England, Portugal, Netherlands, Germany, Spain, France, Italy, Russia, America, Japan, and Australia. Early contacts ranged from brief watering and careening stays to exploratory cruises charting shorelines. During the 19th century, when German and British colonial administrations were being established, exploration was carried out during border-demarcation surveys, by expeditions mounted specifically to explore the interior of the island, and by mission and administration patrols.

Since late in the 19th century a considerable volume of information has been collected by scientific expeditions organized by overseas institutions or governments, by petroleum exploration groups, and by mineral prospecting and mining groups and individuals. In recent years many overseas mining and prospecting companies have been active.

All these ventures have contributed to our knowledge of the geology and geomorphology of the island. At times the published written record of investigations has been fragmentary and obscure, at others comprehensive and readily available.

It is the aim of this bibliography to bring together as much as possible of the published data in the fields of geology, geomorphology, and pedology. For practical reasons the scope of its coverage has been limited to that part of the island system east of meridian 141°E. West of this meridian is Irian Jaya; east of it are New Guinea and the neighbouring islands. Current official place names have been used throughout the text.

This annotated bibliography is presented in three parts:

Part 1 contains the abstracts or reviews of all articles processed, entered by subject category and with bibliographic details. The broad field of geology and related sciences has been divided into 18 major and 75 subordinate subject categories, listed in Contents. An article or abstract is allocated to a specific subject category on the basis of principal emphasis; where appropriate, it is cross-referenced to a subsidiary subject category and appears as a 'see also' entry at the beginning of the relevant category. Within each category entries are listed author-alphabetically and numbered sequentially. The sources of abstracts include:

i) the original author's abstract, which is indicated by a parenthetic (Auth.) at the end of the story,

ii) the author's abstract modified by the compiler (Auth/WM), and

iii) an abstract prepared by the compiler (W.M.) or his associate Colin Freeman (C.F.).

Abstracts have been edited where necessary to reduce excessive bulk and improve accessibility and comprehensibility; and most measurements have been converted to metric units.

Part 2 is an alphabetical list of all authors, with short entry cross-referenced by entry number to the abstract in Part 1.

Part 3 is a locality index, in which entries in Part 1 are linked to geographic location by reference to 1 : 250 000 map sheets. Entries for each map sheet are listed by subject category with author short entry cross-referenced by entry number to the abstract in Part 1. Each map sheet is identified by an internal code number, by name, and by international series number e.g. 01-Vanimo SA/54-11. In the internal code number series, the sheets are numbered sequentially from the northwest corner using the system employed in the Bureau of Mineral Resources, Geology and Geophysics (BMR) data storage and retrieval system. This numbering system is also used in the storage and catalogue of unpublished and published data held on file in the Port Moresby office of the Papua New Guinea Geological Survey, Department of Lands, Surveys and Mines. It has proved necessary to name and number a series of six sheets (SA/56-1, SA/56-16, SB/56-4, SB/57-1, SB/57-3 and SC/55-1) not previously used, and hence not fitting the sequential pattern of internal numbering.

Parts 2 and 3 are a revision and recasting of information presented in the Bibliography of the Geology of Eastern New Guinea (Papua New Guinea) (*Bur. Miner. Resour. Aust. Rep. 141 (PNG 5)*), prepared by W. Manser and C. Freeman.

The compilation of this bibliography began as a sideline and aid to research reading on New Guinea geology. It assumed more significant proportions after the discovery of a manuscript which G. A. V. Stanley had been preparing. This manuscript contained bibliographic data on many articles on Papua New Guinea, including many geological references, and has proved a valuable reference source.

It was hoped to make this annotated bibliography exhaustive, but incomplete library holdings and delays in locating and receiving a number of articles have precluded this. All material received and processed by 30 November 1971 has been included and it is hoped to issue periodic supplements.

Copies of all articles will be lodged in the New Guinea collection in the University Library, so as to build up a definitive collection of published information on geology and related fields in eastern New Guinea. The geological segment of this collection has a most useful nucleus in the material acquired from the estate of the late G. A. V. Stanley. This has been added to over the last four years, thanks largely to generous support from Conzinc Riotinto of Australia Ltd, but there are serious gaps in the periodical article coverage. The Librarian of the New Guinea collection in the University Library (P.O. Box 1432, Boroko) would welcome notification of articles, past and forthcoming, not included in this publication. Offprints of articles would be appreciated as they will enable an exhaustive definitive collection to be built up and would facilitate compilation of periodic supplements.

This bibliography could not have been compiled without the reliable support of the Readers Services Section of the Library of the University of Papua and New Guinea. In particular the assistance of Mrs C. Pyne and Mrs N. Reynolds is gratefully acknowledged. Mr Colin Freeman, Librarian of the New Guinea collection, was of considerable assistance in the early stages of collecting material and references and also helped with the abstracting of items. The project was supported in part by assistance from research funds at the University of Papua and New Guinea.

01 JOURNEYS OF DISCOVERY AND EXPLORATION

(a) Ocean Cruises of Discovery and Charting

01-a-1 Anonymous, 1850a — The south-west coast of the Louisiade. *Naut. Mag.*, 19, 361-5.

Rattlesnake and *Bramble* rendezvoused at Adele I. off Rossel I. on 11 June 1849, and followed the north reef between the islands and along Rossel, entering the lagoon through a small entrance near Piron I. After charting some reefs, they moved to the southeast island (Sudest) for water, then investigated Isle Sudest, Johannel (Pana Tinai), Duchateau I., and Duperre I. The south coast of mainland New Guinea was surveyed west to Redscar Head, where a 3900 m peak observed about 65 km inland was named Mt Durville (probably Mt Victoria). (W.M.)

01-a-2 Anonymous, 1850b — The voyage of the *Rattlesnake. Naut. Mag.*, 19, 624-5.

Areas covered in recent tours by HMS *Rattlesnake* are listed. On the latest cruise, the southeast coast of New Guinea and the Louisiade Arch. were surveyed, and natural history material was collected. (W.M.)

01-a-3 Anonymous, 1873a — Tre viaggi del Rev. W. Wyatt Gill, 1872 (Three voyages by Rev. W. Wyatt Gill, 1872, in Italian). *Cosmos,* 1, 223-5.

Journeys by Gill in 1872-73 to Saibai I., Mauat in western Papua, and Redscar Bay near Port Moresby are noted. They are described more fully in entries 01-b-34 and 01-b-35. (W.M.)

01-a-04 Anonymous, 1873b — Recenti esplorazioni nella Papuasis e isole circonvicine — 2. Esplorazione del Capitano Moresby o crociera del *Basilisk* (Recent explorations in Papua and nearby islands — 2 Exploration by Captain Moresby and the crew of the *Basilisk,* in Italian). *Boll. Soc. geogr. ital.,* 10, 70-1.

Reports of Moresby's discoveries in eastern New Guinea around Port Moresby and Milne Bay in 1873 are abstracted (entries 01-a-30 and 01-a-33). (W.M.)

01-a-5 Anonymous, 1873c — Recent discoveries at the eastern end of New Guinea. *Mercant. marine Mag.*, 20, 324-5 and 347-9.

A report by Moresby on his discoveries in southeast Papuan waters is quoted in part. The discovery of China Str. and a large bay (Milne Bay) at the eastern end of the mainland is recorded. The data are preliminary to a more complete report (entry 01-a-33). (W.M.)

01-a-6 Anonymous, 1876b — Flussfahrten im südlichen Neu Guinea — 3. Die Fahrt des *Ellengowan*: Entdeckung des Mai-Kassa-Stroms durch MacFarlane und Stone (River exploration in southern New Guinea — 3. The voyage of the *Ellengowan*: discovery of the Mai Kassa River by MacFarlane and Stone, in German). *Petermanns Mitt.,* 22, 87-9.

The supposed discovery of the Baxter (Mai Kassa) R. by MacFarlane and Stone is reported. The position of its mouth was given as 9°8′S, 142°18′E; the stream here was 2.5 km wide, 3-4 m deep, and flowing strongly. The river was charted for about 70 km to its junction with the Wassi Kassa R. (W.M.)

01-a-7 Anonymous, 1876c — Besuch des *Challenger* in der Humbolt-Bucht in Neu-Guinea und auf der Admiralitäts Inseln (The visit of the

Challenger to Humbolt Bay in New Guinea and to the Admiralty Islands, in German). *Petermanns Mitt.*, 22, 196-7.

A note of the visit by HMS *Challenger* is more fully documented by Swire (entry 02-d-58). (W.M.)

01-a-8 ANONYMOUS, 1887a — Recent New Guinea exploration. *Scott. geogr. Mag.*, 3, 434-5.

Bevan's report (entry 05-b-30) of the discovery and charting of the Douglas (Kikori) and Jubilee (Purari) Rs is summarized. (W.M.)

01-a-9 BELCHER, E., 1843 — NARRATIVE OF A VOYAGE AROUND THE WORLD, PERFORMED IN HER MAJESTY'S SHIP *Sulphur*, DURING THE YEARS 1836-1842 etc. . . . *London, H. Colburn, 2 Vols.*

Landfall on the north coast of New Guinea was near what is probably Karkar I. and Mugil Har. near Madang. The coast is fringed with growing reefs and the sea bed 20 fathoms (36 m) offshore is muddy. A running survey of the bay, named Victoria Bay, revealed a uniformly muddy bottom at 9-30 fathoms (16-55 m), with several reef patches. There was a salty thermal spring with water near boiling point on the south coast of the bay and a cluster of small low islands off the coast. Off the mouth of a large river, probably the Sepik, many floating grass islands were seen. Sea bed 14 km offshore was at 9 fathoms (16 m) and a strong offshore current was recorded. (W.M.)

01-a-10 BEVAN, T. F., 1889 — Further explorations in the regions bordering upon the Papuan Gulf. *Proc. Roy. geogr. Soc.*, 11 (n.s.), 82-90.

During an expedition to re-survey the Jubilee and Douglas Rs, Bell Sound and Deception Bay were visited and inspected, and some of the coastal swamplands traversed. The geology and geomorphology of the limestone country in the upper reaches of the Jubilee R. are described. (W.M.)

01-a-11 BONAPARTE, (Prince) Roland, 1884 — Les derniers voyages des Néerlandais à la Nouvelle Guinée (The latest voyage by the Dutch to New Guinea, in French). *Bull. Soc. Géogr.*, 14(4), 554-61.

The almost complete lack of information about the north coast of New Guinea between 141° and 145° East is noted. Dutch exploration in western New Guinea is summarized and a visit to Orangerie Bay on the south coast of Papua by HMS *Nelson* is mentioned. (W.M.)

01-a-12 BONAPARTE, (Prince) Roland, 1888 — LA NOUVELLE GUINEE. IVe NOTICE-LE GOLFE HUON. *Paris, author,* 62 pp.

Previous work in charting Huon G. is outlined, with detailed accounts of more recent surveys. (W.M.)

01-a-13 BOUGAINVILLE, L. A. de, 1771 — VOYAGE AUTOUR DU MONDE PAR LA FREGATE DU ROI LA BOUDESSE ET LA FLUTE L'ETOILE EN 1766, 1767, 1768, ET 1769 (Voyage around the world in the frigate *La Boudesse* and the storeship *L'Etoile* in 1766, 1767, 1768, and 1769, in French). *Paris, 4 Vols* (2nd Edn in 2 Vols in 1772).

In June 1768 Bougainville sighted the southeast coast of Papua at Orangerie Bay, and sailed east to C. Deliverance at the eastern end of the island now called Rossel. The Louisiade Arch. and C. Deliverance were named. In mid-July, severe earthquakes shook the coast of the southern point of New Ireland, where the ship had anchored in an enclosed bay. (W.M.)

01-a-14 BOUGAINVILLE, L. A. de, 1772 — A VOYAGE ROUND THE WORLD (Translated from French by J. R. Forster). *London, Nourse & Davies,* 476 pp.

This is a translation of Bougainville's account (entry 01-a-13) of his discovery of the southeast coast of mainland Papua and several islands of the Louisiade Arch., and his exploration of the Solomon Is and New Ireland. (W.M.)

01-a-15 BRIDGE, C., 1886 — Cruises in Melanesia, Micronesia and western Polynesia, in 1882, 1883, and 1884, and visits to New Guinea and the Louisiades in 1884 and 1885. *Proc. Roy. geogr. Soc.*, 8 (n.s.), 545-67.

5 cruises were made through the islands of the western Pacific, during which visits were made to New Guinea, New Britain, Duke of York Is, Solomon Is, and Louisiade Arch. (W.M.)

01-a-16 CHALMERS, J., 1887a — Explorations in south eastern New Guinea. *Proc. Roy. geogr. Soc.*, 9 (n.s.), 71-86.

Chalmers' explorations between 1878 and 1885 included cruises in the *Ellengowan* along the south coast east of Hall Sd, travels in the coastal ridges near Mt Astrolabe, a voyage up the Edith R. beyond Doura, a voyage up the Aroa R. and then overland towards Mt Yule, travels inland from Milne Bay, inland traverses around Port Moresby, and a visit to Bald Head near Doura. (W.M.)

01-a-17 D'URVILLE, J. S. C. DUMONT, 1884 — VOYAGE AU POLE SUD ET DANS L'OCEANIE . . . PENDANT LES ANNEES 1837-1838-1839-1840 (Voyage to the South Pole and in Oceania . . . during the years 1837-1838-1839-1840, in French). *Paris, Gide.* 22 Vols text, 7 Vols maps.

D'Urville's cruise resulted in the discovery of Murua (Woodlark), Louisiade and D'Entrecasteaux Is, and the sighting of New Britain. All were recognized as 'high islands' of continental material. (W.M.)

01-a-18 EVERILL, H. C., 1886 — Exploration of New Guinea — official report. *Roy. geogr. Soc. Aust., S. Aust. Br.*, 20 pp.

An expedition surveyed the Fly and Strickland Rs, and the report includes notes on ethnology, geomorphology, geology, and the suitability for settlement and agriculture. (W.M.)

01-a-19 EVERILL, H. C., 1888 — Exploration of New Guinea — Capt. Everill's report. *Trans. Proc. Roy. geogr. Soc. Aust., N.S.W. Br.*, 4, 170-87.

This is a reprint of entry 01-a-18.

01-a-20 FLEURIEU, C. P. C. de, 1790 — DESCOUVERTES DES FRANCAIS EN 1768 ET 1769 DANS LA SUDEST DE LA NOUVELLE-GUINEE (Discoveries of the French in 1768 and 1769 in southeast New Guinea, in French). *Paris, Royal Printing,* 309 pp.

Several features in the New Guinea area were discovered and named by Carteret, Bougainville, and D'Urville in 1766-69. The discovery and early charting of the New Britain-New Ireland-Solomon Is area, the Louisiade Arch., and the south coast of eastern Papua are described using abstracts from ships' journals and original reports. Profile sketches of the Solomon Is, including Bougainville, are copies of the first-ever record of the landforms in the area, as recorded by D'Urville in 1769. (W.M.)

01-a-21 FLEURIEU, C. P. C. de, 1791 — DISCOVERIES OF THE FRENCH IN 1768 AND 1769 IN SOUTH-EAST NEW GUINEA (translated from the French). *London, John Stockdale,* 323 pp.

This is a translation of entry 01-a-20. Information on charts and figures is only partly translated.

01-a-22 HOWARD, D., 1933 — The English activities on the north coast of Australia in the first half of the nineteenth century. *Proc. Roy. geogr. Soc. Aust., S. Aust. Br.*, 33, 21-194.

The state of knowledge of charted areas of New Guinea and nearby Asiatic islands early in the nineteenth century is outlined. (W.M.)

01-a-23 KRUSENSTERN, A. J. de, 1824 — Mémoire pour servir d'analyse et d'explication à la carte de la Nouvelle-Guinée et du Détroit de Torres (Analytical and explanatory notes to accompany the map of New Guinea and Torres Strait, in French). (*In* KRUSENSTERN, A. J. de — RECUEIL DE MEMOIRES HYDROGRAPHIQUES POUR SERVIR D'ANALYSE ET

D'EXPLICATION A L'ATLAS DE L'OCEAN PACIFIQUE (Collection of hydrographic notes analysing and explaining the atlas of the Pacific Ocean, in French). *St Petersburg, Dep. Instruction Publique,* 61-83.)

The geographic co-ordinates and features of many bays and capes of New Guinea are described, and the history of the determination of latitude and longitude is traced for many whose position is uncertain. The volcanic nature of many north coast islands is noted. Most data concern western New Guinea and the definition of Torres Str. (W.M.)

01-a-24 MACGREGOR, W., 1899d — Discovery of the Purari River. *Trans. Proc. Roy. geogr. Soc. Aust., Qld Br.,* 13, 82-7.

Correspondence is presented supporting the claim that Chalmers originally discovered the several mouths of the Purari R. Included is an early German map of the delta system. (W.M.)

01-a-25 MACGREGOR, W., 1899e — *Re* the discovery of the Purari River, British New Guinea. *Trans. Proc. Roy. geogr. Soc. Aust., Qld Br.,* 14, 50-4.

Maps, statements, and documents are offered in support of the claim that the Purari R. was discovered by Chalmers and not by Bevan. (W.M.)

01-a-26 MACLEAY, W., 1875 — The voyage of the *Chevert* to New Guinea. *Nature,* 13, 153-4.

The *Chevert* sailed up the east coast of Australia in mid-1875, reaching New Guinea at the Katow R. in the western Gulf of Papua. The river was surveyed for some 14 km before the party moved to Yule I., which is said to be composed entirely of fossiliferous calcareous sediments rich in faunas closely resembling living forms. (W.M.)

01-a-27 MARKHAM, C. R., 1886 — Progress of discovery on the coasts of New Guinea, with a bibliographical appendix by E. C. Rye. *Roy. geogr. Soc., supp. Pap.,* 1, 267-86.

The history of discovery and early charting of the coastline and islands of New Guinea is outlined, including a review of the early exploration of the eastern part of the island. The relative significance of work by Portuguese, Spanish, Dutch, French, and English navigators and explorers, and later work by German and Russian explorers, is noted. (W.M.)

01-a-28 MESLEE, E. M. La, 1885 — Past explorations of New Guinea, and a scheme for the scientific exploration of the great island. *Trans. Proc. Roy. geogr. Soc. Aust., N.S.W. Br.,* 1, 5-26.

The discovery of New Guinea by Europeans is attributed to the Spaniard Alvaro de Saavedra in 1528, though it is thought that in 1512 the Portuguese who settled in the Moluccas must have known a little about New Guinea. Other early visitors to east New Guinea includes Torres (1606), de Bougainville (1768), Cook (1770), Forrest (1774), Edwards (1791), Bligh (1791), and Flinders (1799). Early Dutch exploration of west New Guinea was carried out by the *Dourga* (1825-6), *Siren* (1832), *Triton* (1828 and 1835), *Postillon* (1835), *Etra* (1858), *Egerton* (1877), and by scientific expeditions by Van der Crab (1871), Teysman et al. (1876), Wallace (N.D.), and D'Albertis and Beccari (1872). Early exploration of east New Guinea was by D'Urville (N.D.), the *Fly* (1842-46), *Rattlesnake* (1846-50), *Chevert* (N.D.), Owen Stanley (1850), John Moresby (1871 and 1876), Miklouho-Maclay (1871, 1874, 1876-77, 1879-81, 1883), and numerous missionaries from the London Missionary Society.

Observations on some of the more recent surveys suggest that the island has potential for agricultural and mineral exploitation, and further exploration is needed to enable a realistic assessment of this potential. (W.M.)

01-a-29 MODERA, J., 1830 — VERHAAL VAN EENE REIZE NAAR AN LANGS DE ZUID-WEST KUST VAN NIEUW GUINEA, GEDAAN EN 1828, DOOR Z.M. CORVET *Triton,* EN Z.M. COLONIALE SCHOENER DE *Iris* (Narrative of a voyage along the southwest coast of New Guinea in 1828, in Dutch). *Haarlem, Loosjes.*

Exploration surveys were made of the southwest and south coast of Dutch New Guinea between Fort Du Bus and Dourga Str., and determined latitude and longitude are listed for several islands, capes, bays, and river mouths. Earlier exploration of west New Guinea, the north coast and New Britain, and the penetration of Torres Str. are summarized.

01-a-30 MORESBY, J., 1873 — Recent discoveries in the south eastern part of New Guinea. *Proc. Roy. geogr. Soc.*, 18, 22-31.

This is a reprint of some data in entry 01-a-33.

01-a-31 MORESBY, J., 1874a — (Discoveries in the Louisiade Archipelago and eastern New Guinea). *Mission Mag. for 1874,* 51-4.

Moresby's report on exploration in HMS *Basilisk* in eastern New Guinea (entry 01-a-33) is summarized. (W.M.)

01-a-32 MORESBY, J., 1874c — Abstract of lecture on New Guinea. *Trans. Roy. Soc. N.Z.*, 6, lxxxi-lxxxix.

Geographical, anthropological, cultural, and geological information in entry 01-a-34 is summarized.

01-a-33 MORESBY, J., 1875a — Recent discoveries at the eastern end of New Guinea. *J. Roy. geogr. Soc.*, 44, 1-14.

In 1873, the *Basilisk* visited the south coast of east New Guinea, and the results are presented in three sections: (i) islands and coast of New Guinea in Torres Str., (ii) coast of New Guinea between 146°20′ E and 148°E and (iii) from 150°E to the eastern tip of New Guinea.

The Torres Str. survey showed that most of this part of the coast and near-shore islands is mangrove-covered flats, except for the 240 m granitic bluff of Cornwallis I., a 60 m hill on the mainland near Saibai I., and the larger islands of Torres Str.

The 1849 survey of 190 km of coast from Yule I. to Hood Pt by Owen Stanley is revised. The mouth of a river (Alabule) opposite Yule I. was charted, rivers feeding into Redscar Bay investigated, and the barrier reef at Redscar Bay charted. The coastal lowlands farther west may have been formed from river-transported alluvial debris. The sudden change in coastal areas east of Redscar Bay is attributed to the style of drainage. Port Moresby harbour was entered through a narrow passage (Basilisk Passage) in the barrier reef. This was the first survey of the eastern part of the mainland, and modifies earlier charts by the addition of a bay (Milne Bay) and the China Strait. 40 km of the north coast was free of shoal reefs. (W.M.)

01-a-34 MORESBY, J., 1875b — Discoveries in eastern New Guinea, by Captain Moresby and officers of HMS *Basilisk. J. Roy. geogr. Soc.*, 45, 153-70.

A follow-up expedition filled in details of the earlier-recorded discovery and naming of Sir Alexander Milne Bay (entries 01-a-30 and 01-a-33). The islands and straits in the D'Entrecasteaux Is are charted and named, including the situation and disposition of beaches, volcanic forms, uplifted reef limestones on Fergusson I., and the existence of a passage through the Louisiade reefs west of Teste (Wari) I.

Notes are made on harbours surveyed — Hall Sd, Port Moresby and the Basilisk Passage, Pitt Bay on Moresby I., and Traitor's Bay on the northeast coast. During the survey of the north coast from East C. to Astrolabe Bay, Stirling Ra., C. Nelson, Dyke Ackland Bay, and Mts Trafalgar, Victory, Gladstone, and Disraeli were named. Geological points noted are the steep drop of hills into deep water with fringing reef along the coastline, and the volcanic activity of Lesson (Bam) I. (W.M.)

01-a-35 MORESBY, J., 1875c — Discoveries in eastern New Guinea by Captain Moresby and the officers of HMS *Basilisk. Proc. Roy. geogr. Soc.*, 19, 225-44.

This is a re-issue of entry 01-a-34. (W.M.)

01-a-36 MORTON, A., 1885 — Notes of a trip to the islands of Torres Strait and the south-east coast of New Guinea. *Trans. Proc. Roy. geogr. Soc. Aust., N.S.W. Br.,* 1, 65-84.

A record of the ethnological aspects of a biological collecting expedition to New Guinea in 1877 includes descriptions of Yule I., Port Moresby, Fairfax Har., parts of the Laloki and Goldie Rs, and Bootless Inlet. 'Colours' of gold were found in the Laloki and Goldie Rs wherever tested. On a second journey, some of the party visited the Louisiade Arch. (W.M.)

01-a-37 PARSONSON, G. J., 1967 — Torres and the discovery of Southern New Guinea. *N.Z. Geogr.,* 23, 132-56.

The history of the documentation of Torres' charting of the south coast of Papua between Baxter Bay and C. Possession in 1606 is traced. Comments are made on the source and reliability of several original charts. It is shown that early reconstructions of Torres' route through the Louisiade Arch. are in error. (W.M.)

01-a-38 POWELL, W., 1883a — Visits to the eastern and north-eastern coast of New Guinea. *Proc. Roy. geogr. Soc.,* 5 (n.s.), 505-17.

The coastal features and people of eastern Papua and some Torres Str. islands are described. (W.M.)

01-a-39 ROSSEL, — (ed.), 1808 — VOYAGE DE D'ENTRECASTEAUX, ENVOYE A LA RECHERCHE DE LA PEROUSE (Voyage by D'Entrecasteaux, sent in search of la Perouse, in French). *Paris, l'Imprimerie Imperiale,* 4 Vols.

Chapter 19 describes the reconnaissance of the Louisiade Arch., the southeast coast of New Guinea, and the north coast of New Britain. In the Louisiades, several low coral islets and larger high islands were roughly charted; high peaks on Sudest (Tagula) and Rossel Is were surveyed and the islands named. The latitude of the southernmost cape of Misima (St Aignan) I. was determined, and the cliffed nature of its coast noted. The discovery and naming of the Trobriand Is on 20 June 1793 is recorded. Eastern Normanby I. was seen to be mountainous.

The north coast of eastern New Guinea was surveyed westward from near C. Nelson to near the present site of Finschhafen. C. Gloucester at the western end of New Britain was charted, and the activity of Mt Langila noted. Considerable volumes of smoke, lava, and ash were produced from Long I. in June 1793. The north coast of New Britain around the Willaumez Pen. is essentially volcanic in origin, with one active cone producing steam and ash. (W.M.)

01-a-40 STANLEY, O., & MACGILLIVRAY, J., 1851 — Explorations in the Pacific Ocean, Louisiade Archipelago and New Guinea. *J. Roy. geogr. Soc.,* 21, 13-8.

The charting of part of the southeast coast of New Guinea and of the Louisiade Arch. is reported. A high range between Orangerie Bay and Redscar Head is mentioned, but no large rivers appear to flow into the sea from it. (W.M.)

01-a-41 THOMSON, B. H., 1889a — New Guinea: narrative of an exploring expedition to the Louisiade and D'Entrecasteaux Islands. *Proc. Roy. geogr. Soc.,* 11 (n.s.), 525-40.

The early part of the 1888 expedition to the Louisiade Arch. was by horseback for 110 km east from Port Moresby, via the villages of the Motu, Saroa, and Loyalupu tribes. The voyage to the Louisiades was undertaken in the Government vessels *Hygeia* and *Swinger* and calls were made at Sudest, Rossel, Joannet (Pana Tinai), St Aignan (Misima), East, Normanby, Fergusson, and Goodenough Is.

Observations are made on the main geomorphic features of each island including associated reefs and geological aspects, with emphasis on gold occurrences. (W.M.)

01-a-42 THOMSON, B. H., 1889b — Narrative of an exploring expedition to the eastern part of New Guinea. *Scott. geogr. Mag.,* 5, 513-27.

This is essentially a repeat of entry 01-a-41.

01-a-43 THOMSON, J. P., 1888b — New Guinea. *Scott. geogr. Mag.*, 4, 334-5.

During Hennessy's cruise (entry 05-b-41) up some of the rivers feeding into the Gulf of Papua, the Vailala, Aivai, Ponaroa (one of the mouths of the Kikori) Rs were visited and parts of the coast charted. (W.M.)

01-a-44 THOMSON, J. P., 1895 — A survey of recent exploration in British New Guinea. *Trans. Proc. Roy. geogr. Soc. Aust., Qld Br.*, 10, 1-17.

Exploration around the Gulf of Papua, along the northeast coast of New Guinea, and in the eastern peninsula has increased considerably the knowledge of the island's geography. (W.M.)

(b) INLAND EXPEDITIONS OF EXPLORATION

See also entries
05-a-1
05-b-2

01-b-1 ANONYMOUS, 1877 — Nieuw-Guinea (in Dutch). *Tijdschr. K. Ned. aardrijksk. Genoot.*, 2, 388-9.

Goldie's excursion to the Laloki R. near Port Moresby is noted (reported more fully in entry 01-b-37). (W.M.)

01-b-2 ANONYMOUS, 1886 — British New Guinea. *Proc. Roy. geogr. Soc.*, 8 (n.s.), 596-8.

Notes on unpublished papers from the estate of Sir Peter Scratchley are mainly on the ethnology of the island, its potential for development, native land systems, and the present and future structure of expatriate administration. There are references to the geomorphology of the eastern parts of the island, and to the discovery of two unnamed rivers flowing into Milne Bay. (W.M.)

01-b-3 ANONYMOUS, 1887c — New Guinea. *Scott. geogr. Mag.*, 3, 649-50.

The ascent of Mt Obree by Cuthbertson (entry 02-b-35) is noted, and exception taken to his assessment of the height of some peaks and of the extent of penetration by a previous expedition under Hartmann. (W.M.)

01-b-4 ANONYMOUS, 1887e — New Guinea Exploration. *Nature*, 36, 351-2.

A news item in the *Sydney Morning Herald* of 23 May 1887 on Bevan's exploration surveys in western Papua is reproduced. The nature and extent of the Aird, Douglas, and Jubilee Rs are recorded, with comments on the deltaic nature of coastal river systems in the region, the development and demeanour of the natives, and on the agricultural potential of the coastal flats. (W.M.)

01-b-5 ANONYMOUS, 1887f — The exploration of New Guinea. *Nature*, 36, 620-2.

Extracts are taken from an article in the Sydney *Daily Telegraph* of 9 July, based on Bevan's notes about his explorations of the Aird, Douglas, and Jubilee Rs in western Papua. Bevan's map is reproduced. (W.M.)

01-b-6 ANONYMOUS, 1888c — New Guinea and Louisiade Group. *Scott. geogr. Mag.*, 4, 165-6.

Articles on Cuthbertson's ascent of Mt Obree (entry 02-b-35) and Douglas' visit to the Louisiade Arch. (entry 02-b-39) are reviewed. (W.M.)

01-b-7 ANONYMOUS, 1889a — Ascent of Mount Owen Stanley, New Guinea. *Proc. Roy. geogr. Soc.*, 11 (n.s.), 504.

Macgregor's ascent of Mt Victoria (height given as 13 121 ft), and the discovery of a 3800 m peak north of the Owen Stanley Ra. named Mt Albert Edward, are recorded. (W.M.)

01-b-8 ANONYMOUS, 1890a — The Fly River, New Guinea. *Proc. Roy. geogr. Soc.*, 12 (n.s.), 352-4.

Macgregor's expedition up the Fly R. in late 1889 is recorded. The river divides at 5°54'S. The east branch was named the Palmer R. and was explored to a point

Traverses were made up the Aroa and Akevailui Rs near Kabati, inland from Redscar Bay west of Port Moresby. The notes deal mainly with the customs and health of the natives met on the traverse north and west of Redscar Bay, during which the party crossed the Maikona, Mabina, Enona, and Varemenana Rs. (W.M.)

01-b-27 CHALMERS, J., 1881b — Further explorations in New Guinea. *Proc. Roy. geogr. Soc.,* 3 (n.s.), 226-7.

The country inland from Redscar Bay, along and west of the Aroa R., is described, with comments on the local population. (W.M.)

01-b-28 CHALMERS, J., 1884 — Recent explorations in the south-eastern coast region of New Guinea. *Proc. Roy. geogr. Soc.* 6 (n.s.), 156-7.

Wykeham R., discovered west of Port Moresby, may form part of the deltaic outlet of a river system draining much of western Papua. (W.M.)

01-b-29 CHALMERS, J., & GILL, W. W., 1885 — WORK AND ADVENTURE IN NEW GUINEA, 1875-1885. *London, Religious Tract Soc.,* 342 pp.

A general account of their stay in New Guinea includes some geographical and geological data reported in geographical journals (entries 01-a-16, 01-b-25, 01-b-28, 01-b-34, 01-b-35). (W.M.)

01-b-30 CHAMPION, I. F., 1940 — The Bamu-Purari patrol, 1936. *Geogr. J.,* 96, 190-206, and 243-57.

The 1936 expedition party in western Papua moved from Daru up the Bamu and Wawoi Rs to Mt Bosavi and Lake Kutubu, returning easterly via the north side of Mts Giluwe and Karimui and down the lower reaches of the Purari R. Astronomical fixes of several major features permitted the checking and correction of sketch maps produced earlier by Spinks, Leahy, and Hides. (W.M.)

01-b-31 CHEESMAN, L. E., 1941 — The mountainous country at the boundary, north New Guinea. *Geogr. J.,* 98, 169-88.

The description of a journey from Hollandia (Djajapura) to the Torricelli Mts includes some comments on geomorphology. (W.M.)

01-b-32 CHINNERY, E. W. P., 1920 — The opening of new territories in New Guinea. *Geogr. J.,* 55, 439-59.

Expeditions went to the following districts: Mambare-Kumusi, north of Kokoda; Mt Obree-Mt Brown, east of Rigo; the Delta Division of western Papua; Mati-Ututi-Irumuku in the western parts of the Delta Division; Moreri-Marigi in the centre of the Delta Division; Pepeha in the west coast of the Delta Division; Mt Chapman and the headwaters of the Lakumuku R. The geomorphology, and some geology and ethnography of each area are outlined. (W.M.)

01-b-33 CHINNERY, E. W. P., 1934 — The central ranges of the Mandated Territory of New Guinea, from Mt Chapman to Mt Hagen. *Geogr. J.,* 84, 398-412.

Recent expeditions and surveys in the central north of Papua include those to Wiwa on the head of the Ono-Waria watershed; the headwater systems of the south-flowing western Tauri, Vailala, and Purari Rs and of the north-flowing Ramu and Sepik Rs; an unnamed high range along the Papua-New Guinea border between Mt Joseph and Mt Hagen (Kubor Ra.); and the tablelands between Mt Hagen, Kratke Ra., and Bismarck Ra. Geographical, surveying, ethnographic, and descriptive notes are included, much of the geographical data being the first reliable recording of the position of some major peaks and ranges, and the courses of some river systems. Fossicking activity and production from gold mines in the Edie Cr./Wau area are noted. (W.M.)

01-b-34 GILL, W. W., 1873 — Three visits to New Guinea. *Proc. Roy. geogr. Soc.,* 18, 31-49.

Several villages near Mauat in western Papua, and the principal features of the

975 km from the coast. The size, rate of flow, and tidal effects of the lower reaches of the Fly R., and the inhospitable nature of the unoccupied river swamps, are noted (reported more fully in entry 02-b-90). (W.M.)

01-b-9 ANONYMOUS, 1890c — New Guinea. *Scott. geogr. Mag.*, 6, 212-3.

Macgregor's report of his visits to the Milne Bay area (entry 02-b-89) is summarized. (W.M.)

01-b-10 ANONYMOUS, 1890e — New Guinea — Kiwai Island, Fly River. *Scott. geogr. Mag.*, 6, 383-5.

Macgregor's visits to Kiwai I. at the mouth of the Fly R. (entry 06-d-4), and up the Fly R. (entry 02-b-90) are outlined. (W.M.)

01-b-11 ANONYMOUS, 1890f — New Guinea. *Scott. geogr. Mag.*, 6, 552-3.

Macgregor's explorations west of Strachan I. are outlined (entry 05-a-110). (W.M.)

01-b-12 ANONYMOUS, 1891b — British New Guinea. *Scott. geogr. Mag.*, 7, 162-3.

Thomson's report (entry 02-b-177) of Macgregor's visit to the northeast coast of British New Guinea in July 1890 (entry 02-b-93) is abstracted. Notes are given on outcrops along the coast and in the coastal lowlands and hills and on the fumarolic activity of Mt Victory. Visits to the Trobriand, Marua (Woodlark), and Nada (Laughlan) Is are mentioned. (W.M.)

01-b-13 ANONYMOUS, 1897a — Sir W. Macgregor's journey across New Guinea. *Geogr. J.*, 9, 93-4.

Macgregor's crossing of British New Guinea from Mambare Bay to Vanapa R., including his traverse to the Owen Stanley Ra. (entry 05-a-111) is noted. (W.M.)

01-b-14 ANONYMOUS, 1908a — Recent exploration in New Guinea — I. Journeys of Messrs Barton, Strong, Monkton and others. *Geogr. J.*, 32, 266-70.

A map at 1 : 750 000 scale covers the area from the Purari R. in the Gulf of Papua to Cloudy Bay east of Port Moresby, and to the north coast and the boundary of German New Guinea east of the upper reaches of the Lakekamu R. It incorporates results of expeditions during 1900-1907 by Barton, Blayney (entry 05-a-61), Walker (entry 05-a-170), Monkton (entries 01-b-57 and 02-b-122), and Strong (entry 02-b-172). Summaries of these expeditions are included in the accompanying text. (W.M.)

01-b-15 ANONYMOUS, 1909a — The Dammkohler-Frohlich expedition in German New Guinea. *Geogr. J.*, 33, 333.

Frohlich's account (entry 05-a-78) of an expedition up the Markham R. and across the western end of the Finisterre Ra. is summarized. (W.M.)

01-b-16 ANONYMOUS, 1909d — Von der Hamburger Südsee-Expedition — Erste Durchquerung von Neu-Pommern (Notes on the Hamburg South Sea Expedition — First crossing of New Britain, in German). *Globus*, 96, 64-7.

New Britain was crossed from near Kandrian on the south coast to Nukuhu on the north coast, through the low divide between the western end of the Whiteman Ra. and the ranges south of Cape Raoult. The expedition was primarily ethnographic, but the report contains a map and profile of this previously unrecorded area. (W.M.)

01-b-17 ALBERTIS, L. M. d', 1882 — Expeditions sur le fleuve Fly, Nouvelle Guinée (Expeditions on the Fly River, New Guinea, in French). *Tour du Monde*, 44, 321-36.

The main contributions by d'Albertis in 1876-77 during his fifth and sixth voyages up the Fly R. are recorded. This article is abstracted from d'Albertis' book (entry 05-a-15). A map at about 1 : 250 000 scale depicts the southwest coast and Fly R. system as recorded by d'Albertis.

Most observations recorded here are ethnographic and cultural, though some impressions can be gained of the size and rate of flow of the Fly. Exploration of the Alice (Ok Tedi) R., a Fly tributary, is described. (W.M.)

01-b-18 ARMIT, W. E., 1884 — The 'Melbourne Argus' expedition into the interior of New Guinea. *Proc. Roy. geogr. Soc.*, 6 (n.s.), 37-8.

The *Melbourne Argus* 1884 expedition unsuccessfully attempted to cross the Owen Stanley Ra. between Port Moresby and Dyke Ackland Bay. Observations were made on the southern fall of the range during the expedition. (W.M.)

01-b-19 AUSTEN, L., 1926b — Recent explorations in the North-west District of Papua. *Geogr. J.*, 76, 434-41.

A report on exploration in the headwaters of the Fly and Palmer Rs refers to the physical geomorphology of the area traversed, and to much fragmentary stratigraphic and structural data. Fossiliferous mudstone, sandstone, and limestone on the coastal lowlands give way to underlying fossiliferous limestone forming the main headwater hills. Minor showings of gold and lignite are reported. (W.M.)

01-b-20 BEHRMANN, W., 1913b — Aus Kaiser-Wilhelms-Land (In mainland German New Guinea, in German). *Dtsch. Kolonztg*, 30, 116-7.

The Hunstein Ra. near the April R. southwest of Wewak is 1350 m high, and from it a series of several ranges rises to the main cordillera whose highest peaks appear snow-capped. (W.M.)

01-b-21 BEVAN, T. F., 1888 — FIFTH EXPEDITION TO BRITISH NEW GUINEA. *Sydney, Govt Printer,* 54 pp.

The expedition in the *Mabel* in western Papua visited Bell Sd, the Aird and Jubilee R. systems, Longford Sd, Centenary R., Aird Hills, Newbery Sd, Mitchell Sd, and the Fly R. The surveyor's report (entry 01-b-41) and correspondence about the expedition are appended. The nature and position of several newly-explored rivers are recorded, with comments on the trachytic Aird Hills capped with fossiliferous limestones. (W.M.)

01-b-22 BLACKIE, W. G., 1885 — Sketch of the present state of our knowledge of the island of New Guinea. *Proc. phil. Soc. Glasg.*, 15, 202-25.

The discovery and early exploration of New Guinea are outlined, and discoveries since 1845 are discussed. The gross regional geomorphology, the form of the island, and its mountain chains and river systems are described. The main discussion deals with the suitability of the eastern half of the island for European settlement and the customs and dispositions of the natives. (W.M.)

01-b-23 BONAPARTE, (Prince) Roland, 1887 — LA NOUVELLE GUINEA. III^{e} NOTICE — LE FLEUVE AUGUSTA. *Paris, author,* vii + 16 pp.

Attempts to penetrate the interior of German New Guinea by traversing up the newly-discovered Augusta (Sepik) R. are described. (W.M.)

01-b-24 CHALMERS, J., 1880a — New Guinea — an inland journey. *Mission Mag. for 1880,* 77-80.

During exploration around the tributaries of the Goldie R. near Port Moresby, Mts Elsie and Bellamy were named, and an unsuccessful attempt was made to travel northeasterly from Mt Bellamy across the Owen Stanley Ra. During further excursions on the Sogeri plateau Mt Nisbett and 'Ben Cruachan' were named and the Laloki R. traversed downstream from Rouna Falls. The top of the falls has an estimated height of 408 m and the falls a drop of 275 m. (W.M.)

01-b-25 CHALMERS, J., 1880b — New Guinea. *Proc. Roy. geogr. Soc.,* 2 (n.s.), 315-6.

Comments are made on the natural state and development potential of several valleys and plateaux in the vicinity of Port Moresby, visited in 1879. Some of the traverses described in entry 01-b-24 are noted. (W.M.)

01-b-26 CHALMERS, J., 1881a — New Guinea — the Kabati district. *Mission Mag. for 1881,* 56-60.

coastline and coastal lowlands, are described. Observations are made on the coastline and near-coastal streams in the Redscar Bay area. (W.M.)

01-b-35 GILL, W. W., 1875 — Three visits to New Guinea. *J. Roy. geogr. Soc.*, 44, 15-30.

This is a re-issue of entry 01-b-34. (W.M.)

01-b-36 GIULIANETTI, A., 1898 — Nella Nuova Guinea Britannica (Concerning British New Guinea, in Italian). *Boll., Soc. geogr. Ital.*, 11, 385-99.

Macgregor's expedition to Mt Scratchley and the Wharton Ra. in 1897 (entry 01-b-54) is described, and some impression can be gained of the terrain, stream systems, and stream flow characteristics. (W.M.)

01-b-37 GOLDIE, A., 1878 — A journey in the interior of New Guinea from Port Moresby. *Proc. Roy. geogr. Soc.*, 22, 219-23.

Short journeys were made around Port Moresby to the Laloki R. and supposedly up the Astrolabe Ra. from the south, in the Redscar Bay district, and an attempt was made to reach an unlocated gold prospect outside Port Moresby. (W.M.)

01-b-38 GRIFFITHS, G. S., 1885 — New Guinea as a field for geographical research. *Proc. Roy. geogr. Soc. Aust., Vic. Br.*, 2, 55-67.

The island of New Guinea may represent one of the world's largest unexplored areas. Its discovery, early records of exploration, gross structure, and physical features are described. Notes are made on the inhabitants and potential of the island, which should be systematically explored. (W.M.)

01-b-39 HARGRAVE, L., 1885 — On the exploration of New Guinea (Letter). *Proc. Roy. geogr. Soc. Aust., S. Aust. Br.*, 2, 26.

A survey and notes on the Fly R. are presented in the hope that it will be a useful line of communication for survey and exploration parties in the region. The writer predicts that a river as large as the Fly will be found draining the country to the west and emptying into Dourga Strs. (W.M.)

01-b-40 HARTMANN, C. H., 1887 — Ascent of the Owen Stanley Range, New Guinea. *Proc. Roy. geogr. Soc.*, 9 (n.s.), 621.

The route of the crossing of the Owen Stanley Ra. followed from Rigo up the Kemp Welch and Musgrave Rs and the range was crossed in the saddle between Mt Obree and Mt Brown. (W.M.)

01-b-41 HEMMY, H. J., 1888 — Report on the rivers and country traversed on my trip with Mr Theodore Bevan's exploring expedition in New Guinea during November and December, 1887. *In* BEVAN, T. F. — FIFTH EXPEDITION TO NEW GUINEA. *Sydney, Govt Printer*, 29-32.

Stream channel characteristics and features of the surrounding lowlands are recorded for the Bell, Douglas, Newbery, Philp, and Jubilee Rs. The extent of navigable streams in western Papua and their value in future communication and development are noted. (W.M.)

01-b-42 HUNTER, G., 1887 — Journal on an expedition from Kappa Kappa to the Kemp Welch River. *Proc. Roy. geogr. Soc. Aust., Qld Br.*, 2, (2), 85-97.

A traverse in the lower reaches of the Kemp Welch, Hunter, and Aleme Rs at the eastern end of the Astrolabe Ra. near Port Moresby is described, including descriptions and impressions of the landscape and villages. (W.M.)

01-b-43 JENA, L. SCHULTZE, 1914 — Forschungen im Inneren der Insel Neu Guinea — Bericht des Führers über die wissenchaftlichen Ergebnisse der deutschen Grenzexpedition in das westliche Kaiser-Wilhelms-Land, 1910 (Investigations in the Interior of the island of New Guinea — Report by the leader on the scientific results of the German Border Expedition in Western Kaiser Wilhelms Land, 1910, in German). *Mitt. dtsch. Schutzgeb., Ergh.*, 11, 1-99.

The Sepik R. is charted and data are presented in 5 coloured maps at scales 1 : 200 000 for the lower 320 km and 1 : 100 000 for the upper reaches. A 1 : 300 000 map of a strip 130 km wide along the Dutch/German border is included. The report is essentially anthropological and contains the first comprehensive maps of the Sepik R. Several topographic panorama sketches supplement the descriptions of the area. Terraced, uplifted coral limestone occurs along the northwest coast, rising to older sediments and metamorphics intruded by dioritic bodies and overlain by hornblende-andesite and other intermediate volcanics. (W.M.)

01-b-44 KARIUS, C. H., 1929a — Expedition across the island of New Guinea. *Papua, ann. Rep. for 1927-28,* App. D, 87-9 (Also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 542-4).

New Guinea was crossed from the mouth of the Fly to the mouth of the Sepik. An earlier unsuccessful attempt to cross the island (entry 05-d-30) is reviewed. (W.M.)

01-b-45 KARIUS, C. H., 1929b — Explorations in the interior of Papua and northwest New Guinea: the sources of the Fly, Palmer, Strickland and Sepik Rivers. *Geogr. J.,* 74, 306-22.

The headwaters of the Fly and Sepik Rs were explored. On the first excursion, the headwaters of the Palmer and Strickland Rs were discovered, two new-found rivers were named Murray and Len, and the limestone foothills traversed. On the second, a crossing was made into the headwaters of the Sepik. Little geographical or geological information is included, but gross features of the Fly R. up to the landing point 824 km from the mouth are noted, particularly the lunar-tide flooding of river flats. (W.M.)

01-b-46 LAUTERBACH, C., 1896c — Die Kaiser-Wilhelmsland-Expedition (The German New Guinea Expedition, in German). *Dtsch. Kolonztg,* 52, 434.

The expedition explored the upper reaches of the Ramu R. and nearby Bismarck and Finisterre Ras. Snow is reported on the high peaks of the Bismarck Ra., and the bed and alluvial plains of the Ramu are described. (W.M.)

01-b-47 LAWES, W. G., 1882 — Further explorations by Mr Lawes in the southeastern part of New Guinea. *Proc. Roy. geogr. Soc.,* 4 (n.s.), 160-2.

Points of geographic interest in the Hall Sd region include the plotting of the Toutou R. and the lower reaches of the Aroa R., and the recognition of Redscar Head as an island. (W.M)

01-b-48 LAWES, W. G., 1883a — An excursion in the interior of New Guinea. *Proc. Roy. geogr. Soc.,* 5 (n.s.), 355-8.

An excursion up Veriata (Wariarata) Mt near Port Moresby recorded its height as 790 or 707 m. The Rouna Falls and Laloki R. are described, and the height of the falls stated as 76 or 106 m. (W.M.)

01-b-49 LAWES, W. G., 1883b — Una recente excursione nella Nuova Guinea (A recent expedition in New Guinea, in Italian). *Boll. Soc. geogr. Ital.,* 8 (n.s.), 529-33.

This is a translation of entry 01-b-48. (W.M.)

01-b-50 LAWES, W. G., 1884 — Recent explorations in south-west New Guinea. *Proc. Roy. geogr. Soc.,* 6 (n.s.), 216-8.

Exploration by Chalmers around the mouth of the Alele, Aivei, and Panaroa Rs in the Gulf of Papua coast suggests that all may be outlets of the one river, here designated the Wykeham. The Aird, Wykeham, and nearby rivers are thought to represent part of the Fly R. drainage system.

The fate of the *Melbourne Age* expedition near Port Moresby and Sogeri was investigated by a party under Chalmers, who found the cause of the attack. (W.M.)

01-b-51 LAWES, W. G., 1887 — Ascent of a peak in the Owen Stanley Range, New Guinea. *Proc. Roy. geogr. Soc.,* 9 (n.s.), 758.

Mt Obree was ascended by a party from the Victorian Branch of the Royal Geographical Society of Australia. The route followed inland from Kappa Kappa, and the height of Mt Obree is given as 2440 m — c/f 3675 m recorded by the *Rattlesnake* survey. (W.M.)

01-b-52 LAWSON, J. A., 1875 — WANDERINGS IN THE INTERIOR OF NEW GUINEA. *London, Chapman & Hall.*

This purports to describe the country and people met during a traverse across western British and German New Guinea in 1872. It refers to a Mt Hercules, 9950 m above sea level, and standing nearly 9150 m above the surrounding country. (W.M.)

01-b-53 LEAHY, M., 1936 — The central highlands of New Guinea. *Geogr. J.,* 87, 229-62.

Several journeys of exploration in the Wahgi Valley and surrounding highland country between Mt Hagen and the Purari Plateau are documented, including ethnological data, comments on geology and landforms, four panoramic photographs, and a topographic map. (W.M.)

01-b-54 MACGREGOR, W., 1899b — Despatch reporting visit inland to the western end of the Owen Stanley Range, and thence across the inland to the north-east coast. *Brit. N. Guinea ann. Rep. for 1897-98,* App. B, 19-29.

During a traverse from the mouth of the Vanapa R., to Mambare Bay, the Owen Stanley and the Wharton Ras were crossed. A general idea of the area can be gleaned from the expedition log. Altitude measurements were made in several places, and peaks and watercourses in the Wharton Ra. were mapped. Gold and osmiridium in the Yodda and Gira Rs are recorded. (W.M.)

01-b-55 MACKAY, D., & LITTLE, W. S., 1911 — The Mackay-Little expedition in southern New Guinea. *Geogr. J.,* 38, 483-7.

In 1908 an expedition explored the Purari and Kikori Rs from Yule I. The geomorphology and geology of the river systems and headwater ranges are described. In the Purari R., thick limestone, slate, and coal-bearing sandstone of probable lower Palaeozoic age crop out and basaltic float is common. *Glossopteris* impressions occur in the coal samples. (W.M.)

01-b-56 MARSHALL, A. J., 1937 — Northern New Guinea, 1936. *Geogr. J.,* 89, 489-506.

Three journeys of exploration in northwest New Guinea are described — (i) inland from Aitape, (ii) from Aitape to Hollandia (Djajapura) via Vanimo, and (iii) over the Torricelli Mts to Yalwi and down the Nopan R. to Witwies. Ethnological data are presented, and a description given of destruction and damage in the Torricelli Mts caused by an undated earthquake. (W.M.)

01-b-57 MONKTON, C. A. W., 1902 — Report by resident magistrate, North-eastern Division, with regard to Doriri Expedition, 1 April to 24 April 1901. *Brit. N. Guinea ann. Rep. for 1900-01,* App. N, 63-9.

The Ibinamo and Musa Rs were followed for part of their length, and the position of these and associated streams such as the Adau and Domara Rs plotted. A 4-mile map accompanies the report. (W.M.)

01-b-58 MURRAY, J. H. P., 1929 — Annual report of the Lieutenant Governor. *Papua ann. Rep. for 1927-28,* 1-12 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 56-68).

The purpose and completion of the crossing of the mainland in western Papua from the Fly to the Sepik (entry 01-b-44) are outlined. Appended magisterial reports (entries 02-b-133, 05-b-146, and 12-e-6) record local details of exploratory patrols, and an appended report (entry 12-e-27) summarizes geological exploration, and mineral prospecting and production activities. (W.M.)

01-b-59 PARKINSON, R. H. R., 1907 — DREISSIG JAHRE IN DER SUDSEE (Thirty years in the South Seas, in German). *Stuttgart, Strecker & Schroder,* 876 pp. (2nd Edn, 1928, 353 pp.)

This essentially anthropological work contains much information about the physical features of New Britain, New Ireland, Bougainville, Admiralty Is, and the St Matthias and Ninigo Groups. It integrates early German exploration and some previously unpublished data, including the eruptive activity of Balbi volcano on Bougainville in 1889. It is illustrated with photographs and maps. (W.M.)

01-b-60 POWELL, W., 1880 — Six years' exploration in New Britain and neighbouring islands. *Proc. Roy. geogr. Soc.*, 2 (n.s.), 645-6.

Discovery and early exploration of the islands off New Guinea are recorded, particularly New Britain, New Ireland, and Duke of York Is. The volcanic features of the Gazelle Pen., and the May 1878 eruption of Tavurvur (Matupi), are recorded. 'The Father' and 'South Son' were active volcanoes, and 'North Son' appeared dormant or extinct. Henry Reid Bay is discovered and named, and the main features of the north coast of New Britain are listed. (W.M.)

01-b-61 STONE, O. C., 1875b — Recent explorations in the interior of New Guinea, from Port Moresby. *Proc. Roy. geogr. Soc.*, 20, 266-73.

The Laroki (Laloki) R. and Mt Astrolabe were visited, and notes made on the river system and course of the Laroki R. (W.M.)

01-b-62 THOMSON, J. P., 1889b — New Guinea: exploration of the Owen Stanley Range. *Scott. geogr. Mag.*, 5, 557-8.

The report of the ascent of Mt Owen Stanley by Macgregor (entry 05-a-108) is abstracted, and the nature of the range outlined and discussed. (W.M.)

01-b-63 THOMSON, J. P., 1892b — A survey of exploration in British New Guinea. *Scott. geogr. Mag.*, 8, 367-75.

This is a re-issue of entry 02-b-178.

01-b-64 THOMSON, J. P., 1896 — Sir Wm. Macgregor's recent journey across New Guinea, and re-ascent of Mt Victoria. *Nature*, 55, 157.

A telegram from Macgregor to the Governor of Queensland, recording the crossing of New Guinea in 1896 from Mambare Bay to the mouth of the Vanapa R. is quoted and some data given on the preparation of maps after the 1889 ascent of Mt Victoria. The approach to Mt Victoria from the Sogeri plateau contains many peaks and sheer cliffs, and was difficult to traverse. The ascent of Mt Victoria followed a route up the Vanapa R. (W.M.)

01-b-65 THOMSON, J. P., & FORBES, H. O., 1897 — Correspondence on 'Sir Wm. Macgregor's recent journey across New Guinea and re-ascent of Mt Victoria.' *Trans. Proc. Roy. geogr. Soc. Aust., Qld Br.*, 12, 43-50.

Correspondence between Thomson (entry 01-b-64) and Forbes (entry 05-a-76) is re-published in juxtaposition, with comments by Thomson. It concerns the veracity and reliability of descriptions of geomorphic features around and on the southeast flanks of Mt Victoria. (W.M.)

01-b-66 TROTTER, C., 1892 — Some notes on recent exploration in British New Guinea. *Proc. Roy. geogr. Soc.*, 14 (n.s.), 788-96.

Recent 'consolidation' exploration in British New Guinea indicates that potential for development is greater than first suspected. Sheltered harbours were found on the north and southeast coasts, and during the survey Mt Victory was seen as a steaming volcano. Additional data, mainly about settlement, are given for the Fly and Aird Rs and their tributaries.

Macgregor's visit to the Trobriand Is (entry 02-b-91) is summarized, with mention of the geology and geomorphology but with emphasis on the ethnography of the area embracing the Trobriand, Woodlark, D'Entrecasteaux, and Louisiade Is. (W.M.)

01-b-67 ZOLLER, H., 1889 — Fresh explorations in New Guinea. *Proc. Roy. geogr. Soc.* 11 (n.s.), 177.

During an expedition inland from Constantine Har. in German New Guinea, the Kratke Ra. was discovered and named, and a large area of previously undescribed country in the Finisterre and Bismarck Ras visited. (W.M.)

02 AREAL GEOLOGY

(a) General and Regional

See also entries

03-a-7	03-a-11	14-c-6	17-a-2
03-a-10	03-d-12		

02-a-1 Anonymous, 1945 — Geology and physical structure (*In* Great Britain. Naval Staff, Intelligence Division — Pacific Islands — Vol. 1, General Survey. *London, H.M.S.O.*, 5-56.)

A broad geological description is given of the Pacific Ocean, contained islands, and some islands outside the Pacific Basin including New Guinea. It summarizes data and interpretations, but contains no new material. Changes in sea level and evidence thereof, the nature and development of coral reefs and reef islands, and current volcanic activity are emphasized. A chronological record of historic eruptions in major volcanic centres includes islands off the northeast coast of New Guinea, the north coast of New Britain, and the Solomon Is. Belts and depth zones of seismic activity are outlined and discussed. Photographs and diagrams supplement the text. (W.M.)

02-a-2 Anglo-Persian Oil Company, 1930 — The oil exploration work in Papua and New Guinea conducted by the Anglo-Persian Oil Co. on behalf of the Government of the Commonwealth of Australia, 1920-29. *London, H.M.S.O.*, 4 Vols, 2 atlases, 100pp, 96pp, 116pp, 131pp.

Geological investigations during 2 surveys in western Papua and western New Guinea in 1920-23 and 1927-29, and drilling in western Papua during the first expedition, are presented as a series of reports. Each is abstracted and listed separately — entries 02-b-50, 02-b-52 to 02-b-56, 02-b-115 to 02-b-120, 02-b-123, 02-b-124, 02-b-125, 02-b-135, 02-b-181, 02-c-21, 02-c-26, 02-c-34 to 02-c-36, 03-c-4, 03-d-4 to 03-d-8, 04-b-4 to 04-b-6, 04-g-9, 12-e-20, 12-e-34, 12-j-31. (W.M.)

02-a-3 Avias, J., 1971 — Major features of the New Guinea-Louisiade-New Caledonia-Norfolk arc system. *12th Pacif. Sci. Cong., Canberra*, Abs. Vol., 364.

The structural and geological history of the New Guinea-Louisiades-New Caledonia-Norfolk system (inner Melanesian arc) is summarized:

1. A Permian marginal subsiding zone along a Tasmantis block and further trough development during Triassic-early Jurassic time (with andesitic volcanism).
2. *Diastrophism* phase of late Jurassic age mainly with low-grade metamorphism.
3. *Stress-release* by down-faulting and Cretaceous transgression.
4. Late Cretaceous-Paleocene development of a major reverse fault zone (*Owen Stanley fault* of New Guinea, Gonord's *'accident ouest Caledonien'* in New Caledonia) gave rise to geanticlinal blocks and brought oceanic lavas and sediments to the surface.
5. Oligocene-lower Miocene paroxysmic phase causing the basal layer of adjacent oceanic crust to be upthrust westward against the sialic margin. This gave rise to an overthrust slab of ultramafics lubricated by serpentinites and metamorphosed vulcano-sedimentary formations. Under the overthrust, low-grade metamorphism was generated, with high-pressure minerals. A 'thermal diapir' rose along the shear

heat zones of the Benioff plane resulting in a granodioritic magma which injected the whole previous sequence and completed the uplift of the arc; the uprising generated tensional forces in the Coral Sea and New Caledonian Basins, with consequent down-faulting.
6. Stress release followed, normal faulting giving rise to graben structures, stabilization of the whole zone, and death of the arc.

Subsequently there have been differential interaction and accommodation movements of the Australian and Pacific plates, which in the inner arc have generated transcurrent faulting and arc fragmentation with 3 main segments — Norfolk, New Caledonian, and New Guinea-Louisiades. (Auth.)

02-a-4 BAIN, J. H. C., DAVIES, H. L., & RYBURN, R. J., 1971 — Regional geology of Papua New Guinea: some new concepts. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 450.

Pre-Mesozoic basement exposed in the central ranges and on the southwest coast of Papua New Guinea is overlain by Mesozoic and Cainozoic rocks, mainly sedimentary in the south and southwest, and with an increasing igneous component to the north and northeast. At the watershed of the central ranges unmetamorphosed sediments (to the south) pass into highly deformed and, in some places, metamorphosed sediments with a volcanic component and many igneous intrusions. The large islands northeast of the mainland consist entirely of Cainozoic volcanics and limestone.

New Guinea Mesozoic rocks formed by sedimentation mainly from the Australian proto-continent and by *in situ* volcanic activity. Cainozoic rocks formed by reworking of older sediments, volcanism, plutonism, and limestone deposition. A major tectonic event in the early Cainozoic (in some areas dated as Oligocene) was marked by faulting, folding, and metamorphism of pre-existing sediments to greenschist, blueschist, amphibolite, pyroxene granulite, and eclogite facies. In southeast New Guinea a plate of oceanic crust and mantle was thrust over and metamorphosed Mesozoic sediments. Extensive volcanism and plutonism in mid-Miocene were followed by block faulting, strike-slip faulting, vigorous differential uplift, and rapid accumulation of sediments in marginal basins. The large islands to the northeast were formed by island arc volcanism which started in the Eocene (New Britain) and Oligocene (New Ireland and probably Bougainville), was quiescent in middle Miocene, and reactivated in the Pliocene-Quaternary. (Auth.)

02-a-5 BARTON, R. H., 1966 — Photogeology. *Proc. 8th Comm. Min. metall. Cong.,* 5, 21-9.

A photograph used to illustrate the paper is an example of reflection of bedding attitude through jungle cover in an area thought (by W.M.) to be in the ranges north of the Sepik River, near Maprik. (Auth./W.M.)

02-a-6 DAVID, T. W. E., 1914 — The Geology of the Commonwealth — II Papua. *Brit. Ass. Adv. Sci., Melb. Mtg, Federal Handbk on Australia,* 316-25.

Regional stratigraphic and tectonic trends suggest that the evolution of New Guinea is closely related to the post-Palaeozoic growth of the East Indies. Major elements are traced along the island using geological configuration and geomorphic expression. Volcanism is related to fault activity, which is greater in the north Prograding deltas of large rivers are rapidly building coastal plains and modifying coastlines, particularly in the western Gulf of Papua. The economic potential of coal and oil is discussed and some chemical analyses of coals and lignite are listed. (W.M.)

02-a-7 DOW, D. B., & BAIN, J. H. C., 1970 — A Miocene volcanic arc in New Guinea. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Volcanic rocks of Miocene age form a discontinuous belt up to 100 km wide extending 2000 km from the western end of the Vogelkop southeastwards along the highlands of West Irian and New Guinea to central Papua. Volcanic rocks are generally confined to the lower half of the rocks of the belt, and consist largely of massive agglomerate with intercalated lava flows and finer pyroclastics, all of basic to intermediate composition. Commonly associated with the volcanic rocks are large composite plutons of intermediate composition whose numerous small apophyses intrude the lower part of the volcanic sequence throughout the volcanic arc. Sulphide mineralization is common in this environment and at least one porphyry-type copper deposit (Freida Prospect) has been located. (Auth.)

02-a-8 DWYER, R. E. P., 1941 — Rubber production in New Guinea & Papua. *N. Guinea agric. Gaz.*, 7(3), 169-98.

The geology and topography of Papua New Guinea are related to the regional distribution of soil types. The data were obtained from previously published data and include original comparisons with successions and events in Java and Malaya. The oldest rocks are Devonian limestone in the Strickland R. area, though older rocks are known in Dutch New Guinea. There are abundant metamorphic and volcanic rocks, and volcanics and limestone are the commonest Quaternary rocks. The richest soils have developed on the most recent volcanic rocks; deltaic and estuarine terrigenous soils are moderately fertile, as are some soils on limestone. (W.M.)

02-a-9 FISHER, N. H., 1969 — The Bureau of Mineral Resources in Papua and New Guinea. *Aust. Ext. Terr.*, 9(4), 2-9.

The style and extent of geological exploration in Papua and New Guinea by both BMR and petroleum companies to 1969 are outlined, including geological, geophysical, volcanological, and oceanographic surveys. The roles of resident and Canberra-based geological personnel are outlined, and areas in which work is in progress delineated. (W.M.)

02-a-10 GREAT BRITAIN. NAVAL STAFF, NAVAL INTELLIGENCE DIVISION, 1945a — PACIFIC ISLANDS — VOL. I: GENERAL SURVEY. *London, Brit. Admir. Bd* (Geogr. Handbk Ser., B.R. 519), xv + 599 pp.

The geology and soils of the Pacific Ocean and its islands, including Papua New Guinea and nearby islands, are discussed in two chapters. The chapter on geology and physical structure of the Pacific Ocean reviews current hypotheses on the age and origin of the Pacific Basin, the circum-Pacific active volcanic and seismic zone, and the continental structure of the Pacific rim. Recent volcanic activity is tabulated. Rock types, potential economic minerals, sea floor structure, volcanism, seismic activity, coastline erosion and evidence of sea level changes, reef structures, and sea floor sediments are discussed, and a reading list on several subject areas is included. The soils chapter outlines the process of soil formation, illustrating it with examples from the Pacific islands area, including peat formation in lowland western Papua, and podzol formation in the Ramu Valley. Relation of soil and climate to vegetation and agriculture, and soil erosion conditions are noted. (W.M.)

02-a-11 GREAT BRITAIN. NAVAL STAFF, NAVAL INTELLIGENCE DIVISION, 1945c — PACIFIC ISLANDS — VOL. IV: WESTERN PACIFIC (NEW GUINEA AND ISLANDS NORTHWARD). *London, Brit. Admir. Bd* (Geogr. Handbk Ser., B.R. 519c), xvi + 526 pp.

Much of the volume discusses the geology and physical features, coast and navigable rivers, climate, vegetation and fauna, history, population, people, government and social services, economics, ports and settlements, and communications of Papua New Guinea, including New Ireland and adjacent small islands, Admiralty Is, islands off southeastern Papua, and the Louisiade Arch. The chapter on geology and physical features of New Guinea synthesizes known data, sometimes with a new interpretation — e.g. some of the Gulf of Papua coastal lowland geomorphology. The island is discussed on the basis of gross geology, and then within the framework of major physiographic regions. The chapter on coasts and navigable rivers includes data on reefs and stream flow, and descriptions of the country through which the rivers flow. (W.M.)

02-a-12 HORNE, R. G., 1967 — Geology of Papua and New Guinea. *N.Z.J. Geol. Geophys.,* 10, 1195-7.

The principal geological features of New Guinea are outlined, especially the nature of the sedimentary pile. (W.M.)

02-a-13 HOVIG, P., 1937 — Mijnbouw en geologie (Mining and geology, in Dutch with English summary). *In* KLEIN, W. C. — NIEUW GUINEA. *Amsterdam, Molukken-Institut,* 2, 547-98.

A series of major structural elements extends from Huon Gulf to the Vogelkop in northwest Dutch New Guinea. Extrapolation along these trends permits the geology of mapped areas to be extended to some degree into unmapped areas.

Devonian and Permian, but no Triassic, strata are known in Dutch New Guinea; none of them are yet recognized in the eastern part of the island. A complete but interrupted Tertiary succession of sediments and igneous rocks is present. Younger volcanoes are known only in the northern ranges, but may be present as a westward extension of the andesite mapped on the Fly R. by Stanley.

No mining has yet been undertaken in Dutch New Guinea and little is known of its mineral resources. Comparison with areas such as Bulolo Valley and Misima suggest favourable environments exist, particularly in association with the younger andesitic volcanoes. (W.M.)

02-a-14 JAEGER, J. C., & THYER, R. F., 1963 — Geophysics in Australia. *10th Pacif. Sci. Cong., Honolulu, Rep. Standing Comm. Geol. Solid Earth Geophys. Pacif. Basin,* 15-26.

The development of gravity, geomagnetic, seismic, rock magnetic, heat flow, and age determination studies in Australia and New Guinea in the period 1920-1961 is outlined. (W.M.)

02-a-15 RANGE, P., 1937 — Die deutsche Südsee und Kiautschou, Geologie und Bodenschätze (Geology and mineral resources of the German colonies in the South Sea and of Kai Chow China, in German). *Z. dtsch. geol. Ges.,* 89, 433-68.

The regional tectonic setting and gross geology of the German Pacific colonies including New Guinea are outlined as a background to a note on mineralized environments and mines in the region. The only significant mineralization reported in German New Guinea is alluvial gold being exploited in the Bulolo and Waria Rs. (W.M.)

02-a-16 REED, F. R. C., 1949 — Oceania: Section I — British New Guinea (Papua). Section II — Mandated New Guinea (Former Kaiser Wilhelmsland). *In* REED, F. R. C. — GEOLOGY OF THE BRITISH EMPIRE, 2nd edn. *London, Arnold,* 667-81.

The island of New Guinea forms part of the Australian continental block (as defined by the 100-fathom (180 m) line), but its gross structures represent younger episodes of folding than any in Australia and are more related to structures in the Indonesian region. Regional geology, volcanic centres, and the reef systems are outlined, briefly integrating major previous syntheses and articles. Notes are made on economic geology. (W.M.)

02-a-17 RENWICK, A., 1970a — Geology. *In* WARD, R. G., & LEA, D. A. M., *(Eds)* — AN ATLAS OF PAPUA AND NEW GUINEA. *Port Moresby and Glasgow, Univ. Papua New Guinea & Collins-Longman,* 32-3.

Upper Palaeozoic metamorphics and lower Triassic granitic intrusives form the core and basement on which younger strata accumulated. Mesozoic marine strata in eastern Papua are now represented by the Owen Stanley Metamorphics of greenschist grade, and metamorphics of similar grade in the Papuan islands. Mesozoic strata in the western highlands are exposed as deformed volcanics and marine clastic sediments, and as derived regional metamorphics.

Extensive orogenesis, volcanism and clastic sedimentation occurred in Lower Tertiary time. Widespread epeirogenic adjustments occurred in Upper Tertiary time when great thicknesses of biogenic limestone accumulated. Restricted active volcanism and derived clastic sedimentation continued in the Upper Tertiary. Middle Miocene to Quaternary was marked by extensive deposition of marine sediments in the north, and volcanigene sediments in the Aure Trough. Volcanism and reef limestone growth continued along the north coast and offshore islands, and some granitic and basic intrusives were emplaced during Miocene and Pliocene times. Quaternary activity included widespread active volcanism, and active and rapid isostatic movement. (W.M.)

02-a-18 SAPPER, K., 1915 — Die deutschen Südseebesitzungen (The German possessions in the South Sea, in German). *Geogr. Z.*, 21, 624-45.

This outlines the situation, climate, geology, landforms and mineral resources of the German colonies in the western Pacific, including Bougainville, Buka, New Britain, and mainland New Guinea. Volcanics and uplifted reef limestone were important in forming much of the land areas and the current volcanic and seismic activity in some places is noted. Economic mineral potential may lie in coal, gold, and petroleum in mainland New Guinea, and phosphate on some small limestone islands. (W.M.)

02-a-19 SMITH, T. LANGFORD, 1951b — Geology. *In* THE RESOURCES OF THE TERRITORY OF NEW GUINEA. *Div. Reg. Devel., Dep. nat. Devel. Melb., Govt Printer,* 25-34.

The geology of Papua and New Guinea is outlined; general and regional structure, stratigraphy, volcanic deposits, intrusive igneous rocks, basement metamorphics, and raised Recent coral reefs are discussed. (W.M.)

02-a-20 STANLEY, E. R., 1921b — A contribution to the geology of New Guinea. *Papua Bull.* 7, 15 pp.

The main geomorphic feature of New Guinea is the Owen Stanley Ra., from which foothill ranges fall to the coast and numerous large rivers drain. The flat coastal strip is much wider in the south than in the north. The islands off the east coast are mountainous and represent a drowned continuation of the Owen Stanley Ra. The stratigraphy is tabulated.

The 100-fathom (180m) line is taken as the edge of the continental mass, and a link with Australia is shown. Tectonic trend-lines are traced north from Australia into the delta area of western Papua, where they are lost under Recent sediment and abut along the centre of the island against the main trend, named the First Australian Arc, which can be traced east into the Asian islands. One branch includes the Finisterre Ra.-New Britain chain, and another includes Hydrographers Ra.-C. Nelson-D'Entrecasteaux Is-Misima I. A subsidiary Papuan Arc is recognized in the lineament containing D'Entrecasteaux Reefs-Lusancay Is and Reefs-Trobriand Is-Egum and Tokuna Groups-Laughlan Is. The Second Australian Arc contains New Ireland-Solomon Is-Santa Cruz-New Zealand, and the Third Australian Arc passes through the Ladrones-Carolinas-Marshall-Gilbert and Ellice-Fiji. Two eastward-younging volcanic areas are recognized: on the New Britain-Madang line, and through the Papuan islands, Mt Victory, and Mt Lamington. (W.M.)

02-a-21 STANLEY, G. A. V., 1958 — Geology of the Island of New Guinea. *Aust. Mus. Mag.*, 12, 380-3

New Guinea forms the northern margin of the Australian continent, part of which is covered by a shallow sea — the Arafura Sea, Torres Str., and along the south coast of Papua to include much of the Solomon Sea. Relief ranges up to 4730 m in West Irian, and many mountain ranges are deeply dissected.

Palaeozoic metamorphic rocks intruded by acid and intermediate igneous bodies are known in West Irian, and the oldest rocks in eastern New Guinea are recrystallized Permian limestone near Mt Hagen. Mesozoic rocks appear as thick continuous sedimentary successions or as fault wedges of metamorphics. Most of the island is composed of Tertiary and younger sediments and volcanics. Numerous active or recently-extinct volcanoes are preserved, some with glaciated summits.

The economic mineral potential of the island may depend on petroleum, gas, gold, bauxite, nickel, manganese, monazite, and copper. (W.M.)

02-a-22 TERMIER, H., & TERMIER, G., 1956 — TRAITE DE GEOLOGIE: L'EVOLUTION DE LA LITHOSPHERE, II OROGENESE — FASCICULE I: ATLAS DE GEOLOGIE STRUCTURALE (in French). *Paris, Masson,* 498 pp.

The development of the Papuan Arc is traced as part of the geological evolution of the Australasian region. The arc extends from New Guinea through New Caledonia to New Zealand, and has been active since Mid-Palaeozoic. The oldest strata known in New Guinea are Permian marine sediments; the metamorphics of the main cordillera may be Upper Jurassic to Cretaceous. Most intrusives are thought to have been emplaced during the lower Miocene, and volcanism has been the main activity since mid-Pliocene. The island is still tectonically active.

02-a-23 THOMPSON, J. E., 1956 — Geology in the Territory of Papua-New Guinea. *Proc. 8th Pacif. Sci. Cong., Manilla,* 2, 273-7.

The history of geological investigation of Papua New Guinea is outlined, including references to tectonics, stratigraphy, and economic geology. (W.M.)

02-a-24 THOMPSON, J. E., 1967a — A geological history of eastern New Guinea. *APEA J.,* 7(2), 83-93.

The first part of the paper records an interpreted sequence of geological, tectonic, magmatic, and depositional processes which together have built up the present geological structure of New Guinea. The second part deals specifically with stratigraphic aspects of geological history, and is supported by references to sources of information. Generalized palaeogeographic maps are presented, and schematic diagrams trace the tectonic evolution of the Papuan Basin and eastern Papua. (Auth./W.M.)

02-a-25 TROTTER, C., 1883a — On New Guinea: a sketch of the physical geography, natural resources and character of the inhabitants. *Proc. Roy. geogr. Soc.,* 5 (n.s.), 670-2.

A land connexion with Australia as recently as lower Miocene is postulated on the evidence of marine fossils and amphibia. The principal features of the western Papua coastal plains and Torres Str. are outlined, and comments made on the geology of the Owen Stanley Ra. of eastern Papua and the ranges near C. Vogel. (W.M.)

02-a-26 TROTTER, C., 1883b — Some account of New Guinea. *Sci. Mthly,* Dec., 36-9.

This summaries part of entry 02-a-25.

02-a-27 TROTTER, C., 1884a — New Guinea: a summary of our present knowledge with regard to the island. *Proc. Roy. geogr. Soc.,* 6 (n.s.), 196-216.

The discovery of New Guinea by Antonio de Abreu in 1511, and its early exploration by Portuguese and Spanish navigators and expeditions are outlined. Comments are made on the work of D'Urville, recent exploration in Dutch New Guinea, exploration of the interior, and the geological and physiographic affinities with Australia since the early Tertiary. The geology, seismic activity, and volcanology of the island are mentioned. (W.M.)

02-a-28 TROTTER, C., 1884b — On New Guinea: a sketch of the physical geography, natural resources and character of its inhabitants. *Brit. Ass. Adv. Sci., Rep. for 1883,* Sec. E, 595-7.

Essentially the same as entry 02-a-25.

02-a-29 TROTTER, C., 1884c — Some account of New Guinea. *Sci. Mthly,* Jan., 69-72.

This summarizes part of entry 02-a-28.

02-a-30 WALLACE, A. R. (Ed.), 1883a — New Guinea and the Papuans. *In* STANFORDS COMPENDIUM OF GEOGRAPHY AND TRAVEL: AUSTRALASIA. *London, Stanford,* 434-64.

This is one of the earliest general summaries and statements on New Guinea. A large low plateau is thought to lie between two major ranges, and a large deltaic plain south of the main range. The central range of eastern New Guinea may be separated from that in Dutch New Guinea by the Fly R. headwaters valley. Most of the island is composed of sedimentary rocks and fringed with coral limestone covered with auriferous quartz sand. Many stack islands are formed of horizontal sandstone. The soil is rich, though there are no volcanoes on the mainland.

(Most of this information was subsequently found to be incorrect.) (W.M.)

(b) PAPUA

See also entries

01-a-10	04-i-7	12-a-21	12-e-28
01-a-17	05-a-22	12-a-44	12-h-4
01-a-26	05-a-60	12-b-25	12-i-87
01-a-34	05-b-27	12-b-40	13-b-45
01-b-19	05-d-37	12-b-73	13-e-1
01-b-21	06-a-2	12-b-87	14-a-48
01-b-55	06-a-8	12-b-94	14-c-7
02-a-13	06-a-10	12-c-59	16-a-3
03-c-4	06-b-1	12-c-64	17-b-19
03-c-5	07-a-23	12-d-1	
03-e-20	08-b-16	12-d-2	
04-g-8	10-b-1	12-d-4	

02-b-1 ANONYMOUS, 1889b — Explorations in south-eastern New Guinea. *Proc. Roy. geogr. Soc.,* 11 (n.s.), 504.

This summarizes entry 02-b-89.

02-b-2 ANONYMOUS, 1889c — Successful ascent of the Owen Stanley Range, New Guinea. *Proc. Roy. geogr. Soc. Aust., Qld Br.,* 4, 70-2.

In reporting the ascent of the Owen Stanley Ra., Macgregor (entry 05-a-108) gave the following peak heights: Mt Victoria 4000 m, Mt Knutsford 3502 m, Mt Douglas 3595 m, Mt Winterheight 3622 m, Mt Albert Edward South Dome 3810 m, Mt Scratchley 3660 m, Mt Gilles 2440 m and Mt Parkes 2440 m. The rugged Owen Stanley Ra. is composed of slate, granite, and quartz and mica schist. (W.M.)

02-b-3 ANONYMOUS, 1890b — Some scientific results of Sir William Magregor's recent expedition to the Owen Stanley Range. *Proc. Roy. geogr. Soc.,* 12 (n.s.) 616-8.

Scientific results of an expedition led by Macgregor (entry 05-a-108) are summarized. Geological samples collected from the Vanapa R. were identified by Rands (entry 02-b-141) and include sandstone, slate, and schists, many of which are auriferous. (W.M.)

02-b-4 ANONYMOUS, 1891c — (No title) *Nature,* 45, 209.

This notes the identification of a suite of sedimentary and volcanic rocks from the Fly R. by Jack (entry 08-b-4) and a collection of sediments and volcanics from several localities by Maitland (entry 02-b-108). (W.M.)

02-b-5 ANONYMOUS, 1892b — Visits to Buhutu and Wari tribes, British New Guinea. *Proc. Roy. geogr. Soc.,* 14 (n.s.), 414-5.

The Kaisabel Ra. rises to 250 m at Cloudy Mt (Mt Gugusara), and is composed of raised limestone and lava, previously recorded as basaltic lavas. Beaches west of Orangerie Bay are composed of dense basaltic shingle. Some of the data in entry 02-b-91 are recorded. (W.M.)

02-b-6 ANONYMOUS, 1892d — Further explorations in British New Guinea. *Proc. Roy. geogr. Soc.*, 14 (n.s.), 863.

Some of Macgregor's tour reports are noted, including one to Rossel I. (entry 05-d-32), and to villages in the Kemp Welch area where the agricultural potential of nearby limestone hills is mentioned. (W.M.)

02-b-7 ANONYMOUS, 1897c — Sir William Macgregor's journey across New Guinea. *Geogr. J.*, 9, 449-50.

Macgregor's report (entry 02-b-105) of his crossing of New Guinea from Mambare Bay to the mouth of the Vanapa R. is abstracted. (W.M.)

02-b-8 ANONYMOUS, 1897d — British New Guinea. *Scott. geogr. Mag.*, 13, 44.

A telegram reporting the crossing of Papua from the Mambare Bay via Mt Scratchley and Mt Victoria to the mouth of the Vanapa R. by Macgregor (entry 02-b-105) is quoted; the main mountain chain is composed of low-grade metamorphics intruded by vein quartz, much of which is auriferous. (W.M.)

02-b-9 ANONYMOUS, 1898a — Sir William Macgregor's explorations on the north coast of New Guinea. *Geogr. J.*, 12, 318.

Gold is abundant in stream sediments in the Mambare and Gira Rs; rapids and steep sandstone cliffs turned the party back (entry 02-b-107). (W.M.)

02-b-10 ANONYMOUS, 1938a — Papuan geology suggests good potentialities. *World Petrol.*, 9, 45.

Examination of the Apinaipi-Oiapu structures suggests a reasonable petroleum potential. In the Oiapu anticline, Miocene mudstone and calcareous sandstone were revealed by drilling and oil and gas traces encountered. (W.M.)

02-b-11 ANONYMOUS, 1939 — New Guinea oil search to be intensified. *World Petrol.*, 10, 23-5.

Drilling sites were established in Dutch New Guinea near the Vogelkop, and in Papua at Oiapu and Apinaipi. Several shallow stratigraphic holes in the Oiapu-Apinaipi area, drilled by Papuan Apinaipi Petroleum Co., penetrated marine mudstone and strand-line sandstone and encountered traces of petroleum. (W.M.)

02-b-12 ARCHBOLD, R., & RAND, A. L., 1935 — Results of the Archbold Expeditions. No. 7 — Summary of the 1933-1934 Papuan Expedition. *Amer. Mus. nat. Hist. Bull.*, 68, 527-79.

Mt Albert Edward was ascended from the south, after a traverse from Yule I. along the Dilava R. to Murray Pass in the Wharton Ra. at the head of the Chirima R. The Dilava R. flows swiftly in a narrow boulder-strewn stream bed, and many spurs are scarred by land-slips. In the Agua R. near Mafulu terraces on the ridges pass upstream into bare limestone rock faces. There are extensive swampy flats on Wharton Ra. summit plateau, and bare outcrops of schist on the summit of Mt Albert Edward. (W.M.)

02-b-13 ARMIT, W. E., 1901b — Diary of a trip to the Yodda Valley, undertaken for the purpose of discovering a practicable road to the new diggings, and of laying out the prospecting claim at Blazed Tree Creek. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. R, 87-94.

Slate crops out on the eastern face of Mt Nisbett, and rich dark black-brown soils occur on its lower slopes near the Kumusi R. The report is mainly a daily log of traverses in the Kumusi and Mambare Rs headwaters area. (W.M.)

02-b-14 ARMIT, W. E., 1901c — Report on the new road from Tamata to Yodda Valley, on the Yodda Goldfield, and on the natives inhabiting the Kumusi and Yodda Valley. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. S, 96-8.

The route is up the Mambare R. to the Yodda (upper reaches of the Mambare

R.), and across a low divide (near the present site of Kokoda) into the valley of the Kumusi R. The lower reaches of the Mambare R. pass through diorite, shedding gold in a pebbly wash. Farther upstream diorite passes to slate and schist veined with auriferous and barren quartz. These crop out on Mt Nisbett and Mt Bellamy, and wash is carried into the Mambare by fast-flowing streams on the flanks. The abundance of gold in the Yodda is due partly to re-cycling of prior alluvial concentrations in the valley of the Chirima R., where deep leads may occur. Gold reefs are known on Mt Scratchley and could be found on Mts Bellamy and Morehead. Pay results from several alluvial claims in the Yodda are quoted, and the extent of the field estimated as at least 2.5 km^2. A goldfield should be proclaimed in the Yodda area. (W.M.)

02-b-15 ATKINSON, O. J., 1928 — Divisional report — Baniara, North-Eastern Division. *Papua ann. Rep. for 1926-27*, 50-2 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28*, 2, 2320-2.

A shallow (55 m) oil exploration well drilling in the Kukuia Anticline in the C. Vogel area penetrated sandy fossiliferous shale, calcareous shale with interbedded limestone and fossiliferous shale. Shows of gas and oil were met in the upper 45 m. (W.M.)

02-b-16 AUSTEN, L., 1925 — Report of a patrol from Wukpit camp (Tedi River) to Star Mountains. *Papua ann. Rep. for 1922-23*, App. III, 27-37 (also issued as *Aust. parl. Pap. 3, Sess. 1925*, 2, 2589-99).

Descriptions are given of the course of the Fly and Tedi Rs, and of the country at the head of the Tedi, which has numerous islands and rapids in its upper reaches. The headwater country is rugged and dissected, becoming more precipitous towards the main part of the Star Mts. Sandstone, fossiliferous mudstone, and limestone are reported from the upper reaches of the Tedi, and northwest of the Ok Tedi-Ok Mart junction. (W.M.)

02-b-17 AUSTEN, L., 1926a — Geological specimens from the North-west District of Papua. *Papua ann. Rep. for 1924-25*, 11 (also issued as *Aust. parl. Pap. 41, Sess. 1926-28*, 2, 2075).

Sediments and fossils collected from northwestern Papua include sandstone, mudstone, conglomerate, and limestone, with many marine shelly fossils and microfossils. (W.M.)

02-b-18 AUSTRALASIAN PETROLEUM COMPANY, 1961a — Geological results of petroleum exploration in Western Papua, 1937-1961. *J. geol. Soc. Aust.*, 8, 1-133.

Stratigraphic details from surficial mapping and drilling in western Papua are listed. Strata range from pre-Mesozoic crystalline basement to Quaternary sediments. Palaeontological data, structural synthesis, and petroleum potential are discussed. (W.M.)

02-b-19 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1956 — Annual report — mining and geology. *Papua ann. Rep. for 1955-56*, 42-4 and 131 (also issued as *Aust. parl. Pap. 65, Sess. 1956-58*, 5, 449-51 and 538).

In the middle reaches of the Brown and Goldie Rs near Port Moresby are complexly-folded regionally metamorphosed sediments interbedded with volcanics. The absence of plutonic basic rocks, present in the adjacent Astrolabe mineral field, reduces prospects of finding copper mineralization. Good aquifers were found near Port Moresby in Tertiary volcanics under a thin alluvial cover. Limited tests indicate that salinity decreases from the trough towards the valley flanks.

There was unusual seismic activity near Dobu Passage off Normanby I. A show of gas was met in Kuru No. 1 bore. Annual production figures for gold, silver, platinum, copper ore, and manganese ore for each of the preceding 5 years are given. (W.M.)

02-b-20 BAR, C. B., CORTEL, H. J., & ESCHER, A. E., 1961 — Geological results of the Star Mountains (Sterrengebergte) Expedition. *Nova Guinea*, 10 (n.s.), (4), 39-99.

An expedition to the Star Mts traversed along the range into Papua New Guinea in the Telefomin-upper Fly R. area. Some field work was done in northwest Papua, and photo-interpretations extended geomorphic zones into southwestern Papua. Mt Arem and Mt Isil in western Papua are late Pleistocene andesitic volcanic centres, their products mantling late Miocene-early Pliocene marine clastic sediments and limestone. Much of the southern foothills are mapped as Pleistocene conglomerates and tuffaceous clastic marine sediments of the Birim Formation. (W.M.)

02-b-21 BARTON, F. R., 1902a — Report of patrol made in the Central District in October and November 1900. *Brit. N. Guinea Ann. rep. for 1900-01,* App. T, 89-94.

In the upper reaches of the Kemp Welch R. system conglomerate crops out in several precipitous narrow ridges. The deep red soils may indicate abundant iron, and west of Pyramid Hill magnetic compasses are reported not to have functioned normally. (W.M.)

02-b-22 BEAVER, W. N., 1920 — UNEXPLORED NEW GUINEA. *London, Seeley Service,* 320 pp.

The alluvials in Strachan I. in western Papua are reputed to contain gold, but this is probably pyrite or mica. Daru is a low island composed of sandstone with some lignite, overlain by alluvials and with abundant scree of ironstone. (W.M.)

02-b-23 BELL, L. L., 1909 — Account of a patrol in Rossel Island. *Papua ann. Rep. for 1908-09,* App. D, 103-9 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2055-61).

The presence of diorite on the southeast fall of the main hills is reported. (W.M.)

02-b-24 BELL, L. L., 1911 — Exploring in Papua. *Vic. geogr. J.,* 28, 31-63.

In 1910 an expedition explored the upper reaches of the Kikori R. and some country farther north from which coal had been reported. Areas of undulating hills on sedimentary rocks and limestone are recorded. Mt Murray appears to comprise a series of terraced limestones. Large areas of dissected limestone are exposed in a wide plateau west to Mt Murray, and some karst-type topography is developed. In the upper reaches of the Kikori R. coal was found in seams and boulders, some tributaries from ranges in the north contain basaltic debris, and small intrusive basaltic bodies puncture the plateau limestone. (W.M.)

02-b-25 BRASS, L. J., 1956 — Results of the Archbold Expeditions: No. 75 — Summary of the fourth Archbold Expedition to New Guinea (1953). *Amer. Mus. nat. Hist. Bull.* 111, 79-152.

The expedition covered the Kuagira R. valley north from Mt Dayman, the Baniara district on the north shore of Goodenough Bay, and Goodenough I. Streams in the Goropu Mts and around Mt Dayman cross an alluviated intramontane basin before cutting through coastal ranges. In the basin streams are incised, straight, swift, and heavily loaded with sediment. The Gwariu R. runs through boulder-bed deposits of waterworn igneous material with little sandy matrix; rock types include diorite, gabbro, reef quartz, schist, chert, phyllite, and tuff. They are interpreted as Recent sheet-flood deposits formed after land-slip barriers were breached at or behind gorges or defiles cut into basement outcrops found farther upstream. Outcrops of shale and phyllite on the lower northern slopes of Mt Dayman suggest it is not a volcanic cone as had been thought. Pleistocene limestone occurs near Baniara, and tuffaceous greywacke of unknown age crops out near Moi Biri Bay on the south coast of Collingwood Bay. (W.M.)

02-b-26 BRASS, L. J., 1959 — Results of the Archbold Expeditions: No. 79 — Summary of the fifth Archbold Expedition to New Guinea (1956-1957). *Amer. Mus. nat. Hist. Bull.* 118, 1-70.

The expedition operated in the D'Entrecasteaux Group, on Misima, Sudest and Rossel Is in the Louisiade Arch., and on Woodlark I. Collecting visits were made to Milne Bay and to Kiriwina in the Trobriand Is. Most islands in the D'Entrecasteaux and Louisiade groups consist largely of metamorphic rocks intruded by plutonics and dykes of granite, gabbro, syenodiorite and related porphyries. Slate crops out on Sudest and Rossel, and Pleistocene volcanics make up much of the D'Entrecasteaux, Misima, and Woodlark Is. Pleistocene limestones form the Trobriand Is and crop out extensively on Woodlark. Terraced limestones on the south coast of Misima are up to 300 m thick and indicate at least five distinct elevations in Cainozoic time. Fringing barrier reefs encircle Rossel I. and the entire Calvados Chain. Comments about the various collecting sites include details about the geology and landforms of individual islands.

The Vogel Syncline may be coterminous with the intermontane trough of the Ramu and Markham Rs and may extend eastward into the deep between Misima in the north and the Calvados Chain including Rossel and Sudest in the south. Most eustatic tectonism started in the late Tertiary and culminated during the Pliocene or early Pleistocene.

02-b-27 Brown, L. N., 1925b — The island of Misima. *Papua ann. Rep. for 1922-23,* App. II, Pt VI, 21-2 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2583-4).

Misima is mostly coral, in places associated with granite, basalt, conglomerate, and sandstone. Terraced shelving ridges along the coast indicate several phases of volcanic uplift. Gold has been worked on Mt Sisa. (W.M.)

02-b-28 Cawley, F. R., 1925a — Delta Division. *Papua ann. Rep. for 1923-24,* 18-9 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2645-6).

In the foothills of the Purari R. system are low undulose ridges on mudstone and siltstone, and abundant coal float in some streams. In one unlocated stream coal outcrops are up to 12 m wide. (W.M.)

02-b-29 Cawley, F. R., 1925b — The upper Waria River District, with notes on the Mawai, Bali, Owasupu and Yewa tribes. *Papua ann. Rep. for 1922-3,* 25-7 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2586-8).

The country through which the Waria R. flows into Huon G. is deeply dissected and mostly of supposed volcanic origin. Diorite, basalt, and granite are recorded, and alluvial gold has been won from the lower reaches of the river. (W.M.)

02-b-30 Champion, I. F., 1941 — Territory of Papua — Lake Kutubu police camp: report of patrol made to Mubi, Erave, Iaro, Kagua, Akuru, Nembi and Wage valleys. *Papua ann. Rep. for 1939-40,* App. 29-37 (also issued as *Aust. parl. Pap. 35, Sess. 1941,* 2, 1356-64).

Most of the country near the headwaters of the Purari and Kikori Rs is rugged limestone or plateau swamp. (Auth./W.M.)

02-b-31 Chance, S. H., 1927 — A short description of the upper Era River district of the Kikori Division. *Papua ann. Rep. for 1925-26,* App. VIII, 98 (also issued as *Aust. parl. Pap. 100, Sess. 1926-28,* 2, 2144).

The Iowa and Era Rs are described and several outcrops of limestone noted on the accompanying map. (W.M.)

02-b-32 Chinnery, E. W. P., 1918 — Report on patrol in Mt Yule district. *Papua ann. Rep. for 1916-17,* App. C, 50-68 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1490-1508).

Black sericite schist with colours of pyrite and graphite is the most abundant rock collected from the Mt Yule area. Other metamorphics include quartz-biotite gneiss, chlorite-mica and mica-hornblende schists, and calcite-veined limestone. Igneous samples include leuco-diorite and granodiorite, both with some pyrite. A volcanic agglomerate of trachytic or rhyolitic affinities was identified and several minerals of no economic potential recorded. (W.M.)

02-b-33 Clunas, A., 1899a — Report on traverse inland from Clarkes Fort, lower Mambare River. *Brit. N. Guinea ann. Rep. for 1897-98,* Addendum to App. F, 50.

The north and northeast foothill slopes of Mt Parkes are formed of granite and sandstone. (W.M.)

02-b-34 CLUNAS, A., 1899b — Report of expedition undertaken by Messrs Clunas and party from Clarkes Fort to the Yodda Valley, via Kumusi Valley. *Brit. N. Guinea ann. Rep. for 1897-98,* Encl. 3 in App. F, 53-4.

The lower reaches of Opi R. and its tributaries contain debris of granite, sandstone, and quartz. The eastern slopes of Mt Parkes are dissected hills of granite and sandstone and the same rock types crop out on its north and northeast foothills. Colours of gold were found in most streams, including the Kumusi R. south of Mt Parkes, and the Yodda (Mambare) R. west of Mt Parkes (W.M.)

02-b-35 CUTHBERTSON, W. R., 1887 — Explorations of the Highlands of south-eastern British New Guinea. *Trans. Proc. Roy. geogr. Soc. Aust., Vic. Br.,* 5(2), 7-43.

The country for some 27 km inland from Kappa Kappa (about 50 km southeast of Port Moresby) to Mt Douglas is gentle rolling hills of limestone. North and east of Mt Douglas granite and slate continue to the main range. Mt Obree was approached from the valley of the Margaret R., in which rock debris includes granite, slate, vein quartz, and pyrite. The Kemp Welch R. and its headwater hills are described. (W.M.)

02-b-36 DAVIES, H. L., 1965a — Papuan basic belt, *38th ANZAAS Cong., Hobart,* Sec. C Abs. (listed by title in *Aust. J. Sci.,* 28, 312).

The Papuan Basic Belt, about 400 km long and up to 40 km wide, forms a chain of mountain ranges northeast of the Owen Stanley Ra. between Salamaua and the Musa R. It may be a fault-emplaced segment of suboceanic mantle. Ultramafic and gabbroic rocks are present in the approximate proportions 40 : 60 but are not organized into any order except that the ultramafic rocks generally crop out on the inland (southwest) side of the Belt. Cumulative textures such as layering are rare and have random orientation. Contacts with the surrounding volcanic and metamorphic rocks are faulted or concealed. In recent time movement on the Owen Stanley Fault on the southwestern margin has been about 5000 m in a left lateral sense and 2000-5000 m vertically. (Auth.)

02-b-37 DAVIES, H. L., 1969 — Oceanic mantle and crust exposed in eastern Papua. *Trans. Amer. geophys. Un.,* 50, 464.

In the Eocene or Oligocene a slab of oceanic crust and upper mantle about 400 km long and 30 km thick moved west or southwest over a linear trough of Cretaceous sialic sediments now forming the sialic core of eastern Papua. Late Tertiary uplift of the sialic core tilted the oceanic slab to expose basal ultramafics overlain by 5-10 km of gabbro, overlain in turn by 5-10 km of Cretaceous tholeiitic basalt and minor andesite. Eocene quartz diorite intrudes at the gabbro-basalt interface. These rocks make up the Papuan Ultramafic Belt. They are alkali-poor and rarely contain any potash feldspar or mica. The sialic core is about 900 km long, 60 km wide, and up to 40 km thick, and consists of phyllite, schist, and gneiss, with granitic intrusives. The parent sediments of the core may have been shed from the Australian continent or have developed in situ by repeated volcanic fractionation of oceanic mantle. (Auth.)

02-b-38 DAVIES, H. L., & IVES, D. J., 1965 — The geology of Fergusson and Goodenough Islands, Papua. *Bur. Miner. Resour. Aust. Rep.* 82, 65 pp.

Goodenough I. has a 2500-m range, the 'Goodenough Block', and Fergusson I. two 1800-m ranges, the 'Mailolo Block' and the 'Oiatabu-Morima Arc'. The Goodenough Block consists of metamorphic rocks with a granodiorite core; the Mailolo Block is the northern half of a dome of metamorphics; the Oiatabu-Morima Arc is a remnant of the southeastern half of a dome of metamorphics with a granodiorite core. Ultramafic rocks occur within the metamorphic rocks and on some of the marginal faults, and volcanic rocks also occur on some of the marginal faults. The metamorphic rocks are at least 2000 m thick, and consist of quartz-feldspathic gneiss and minor schist, amphibolite, and calcareous gneiss. The ultramafic rocks are highly magnesian dunite, harzburgite, and pyroxenite; they are partly or completely serpentinized, and sometimes opalized and carbonated. The granodioritic rocks vary locally to trondhjemite and adamellite, and even to granite. Metasomatized gabbro occurs as inliers within the granodiorite. There are volcanic cones on southeastern Fergusson I. (Lamonai and Oiau) and on Dobu I., and small cones on Goodenough I.

The postulated geological history is: 1. Deposition of at least 2000 m of sediments; 2. Regional metamorphism by deep burial; 3. Emplacement of ultramafic and gabbroic rocks, perhaps contemporaneously; 4. Emplacement of medium to high-level plutons of granodiorite resulting in a) local doming of the metamorphics, and b) faulting on the dome margins; 5. Elevation of the domes of metamorphics, probably in Quaternary time, by movement on the marginal faults; 6. Volcanism; 7. Partial dissection of the domes by trans-current faulting and erosion; continuing volcanism.

Pumice in Oiau and Dobu cones may be of economic interest; there is an estimated 10 million tonnes of pumice on Oiau. Bauxite may occur on Sanaroa and southeastern Fergusson I. (Auth.)

02-b-39 DOUGLAS, J., 1888 — Notes on a recent cruise through the Louisiade Group of Islands. *Trans. Proc., Roy. geogr. Soc. Aust., Vic. Br.*, 5, 46-59.

The Louisiade Group consists of the islands east of Booker (Utian) I. at the western end of the Calvados Chain. On Sudest (Tagula), vein quartz cutting through low-grade metamorphics west of Mt Rattlesnake (Mt Rui) contains no gold. Extensive barrier and fringing reef shoals are developed around Sudest, on the south coast of Rossel, and on the southeast point of Misima. The Conflict Group is a lagoon surrounded by about twelve islands, with good channels at the east and west ends of the lagoon. (W.M.)

02-b-40 EDELFELT, E. G., 1886 — Notes on New Guinea. *Proc. Roy. geogr. Soc. Aust., Qld Br.*, 2(1), 17-26.

Strata cropping out in the Maiva area near Yule I. include 'slate and ironstone' hills up to 200 m high. (W.M.)

02-b-41 ENGLISH, A. C., 1898 — Report by Government Agent for Rigo subdistrict on expedition to eastern slopes of Mount Potter. *Brit. N. Guinea ann. Rep. for 1897-89*. App. U, 115-7.

Limestone underlies rolling hills in a small area around Rigo. The bed of the Jawarere R. at its junction with the Kemp Welch contains slate, quartz, and granite. (W.M.)

02-b-42 ENGLISH, A. C., 1907 — Report of the Warden of the Keveri Goldfield for year 1905-6. *Brit. N. Guinea ann. Rep. for 1905-06*, 72.

Samples from the Keveri R. included concretionary crystalline pyrite, calcareous conglomerate, altered and sheared diorite, feldspathic sandstone, mudstone, peaty plant material, and fresh microdiorite. Another sample carried about 4 g gold and 10 g silver per tonne. Gold was produced from a gully which needs blasting to allow access to alluvial concentrations; about 16 kg were won in the year. (W.M.)

02-b-43 ETHELL, A. L., 1946 — Across Papua's mighty delta. *Qld geogr. J.*, 50, 65-83.

The relief and features of the Kikori-Samberigi Valley-Mt Murray-L. Tebera-Purari R. area include deep narrow gorges cut through limestones by Iehe and Isegi Crs, and numerous ridges and peaks of limestone. Most place names do not appear on present maps. (W.M.)

02-b-44 FORBES, H. O., 1886 — North-east coast — memo by Mr H. O. Forbes. *In* FORT, G. S.: Report on British New Guinea from data and notes by the late Sir Peter Scratchley, Her Majesty's Special Commissioner. *Qld parl. Pap.* 36.

The eastern south coast of Goodenough Bay rises to steep hills and passes westward to dissected hills thought to be sandstone. Farther west it passes into rolling hills in which the strata dip inland. Exposed strata include argillaceous sandstone becoming coarser up the succession. (W.M.)

02-b-45 FORBES, H. O., 1888a — Expedition to the eastern slopes of Mt Owen Stanley. *Brit. N. Guinea ann. Rep. for 1887 (Qld)*, App. F, 28-33.

The upper reaches of the Goldie R. contain abundant slate, porphyry, and granite, and some agglomerate was seen in the Astrolabe Ra. (W.M.)

02-b-46 FORBES, H. O., 1888b — On attempts to reach the Owen Stanley peak. *Scott. geogr. Mag.*, 4, 401-15.

Several sharp hills of possible volcanic origin stud the rolling plains east of Port Moresby. Farther east the Astrolabe Ra. rises precipitously to 400 m and is composed of conglomerate of both angular and rounded material dipping gently northeast. Most clasts in the conglomerate are volcanic, but its extent and bedding, as well as elongate cavities from which tree trunks are thought to have been weathered, suggest a sedimentary rather than a pyroclastic origin. Large blocks of conglomerate litter the floor of the Laloki R. downstream from Laloki (Rouna) Falls. They crop out in the Richardson Ra. (? east of Jawarere), with underlying soft black slate exposed in the Crombie (Musgrave) R. Conglomerate cliffs in the upper reaches of the Goldie R. form the high country and some basalt is exposed in creek beds. Porphyritic and granitic material occur in stream float. (W.M.)

02-b-47 GARDNER, J. V., 1970 — Submarine geology of the Western Coral Sea. *Bull. geol. Soc. Amer.*, 81, 2599-614.

The Coral Sea Basin was probably formed by late Eocene-early Oligocene rotational spreading accompanied by large-scale subsidence of the margins. An early Miocene erosional unconformity previously identified on seismic reflection records, across the marginal Queensland Plateau, represents the first marine transgression onto the basin margin. Subsidence continued, accompanied by faulting which subdivided the margin into four plateaux, generally bounded by one or more of the four submarine troughs. Subsidence rates average 17-24 cm/1000 yrs for the Coral Sea Basin since lower Miocene time. Thick terrigenous turbidite sequences derived from New Guinea were deposited in the basin during the last glacial stage, but mainly calcareous pelagic sediments have accumulated since then. Holocene pelagic sedimentation rates are 3.6 cm/1000 yrs, whereas glacial Pleistocene rates are higher by at least a factor of four. (Auth.)

02-b-48 GILLESPIE, A., 1921a — General report for January, 1921. *In* ANGLO-PERSIAN OIL COMPANY—Oilfields in Papua: reports of operations of the Anglo-Persian Oil Company during January and February 1921. *Aust. parl. Pap. 104, Sess. 1920-21,* 3, 2018.

The Aipa-Ie Hills area was explored, and preparation made to drill at Popo. (W.M.)

02-b-49 GLAESSNER, M. F., 1952a — Geology of Port Moresby, Papua. *Univ. Adel., Mawson Anniv. Vol.*, 63-86.

The following litho-stratigraphic units are introduced: *Bogoro Limestone* (Upper Cretaceous), up to 90 m thick, mostly sheared pink limestone and calcareous shale, with upper Senonian forams (listed); *Barune Sandstone* (Upper Cretaceous), up to 30 m of calcareous sandstone containing Upper Senonian forams (partly listed) and microfaunal debris, and thought to represent the shoreward sandy facies of the Bogoro Limestone; *Port Moresby Group* (Eocene; fauna listed), a deep-water eastern facies of nummulitic limestone, siltstone, chert, and cherty argillite and a shallower-water western facies containing chert, siltstone, marl, and limestone; *Dokuna Tuff and Agglomerate* (middle Oligocene), 600 m + (est.), basaltic tuff and agglomerate which may contain derived boulders of older fossiliferous limestone, and with occasional horizons of limestone containing larger forams (partly listed); *Boira Tuff and Limestone* (upper Oligocene), foraminiferal basaltic tuff and limestone; *Siro Beds* (lower Miocene), fluviatile sandy and conglomeratic beds containing detritus mainly of crystalline igneous and metamorphic rocks; *Astrolabe Agglomerates and Tuffs* (Pliocene), mentioned only briefly; Pleistocene and Recent coralline reefs, talus deposits, and swamp and beach deposits. Intrusive igneous rocks include pods of early Oligocene serpentinite near Port Moresby, and Oligocene gabbroic rocks farther east.

A series of northwest-trending reverse faults and asymmetric isoclinal folds in pre-Pliocene strata are mapped and discussed, and an outlined palaeogeographic reconstruction is included. (W.M.)

02-b-50 GRAY, W. M., 1930b — Report on properties of the Oriomo Oil Limited. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.,* 2, 7-16.

The properties cover about 2600 km^2 on the mainland near Daru. Stratigraphic subdivision is based on outcrops and bore core data. The *Imbi Group,* 15-30 m of Pliocene marine sand, clay, silt, and detrital fossiliferous limestone, covers most of the area but crops out rarely. Some strata are tuffaceous, and lateral facies variation indicates a southwest shallowing of the shallow sea. The *Oriomo Limestone,* 430 m of fossiliferous limestone, has three fossil zones. In several bores, it apparently rests conformably on detrital ferruginous sandstone of an Upper Cretaceous unit (? Desert Sandstone).

A broad gentle anticlinal flexure trends east-west and probably plunges gently eastward. Bore core samples and supposed surficial indications of petroleum are discussed, but commercial petroleum accumulations are unlikely. (W.M.)

02-b-51 GRAY, W., & BOURCHIER, J. R., 1921 — Geological survey of Kira-Ie Hills district, Papua: Progress report for the month ending 8th February, 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua — Report of operations of the Anglo-Persian Oil Company during January and February, 1921. *Aust. parl. Pap. 104, Sess. 1920-21,* Vol. 3, 2019-20.

Petroliferous strata, considerably disturbed, were mapped near Ie Inlet and Aipa Hills. (W.M.)

02-b-52 GRAY, W., & BOURCHIER, J. R., 1920a — Honoro area, Gulf Division. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.,* 1, 44-51.

Strata west of the mouth of the Vailala R. are grouped into four units: (i) *Upper Sandstone Group,* 420 m of upper Miocene sandstone, coarse sandstone, conglomerate, and calcareous sandstone with interbeds of subequal amounts of mudstone. There is a coal seam near the base, and several lignite seams in the sequence. Fossils are present in the mudstone and coarser sandstone. (ii) *Upper Mudstone Group,* about 300 m of upper Miocene mudstone, sandy mudstone, and some fine sandstone and calcareous mudstone. Fossils are abundant. (iii) *Sandy Mudstone Group,* about 400 m of upper Miocene fine sandstone and sandy mudstone with interbeds of mudstone and calcareous mudstone. Lateral facies variation is marked. (iv) *Lower Mudstone Group,* 150-300 m of exposed middle Miocene massive mudstone, ferruginous mudstone, ferruginous sandy mudstone, and sandstone. Many mudstones are mobile, plastic, and veined with carbonate. Correlation of these strata with the successions at Upoia and Aipa are discussed.

The strata are exposed in an asymmetric anticline plunging southeast with its steep limb to the southwest and cut by numerous faults. (W.M.)

02-b-53 GRAY, W., & BOURCHIER, J. R., 1930b — Kira-Hahi area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 52-6.

East of the mouth of the Vailala R. the poorly exposed strata include rocks suggesting equivalence with Miocene beds west of the river. The structure is a disrupted broad east-west monoclinal flexure with beds dipping northeast. It may represent one flank of a west-plunging anticlinal fold with a hinge south of the exposures. Several 'gas blows' and mud volcanoes are recorded, but further investigation is not recommended. (W.M.)

02-b-54 GRAY, W., & BOURCHIER, J. R., 1930c — Aipa Hills area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 57-65.

Strata in the Aipa Hills area west of Kerema are grouped into five units: (a) *Coralline Limestone Group,* 170 m of stratified, crystalline, coralline limestone, calcareous shelly mudstone and micaceous shelly siltstone. It is probably Pliocene and rests unconformably on Miocene strata in which the units are: (b) *Upper or Sandy Mudstone Group,* 275 m of mudstone, sandy mudstone, and limestone with some calcareous sandstone and coarse sandstone; (c) *Grit Group,* 270 m of massive sandstone, coarse sandstone, micaceous sandstone, calcareous mudstone, and limestone; (d) *Plant Remains Group,* 570 m of massive calcareous coarse sandstone, mudstone, and limestone, overlain by calcareous sandstone and coarse sandstone with thin lenticular conglomerate, mudstone, and lignite; (e) *Lower Mudstone Group* (including the 'petroliferous series'), about 1000 m of mudstone, sandy mudstone, and minor sandstone and limestone. Petroleum indications appear over a 340 m interval in this unit, starting some 365 m below the Plant Remains Group.

The strata are exposed in a faulted fold with two anticlinal flexures separated by a synclinal fold. Further investigation is warranted but a large oilfield is unlikely. (W.M.)

02-b-55 GRAY, W., & BOURCHIER, J. R., 1930d — Opau-Ingham Hills-Kerema area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 66-73.

The following units occur: (a) *Saraura Group,* 480 m of fine sandstone, micaceous sandstone and massive sandstone containing abundant plant remains. It only crops out near Maivera village and its relation to other units is unknown; (b) *Kerema Group,* 1500 m of calcareous sandstone and coarse sandstone, mudstone and lignite assigned to the *Plant Remains Group,* together with 180 to 600 m of mudstone and sandy mudstone assigned to the *Petroliferous or Lower Mudstone Group. The Matupe River Group* and *Marua Mudstone* are facies variants of the Plant Remains Group.

The structure in the Kerema-Ingham Hills area is a wide synclinal basin trending northwest, with flank dips varying from 25° to 70°. A series of small anticlinal folds occurs in the Opau R. area. Further investigation is not recommended. (W.M.)

02-b-56 GRAY, W., & VERTEUIL, J. P. de, 1930 — Purari-Kikori Area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATOIN WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 74-86.

The area is divided geologically into three distinct zones: In the *Purari R.* district, conglomerate, sandstone, and mudstone overlie a succession dominated by sandy mudstone and mudstone with limestone and lignite horizons. They are folded into a series of faulted, tight northwest-trending anticlines and synclines.

In the *Era R.* district, there are three groups (a) *Upper Group,* 600 m of clay, mudstone, lignite, coal seams, sandstone, and occasional limestone; (b) *Middle Group,* 1000 m of fossiliferous sandstone, sandy mudstone, mudstone, calcareous coarse sandstone and limestone; (c) *Lower Group,* 500 m of sandstone, conglomerate, calcareous sandstone, and mudstone, with many fossiliferous beds. They are folded into a broad symmetric anticline with a northwest trend.

In the *Oiwa-Wai-i-Sirebe* district there are four groups: (i) *Sirebe Limestone Group,* 450 m of crystalline, coralline and foraminiferal limestone resting unconformably on Tertiary strata, and extending west and northwest of the area studied; (ii) *Volcanic Plateau Series,* conglomerate, agglomerate, tuff and basalt, thinning away from Mt Favenc which probably represents their focus of eruption; (iii) *Lower Group,* the youngest Tertiary unit, mudstone, sandy mudstone, sandstone, and some limestone, in which the faunas indicate alternating estuarine and marine conditions; (iv) *Sire Group,* mudstone, sandy mudstone and fossiliferous sandstone overlying micaceous sandstone and mudstone. (W.M.)

02-b-57 GRAY, W., MONTGOMERY, J. M., & BOURCHIER, J. R., 1921 — Geological survey of the Kira-Ie Hills district, Papua; progress report for the month ending 31st January, 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields of Papua; reports on operations of the Anglo-Persian Oil Company during January and February, 1921. *Aust. parl. Pap. 104, Sess. 1920-21,* 3, 2018-9.

Preliminary results of the Kira and Ie Hills (Aipa) survey are recorded. Oil showings in the Kira area were inspected, and comments made on difficulty of access and lack of continuity of outcrop. (W.M.)

02-b-58 GREFFRATH, H., 1876 — Die neuesten Entdeckungsreisen in Neu-Guinea: Die Expeditionen Macleays und MacFarlanes (The latest discoveries in New Guinea: The Macleay and MacFarlane expeditions, in German). *Z. allg. Erdk.,* 11, 1-21.

The coastline around the Katow (Baxter) R. is low, flat, swampy, and rimmed with mangroves. The Katow R. is about 180 m wide at its mouth and about 25 m wide 3 km upstream. Yule I. is composed of deformed sedimentary rocks, rimmed with coral reefs, and has a central hill of conglomerate. (W.M.)

02-b-59 HAANTJENS, H. A., 1964d — Physical regions of the Wanigela-Cape Vogel area. *In* HAANTJENS, H. A. (Ed.) — (b). General report on the lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.,* 12, 17-20.

The Tufi-C. Vogel area has been divided into six physical regions with distinct characteristics and well defined boundaries:

The *Owen Stanley Mountain Ra.* is bounded on the north by a major fault in the west and central parts and by unconformable contact with younger sedimentary rocks in the east. There is a pre-Tertiary metamorphic block of schist and phyllite east of Wowo Gap, and a plutonic unit of gabbro and ultrabasic rocks west of the gap.

The *C. Nelson Volcanic Mts and Alluvial Fans* are developed around Mt Trafalgar and Mt Victory. Mt Trafalgar-Topographers Ra. is a deeply-dissected extinct volcano with steep mountain spurs, broad plateau-like slopes and deep gorges. Mt Victory is a dormant volcano, mainly composed of deeply-dissected broadly concave slopes of andesitic agglomerate and ash, and recent lavas.

Ruaba Badlands occur in deeply-dissected well bedded Tertiary sediments in the eastern foothills of the Owen Stanley Ra. In the east several volcanic plugs intrude the pile, which unconformably overlies older regional metamorphics. The sharp northern boundary is controlled by an active fault.

C. Vogel Dissected Uplands and Alluvial Valleys reflect lithology and structure. Juvenile karst is developed on recently-uplifted reef limestones at C. Vogel; Tertiary marine strata farther west develop cuestas and hogbacks; marls on the north and south flanks form steep ridges with concave slopes; basic hypabyssal intrusives stand out as high ridges east of Ruaba R.

Goropu Piedmont and Coastal Plains cover the C. Nelson volcanic mountains and the Musa Valley-C. Vogel uplands. The plains have appreciable gradients and are traversed by numerous small fast-flowing rivers. Distinctive elements include higher piedmont terraces now moderately dissected, younger stable floodplains, young actively-aggrading outwash plains, low dissected hills of (?) Pleistocene basic lavas and agglomerates, and a Recent volcano cone and lava sheet.

Musa Valley Floodplain in the west consists of levees and back plains of the Musa R. and is fringed by swampy lowlands against the Goropu plains and C. Nelson volcanics. (W.M.)

02-b-60 HAANTJENS, H. A. (Ed.), 1964b — General report on lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.*, 12, 99 pp.

Specialized reports on the Tufi-C. Vogel area describe land forms (entry 05-a-88), soils (entry 07-a-6), vegetation and climate and assess land use potential and forest resources. They are integrated into a general summary (entry 05-a-83). (W.M.)

02-b-61 HADDON, A. C., 1900 — Studies in the anthropogeography of British New Guinea. *Geogr. J.*, 16, 265-91 and 414-41.

The backbone of British New Guinea comprises a series of mountain ranges running northwest. The submerged south end constitutes the Louisiade Arch.; the north end passes into the Blucher and Victor Emmanuel Ras, and continues to the western end of Dutch New Guinea. The central mountains, composed of crystalline schist of undetermined age, slate and gneiss, are flanked in many places by areas of igneous rocks, such as basalt, ash, and other volcanics.

Between the Aroa and Biaru Rs west of Port Moresby, the *Port Moresby Beds* are a narrow coastal band of Tertiary sandy shale, limestone, and calcareosiliceous rocks. They form a broader coastal band from Redscar Bay to Round Pt, and extend into the interior to the central schists. From Jokea to Bereina the *Kivori Grits* are a linear outcrop of Post-Tertiary grit, sandstone, and conglomerate parallel to the Port Moresby Beds and forming the low Kivori Hills.

The southeast peninsula has a central range consisting mainly of slate and schist with an east-northeast strike. Lateral mountains of acid and basic volcanic rocks are bounded on the east by contorted Tertiary beds extending to the coast.

In west British New Guinea the Blucher Ra. rises to about 1800 m but the Donaldson Mts are only about 600 m high. At their bases is a flat alluvial plateau with low sandstone and limestone hills about 30 to 45 m high. Between the Bamu and the Lakekamu Rs are the Turama, the intricate delta systems of the Omati, Kikori (Aird), and Purari, and the Vailala and smaller rivers. Hood Pt, evidently formed mainly by the Wanigela R., is a low, level spit of sea-sand and alluvium brought down by the river, deposited in salt water, and heaped to leeward by the indirect action of the prevailing southeast wind. (W.M.)

02-b-62 HADDON, A. C., 1935 — REPORTS OF THE CAMBRIDGE ANTHROPOLOGICAL EXPEDITION TO TORRES STRAIT. — VOL. I — GENERAL ETHNOGRAPHY. *Cambridge, Camb. Univ. Press,* xiv + 421 pp.

Three groups of Torres Str. islands are recognized — a western group of coral islets and high islands of intrusives and sediments, a central group of coral islets only, and an eastern group of coral islets and high volcanic islands. A description of Daru I. quoted from Beaver (entry 02-b-22) is included. (W.M.)

02-b-63 HADDON, A. C., SOLLAS, W. C., & COLE, G. J., 1904 — On the geology of Torres Strait. *Trans. Roy. Ir. Acad.*, 30, 419-76.

There are three distinct zones of Torres Str. islands. A zone of volcanic islands east of 143°29′E comprises mostly basaltic lavas, and some have fringing reefs and coral islets. East of the zone the sea floor drops away into the ocean depths, but to the west it is about 20 m.

A second zone of islands between 143°29′E and 142°48′E consists of coralline reef and shoal limestones, and shoal reefs abound. A north-south zone of islands west of 142°48′E is composed of continental syenite, porphyry and schist, and some have fringing reefs. The western zone of islands is a continuation of the east Australian mainland, and is traced north from C. York Pen. to mainland New Guinea at Mabudauan Hill west of Daru. The rapid rate of supply of terrigenous detritus by the Strickland-Fly river system is causing a slow southward progression of the coastline around the Fly delta.

The composition, form and spatial relationships of the larger islands in each of the three zones are described, with notes on Mabudauan Hill and the islands in the Fly delta. The tectonic framework of the area around the straits, and the tectonic position of New Guinea are discussed. Recent tectonic or isostatic subsidence and uplift are recognized in the light of the lithologic character of the Papuan and Solomon Is, and the distribution of Recent reef limestones on mainland New Guinea. (W.M.)

02-b-64 HARGRAVE, L., 1877 — (Report on specimens from the Fly River, collected by Signor D'Albertis, in German). *Z. Ges. Erdk.*, 12, 150-1.

Specimens collected but not located include granite, milky and blue quartz, reddish sandstone, serpentinite, black iron-sandstone, and copper ore. (W.M.)

02-b-65 HELY, B. A., 1899 — Report of the Resident Magistrate for the Western Division. *Brit. N. Guinea ann. Rep. for 1897-98,* App. L, 78-82.

The western or Fly R. fall of the Fly/Oriomo divide rises gradually from swampy areas of sand and mud through iron-rich reddish loam with ironstone outcrops. (W.M.)

02-b-66 HENNESSY, J. M., 1886 — A few months experience in New Guinea. *Proc. Roy. geogr. Soc. Aust., Qld Br.*, 1, 106-16.

Sand-cemented conglomerates crop out in the Astrolabe Ra., which rises to about 600 m east of Port Moresby. They may have come from a large stream and been emplaced by volcanic agencies (*sic*). The Kowna (Rouna) Falls have an estimated drop of 300 m. The hills surrounding Sogeri Plateau may have been part of a large volcanic crater rim complex, since disrupted by earthquakes. (W.M.)

02-b-67 HUNTE, G. R. le, 1901a — Despatch reporting visit of inspection to the eastern part of the possession. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. B, 4-9.

The main Laughlan Is are low reef islands, but Cannac I. rises 35 m above sea level and appears composed of diorite, apparently dipping steeply with an east-west trend. On Woodlark Is. samples of gold-bearing blue clays from Kalumadau mine area were seen. A recent landslip near the mine office exposed auriferous reef and derived soils. Kitava I. coastline has 4 terraces. (W.M.)

02-b-68 HUNTE, G. R. le, 1901b — Despatch reporting continuation of visit of inspection to eastern and southeastern divisions of the possession. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. C, 12-7.

Gold is being produced in small amounts from alluvial deposits in the Mambare and Gira Rs. The west coast of Goodenough Bay is precipitous, and comprises outcropping conglomerate apparently much distorted. (W.M.)

02-b-69 HUNTE, G. R. le, 1902 — Despatch reporting visit of inspection to the eastern parts of the possession. *Brit. N. Guinea ann. Rep. for 1900-01,* App. C, 12-23.

The high peak at the north end of the largest island in the Egum Group may be the peak of a submerged mountain around which a fringing atoll has grown. The fissile strata dip vertically and contain a vein of 'pink rock'. (W.M.)

02-b-70 JACK, R. L., & CLARKE, A. W., 1889 — Report on rock and other specimens from New Guinea and neighbouring islands. *Brit. N. Guinea, Govt Gaz.*, 2(10), 38-9.

Samples from mainland Papua include basic igneous rocks from Mullins Har. and nearby hills. Samples from Louisiade Arch. include metamorphics from Tagula, Rossel, and Misima, and limestone from Teste (Wari). Basic and intermediate igneous rocks are recorded from Fergusson, Goodenough and Normanby Is. (W.M.)

02-b-71 JACK, R. L., & ETHERIDGE, R., Jr, 1892 — THE GEOLOGY AND PALAEONTOLOGY OF QUEENSLAND AND NEW GUINEA, 2 Vols. *Brisbane, Govt Printer,* Vol. 1 768 pp., Vol. 2 69 pl.

The geology and palaeontology of British New Guinea are discussed. The distribution of post-Tertiary land molluscs in Queensland is evaluated as evidence for a Tertiary land bridge to Australia.

Descriptions of several igneous rocks from Nell and Goodenough Is are included in petrographic notes prepared by Clarke (entry 09-b-6). The chapter on the geology consists largely of excerpts from entry 2-b-111, supplemented by a few comments by Jack. The chapter on the palaeontology includes descriptions of known genera and species of invertebrates. The localities and ages of several known specimens are revised, and several interpretations of the age significance and affinities of the New Guinea faunas are discussed and reviewed. (W.M.)

02-b-72 KEYSER, F. de, 1961 — Misima Island — geology and gold mineralization. *Bur. Miner. Resour. Aust. Rep.* 57, 36 pp.

Misima is composed mainly of folded and faulted metamorphic rocks covered in the northeast by about 400 m of Tertiary beds and surrounded in the south and east by a rim of raised Quaternary coral reefs.

The metamorphic rocks can be divided into a higher-grade metamorphic series in the west and a lower-grade metamorphic series in the east. Amphibolite (*Lalama Amphibolite*) and overlying gneiss and schist (*Oiatau Gneiss*) of the almandine-amphibolite facies of regional metamorphism constitute the higher-grade metamorphics. The lower-grade metamorphics consist of a volcanic formation (*Ara Greenschist*) overlain by a succession of intergrading dark graphitic and micaceous phyllite and schist, quartzose schist and banded schist (*Umuna Schist*), separated by marble and limestone (*St Patrick Limestone*). Tertiary deposits include rocks of three different penecontemporaneous types: a volcanic facies in the east (*Kobel Volcanics*), a conglomeratic facies in the west (*Liak Conglomerate*), and an intermediate clastic facies (*Gulewa Formation*). Quaternary coral reefs were raised up to 400 m above sea level in several stages. Pre-Tertiary igneous rocks include hornblendite and trondhiemite in the west, and dacitic and andesitic porphyries in the east. Post-metamorphic basic and acid dykes cut across the higher-grade metamorphics.

Native gold, the only mineral mined, is accompanied by small quantities of base-metal sulphides, and is restricted to eastern Misima. Total production from both alluvial and lode sources has been about 6800 kg of fine gold. Lode gold was mined before World War II from the Umuna lode. Reserves in the oxidized portion of the Umuna lode are not large enough to warrant re-opening the mine, but an orebody of sufficient volume and grade may be present in the unexplored primary zone. Mineralization is epithermal and connected with intrusive porphyry. The Double Chance, a postwar discovery, is an open cut on a series of thin leaders spaced closely enough to allow profitable mining as a one-man enterprise. Further lodes may be concealed beneath overburden in eastern Misima, but they are unlikely to be found by surface exploration and panning alone. The most favourable areas to seek gold are where porphyry crops out abundantly, and near the greenschist boundary. (Auth./W.M.)

02-b-73 KUGLER, A., 1965 — Tectonics of Kukukuku lobe. *38th ANZAAS Cong., Hobart,* Sec. C Abs (listed by title in *Aust. J. Sci.,* 28, 312).

This is known only by title from its listing in *Aust. J. Sci.*

02-b-74 LANGFORD, W. G., 1918 — Report on the geology of the Hohoro district, Papuan oilfield. *Papua Bull.* 4, 16 pp.

The Hohoro petroleum prospect area, 5 km inland from the mouth of the Vailala R., has had several gas 'blows'. The exposed strata are fossiliferous estuarine or deltaic detrital sediments of middle and upper Miocene age, mainly sandstone interbedded with sandy mudstone and mudstone with subordinate detrital limestone. The limestone is foraminiferal with admixtures of terrigenous detritus, often grading to shelly marls. Thin lignitic coal seams of low quality crop out.

The structure is an anticline plunging southward on an axis trending 306° swinging to 326° in the west. It is cut by a shear zone trending 317° with sinistral displacement. (W.M.)

02-b-75 LANGFORD, W. G., 1919 — Investigating the Papuan oilfields. *Petrol. World,* 16, 19-24.

This is a re-issue of *Papua Bull.* 4 (entry 02-b-74).

02-b-76 LAWES, W. G., 1875 — Yule Island Revisited. *Mission Mag. Chron. for 1875,* 217-9.

Most outcrop at the eastern end of Yule I. is elevated coralline limestone. (W.M.)

02-b-77 MABBUTT, J. A., 1965a — Summary description of the Port Moresby-Kairuku area. *In* MABBUTT, J. A., et al. — Lands of the Port Moresby-Kairuku area, Papua-New Guinea. *CSIRO, Land Res. Ser.,* 14, 12-8.

Summaries of specialist reports are used to introduce descriptions of land systems (entry 05-a-105). The summary of the geology of the area comprising the coastal plains and the foothills of inland ranges between Kappa Kappa and the mouth of the Biaru R. is based on the section by Speight (entry 02-b-156), and notes the northwest-trending folds and faults in Miocene marine sediments; the gentle warping of Pliocene volcanics in the Sogeri area and Pliocene terrestrial sediments near Palipala; and the concordant basic intrusives with associated copper mineralization in the coastal hills east of Port Moresby.

The summary of the geomorphology is based on the section by Mabbutt (entry 05-a-103) and notes the characteristic land forms and processes developed in environmental zones in coastal hills, foothill, upland, plains, swamp and littoral plains zones. Soils have been separated into 13 groups based on profile form and wetness and the development of environmental zones (entry 07-a-19) is noted. (W.M.)

02-b-78 MACGILLIVRAY, J., 1851 — Sketch of the natural history of such portions of the Louisiade Archipelago and New Guinea, as were visited by H.M.S. *Rattlesnake,* June to September, 1849. *J. Roy. geogr. Soc.,* 21, 15-8.

Mica slate crops out on all the Louisiade Is visited except low coral-reef islands. On South-East (Sudest) I. the strata dip 60° west. In southeast New Guinea, siliceous breccia is recorded from Dumoulin I.; volcanic agglomerate and tuff capped by basalt form Brumer I.; volcanic glass and hornblende andesite occur near Dufaure I.; and coralline terraces occur at Redscar Head. (W.M.)

02-b-79 MACGILLIVRAY, J., 1852 — NARRATIVE OF A VOYAGE OF H.M.S. RATTLESNAKE COMMANDED BY THE LATE CAPTAIN OWEN STANLEY, DURING THE YEARS 1846-50: including discoveries and surveys in New Guinea, the Louisiade Archipelago, etc. *London, Boone,* 2 Vols.

The main range of eastern New Guinea seen from the south appears granitic and contains no evidence of active or recently-active volcanoes as was expected from reports of features on the north coast. Brumer I. is composed of igneous rocks; Dufaure (Bona Bona) I. at the mouth of Mullins Har. is probably of hornblende porphyrite, and obsidian crops out nearby. Mt Astrolabe east of Port Moresby is of 'trap' (basalt), as probably are several nearby low conical hills. Redscar Head is composed of limestone, and islands offshore are raised coralline islets. The western limits of the barrier reef occur here.

The Louisiade Arch. is defined as being within 10°40′ and 11°40′S, 151° and 154°30′E. Low islands in the west are coralline; higher islands were composed of mica slate trending in the same direction as the archipelago. Barrier reefs are developed on Rossel and Sudest Is which are mountainous and composed of slate. Pig (Panaete) I. is composed of slate. The barrier reef is cut by a few deep channels, contains chain islets and atolls, and occasional stacks with notched high-tide marks above present sea levels. The coral reefs of the Louisiades are considered examples of reefs developed according to Darwin's theory. (W.M.)

02-b-80 MacGregor, W., 1890a — Despatch reporting visit of inspection to Sudest Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. B, 2-3.

Gold on Sudest (Tagula) I. occurs in alluvial concentrations in stream beds, and prospects are not encouraging. The island is composed of quartz-veined slate, but auriferous lodes have not been discovered. (W.M.)

02-b-81 MacGregor, W., 1890b — Despatch reporting visit of inspection to Rossel Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. C, 3-4.

Small quantities of gold are found in stream gravels on Rossel I., but parent auriferous lodes were not seen in the slates constituting the main outcrops in the hills. (W.M.)

02-b-82 MacGregor, W., 1890c — Despatch reporting visit of inspection to Joannet Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. D, 4-5.

Joannet (Pana Tinai) I. is composed of slate, abundantly veined with quartz. Colours of gold were found in some stream samples, but auriferous vein quartz has not been seen. (W.M.)

02-b-83 MacGregor, W., 1890d — Despatch reporting visit of inspection to St Aignan Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. E, 5-6.

The mountainous western end rises to 2400 m and is composed of schistose slate forming bold cliffs. The eastern hills rise to about 600 m, and are chiefly of coralline limestone, conglomerate, and quartz-veined slate. Uplifted terraced coral limestones fringe the east coast. Gold has been found in the eastern end of the island, but not in payable quantities. The western side has not been explored for alluvial gold which is unlikely to have been concentrated in the swift steep-falling streams. (W.M.)

02-b-84 MacGregor, W., 1890e — Despatch reporting visit of inspection to Normanby Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. F, 6-9.

In the southeast slate and schist of varying hardness crop out and weather readily. Veins of quartz occur sub-parallel to the sub-horizontal foliation in the metamorphics, and colours of gold are seen in many stream samples. Quartz-veined schist and dolomite occur in the centre of the island, and gold colours are seen in stream samples. The northern part of the island is mostly limestone and basalt and peaks yield debris of porphyritic rocks into stream gravels, in some of which traces of tin have been found. (W.M.)

02-b-85 MacGregor, W., 1890f — Despatch reporting visit of inspection to Goulvain Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. G, 9.

Goulvain (Dobu) I. is of volcanic origin and has an extinct crater about 150 m high near the centre. Welle (Sanaroa) east of Fergusson I. is another low island of volcanic origin. (W.M.)

02-b-86 MACGREGOR, W., 1890g — Despatch reporting visit of inspection to Fergusson Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. H, 9-13.

Two large mountain blocks are recognized: Kilberran at 1800 m is the highest peak in the northeast; Maybole Ra. in the northwest rises to about 1500 m; both are composed of quartz-veined micaceous schist and slate. The southeast is entirely of igneous origin. Precious metals have not been found. Fumaroles are noted. (W.M.)

02-b-87 MACGREGOR, W., 1890h — Despatch reporting visit of inspection to Goodenough Island. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. I, 13-4.

A mountain chain in central Goodenough I. rises to 2100 m. In the southeast are extensive flats with rich soil overlying quartz-veined slate and mica schist. On the south coast are spurs and peninsulas of volcanic rock, and a recently-extinct volcanic vent, with some terraced uplifted coralline limestones. Colours of gold were found on one creek, but it is unlikely that payable quantities will be found. (W.M.)

02-b-88 MACGREGOR, W., 1890i — Despatch reporting visit of inspection to districts lying east of Port Moresby. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. J, 14-6.

Near Port Moresby are occasional valleys with good soil, between low rounded hills. The hill country runs some 8 km back from the coast, passing into the conglomerate-capped Astrolabe Ra. which is about 1000-1200 m high. (W.M.)

02-b-89 MACGREGOR, W., 1890j — Despatch reporting visits of inspection to various localities in eastern part of possession. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, App. O, 24-8.

Much of the divide between Milne Bay and Bentley Bay is apparently composed of deformed basaltic volcanics which produce a heavy mantle of rich dark soil. No valuable mineral deposits can be expected in the area. The country between Milne Bay and Mullins Har. is a line of low basaltic hills up to 240 m high, with terraced uplifted coralline limestone on the Mullins fall. Most derived soils are poor, and no sign of valuable ores was seen. Logea (Heath) I. near Samarai is at least partly of volcanic origin and up to 300 m high. The hilly island of Sariba (Hayter) near Samarai is composed of conglomerate. Tubutu I. in the Engineer Group is about 2 km long and rises to 90 m in a sandstone ridge. (W.M.)

02-b-90 MACGREGOR, W., 1890n — Despatch giving details of an expedition undertaken to explore the course of the Fly River and some of its effluents. *Brit. N. Guinea ann. Rep. for 1889-90,* App. G, 49-64.

The Fly R. is described between points 280 and 970 km from the coast. Current flow measurements were made at several places. The confluence of the Strickland and Fly Rs, named Everill Junction, is determined as 7°26′S, 141°18′E. D'Albertis Junction, the confluence of the Alice and Fly Rs, is fixed at 6°11′S, and about 10 km east of the border (141°E). About 815 km from the mouth of the Fly river bars contain pebbles of granite, limestone, conglomerate, quartz, slate, basalt, flint, coral, and coal, and low country gives way to low hills of sandstone and clay. The junction of the Fly and Palmer Rs is named Palmer Junction, and for some distance up the Palmer the country is low sandstone and mudstone hills. (W.M.)

02-b-91 MACGREGOR, W., 1892a — Despatch reporting visit of inspection to various districts in the east end of the possession. *Brit. N. Guinea ann. Rep. for 1890-91,* App. A, 1-4.

Milne Bay, the Conflict Group, and Misima, Tagula, Rossel, and Wari (Teste) Is were visited. The Conflict Group forms an atoll about 16 km across east-west and about 8 km across north-south. Some 20 uninhabited small islands lie on the atoll, around a deep inner lagoon with navigable passages for large ships in the southeast and northwest. The islands lie 1-2.5 m above high tide and are composed of coralline sandy soil admixed with decaying vegetable matter. (W.M.)

02-b-92 MACGREGOR, W., 1892b — Despatch reporting visit to Nada (Laughlan) Islands. *Brit. N. Guinea ann. Rep. for 1890-91,* App. C, 9.

The Laughlan Is, east of Woodlark I., are a group of atoll islands all less than 3 m above sea level and with little or no soil. The atoll is 6-8 km across and open to the east. (W.M.)

02-b-93 MACGREGOR, W., 1892c — Despatch reporting visit of inspection to north-east coast of the possession. *Brit. N. Guinea ann. Rep. for 1890-91,* App. D, 10-8.

The eastern end of Owen Stanley Ra., C. Vogel, Mt Victory, Mt Trafalgar, Hydrographer Ra., and Boundary C. are described. On C. Vogel Pen. Mt Girumia rises to 600-750 m as an isolated peak surrounded by low hills. South of Goodenough Bay, the coastal range at 600-900 m falls through terraces to the coast and continues northwest past the head of the bay. Along the south shore of Collingwood Bay is a series of coralline islands, and a 30-km wide coastal plain of uplifted coralline limestone extends to a range rising to about 300 m.

Mt Victory is a steep rugged volcanic peak rising to about 1200 m. On the ocean-facing slopes are the scars of large land-slips which may have generated earthquake shocks felt in the area. The lower slopes of Mts Victory and Trafalgar are of conglomerate. Narrow, deep re-entrants have been cut into the coastline, on which fringing coral reefs are developed. Hydrographer Ra. rises to 900-1200 m and runs almost to the coast along its entire length. Boundary C. (C. Ward Hunt) consists of several square km of low hills of metamorphic rock, with outliers of conglomerate on the near-coastal islands. (W.M.)

02-b-94 MACGREGOR, W., 1892e — Despatch covering continuation report of the expedition to the Hovio Range (Mt Yule). *Brit. N. Guinea ann. Rep. for 1890-91,* App. K, 34-42.

The country in the range appears schistose and bears traces of gold. A cursory examination by Belford is reported. (W.M.)

02-b-95 MACGREGOR, W., 1892f — Despatch reporting visit of inspection to the Louisiades and neighbouring islands. *Brit. N. Guinea ann. Rep. for 1880-91,* App. Q, 65-70.

Geological and geomorphological notes were made on several islands not previously visited. The Bonabonana (Torlesse) Is are a group of three low, uninhabited coral islands near Deboyne I. Panaete (Deboyne) I. is generally flat and low, 20-25 km^2 in area, composed of limestone and lavas, and has a high hill at the western end. Nearby Panapompom (Ware), a low hilly island about 10 km^2 in area with hills rising to 150-180 m, appears composed of schist. Utian (Brooker), I., about 5 km^2 in area, of volcanic origin and with hills rising to 120-150 m, lies inside a large lagoon into which there is only a small shallow passage. Nearby Pannarora (Eddystone) is a rocky limestone island. Kimuta (Renard) I. is composed of schist and extensive lavas.

Gold workings on the west end of Tagula were inspected and found to be barely payable. On the south coast of Tagula the barrier reef forms a neutral anchorage breakwater. Gold workings on Misima were inspected, and the activity of alluvial mining and grade of ore suggest the field will remain productive for some years. (W.M.)

02-b-96 MACGREGOR, W., 1893a — Despatch reporting visits to the D'Entrecasteaux and Trobriand Groups. *Brit. N. Guinea ann. Rep. for 1891-92,* App. A, 1-7.

Mt Edagwaba forms much of the southern part of Fergusson I., and is composed of micaceous schist. The flanks are deeply dissected by swift-flowing streams. The hills around Nawawara in the southwest are of volcanic origin. Around Seymour Bay sulphur and alum deposits are associated with fumarolic areas and boiling lakes, and these may be worth exploiting. The northwest block of Fergusson is occupied by the 1000-1200 m Mt Kubioia, composed of mica schist. The offshore islands of Wagipa and Bagiagia are low coral islets. In the Trobriand Group, Buriwadi is a low coral islet thought to be typical of the islands in the group; Vakuta is also uplifted coral. (W.M.)

02-b-97 MACGREGOR, W., 1894a — Despatch reporting visit of inspection to certain places in the D'Entrecasteaux Group and neighbouring islands. *Brit. N. Guinea ann. Rep. for 1892-93,* App. C, 8-14.

Hills rising out of Goodenough Bay are of basalt with many terraces of limestone on the lower steep slopes. Near Radawa limestone gives way to dipping sandstone in the foothill slopes. (W.M.)

02-b-98 MACGREGOR, W., 1894b — Despatch reporting inspection of the Gulf of Papua from Hall Sound to Port Bevan. *Brit. N. Guinea ann. Rep. for 1892-93,* App. G, 24-36.

Low hills about 30 km up the Lakekamu R. appear to be composed of quartz shingle debris probably derived from the main range. Debris in the Tauri R. about 55 km up from its junction with the Lakekamu contains slate, quartz, conglomerate, basalt and serpentinite derived from nearby low hills and the main range. The Bailala (Vailala) R. was traversed for about 130 km, and the geology and geomorphology of the country noted and stream flow characteristics recorded. The Purari R. was revisited and partly surveyed. Comments are made on the geomorphology of the river flats and low alluvial hills over the 120 km of river traversed. The deltaic outlets of the Kikori R. were examined, and the river followed for about 25 km. (W.M.)

02-b-99 MACGREGOR, W., 1894d — Despatch reporting visit to the D'Entrecasteaux and neighbouring islands. *Brit. N. Guinea ann. Rep. for 1893-94,* App. D, 16-21.

Hot springs at Waipoiana on the northeast coast of Normanby I. are on the contact of plutonic intrusives and schist. They lie on a line of hot springs through Dobu and Fergusson Is to Mt Victory on the mainland. On Murua I., near Woodlark I., basaltic rocks form coastal hills, often with fringing coral reefs. Quartz-veined metamorphosed basalt from one hillside is used in axe-heads in a large part of eastern British New Guinea. Iwa I. in the Marshall Bennett Group is an uplifted coral atoll, with peripheral hills rising to 90 m and surrounding a marshy plateau representing the lagoon floor. Simsin, Nauria and Wagalasu Is in the Amphlett Group are of volcanic origin, with extensive shoal and fringing reefs. Kava and nearby islands in the Lusancay Group are of uplifted coralline limestone. (W.M.)

02-b-100 MACGREGOR, W., 1894f — Despatch reporting visit of inspection to the north-east coast. *Brit. N. Guinea ann. Rep. for 1893-94,* App. F, 30-8.

The lower reaches of several rivers between C. Vogel and the German New Guinea border were examined, and the position of some mouths determined. Debris in most rivers is derived from low-grade metamorphics and jade (serpentinite), and colours of gold were seen. Fumaroles were active on Mt Victory. (W.M.)

02-b-101 MACGREGOR, W., 1894g — Despatch reporting visit to eastern end of the possession. *Brit. N. Guinea ann. Rep. for 1893-94,* App. G, 38-40.

Veneina I., near Woodlark I., is composed of siliceous slate. Gold workings at Griffin Pt on Tagula I. suggest the auriferous quartz veins and schists could be an economic prospect. (W.M.)

02-b-102 MACGREGOR, W., 1895a — British New Guinea. *Scott. geogr. Mag.,* 11, 161-80.

The main backbone of Papua is a series of mountains which are higher and more continuous in the east, and lower, more dissected, and farther from the coast in the west. The highest peak is Mt Victoria (over 3900 m). The mountains in the west are mostly of sandstone and limestone, in the centre schist and volcanics, in the east a wide variety of rock types. All are rugged, precipitous, and drained by large rivers, many of which are navigable for long distances. The principal islands to the east are mountainous and of schist and volcanics, with several low coral islets. The only valuable metal in quantity is gold, which occurs in many river beds and is worked in some. Jade, cinnabar, and coal also occur. (W.M.)

02-b-103 MacGregor, W., 1897b — Despatch reporting visit to Dobu and Duau Islands. *Brit. N. Guinea ann. Rep. for 1895-96,* App. B, 3-6 and 78.

The country around Marasi on the north coast of Duau (Fergusson) I. is of volcanic origin and the rich soil contains much pumice and obsidian. Volcanics crop out on the lower flanks of foothills, and sandstone and schist at higher altitudes. Similar country occurs in the northwest. On the northeast coast of Seymour Bay, sulphurous solfataric areas are developed, apparently in a shear zone in fossiliferous sandstone. 7148 oz of gold valued at £25 018 was exported during the year. (W.M.)

02-b-104 MacGregor, W., 1897f — Despatch reporting visit of inspection to western division of the possession. *Brit. N. Guinea ann. Rep. for 1895-96,* App. I, 38-49.

Inland from Daru the country is undulating with rounded hills up to 120 m high. Fossiliferous coralline limestone found in many stream boulders may underlie much of the area. (W.M.)

02-b-105 MacGregor, W., 1898b — Despatch reporting ascent of Mambare River and journey across the island. *Brit. N. Guinea ann. Rep. for 1896-97,* App. C, 4-14.

The Mambare R. was traversed to its head, Mts Scratchley, Winterheight and Knutsford climbed, and the upper headwaters of the Vanapa R. visited. Mt Victoria is named and its position fixed.

The report contains descriptions of the Mambare R., some tributaries, the hill country, botanical altitudinal zoning, lists cadastral data on the ranges and peaks, mentions gold prospecting, and gives geological notes. At the mouth of the Mambare R., the river bed contains coral debris and the surrounding country is low hills of metamorphic rocks. About 400 km up-river, stream-bed debris includes granite, basalt, slate, and quartz. Gold is found in most streams, and osmiridium is reported in many. Much of the range is composed of slate and schist veined with quartz. An earth tremor on Winterheight on 24 August 1896 lasted about 20 seconds. (W.M.)

02-b-106 MacGregor, W., 1898d — Despatch in continuation of report of ascent of Mambare River to effect punishment of murderers. *Brit. N. Guinea ann. Rep. for 1896-97,* App. H, 29-34.

Along the Gira R. colours of gold were found in many localities. Some sandstone and conglomerate cliffs occur on the northern foothills of Mt Albert Edward. (W.M.)

02-b-107 MacGregor, W., 1899a — Despatch reporting visit of inspection to district lying between Port Moresby and the headwaters of the Goldie and Brown Rivers. *Brit. N. Guinea ann. Rep. for 1897-98,* App. A, 1-18.

The plateau around the Sogeri area is conglomeratic, and quartz and schist are exposed in the headwaters of the Goldie and Brown Rs. Ginianumu Hill, which may be part of an extinct volcano, is capped with light pumiceous lava that weathers to a rich red clayey soil. (W.M.)

02-b-108 Maitland, A. G., 1890 — Notes on some New Guinea specimens. *Brit. N. Guinea Govt Gaz.,* 3(16), 75.

Samples from Yule I., islands off the north coast of Papua, and several islands in the Louisiade Arch., include basalt, andesite, vein quartz, porphyry, low-grade metamorphics, reef limestone, and granite. (W.M.)

02-b-109 Maitland, A. G., 1891 — Notes on some geological specimens collected in British New Guinea in 1890-91. *Brit. N. Guinea Govt Gaz.,* 4(6), 23-4.

Specimens from the Mt Yule area include augite andesite from Mt Drew, decomposed andesite from the summit and upper spurs of Mt Yule; stream gravels from one of the shedding rivers contain magnetite sand, quartz, and clayey sandstone. Unlocated basalt, mica schist, vein quartz with pyrite, limestone, and weathered andesite were noted from this area, and augite andesite from Were Were, Mullins Har. (W.M.)

02-b-110 MAITLAND, A. G., 1892b — Geological observations in British New Guinea in 1891. *Geol. Surv. Qld Rep.* 85, 1-33.

Previous notes on the geology of British New Guinea and the stratigraphy of known areas are summarized. Strata range in age from uncertain pre-Tertiary to Recent, and the following units are recognized: (1) Recent superficial deposits in river plains and coastal flats, (2) coral reefs, (3) *Kevori Grits* of Post-Tertiary age, (4) *Port Moresby Beds* of possible Tertiary age, (5) *Boioro Limestone,* (6) metamorphic rocks of unassigned age, (7) igneous rocks in which suites of basalt-volcanics-ash and diorite-acid dykes are included, and (8) plutonic acid intrusives.

Economic geology deals mainly with the occurrence and production of gold in the Papuan islands and the Mekeo district; iron, sulphur, graphite, lignite, and mercury are also mentioned. A bibliography of the geology of New Guinea is appended, and is the first published integration of New Guinea data. (W.M.)

02-b-111 MAITLAND, A. G., 1893 — Geological observations in British New Guinea in 1891. *Brit. N. Guinea ann. Rep. for 1891-92,* App. M, 53-85.

This is a re-issue of entry 02-b-110. (W.M.)

02-b-112 MAITLAND, A. G., 1905a — Salient features of the geology of British New Guinea (Papua). *J. West. Aust. nat. Hist. Soc.* 2, 32-56.

The discovery and early geological work in British New Guinea is outlined, including a description of the central range, the Pleistocene to Recent fringing terraced coral reefs and limestone, the volcanic rocks east of Port Moresby, the continental nature of many Papuan islands, and the 3600 m Melanesian Plateau. Stratigraphic notes cover units ranging from possible Archaean (crystalline basement) and Devonian (Tauri Limestone) to post-Tertiary (Kevori Grits). The occurrence and production of gold are mentioned. (W.M.)

02-b-113 MAITLAND, A. G., 1905b — Salient geological features of British New Guinea (abstract only). *Nature,* 73, 108.

This is a review of entry 02-b-112.

02-b-114 MAYO, H. T., 1921b — Geological survey, Papua: progress report, Popo area, February, 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua: reports of the operations of the Anglo-Persian Oil Company during March to July, 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2023-4.

Mapping of the Popo Anticline was completed and the Apinaipi Anticline north of the Biaru R. was investigated. The structure south of the river is developed north of the river, and the exposed strata are stratigraphically higher than those in the crest of the Apinaipi dome. (W.M.)

02-b-115 MAYO, H. T., 1930 — Iokea-Apinaipi area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929, *London, H.M.S.O.*, 1, 30-2.

The geomorphology, stratigraphy, and structure of an area about 25 km northwest of C. Possession are outlined. Petroleum indications include two 'gas blows' without oil, and it is recommended that the domal structure be drilled.

The strata are divided into (i) *Lower (Argillaceous) Group,* upper Miocene mudstone and sandy mudstone with interbeds of marly limestone and shelly limestone high in the unit. It is lithologically correlated with the Lower (Argillaceous) Group in the Oiapu area. (ii) *Upper (Arenaceous) Group,* 850 m of Pliocene marly sandstone, coarse sandstone and conglomerate with interbeds of mudstone and coralline limestone low in the unit. It is equated with the Middle (Calcareous) and Upper (Arenaceous) Groups in the Oiapu area.

The structure, a geniculate anticline, can be traced northwards into the Apinaipi Anticline and southwards parallel to the Oiapu Anticline. (W.M.)

02-b-116 MAYO, H. T., & VERTEUIL, J. P. de, 1930a — Apinaipi area, north of the Biaru River. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 33-4.

All strata exposed belong to the *Upper* (*Arenaceous*) *Group,* 820 m of coarse sandstone, conglomerate, and marly sandstone and minor sandy mudstone. Coarse detritus includes many igneous and chert fragments. A broad asymmetric anticline has flank dips of 75° west and 35° east and a north-trending axis. The area should be tested for petroleum only if tests at Popo and Iokea-Apinaipi are successful. (W.M.)

02-b-117 MAYO, H. T., & VERTEUIL, J. P. de, 1930b — Lesi area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 35-6.

Strata exposed in coastal hills about 30 km northeast of C. Possession are coarse sandstone, conglomerate, marly sandstone, and some sandy mudstone with calcareous bands. They are assigned to the *Upper* (*Arenaceous*) *Group,* are about 800 m thick, and may be lithologically correlated with Pliocene strata on Yule I. A broad anticlinal fold has a northerly trend. (W.M.)

02-b-118 MAYO, H. T., & VERTEUIL, J. P. de, 1930c — Popo area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 37-43.

The Popo area near the mouth of the Kapuri R. was the site of the first test well in the Papuan G. coast structures investigated for petroleum reservoirs. The strata are divided into the *Lower* (*Argillaceous*) *Group* and *Upper* (*Arenaceous*) *Group.* Forams from the early limestones in the latter indicate a Miocene-Pliocene age. The Popo Anticline is an asymmetrical structure plunging southwest with flank dips of 25-45° southwest and 75-90° northeast or rarely inverted to 60°. It parallels the Lesi Anticline and lies northeast of it, and the Popo and Apinaipi folds may be coaxial. (W.M.)

02-b-119 MAYO, H. T., MONTGOMERY, J. N., & VERTEUIL, J. P. de, 1930a — Yule Island-Delena-Bokaina Area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 17-20.

Yule I. and Delena Head on the mainland were mapped stratigraphically, and the broad structures noted. The strata on Yule I. are divided into three groups: (1) *Lower* (*Arenaceous*) *Group,* contorted brecciated beds of sandstone and conglomerate with interbeds of thin limestone and minor shale or mudstone; the coarser sediments contain abundant chert, and igneous fragments partly plutonic in origin; (2) *Middle* (*Lower* or *Argillaceous*) *Group,* interbedded sandstone, coralline and foraminiferal limestone, and volcanic agglomerate and tuff having an eruption centre in the axial valley of the island; faunas from the limestone indicate a Pliocene or possibly younger age. (3) *Upper* (*Middle* or *Calcareous*) *Group,* relatively undisturbed shelly coarse sandstone, saccharoidal fossiliferous limestone, and calcareous shelly clay; igneous debris is found in all sediments and resembles the underlying pyroclastics; faunas from the limestones indicate a Pliocene-Pleistocene age. The succession at Delena broadly resembles that on the island. The strata on the island and at Delena lie on the faulted northern limb of an anticlinal fold which can be traced farther northwest. (W.M.)

02-b-120 MAYO, H. T., MONTGOMERY, J. N., & VERTEUIL, J. P. de, 1930b — Maiva-Kivori area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 21-2.

The structure and stratigraphy of the C. Possession area, and correlations to the northwest are discussed. Outcropping strata are the *Middle* (*Calcareous*) *Group* of coralline and foraminiferal limestone, and the *Upper* (*Arenaceous*) *Group* with conglomerate and coarse sandstone interbedded with argillaceous and calcareous sandstone, marl, and calcareous tufa. They are in a slightly asymmetrical anticline, the trend of which can be followed northwest into the Oiapu Anticline. (W.M.)

02-b-121 MONKTON, C. A. W., 1907a — Report on the Gira Goldfield for the year ending 30th June, 1906. *Brit. N. Guinea ann. Rep. for 1905-06*, 71-2.

The Gira Goldfield covers about 2300 km2 in the lower and middle reaches of the Gira, Aikora, and Waria Rs. Most outcrops are 'diorite and slate'. About 170 kg of gold were won by alluvial methods during the year. (W.M.)

02-b-122 MONKTON, C. A. W., 1907b — (Ascent and mapping of Mt Albert Edward). *Brit N. Guinea ann. Rep. for 1905-06*, 85-93.

Mt Albert Edward was climbed from the west, and traversed along the summit ridges. Gold is being won in small amounts from claims on the Aikora R., where stalactitic growths of what may be silica are found in the porous gravels. Quartz crops out on the western spur of the summit and in the summit area. Mineralized quartz and gold was found in the headwaters of the Chirima R. (W.M.)

02-b-123 MONTGOMERY, J. N., 1930a — A contribution to the Tertiary geology of Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 3-80.

The stratigraphic geology of the Port Moresby area is outlined, with faunal lists, for the following units: Cretaceous *Lower Port Moresby Beds*, unnamed Eocene a-b limestones, *Upper Port Moresby Beds* and *Idumara Limestone-grits*, green and dark tuffs. *Bootless Inlet Limestone* and limestone-grits, indurated and metamorphosed limestones, tuffs of the Laloki and Dobuna mines, conglomerates at the base of Hombrom Bluff, agglomerates of the Astrolabe Ra., and eruptive rocks of the Port Moresby-Bootless Inlet area. Similar information is recorded for tuff and limestone at Boera Head, limestone at Redscar Head (Lagaba I.), limestone and tuff at Dareba Hill, sediments in the Oroi area, Yule I. and Delena, and from some Popo bore cores. The tectonics and the geological evolution of the area are discussed. (W.M.)

02-b-124 MONTGOMERY, J. N., 1930b — Petrographic notes on rock-specimens from Cape Vogel Peninsula. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, App. 5, 77-80.

Enstatite pyroxenite, basalt, glassy and propylitized lavas and analcime dolerite from the *Volcanic-Complex Group* all exhibit considerable deuteric and weathering alteration. From the same group feldspathic tuff, fossiliferous green tuff and radiolarite are recorded and described. The *Lower Arenaceous Group* samples include re-sorted tuff, limestone, and opaline chert. (Auth./W.M.)

02-b-125 MONTGOMERY, J. N., 1930c — A brief review of the oil prospecting work at Upoia, 1911-1920. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 87-94.

The petrography and probable deltaic origin of the thick succession of marl, siltstone, sandstone, limestone and transitional lithologies are discussed, and earlier structural interpretations reviewed. (W.M.)

02-b-126 MURRAY, J. H. P., 1919 — Annual report of the Lieutenant-Governor. *Papuan ann. Rep. for 1917-18*, 5-11 and 32 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19*, 6, 1625-36, and 1657).

Explorations by several patrols are recorded, and notes on a patrol in the upper Kikori R. area indicate that limestone crops out widely in northwest-trending ridges and ranges. Statistics are given for exports in the previous 10 years of copper ore, gold, gold ore and concentrates. Appendices (entries 02-b-166, 02-b-167, 12-i-16, 12-i-92, 12-i-108, 12-i-109) record geological and mining activity. (W.M.)

02-b-127 MURRAY, J. H. P., 1926 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1924-25*, 7-20 (also issued as *Aust. parl. Pap. 41, Sess. 1926-28*, 2, 2072-85).

Extensive, deeply-dissected limestone country is recorded in the headwaters of the Fly R. (W.M.)

02-b-128 MURRAY, J. H. P., 1933 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1931-32*, 3-21, 27, and 31 (also issued as *Aust. parl. Pap. 193, Sess. 1932-34*, 3, 2182-2200, 2206, and 2210).

Conglomerate crops out in the upper (?)Kunimaipi R. Gold production figures for each goldfield for the year, and the total to date for each field, are listed. A table gives value and amount of exports of copper, osmiridium, gold ore and concentrates, and gold for each of the previous 5 years. (Auth./W.M.)

02-b-129 MURRAY, J. H. P., 1937 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1935-36*, 5-21, and 30.

Coal is reported in the stream bed of the upper Aramia R. in western Papua. On Pama Vara Vara I. in the Calvados Chain, elevated limestone reefs form terraces, on one of which is a small salt-water lake. Prospecting activity on the goldfields is summarized, and the amount and value of exports of copper ore, gold, gold ore and concentrates, osmiridium, and platinum are given for each of the previous 5 years. (Auth./W.M.)

02-b-130 MURRAY, J. H. P., 1938 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1936-37*, 5-39 and 49 (also issued as *Aust. parl. Pap. 27, Sess. 1937-40*, 3, 1084-1118, and 1128).

Limestone terrain east of the upper Turama R. contains several caves and sinkholes and sometimes the river enters or leaves underground channels. Hot springs occur near the junction of Bomo Cr. and Omati R., and small amounts of magnetite were found in the area. The amount and value of exports of gold, gold ore and concentrates, copper ore, osmiridium, and platinum are given for each of the previous 5 years. (W.M.)

02-b-131 MURRAY, J. H. P., 1939 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1937-38*, 5-45 and 55 (also issued as *Aust. parl. Pap. 165, Sess. 1937-40*, 3, 1136-76, and 1186).

Limestone crops out near L. Tabera north of Mt Musgrave, and coal is reported from the mountain southwest of the lake. The quantity and value of exports of copper ore, gold, gold ore and concentrates, osmiridium, and platinum are given for each of the previous 5 years. (Auth./W.M.)

02-b-132 NEWCOMBE, A. B., 1913 — Report on prospecting expedition, Lakekamu goldfield. *Papua ann. Rep. for 1912-13,* 37-8 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 423-24).

The hills at the head of the Lakekamu R. are conglomeratic, and many landslips have occurred. (W.M.)

02-b-133 OLDHAM, E. R., 1929 — Magisterial reports — western division. *Papua ann. Rep. for 1927-28,* 19-22 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 474-7).

Granite was reached at an unrecorded depth in the Maremosab bore of Oriomo Oil Ltd, which has prepared a geological map and report on part of the Fly R. (W.M.)

02-b-134 OSBORNE, N., 1951 — A brief geological history of Australian New Guinea. *Papua-New Guinea Sci. Soc., ann. Rep. for 1951,* App. A. 30-4.

New Guinea is fundamentally part of the Australian continent, and part of the continental shield may be recognized in the Mabaduan-Bensbach area. Most of New Guinea represents recently deformed marginal geosynclinal piles considerably younger than most Australian strata.

The oldest known rocks are Permian limestone resting unconformably on granite in the Kubor Ra. near Mt Hagen. They are overlain unconformably by late Mesozoic and early Tertiary strata which accumulated in a major depositional basin on the present site of the Owen Stanley Ra. and the New Guinea Highlands. Late Tertiary strata accumulated in two depositional sites — the Bewani and Aure Troughs — developed by the partial disintegration of the early Tertiary trough. Active volcanism accompanied the development of these troughs and contributed abundantly to the accumulating pile. Compressive tectonism over a long period caused the deeper parts of the troughs to emerge as land masses. Eustatic uplift and compensatory depression since the end of the Tertiary cause the present gross geomorphic features, including major range and valley systems and uplifted reefs. (W.M.)

02-b-135 PAPP, S., & JONES, J. NASON, 1930 — Geology of part of the Cape Vogel Peninsula, north-east Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.* 2, 26-39.

The strata occur in faulted anticlinal and synclinal folds with east-west axial trends and flank dips of 5-40°. Late Tertiary intrusive masses sub-parallel to the fold trends have disturbed the structure. Six sedimentary units are recognized: (1) *White Marl Group,* 240+ m of middle Miocene fossiliferous marl, apparently overlain conformably by (2) *Lower Arenaceous Group,* up to 2400 m of sandstone, coarse sandstone, and conglomerate, with interbeds of marl and lignite; the abundant fossils suggest a Middle Miocene age; it is overlain conformably by (3) *Upper Arenaceous Group,* 1400 m of detrital sediments similar to those in the underlying group, with fossils indicating a Miocene-Pliocene age; (4) Raised late Pliocene to Recent coralline reefs; (5) Recent fringing coastal coralline reefs; (6) extensive alluvial deposits of clay, sands, muds and gravels. The results of the Kukuia (Kaiwatara) test wells indicate that the area is not a potential petroleum reservoir. (W.M.)

02-b-136 PATERSON, S. J., 1964a — Geology of the Buna-Kokoda area. *In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.,* 10, 54-61.

Rocks exposed were basement or deposits of the Mesozoic-Tertiary C. Vogel Basin, and igneous material intruded into the pile or extruded over part of it. Strata range in age from Palaeozoic *Owen Stanley Metamorphics,* through low-grade metamorphics, Ajule-Kajule ultrabasic intrusives of possible Mesozoic age, thick marine Tertiary epiclastic sediments and basic volcanics in the *Iauga Formation* and *Robinson Bay Limestone,* terrestrial sediments of the *Mamama Formation* of probable Pliocene age, and Quaternary andesitic volcanics (*Hydrographers Ra. Volcanics* and *Mt Lamington Volcanics*) and alluvium. The Palaeozoic strata are intensely folded and fractured and dip steeply; younger strata are gently folded and dip steeply only near fault zones. Two major fault zones cut the area. (W.M.)

02-b-137 Paterson, S. J., & Kicinski, F. M., 1956 — An account of the geology and petroleum prospects of the Cape Vogel Basin, Papua. *In* Crespin, I. et al. — Papers on Tertiary micropalaeontology. *Bur. Miner. Resour. Aust. Rep.* 25, 47-70.

Available data are collated on the geology and petroleum prospects of C. Vogel Basin between the Morobe Arc and Owen Stanley Folded Zone (of Glaessner, 1950) and the D'Entrecasteaux Arc. In the south and north parts, basal rocks are mostly volcanic and in the north non-volcanic deposits are of minor importance. In the central part, C. Vogel Pen., are about 4200 m of mainly arenaceous sediments aged from middle Miocene to Recent. A major anticline exists in the C. Vogel Pen. area. The extensive development of shallow, non-marine arenaceous sediments, the absence of surface indications of oil and of any oil in the three test wells, and the long history of volcanic activity, suggest that the area has slight petroleum prospects. (Auth./W.M.)

02-6-138 Powell, C. McA., 1965a — Eocene cherts at Port Moresby. *38th ANZAAS Cong., Hobart,* Sec. C Abs. (listed by title in *Aust. J. Sci.,* 28, 312).

Eocene chert with some claystone and calcarenite have been folded while still unconsolidated. The folding began in the layers near the sediment-water interface and progressively involved thicker sheets of sediment. The chert was derived from clastic particles with up to 50% sponge spicules. Chalcedonic spherulites grew after deposition and were not deformed by folding. Interbedded calcarenites show two clastic fractions: one contains well rounded quartz and basic plagioclase derived from a high-energy shallow-water environment; the other contains angular, more finely grained, fractured quartz and sodic plagioclase derived from a volcanic terrain and receiving little abrasion or sorting during transport. Lower Eocene planktonic forams associated with the well rounded clastic fraction suggest that the depth of accumulation was at least 100 m. The environment is interpreted as an unstable shelf tilting southwest, thereby causing gravity sliding. (Auth.)

02-b-139 Power, P. E., 1960 — Geology. *In* Papuan Apinaipi Petroleum Co. Ltd. — Kaufana No. 1 Bore, Papua. *Bur. Miner. Resour. Aust. Petrol. Search Subs. Acts Publ.* 1, 7-19.

The Kaufana Anticline is one of several in Pliocene and Miocene strata east of Yule I. Strata cropping out are the *Kaieu Greywacke* (Miocene f_{1-2}, 210 m), *Bokama Limestone* (f_3, 60 m), *Diumana Greywacke* (f_3, 180 m), *Vanumai Siltstone* (g, 180 m), and the *Kaufana Beds* (Pliocene, 500 m). The Diumana Greywacke and younger Miocene faunas are listed and the succession penetrated by the bore is summarized. No showings of oil or gas were recorded. (W.M.)

02-b-140 Rand, A. L., & Brass, L. J., 1940 — Results of the Archbold Expedition No. 29 — summary of the 1936-37 New Guinea Expedition. *Bull. Amer. Mus. nat. Hist.,* 77, 341-80.

The coastal lowland of western Papua, punctured only by the granitic Mabadauan Hill, extends inland to the Elevala R. where low dissected hills continue to the limestone 'barrier' across the Fly and Palmer Rs south of Blucher Ra. A second limestone barrier forms Blucher Ra. and continues southeast beyond Mt Leonard

Murray (Mt Bosavi) to Darai Hills. Mt Leonard Murray is an extinct cone volcano with crater lake and nearby subsidiary cones. Karst topography with irregularly distributed cones and dolinas is developed on limestone south of Mt Leonard Murray. (W.M.)

02-b-141 RANDS, W. H., 1890 — Report on geological specimens from New Guinea. *Brit. N. Guinea ann. Rep. for 1888-89 (Qld)*, encl. in App. V, 55-6 (also issued as *Brit. N. Guinea ann. Rep. for 1888-89 (Vic.), encl.* in App. F, 54-6).

On expeditions up the Vanapa R. to Mt Victoria (entry 05-a-108) and in the Rigo-Musgrave R. area east of Port Moresby, samples of sedimentary and metamorphic rocks, stream-bed gravels, vein quartz, and basaltic lavas were collected. They are described and their locations listed. (W.M.)

02-b-142 RICKWOOD, F. K., 1968 — The geology of western Papua. *APEA J.*, 8, 51-61.

Two principal phases of sedimentary deposition are known in western Papua — Mesozoic and Tertiary. Mesozoic rocks crop out in the central ranges of New Guinea and have been penetrated in 20 wells in the southern coastal area. Folding, emergence, and erosion occurred at the end of the Mesozoic after epeirogenic uplift of the northeast margin of the Australian continent. Subsequent Tertiary transgression is represented mostly by Eocene and Oligocene limestones of limited thickness. During the Miocene western Papua was possibly the site of an arcuate orthogeosynclinal complex. North of the Papuan Gulf subdivision into a eugeosynclinal and miogeosynclinal trough is shown by the development, in Kereruan time, of the Aure Trough and the Omati Basin. During the lower and middle Miocene huge thicknesses of greywacke and shale were deposited in the Aure Trough, and west and southwest of the trough a limestone succession consisting mainly of basinal, fore-reef limestone and shoal reefs was deposited over an area about 320 km wide with its maximum thickness at Omati. The upper Miocene was marked by widespread development of argillaceous and arenaceous facies with minor limestone development. Upper Miocene movements led to restriction of the Pliocene basin of sedimentation and the formation of shallow-water arenaceous rocks with less mudstone and coal. The final major phase of folding and uplift probably began in late Pliocene time and has continued to the present, accompanied by volcanism and vigorous erosion. (Auth.)

02-b-143 RUXTON, B. P., 1967b — Geology of the Safia-Pongani area. *In* RUXTON, B. P., et al. — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.*, 17, 79-85.

The area has been divided into 6 tectonic regions: (a) *Owen Stanley Metamorphic Belt* in the southeast and west composed of calcareous and chloritic quartz-sericite phyllite, highly folded and faulted along northwest axes, of possible Palaeozoic age; (b) *Amora* Block in the south, infaulted between the blocks of Owen Stanley Metamorphics, and comprising a series of broadly folded altered basalt, greywacke conglomerate and calcareous siltstone with minor limestone (Urere Metamorphics of Smith and Green, entry 02-b-150) (c) *Morobe Arc* of ultrabasic and basic intrusive plutonics; (d) *Musa Basin* and *Kumusi Trough,* probably starting in the Pliocene when fluvial and lacustrine detrital sediments accumulated. Most recent deposits in the Kumusi Trough include ash from Mt Lamington; (e) *Mangalese Plateau,* a downfaulted block of basic and ultrabasic rocks and Urere Metamorphics thickly blanketed with unfolded block-faulted terrestrial sediments and andesitic volcanics of Pliocene to Recent age; (f) *Cape Vogel Geosyncline,* an active linear belt of subsidence in which Mesozoic to Recent sediments and andesitic volcanics have accumulated. (W.M.)

02-b-144 RUXTON, B. P., 1969b — Geology of the Kerema-Vailala area. *In* RUXTON, B. P., et al. — Lands of the Kerema-Vailala area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.,* 23, 58-64).

This report is based largely on work by Australasian Petroleum Co. (entry 02-b-8). Mesozoic greywacke and mudstone form basement for Tertiary marine sediments. The succession is mainly lower to middle Miocene mudstone and greywacke deposited in the Aure Trough, whose eastern hinge-line is indicated by reef limestone along the Tauri and Kapau Rs. East of them are lower and middle Miocene terrestrial conglomerate, andesite and basalt. Upper Miocene strata, mainly mudstone and greywacke, north of the Purari and Vailala mouths exceed 2700 m in thickness, thinning eastward. East of the Lakekamu R. is a non-marine succession of conglomerate and sandstone. Pliocene strata, chiefly marine sandstone and mudstone more than 240 m thick, occur in a north-northwest-trending belt inland from the Purari and Vailala mouths. Quaternary sedimentation has been mostly terrestrial. Major deformation was in mid-Pliocene, when a series of northwest-trending folds and faults were developed. Chemical data on the Aure Trough sediments are quoted from Edwards (entry 08-b-2). (W.M.)

02-b-145 RYAN, H. J., 1914 — Patrol west of the Kikori and across the head waters of the Omati, Turama, Gama and Awarra Rivers. *Papua ann. Rep. for 1913-14,* App. i, 170-80 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1690-1700).

Limestone crops out in the bed and headwater ranges of the Kikori R. and in many higher ridges west to the headwaters of the Turama R. Sandstone, shale, mudstone and coal crop out west of the Turama. Many coal seams of poor quality were seen in the bed of the Awarra (Bamu) R. upstream from the confluence of the Bamu (Wawoi) R. (W.M.)

02-b-146 SAUNDERS, H. M., 1924 — A patrol in Papua. *Qld geogr. J.,* 39, 22-37.

The route from Kikori to the Samberigi Valley near Mt Murray is through severe gorge and pinnacle country developed on limestone. Shear cliffs up to 450 m high are common. (W.M.)

02-b-147 SELIGMANN, C. G., 1908 — Mr Monkton's journey across New Guinea. *Geogr. J.,* 32, 503-7.

Monkton's report on his traverse from the Mambare R. to the Papua G. down the Lakekamu R. is quoted (entry 02-b-122). In the upper reaches of the Waria R. white 'opalline' tuffs are reported. Granitic rocks crop out on the lower north flanks of Mt Chapman. (W.M.)

02-b-148 SELIGMANN, C. G., & STRONG, W. M., 1906 — Anthropogeographical investigations in British New Guinea. *Geogr. J.,* 27, 225-42 and 347-69.

Rocky sandstone crops out on Yule I. and along the mainland coast southeast to C. Possession, and basaltic breccia forms hills north of Eboa and near Obo. Raised coralline limestone forms hills inland from Waima, and Recent fossiliferous mudstone cliffs at C. Possession. Metamorphic rocks and alluvial gravel are exposed in the middle reaches of the Biaru R. Tokunu in the Alcester Is rises to 55 m above sea level, and is of elevated coralline limestone, the lower beds of which are recrystallized. On Murua (Woodlark) I. raised coral reefs mantle auriferous mudstone cliffs at C. Possession. Metamorphic rocks and alluvial gravel are exposed quarry for dense ash and rhyolitic lava used for implements and granitic blocks used as grinding stones occur as float. The Marshall Bennett Is are elevated platform reef atolls with heights ranging from 100 m on Iwa to 140 m on Gawa and Kwaiawata. Kitava I. in the Trobriands is a reef atoll raised 90 m above sea level. On Egum atoll several coral islets surround a central island on which probable metamorphic rocks crop out. (W.M.)

02-b-149 SMITH, I. E., 1970c — Late Cainozoic uplift and geomorphology in southeastern Papua. *Search,* 1, 222-5.

Southeast Papua has been tectonically active since emergence in the Miocene. Post-Miocene uplift is at least 3000-4000 m and probably occurred in two stages (Late Miocene to Late Pliocene, and late Quaternary to Recent). Uplift of the north coast, tilting of blocks of unconsolidated Pleistocene detrital sediments, and erosion of residual plateaux of Pleistocene reef limestone, are evidence of the most recent tectonic activity affecting fault-bounded rocks with varying relative uplift or depression. (Auth./W.M.)

02-b-150 SMITH, J. W., & GREEN, D. H., 1961 — The geology of the Musa Valley area, Papua. *Bur. Miner. Resour. Aust. Rep.* 52, 41 pp.

The oldest rocks, the *Goropu Metamorphics,* are regionally metamorphised phyllite, schist, and quartzite which may be equivalent to the 'Owen Stanley Series' of probable Palaeozoic age. Unconformably overlying them are the Cretaceous(?) *Urere Metamorphics,* which consist of thermally-metamorphised siltstone, greywacke-conglomerate, limestone, and basalt. Gently-folded non-marine *Domara River Beds* of Pleistocene age occupy roughly the present Musa Valley, where volcanic activity preceded the main sedimentation in several places. The unconformably overlying *Silimidi Beds* include the *Sivai Breccia,* which contains at least two beds of ultrabasic breccia, probably the extrusive sheet equivalent of breccia bodies within the basic-ultrabasic belt. The Recent *Sesara* and *Waiowa Volcanics* crop out north of the Didana-Sibium Ra. and the Goropu Mts.

The basic-ultrabasic rocks are at the southeast end of the Papuan basic belt. The basic-ultrabasic suite, which includes peridotite, dunite, pyroxenite, picrite, and gabbro, shows differentiation but not on a simple pattern. Banding is often well developed and dips have been recorded. Peridotite and serpentinite breccia pipes and irregular bodies within the ultrabasic suite are common, and probably represent vents of a volcanic explosive phase. Other intrusives within the area include diorite-granodiorite, andesitic porphyry, and lamprophyric rocks. Faulting trends east-southeast parallel to the strike of the rocks, and the Musa Valley is partly a faulted trough. The Goropu Mts are strongly faulted on the north and west sides.

Soil samples showed sub-economic nickel with a maximum nickel content of 1.06%. Disseminated pyrite and chalcopyrite introduced at least partly by the diorite-granodiorite bodies were seen in the Goropu and Urere Metamorphics. (Auth./W.M.)

02-b-151 SMITH, M. STANIFORTH C., 1908b — Report on Mines. *Papua ann. Rep. for 1906-7,* App. G, 73-87 (also issued as *Aust. parl. Pap. 160, Sess. 1907-8, 2,* 1497-1511).

In Papua the following rock groups are recognized: (a) Recent superficial deposits of the Gulf of Papua coast, (b) *Kivori Grits* of Pleistocene age near Port Moresby, (c) *Port Moresby Beds,* sandstone, shale, and limestone near and east of Port Moresby, (d) raised coral reefs and associated sediments on the north coast and in the Papuan islands, (e) metamorphic rocks, perhaps Archaean, in the median range, (f) volcanic rocks of probable Recent age in the median range and on the northeast coast, (g) plutonic rocks in small areas. Schist, plutonic intrusives, volcanics and uplifted reef limestone crop out on Woodlark I.

Gold is associated with metamorphic rocks in the median range of the mainland and in the islands to the east. Mining activities on Woodlark (Murua), Louisiade, Milne Bay, Gira, and Yodda Goldfields, and the Astrolabe Mineral Field are summarized, with production and assay figures (entries 12-i-91, 12-b-37, 12-b-83, 12-c-63, 12-c-42). Copper from Woolark and Misima, lead from Woodlark, mercury (cinnabar) from Mambare R., graphite from several unrecorded localities, osmiridium from the Mambare and Gira Rs, zinc (sphalerite) from Woodlark, sulphur in the D'Entrecasteaux Group, and low-grade coal from western Papua, are recorded.

02-b-152 SMITH, M. STANIFORTH C., 1908c — Annual report, Director of Mines. *Papua ann. Rep. for 1907-8,* 103-109 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2145-51).

Total gold production in the declared goldfields is about 7750 kg. Host rocks for copper mineralization in the Astrolabe Mineral Field are altered steeply-dipping sandstone and shale overlain by basalt and breccia shed from the Astrolabe Ra.

and Hombrom Bluff; about 165 tonnes of ore was shipped during the year. Economic minerals found in Papua are listed, together with reports from mining wardens (entries 12-i-48, 12-i-60, 12-i-74, 12-i-115). (W.M.)

02-b-153 SMITH, M. STANIFORTH C., 1908d — HANDBOOK OF THE TERRITORY OF PAPUA. *Melbourne, Govt Printer,* 108 pp.

The physiography, administration, and natural resources of Papua are outlined, including descriptions of major geomorphic elements, geology, and summaries of economic mineral resources and production (entries 12-a-24, 12-a-31, 12-a-34, 12-a-41). The geological outline is a summary of entry 02-b-112. (H.M.)

02-b-154 SMITH, M. STANIFORTH C., 1911c — Kikori expedition. *Papua ann. Rep. for 1910-11,* 165-71 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 729-35).

Limestone crops out on ridges north of the Sireba (Kikori) R. 120 km from the coast, and in much of the country north and east of Mt Murray; occasional plugs of basaltic material penetrate the limestone; karst sinks are common. Stream-bed debris in the headwaters of the Kikori R. includes fossilferous limestone and sandstone, black coal, mudstone, sandstone, and conglomerate. Extensive seams of hard, bright, black coal exposed in the upper reaches of the Kikori R. may be co-extensive with coal reported from the Strickland R. about 30 km to the west. (W.M.)

02-b-155 SMITH, M. STANIFORTH C., 1912c — Exploration in Papua. *Geogr. J.,* 39, 313-34.

An expedition went inland from the navigable limit of the Kikori R. to Mt Murray and west to the southeast branch of the Kikori R. The geomorphology, geology, and ethnology are outlined and a map is included. Limestone intruded by basalt constitutes most of the hill country traversed, and the main divide to the north seems composed mainly of basaltic volcanics. Karst topography is developed on the limestone. Terrigenous sediments and coal occur in the river lowlands, and may be Carboniferous on the evidence of the coal. In one of the western headwater streams of the Kikori R. most of the debris is good-quality hard coal. (W.M.)

02-b-156 SPEIGHT, J. G., 1965c — Geology of the Port Moresby-Kairuku area. *In* MABBUTT, J. A., et al. — Lands of the Port Moresby-Kairuku area, Papua-New Guinea. *CSIRO, Land Res. Ser.,* 14, 95-108.

Cretaceous to Recent strata and intrusives are recognized, and the stratigraphic subdivision of Glaessner (entry 02-b-49) is followed. Strata are categorized according to the nature of their deformation, and rock type and deformation style are correlated with geomorphic expression as represented in land systems defined and illustrated by Mabbutt (entry 05-a-103) and Mabbutt et al. (entry 05-a-105). The economic geology of the area is summarized. (W.M.)

02-b-157 STANLEY, E. R., 1911a — Report of the examination of the Hall Sound district. *Papua ann. Rep. for 1910-11,* 31-3 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 595-7).

Inland from Rarai is a series of low parallel ridges of rapidly-decomposing basaltic and andesitic volcanic rocks exposed in Cully Peaks, Kumi Kumi Ra., and the Kumuga Ra. spur leading to Mt Yule. Float debris in streams includes porphyritic basaltic lava, basaltic tuff, auriferous vein quartz, conglomerate, volcanic tuff, leucodiorite, amygdaloidal lava of olivine basalt affinities with zeolite and calcite amygdale fillings, and leucogranite. Coastal ranges between C. Suckling and Kivori almost parallel the coast in a line passing through Yule I., where fossiliferous limestone and calcareous shale with minor sandstone and conglomerate crop out. A large basaltic hill is in the centre of the island, raised coral reefs rim much of the coastline, and sub-horizontal sandstone represents raised beach deposits. A Tertiary age is given to these strata. (W.M.)

02-b-158 STANLEY, E. R., 1911b — Report on the Astrolabe Mineral Field. *Papua ann. Rep. for 1910-11,* 34-7 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 598-601).

Ore types, structural setting of ore bodies, and mining development are outlined for the Dubuna, Mt Diamond, Laloki, Tobo, Merrie England, and Sapphire Mineral Leases; and the Elvira, Moresby King, Astrolabe, Anaconda, and Hector mines. The copper ores all occur as primary sulphides on which carbonates are present in the oxidized zone, and cupriferous gossans are developed. Host rocks are altered calcareous slate, limestone, and siltstone. Archaean gneiss forms basement for the ore-bearing sediments which are overlain by basaltic volcanics and agglomerates of post-Tertiary age. Early Tertiary basaltic dykes carrying metallic sulphides intrude the host rocks of the orebodies. Late Tertiary sandstone, limestone, and calcareous shale lie between these strata and the Port Moresby Beds on which they appear to rest unconformably. The prospects of the copper field are considered good. (W.M.)

02-b-159 STANLEY, E. R., 1912a — Report on the geology of the Vailala petroleum area, Gulf Division, Papua. *Papua ann. Rep. for 1911-12,* 175-80 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 861-6).

Outcrops are mostly fossiliferous calcareous sandstone, grit, limestone, and mudstone. Their age is unknown, though the presence of coal and carbonaceous debris, and comparison with similar strata west of the Purari R. (entry 12-e-9) suggest a Tertiary age. Grits on Cupola Hill are probably a westward extension of the Kevori Grits near Kerema (entry 02-b-110). Petroleum and natural gas vents appear as bubbling mud pools in stream beds, from which inflammable gases issue and on many of which is an iridescent oily scum. One petroleum sample was a dark brown, viscous liquid, fluorescent in greens under reflected light, brownish yellow in thin film, and had a specific gravity of 0.974. The Vailala oilfield may be of considerable extent and potential. (W.M.)

02-b-160 STANLEY, E. R., 1912b — Report on the geology of Woodlark Island (Murua), Papua. *Papua ann. Rep. for 1911-12,* 189-208 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 875-88).

This is similar to entry 02-b-161 with the addition of production statistics, details about mine-site development on individual leases, and field sketches. (W.M).

02-b-161 STANLEY, E. R., 1912c — REPORT ON THE GEOLOGY OF WOODLARK ISLAND *Melb., Govt Printer,* 22 pp.

Woodlark I. has several high peaks of low-grade regional metamorphics and sediments of unknown age, interconnected by Tertiary and Recent elevated reef limestone in which several stages of uplift and subsidence are recognized. Large areas of younger detrital sediments are presently accumulating. Gold-bearing quartz veins associated with the intrusive igneous bodies are mined in the Kulumadau, Busai, and Karavakum mining centres. (W.M.)

02-b-162 STANLEY, E. R., 1913 — The Papuan petroleum area. *14th Cong. Aust. Ass. Adv. Sci., Melbourne,* 200-6.

The area near the mouth of the Vailala R. contains sandstone, mudstone, fossiliferous limestone, and lignite in what may be a very broad gentle anticlinal feature. There are numerous gas-escape 'boiling mud' localities; a sample of crude petroleum was analysed. The possible areal distribution of the petroleum is discussed, and further investigation is recommended. (W.M.)

02-b-163 STANLEY, E. R., 1915 — Report on the geology of Misima (St Aignan), Louisiade Gold-field. *Papua Bull.* 3, 24 pp.

Misima I. is part of a partly submerged continental mass which has undergone periodic recent subsidence and uplift. The axial mountain range is composed of schist, gneiss, gabbro, and acid porphyry of unknown age, and much of the island is fringed with Recent terraced limestone overlying late Tertiary pyroclastics and lavas in the northeast coastal area. Farther west late Tertiary calcareous sandstone, mudstone, unfossiliferous limestone and conglomerate crop out. Outcrop features and production methods in the several gold mines are discussed and three geological maps and a cross-section are included. (W.M.)

02-b-164 Stanley, E. R., 1917a — The Louisiade goldfield. *Papua ann. Rep. for 1914-15,* 141-2 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1345-6).

The Massive Lode at Mt Sisa on Misima is a true reef-quartz orebody, in which most gold occurs in iron-stained quartz veinlets. The main reef trends northwest and dips steeply southwest. Adjacent orebodies contain gold in milky quartz veins in a black, gritty, iron-bearing material. Country rock is limestone carrying large masses of sulphides and traces of copper. Near Tauhik is quartzite rich in pyrite, sphalerite, galena, and with traces of disseminated gold. Misima I. contains schist and gneiss penetrated by porphyry dykes and basic felsic dykes. Uplifted coral reef terraces rim the south and northwest coasts, and Recent volcanic agglomerates occur on the northeast coast where they overlie late Tertiary detrital sediments. Several stages of recent uplift are recognized. (W.M.)

02-b-165 Stanley, E. R., 1918b — Report on specimens collected by E. W. P. Chinnery on a patrol in the Mt Yule district. *Papua ann. Rep. for 1916-17,* App. C, 63-4 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1503-4).

Large outcrops of supposed granite are near Mt Strong, northeast of Mt Chapman. Nearby ridges are schist and shale. Streams contain abundant biotite and were panned unsuccessfully for gold. (W.M.)

02-b-166 Stanley, E. R., 1919a — Annual report of Government Geologist. *Papua ann. Rep. for 1917-18,* 44-7 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19,* 6, 1564-7).

A traverse from Rigo to Buna Bay (entry 02-b-167), and the investigation of the feasibility of draining the Vaigana (Waigani) swamp near Port Moresby, are noted. Mining activity on each of the gold and mineral fields, and production statistics for gold and copper are listed. Mining wardens' reports (entries 12-i-16, 12-i-92, 12-i-108, 12-i-109) detail mining and exploration activity and production figures. (W.M.)

02-b-167 Stanley, E. R., 1919b — Geological expedition across the Owen Stanley Range. *Papua ann. Rep. for 1917-18,* App. D, 75-84 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19,* 6, 1595-1604).

The first geological traverse across New Guinea, from Rigo to Buna Bay, investigated the geology of the headwaters of the Kemp Welch, Musa, and Kumusi Rs, the potential of declared goldfields, and a reported edible mudstone. The potential of the goldfields was found disappointing. The edible mudstone in the valley of the Mamama (Little Kamusi) R. south of Mt Lamington is derived largely from nickeliferous serpentinite and peridotite of Tertiary age, overlain by mudstone and agglomerate of the Mamama Series of supposed Tertiary age.

Recent Alluvium on the coastal plains and in many river beds and intermontane basins is typically sandy and conglomeratic. *Late Tertiary Volcanics* include basaltic and andesitic agglomerates, vesicular olivine basalt, and some trachyte and andesite. They usually cap hills 1500-1800 m high and originally covered a large area. Sulphurous hot springs in schist occur near the Mimai-Awaru junction. *Tertiary strata* include the Port Moresby and Eriama series (low-grade regional metamorphics and controlled fossilferous siliceous sediments) and the Mamama series (sub-horizontal mudstone, carbonaceous sandstone, and volcaniclastic conglomerate with serpentinite detritus). *Pre-Tertiary metamorphic rocks* include phyllite, sandstone, schist, and sericite slate of the Kemp Welch-Astrolabe series; mica-, epidote- and chlorite-schist and gneiss of the Owen Stanley series; non-fossilferous crystalline limestone; and serpentinized peridotite and amphibolite of the Serpentine series. *Igneous rocks* include basaltic lavas and basic porphyries, dolerite, granite, syenite, porphyry, and granodiorite. (W.M.)

02-b-168 STANLEY, E. R., 1920a — Annual report of the Government Geologist for the year ending 30th June 1919. *Papua ann. Rep. for 1918-19,* 75-82 (also issued as *Aust. parl. Pap. 25, Sess. 1920-21,* 3, 1843-50).

On the eastern fall of the Astrolabe plateau, the vegetation changes markedly from scrub on soils derived from basaltic and andesitic agglomerate and conglomerate of the plateau to forest on the slate and dykes of the underlying Kemp Welch series. Fossiliferous marine sediments and interbedded volcanics, ranging in age from Miocene to Pleistocene, were recorded between Yule I. and the Ambo Mts where a succession of (?) Archaean and (?) Huronian metamorphics crop out. The Tertiary succession between Yule I. and Port Moresby is recorded.

On Fergusson I. two series of metamorphic rocks of supposed Precambrian age are overlain unconformably by late Tertiary sediments and volcanics; sulphurous fumarolic areas are numerous.

Oil indications were reported in the C. Vogel area where there are thick Tertiary sediments. A water-power survey was conducted and the headwaters of the Musa R. unsuccessfully prospected for gold. Notes on activity in the goldfields indicate little production (wardens' reports in entries 12-b-89, 12-i-1, 12-i-52, 12-i-96, 12-i-110, 12-i-111). (W.M.)

02-b-169 STANLEY, E. R., 1920b — Report on the geology of Fergusson Island (Moratau). *Papua Bull.* 6, 26 pp.

The geomorphology, stratigraphic and structural geology, tectonic setting and significance, volcanology, solfataric activity, and economic geology of Fergusson I. are discussed. It comprises older metamorphics and intrusives of unknown age, overlain largely by late Tertiary andesitic and acid lavas and pyroclastics, and by Recent alluvium and raised coralline reefs. Analogy is made with Normanby and Misima Is (entry 02-b-163), though the reefs on Fergusson have not been uplifted as much as have those on Misima. Fergusson I. is a continental mass on the line of continuation of the New Guinea mainland. On evidence of volcanic activity, it may lie on an offshoot from the main range trend which includes C. Nelson, Hydrographers Ra., Mt Lamington, and Mt Albert Edward, and which was elevated during the early Tertiary tectonism. (W.M.)

02-b-170 STANLEY, E. R., 1921a — Annual report of the Government Geologist for the year ending 30th June 1920. *Papua ann. Rep. for 1919-20,* 88-96 (also issued as *Aust. parl. Pap. 97, Sess. 1920-21,* 3, 1974-82).

The geology of Papua is summarized in tabular form, emphasizing stratigraphy and distribution of formations. Fossiliferous late Tertiary mudstone and limestone, overlain unconformably by basalt and agglomerate, crops out widely in the Kikori area, and gold was found in the Koro (Curnick) R., a Kikori tributary. Fossiliferous limestone outcropping between Port Moresby and Redscar Head appears to form a succession with probable unconformities in it.

Several ores were analysed and an osmiridium report (entry 12-c-61) reproduced. Reports on the gold and mineral fields record developmental activity, which is supported by statistics in wardens' reports (entries 12-i-65, 12-i-90 and 12-i-120). (W.M.)

02-b-171 STANLEY, E. R., 1923k — GEOLOGY OF PAPUA. *Melb., Govt Printer,* 56 pp.

Data collected by previous workers is integrated with data by Stanley while first Government Geologist of Papua. It contains a definitive interpretation of the regional stratigraphic and structural geology of Papua, and its known and potential mineral and petroleum wealth.

Metamorphic basement exposed in the main range and eastern Papua may be Archaean(?) to late Palaeozoic, and rest on an Archaean(?) basement of serpentinized ultrabasic intrusives east of Owen Stanley Ra. A succession of Jurassic (or Cretaceous) to Pleistocene marine sediments and volcanics with associated minor intrusives comprise most of Papua, with large areas of Recent limestones and terrigenous deltaic sediments. Some active volcanoes and fumarolic areas occur in the D'Entrecasteaux Group. (W.M.)

02-b-172 STRONG, W. M., 1908 — Notes on the central part of the southern coast of Papua (British New Guinea). *Geogr. J.*, 32, 270-4.

The coastal tract between the Purari R. and Galley Reach is low and flat except for island-like masses rising from the plains, or continuations of inland ranges towards the coast. The Owen Stanley Ra. is composed of deep-seated plutonics or metamorphic rocks flanked by volcanics. Low coastal hills are of stratified sediments and the plains of outwash debris. (W.M.)

02-b-173 SYKES, S. V., 1961 — Geology and objectives of the survey. (*In* AUSTRALASIAN PETROLEUM COMPANY — Puri seismic survey, Papua 1959. *Bur. Miner. Resour. Aust. Petrol. Subs. Acts Publ.* 21, 12-7).

In the shelf zone adjoining the southwest margin of the Aure Trough, a succession of up to 5000 m of Lower Cretaceous, Eocene, Miocene, and Pliocene limestone and marine detrital sediments is overlain by 150 m of Pleistocene volcanic agglomerate and Recent alluvial and deltaic deposits. Breaks in the succession occur above and below the Eocene strata and below the Pleistocene agglomerates. The Puri Anticline and Kereru Ra. are asymmetric anticlines on the south margin of the Pliocene deformation belt and are thrust-faulted to the south-southwest. Farther south the strata are gently folded and cut by several faults. (W.M.)

02-b-174 THOMSON, J. P., 1889a — British New Guinea. *Scott. geogr. Mag.*, 5, 271-7.

This reports Macgregor's visits to several Papuan islands: St Aignan (Misima, entry 02-b-83), Joannet (Pana Tinani, entry 02-b-82), Normanby (entry 02-b-84), Fergusson (entry 02-b-86), Goulvain and Welle (Sonoroa, entry 02-b-85) and Goodenough (entry 05-a-11). (W.M.)

02-b-175 THOMSON, J. P., 1890b — Sir William Macgregor's upper Fly River exploration, British New Guinea. *Proc. Roy. geogr. Soc. Aust., Qld Br.*, 5, 94-100.

Macgregor's account of his traverse up the Fly R. in 1889-1890 (entry 02-b-90) is summarized. (W.M.)

02-b-176 THOMPSON, J. P., 1891a — Ascent of Mount Yule. *Scott. geogr. Mag.*, 7, 445-6.

This summarizes entry 02-b-94.

02-b-177 THOMSON, J. P., 1891b — On the north-east coast of British New Guinea, and some of the adjacent islands. *Proc. Roy. geogr. Soc. Aust., Qld Br.*, 6, 32-42.

Macgregor's observations on the northeast coast of Papua (entry 02-b-93), Trobriand Is (entry 02-b-96), and Nada (Laughlan Is) (entry 02-b-92), are summarized.

02-b-178 THOMSON, J. P., 1892a — Exploration and discoveries in British New Guinea since the proclamation of sovereignty. *4th Cong. Aust. Assoc. Adv. Sci., Hobart*, 4, 419-39.

Summaries are made of reports by Macgregor on Louisiade Arch. (entries 02-b-80, 02-b-81, 02-b-82, 02-b-88, 02-b-91 and 02-b-95), St Aignan (entries 02-b-83 and 02-b-91), Fergusson I. (entries 02-b-86 and 02-b-91), Normanby I. (entries 02-b-84 and 02-b-96), Trobriand Is (entries 02-b-96 and 05-d-32), Nada (Laughlan) and Murua (Woodlark) Is (entry 02-b-92), the northeast coast of Papua (entry 02-b-93), east of Port Moresby (entries 02-b-88 and 05-a-108), Owen Stanley Ra. northeast of Port Moresby (entry 02-b-89), Mt Yule area (entry 02-b-94), Fly R. (entry 02-b-90), and west of the Fly (entry 05-a-110). A summary of the geology of the inland, as it was known before a study by Maitland (entry 02-b-110), is given. (W.M.)

02-b-179 THOMSON, J. P., 1892c — BRITISH NEW GUINEA. *London, George Philip*, xviii + 336 pp.

Macgregor's expeditions in the period 1887-1891 are summarized. Appendices contain detailed notes on geology, flora, and fauna and a map at 1 inch : 80 miles scale is included.

Original data in the appendix include an article by Etheridge (entry 04-g-16) and descriptions of hot-spring water samples from Fergusson I. (entry 11-b-7). (W.M.)

02-b-180 TRAIL, D. S., 1967 — Geology of Woodlark Island, Papua. *Bur. Miner. Resour. Aust. Rep.* 115 (Rep. PNG 3), 1-32.

Woodlark I. is composed of eroded, locally mineralized Tertiary volcanics and is fringed by raised tilted Quaternary terraced coralline limestone. The oldest unit is the Tertiary(?) *Loluai Volcanics* containing andesitic basalt and pyroclastics interbedded with marine terrigenous sediments and some agglomerate. They are unconformably overlain by the lower Miocene *Suloga Limestone,* which in turn is overlain by volcanic units (*Tabukui Beds, Wonai Hill Formation,* and *Okiduse Volcanics*) — broadly resembling each other and the Loluai Volcanics. The fossiliferous lower Miocene *Nasai Limestone* overlies them comformably, and is unconformably overlain by Recent reef limestone and minor marine clay and conglomerate.

Tertiary volcanism centres are not generally recognizable. Dolerite sills intrude the lower part of the succession, and granite dykes intrude nearly all the Tertiary succession. Dykes of diorite, lamprophyre, basalt, and ultrabasic rock intrude the Tertiary volcanics. Structural interpretation is restricted by poor exposures. Alluvial gold has been derived mostly from the lower Miocene volcanics or from rocks intruding them. The gold-bearing reefs are commonly pug-filled shear zones a few cm to 30 m wide. In the primary zone the gold is associated with galena, sphalerite, chalcopyrite, pyrite, calcite, and quartz and may be the product of a late hydrothermal phase of volcanic activity. Many small, rich, gold reefs were worked only to the water-table though the Kulumadau gold mine was mined to 120 m. Alluvial gold may occur in payable quantities in conglomerates interbedded with soft Quaternary marine clays east and west of the Okiduse Ra. The alluvial flats of the Sinkurai R. where it emerges from the Okiduse Ra. warrant testing as a gold-dredging prospect.

On Suloga Pen. dyke-like copper-bearing magnetite-hematite lodes occur in skarn rocks, near dolerite sills intruded into the lower members of the Tertiary succession; further assessment is recommended. A small deposit of manganese oxide occurs in the Loluai Volcanics. (Auth./W.M.)

02-b-181 VERTEUIL, J. P. de, 1930 — Oiapu Area. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929, *London, H.M.S.O.*, 1, 23-9.

The Oiapu Anticline west of C. Possession is worth further investigation as a potential petroleum reservoir, subject to results from tests on the adjacent Iokea-Apinaipi Dome. The structure is a symmetrical upright anticline with flank dips 30-40° and axis trending northwest.

The strata are subdivided into three groups: *Lower (Argillaceous) Group,* grey mudstone with limestone and marly sandstone interbeds; *Middle (Calcareous) Group,* up to 330 m of Pliocene-Miocene coralline limestone and calcareous sandstone with interbeds of foraminiferal coarse sandstone and conglomerate; *Upper (Arenaceous) Group,* unconformable with the Middle Group, about 450 m of Pliocene fossiliferous brown sandstone, coarse sandstone and conglomerate, marl and detrital or coralline limestone. *Pyroclastic Igneous rocks* of olivine basalt and augite-hornblende andesite affinities are interbedded with the sediments in sill-like bodies. (W.M.)

02-b-182 WADE, A., 1918 — Introductory comments to Mr Chapman's report (on a collection of Cainozoic fossils from the oil fields of Papua). *Papua Bull.* 5, 1-7.

Between Yule I. and the Purari R. the following units are recognized: (1) Recent surface deposits. (2) Pleistocene *Ie Hills Series* of uplifted coralline limestone with interbedded mudstone at the base, resting unconformably on older strata, the hiatus represented partly by porphyritic lava on Yule I. and possibly by andesite in the Vailala R. headwaters. (3) Pliocene *C. Possession Beds* (including the *Kivori Grits*) of calcareous grit, sandstone, conglomerate, and fossiliferous limestone. (4) Upper Miocene *Vaiviri Series* (including *Biai Grits*) similar to the C. Possession Beds but also containing blue marl and mudstone. The coal at Vaiviri, Haiare, Ekoa, and Hepiri is referred to this unit, as is the upper oil horizon at Upoia. (5) Middle Miocene *Upoia Series* (including the *Keke Limestone*) of blue clay, mudstone and marl, soft sandstone and hard calcareous grit, and fine-grained limestone interbedded with claystone and massive coralline limestone. (6) Unnamed lower Miocene strata similar to the Upoia Series, containing globigerina chalk at Overi. The Lower Keke Limestone may belong to this unit. (7) Pre-Miocene *Morupo-Iovo Series* of massive grit, sandstone, and conglomerate, calcareous in places and with some traces of petroleum. (8) Erratic chert fragments at Yule I. and near Keke may belong to the *Port Moresby Series.*

The distribution and structure of the units are discussed and fold trends may be a continuation of fold trends in North Queensland. (W.M.)

02-b-183 WHITAKER, W. G., & WILLMOTT, W. F., 1969 — The nomenclature of the igneous rocks of Torres Strait, Queensland. *Qld Govt Min. J.,* 70, 530-6.

A succession of two intrusive and nine volcanic and sedimentary units are recognized in the Torres Str. islands, on C. York Pen., and on the south coast of western Papua. On Daru I., *Maer Volcanics* of Quaternary age are represented by calcareous tuff and tuffaceous sedimentary facies in which detrital limestone fragments contain Pleistocene or Recent faunas. Mabadauan Hill is a residual of *Badu Granite* of probable Permian age. It is a high-level intrusive with several petrographic types represented and associated with acid to intermediate porphyry dykes. A small patch of *Torres Str. Volcanics* of Carboniferous age crops out east of Mabadauan Hill and consists of garnet-quartz-feldspar-biotite hornfels. (W.M.)

02-b-184 WHITTON, W., 1889 — Statement furnished on the Woodlark Group. *Brit. N. Guinea ann. Rep. for 1888 (Qld)*, App. A, 38-9 (also issued as *Brit. N. Guinea ann. Rep. for 1888 (Vic.)*, App. H, 41-2).

The reefs, anchorages, and islands of Woodlark I. and the Albatross Group (Egum Is) are described. The Albatross Group is volcanic, with barrier shoal reefs. (W.M.)

02-b-185 WILKINSON, C. S., 1888 — Report on the geological specimens from New Guinea, collected by the exploring expedition of the Geographical Society of Australasia. *Trans. Proc. Roy. geogr. Soc. Aust., N.S.W. Br.,* 3-4, 203-6.

Samples from the bed and banks of the lower reaches of the Strickland R. include unfossiliferous red and yellow ferruginous sandy clays of inferred Tertiary or Pleistocene age. 120 km up from the Strickland junction, river-bed gravels included red and white marble, limestone, altered slate (with quartz veins) of inferred Silurian age, brown jasperoid rock, quartz syenite, dense basalt, vesicular basalt, and scoria, and calcareous shale which crops out in the river banks 100-120 km farther upstream, where the Cretaceous fauna included *Gryphaea, Modiola, Aviculopecten, Protocardium, Cidaris, Ammonites,* and *Inoceramus.* Seams of lignite are seen in river banks. Igneous and metamorphic debris in the river bed may be derived from the ranges farther north, where the Strickland R. rises. (W.M.)

02-b-186 WILLIAMS, F. E., 1938 — Recently discovered megaliths in the Trobriand Islands. *Papua ann. Rep. for 1936-37,* 34-35 (also issued as *Aust. parl. Pap. 27, Sess. 1937-40,* 3, 1113-5.

Kiriwina I. in the Trobriand Is is composed of nummulitic and coralline limestone of an uplifted atoll. Beach rock accumulating on the coastline forms a platform for about 75 m out from the water-line. (W.M.)

02-b-187 YATES, K. R., and de FERRANTI, R. Z., 1967 — Geology and mineral deposits Port Moresby/Kemp Welch area, Papua. *Bur. Miner. Resour. Aust. Rep.* 105 (Rep. PNG 1), 117 pp.

The area contains rocks ranging from Upper Cretaceous to Pleistocene in age but only Eocene (*Port Moresby Beds*), Oligocene (*Sadowa Gabbro*), and Pliocene (*Astrolabe Agglomerate*) beds crop out widely. The Port Moresby Beds consist of a lutite and a chert facies; the lutite facies, confined to the Astrolabe Mineral Field, comprises calcareous to argillaceous lutite, shale, and limestone; elsewhere chert, limestone, and calcareous sandstone of the chert facies are dominant. The Sadowa Gabbro intrudes the Port Moresby Beds and forms a discordant basic batholith extending beyond the area mapped.

The Astrolabe Mineral Field was worked for copper and gold from 1906 to 1942; 80 000-85 000 tonnes of copper were produced, mainly from the Laloki, Dubuna, and Sapphire-Moresby King mines. Copper mineralization occurs within the lutite facies in the Port Moresby Beds. The orebodies are lenticular and faulting and brecciation are common, particularly along the lode margins. The mineral assemblage is pyrite, marcasite, chalcopyrite and sphalerite, with minor galena, arsenopyrite, specularite, and gold. The Laloki mine was the most productive on the field; current inferred ore reserves are 270 000 tonnes assaying 4.6% copper and 6.3 g/tonne gold. The ore is associated with steeply-dipping black shale in a succession of calcareous to non-calcareous lutite and sedimentary breccia. The reopening of the Laloki mine, or any other in the field, depends on the development of a suitable ore treatment process. The ore appears to be syngenetic.

Manganese ore of battery grade has been won from the Pandora mine in the Rigo area, and further discoveries are possible. Geochemical samples from stream sediments, gossans, and outcrops were analysed for copper, zinc, nickel, and cobalt, and the results are tabulated. Two anomalous areas showing significantly high total copper values were found in the Astrolabe Mineral Field. An area of 50 km^2 of moderately high copper and zinc values near the Kemp Welch R. may be related to slight composition changes in the Sadowa Gabbro. (Auth./W.M.)

(c) NEW GUINEA MAINLAND

See also entries

01-b-43	05-a-51	06-a-3	14-a-25
02-d-45	05-a-54	09-b-15	14-a-48
05-a-32	05-b-19	12-b-10	17-b-14
05-a-49	05-b-21	12-b-11	
05-a-50	05-c-32	12-f-3	

02-c-1 ANONYMOUS, 1882 — (Note on Proceedings of the Geographical Society of St Petersburg.) *Proc. Roy. geogr. Soc.*, 4 (n.s.), 768-9.

The work of Miklouho-Maclay in New Guinea is outlined, including his studies on the Maclay Coast (entry 02-c-30) (W.M.)

02-c-2 ANONYMOUS, 1898e — Dr Lauterbach on the geographical results of the Kaiser-Wilhelms-Land expedition. *Geogr. J.*, 12, 617-8.

Work by Lauterbach (entry 02-c-29) is quoted. (W.M.)

02-c-3 ANONYMOUS, 1912 — Nachrichten von der deutschen Neuguinea-Expedition — II (Report from the German New Guinea expedition — II, in German). *Z. Ges. Erdk.*, 47, 457-9.

Low-grade regional metamorphics form Hunstein Ra. near the confluence of the April and Sepik Rs. (The author is sometimes quoted as H. Spethmann.) (W.M.)

02-c-4 ANONYMOUS, 1913b — The Kaiserin Augusta River expedition, German New Guinea. *Geogr. J.*, 41, 390-1.

Work by Behrmann south of the April R. (entry 02-c-8) is noted. The main divide rises to about 2370 m behind a separated front range which appears to meet the main range farther west. The ranges are composed of quartz-veined slate and shale. (W.M.)

02-c-5 AUSTRALIA. PARLIAMENT, 1940 — Annual report — mining. *New Guinea ann. Rep. for 1938-39,* 101 and 118-21.

Over 6000 m of Lower Tertiary to Mesozoic strata rest on older granodiorite batholiths in the Chimbu-Mt Hagen area. Prospecting on Bougainville located areas where copper, gold, zinc, and iron occur. The amount and value of gold, platinum, and silver exported in the last two years are tabulated. (W.M.)

02-c-6 AUSTRALIA. PARLIAMENT, 1958 — Annual report — mineral resources. *New Guinea ann. Rep. for 1956-57,* 72-4 and 178 (also issued as *Aust. parl. Pap. 22, Sess. 1958,* 7, 175-7 and 281).

Near Aifunka in the Eastern Highlands, outcropping andesitic volcanic breccia is cut by gold-bearing hematite veins. The amount and value of gold, platinum, osmiridium, and iridium exported in each of the preceding five years are tabulated. (W.M.)

02-c-7 AUSTRALIA. PARLIAMENT, 1960 — Annual report — mineral resources. *New Guinea ann. Rep. for 1958-59,* 81-4 and 185 (also issued as *Aust. parl. Pap. 13, Sess. 1960-61,* 3, 862-5 and 966).

The northern exposures of the Papuan Ultramafic Belt were located in the Bitoi-Salamaua area, and a major fault was found along the northern front of the Bismarck Ra. Surveys were made in the Edie Cr., Kainantu, and Snake R. areas. The amount and value of exports of gold, silver and platinum in each of the previous five years are tabulated. (W.M.)

02-c-8 BEHRMANN, W., 1913a — Auf Kaiser-Wilhelms-Land: Expedition des Reichs-Kolonialamts zur Erforschung des Kaiserin-Augusta Fluss (Sepik) in Kaiser-Wilhelms-Land (*In* New Guinea — expedition of the Royal Institute to explore the Kaiserin-Augusta (Sepik) River in New Guinea, in German). *Dtsch Kolonztg,* 2(44), 743-4.

The lower reaches of five tributaries of the Sepik R. — the Freida, Leonard Schultze, April, Yuat, and Keram Rs — are mapped for the first time. They flow over alluvial plains through which rise some low, rounded peaks of regional metamorphics. The upper reaches of the Sepik R. are more deeply dissected. (W.M.)

02-c-9 BLACKWOOD, B., 1939 — Life on the upper Watut, New Guinea. *Geogr. J.*, 94, 11-28.

The Watut R. rises in the Ekuti Ra., where granite and slate crops out in areas 2400-3600 m above sea level. Its upper reaches are in narrow gorges but near Otibanda the valley floor opens out considerably. Slate and porphyry of the Kaindi Series crop out in ranges west of Otibanda. (W.M.)

02-c-10 BRANCH, C. D., 1967g — Volcanic activity at Mt Yelia, New Guinea. *In* BRANCH, C. D. — Short papers from the Volcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (Rep. PNG 2), 35-9.

Mt Yelia is a dormant volcano, 3390 m above sea level, in the Owen Stanley Ra. north of Menyamya. Its volcanic structure in the upper 900 m comprises a northern dome and crater complex, a southern crater ridge, and a dome, all of augite-lamprobolite dacite. Decadent solfatara areas are along the inner face of the southern ridge, and at the base of the dome on the southern and eastern sides about 2700 m above sea level. All solfataras are cold and consist of sulphur-encrusted talus blocks with hydrogen sulphide and a little sulphur dioxide issuing from fissures between them. The volcano is similar to Lamington and *nuées ardentes* may be produced in future eruptions. Two possible avalanche valleys east and west of the mountain drain steeply to sparsely populated valleys which should be evacuated if an eruption seems imminent. (Auth.)

02-c-11 BRASS, L. J., 1964 — Results of the Archbold Expeditions. No. 86 — Summary of the sixth Archbold Expedition to New Guinea (1959). *Bull. Amer. Mus. nat. Hist.,* 127, 145-216.

Work was from camps near Mt Wilhelm and Mt Otto in the Bismarck Ra., in the Asaro Valley near Lufa, near Okapa and Purosa on the western slopes of Mt Michael, on the Wanton R. east of Kainantu, at three sites near Gabensis on the Lae-Bulolo road, on the Ramu-Markham divide, and at Edie Cr. near Wau. The Mt Wilhelm and Otto sites are in granodiorite and schist, and the glaciated nature of the terrain of Mt Wilhelm is apparent from site descriptions and phototgraphs. Mt Elimbari, southwest of Goroka, has bold limestone bluffs forming summit peaks. Granite and limestone crop out near Arau on the Wanton R. (W.M.)

02-c-12 DOW, D. B., 1965 — Regional mapping, Western Highlands of New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT, 1960-65. *Canberra, Aust. Acad. Sci.,* 116, abs. only.

Rocks of the Western Highlands, though much faulted, offer a fairly complete record of sedimentation and igneous activity from Triassic to Recent times. A widespread intrusion of gabbro and dolerite occurred in the lower Miocene, accompanied by basic volcanism. This igneous activity may be directly related to the emplacement of the Marum Basic Belt, which has many features in common with the Papuan Basic Belt. The Bureau of Mineral Resources will map the southern watershed area of the Sepik R., the largest unmapped area in New Guinea. This will be co-ordinated with petrological studies and isotopic age determinations of the igneous rocks. (W.M.)

02-c-13 DOW, D. B., 1967 — Regional mapping in New Guinea. (*In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT, 1965-67. *Canberra, Aust. Acad. Sci.,* 131).

In the eastern part of the southern watershed of the Sepik R., large bodies of serpentinized peridotite and pyroxenite appear to have intrusive contacts with the enclosing Lower Tertiary rocks. (Auth.)

02-c-14 DOW, D. B., & DAVIES, H. L., 1964 — The geology of the Bowutu Mountains, New Guinea. *Bur. Miner. Resour. Aust. Rep.* 75, 31 pp.

The map area covers the Bowutu Mts, part of the northwest Owen Stanley Ra., and the Waria Rift Valley which separates them. The Bowutu Mts form the northwest end of the Papuan Ultrabasic Belt, which was emplaced in fluid or near-solid state in Upper Cretaceous, Lower Tertiary, or lower Middle Tertiary time. Gravity differentiation before or during emplacement produced ultrabasic, basic, and acidic rocks in turn, but tectonic movements and stress during crystallization prevented the development of orderly layering and caused the intrusion of residual magma into the already-solidified parts of the pluton.

The Owen Stanley Ra. is composed of *Owen Stanley Metamorphics,* which include the *Kaindi Metamorphics* (metamorphosed Palaeozoic or Lower Mesozoic shelf and trough-type sediments), and fossiliferous greywacke and sericite schist of Cretaceous age. Rocks within the Waria Rift Valley are Lower Tertiary fine-grained sediments and basic volcanics (*Nipanata Beds*), and a discontinuous veneer of Recent alluvium. Altered volcanics (*Lokanu Metavolcanics*) cropping out near Salamaua can probably be correlated with the Nipanata Beds. Lower Miocene basic and intermediate volcanics (*Mageri Volcanics*) crop out along the northeast flank of the Bowutu Mts.

The Owen Stanley Metamorphics and the Ultrabasic Belt are separated by the

Owen Stanley and Timeno Faults. The main movement on the faults has been transcurrent, the Ultrabasic Belt moving northwest relative to the Owen Stanley Metamorphics. Where movement was impeded by the northerly curve of the Owen Stanley Fault, the Ultrabasic Belt has been locally elevated and the basal ultramafic part of the pluton is now exposed.

Gold is shed from the Kaindi Metamorphics, the Ultrabasic Belt, and the Mageri Volcanics, and about 28 kg has been won, mostly from alluvial workings in the middle Waria Valley. Platinum and osmiridium occur with the gold. Lateritic concentrations of nickel have been found in soils developed over the ultramafic rocks, but in the two areas tested are below economic grade. Copper mineralization occurs at a number of places in the Bowutu Mts. The writers recommend nickel be sought northeast of Lake Trist, and copper near the Timeno Fault and in the northeast Bowutu Mts. (Auth.)

02-c-15 Dow, D. B., & DEKKER, F. E., 1964 — The geology of the Bismarck Mountains, New Guinea. *Bur Miner. Resour. Aust. Rep.* 76, 45 pp.

Upper Triassic rocks comprise the *Jimi Greywacke* and the overlying *Kana Formation,* a marine unit composed mainly of feldspathic detritus from acid volcanic eruptions. The *Bismarck Granodiorite,* earlier regarded as Palaeozoic, was probably intruded during a moderate orogeny which folded the Upper Triassic rocks in uppermost Triassic or lowermost Jurassic time. After a short period of erosion, an essentially conformable sequence was laid down between the Lower Jurassic and the lower Miocene. These sediments have been divided into: *Balimbu Greywacke* (Lower Jurassic), *Mongum Volcanics* (Middle Jurassic), *Maril Shale* (Upper Jurassic), *Kondaku Tuff* (Lower Cretaceous), *Kompiai Formation* (?Middle Cretaceous), *Kumbruf Volcanics* (Upper Cretaceous), and *Asai Beds* (Upper Cretaceous to lower Miocene). Gabbro and some intermediate differentiates, (*Oipo Intrusives*), were emplaced probably in Miocene time, about the same time as rocks of the *Marum Basic Belt,* a large gabbro sill intruded by a dunite plug. Small andesite porphyry intrusions are probably Pliocene, and the terrestrial *Kirambul Conglomerate* was probably laid down during accelerated erosion in the Pleistocene.

The structure is dominated by slightly-curved vertical faults concentrated in zones several km wide. These faults are mainly transcurrent, and there is evidence that rivers crossing the still-active Simbai Fault have been offset 3 km horizontally.

The survey revealed a plug of dunite cropping out over an area of about 250 km^2 within the Marum Basic Belt. Scout auger holes showed that it is covered by deep nickeliferous soils which warrant further testing. Stream sediments were sampled but the only anomalous sample was collected near the Yanderra copper deposit. (Auth.)

02-c-16 Dow, D. B., & PLANE, M. D., 1965 — The geology of the Kainantu Goldfields. *Bur. Miner. Resour. Aust. Rep.* 79, 29 pp.

Probable Palaeozoic metamorphic rocks, (*Bena Bena Formation*), intruded by Upper Triassic *Bismarck Granodiorite* and *Mt Victor Granodiorite,* constitute basement, on which Tertiary 'e'-stage (lower Miocene) *Nasananka Conglomerate* and *Omaura Greywacke* were laid down. 'f1-2'-stage (lower Miocene) *Lamari Conglomerate,* comprising volcanic rocks and conglomerate, rests disconformably on the Omaura Greywacke. Later rocks are the andesitic *Aifunka Volcanics* of probable Pliocene age, Pleistocene lake sediments, and Recent alluvial deposits. Extensive intrusion of dolerite and gabbro (*Akuna Dolerite*) accompanied the 'f1-2'-stage volcanism, and intrusion of the andesitic *Elendora Porphyry* accompanied the Pliocene volcanics. Basement rocks and the 'e'-stage sediments were broadly folded along east-west axes before deposition of the Lamari Conglomerate. Later folding and concomitant faulting along east-northeast axes formed the Arona Syncline.

Some alluvial gold was shed by the Nasananka Conglomerate but most economic gold deposits derive from the Elendora Porphyry, and were deposited in lake sediments and reworked by recent streams. Lode gold is known at several places, but only the Barola Reefs Mine and Mt Victor Prospect are possible economic prospects. Minor deposits of lead-zinc, copper, cinnabar, beryl, and rutile are not economic. A large pyrite deposit at Mt Victor is a potential sulphur source. (Auth.)

02-c-17 EDWARDS, A. B., & GLAESSNER, M. F., 1953 — Mesozoic and Tertiary sediments from the Wahgi Valley, New Guinea. *Proc. Roy. Soc. Vic.*, 64, 93-112.

The following units are described: (i) *Maril Shales,* 1370 m of siliceous and calcareous shale containing the Upper Jurassic mollusc *Buchia malayomaoria* (Krumbeck); (ii) *Kondaku Tuffs,* 1850 m of andesitic tuff, tuffaceous mudstone, and andesitic greywacke, the fauna suggesting correlation with the Purari Formation (entry 03-c-3). Lower Aptian forms were found near Musal village and an Albian fauna southeast of Chimbu village; (iii) *Maram Shales,* 1580 m of shale, mudstone, and minor greywacke, with a Cenomanian fauna; (iv) *Chimbu Tuffs,* 1740 m of tuff and tuffaceous mudstone with bands and lenses of foraminiferal limestone of Eocene and possibly Upper Cretaceous age.

The composition, thickness, and areal extent of the Mesozoic strata suggest eugeosynclinal accumulation in a subsiding trough elongate roughly in the direction of the present cordillera, with a discontinuous and spasmodically-active andesitic island chain to the north. (W.M.)

02-c-18 FISHER, N. H., 1944a — Outline of the geology of the Morobe Goldfields. *Proc. Roy. Soc. Qld,* 55, 51-8.

The *Kaindi Series* of metamorphics of possible Palaeozoic age is mainly schist, slate, phyllite, and crystalline limestone. It is foliated, sheared, veined, and unfossiliferous. It is intruded by the pre-Tertiary *Morobe Batholith,* which is granodioritic, with a variety of acid and intermediate differentiates in marginal phases. The overlying *Tertiary Series,* which dates the Morobe Batholith as pre-Tertiary in exposures to the west, has been removed by erosion in the Morobe Goldfields area. The *Early Porphyries* is a series of quartz-biotite porphyries postdating the granodiorite; in the Wau-Edie Cr. area the Miocene *Lower Edie Porphyry* is followed by the Pliocene *Late Porphyries and Volcanics,* which show two and possibly three generations of intrusions. Hydrothermally-altered, acid, shallow intrusions and lavas of this series are probably genetically related to andesitic and dacitic agglomerates near Wau. The *Otibanda Series* of freshwater shale, mudstone, sandstone, and basal intercalated tuff accumulated in pyroclastic-dammed lakes. Vertebrate remains indicate a Pleistocene age. (W.M.)

02-c-19 FISHER, N. H., 1970 — Wau geology re-interpreted. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

In the Wau-Edie Cr. area, the *Kaindi Metamorphics* of probable Cretaceous age were intruded firstly by the *Lower Edie Porphyry* and later by other porphyritic bodies; the *Upper Edie Pohphyry* was accompanied by intense metasomatism. Volcanic breccias consisting mainly of fragments of Kaindi Metamorphics and Lower Edie Porphyry were also intruded by later small porphyry bodies. Volcanic agglomerates form the lower part of a lacustrine sequence in much of the Bulolo and Watut Valleys. Rhyolite breccia in the 'Koranga Crater' area near Wau is the latest igneous rock. Gold-bearing ore bodies occur in all formations up to the agglomerate, especially in the metasomatized 'mudstone' near the Upper Edie Porphyry and in the breccia in the Golden Ridges area.

Re-examination of the Wau area suggests that the 'Koranga Crater' played a much more important part in the geological development of the area than thought earlier; that it is a volcanic neck about 1 km in diameter; that the early (probably Pliocene) outburst through the Kaindi Metamorphics and Lower Edie Porphyry created coarse, angular, volcanic breccias; that widespread volcanic agglomerates extending for 30 km down the Bulolo and Watut Valleys mainly represent glowing cloud deposits from the volcano or derived volcanic sediments; that mineralization in the Golden Ridges-Upper Ridges area is associated with the later phases of volcanic activity and that mineralization at Edie Cr. was possibly contemporaneous; and that the latest rhyolitic flows from the volcano are quite recent, postdating the lacustrine deposits, which are strongly faulted and in places overturned near the crater, and possibly postdating even the overlying fanglomerates. (Auth.)

02-c-20 FRIEDERICI, G., 1910 — In das Hinterland der Nordküste des Kaiser-Wilhelmsland, Neuguinea (The coastal ranges of the north coast of Kaiser-Wilhelms-Land, New Guinea, in German). *Petermanns Mitt.*, 56(2), 182-6.

The coast of northwest German New Guinea between Aitape and Hollandia was traversed in 1903 by the Hanseatic South Sea Expedition. The Torricelli and Bewani Ras were crossed, and geological material collected for later study. The range of intermediate volcanics and metmorphics collected is noted, and intrusives, limestones, and detrital sediments are identified. (W.M.)

02-c-21 GRAY, W. M., 1930c — Geological report on the Barum River Oil concession, Madang district, New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929, *London, H.M.S.O.*, 2, 40-9.

The sedimentary succession in an area of 2500 km^2 south and southwest of Madang contains five series: (i) *Gum Series,* igneous and some deformed sedimentary rocks, heavily sheared and foliated, of unknown age and thickness; (ii) *Mebu Series,* unfossiliferous limestone and sandstone, deformed and intruded by basic masses and veined with calcite; (iii) *Mena Series,* micaceous shale and sandstone with carbonaceous bands, orbitoidal coarse sandstone, and massive conglomerate. Exposures in the east are deformed and intruded, but elsewhere are undisturbed. There are three groups within this series — *Conglomerate Group, Shale Group,* and *Sandstone Group.* A lower to middle Miocene age is suggested; (iv) *Ouba Series,* massive conglomerate, sandstone, fossiliferous limestone, foraminiferal marl and mudstone. It rests unconformably on the Mena and Mebu Series in the east, but in the west appears to pass gradationally into the Mena Series. The rich fossil faunas suggest an upper Miocene age; (v) *Madang Series,* 15 m of Pleistocene fossiliferous marine limestone and unfossiliferous silt.

The strata are exposed in a broad anticlinal flexure in the central north, and in a complex folded and faulted structure farther south. Indications of petroleum are noted, but the results of the survey indicate that the area is not a potential oil-field. An analysis of natural gas from Duene R. is given. (W.M.)

02-c-22 HAANTJENS, H. A., 1970a — Geological and geomorphic history of the Goroka-Mount Hagen area. *In* HAANTJENS, H. A. (Ed.) — Lands of the Goroka-Mount Hagen area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 27, 19-23.

Palaeozoic regional metamorphics of schist grade are intruded by several large bodies of Permian or Triassic-Jurassic granodiorite. Upper Jurassic to lower Miocene strata accumulated in a eugeosynclinal marine area in which transgression was from the east and north, with a shelf in the Wahgi Valley area. Terrestrial and lacustrine deposits accumulated in the eastern part of the area.

Deformational orogenesis which began in the Miocene was most active during the Pliocene and Pleistocene, and the major structural trends run southeast, with greater differential uplift in the north. Some of the many large faults are still active. The geomorphology of the area markedly reflects the tectonic activity. The strong tectonic activity has resulted in a heavy supply of detritus from rising hills, causing extensive alluvial and lacustrine deposits. It may have changed the direction of flow of the Wahgi R. The area is now in a state of relative tectonic and geomorphic stability. Geomorphic features are listed and include glacial landforms.

02-c-23 HALL, R. J., & HARTLEY, J. S., 1970 — Geology of the Frieda Porphyry copper deposit. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

The Frieda porphyry copper prospect, about 65 km north of Telefomin, is an extensive area of Cretaceous to Eocene *Salumei Formation,* much of which has been regionally metamorphosed to greenschist facies (*Salumei Metamorphics*). In part of the area, shale and greywacke of the lower to middle Miocene *Wogamush Beds* unconformably overlie the Salumei Metamorphics.

The *Frieda Intrusive Complex* consists of two elements: (1) an andesitic core, surrounded by (2) a marginal zone of intermediate porphyritic dykes and plugs, the youngest of which is 16 million years old. Probably concurrent with the intrusion of the complex, block-faulting resulted in a down-faulted rim of Wogamush Beds between the Marginal Zone and the Salumei Metamorphics. Copper mineralization is associated with the porphyritic intrusives emplaced along the perimeter of the andesitic core. (Auth.)

02-c-24 HENRY, W. J., 1966 — Civil engineering aspects of the Upper Ramu River hydro-electric scheme (No. 1 power station and storage dam). *In* FRASER, J. B., & VALLANCE, D. B. — UPPER RAMU RIVER HYDRO-ELECTRIC SCHEME: NO 1 POWER STATION AND ASSOCIATED WORKS. *Canberra, Comm. Dep. Works,* 15-34.

The Ramu R. falls 7500 m over 8 km from the Eastern Highlands Plateau to the plains at Gusap, and its potential for a 60 MW power station is assessed. Bedrock is a succession of folded metamorphosed sediments intruded by basaltic sills and dykes. The sediments are mostly siltstone, greywacke, shale, and crystalline limestone, cut by tight joints and faults or shear zones with small displacements. Bedrock is deeply weathered at the surface, but fresh and strong beneath the weathered zone. Up to 100 m of lake sediments overlie bedrock in the reservoir site. The basal bed of conglomerate, with silty or clayey matrix, is overlain by sandy clay, clayey sand, silty clay, and clay, which are flat-lying and sufficiently strong and impermeable to be adequate foundations and fill for an earth dam.

Initial investigations included field geological studies (entry 12-f-3), shot-hole percussion diamond drilling of the dam and power station site, mechanical testing of drill core, some costeans, shafts and auger holes testing depth of sediment overburden, geophysical testing of depth of overburden and weathered basement, tests of permeability and strength of earth fill materials, (entry 12-f-1), and hydrological monitoring of the catchment area (entry 05-b-57). An earth or rock fill dam and an underground power station and ancillary structures are recommended. (W.M.)

02-c-25 JENSEN, H. I., 1925 — Geological features of the Mandated Territory of New Guinea. *Proc. Roy. Soc. Qld,* 37, 148-51.

There are three distinct suites of rocks in mainland New Guinea: (1) schist, slate, quartzite, greywacke, and acid to basic intrusives of Palaeozoic or possibly Precambrian age; (2) less metamorphosed sediments, mainly on the coastal strip, are folded, faulted, and intruded by granite, diorite, and serpentinite (*Astrolabe-Kemp Welch Series* of Cretaceous and Tertiary age); (3) a narrow belt of deformed unmetamorphosed Miocene to Recent sediments rimming the island. A similar gross structure with three rock suites is recognized in New Ireland and New Britain.

Extensive rift blocks and valleys are seen on land and beneath the sea around New Guinea and New Britain, and large faults control the distribution of blocks of metamorphic, sedimentary, and volcanic rocks. Faults trending mostly northwest often act as foci for volcanic eruptions. (W.M.)

02-c-26 JONES, J. NASON, 1930 — Geology of the Finsch Coast area, North-West New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF

THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, **3, 2-116.**

The geomorphology, stratigraphy, structure, tectonics, and petroleum prospects of northwest New Guinea west of Aitape are detailed, including previously unrecorded stratigraphic and faunal data and correlation and comparative stratigraphy studies. New Guinea faunal studies are related to Dutch studies in West New Guinea and Borneo. (W.M.)

02-c-27 LAUTERBACH, C., 1896a — Über die vorbereitende Tour in das Oertzen-Gebirge (On a reconnaissance traverse in the Oertzen (west end of Finisterre) Range, in German). *Verh. Ges. Erdk.*, 23, 360-1.

Oertzen Mts are composed of alternating shale and conglomerate with a southeast trend. West of them a series of low sub-parallel ranges trends southeast. (W.M.)

02-c-28 LAUTERBACH, C., 1896b — Über den Fortgang der Kaiser-Wilhelms-Land-Expedition (On the progress of Kaiser-Wilhelms-Land Expedition, in German). *Verh. Ges. Erdk.*, 23, 361-4.

Strata exposed in ranges in the upper reaches of the Gogol R. near Madang include sandstone, soft dark shale, and minor conglomerate. (W.M.)

02-c-29 LAUTERBACH, C., 1898 — Die geographische Ergebnisse der Kaiser-Wilhelms-Land-Expedition (The geographical results of the Kaiser-Wilhelms-Land Expedition, in German). *Z. Ges. Erdk.*, 33, 141-77.

Oertzen Ra. south of Astrolabe Bay has a core of old volcanic rocks flanked by sediments and coral limestone. The Bismarck Ra. consists of crystalline metamorphics. (W.M.)

02-c-30 MACLAY, N. de MIKLOUHO, 1874 — Notice météorologique concernant la Côte-Maclay en Nouvelle-Guinée (Meteorological note on the Maclay coast of New Guinea, in French). *Natuurk. Tijdschr. Ned.-Indie,* 33, 430-1.

The north coast of New Guinea between C. Rigny and C. Duperre is fringed with coralline limestone uplifted nearly 2 m above sea level. Mountains south of Astrolabe Bay rise to 2400-2700 m. A severe earth tremor was felt late in 1871. (W.M.)

02-c-31 MCMILLAN, N. J., & MALONE, E. J., 1960 — The geology of the eastern Central Highlands of New Guinea. *Bur. Miner. Resour. Aust. Rep.* 48.

The geology of the eastern portion of the central Highlands of New Guinea was mapped. The *Bena Bena Formation,* the *Goroka Formation,* and the *Bismarck Granodiorite,* all thought older than Permian, constitute the basement complex, which is overlain unconformably by Upper Cretaceous, Eocene, Oligocene, Miocene, and younger rocks of which the Miocene is the thickest and most widespread.

The main post-Palaeozoic orogeny started during Miocene time with the deposition of thick volcanics. Basement and younger sediments were folded during the subsequent culmination of the orogeny, probably in late Pliocene. Faulting which accompanied the folding is still continuing. No large-scale economic mineralization was found. (Auth.)

02-c-32 MARCHANT, S., 1969a — A photogeological assessment of the petroleum geology of the Northern New Guinea Basin, north of the Sepik River, Territory of New Guinea. *Bur. Miner. Resour. Aust. Rep.* 130 (Rep. PNG 4), 78 pp.

The study, confined to upland areas north of the Sepik Plains, continued work begun by Stanley and was aided by surface information obtained by Australasian Petroleum Company Pty Ltd. The sequence comprises Tertiary sediments resting on basement. On photographic evidence, six broad stratigraphic units above the basement are distinguished, and they correlate reasonably with APC units. Definitions from APC reports are given in an Appendix (entry 03-a-9). The photogeological and APC units correlate broadly with the sequence established by Visser and Hermes in West Irian.

Except for an area near Border Mts, the main structural feature is high-angled thrusting trending north of west, interrupted by cross-faulting which could be tensional under east-west rotational stress or dextral and sinistral transcurrent under northeast compressional stress. This applies throughout the area except in a central zone roughly along longitude 142°30'E where the strike is about north-south. Near Border Mts, probably separated from the main area by northwest faults along the Bapi valley, is a different tectonic regime with flat-lying sediments resting on basement. On the evidence of the volcanicity, seismicity, structural pattern, and relation with the ocean floor to the north, the trapezoidal central area of New Guinea may be distinct from areas to the east and west; it is not a modern mobile belt in the same stage of development as the Banda and New Britain areas, and it may not have been subjected to massive east-west rotational stress as postulated by Carey.

The petroleum prospects of the mountain ranges, coastal ranges, and coastal plains are negligible, chiefly due to an unsuitable structural pattern. South of the mountains, in the Sepik Plains and on the slopes to them, prospects are better though much of the area seems to be a simple homocline with only a few narrow faulted and disrupted folds. The Bongos-Namblo fold is the most attractive and warrants testing. (Auth./W.M.)

02-c-33 MARR, C. C., 1938 — Agricultural survey of the Markham Valley. *New Guinea agric. Gaz.*, 4(1), 2-12.

The Markham R. may follow a fault-bounded trough. In the north, conglomerate, sandstone, and fossiliferous mudstone are exposed in the Leron R. area, and may extend eastward. Coal is known near the mouth of the Markham and crystalline limestone near its headwaters. The main ridges of the Saruwaged and Cromwell Ras of Huon Pen. appear to be diorite. Most of the valley-fill sediments and the sedimentary rocks around the Leron R. are thought to have accumulated in an estaurine environment. The valley morphology and soils are discussed. (W.M.)

02-c-34 PAPP, S., 1930a — Geology of the northeastern part of the Sepik District, Mandated Territory of New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 2, 65-79.

Sedimentary strata ranging in age from Miocene to Recent, are about 1600 m thick. Miocene strata are conglomerate, coarse glauconitic sandstone, sandstone, foraminiferal and calcareous marls, and marly limestone. Plant debris and faunas are common in the sandy and marly beds, and several faunas are listed. Pliocene to Pleistocene fossiliferous limestone overlies the Miocene unconformably, and there is an extensive cover of Pleistocene to Recent terrestrial sediments. Small exposures of pre-Miocene or early Miocene intrusions and pyroclastics are in places associated with crystalline schist.

The simple regional structure is open undulatory folding and block-faulting, and regional isostatic movement of coral reefs is noted. Test drill results are discussed and it is concluded that the area is not a potential oilfield. (W.M.)

02-c-35 PAPP, S., 1930b — Geological report on the licensed area of the Sapik Valley Oil Company Limited, Mandated Territory of New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 2, 83-5.

There is little chance of petroleum being found in an area of alluvium-screened metamorphic rocks of probable pre-Tertiary age. (W.M.)

02-c-36 PAPP, S., 1930c — Geological notes on the Hansemann coast between Wewak and Kaup, Mandated Territory of New Guinea. *In* ANGLO-

PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA 1920-1929. *London, H.M.S.O.*, 2, 86-91.

Coastline exposures between Wewak and Kaup, and traverses through Koigin and Kandai-Tring-Kunambu-Kaup are described. Sedimentary strata include fossiliferous Miocene marl-limestone and sandstone-conglomerate successions, raised fossiliferous Pliocene and Pleistocene coralline reefs and gravel terraces, and Recent coral reefs and alluvial deposits. Most of the area lies on pre-Miocene basic intrusions and acid and basic pyroclastics. The area is not a potential oilfield. (W.M.)

02-c-37 PATERSON, S. J., & PERRY, W. J., 1964 — The geology of the upper Sepik-August River area, New Guinea. *J. geol. Soc. Aust.*, 11, 201-11.

The northeastern and southern parts of the area are ranges of metamorphic and igneous rocks. The northwestern part is a south-trending embayment of the northern geosyncline of New Guinea. Most of the embayment is blanketed by alluvium and volcanic rocks, but a composite thickness of 2840 m of Upper Cretaceous to Pliocene sediments has been measured in scattered outcrops. Gravity traverses across the sedimentary zone indicate a major anomaly which suggests the presence of about 4500 m of sediments. (Auth./W.M.)

02-c-38 PERRY, R. A., 1965b — Outline of the geology and geomorphology of the Wabag-Tari area. *In* PERRY, R. A., et al. — General report on the lands of the Wabag-Tari area, Territory of Papua and New Guinea, 1960-61. *CSIRO, Land Res. Ser.* 15, 70-84.

The Wabag-Tari area is part of the broadening of the central cordillera associated with the change in trend from west-northwest in the west to northwest in the east. It has undergone intense orogeny and uplift at a fairly late stage in geologic history, and frequent earth tremors indicate that movement is continuing. Strong youthful relief reflects the influence of a young, active tectonic history.

Nine geological evolution phases are delineated: (a) late Mesozoic accumulation in the Papuan Geosyncline, with less subsidence along the Erave-Wana rise in the Jurassic and associated deepening of the Kutubu Trough; (b) late Jurassic warping leading to late Cretaceous emergence; (c) downwarping and marine transgression from the northeast during early Miocene, accumulation of a northeast-thickening wedge of progressively deeper-water marine limestone and terrigenous epiclastic sediments passing into clastics and basic volcanics, and development of extensive shoal limestone south and west of the re-activated Erave-Wana rise in lower and middle Miocene; (d) orogenic emergence with associated deformation and basic intrusive activity in late Pliocene or early Pleistocene, followed by planation; (e) rapid eustatic(?) uplift in early to middle Pleistocene, with active erosion and incision of deep valleys; (f) intermittent basic volcanism in the Pleistocene from centres at Mt Hagen, Mt Giluwe, Mt Ialibu and Doma Peaks; (g) alluviation and incision of rivers; (h) glaciation in Pleistocene to Recent time around the summit of Mt Giluwe and nearby peaks; (i) present erosion and degradation.

The relationship between geology and land systems (entry 05-a-125) depends on lithology, and features of land units on limestone, sediments, basic intrusives, volcanics, and alluvium are outlined. Structural and relief units are listed. (W.M.)

02-c-39 PLANE, M. D., 1967b — Stratigraphy and vertebrate fauna of the Otibanda Formation, New Guinea. *Bur. Miner. Resour. Aust. Bull.* 86, 64 pp.

Late Tertiary intermontane, lacustrine, and fluvial beds in the Morobe area contain vertebrate fossils associated with dated pyroclastic rocks. Metamorphic rocks ranging from probable Palaeozoic to middle or late Cretaceous form a basement into which granodiorite plutons were intruded in the late Cretaceous or early Tertiary. Probable Oligocene or Miocene porphyritic rocks intruded the metamorphics and granodiorite; this activity culminated in explosive volcanism producing vast quantities of agglomerate which blocked the drainages; lacustrine and floodplain sediments (*Otibanda*

Formation) formed behind the dams in the Pliocene. Fossiliferous sandstone and mudstone with conglomerate and intercalated pyroclastic rocks yield K/Ar dates from below the mammal horizons of 6.1 and 7.6 m.y. A 5.7 m.y. date higher in the section is associated with the type faunal locality, which has produced an incisor of the earliest known rodent from the Australian region and new representatives of the marsupial families Macropodidae and Diprotodontidae; the fauna also includes gastropods, crocodilians, snakes, birds, and a dasyurid. (Auth.).

02-c-40 POCH, R., 1907a — Travels in German, British and Dutch New Guinea. *Geogr. J.*, 30, 609-16.

On the mainland opposite the 900 m high volcanic Manam I., steep mountain chains are rimmed with uplifted coral reefs. The Finschhafen coast is rimmed with uplifted coral and overlying chalk and sandstone. The narrow central part of New-Mecklenburg (New Ireland) is composed of coral-fringed shores and a central range of coral limestone up to 400 m high. C. Nelson in Papua is of volcanic origin, with steep-sided valleys running to the sea from three cones. (W.M.)

02-c-41 POCH, R., 1907b — Wanderungen in Gebiete der Kai, Deutsch-Neuguinea (Exploration of the Kai district, German New Guinea, in German). *Mitt. dtsch. Schutzgeb.*, 20, 223-31.

In the Sattelberg (Saruwaged) Ra. coralline limestone crops out in plateaux at 900 m altitude, and terraces fall to the north coast. (W.M.)

02-c-42 RAGGATT, H. G., 1928 — A geological reconnaissance of part of the Aitape district, Mandated Territory of New Guinea. *Proc. Roy. Soc. Qld* 40, 66-90.

The stratigraphic succession includes: (1) Recent coastal deposits of estuarine and fluvial epiclastic sediments, (2) Recent *Matapau Coralline Limestone,* interbedded limestone, mudstone, and pyroclastics of unknown thickness, (3) Recent *Mau River Beds* of mudstone and conglomerate, resting unconformably on (4) *Aitape Beds* of probably Pliocene age, about 1500 m of limestone and volcanics, (5) *Mendam Beds* of unknown thickness and possible Pliocene age, mainly conglomerate, sandstone, and agglomerate, unconformably overlying (6) *Yalingo River Beds* and *Ulau Beds,* about 750 m of micaceous mudstone, shale, and sandstone of probable Miocene age, (7) *Aitertap Beds,* 200-300 m of mudstone of possible Miocene age and(?) *Blire River Beds* of shale, sandstone, and limestone. These unconformably overlie pre-Miocene metasediments and pre-Cretaceous schist and gneiss exposed in the main divide.

Unit characteristics, structure, palaeontology, and geological history are summarized. The area is a possible but unlikely oilfield. (W.M.)

02-c-43 REIBER, J., & RICHARZ, P. S., 1910 — Eine geologische Expedition in das Toricelligebirge, Kaiser-Wilhelms-Land (A geological expedition to the Toricelli Mountains, German New Guinea, in German). *Petermanns Mitt.*, 56, 78-80 and 132-5.

In the Torricelli Ra. southeast of Aitape, metamorphic rocks are overlain by limestone, marine clastic sediments, and lavas of possible Miocene age, and intruded by granitic and syenitic plutonics and associated porphyries. (W.M.)

02-c-44 RICHARZ, P. S., 1910 — Geologische Mitteilungen aus dem Indo-Australischen Archipel— VIIr De geologische Bau von Kaiser-Wilhelms-Land nach dem leutigen stand unseres Wissens. (Geological investigations in the Indo-Australian Archipelago — VII — The geological structure of Kaiser-Wilhelms-Land in the light of our present knowledge, in German). *Neues Jb. Miner. Geol. Paläont. Beilbd.*, 29, 406-536.

This collates work by German geological explorers and missionaries along the north ranges and offshore islands of New Guinea prior to 1910. It deals mainly with the deposits of the offshore active and dormant volcanic islands, Recent and Pleistocene limestones and evidence of changes in sea level, modern marine sediments and strand-line deposits, and the origin of Recent limestones and pyroclastic rocks and associated weathering products. (W.M.)

02-c-45 RICKWOOD, F. K., 1955 — The geology of the Western Highlands of New Guinea. *J. geol. Soc. Aust.*, 2, 63-82.

The oldest rocks in the Western Highlands of New Guinea are granite and metamorphic rocks, unconformably overlain by an incomplete marine succession of Permian, Upper Jurassic, Cretaceous, Eocene, Oligocene, and Miocene sediments up to 10 000 m thick. The sedimentary succession in the east is much thicker than in the west. Jurassic seas transgressed from the east. Faunal and petrological studies show that the western part was out of range of the sources of Cretaceous volcanism and that slow pelagic sedimentation continued into the lower Miocene. By middle Miocene a volcanic island arc had developed near the Lai Syncline and the shallow-water sediments are rich in volcanic debris. Both sediments and basement were folded into a number of anticlines and synclines at the end of the Pliocene. Vigorous erosion was followed by extensive Pleistocene volcanism in the west. Pleistocene glaciation occurred in the Bismarck Ra. down to about 4000 m altitude. (Auth.)

02-c-46 STANLEY, E. R., 1923 1 — Report on the salient geological features and natural resources of the New Guinea Territory. *New Guinea ann. Rep. for 1921-22*, App. B, 1-99 (also issued as *Aust. parl. Pap. 16, Sess. 1923-24*, 4, 1475-1570).

The coast of much of mainland New Guinea and the offshore islands is bordered by recently-uplifted Recent coralline limestone. The inland areas of the mainland are composed of deformed Tertiary sediments and volcanics resting on a basement of Mesozoic marine sediments and intruded by granitic to intermediate plutonics. Still-active volcanic areas provide much of the material of the islands, which also include uplifted limestone islets. Known and potential mineral resources are discussed. This is a major reference work, and includes data collected by numerous German expeditions and some by Stanley. Much of the information was not previously recorded. (W.M.)

02-c-47 TAYLOR, J. L., 1935 — Résumé — Mt Hagen Patrol. *New Guinea, ann. Rep. for 1933-34*, App. B, 113-7 (also issued as *Aust. parl. Pap. 145, Sess. 1934-37*, 2, 956-60).

The Wahgi valley contains numerous terraced river base levels. The upper reaches rise through rolling volcanic plains to Mt Hagen, and fall rapidly to the Sepik (Yuat) valley in the north and the Purari valley in the south. Plutonic rocks are exposed in the upper reaches of the Jimi valley, and volcanics in the Baiyer valley. From the top of Mt Hagen the volcanic form of Mt Giluwer (Giluwe) was seen, and high limestone cliffs occur farther west. (Auth./W.M.)

02-c-48 TAYLOR, J. L., 1940 — Interim report on the Hagen-Sepik patrol, 1938-39. *New Guinea ann. Rep. for 1938-39*, App. B, 137-49.

A year-long expedition examined the highlands between Mt Hagen, the head of the Strickland and Sepik Rs and the Dutch New Guinea border, and went down the Sepik and up the Yuat and Tarua Rs to Wabag. Limestone and calcareous shale crop out in the Victor Emmanuel Ra. and its eastern approaches; pyrite and gold occur, and streams were tested for gold. (W.M.)

02-c-49 WERNER, E., 1909 — Im westlichen Finisterregebirge und an der Nordküste von Deutsch-Neuguinea (In the western Finisterre Range and on the north coast of German New Guinea, in German). *Petermanns Mitt.*, 55, 73-82, and 107-13.

The Finisterre Ra. south of Astrolabe Bay is dissected by numerous swift-flowing rivers. Its terrain is described with the aid of maps and sketches, unlocated 'sedimentary rocks' and 'eruptive rocks' are recorded, and limestone noted. (W.M.)

02-c-50 WOODS, J. T., 1962 — Fossil marsupials and Cainozoic continental stratigraphy in Australia: a review. *Mem. Qld Mus.*, 14(2), 41-9.

Nototherium watutense is known from the Watut R. near Wau, in unconsolidated sediments of probable Pleistocene age occurring in two distinct provinces within the *Otibanda Formation,* a terrestrial unit deposited on an andesitic volcanic basement. The east province contains andesitic volcanic detritus admixed with the terrigenous clastics and may be slightly older than the wholly terrigenous west province. (W.M.)

02-c-51 ZOLLER, H., 1890 — Meine Expedition in das Finisterre-Gebirge. (My expedition in the Finisterre Range, in German). *Petermanns Mitt.,* 36, 233-5.

In the Finisterre Ra. south of Astrolabe Bay sandstone, calcareous shale, conglomerate and tuff crop out and are overlain in places by coralline limestone. Some granitic and porphyry intrusives occur, associated with trachytic and andesitic volcanics. (W.M.)

(d) NEW GUINEA ISLANDS

See also entries

01-a-17	05-c-34	09-b-28	14-a-43
02-c-46	05-c-50	12-c-29	14-a-48
02-d-57	05-d-10	12-c-39	14-a-54
05-c-28	05-e-5	12-c-41	14-c-1
05-c-29	08-e-1	12-c-64	
05-c-33	09-b-10	14-a-35	

02-d-1 ANONYMOUS, 1894a — German New Guinea. *Geogr. J.,* 3, 519-20.

Work in the volcanic Schouten Is and coastal New Guinea by Kambach is summarized. (W.M.)

02-d-2 ANONYMOUS, 1894c — Neu-Mecklenburg. *Scott. geogr. Mag.,* 10, 376-8.

New Ireland has three distinct geological regions: (1) in the northwest a long lateritic plain slopes to the sea, with offshore islands of clastic rocks; (2) the middle of the island is composed of alternating sandstone and limestone resting on porphyry, basalt, dolerite and granite; (3) the south of the island, largely unexplored, seems largely of volcanic origin. (W.M.)

02-d-3 ANONYMOUS, 1899 — The Bismarck Archipelago. *Scott. geogr. Mag.,* 15, 546-7.

This is a translation of entry 02-d-29.

02-d-4 ANONYMOUS, 1901 — Geology of the Bismarck Archipelago. *Geogr. J.,* 17, 197-8.

A report by Thilenius (entry 02-d-60) on the geology of New Britain is noted, particularly the contribution of coral and volcanic products in forming the island; obsidian, basalt, and shallow intrusives abound; the central mountain chain may be a continuation of the metamorphic series on mainland New Guinea. New Ireland is thought to be a raised fringing reef. (W.M.)

02-d-5 ANONYMOUS, 1907 — Über die geographische Verbreitung der vulkanischen Gebilde und Erscheinungen im Bismarck-Archipel und auf den Salomon Inseln (On the geographic distribution of volcanic mountains and their expression in the Bismarck Archipelago and the Solomon Islands, in German). *Globus,* 92, 354.

This notes an article by K. L. Hammer who outlines the distribution of volcanic ranges in the region; much of the Gazelle Pen., northern New Britain, and Bougainville I. comprise active or extinct volcanoes and their products. (W.M.)

02-d-6 ANONYMOUS, 1908b — German research in the Western Pacific. *Geogr. J.,* 32, 624-5.

Surveys in New Hanover, New Ireland, and Bougainville by Friederici and Sapper (entry 02-d-26) are recorded. New Hanover and New Ireland are mainly limestones; coal was found on the southwest coast of New Ireland. (W.M.)

02-d-7 ANONYMOUS, 1908c — Deutsch-Neuguinea: über die Expedition des Professors Dr Sapper nach dem Bismarck-Archipel (German New Guinea: on the expedition by Professor Dr Sapper to the Bismarck Archipelago, in German). *Dtsch. Kolonbltt,* 19, 743.

New Hanover and nearby islets are composed of recently-uplifted coralline reef limestone resting on a partly-exposed basement of volcanics. (W.M.)

02-d-8 ANONYMOUS, 1908d — Deutsch-Neuguinea: Wegebau im Norden der Gazelle-Halbinsel (German New Guinea: road-building in the northern parts of the Gazelle Peninsula, in German). *Dtsch. Kolonbltt,* 19, 743-4.

Cuttings made during road-building near the present site of Rabaul revealed stratified volcanic pumiceous ash and older sediments. (W.M.)

02-d-9 ANONYMOUS, 1908e — Deutsch-Neuguinea: von der Expedition Sapper-Friederici (German New Guinea: news of the Sapper-Friederici expedition, in German). *Dtsch. Kolonbltt,* 19, 1009-10.

Much of northern New Ireland comprises volcanics intruded by plutonics and overlain by limestones in the Schleinitz and Lelet Ras. Bougainville I. is composed largely of volcanic eruptive lavas and tuffs, probably related to the active centres of Balbi and Bagana, both of which were issuing small amounts of smoke; marine sediments are rare. (W.M.)

02-d-10 ANONYMOUS, 1944a — New Britain Island. *Rocks Miner.,* 19, 110-1.

Notes on the geology of New Britain include rock and mineral descriptions by Liversidge (entry 08-b-10). Its prominent geological features are active and dormant volcanoes. (W.M.)

02-d-11 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45), ALLIED GEOGRAPHICAL SECTION: 1943ak — Area study of eastern New Britain excluding Gazelle Peninsula. *Terrain Study Allied geogr. Sec.* 51, 45 pp.

This part of New Britain has two main groups of mountain systems, axial ranges which form the main divide are of continental origin, and more isolated peaks which are of volcanic origin. Little is known of the inland high ranges. Slate and granite crop out and some ridges have limestone caps. The mountain range near the southeast coast is almost entirely of limestone, shale, and sandstone. Some isolated peaks are of more recent volcanic origin, and active volcanoes are often met. (C.F.)

02-d-12 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45), ALLIED GEOGRAPHICAL SECTION, 1944j — Locality study of Kavieng. *Terrain study Allied geogr. Sec.* 75, 33 pp.

This part of New Ireland is composed of raised coral in coastal areas and low limestone hills farther south. The central and southern region is andesite, with inlying areas of alluvial sand, gravel, and marsh. Coastal areas and offshore reefs are described, supplemented by aerial photographs. (C.F.)

02-d-13 BLAKE, D. H., 1967 — Bougainville Island North and South — 1 : 250 000 Geological Series, *Bur. Miner. Resour. Aust. explan. Notes* SB/56-8 and SB/56-12.

A geological map of Buka and Bougainville Is contains lithostratigraphic, seismic, and volcanic activity data. The accompanying text, based on the work of Blake and Miezitis (entry 02-d-15), outlines the stratigraphy, structure, volcanism, seismicity, economic resources, and geological evolution of the islands. (W.M.)

02-d-14 BLAKE, D. H., 1968 — Post-Miocene volcanoes on Bougainville Island, Territory of Papua and New Guinea. *Bull. Volc., Ser. II,* 32, 121-38.

From northwest to southeast, 17 post-Miocene strato-volcanoes have been identified on Bougainville; Tore, Balbi, Numa Numa, Billy Mitchell, Bagani, Reini, and Bakanovi volcanoes and the Takuan and Toroka groups of volcanoes: the Toroka group includes Loloru volcano. Several other post-Miocene volcanoes in northern

Bougainville have not been accurately delineated. Only three of the volcanoes are active or potentially active — Bagana (the most active volcano in the New Guinea area), and the dormant Balbi and Loloru. The volcanoes are built up of lavas and pyroclastic deposits mostly of andesitic composition, and some dacite. Modal and chemical analyses show that they belong to the calcalkaline suite characteristic of orogenic regions. (Auth.)

02-d-15 BLAKE, D. H., & MIEZITIS, Y., 1967a — Geology of Bougainville and Buka Islands, New Guinea. *Bur. Miner. Resour. Aust. Bull.* 93 (Bull. PNG 1), 56 pp.

The oldest rocks exposed, probably upper Oligocene to lower Miocene, are the *Kieta Volcanics,* which form Crown Prince and Deuro Ras of southern Bougainville, and the *Buka Formation,* which forms Parkinson Ra. on Buka. They consist of subaerial andesitic and basaltic lavas, agglomerate, tuff, a basic pillow lava, and waterlaid sedimentary rocks composed of volcanic material. In central Bougainville the Kieta Volcanics are locally overlain by a lower Miocene ('e' stage) reef limestone, the *Keriaka Limestone,* which forms a tilted plateau on the south side of the Balbi Volcano, and is overlain by probable Miocene to Pliocene volcanics. The younger volcanic rocks on Bougainville, which crop out over the greater part of the island, form the *Bougainville Group* of Pliocene (?) to Recent age. It consists mainly of andesitic lavas, agglomerate, tuff, and derived sediments, and includes nine formations, comprising the products of a readily-identifiable volcano or volcano group. The volcanic rocks belong to the calcalkaline suite characteristic of orogenic regions. A Pleistocene reef complex, the *Sohano Limestone,* forms most of Buka and also crops out on the north coast of Bougainville. Dioritic intrusions, commonly surrounded by narrow metamorphic aureoles, within the volcanic outcrops may form the cores of deeply eroded volcanic centres.

Three major structural directions are apparent: a northwest trend (Bougainville I. and most Pleistocene and Recent volcanoes on it); a northwest trend (Buka I. and the Parkinson Ra.); and a west to west-northwest trend (Crown Prince and Deuro Ras and most lineaments visible on air-photographs). There is no evidence of strong folding and little evidence of large-scale faulting; known gold and copper mineralization on Bougainville is associated with two porphyritic microdiorite bodies intruding agglomerate of the Kieta Volcanics. Gold occurs in quartz stockworks within 'porphyry copper' deposits. Small quantities of alluvial and eluvial gold have also been found. Many beach sands around the Bougainville coast contain concentrations of titaniferous magnetite. (Auth.)

02-d-16 BLAKE, D. H., & MIEZITIS, Y., 1967b — Bougainville and Buka Islands, New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT, 1965-67. *Canberra, Aust. Acad. Sci.,* 188.

This summarizes entry 02-d-15.

02-d-17 BROWN, G., 1877 — Notes on the Duke of York Group, New Britain and New Ireland. *J. Roy. geogr. Soc.,* 47, 137-50.

In the Duke of York Group, coastal features, anchorages, and distribution of fringing reefs are described.

On New Ireland the main axial range is composed of limestone which dips gently east. The precipitous western limits and gently-sloping eastern limits of the limestone are noted, as is their effect on the coastline and distribution of fringing reefs; drift boulders of foraminiferal chalk were found on some bays on the west coast.

Notes are made on the coastline and volcanic peaks around Rabaul, where Matupi was smouldering. (W.M.)

02-d-18 BROWN, G., 1881 — A journey along the coasts of New Ireland and neighbouring islands. *Proc. Roy. geogr. Soc.,* 3 (n.s.), 213-20.

New Ireland was crossed from west to east near Kuramut. All exposures were limestone, often with 'terra rossa' developed. The east-dipping limestone gives coastal lowlands flat country and offshore fringing reefs on the east, and steep near-coast cliffs and a narrow coastal flat strip on the west with fringing reefs less developed and closer inshore. The distribution of fringing reefs on New Hanover, Sandwich, and Portland Is is noted. (W.M.)

02-d-19 COHN, L., 1913 — Beobachtungen von dem Admiralitätsinseln (Observations in the Admiralty Islands, in German). *Petermanns Mitt.*, 59, 315-20.

Manus I. is essentially volcanic in origin, and some younger limestone crops out. Lou, Baluan, Pom, and Mok are volcanic islands, composed of basalts with subordinate basaltic tuffs. Smaller islands south of Manus are coralline limestone islets. (W.M.)

02-d-20 COLEMAN, P. J., 1970 — Geology of the Solomon and New Hebrides Islands as part of the Melanesian Re-entrant, Southwest Pacific. *Pacif. Sci.*, 24, 289-314.

The Solomon and New Hebrides Is are examples of the 'fractured island chain'. Similarities and differences of the geology, structure, volcanology, and seismic features of each group are noted. Bougainville I. is part of the Solomon group, characterized by a thick succession of oceanic organigenic sediments, thick piles of andesitic volcanics, and active volcanic and seismic zones associated with essentially transcurrent fault systems. (W.M.)

02-d-21 COLEMAN, P. J., GROVER, J. C., STANTON, R. L., & THOMPSON, R. B., 1965 — A first geological map of the British Solomon Islands, 1962. *Brit. Solomon Is geol. Rec.*, 2, 16-7.

The Solomon Is are composed essentially of andesitic lavas and pyroclastics and derived sediments, ranging in age from Eocene to Recent and resting on a Mesozoic basement of sediments, lavas, and intrusives of gabbroic, dioritic, and granitic affinities. Structural characteristics of the islands differ considerably, but fit a regional pattern with broad provinces. An ocean deep occurs south of the island chain, and the seismically active zone dips away from Australia, in contrast with other Pacific rim island festoons. (W.M.)

02-d-22 DANNEIL, C., 1902 — Zwei wenig bekannte Inseln östlich von St Matthias im Bismarck-Archipel (Two little-known islands east of St Matthias in the Bismarck Archipelago, in German). *Petermanns Mitt.*, 48, 278-86.

Kerue (Emira) and Squally (Tench) Is are both low coral islets. (W.M.)

02-d-23 DELAND, C. C., 1936 — Isle of Bougainville. *Proc. Roy. geogr. Soc. Aust., S. Aust. Br.*, 37, 91-5.

About 30 km south of Bagana, calcareous mudstone is intruded by granitic rocks near the junction of the Pine and Kiro Rs. Coastal flats around Numa Numa Bay northeast of Bagana are covered with volcanic ash and some deeply weathered lava. Farther west up the Orovavi R., these are overlain by more resistant lavas containing pyrite (? chalcopyrite) and thick fossiliferous and crystalline limestone crop out. Most aluvial samples contained small accounts of gold, silver, copper, zinc, and lead. Bagana was emitting huge volumes of steam, and fumaroles were seen down to 300 m below the summit. (W.M.)

02-d-24 FISHER, N. H., 1939a — Geology and vulcanology of Blanche Bay, and the surrounding area, New Britain. *New Guinea geol. Bull.* 1.

Blanche Bay is a caldera collapse feature, with present active centres within the main crater rim and some extinct centres on the outward-dipping flanks. Basement rocks in northeast Gazelle Pen. are a complex of metamorphic and intrusive igneous rocks, exposed in the Baining Mts, overlain by lower Miocene mudstone, sandstone, shale, conglomerate, and limestone. Pyroclastics mantle much of the area, thinning away from the Rabaul crater centre. Interbedded fossiliferous limestones low in the pile of pyroclastics contain Pliocene calcareous algae and forams.

The 1937, 1878, and 1850 eruptions are discussed, including the warning phenomena, eruptive sequence, associated phenomena and effects of the 1937 eruption of Vulcan and Tavurvur. The structure and tectonic setting of the volcanoes around Rabaul are outlined, and distribution and petrographic descriptions given for volcanic rocks and glasses. (W.M.)

02-d-25 FISHER, N. H., 1942c — Geological report on Talele Goldfield and environs. *New Guinea geol. Bull.* 3, 50-9.

In the Talele Goldfield in northwest Gazelle Pen. prospecting for iron and gold has been spasmodic since early this century. Basement rocks (*Baining Series*) are mainly shale with some sandstone, conglomerate, quartzite, schist, phyllite, and crystalline limestone. They have been intruded by diorite, granodiorite, porphyrite, and dolerite. A thin veneer of volcanic pyroclastics and Pleistocene to Recent fossiliferous limestones is partly preserved.

Iron ore occurs as lensoid bodies of magnetite and hematite with minor crystalline pyrite within shales of the Baining Series. They may represent replacement bodies, the material having been derived from intrusive igneous rocks (probably granodiorite). Gold occurs in gold-magnetite bodies within the shales of the Baining Series. Some lodes have been worked, and some alluvial deposits prospected. The potential of the field is poor. (W.M.)

02-d-26 FRIEDERICI, G., & SAPPER, K., 1910 — Aus den Schutzgebieten der Sudsee — Buka (On the possessions in the South Sea — Buka, in German). *Mitt. dtsch. Schutzgeb.,* 23, 193-206.

Buka I. has large areas of plateau limestone overlying volcanic rocks of the Parkinson Ra. Numerous notched coastal limestone cliffs permit measurement of sea-level movements. In the Parkinson Ra. and the islands farther south, andesitic tuff is intruded by syenite. Several geological traverses are described. (W.M.)

02-d-27 GREAT BRITAIN NAVAL STAFF, NAVAL INTELLIGENCE DIVISION 1954b — PACIFIC ISLANDS — VOL. III: WESTERN PACIFIC (TONGA TO THE SOLOMON ISLANDS). *London, Brit. Admir. Bd* (Geogr. Handbook Ser. B.R. 519 B), xviii + 741 pp.

The Nissan, Kilinailau (Carteret), Tauu (Mortlock), and Nukumanu (Tasman) Is are atolls or atoll groups. Passages and lagoon floors are clear of reefs, and beaches are uniformly coral sands. Buka and Bougainville are mountainous islands composed largely of volcanic rocks, with some terraced areas of uplifted coralline limestones. Fringing and barrier reefs are developed off the coastlines, except where there is a steep fall to the shore. Balbi and Bagana on Bougainville are active volcanoes. (W.M.)

02-d-28 GUPPY, H. B., 1887b — THE SOLOMON ISLANDS, THEIR GEOLOGY, GENERAL FEATURES AND SUITABILITY FOR COLONISATION. *London, Swan Sonnenschein,* 152 pp.

This, the first major work on the geology of the Solomon Is, discusses classification of islands; descriptions of the age, formation, structure, and rock types of several islands; theories of coral reef formation and growth; Pleistocene and Recent sea level fluctuations; and volcanic activity and earthquake shocks.

There are 3 types of volcanic islands: (1) large mountainous islands of crystalline basic-ultrabasic intrusives and extrusives (such as Bougainville); (2) those with andesitic lavas and pyroclastics on an older core of crystalline basic to intermediate intrusives; (3) andesitic volcanoes, whose recent origin is shown by preservation of cone forms. Bougainville is probably the youngest of the crystalline-complex islands, with recent andesitic cones preserved and older cones more dissected.

Bagana is the only active volcano at this time, but several vents are known to be dormant; Bagana is constantly issuing steam and erupted violently in early 1884.

Earthquake shocks are frequent and mostly of moderate intensity, though local high-intensity shocks are felt near volcanic centres. (W.M.)

02-d-29 HAHL, A., 1899—Der Bismarck-Archipel und die Salomons-Inseln (The Bismarck Archipelago and the Solomon Islands, in German). *Mitt. dtsch. Schutzgeb.*, 12, 107-18.

There are 3 large and 23 small islands in the Bismarck Arch. The southern part of New Britain has a median mountain chain and large rivers feeding from it. 2 extinct volcanoes, Below and Hunstein, are in the west, and a chain of extinct volcanoes on the north coast. Vater and Sudsohn (Father and South Son) are active volcanoes. The Gazelle Pen. is built up of a series of northeast-trending mountain chains and a large depositional plateau to the north. Recent volcanism has produced extensive deposits from Varzin and the Blanche Bay craters Nordtochter (North Daughter), Sudtochter (South Daughter), Mutter (The Mother), and an unnamed crater (Vulcan). A broad depression separates the northern areas of pumice overlying limestone from the limestone of the Baining Mts in the south.

New Ireland consists of 3 or 4 parts which may have been disconnected originally; 7 or 8 terraces are developed in calcareous rocks on the west coast. New Hanover may be of volcanic origin, flanked by recently uplifted coralline limestone. Numerous small low reef islands stud the area, and on Neu-Lauenburg (Duke of York Is) the limestone has been uplifted by up to 50 m. (W.M.)

02-d-30 HAMLIN, H., 1929—First ascent of Mt Balbi. *Aust. Geogr.*, 1(2), 31-8.

The summit of Balbi occupies some 12 km², with crater rim peaks rising to about 2700 m. The fall to the east is precipitous and deeply dissected; that to the west is dissected but less precipitous. The volcano was scaled from the south through a series of discontinuous valleys and ridges. No radial spur is present to afford direct access to the crater lake area, which lies in a large amphitheatre surrounded by volcanic peaks rising a further 300 m. (W.M.)

02-d-31 HEMING, R. F., 1970—The volcanic geology of Rabaul Caldera, New Britain. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Rabaul Caldera extends from Wide Bay to New Ireland and is dominated by faults trending northwest to north. St Georges Channel is the locus of earthquakes of magnitude 4-5 to 7, and seismic refraction work indicates a major fault along its floor and intersecting the mantle boundary. Rabaul is an isolated volcanic centre with no apparent links either to the New Britain-New Guinea Inner Arc, or to the Outer Arc. Its position within a zone of major faults suggests that they mainly influence the appearance of volcanism in the area.

The caldera is elliptical in plan, possibly with at least two major original cones and smaller parasitic cones on the flanks. The collapse volume of such a structure would be about 70 km³. Collapse of the primitive structure occurs in two stages. The latest collapse, and possibly the earlier one, was accompanied by the eruption of ash flows. Eruptions accompanying the final collapse began with powerful vulcanian explosions which ejected a dacitic pumice, forming graded beds locally about 10 m thick. Ash flows subsequently mantled the entire area of the volcano, and carbonized wood fragments from the flow base gave an age of 1200 years B.P. The ancestral structure is made up of basalt and andesite. (Auth.)

02-d-32 HOHNEN, P. D., and MANSER, W., 1970—Epeirogenesis in the Bismarck Archipelago. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

14 terraces, each about 100 m thick, reach from sea level up to 1400 m on the Lelet Plateau of New Ireland. They comprise a succession of sub-horizontal biostromal limestones, where each successive deposit is of slightly less areal extent than the preceding one. The age of the limestones ranges from lower Miocene to Pliocene and possibly Pleistocene. Each terrace represents a depositional hiatus. Similar biostromal and largely coralline limestones are now forming offshore over narrow depth ranges. Thus, since the lower Miocene the island has undergone

rhythmic pulsatory subsidence followed most recently by rapid uplift through 1400 m. (Auth.)

02-d-33 KICINSKI, F. M., & BELFORD, D. J., 1956 — Note on the Tertiary succession and Foraminifera of Manus Island. *In* CRESPIN, I., et al. — Papers on Tertiary micropalaeontology. *Bur. Miner. Resour. Aust. Rep.* 25, 71-5.

Plutonic basement is overlain by a succession of *Hinterland Limestone* of Miocene lower 'f' age, marine tuffaceous siltstone with volcanic tuff and flows of Miocene 'f_3' to 'g' age, with partial covering of Pleistocene to Recent volcanic tuffs and flows and raised coral reefs. A geological map and Miocene faunal lists are included. (W.M.)

02-d-34 KNIGHT, C. L., FRASER, R. B., & BAUMER, A., 1971 — Geology of the Bougainville copper orebody, New Guinea. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 416-7.

The orebody is in a 12 km^2 copper geochemical anomaly in and near an intermediate complex intrusive into a Miocene volcanic suite comprising andesite flows, agglomerate, tuff, dykes, and some associated sediments. The intrusive is about 4 km in diameter, and consists mainly of the *Kaverong Quartz Diorite.* The orebody is localized at the southern edge of the intrusive and in the adjacent andesite. There are 4 intrusive rock types — Leucocratic Quartz Diorite, small intrusives separate from the main mass, and in and around which the highest grade is localized; Biotite Diorite, host for much of the ore; Biotite Granodiorite, of which a 365 m diameter portion is only weakly mineralized and constitutes a low-grade central core to the orebody; and Biuro Granodiorite.

The orebody in plan, as defined by the 0.3% Cu contour, is 1700 m by 1000 m with a low-grade centre and a low-grade indentation (Biuro Granodiorite) which might be regarded as a second low-grade centre. Grades can be contoured, and outwards beyond the 0.3% contour, grade falls off gradually by an increase in the ratio of pyrite to chalcopyrite. The sulphide minerals are chalcopyrite in excess of pyrite, with a little bornite. Gold values vary sympathetically with copper. Although some copper is disseminated throughout the hosts, most of it is in veins; concentric alteration zoning is from potassic in the centre outward through argillic to propylitic. Reserves of primary ore within a designed open pit are estimated at 1000 million tonnes of grade 0.48% Cu and 245 g/tonne Au. Mineralization continues to an unknown depth, and secondary enrichment is unimportant. Engineering aspects of pit development have been investigated. (Auth.)

02-d-35 LANGHANS, P., 1898 — Beiträge zur Kenntnis der deutschen Schutzgebiete: 12A Kerrawarra in der Neu-Lauenberg Gruppe. (Contribution to our knowledge of the German colonies: 12A. Karrawarra in the Neu-Lauenberg (Duke of York) Group, in German). *Petermanns Mitt.,* 44, 275-6.

Karrawarra, the most southerly of the Neu-Lauenberg Group, is a low coral limestone islet. (W.M.)

02-d-36 MACNAB, R. P., 1970 — Geological evolution of the Bismarck Archipelago. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Islands of the Bismarck Arch. are raised parts of a thick accumulation of Cainozoic volcanogenic rocks and minor limestone deposited on oceanic crust between the deformed marginal basins of the Australian continent and the 'Pacific Plate'. Volcaniclastic rocks deposited in a major period of largely andesitic submarine volcanism in the Eocene were indurated and deformed before a second period of extensive submarine and minor subaerial andesitic and some basaltic volcanism during upper Oligocene-lower Miocene. Products of Eocene volcanism form the core of New Britain, where they are overlain in some areas by the upper Oligocene-lower Miocene volcanics, which form the core of southern New Ireland, probably New Hanover, and possibly Manus I. During the middle Miocene carbonate deposition was widespread; volcanic rocks of this age are not recorded from the Bismarck Arch. Extensive sheets of thick-bedded, bioclastic middle Miocene limestone up to 1200 m thick mantle large areas of older volcanics in New Britain, New Ireland, and Manus I. In several areas limestone deposition may have continued into the upper Miocene, and in northern New Ireland possibly into the Pliocene.

Andesitic and basaltic subaerial volcanism of upper Miocene to Pliocene age gave rise to lavas, agglomerate and tuff, and tuffaceous terrestrial and marine sediments, which are exposed in northeast New Britain, central New Ireland, and Manus I. High-level intermediate plutons intrude Eocene volcanics in New Britain; in New Ireland and New Hanover they probably intrude upper Oligocene-lower Miocene volcanics. Quaternary volcanism is represented by a line of volcanic islands east of New Ireland, volcanoes in the Admiralty Is, the Rabaul volcanic centre, and the eastern end of the Bismarck volcanic arc. The present tectonic cycle in the Bismarck Arch. probably began in upper Pliocene time, and is characterized in most areas by uplift. At present the Gazelle Pen., New Ireland, New Hanover, and probably the Admiralty Is belong to the Solomon Is tectonic unit. In contrast, New Britain west of the Gazelle Pen. lies in a separate unit. (Auth.)

02-d-37 MACNAMARA, P. M., 1968 — Rock types and mineralization at Panguna porphyry copper prospect, upper Kaverong valley, Bougainville. *Proc. Aust. Inst. Min. Metall.*, 228, 71-9.

A large body of porphyry-type copper mineralization at Panguna is associated with the intrusion of quartz diorite/granodiorite into andesite, particularly with the contact zone. Metasomatism of both intrusives and andesite resulted in the formation of biotite pseudomorphing hornblende and the veining of the resultant biotite diorite and biotitized andesite by quartz-chalcopyrite veins with pink orthoclase and dark biotite selvages, respectively. The orientation of intrusives and veins appears to be controlled by pre-mineralization fault-joint patterns in the intruded *Kieta Volcanics*. (W.M.)

02-d-38 NOAKES, L. C., 1942 — Geological report on the island of New Britain. *New Guinea geol. Bull.*, 3, 3-39.

The oldest strata are the pre-Tertiary *Baining Series* exposed in Gazelle Pen., in central Nakanai, and as inliers along the centre of the island south of Talasea. It comprises metamorphics such as slate, hornfels, and phyllite, and some limestone. It is intruded by pre-Tertiary granitic and dioritic masses and by Tertiary intrusives. Miocene strata (*Neogene Series*) include limestone, shale, and lignite, and crop out on the Gazelle Pen. west coast, around Jacquinot Bay, the south Nakanai coast, and on the northern flanks of the Whiteman Ra. Foraminiferal evidence indicates a lower Miocene to upper Miocene age, with a gap in the succession during the middle Miocene. Possible Pliocene and proven Pleistocene strata (*Lamogai Series*) west of Whiteman Ra. along the south coast, and the east coast of the Gazelle Pen., include sandstone, shale, fine sandy marl, and limestone. Coralline and foraminiferal faunas in the higher limestone indicate a Pleistocene age.

Igneous rocks form 4 groups: undated older plutonic rocks ranging from diorite to granite, exposed on the north coast of the Gazelle Pen. and in the Nakanai Ra.; Palaeocene or Eocene acid to intermediate porphyries and porphyrites exposed in the Baining Ra., the central Nakanai Ra., and the eastern Whiteman Ra.; later Tertiary basaltic flows interbedded with the Lamogai Series in the north Baining and Wide Bay areas; recent basaltic and andesitic volcanics along the north coast and on the Gazelle Pen.

Pre-Tertiary fold trends have largely determined the form and topography of the island. Deformation of younger Neogene Series was induced by rejuvenation of the island axis, and seems independent of basement structures. Later Tertiary and younger strata are affected by isostatic uplift which appears greater in the south than in the north.

Known reserves of sulphur, gold, coal, tin, petroleum, limestone, iron, copper, and silver-lead-zinc are described, but the economic mineral potential seems unfavourable. (W.M.)

02-d-39 PARKINSON, R. H. R., 1901 — Die Insel St Matthias, Bismarck-Archipel (St Matthias Island, Bismarck Archipelago, in German). *Globus,* 79, 256.

The main peak and range of St Matthias (Massau) is volcanic. It is rimmed with uplifted coral limestone which has a cliffed fall 250 m to the coast on the west and a lower cliffed fall to a coastal sand strip on the east. The island is rimmed with coral fringing reef, and small offshore islets are uplifted reef. (W.M.)

02-d-40 PFLUGER, A., 1901a — Einige geologische Bemerkungen über den Bismarck-Archipel (Some geological observations on the Bismarck Archipelago, in German). *Mitt. dtsch. Schutzgeb.,* 14, 131-8.

The Gazelle Pen. is essentially volcanic, the main peaks being the extinct Mother and North and South Daughters, and the fumarolic Matupi which erupted in 1878 produce abundant pyroclastic debris. Vulcan in Simpson Har. also erupted in 1878. The Duke of York Is are low coral islets. Watom I. north of the Gazelle Pen. is another volcanic cone, presumed extinct. Baining Mts are mostly capped with coralline limestone overlying marble, lavas, and metamorphics intruded by granite and syenite. Extensive areas of volcanics occur on the western fall. West of Open Bay a series of active volcanic cones extends as far as the Willaumez Pen.

On New Ireland, limestone-capped ranges in the north give way to a low-lying saddle on sandstone and tuff. Farther south limestone and volcanics overlie sandstone, and the coast is notched above sea level. (W.M.)

02-d-41 POCH, R., 1908a — Wanderungen im nördlichen Teile von Sud-Neumecklenberg (Exploration in the northern part of southern New Ireland, in German). *Globus,* 93, 7-12.

North of Namatanai the country rises to the limestone-capped Schleinitz Ra. with a steep scarp on the western fall. A similar profile southwest of Namatanai has less exaggerated relief. Off the west coast are occasional undercut stacks of Recent coralline limestone and on the coastline are notched limestone cliffs. (W.M.)

02-d-42 RANNIE, D., 1889 — New Ireland. *Proc. Roy. geogr. Soc. Aust., Qld Br.,* 3(2), 73-91.

Coal is reported from near C. Santa Maria near Matakan, and iron and crystalline quartz from the southern part of the island. In Blanche Bay (Rabaul) on New Britain, a volcanic island was recently formed and has active hot springs.

02-d-43 REIBER, J., 1907 — Vorläufiger Bericht über geologische Untersuchungen in Kaiser-Wilhelms-Land (Preliminary report on geological observations in German New Guinea, in German). *Petermanns Mitt.,* 53, 285-6.

Tumleo I. is composed of coralline limestone of possible Miocene age overlain by basaltic agglomerate and tuff. The limestones contain forams, brachiopods, and pelecypods; the lava blocks are porphyritic. The notched coastline indicates changes in sea level. Manam, Lesson (Bam), and Kairiru Is are of volcanic origin. (W.M.)

02-d-44 SAPPER, K., 1909 — Neu-Mecklenburg (New Ireland, in German). *Geogr. Z.,* 15, 425-50.

The dominance of limestone outcrops in the centre has had a strong influence on the land form and stream system development in the Lelet and Schleinitz Ras. It contrasts strongly with the subdued topography developed on low uplifted limestone or weathered volcanics in the north, and with the more diverse dissected southern part where volcanics, limestone, detrital sediments, and intrusives crop out. (W.M.)

02-d-45 SAPPER, K., 1910a — Beiträge zur Kenntnis Neu-pommerns und des Kaiser-Wilhelms-Land (On investigations in New Britain and German New Guinea, in German). *Petermanns Mitt.,* 56 (1), 189-93; 255-6.

The Gazelle Pen. is composed largely of volanic rocks. There is an old dissected centre (Mt Varzin) near Rabaul and many active or recently-active centres, which are andesitic and produced ash and some lavas. On the west and northwest of the peninsula older andesite underlies limestone plateaux, conglomerate crops out near the Warangoi R., and limestone crops out in its headwater range. Dioritic intrusives are known from the inland of the peninsula. Parts of the peninsula coast are fringed with coral reefs. Islands off the south coast of New Britain are terraced limestone. Active volcanoes exist on western New Britain. The south coast between 149°25'E and 150°25'E is terraced coral limestone, rising to 200 m with terraces at 36 m, 92 m, and 126 m. Watom I. to the north is an ancient volcanic cone.

Near Aitape in western New Guinea, andesitic tuff and conglomerate are intruded by hornblende gabbro. In 1907 a nearby volcano (? Bam) erupted andesitic pumice with large glowing clouds of ash and volcanic steam clouds; it erupted again in 1909 when earth tremors were felt over a large area. Schouten Is off the mouth of the Sepik are terraced coralline limestone 25 to 40 m above sea level, with pumice overlying limestone on some islands. Bam and Manam Is are active andesitic to basaltic volcanoes; Long I. is a volcano no longer active. (W.M.)

02-d-46 SAPPER, K., 1910b — Aus den Schutzgebieten der Sudsee — Eine Durchquerung von Bougainville (On the possessions in the South Sea — A journey across Bougainville, in German). *Mitt. dtsch. Schutzgeb.*, 23, 206-17.

Outcrops of porphyritic hornblende andesite, dacite, andesitic tuff, syenite, and andesitic porphyry dykes are noted in the main dividing range (Crown Prince Ra.). Bagana volcanic peak was issuing a considerable cloud of smoke. (W.M.)

02-d-47 SAPPER, K., 1910c — Wissenschaftliche Ergebnisse einer amtlichen Forschungsreise nach dem Bismarck Archipel im Jahre 1908 — 1. Beitrag zur Landeskunde von Neu-Mecklenberg und seiner Nachbarinseln (Scientific results of an official investigation in the Bismarck Archipelago in 1908 — 1. Contribution on the geography of New Ireland and nearby islands, in German). *Mitt. dtsch. Schutzgeb., Erg.*, 3, 1-130.

Much of northern New Ireland is formed of Tertiary limestone with precipitous plateau edges, overlying Tertiary volcanics and volcanigene sediments mostly of andesitic composition. Brown coal crops out near Matakan plantation and dioritic intrusives and gneiss are known to outcrop inland south of Namatanai. The coasts are largely formed on terraced sub-Recent limestone, usually notched at different levels between 2 and 10 m above present sea level; terraces range 2 to 800 m above sea level. Traverse data suggest that there is a metamorphic basement overlain by a succession of Oligocene to Pleistocene limestones, volcanic tuffs and derived sediments, conglomerates, calcareous and tuffaceous shales, and sandstones and coal. Diorite of unknown age intrudes these strata in southern New Ireland. Several earthquakes were felt during the period 3 March to 26 April, 1908. (W.M.)

02-d-48 SCHLAGENHAUFEN, O., 1908b — Orientierungs-marsche an der Ostkust von sud-Neu-Mecklenberg (A journey of exploration on the east coast of southern New Ireland, in German). *Mitt. dtsch. Schutzgeb.* 21, 213-20.

The east coast of southern New Ireland is embayed, and several large rivers feed to it from the backing ranges. In places there are wide gravelly alluvial plains, in others a cliffed coast or limestone terraces. (W.M.)

02-d-49 SCHLAGENHAUFEN, O., 1909 — Geographisches und sprachliches von der Feni-Inseln (The geography and languages of Feni Islands, in German). *Globus*, 95, 69-71.

The Feni Is are one of a small group of islands off the southeast coast of New Ireland. Nearby Nissan I. is an atoll group, and this and several other small islands are named. The Feni Is comprise 2 separated islands — Ambitle the larger, and Babase northeast of Ambitle. Both are mountainous islands rising steeply from the sea. (W.M.)

02-d-50 SCHLEINITZ, G. E. G., 1877 — Geographische und ethnographische Beobachtungen auf Neu-Guinea, dem Neu-Britannia und Salomons Archipel, angestellt auf S.M.S. *Gazelle* bei ihrer Reise um die Erde 1874-76. (Geographic and ethnographic investigations in New Guinea, New Britain and the Solomon Islands, undertaken by HMS *Gazelle* during her world cruise in 1874-76, in German). *Z. Ges. Erdk., Berl.,* 12, 230-66.

The coast of New Hanover is rimmed with coral reefs and the island appears to be composed of uplifted coral reefs overlying intrusive basaltic rocks and hornblende andesites. Seen from the west, the main range of north New Ireland appears to be a little-dissected plateau with precipitous coast-fall cliffs, and the coast is rimmed with barrier reefs. The Gazelle Pen. contains several probable volcanic cones. The central southern ranges of New Ireland probably are granite, diorite, and hornblende gabbro, and porphyry occurs farther south. The southern part of the Gazelle Pen. is composed of andesitic porphyry, lavas, tuff, and tuffaceous sandstone. The Ninigo Group consists of low coral islets.

02-d-51 SCHLEINITZ, G. E., 1896 — Begleitwörte zur Karte der Nordkuste des westlichen Teil der Insel Neu-Pommern (Notes to accompany the map of the north coast of the western part of the island of New Britain, in German). *Z. Ges. Erdk., Berl.,* 31, 137-54.

The north coast west from Talasea to C. Gloucester has an embayed shore, offshore fringing and barrier reefs, reef patches, and sediments shoals. The western part appears composed largely of limestone and sediments intruded by crystalline rocks and partly covered by younger volcanics from still-preserved cones. Several active or recently-active cones form C. Gloucester and adjacent islands to the north and west, and in 1886 one of the centres on C. Gloucester was active, producing ash, smoke, and a little lava. (W.M.)

02-d-52 SCHLEINITZ, G. E. G., 1897 — Begleitwörte zur Karte des östlichen Teils der Insel Neu-Pommern (Notes to accompany the map of the eastern part of the island of New Britain, in German). *Z. Ges. Erdk., Berl.,* 32, 349-59.

Willaumez Pen. is built up of volcanoes and their products, and a large number of volcanic cones are seen on the north coast of New Britain and in the Gazelle Pen. Older volcanic rocks underlie plateau limestones in the south of the Gazelle Pen. near Open Bay. On the south coast several terraces of limestone form a cliffed coastline. (W.M.)

02-d-53 SPEIGHT, J. G., 1965d — Geology of Bougainville. *38th ANZAAS Cong., Hobart,* Sec. C Abs. (listed by title in *Aust. J. Sci.,* 28, 312).

Bougainville is elongated northwest in the line of the Solomon arc. Pleistocene and Recent volcanoes and associated sediments occupy more than half the island, Tertiary rocks are widespread, and there is a notable belt of pre-Miocene basement across the island, capped by lower or middle Miocene reef limestone. Basement, mainly volcanic sediments and agglomerate, is steeply folded on north-south axes and intruded by diorite. It is confined to a belt 30 km wide through central Bougainville by long sub-parallel faults. Unconformably overlying the basement are massive reef limestones — lower-middle Miocene, the largest outcrop of which is an ancient coral reef with well preserved reef fronts, reef flats and lagoons. Remnants of an extensive andesitic agglomerate sheet also overlie basement unconformably in the Kieta area. Calcareous, volcanic sediments, and associated andesitic lavas deformed to moderate dips occur in the far south, and on Buka I. where the structure is planar. Pleistocene and Recent volcanoes have been subdivided into older, younger, and active, without any concomitant change in petrology. The rocks are all orogenic andesites within the range siliceous to basaltic andesite. All eruptive centres lie within 8 km of a line along the island axis. Most volcanoes are strato-cones, built largely by *nuée* and lahar deposition, but several, including the active Bagana, are steep-sided lava-cones. Bagana emits a dense steamy plume continuously, and is subject to spasmodic explosive activity, as in 1950 when forested areas were devastated. Balbi has an active solfatara field, and is said to have erupted between 1800 and 1850. Sub-Recent volcanic ash overlies most of Bougainville. Extensive upper Pleistocene raised coral reefs occur in the north. Uplift isopleths may be readily traced, and swing from 270° in the southeast of the raised area to 345° in the centre and north, indicating a zone of maximum uplift exceeding 90 m off the east coast of Buka I.

There are 3 distinct lineaments in the structure of the area. The 'volcanic arc' trend from the southeastern chain of the Solomon Is through to Tabar Is is represented by the volcanic axis of Bougainville, but not by the trends of either faulting or folding. Major faults bounding the uplifted basement lie more nearly east-west and are extensions of structures on the *echelon* of islands of the northeastern chain of the Solomons. Fold axes, from the most ancient times to the present, are more nearly north-south. The zone of extreme seismicity (shallow, intermediate, and deep shocks) centred on Empress Augusta Bay extends over southern Bougainville but ends abruptly at the northern margin of basement outcrop. Northern Bougainville, despite intense sub-Recent tectonic warping, is practically aseismic. (Auth.)

02-d-54 SPEIGHT, J. G., 1967a — Geology of Bougainville and Buka Islands. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 71-7.

A succession of stratigraphic units, Oligocene or Eocene to Recent, is dominated by andesitic lavas, tuff agglomerate, derived epiclastic sediments, and minor detrital fossiliferous limestone. The Quaternary succession is mainly andesitic volcanics with interbedded middle Pleistocene and Recent coralline limestones. Intermediate igneous intrusive bodies penetrate many middle Pleistocene or older units.

The Bougainville volcanic centres parallel the volcanic lineament from Guadalcanal and New Georgia to and through the volcanic chain off the east coast of New Ireland. The main tectonic lineament trends 160° and is cut by structural breaks interpreted as faults in a zone which appears to be an extension of the Central Province zone recognized in Santa Ysabel and Choiseul. Seismic and gravity observations suggest this is an area of strong compressive stress. The effect of lithology and structure on land forms is great, and is detailed in entry 05-e-19. (W.M.)

02-d-55 SPRY, W. J. J., 1876 — THE CRUISE OF HER MAJESTY'S SHIP CHALLENGER: VOYAGES OVER MANY SEAS, SCENES IN MANY LANDS. *London, Sampson Low, Marston Searle & Rivington,* xviii + 388 pp.

HMS *Challenger* anchored in Nares Har. on the northwest coast of Wild (Manus) I. in February 1875. The islets off the coast are low coral islets. Some spears carried by natives were tipped with obsidian reportedly found on the island. (W.M)

02-d-56 STEPHAN, E., & GRAEBNER, F., 1907 — NEU-MECKLENBURG, BISMARCK-ARCHIPEL; DIE KUSTE VON UMUDDU BIS KAP ST GEORG (New Ireland, Bismarck Archipelago; the coast from Umuda to Cape St George, in German). *Berlin, Dietrich Reimer,* xii + 242 pp.

The southwest coast of New Ireland is drained by five large rivers and is embayed. Much of the coast is fringed by coral reef, except near the bluff at C. St George. The streams carry debris of porphyry, granite, andesite, sandstone, andesitic tuff, and dolerite. Coastal outcrops are notched uplifted coralline limestones. (W.M.)

02-d-57 STUTZER, O., 1910 — Über Gesteine der Insel Lou, Admiralitätsgruppe, Sudsee (On the rocks of Lou Island, Admiralty Group, South Sea, in German. *Mber. dtsch. geol. Ges.,* 62, 586-9.

Rocks from the Gazelle Pen. were identified (entry 09-b-16) as monzonite, augite porphyry, glassy augite andesite, andesitic tuff, and limestone. Samples from the Admiralty Group now extend the known distribution of volcanic rock types, and include obsidian, fluidal devitrified obsidian, and dense glassy micro-porphyritic types. Microcrystalline glassy rocks with plagioclase, magnetite, and augite are tentatively identified as augite andesites similar to Gazelle Pen. material. (W.M.)

02-d-58 SWIRE, H., 1938 — THE VOYAGE OF THE CHALLENGER: A PERSONAL NARRATIVE OF THE HISTORIC CIRCUMNAVIGATION OF THE GLOBE IN THE YEARS 1872-76. *London, Golden Cockerel Press,* 2 Vols (Facsimile Edition, 1938).

Fringing reefs occur off Nares Har. on the northwest coast of Wild (Manus) I. and obsidian used in spearheads may crop out nearby (see 02-d-55). (W.M.)

02-d-59 TALLARD, C. A., 1970 — Exploration in the Australian Trust Territory of New Guinea. *APEA J.,* 10(2), 74-7.

Petroleum exploration in New Guinea began in 1921 as an extension of surveys conducted in Papua by Anglo Persian for the Australian and British Governments. After the war the present phase of exploration began when Permit 41, New Guinea, was issued on 10 January, 1965. Recent geological explorations on Permit 41, New Guinea, and on Permit 48, New Ireland and New Britain, has added new data that has led to the use of more sophisticated geophysical tools in the Ramu R. and Sepik R. areas and has moved exploration activities towards a more mature stage of development.

Summaries of the geology and evolution of northern New Ireland and western New Britain indicate that late-Tertiary marine deposition ended with intrusion and associated warping or tilting; Pleistocene volcanic centres in western New Britain are still active. In the Aitape-Madang area more complicated and advanced tectonic disturbance of the mid-Tertiary marine succession has occurred. (Auth./W.M.)

02-d-60 THILENIUS, G., 1900 — Geologische Notizen aus dem Bismarck-Archipel (Geological notes on the Bismarck Archipelago, in German). *Globus,* 78, 201-3.

The Nukumanu, Tauu, Kilinailau, Green and Nuguria Grops are coral islets. The central range of New Britain contains metamorphics and intrusives correlated with the main north coast range of New Guinea. The Baining Mts and Gazelle Pen. are different and younger, being composed of volcanics and limestone with still-active volcanic centres. New Ireland is possibly the prior barrier reef of ancestral Gazelle Pen.

In the Admiralty Group obsidian overlies microgranite with associated pyrolusite, and is overlain by limestone in which terraces indicate changes in sea level. The coral atolls of the Hermit Is in the Ninigo Group are built on a central basement of basalt; other islands in the Ninigo Group are coralline. (W.M.)

02-d-61 WALLACE, A. R., 1883b — Other islands of Melanesia. *In* STANDFORDS COMPENDIUM OF GEOGRAPHY AND TRAVEL: AUSTRALASIA. *London, Edward Standford,* 465-91.

The Admiralty Is are low coral islets or mountainous islands. New Britain and New Ireland are mountainous. New Ireland is composed mostly of limestone and is fringed with coral reefs. New Britain is believed to be more mountainous and an active volcano (probably Vulcan) is known. (W.M.)

03 STRATIGRAPHY AND HISTORICAL GEOLOGY

(a) AREAL AND GENERAL

See also entries

12-d-8 12-e-28 12-h-4

03-a-1 AHMAD, F., 1961 — Paleogeography of the Gondwana period in Gondwanaland, with special reference to India and Australia, and its bearings on the theory of continental drift. *Mem. geol. Surv. India,* 90, 142 pp.

The stratigraphy, areal distribution, and tectonism of the Upper Carboniferous to Lower Cretaceous Gondwana Series in India and Australia is discussed, with palaeogeographic reconstruction for several phases of its development and disintegration. Mesozoic and Cainozoic sedimentary successions and tectonism in New Guinea are mentioned as part of the reconstruction of the post-Permian palaeogeography of Gondwanaland. There has been considerable relocation of continental masses during the development and disintegration of Gondwanaland. (W.M.)

03-a-2 AUSTRALASIAN PETROLEUM COMPANY, 1961b — Puri No. 1 Well, Papua. *Bur. Miner. Resour. Aust. Petrol. Subs. Acts Publ.* 6, 59 pp.

Puri No. 1 well penetrated Tertiary strata exposed in the Puri Anticline east of Mt Favenc. About 1800 m of Cretaceous to Miocene strata were drilled, some Lower Miocene and older strata being repeated below a reverse fault at 2260 m. Considerable thicknesses of siltstone and greywacke are interrupted in places by marly layers and detrital limestone. A structural profile interprets the Puri Anticline as asymmetric to the southwest, and disrupted by a reverse fault dipping northeast. Well logs, drill stem tests, and faunal lists are noted. Several oil and gas shows were encountered. (W.M.)

03-a-3 AUSTRALASIAN PETROLEUM COMPANY, 1963 — Addendum to geological results of petroleum exploration in Western Papua, 1937-1961. *J. geol. Soc. Aust.,* 10(2), 365-6.

Recent seismic data indicate 6000 m of cover over basement between the Turama and Gama Rs, compared with 3600 m indicated on the original isopach maps (entry 02-b-18). This may be due to (a) thicker lower Miocene strata in the Omati Trough than originally recognized or thought, (b) thicker Jurassic and Cretaceous strata in the original fill of the basin, and (c) thicker pre- and early Jurassic sediments or metamorphics above the seismic reflector. The evidence of these interpretations is inconclusive. (W.M.)

03-a-4 BEMMELEN, R. W. van, 1949 — THE GEOLOGY OF INDONESIA. *The Hague, Govt Printer,* 4 vols.

Jurassic strata are recorded from the October and upper Strickland Rs. Lower Cretaceous strata are not known, but Upper Cretaceous are recorded in the Fly-Strickland area, the Wahgi R. area, and near Port Moresby. Tertiary strata make up most of east New Guinea and include sediments and volcanics in a succession with few major breaks. Undeformed Tertiary strata occur south of Mt Favenc in western Papua, but to the north they are considerably deformed.

Several major tectonic zones may be recognized in eastern New Guinea, including the Rook volcanic area, an Interdeep between this arc and the mainland, the non-volcanic north coast range, the Ramu-Markham depression, and the central mountain range. The origin and relative ages of these structures relate to northward movement of a major crustal undulation. (W.M.)

03-a-5 Dow, D. B., 1969 — Post-Palaeozoic volcanism in New Guinea (Abstract only). *Geol. Soc. Aust., spec. Publ.,* 2, 203.

Volcanic rocks are absent from most of the post-Palaeozoic geological record in southwest Papua which structurally is part of the Australian craton. By contrast, the mountainous backbone of New Guinea is a mobile belt in which the geologic column is punctuated by many volcanic episodes, nearly all marine and mainly basic in composition, though andesitic volcanism made a substantial contribution in places. The oldest volcanics, apart from thin dacitic lavas of unknown age overlying granitic basement in Papua, are widespread dacite pyroclastics, dacite lavas, and derived sediments, of late Triassic age. Marine basic volcanics several thousand metres thick were extruded in the early Jurassic, early Cretaceous, and late Cretaceous, and thin discontinuous Eocene volcanics are known. Intense tectonic activity in the early Miocene was accompanied by the most widespread volcanic activity of the New Guinea geological record. The volcanics are basic to intermediate and are found throughout the New Guinea Mobile Belt and the New Guinea islands. (Auth.)

03-a-6 FISHER, N. H., 1963 — Advances in geology in Australia since 1920. *10th Pacif. Sci. Cong., Honolulu, Report of standing committee on geology and solid earth geophysics of the Pacific Basin,* 3-14.

The development of geological science in Australia and New Guinea in the period 1920-1961, and the activities of professional groups, State and Commonwealth surveys, and specialist service groups are outlined (W.M.)

03-a-7 GAGEL, C., 1912 — Beiträge zur Geologie vom Kaiser-Wilhelmsland (Contribution to the geology of Kaiser-Wilhelmsland, in German). *Beitr. geol. Erforsch. dtsch. Schutzgeb.,* 4, 1-55.

Geological data collected by German geologists, missionaries, and company officers are collated, including petrographic data on samples and specimens from most parts of German New Guinea, and some analyses of igneous rocks. (W.M.)

03-a-8 GILLESPIE, J., 1967 — The geology of the gas fields of western Papua. *In* Proceedings of the Third Symposium on the development of petroleum resources in Asia and the Far East. *United Nations, ECAFE, Min. Resour. Devel. Ser.,* 26(1), 166-72.

The reserves of 4 gas fields in Papua — Kurua, Bwata, Barikewa, and Iehi — have not yet been determined. In the *Kuru* field, gas was encountered in Kuru No. 1 in the asymmetric, axially-disrupted Kuru Anticline in upper Miocene mudstone which is unconformably overlain by Pliocene conglomerate and sandstone and the Pleistocene volcanics of Mt Favenc. Kuru Nos 2 and 3 penetrated middle and lower Miocene siltstone and limestone resting on Eocene detrital limestone and Cretaceous silty mudstone. *Bwata* field lies in the asymmetric, axially-disturbed Bwata Anticline which is within a larger synclinal feature east of Mt Favenc. The succession is the same as in the Kuru Anticline, and gas was encountered in upper Miocene sandstone and lower Miocene limestone. Gas reserves are estimated at 5.8×10^9 m^3. *Barikewa* field is developed in Lower Cretaceous sandstone in the Barikewa Anticline west of Mt Favenc. Barikewa No. 1 penetrated lower Miocene detrital reef shoal limestone, Eocene foraminiferal and argillaceous limestones with chert, Upper Cretaceous siltstone and mudstone with interbedded sandstone, and Jurassic micaceous mudstone and siltstone with some tight sandstone. These rest with probable unconformity on a pre-Jurassic basement of well cemented calcareous sandstone. Estimates of recoverable reserves in the Lower Cretaceous sands range from 0.8×10^9 to 8.5×10^9 m^3. *Iehi* field is in Miocene sediments in the Iehi Anticline northwest of Mt Favenc. Iehi No. 1 intersected lower Miocene crystalline and algal limestones, Eocene detrital and shelly limestones and conglomerate, Upper Cretaceous silty mudstone with two tight sandstone beds, Lower Cretaceous mudstone and siltstone with two sand horizons containing gas, and Jurassic silty mudstone and sandstone. Gas reserves are estimated as between 0.3 x 10^9 and 3.5 x 10^9 m^3. (W.M.)

03-a-9 MARCHANT, S., 1969b — Stratigraphic definitions and nomenclature. Appendix 1 *in* MARCHANT, S. — A photogeological assessment of the petroleum geology of the North New Guinea Basin, north of the Sepik River, Territory of New Guinea. *Bur. Miner. Resour. Aust. Rep.* 130 (Rep. PNG 4), 59-75.

Stratigraphic units mapped in the North New Guinea Basin in New Guinea and West Irian are defined, with notes on origin and synonymy of names, distribution and thickness of unit, lithology and fauna, age and relationships, and location of type areas or sections. (W.M.)

03-a-10 MONTGOMERY, J. N., OSBORNE, N., & GLAESSNER, M. F., 1944 — Explanatory notes to accompany a geological sketch map of eastern New Guinea. Prep. for *Directorate Res., L.H.Q., Melbourne,* 32 pp.

The principal geomorphic features of Papua New Guinea and their relation to tectonic features are outlined and the main structural features and the tectonic evolution of the island summarized. The succession is broadly divided into Mesozoic, Lower Tertiary (Eocene-Oligocene), Upper Tertiary (Miocene-Pliocene), Pleistocene, and Recent. A core of metamorphic rocks is exposed in the Owen Stanley Ra. with younger sediments and associated volcanic rocks on the flanks and foothills. The main intrustive masses are mentioned. (W.M.)

03-a-11 MONTGOMERY, J. M., OSBORNE, N., & GLAESSNER, M. F., 1950 — Outline of the geology of Australian New Guinea. (*In* DAVID, T. W. E. — GEOLOGY OF THE COMMONWEALTH OF AUSTRALIA (W. R. BROWNE, Ed.), 3 Vols. *London, Arnold,* 1, 662-85).

This updates entry 03-a-10.

03-a-12 OSBORNE, N., 1956 — The sedimentary basins of the Australian territory of Papua and New Guinea. (Symposium sobre Yaimientos de Petroleo y Gas). *20th Int. geol. Cong., Mexico,* 2, 227-35.

Two important sedimentary basins in Papua New Guinea are the Northern Basin and the Papuan Basin, both extending into Dutch New Guinea. They are fundamentally geosynclinal structures, separated by a zone of crystalline basement in the northern half of the Central Cordillera, but with a possible connexion, at present obscure, through the saddle between the Bismarck and Owen Stanley Ras. The Papuan Basin contains a considerable thickness of Upper Jurassic to Pliocene sediments which have been strongly folded and, in some zones, highly faulted to the point of imbrication. Small gas and oil seepages are widely distributed throughout the basin. The Northern Basin contains only Upper Tertiary rocks, mainly marine, resting unconformably on granitic and metamorphic basement with scattered erosional remnants of uppermost Cretaceous and Eocene limestone. The zone of greatest known aggregate thickness, about 10 000 m, occurs in front of the steep upthrust of the Bewani-Torricelli Mts and is also the zone of strongest folding and faulting. Gas and oil shows are relatively scarce, but widely distributed. (Auth.)

03-a-13 OSBORNE, N., 1965 — Petroleum geology of Australian New Guinea. *8th Comm. Min. metall. Cong., Australasia, Publ. 5 (Petroleum),* 99-112.

Two distinct sedimentary basins are recognized — the Papuan Basin which occupies most of the western part of the Central Cordillera and all of western Papua, and the Northern Geocycline which extends from beyond the western border to the Huon Pen. and lies north of the middle Sepik R. and northeast of the Ramu and Markham Rs.

The Papuan Basin is a composite Mesozoic and Tertiary structure consisting of 3 separate geosynclines arranged in arcuate fashion around northeast Australia. The outer unit, the Papuan Geosyncline, is a eugeosyncline in which the sedimentary section aggregates more than 17 000 m. It is now mostly high land, strongly folded, and strike-faulted. The middle unit, the Omati Basin, is a miogeosyncline with a sedimentary section aggregating about 12 000 m. The zone next to the Papuan Geosyncline is well folded but the greater area includes only gentle structural undulations. The inner unit, the Morehead Basin, is an intracratonic basin whose sedimentary section is about 2700 m thick and in which little structural relief has been detected.

The Northern Geosyncline is a eugeosynclinal structure of lower Miocene to Pliocene age. The sedimentary section in the western part, the Bewani Geosyncline, aggregates about 10 000 m. The Bewani and Torricelli Mts are thrust-faulted blocks in this geosyncline, complicated by sharp folding and faulting. The Adelbert, Finisterre, and Saruwaged Mts may be the southeast continuation of the Bewani-Torricelli mountain zone, forming the uplifted core of the rest of the Northern Geosyncline. (Auth.)

03-a-14 SMITH, E. M., 1966 — Lexique stratigraphique internationale: Vol. VI Océanie, fasc. 3a, Nouvelle-Guinée. *21st int. geol. Cong., Copenhagen, Comm. Stratigr., Cent. Nat. Rech. Sci.*

The determination, type exposures, and partial synonymy of stratigraphic units in West Irian, Papua New Guinea, the Bismarck Arch., and the Solomon Is are given for units described before 1960. (W.M.)

03-a-15 SMITH, T. H., 1943 — The geology of New Guinea. *Aust. Mus. Mag.*, 8(3), 91-5.

New Guinea lies on a continuation of the Himalaya-Burma tectonic arc, as shown by its style of deformation and the direction and age of Pliocene folding and faulting. The median 'backbone' of New Guinea is deformed schist and gneiss intruded by granitic rocks which in east New Guinea may be Precambrian, but in Dutch New Guinea could be younger. During the Cretaceous, New Guinea was connected to Australia, with deposition of terrigenous detritus in large shallow seas. Cretaceous and Tertiary terrigenous sediments and limestones were folded and faulted during the Pliocene deformation, and uplifted to their present positions. Horizontal Pleistocene and younger estuarine and volcanic deposits overlie them, and deltas are now building up in the Fly and Kikori Rs. Volcanic rocks are present in Tertiary and younger strata, and there are Pleistocene and younger volcanic centres, some still active. Some intrusive serpentine and gabbro crop out.

Gold has been produced from the Edie Cr.-Bulolo area, several islands in the Louisiade Arch., and many other areas. Osmiridium is known in the Kokoda-Bulolo area, and a little platinum has been produced inland from Astrolabe Bay. Copper has been worked in mines near Port Moresby, and other metallic ores have been discovered. Coal and petroleum occur, and the latter is being actively prospected.

Using the 100-fathom (180 m) line as the edge of the continental block, the Australian-New Guinea block has been separated from the Java-Asia block by a narrow, tectonically-active belt since the close of the Cretaceous, though a land connexion from Australia to New Guinea has not existed since early Tertiary. (W.M.)

03-a-16 STANLEY, E. R., 1923b — Notes on the structural relationships of the volcanic rocks, late Tertiary and Mesozoic deposits in New Guinea. *Rep. 16th Cong. Aust. Ass. Adv. Sci., New Zealand,* 284-95.

This updates entry 02-a-20. Occurrences of Cretaceous and Jurassic rocks in New Guinea are discussed, and their probable relationship with strata in Queensland is interpreted. Several phases of volcanicity related to tectonic features have been recognized. The first phase gave rise to large areas of andesitic agglomerate and lavas during the post-Miocene and early Pliocene tectonism with major folding and faulting. The late Pliocene second phase, in which basaltic lava is the main product, was contemporaneous with the maximum period of strand-folding. This passed into the third phase, when basic to acid pyroclastics accumulated from early Pliocene to Recent centres aligned on release fractures parallel and normal to the principal north-northwest structural trends. The building of a continuous peninsula from a series of islands in 45 years, producing the Willaumez Pen. in New Britain, is an example of the volume of debris produced and the rapidity with which it builds up.

The distribution of Late Tertiary sedimentary rocks is discussed, particularly those in New Britain. Localities of Mesozoic successions in New Guinea and Papua are described, and possible Mesozoic land bridges between Malaya, East Indies, and Australia discussed (W.M.)

03-a-17 TALLIS, N. C., 1969 — Development of Tertiary West Papuan Basin (Abstract only). *Bull. Amer. Ass. petrol. Geol.* 53, 745.

The West Papuan Basin is integrated closely in the west with a downwarped but structurally rigid segment of the Australian shield, and in the south with the Coral Sea hydrographic basin. It incorporates arcuate geosynclinal development east and north beyond the continental margin. The Tertiary basin developed in 3 distinct phases, the first starting in early Eocene when marine seas transgressed a peneplaned tilted Mesozoic land surface from east to west, and a uniform wedge of shoal limestone and chert was deposited. Regression and erosion occurred in late Eocene time. Late Oligocene oceanic crustal upwarp created an eastern volcanic rim to the basin. Typical orthogeosynclinal deposition followed in the early Miocene, with reef, shoal, and pelagic limestone formed marginal to the stable western (continental) shelf, and with prolific volcanism associated with the eastern (oceanic) flank. Mudstone-greywacke sediments were deposited in a narrow intermediate eugeosyncline. Middle Miocene regional uplift and orogenesis of the Central Mountain geanticlinal belt resulted in the development of an immense southeasterly-prograding system, which rapidly buried the early Miocene sequence. This phase probably still is actively prograding southward into the Coral Sea Basin. (Auth.)

03-a-18 THOMPSON, J. E., 1967b — Sedimentary basins in the Territory of Papua and New Guinea, and the stratigraphic occurrence of hydrocarbons. *In* Proceedings of the Third Symposium on the development of petroleum resources of Asia and the Far East. *United Nations, ECAFE, Min. Resour. Devel. Ser.*, 26(1), 160-5.

Thick sequences of Jurassic to Pliocene marine sediments are prospective for oil and gas. Unmetamorphosed Triassic and Permian sediments exposed in the central highlands have not been recognized either at the outcrop, or in the subsurface, in the flanking sedimentary basins. Low-grade metasediments within the median orogenic belt are probably Palaeozoic or older. Some Mesozoic sediments are regionally metamorphosed, particularly on the flanks of the Owen Stanley Ra. The original form of the pre-Tertiary basins has been severely disfigured by Cainozoic orogenies which have produced the main cordillera. The principal basins of Tertiary marine sedimentation (the Papuan Basin south of the highlands, and the Northern New Guinea Basin north of the highlands) received floods of clastic sediments derived from recurring orogenic movements and associated volcanism along a zone now occupied by the highlands and mountain chains. Basin outlines delimiting the present distribution of unmetamorphosed Mesozoic and Tertiary sediments do not necessarily conform with the original basin margins before folding, emergence, and erosion. Only in the Papuan Basin can opposing basin flanks be confidently recognized. The Northern New Guinea Basin and the C. Vogel Basin, which are both truncated by the coastline, are probably of the open marginal type. Thick Tertiary to Recent sediments have accumulated in offshore areas around Papua New Guinea and adjoining islands but, except off the coast of west Papua, deep water has precluded offshore oil exploration. (Auth.)

03-a-19 WILKINSON, C. S., 1878 — Report on progress of the geological survey during the year 1877. *Dep. Min. N.S.W. ann. Rep. for 1877,* 197-208.

D'Albertis' collection of artifacts, fossils, and rocks from the Fly R. is noted.

The older metamorphic rocks and some intrusives may be Silurian and possibly Carboniferous. (W.M.)

03-a-20 WYLLIE, B. K. N., 1938 — New Guinea. *In* DUNSTAN, A. E., et al. — THE SCIENCE OF PETROLEUM — A COMPREHENSIVE TREATISE OF THE PRINCIPLES AND PRACTICE OF THE PRODUCTION, REFINING, TRANSPORT AND DISTRIBUTION OF OIL. *London, Oxford Univ. Press,* 1, 130.

New Guinea consists of a core of granitic and metamorphic rocks, overlain and flanked by sedimentary and volcanic rocks. Orogenic movement began in Palaeogene time, and Neogene sediments accumulated in a series of discontinuous basins. Sedimentary succession in each basin began with fine-grained open-sea planktonic sediments and ended with shallow marine, littoral, and lacustrine beds. Late Neogene strong orogenesis caused folding and uplift of these strata, now much removed by erosion. The petroleum potential of eastern New Guinea as indicated by Anglo-Persian Oil Company may best be realized by investigating structures in the far west and south of Papua. (W.M.)

(b) PALAEOZOIC

No entries.

(c) MESOZOIC

See also entry
02-b-52

03-c-1 ARKELL, W. J., 1956 — JURASSIC GEOLOGY OF THE WORLD. *Edinburgh and London, Oliver & Boyd,* 806 pp.

New Guinea, New Caledonia, and New Zealand are considered parts of a circum-Pacific orogenic belt, most of which has foundered beneath the sea, and which connects through the fold ranges of west Antarctica to the Andes. During the Jurassic it was an area of marine deposition, the Papuan Geosyncline, with terrigenous detritus derived from land masses occupying the sites of the Tasman and Coral Seas. Callovian limestone on granitic basement in the Fly R. area is unconformably overlain by Tithonian shale and Oxfordian strata. Callovian strata are known from the Strickland-Sepik divide.

The evidence of faunal distribution around the circum-Pacific Jurassic successions does not favour long-term stability of the Pacific Basin or ephemeral land-bridges. It does not permit the recognition of faunal realms and provinces in Jurassic areas, mainly due to faunal complexity and lack of temporal control. A northward spread of temperate and equatorial faunas in the Lower Jurassic and Bajocian and the southward spread of northern faunas during the Callovian and Upper Jurassic can be recognized.

Shield areas were firmly developed, with several mobile belts and geosynclines paralleling their margins. The style of sedimentation and lack of volcanics in the Papuan Geosyncline indicate it was not a mobile belt. Orogenic disturbances of short duration and large intensity can be recognized in the circum-Pacific Jurassic succession, except on the western rim south from Japan. A similar gap exists in the circum-Pacific distribution of volcanics. (W.M.)

03-c-2 BRUNNSCHWEILER, R. O., 1963 — A review of the sequence of *Buchia* species in the Jurassic of Australasia. *Proc. Roy. Soc. Vic.,* 76, 163-8.

Three New Guinea species of ammonoids are included in the distribution table of Jurassic faunal elements in Australasia and the western Pacific. *Kossmatia* and *Paraboliceras* are thought to occur in Tithonian strata, and *Perisphinetes s. str.* in the upper Oxfordian. Localities of the material are not cited. (W.M.)

03-c-3 CAREY, S. W., 1945 — Note on Cretaceous strata in the Purari Valley, Papua. *Proc. Roy. Soc. Vic.*, 56, 123-30.

Stratigraphic sections and a variety of lithologies in floaters are described from a succession of 1500 m of Cretaceous fossiliferous mudstone (*Purari Formation*) unconformably overlain by Eocene fossiliferous limestone. Fossils from both Cretaceous and Tertiary strata are mentioned, and the probable areal distribution of *Exogyra*-bearing sandstone in western Papua and the western New Guinea Highlands is outlined. (W.M.)

03-c-4 GRAY, W., 1930a — Note (on sediment samples and fossils from the Era River, Papua). *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 1, 87-8.

Fossiliferous sandstone and mudstone from the *Era Group* in the Era R. upstream from Woodward Junction contain upper Miocene faunas. Underlying strata from the *Iowa Group* in the Era Anticline contain upper Miocene forams. In the Era Anticline the Era Group is about 2100 m thick and the Iowa Group about 300 m. The oldest strata may be about 600 m stratigraphically above the Petroliferous Group in the Hororo area. (W.M.)

03-c-5 OPPEL, T. W., 1970 — Exploration of the southwest flank of the Papuan Basin. *APEA J.*, 10(2), 62-9.

Stratigraphic drilling and seismic mapping off the east coast of C. York Pen. provides a link between the Papuan Basin and the Laura and other Queensland basins. Carboniferous pyroclastics and Permian granites form the C. York-Oriomo Platform. Mid-Mesozoic sediments east of this ridge become thicker and more basinal regionally eastward. Tension faulting along the southwest flank of the basin has created several closed structures. Tertiary sediments are mainly carbonates and exist in a shelf-reef-forereef arrangement with petroliferous pinnacle reefs located on bathymetrically favoured structures.

Seismic mapping located several structures worth testing. The Anchor Cay structure, with the maximum sedimentary column, was stratigraphically drilled to 3570 m in 1969. The sediments penetrated were a Pliocene reef core, Miocene rocks in a near back-reef environment, and thin Eocene carbonate unconformably on Mesozoic clastics. Immediately beneath the unconformity was reservoir-quality Lower Cretaceous sandstone. Volcanic and/or intrusive exotics became commoner in the Jurassic.

Based on results of the Anchor Cay well, it seems that the most-favoured fairway for sandstone reservoir development is farther west where seismic shooting has indicated several structures. (Auth.)

03-c-6 OSBORNE, N., 1945 — The Mesozoic stratigraphy of the Fly River headwaters, Papua. *Proc. Roy. Soc. Vic.*, 56, 131-48.

The Mesozoic section, nearly 2300 m of marine sediments, is divided lithologically into two units (the *Feing Group* and the *Kuabgen Group*), each argillaceous at the top and arenaceous at the bottom. Fossils give the age of the Feing Group as Cretaceous (Cenomanian-Albian) and of the Kuabgen Group as Upper Jurassic. The basal Kuabgen rocks suggest a derivation from granitic basement which probably underlies them at no great depth. The time break between the Kuabgen and Feing Groups, together with the composition of the basal Feing sediments, suggests an Albian transgression over the uppermost Jurassic. An important unconformity also is indicated between the Feing Group and the overlying Tertiary limestone by another big time break and a sudden and complete change in lithology. (Auth.)

(d) Cainozoic

See also entries

02-b-170	02-d-33	04-g-16	17-b-15
02-b-173	04-g-8	12-j-5	

03-d-1 Chapman, F., 1918 — Report on a collection of Cainozoic fossils from the oilfields of Papua. *Papua Bull.* 5, 8-16.

Pliocene and Miocene faunas are listed from the Yule I.-Purari delta area. (W.M.)

03-d-2 Chapman, F., 1923 — Tertiary formations of Papua. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 950-3.

Lower Miocene strata are recorded from Orevi on the Vailala R., and from Bootless Inlet; middle Miocene strata from Hororo, Keke, the Upper Vailala R., and the Upoia bore; upper Miocene strata from the gulf area of Papua; and Pliocene strata from C. Possession and the Ioka-Maiva area. Correlations with material from Borneo, Java, and Japan are discussed. (W.M.)

03-d-3 Chapman, F., 1925 — On some palaeontological and stratigraphical relationships of the Cainozoic rocks of Papua and New Guinea with those of the East Indies. *Geol.-Mijnb. Genoot. Ned., Verh.,* 8, 81-8.

Strong structural, stratigraphic, and palaeontological affinities exist between New Guinea and Java, Sumatra, and Timor. Eocene coralline and foraminiferal faunas, and similar faunas from Oligocene and Miocene beds show the degrees of these affinities. Some palaeogeographic reconstruction of the accumulation sites of the host limestones, marls, and sandstones is suggested. (W.M.)

03-d-4 Chapman, F., 1930a — Report on fossiliferous contents and age of a collection of green muds and marls from the Iowa River, Papua. *In* Anglo-Persian Oil Company — the oil exploration work in Papua and New Guinea conducted by the Anglo-Persian Oil Company on behalf of the Government of the Commonwealth of Australia, 1920-1929. *London, H.M.S.O.,* 1, 87.

A collection of molluscs and forams from the Iowa (Era) R. exposures of the mid-Tertiary *Lower Group* (entry 02-b-56) indicates an upper Miocene age and suggests correlation with the Vaiviri Beds. (W.M.)

03-d-5 Chapman, F., 1930b — Reports on fossils from Oriomo. *In* Anglo-Persian Oil Company — the oil exploration work in Papua and New Guinea conducted by the Anglo-Persian Oil Company on behalf of the Government of the Commonwealth of Australia, 1920-1929. *London, H.M.S.O.,* 2, 17-25.

Bore-core rocks from the Oriomo area are described, their faunas listed, and their ages discussed. Faunas from thin sections of bore-core samples are listed, together with faunas from some surface and bore cores. The Imbi Group in the Oriomo area is probably Pliocene, and the Oriomo Limestone Aquitanian to late upper Miocene. (W.M.)

03-d-6 Chapman, F., 1930c — Report on a series of fossils from the Barum River area, New Guinea. (*In* Anglo-Persian Oil Company — the oil exploration work in Papua and New Guinea conducted by the Anglo-Persian Oil Company on behalf of the Government of the Commonwealth of Australia, 1920-1929. *London, H.M.S.O.,* 2, 50-7).

Faunas of the Ouba and Mena Series near Madang are listed. The Ouba Series may be Pliocene and possibly late Miocene, and the Mena Series is lower and middle Miocene. One sample of nummulitic limestone from the (?)Gasua Limestone is upper Eocene. (W.M.)

03-d-7 Chapman, F., 1930d — Report on a further series of fossils and rock specimens from the Barum River, New Guinea. *In* Anglo-Persian Oil

COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 2, 58-64.

Faunas of the Ouba Series, Mena Series, and Mebu Series near Madang are listed. Ouba Series samples are from pelagic facies of possible upper Miocene age; Upper Mena Series samples are upper Miocene to Pliocene with one sample suggesting lower Miocene; and Lower Mena Series samples are upper lower Miocene and middle Miocene. The Mebu Series is correlated on palaeontological grounds with the Lower Mena Series. (W.M.)

03-d-8 CHAPMAN, F., 1930e — Report on a series of rock specimens and fossils collected by Dr Simon Papp from the Territory near Marienberg, New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 2, 80-2.

Fossiliferous sediments from the Sepik R. area are described and their Early Tertiary to Recent faunas listed. (W.M.)

03-d-9 COLEMAN, P. J., 1968 — The succession of assemblages of larger Foraminifera in Neogene sediments, Outer Melanesia Province, Indo-Pacific Region. *40th ANZAAS Cong., Christchurch*, Sec. C Abs. (listed by title in *Aust. J. Sci.*, 30, 445).

Neogene sediments of the Outer Melanesian Province (northern New Guinea, Solomons, Fiji, New Hebrides) yield scucessive faunas of larger Foraminifera, remarkably uniform considering the geographic spread of the Province (5000 km). The oldest is an early Miocene, *Eulepidina-Spiroclypeus* fauna (Tertiary upper e). Then follow a *Eulepidina-Conomiogypsinoides*' fauna (lower Miocene, late), another characterized by *Lepidocyclina ferreroi, L. radiata, Miogypsina polymorpha* (Tertiary f_{1-2}, aprpoximately Burdigalian), and another in which *L. martini, C. indopacificus* and *Operculina complanata japonica* dominate (Tertiary f_{2-3}, approximately Helvetian). An upper Miocene-Pliocene fauna is distinguished by *Alveolinella quoyi* and heavily-embossed *'Rotalia' schroeteriana*. The youngest, Quaternary, fauna included *Siderolites (Calcarina) spengleri* and *Baculogypsina sphaerulata*. With the planktonic Foraminifera, these faunas have enabled detailed subdivision and correlation of sediments in the Solomons and New Hebrides. Their composition and distribution complement other evidence suggesting that the Outer Melanesian Province was once (Lower/Middle Tertiary) a stratigraphic/structural unity, possibly the major part of an outer Australasian island arc. (Auth.)

03-d-10 COLLINS, B. W., 1943 — Review of I. Crespin's 'Note on the present knowledge of the Tertiary sequence in Papua, and the Mandated Territory of New Guinea.' *Bull. Amer. Ass. petrol. Geol.* 27, 1266-8.

Entry 03-d-11 is reproduced and a bibliography included.

03-d-11 CRESPIN, I., 1939 — Note on the present knowledge of the Tertiary sequence in Papua and the Mandated Territory of New Guinea. *Proc. 6th Pacif. Sci. Cong., San Francisco,* 2, 529-30.

A tentative classification of the Tertiary strata of Papua New Guinea on the basis of their microfaunal content is tabulated and discussed. (W.M.)

03-d-12 DAVID, T. W. E., 1932 — EXPLANATORY NOTES TO ACCOMPANY A NEW GEOLOGICAL MAP OF THE COMMONWEALTH OF AUSTRALIA. *Sydney, Coun. sci. ind. Res., Aust.*, 177 pp.

The historical and tectonic geology of the Australian contingent from the Precambrian to the Recent is outlined, including the geomorphology, main structural features, and Quaternary geology and palaeogeography. The stratigraphy, volcanology, structural history, and economic geology of Papua New Guinea are discussed. (W.M.)

03-d-13 ETHERIDGE, R., Jr, 1876 — Notes on the geology of New Guinea. *Geol. Mag.*, 3 (Decade 2), 428.

Entry 03-e-27 is discussed. The faunal content of clays and marls from Yule I. and other places in western Papua are noted. The faunas represent the first-recorded Miocene material in the area and may indicate a former land connexion with Australia. (W.M.)

03-d-14 GLAESSNER, M. F., 1959b — Die indo-pazifische Region. (The Indo-Pacific Region, in German). *In* PAPP, A. — EIN HANDBUCH DER STRATIGRAPHISCHEN GEOLOGIE (Handbook of Stratigraphic Geology.) *Stuttgart, Enke,* Bd 3(1), 288-310.

The distribution, correlation, and sedimentary environment of Tertiary strata in the region between Australia-New Zealand and India-Persia are outlined and tabulated. In New Guinea, Eocene deep-water marine calcareous siltstone, chert, and tuff are succeeded by tuffaceous sandstone, greywacke, and shallow marine conglomerate and volcanics. Major deformation was in the Oligocene and late Pliocene. (W.M.)

03-d-15 KICINSKI, F. M., 1956 — Notes on the occurrence of some Tertiary larger Foraminifera on Bougainville Island (Solomon Islands). *In* CRESPIN, I., KICINSKI, F. M., PATERSON, S. J., & BELFORD, D. J. — Papers on Tertiary micropalaeontology. *Bur. Miner. Resour. Aust. Rep.* 25, 76-7.

Faunas from limestone exposed on the Wakunai R. east of Mt Balbi indicate a Miocene e stage; those from a limestone 18 km southeast of Mt Balbi indicate a Miocene lower f stage. (W.M.)

03-d-16 MAWSON, D., & CHAPMAN, F., 1935 — The occurrence of a lower Miocene formation on Bougainville Island. *Trans. Roy. Soc. S. Aust.*, 59, 241-2.

A succession of marine mudstone, foraminiferal limestone (*Orovavi Limestone*), calcareous mudstone, and limestone from the Orovavi (Varovi) R. is described. The Orovavi Limestone has a lower Miocene fauna of calcareous algae and forams. It is an equivalent of the upper division of the Lower Aitape Series in New Guinea, and the Laleppe Series in the New Hebrides. A radiolarian-foraminiferal fauna is recorded from the higher limestone. (W.M.)

03-d-17 PAPUAN APINAIPI PETROLEUM CO. LTD, 1960 — Kaufana No. 1 Bore, Papua. *Bur. Miner. Resour. Aust., Petrol. Search Subs. Acts Publ.* 1, 29 pp.

Kaufana No. 1 was drilled to 1025 m. Thin Pliocene calcareous greywacke unconformably overlies Miocene f-3 siltstone which disconformably overlies Miocene f_{1-2} siltsone, shale, and greywacke. Moicene f_3 Bokama Limestone was not encountered but may have been represented by a stratigraphic equivalent. No shows of petroleum were seen. Faunal lists from several depths are interpreted (entry 04-g-1). (Auth./W.M.)

03-d-18 PLANE, M., 1965 — The stratigraphy and vertebrate fauna of the Otibanda Formation. *38th ANZAAS Cong., Hobart,* Sec. C Abs. (listed by title in *Aust. J. Sci.*, 28, 312).

See entry 02-c-39. (Auth.)

03-d-19 PLANE, M. D., 1966 — Late Tertiary lake deposits and a mammal fauna from New Guinea. (Abstract). *Geol. Soc. Amer., spec. Pap.* 87, 223.

See entry 02-c-39. (Auth.)

03-d-20 RICKWOOD, F. K., 1969 — The history of geological exploration in Australian New Guinea. *Proc. Papua New Guinea Sci. Soc.*, 20, 10-7.

Geological exploration in Papua since Macgillivray on the *'Rattlesnake'* is outlined, including the activities of Anglo-Persian Oil Co. and other petroleum exploration companies in western Papua. The development of concepts of structure and stratigraphy of the Tertiary succession in western Papua and the highlands is traced as an example of the evolution of interpretations in the light of data accumulating during an exploration program. (W.M.)

03-d-21 STANLEY, E. R., 1923g — The Tertiary formations of Papua and the New Guinea Territory. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 970-3.

The distribution and age of Eocene to Pliocene strata in eastern New Guinea, the New Guinea islands, and Papua are noted. (W.M.)

03-d-22 STANLEY, E. R., 1923i — Oil Provinces in New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 2, 1248-51.

Petroleum investigation to date in the Aitape and Keku areas of New Guinea and the southwest coast of Papua is summarized and the stratigraphy discussed. In the Aitape area, about 4500 m of late Tertiary sediments in a faulted asymmetrical anticline trending east-southeast consist of three groups — an upper 730 m of foraminiferal mudstone, sandstone, and sandy mudstone, separated from a lower 100 m of fossiliferous micaceous sandstone, mudstone, and conglomerate by 700 m of unfossiliferous conglomerate, micaceous sandstone, and mudstone. This section can be correlated with the Papuan succession. At Keku, conglomerate and sandstone are intruded by altered igneous rocks.

The Papuan Gulf area is a potential site for petroleum reservoirs. The age and gross stratigraphic correlation of the Papuan and New Guinean successions are tabulated (W.M.)

03-d-23 TERPSTRA, G. R. J., 1969 — Micropalaeontological examination of outcrop samples from New Guinea. (Appendix 2, *in* MARCHANT, S. — A photogeological assessment of the petroleum geology of the Northern New Guinea Basin, north of the Sepik River, Territory of New Guinea. *Bur. Miner. Resour. Aust. Rep.* 130 (Rep. PNG 4), 77-8.

Eight sediment samples from the Sepik R. area contain certain unspecified planktonic microfossils in varying states of preservation. Six of the samples are upper Miocene. (W.M.)

03-d-24 WOODS, J. E. TENISON, 1878a — On a Tertiary formation at New Guinea. *Proc. Linn. Soc. N.S.W.,* 2, 125-8.

Fossiliferous Tertiary limestones collected from Yule I. during the *'Chevert'* cruise are described, their fauna noted ,and the echinoids described, including a new species *Temnechinus macleayana.* Yule I. strata are considered lower Pliocene. Post-Pliocene uplift in the area has been 120-150 m. (W.M.)

(e) PALAEOGEOGRAPHY

See also entries

02-b-138	02-c-17	05-f-3	13-b-24
02-b-149			

03-e-1 ABENDANON, E. C., 1919 — Aequinoctia, an old Paleozoic continent. *J. Geol.* 27, 562-78.

The palaeogeographic and tectonic significance of Palaeozoic and Mesozoic metamorphic rocks of the Dutch East Indies are discussed, and their relation to similar rocks in New Guinea, Australia, and Asia is considered. All represent part of a now partly-fragmented and partly-submerged Palaeozoic continent named *Aequinoctia.* (W.M.)

03-e-2 ALBERTIS, L. M. d', 1879a — Journeys up the Fly River and in other parts of New Guinea. *Proc. Roy. geog. Soc.,* 1, 4-16 (also published in *Boll. Soc. geogr. ital.,* 16, 11-26).

Geographical unity of Australia and New Guinea in the immediate geologic past is based on evidence of extinct faunas, geomorphology of the land masses and Torres Str., geology and geomorphology of the Torres Str. islands, and present faunas. (W.M.)

03-e-3 ANDREWS, E. C., 1924 — Prospecting for petroleum in Australia. *Econ. Geol.,* 19, 157-68.

In Papua New Guinea, numerous oil seepages are known from Mesozoic fossiliferous marine sediments which accumulated in northward-deepening geosynclines that were broken by tectonic movements into troughs and shelves, leading to disruption of the depositional sites and the development of broad gentle flexures in whose upper horizons petroleum has accumulated. This style of deposition and deformation contrasts strongly with the Australian Mesozoic and Cainozoic. (W.M.)

03-e-4 BELFORD, D. J., & SCHEIBNER, V., 1971 — Some notes on the palaeogeography and biostratigraphy of Australia and New Guinea. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 87-8.

The Australia-Papua New Guinea-New Zealand region was not a biogeographic province (as it is in Recent time) either during the Mesozoic or before mid-Miocene. After the late Cretaceous a Recent Indo-Pacific faunal bioprovince began with the closing of the migration route provided by Tethys. In the Tertiary the established foraminiferal zones apply in Papua New Guinea, but New Zealand has its own zonal scheme due to latitudinally-controlled distribution of planktonic forms.

Datum levels should be established, based on evolutionary changes in foraminiferal lineages. For the Cretaeous of Western Australia and Papua New Guinea, existing chronostratigraphic units and foraminiferal zones can be used. In the Great Artesian Basin which has an austral (equivalent to boreal) character, microbiostratigraphic (foraminiferal) zones being established show that the same species occur in the Great Artesian Basin, New Zealand, other areas with marine sedimentation in the southern hemisphere, and boreal areas with marine sedimentation in the northern hemisphere. The biostratigraphic scheme established on these species will differ greatly from that based on the tropical Tethyan faunas, but because a transitional biogeoprovince existed with both boreal/austral and Tethyan faunal elements, it will be possible to correlate these schemes.

In the Tertiary the development of the Indo-Pacific bioprovince resulted from far-reaching episodic changes in the nature of Tethys affecting different areas at different times, and intermittent migration into the developing Indo-Pacific bioprovince was possible. In the Australian-New Zealand region, there appears to be a differentiation into tropical and temperate faunas, with several planktonic types apparently confined to New Zealand and southeast Australia. However, the same species were recently found in the Atlantic and may be expected in southern South America. (Auth.)

03-e-5 BENSON, W. N., 1923 — Palaeozoic and Mesozoic seas in Australasia. *Trans. N.Z. Inst.,* 54, 1-62.

Ideas and evolution of thought on the areal extent of the Australian continental block and landmass include evidence from many workers to indicate the extension of a continental block east to Fiji during the Palaeozoic and Mesozoic. Early correlations of Australian and New Zealand successions are tabulated, and their rationale is considered. The geological history of Australasia from Precambrian to post-Cretaceous time is reconstructed with emphasis on tectonics and sedimentation. A unity of geological history is shown until the end of the Mesozoic, when fragmentation apparently began. (W.M.)

03-e-6 BRUNNSCHWEILER, R. O., 1958 — Indo-Pacific faunal relations during the Mesozoic. *In* CAREY, S. W. (Ed.) — CONTINENTAL DRIFT — A SYMPOSIUM. *Hobart, Univ. Tas.,* 128-33.

Mesozoic marine ammonite faunas in Australia, New Guinea, India, Arabia, East Africa, Madagascar, and South Africa have affinities and local speciation variations indicating rapid interconnexion between these areas with minor isolation of some faunas. These characteristics are compatible with the concept of continental drift but do not prove it. (W.M.)

03-e-7 CHEESMAN, L. E., 1951 — Old mountains of New Guinea. *Nature,* 168(4275), 597.

Affinities of New Guinea fauna and flora are analysed and discussed. The strong Asiatic element present may be related to continuous land connexions with Asia from early Palaeozoic until early Pliocene. The ancient mountain system along the north coast of New Guinea and West Irian may represent the margin of a submerged landmass (Cyclopea) which was the bridge to Asia; the tectonics of its subsidence are outlined. (W.M.)

03-e-8 COTTON, B. C., 1944 — The associated Mollusca. *Rec. S. Aust. Mus.,* 6, 355-6.

The molluscan fauna associated with the hominid Aitape skull (entry 04-h-3) is described and compared with that listed from the same stratigraphic level in the Aitape-Vanimo area (entry 02-c-26). Both the currently-recorded and originally-listed faunas indicate the environment of deposition as the littoral zone of a retreating sea. (W.M.)

03-e-9 DURHAM, J. W., 1963 — Palaeogeographic conclusions in light of biological data. *In* GRESSITT, J. L. (Ed.) — PACIFIC BASIN BIOGEOGRAPHY. *Honolulu, Bishop Mus. Press, 355-65.*

Palaeogeographic maps of the Pacific basin at several stages in the Tertiary and Mesozoic indicate the limited extent of landmass immediately north of present mainland Australia. In the Cretaceous a land area existed between Arnhem Land and the Fly-Digoel area, and an island chain along the north coast of mainland New Guinea. In pre-Pliocene Tertiary time the Fly-Digoel platform was part of a larger Australian landmass, and a discontinuous island chain occupied the present site of the New Guinea highlands. During the Eocene and Miocene the only New Guinea landmass appears to have been the Fly-Digoel platform. During the Pleistocene, the New Guinea landmass was connected to Australia, and was slightly more extensive than at present; New Britain, New Ireland, and the Solomon Islands appear for the first time as landmasses. (W.M.)

03-e-10 GLAESSNER, M. F., 1952b — The geology of the Tasman Sea. *Aust. J. Sci.,* 14, 111-4.

The age and evolution of major structural elements in the oceanic New Zealand-Australia-New Guinea area are discussed in the light of palaeogeographic reconstruction and of theories on constancy and change in geosynclinal structures. The existence of the Papuan Geosyncline during Mesozoic and Cainozoic time is sufficient to account for the distribution of the marine faunas in New Guinea, and their Australian affinities. The origin of the present Tasman Sea may have been quite recent and related to the continuing post-Tertiary subsidence of the Thomson Trough. (W.M.)

03-e-11 GLAESSNER, M. F., 1953 — Orogene und kratgene Fazien im Tertiär des Australischen Raumes (Orogenic and cratogenic facies in the Tertiary of the Australian region, in German). *In* KOBER, L. — SKIZZEN ZUM ANTLITZ DER ERDE. *Wein, Verlag Brüder Horllinek,* 279-86.

The geosynclinal Tertiary succession in New Guinea is contrasted with the shallow shelf succession of the Tertiary of southern Australia, exemplifying the styles of sedimentation and causative tectonism in the two areas. (W.M.)

03-e-12 GOOD, R., 1957a — Some problems of southern floras with special reference to Australasia. *Aust. J. Sci.,* 20, 41-4.

The flora of Australia and New Guinea show contrasts greater than expected considering the narrow discontinuous break across Torres Str. Australia and New Guinea have not always been as close as they are, and neither has occupied its present latitude for long. The distribution of plant types and communities, and the marked physiographic contrasts, show that Australia and New Guinea have only recently become associated, and are not one continental unit. They apparently joined and occupied their present positions owing to independent convergent drift which is still continuing. (W.M.)

03-e-13 GOOD, R., 1960 — On the geographical relationships of the Angiosperm flora of New Guinea. *Bull. Brit. Mus. (nat. Hist.), Botany,* 2(8), 205-26.

The main elements of the indigenous angiosperm flora of New Guinea are delineated in terms of families and endemic species, and 8 main categories recognized on the basis of their geographic distribution. The possibility of species having migrated from nearby landmasses in recent geologic time is noted. (W.M.)

03-e-14 GOOD, R., 1963 — On the biological and physical relationship between New Guinea and Australia. *In* GRESSITT, J. L. (Ed.) — PACIFIC BASIN BIOGEOGRAPHY. *Honolulu, Bishop Mus. Press,* 301-9.

Torres Str. may have been a dry landbridge between Australia and New Guinea at one or more times since the end of the Tertiary. To explain the present distribution of fauna and flora, it is postulated that Australia and New Guinea have been two discrete widely-separated landmasses which only recently assumed their present relative positions. The contrasting styles of geology and landscape are evidence for this. (W.M.)

03-e-15 GREGORY, J. W., 1930 — The geological history of the Pacific Ocean. *Quart. J. geol. Soc. Lond.,* 86, cxxii-cxxxvi.

Biological, geological, and tectonic evidence of the history of the Pacific Ocean since the Cambrian is surveyed. Palaeogeographic reconstruction is made of several ancient landmasses whose possible existence is discussed. The ocean has been present as a crustal feature since the Cambrian, but at times it has been represented by much smaller land-locked seas, and the area and margins of the ocean have been changing constantly. Several landbridges existed across the present area of the ocean, whose present size and extent is due to expansion and internal block-subsidence of oceanic crustal material. Other theories are outlined and assessed. (W.M.)

03-e-16 HARRISON, J., 1969 — A review of the sedimentary history of the island of New Guinea. *APEA J.,* 9, 41-8.

The sedimentary history of New Guinea, except the Vogelkop area and eastern Papua, is traced from the Cambrian to the Recent. Palaeogeographic maps indicate land, marine shoal, and deep-water marine areas for each of the Cambrian, Mid-Palaeozoic, Permo-Carboniferous and Triassic, Jurassic, Lower Cretaceous, Upper Cretaceous, Eocene-Oligocene, lower Miocene, upper Miocene, Pliocene, and Pleistocene. Tectonic history is noted insofar as it affects formation of uplifted and downwarped areas. (W.M.)

03-e-17 MATSUMOTO, T., 1967 — Fundamental problems in the Circum-Pacific orogenesis. *Tectonophysics,* 4, 595-613.

The orogenies in the circum-Pacific belt are polycyclic. The old and next youngest orogenic cycles overlapped each other in time-range and shifted in areal distribution. The fundamental tectonic framework of the circum-Pacific mobile belt seems to have changed from the old cycle to the young. The Late Palaeozoic-Mesozoic major cycle evidently played the major role in constructing the circum-Pacific oregenic system and probably also the Pacific Ocean. The formation of the voluminous granitic batholiths in the system, development of the glaucophanitic metamorphic zone, and extrusion of an enormous amount of volcanic matter in geosynclines and on the west-central oceanic rise mark the fundamental change. They may have been closely related to crustal and sub-crustal processes beneath the Pacific Ocean and surrounding continents. The Cainozic tectonic regeneration greatly modified the old structure, giving rise to the island-arc system and other new configurations. The New Guinea region was an active orthogeosyncline during the Cretaceous, with active terrestrial and submarine volcanoes. (Auth./W.M.)

03-e-18 MENARD, H. W., & HAMILTON, E. L., 1963 — Palaeogeography of the tropical Pacific. *In* GRESSITT, J. L. (Ed.) — PACIFIC BASIN BIOGEOGRAPHY. *Honolulu, Bishop Mus. Press,* 193-217.

The western margin of the present Pacific Basin may lie east and north of New Ireland and New Britain, and extend southeast almost parallel to the trend of the Solomon Is. Palaeogeographic reconstruction of landmasses around the Pacific rim during the Cretaceous and Tertiary indicate large areas of New Guinea as landmass, and a landbridge between Australia and New Guinea west of Torres Str. during the Cretaceous. (W.M.)

03-e-19 MEYERHOFF, A. A., & TEICHERT, C., 1971 — Continental drift, III: Late Palaeozoic glacial centres, and Devonian-Eocene coal distribution. *J. Geol.*, 79, 285-321.

Glaciation and large-scale coal deposition cannot take place without adequate water. If the Gondwanaland and Laurasia supercontinents existed, Proterozoic and Palaeozoic glaciations would not have been possible deep in their interiors, nor could the major Carboniferous, Permian, and younger coalfields of east North and South America, east Africa, and India have formed. The presence of major late Palaeozoic ice-centres in Western Australia, central India and northwest Pakistan, Africa, Brazil, and the Atlantic-Indian Ocean margins of Antarctica, and of large Palaeozoic coalfields in east Africa, east India, Brazil, and east North America indicates that large water supplies were close to places where glaciation occurred and where coalfields formed. This suggests that current reconstructions of Gondwanaland and Laurasia are wrong. Coal accumulated where plant decay was slight, average annual temperature ranged from cool to warm, and annual rainfall exceeded 1500-2000 mm. The amount of rain required could not have been precipitated unless late Palaeozoic Atlantic and Indian Oceans existed. The possibility that they were inland seas is eliminated by their circulation requirements. The Palaeoclimatic reconstruction is based partly on the recognition of Permian coal in western Papua, and Lower-Middle Jurassic coal around the Gulf of Papua; no Palaeocene to Eocene coal is recognized in Papua New Guinea. (Auth./W.M.)

03-e-20 NEWTON, H. J., 1964 — Petroleum possibilities of the Gulf of Carpentaria. *APEA J.*, 4, 32-7.

North of the G. of Carpentaria, the West Irian basement has been stable since Precambrian time, but the Papuan basement of the Morehead Basin has been stable since Lower Jurassic. The relief of the Morehead Basin basement ranges about 150 m; elevation ranges from 0 to 3600 m below sea level with most areas lying about 1800 to 2400 m. Basement is of granitic and regional metamorphic rocks and basin fill is Jurassic sands. Many aeromagnetic traverses cover the G. of Carpentaria, and some tie into the Papua mainland west of Daru. The G. of Carpentaria is a north-trending graben. Traces of petroleum have been found in many wells drilled near and on the mainland-Papua edge of the Gulf basin, but reservoir structures seem restricted to basement highs, stratigraphic traps, and fault traps. (W.M.)

03-e-21 STACH, L. W., 1964 — Petroleum potentialities of the continental shelf between Cape York and South-Western Papua. *APEA J.*, 4, 68-73.

Palaeozoic stressed and unstressed granites and genetically-treated acid pyroclastics form basement, seen in several Torres Str. islands and in a few mainland exposures, and in Papuan drill tests. Mesozoic and Tertiary marine sediments of the Morehead Basin wedge out and thin eastward onto the York-Oriomo high. Tertiary limestone crops out, and Mesozoic limestone is known from drill holes in Papua where they wedge westward into a thicker Upper Cretaceous to Pliocene mudstone-limestone-coal succession. Farther west in the Morehead Basin thicker successions are covered with a thick mantle of Recent fluvial and estuarine deposits. Quaternary volcanic centres occur in the Bosavi Mts, with basalt, agglomerate, and hornblende andesite, and in Biwau Hills, with andesitic tuff and olivine basalt. Several basaltic islands on the eastern edge of the continental shelf in Torres Str. are Quaternary.

The Komewu Fault, regarded as marking the boundary between the stable shelf area in the west and the gently-folded Papua Basin in the east, extends south to the Barrier Reef east of C. York. Geophysical evidence suggests structural traps for petroleum east and west of the fault. Post-Jurassic tectonism of the region is essentially a history of gentle isostatic warping. Petroleum potential appears greatest east of the Komewu Fault. (W.M.)

03-e-22 STIRTON, R. A., 1958 — The relationships and origin of Australian Monotremes and Marsupials. *In* CAREY, S. W. (Ed.) — CONTINENTAL DRIFT — A SYMPOSIUM, *Hobart, Univ. Tas.* 172-4.

The evidence of faunal distribution and speciation in the monotremes and marsupials points to the isolation of Australia, New Guinea, and Tasmania during the Cainozoic and at least part of the Mesozoic. It appears that marsupials reached Australia after it had been separated from Asia during the Mesozoic. (W.M.)

03-e-23 TAKAI, F., 1953 — A summary of the mammalian faunas of Eastern Asia and the interrelationships of continents since the Mesozoic. *Proc. 7th Pacif. Sci. Cong., New Zealand,* 2, 289-301.

Broad changes in 24 mammalian faunas from the west Pacific seaboard, Burma, and Indonesia are discussed in order of geological age, starting with Mesozoic forms. The time and place of appearance of each fauna, its areal and temporal distribution, and time of extinction are noted. Inter-relationships of the faunas in Asia, Europe, and North America are tabulated. (W.M.)

03-e-24 TERMIER, H., & TERMIER, G., 1952 — HISTOIRE GEOLOGIQUE DE LA BIOSPHERE (in French). *Paris, Masson,* 721 pp.

In a series of maps showing the palaeogeographic evolution of the earth, the Tasman Geosyncline was a depositional site in west Papua during the Carboniferous with marginal shallow seas developing farther east during the Permian, and the Papua Geosyncline developing during the early Permian. This geosyncline existed intermittently from mid-Jurassic to upper Miocene, flanked by active volcanoes to the north during the late Cretaceous. (W.M.)

03-e-25 THOMSON, J. P., 1901 — The geographical evolution of the Australian continent. *Qld geogr. J.,* 16, 1-25.

Palaeogeographic maps indicating land areas during the Palaeozoic, Mesozoic, and Tertiary show a marked sudden increase in land areas during the Mesozoic. The Australian continent extended east to New Zealand, New Hebrides, and Fiji, and northwest to Borneo. Land areas were bridges for mammalian migration in the region and may explain many elements of faunal and floral distribution. Large long-lasting areas of landbridges connected with New Guinea. The nature and distribution of faunas, and the southern extension of the Australian continental landmass during the Mesozoic and Tertiary are noted. (W.M.)

03-e-26 TRICART, J., 1971 — Pleistocene snowline and present periglacial processes in the Venezuelan Andes compared with Papua. *Aust. geogr. Stud.,* 9, 85-6.

Pleistocene snowlines in the Venezuelan Andes are consistently slightly higher than in Papua, but have depended on direction of prevailing moist winds. Present-day periglacial phenomena can be recognized in both countries above 4000 m, relating closely with Quaternary stratified screes at 3900-4000 m. (W.M.)

03-e-27 WILKINSON, C. S., 1876a — Notes on a collection of geological specimens collected by W. Macleay, Esq. from the coasts of New Guinea, Cape York and neighbourhood islands. *Proc. Linn. Soc. N.S.W.,* 1, 113-7.

Detrital and chemical specimens collected during the cruise of the *'Chevert'* include fossiliferous marine clays from Hall Sd, Yule I., and Katau R., and fossiliferous oolitic limestone from Bramble Cay. These are the first-known lower Miocene rocks from Papua. The distribution of Miocene seas is discussed and a Miocene landbridge with Australia postulated. (W.M.)

03-e-28 WILKINSON, C. S., 1876b — Notes on a collection of geological specimens from the coasts of New Guinea, Cape York and neighbourhood islands collected by Wm. Macleay, Esq. *Ann. Mag. nat. Hist.,* (Ser. 4), 18, 190-2.

This is a re-issue of entry 03-e-27.

03-e-29 WILKINSON, C. S., 1876c — Notes on a collection of geological specimens collected by Wm. Macleay from the coasts of New Guinea, Cape York and neighbouring islands. *Canad. Nat. & quart. J. Sci.,* 8 (n.s.), 156-60.

This is a re-issue of entry 03-e-27.

04 PALAEONTOLOGY

(a) GENERAL

CRESPIN, I., 1948b — Foraminifera in Australian stratigraphy. *18th Int. geol. Cong., London,* 15, 64-9.

Forams are useful in Mesozoic and Cainozoic stratigraphy, and to a lesser extent in Upper Palaeozoic studies, in Australia and New Guinea. The distribution of Tertiary, Cretaceous, Jurassic, Permian, and Devonian faunas, and their interpretation and significance, are discussed. (W.M.)

04-a-2 CRESPIN, I., 1956 — Micropalaeontological investigations in the Bureau of Mineral Resources, Geology and Geophysics, 1927-1952. *Bur. Miner. Resour. Aust. Rep.* 20, 77 pp.

The source of some of the material in the Commonwealth Palaeontological Collection, housed in Canberra by the Bureau of Mineral Resources, is outlined. Unpublished reports describing micropalaeontological material are listed by State. 110 reports have been prepared on more than 6400 samples collected in Papua and New Guinea up to 1952. (W.M.)

04-a-3 CRESPIN, I., 1958 — Microfossils in Australian and New Guinea stratigraphy. *J. Proc. Roy. Soc. N.S.W.,* 92, 133-47.

Progress in micropalaeontology in Australia and New Guinea is reviewed, and a comprehensive bibliography given. The use of microfossils, including microscopic fragments of larger forms such as plant spores, is discussed under taxonomic groups. (W.M.)

04-a-4 CRESPIN, I., 1960 — Catalogue of type and figured specimens in the Commonwealth Palaeontological Collection, Canberra. *Bur. Miner. Resour. Aust. Rep.* 54, 148 pp.

The Commonwealth Palaeontological Collection contains more than 3000 primary or supplementary type specimens listed and arranged in this catalogue in alphabetic order in their appropriate larger biological groups. Publications are cited in which description, registered number, type locality, and geological age are given. The catalogue is complete to December 1959. Type forms represented by Papua and New Guinea specimens are 16 forams. (Auth./W.M.)

04-a-5 CRESPIN, I., 1971 — Catalogue of additional type and figured specimens of Protista (Foraminifera, Radiolaria and Tintinnina) in the Commonwealth Palaeontological Collection, Canberra. *Bur. Miner. Resour. Aust. Rep.* 148, 1-136.

213 species of forams from Tertiary strata in Papua and New Guinea are included, for which information is given on synonymy, collection number, geographic and stratigraphic location, assigned age, and source reference. Corrigenda to entry 04-g-3 are included. (W.M.)

04-a-6 ETHERIDGE, R., Jr, 1889 — Our present knowledge of the palaeontology of New Guinea. *N.S.W. geol. Surv. Rec.* 1, 172-9.

Previous palaeontological reports on material from Papua are recorded and reviewed, and descriptions given of new collections of late Tertiary faunas from the Fly R., Yule I., Strickland R., Bevan's fifth expedition in the Aird Hills and Douglas R., and material collected near Maina village by the Queensland Museum geological survey (see entry 04-g-16). (W.M.)

04-a-7 SINGLETON, F. A., 1945 — A catalogue of type and figured specimens of fossils in the Melbourne University Geology Department. *Proc. Roy. Soc. Vic.*, 56, 229-84.

The Geological Museum of Melbourne University contains more than 200 primary or supplementary type specimens. These are listed under the appropriate species, which are arranged alphabetically under larger biological groups. For each the literature, geological horizon, locality, and source are given. The only material from Papua and New Guinea listed is *Tetrabelus macgregori* Glaessner, holotype, a cephalopod from the Purari Formation (Aptian-Albian) at Purari R. (Auth./W.M.)

04-a-8 SKWARKO, S. K., 1970 — Bibliography of the Mesozoic palaeontology of Australia and New Guinea. *In* Australia. Bureau of Mineral Resources palaeontological papers, 1967. *Bur. Miner. Resour. Aust. Bull.* 108, 237-80.

This lists all known publications which describe, list, or mention mostly Mesozoic fossils of the larger type in Australia and New Guinea. Plant remains and marine and non-marine micro-organisms are excluded. (W.M.)

(b) REGIONAL CORRELATION AND PALAEOGEOLOGY

See also entries

02-b-71 02-c-26

04-b-1 ANONYMOUS, 1962 — Generalised formation correlation of Australia and Papua. *Oil Gas J.*, 60, 72-5.

Successions exposed in the flanks and trough of the Papua Basin and in the North New Guinea Basin are correlated with each other and with successions in the major sedimentary basins of Australia. (W.M.)

04-b-2 ADAMS, C. G., 1970 — A reconsideration of the East Indian letter classification of the Tertiary. *Bull. Brit. Mus. (nat. His.), Geol.*, 19, 87-137.

Successions of fossiliferous Tertiary strata from 17 localities in the Pakistan-East Indies-West Pacific region are noted, with comments on their significance. The Chimbu Limestone succession in the New Guinea highlands (entry 02-c-45) contains a thick Tertiary Tc stage with minor Upper Te stage beds above; Lower Te faunas are poorly represented in Papua. Characteristics and diagnostic faunas of each stage are noted, and the definition of stage boundaries discussed. (W.M.)

04-b-3 BOWEN, R., 1961 — Palaeotemperature analyses of Mesozoic Belemnoidea from Australia and New Guinea. *Bull. geol. Soc. Amer.*, 72, 769-73.

Palaeotemperature analyses on more than 60 Belemnoidea from Mesozoic strata in Western and South Australia and New Guinea show a cooling from the Jurassic into the Cretaceous consistent with the extension of the Albian and Coniacian-Santonian climatic maxima, previously shown in Europe, into the Australian area. The readings reject a Cretaceous ice age in South Australia. Palaeotemperature results agree with a possible large migration of Australia during the Mesozoic. One specimen from the Upper Jurassic Kuabgen Group in the upper Fly R. indicated an ocean temperature of 15.9°C. (Auth./W.M.)

04-b-4 CHAPMAN, F., 1930g — Correlation of Redscar Head with Oriomo. Appendix 2, p. 72, *in* MONTGOMERY, J. N.—A contribution to the Tertiary geology of Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 3-80.

Outcrops of strata at Redscar Head contain e-stage large forams, and deep core samples from Oriomo f-stage large forams. (W.M.)

04-b-5 CHAPMAN, F., 1930h — Correlation between Port Moresby (Papua) and New Guinea areas. Appendix 3, pp. 72-74, *in* MONTGOMERY, J. N. — A contribution to the Tertiary geology of Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 3-80.

On foraminiferal evidence, successions in Papua and New Guinea are assigned ages in terms of letter stages of the Dutch East Indies, and correlations made between east New Guinea areas. (W.M.)

04-b-6 CHAPMAN, F., 1930i — Correlation of the stages *a* to *g* (Eocene to Pliocene) of the Dutch East Indies with Papua. Appendix 4, pp. 65-76, *in* MONTGOMERY, J. N. — A contribution to the Tertiary geology of Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 3-80.

Correlations are made between letter stages of the Tertiary succession in the Dutch East Indies and east New Guinea areas. Evidence for recognizing Cretaceous strata in Papua is cited. (W.M.)

04-b-7 CRESPIN, I., 1948a — Indo-Pacific influences in Australian Tertiary foraminiferal assemblages. *Trans. Roy. Soc. Aust.*, 72, 133-42.

Indo-Pacific elements in foraminiferal assemblages are used to correlate marine Tertiary strata on the Australian mainland with successions in New Guinea, Java, and Sumatra. On this basis a palaeogeographic reconstruction is made. (W.M.)

04-b-8 CRESPIN, I., 1950 — Australian microfaunas and their relationships to assemblages elsewhere in the Pacific region. *J. Palaeont.*, 24, 421-9.

Marine Tertiary rocks in Australia are confined chiefly to narrow strips along the west and south coasts and the north coast of Tasmania. Differences in sedimentation and foraminiferal assemblages suggest that they were laid down in two major sedimentary provinces, the Austral-Indo-Pacific Province and the Bass Strait Province. The foraminiferal assemblages in each province are discussed and correlations suggested with other areas in the Indo-Pacific region and New Zealand. (Auth.)

04-b-9 CRESPIN, I., 1953 — Australian Tertiary microfaunas and their relationships with assemblages elsewhere in the Pacific Region. *Proc. 7th Pacif. Sci. Cong., New Zealand*, 2, 47.

The Austral-Indo-Pacific Province is a southerly extension from the Dutch East Indies of Indo-Pacific conditions in Tertiary time as indicated by the warm to tropical foraminiferal assemblages. The Bass Strait Province contains assemblages indicating deeper water and more temperate conditions. The sediments are comparatively thin in the Austral-Indo-Pacific Province but more than 900 m were penetrated in southeast Victoria bores in the Bass Strait Provence. The f-stage zonal forams in the Austral-Indo-Pacific Province can be correlated with the Rembangian stage of Java with a short period of ecologic conditions suitable for the development of zonal species in the Bass Strait Province. (Auth.)

04-b-10 DORMAN, F. H., 1968 — Some Australian oxygen isotope temperatures and a theory for a 30 million year world temperature cycle. *J. Geol.*, 76, 297-313.

Oxygen-isotope temperatures are reported for living and fossil shells. Shells used included Upper Jurassic belemnites from the upper Fly R. Palaeotemperatures are summarized for the Jurassic, Cretaceous, and Tertiary and a 30-m.y. temperature cycle is suggested. This cycle is explained in terms of atmospheric CO_2 content and may be extended to explain glacial ages.

A warm climate with a sea temperature of *ca* 22°C is indicated in the Australia-New Guinea region during the Cenomanian. Upper Jurassic temperatures of 30.5, 20.5, and an anomalous 13.5°C are contradictory, and do not agree with an earlier determination (entry 04-b-3) of 15.9°C for this region. (Auth./W.M.)

04-b-11 GILL, E. D., 1968 — Palaeoecology of fossil human skeletons. *Palaeogeogr. Palaeoclimatol. Palaeoecol.,* 4, 211-7.

The paucity of hominid fossil remains is discussed in terms of preservation state and diagenetic history. The discussion is related to several known Australian and New Guinea occurrences, including Aitape (entry 17-b-9). The Aitape skull fragments were found in marine detrital sediments, and may have survived leaching because leaching was impeded by burial in fine sediment, and because insufficient time had elapsed for decomposition by alkaline connate solutions which prevented attack by acids generated during vegetable debris decay. (W.M.)

04-b-12 GLAESSNER, M. F., 1943 — Problems of stratigraphic correlation in the Indo-Pacific region. *Proc. Roy. Soc. Vic.,* 55, 41-80.

The distribution and stage ages of Jurassic marine deposits in the Indo-Pacific region and their regional correlation based on ammonite zones are reviewed. Cretaceous marine strata and their correlation based on molluscan faunas are discussed. Results of recent biostratigraphic studies in the East Indies are compared with data on the stratigraphy of New Guinea and of some other islands in the southwest Pacific. The use of molluscan faunas, larger and smaller forams, and vertebrate fauna studies integrated with marine molluscan fauna studies is reviewed. The significance of larger and smaller forams for the relatively fine stratigraphic subdivision of the sequence of Indo-Pacific Tertiary deposits into Series and Stages is discussed. A correlation is made of Tertiary marine strata, based on foraminiferal faunas and 44 species of Miocene index forams are listed. (Auth./W.M.)

04-b-13 GLAESSNER, M. F., 1959a — Tertiary stratigraphic correlation in the Indo-Pacific region and Australia. *J. geol. Soc. India,* 1, 53-67.

Tertiary sequences are correlated between India, islands of the western Pacific, and Australia. Drooger's work on the Miocene stratigraphic distribution of Miogypsinidae and of pelagic Foraminifera is noted. Apparent discrepancies from Formosa and Saipan are examined and the factual data found to be compatible with Drooger's dating of the entry of *Orbulina.* Abundant information from southeast Australia on foraminiferal biostratigraphy is reviewed. Upper Eocene to Miocene foraminiferal zones can be regionally recognized, including the important *Globigerinoides bispherica* zone. While its placing in the Helvetian in accordance with Drooger's findings in Europe is compatible with new observations and is tentatively accepted, a Burdigalian age cannot be ruled out on present evidence. The occurrence of Palaeocene, Eocene, and Miocene distinctive markers leads to the first detailed correlation of Australian and Indo-Pacific Tertiary strata. (Auth.)

04-b-14 LLOYD, A. R., 1968 — Possible Miocene marine transgression in northern Australia. *Bur. Miner. Resour. Aust. Bull.* 80, 85-100.

Palaeontological evidence for a Miocene marine transgression over much of northern Australia is based on the distribution of several foraminiferal species; it is noted that *Ammonia beccarii* is found in lower Miocene marine sediments in the Gazelle Pen. (W.M.)

04-b-15 MCTAVISH, R. A., 1966 — Planktonic Foraminifera from the Malaita Group, British Solomon Islands. *Micropalaeontology,* 12(1), 1-36.

A succession based mainly on planktonic forams contains 10 units ranging from upper Eocene to upper Miocene-Pliocene. The Malaita Group, exposed on Malaita, Maramasike, and Ulawa, contains the entire succession. Correlation of its faunas with others from the Indo-Pacific region has confirmed the time-stratigraphic succession of the Solomons.

The stratigraphic and geographic distribution of forams and the definition of stage boundaries within the Tertiary are discussed. The Eocene age of the Port Moresby Beds (entry 02-b-49) is restricted to upper Eocene on the evidence of a *Globigerina-Globorotalia* fauna in limestone lenses; the position of the middle-upper Miocene boundary in western Papua (entry 04-g-1) is shifted upwards on the evidence of the distribution of the *Sphaeroidinellopsis seminulina* fauna; the division of the Muruan 'stage' into Upper and Lower is discounted on the evidence of the distribution of the *Globigerina deutertrei* fauna; and the supposed Pliocene chalks of New Ireland (entry 04-g-24) are more likely upper Miocene or older on the evidence of the distribution of *Globigerina deutertrei* and *Miogypsina* species. (Auth./W.M.)

04-b-16 STIRTON, R. A., TEDFORD, R. H., & WOODBURNE, M. O. — 1967 Review of Tertiary mammal-bearing deposits in Australia. (Abstract only). *39th ANZAAS Cong., Melbourne,* Sec. C Abs., K6-7.

11 terrestrial fossil mammal faunas from near-shore marine, paralic, lacustrine, and fluviatile sediments in central, southern, and eastern Australia and eastern New Guinea are represented by fossil remains collected from a bed or groups of stratigraphically closely associated beds at a given locality and often from a single rock unit. Certain well represented and better studied mammalian groups, such as members of the diprotodontid subfamily Zygomaturinae, have been useful in correlating the geographically scattered faunas.

The earliest known, well represented faunas (Ngapakaldi, Riversleigh) include a variety of marsupial families represented by structurally primitive members of their lineages, but clearly assignable to their respective groups. These assemblages confirm hypotheses that the initial differentiation of the Marsupialia in Australia was an early Tertiary or late Cretaceous event. Miocene faunas (especially the Kutjamarpu and Alcoota) also include the marsupial families Thylacinidae, Phalangeridae, and Vombatidae, and problematical teeth that may represent the Monotremata. The diprotodontids are more diverse and true macropodine kangaroos appear in the Miocene. Pliocene faunas are poorly represented in Australia except for the latter part (Palankarinna and Chinchilla), but greater geographic spread is provided by the radiometrically-dated mid-Pliocene Awe fauna from New Guinea. True diprotodontine diprotodontids appear only in late Pliocene, and the family as a whole remains diverse. (Auth./W.M.)

(c) PALAEOZOIC

04-c-1 GLAESSNER, M. F., LLEWELLYN, K. M., & STANLEY, G. A. V., 1950 — Fossiliferous rocks of Permian age from the Territory of New Guinea. *Aust. J. Sci.,* 13, 24-5.

Fossiliferous detrital limestone overlies the Kubor Granite near Mt Hagen. It contains detrital quartz, mica, feldspar, and quartzite. A Permian age is based on evidence of the smaller forams *Geinitzina* sp., *Pachyphloia* sp., *Nodosaria* sp., *Textularia* sp., and *Glomospira* sp. Associated fauna is noted. (W.M.)

(d) MESOZOIC INVERTEBRATES

04-d-1 COOKSON, I. C., & EISENACK, A., 1958 — Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proc. Roy. Soc. Vic.,* 70, 19-79.

The distribution of 75 species of fossil microplankton from Australia and New Guinea Upper Jurassic and Cretaceous deposits is recorded, including 12 new genera and 54 new species. Upper Jurassic, Aptian, Albian, Cenomanian, and Campanian microplankton assemblages are distinguished, and some are identified with European species.

New Guinea species are from two localities: (i) An Upper Jurassic-Cretaceous assemblage from Island Exploration Co. Ltd No. 1 well at Omati R.; (ii) A small Upper Jurassic assemblage from Australian Petroleum Co. Wana well at Era R. (W.M.)

04-d-2 DEFLANDRE, G., & COOKSON, I. C., 1955 — Fossil microplankton from Australian late Mesozoic and Tertiary sediments. *Aust. J. marine freshw. Res.*, 6, 242-313.

This is the first comprehensive account of fossil microplankton assemblages from the southern hemisphere. Dinoflagellates, hystrichosphaerids, and micro-organisms of uncertain affinity, all with unmineralized membranes, are classified. 25 genera, of which 4 are new, and 75 species, of which 46 are new, have been recorded from Cretaceous and Tertiary deposits. Material examined included pteriolophyte spores and coniferous pollen grains from bore samples of Lower Cretaceous carbonaceous sandstones and hard coaly material in the Ena (Era) R. area. (Auth.)

04-d-3 ERNI, A., 1944 — Ein Cenoman-Ammonit *Cunningtoniceras holtkeri* nov. spec. aus Neuguinea, nebst Bemerkungen über einige andere Fossilien von dieser Inseln (A Cenomanian ammonite *Cunningtoniceras holtkeri* nov. spec. from New Guinea, with notes on some other fossils from this island, in German). (Abstract only). *Verh. schweiz. naturf. Ges.*, 124, 122.

A new ammonite from Cretaceous strata near Mt Hagen is described in entry 04-d-4. (W.M.)

04-d-4 ERNI, A., 1945 — Ein Cenoman-Ammonit, *Cunningtoniceras holtkeri* nov. spec. aus Neuguinea, nebst Bemerkungen über einige andere Fossilien von dieser Inseln (mit einem Beitrag von Georg Holtker) (A Cenomanian ammonite *Cunningtoniceras holtkeri* nov. spec. from New Guinea, with notes on some other fossils from this island, with a contribution by George Holtker, in German). *Eclog. geol. Helv.*, 37, 468-75.

A new Cretaceous ammonite from the Wahgi Valley of New Guinea is described, and is regarded as an index Cenomanian form. (W.M.)

04-d-5 GLAESSNER, M. F., 1945 — Mesozoic fossils from the central highlands of New Guinea. *Proc. Roy. Soc. Vic.*, 56, 151-68.

Upper Jurassic and middle Cretaceous molluscs from Central New Guinea are described, including genera and species known from the Upper Jurassic of northwest India and the East Indies (*Buchlia-Belemnopsis* fauna), from the upper Albian and Cenomanian of southern India, and from the Aptian-Albian of Australia. Lists of forams are given and the stratigraphic position of fossiliferous Mesozoic sediments of Papua New Guinea is discussed. (Auth.)

04-d-6 GLAESSNER, M. F., 1949 — Mesozoic fossils from the Snake River, central New Guinea. *Qld Mus. Mem.*, 12(4), 165-80.

1 species of sponge, 6 species of lamellibranchs including 2 new species, and a new species of gastropod from the Kaindi Metamorphic Group are described. The age of the fauna is Mesozoic, probably Aptian-Albian or Cenomanian. The significance of the Mesozoic age is discussed in terms of the age of the Morobe Batholith, the distribution and age of metamorphosed and unmetamorphosed Cretaceous strata, and their structural trends. (W.M.)

04-d-7 GLAESSNER, M. F., 1957 — Cretaceous belemnites from Australia, New Zealand and New Guinea. *Aust. J. Sci.*, 20, 88-9.

The systematics of *Belemnites eremos* Tate and the Dimitobelidae in Australasia are discussed in the light of two new unlocated specimens of *Dimitobelus* from New Guinea and one from New South Wales. (W.M.)

04-d-8 GLAESSNER, M. F., 1958 — New Cretaceous fossils from New Guinea. *S. Aust. Mus. Rec.*, 13(2), 199-226.

Mollusca including the ammonite *Chimbuites sinuosocostatus* gen. et sp. nov., *Pleuromya cuneata* sp. nov., and several species previously known from Australia are described from the Albian of Papua New Guinea. Two new Trigonias, a dimitobelid belemnite, and a new species of tubicolous worm *Rotularia* are described from the Cenomanian. Material came from the drainage basins of the Purari and Wahgi Rs. (Auth./W.M.)

04-d-9 GLAESSNER, M. F., 1960 — Upper Cretaceous larger Foraminifera from New Guinea. *Sci. Rep. Tohoko Univ., Hanzawa Memorial Vol.,* 37-44.

Pseudorbitoides israelskii Vaughan and Cole and *Orbitoides tissoti* Schlumberger are abundant in the upper Senonian (Campanian) of the Port Moresby area. It is the first occurrence of this distinctive generic assemblage and of the species *P. israelskii* outside the Caribbean-Gulf of Mexico area; a similar assemblage has been reported from the Australian Alps. (Auth.)

04-d-10 SCHLUTER, H., 1928 — Jurafossilien vom Oberen Sepik auf Neu-Guinea (Jurassic fossils from the upper Sepik in New Guinea, in German). *Nova Guinea,* 6(3), 53-61.

In the Sepik R. at the Dutch New Guinea border are outcrops and float of dark pyritic shale, limestone, and tuff containing a Jurassic marine shelly fauna. The location was noted by Schultze-Jena (entry 01-b-42) and lithologies described by Glaessner (entry 09-b-11). The fauna includes pelecypods, belemnites, pectens, and *Inoceramus* spp. and is correlated with similar Jurassic faunas from the Vogelkop and New Zealand. (W.M.)

04-d-11 SKWARKO, S. K., 1963 — New Mesozoic fossil occurrences in New Guinea, and their stratigraphical significance. *Aust. J. Sci.,* 26, 24-5.

Upper Triassic and Jurassic shelly faunas from the Bismarck Mts comprise pelecypods, gastropods, brachiopods, and cephalopods, and include 9 new species. (W.M.)

04-d-12 SKWARKO, S. K., 1967a — Mesozoic mollusca from Australia and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 75, 100 pp.

Two papers are abstracted separately in entries 04-d-13 and 04-d-14.

04-d-13 SKWARKO, S. K., 1967b — Mesozoic fossils from eastern New Guinea — (a) First Upper Triassic and (?) Lower Jurassic marine Mollusca from New Guinea. *In* SKWARKO, S. K. — Mesozoic Mollusca from Australia and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 75, 37-82.

The Upper Triassic and the (?)Lower Jurassic faunas from the Jimi R. area are the first of those ages recorded from mainland New Guinea. 5 sedimentary units are represented, and 21 genera and species described, including 2 new genera, 11 new species, and 1 new subspecies.

The Jimi Greywacke is richly fossiliferous and has an Upper Triassic (Carnian-Norian) assemblage. The Kana Formation, composed of detritus derived from acid volcanics, is stratigraphically higher than the Jimi Greywacke and its fauna indicates an Upper Triassic age. The Balimbu Greywacke is probably Lower Jurassic (Sinemurian-Pliensbachian). The Mongum Volcanics are basaltic marine volcanics which lie between the Balimbu Greywacke and the Maril Shale. The Maril Shale is of Upper Jurassic (Kimmeridgian) age. (Auth.)

04-d-14 SKWARKO, S. K., 1967c — Mesozoic fossils from eastern New Guinea — (b) Lower Cretaceous Mollusca from the Sampa Beds near Wau, New Guinea. *In* SKWARKO, S. K. — Mesozoic Mollusca from Australia and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 75, 85-100.

11 molluscs described from the Cretaceous Sampa Beds of the Lake Trist area include 5 new species, and 4 forms previously described from the Snake R. Beds about 65 km to the northwest. The Sampa beds, which may have been deposited at about the same time as the Snake R. Beds, are regarded as Lower Cretaceous. (Auth.)

04-d-15 WESTERMAN, G. E. G., & GETTY, T. A., 1970 — New Middle Jurassic Ammonitina from New Guinea. *Bull. Amer. Paleont.,* 57, 227-321.

Based on West Irian faunal affinities, Bajocian to Callovian ammonite genera are found to have distinctive elements: lower Bajocian is represented by *Docidoceras* s.s., *Fontannesia*, and *Pseudotoites*; middle Bajocian by diverse *Stephanoceras* s.l. and *Chondroceras*; doubtful upper Bajocian by *Chondroceras* ?(*Praetulites*) and possibly by *Cadomites*?; possible Bathonian by *Tullites*?, *Cadomites*?, and *Bullatimorphites* of the *B. uhligi* and (?)*B. microstoma* groups; lower Callovian by diverse *Macrocephalites* s.l.; lower middle Callovian by *Subkossmatia, Idiocycloceras*, and *Eucycloceras*(?). Genera from Strickland Gorge are assigned to the upper middle Bajocian and to the lower Callovian (see entry 04-a-6). (W.M.)

(e) Mesozoic Vertebrates

04-e-1 Glaessner, M. F., 1942 — The occurrence of the New Guinea turtle (*Carettochelys*) in the Miocene of Papua. *Rec. Aust. Mus.*, 21, 106.

Fragments of the nuchal plate of a turtle from Pliocene sediments near the mouth of the Vailala R. are described, figured, and assigned to the family Carettochelyidae. They are almost identical with the nuchal plate of the living *Carettochelys insculpata* Ramsay, and the fossil form is assigned to this genus. Considered in the light of possible land bridges, the ancestral form probably reached New Guinea before its isolation early in the Eocene. (W.M.)

(f) Mesozoic Palaeobotany

04-f-1 Cookson, I. C., & Dettmann, M. E., 1958a — Some trilete spores from Upper Mesozoic deposits in the Eastern Australian region. *Proc. Roy. Soc. Vic.*, 70, 95-128.

New occurrences of 4 megaspore species are noted, and 29 trilete microspores recorded. A Lower Cretaceous (Albian) age is indicated for several Victorian localities. Included in the material are 5 genera of microspores and 1 species of megaspore from the Omati bore, Papua. (W.M.)

04-f-2 Cookson, I. C., & Dettmann, M. E., 1958b — Cretaceous 'megaspores' and a closely associated microspore from the Australian region. *Micropalaeontology,* 4, 39-49.

European Lower Cretaceous species *Pyrobolospora hexapartita* (Dijkstra) and *Minerisporites marginatus* (Dijkstra) are recorded from Australian Upper Mesozoic deposits in South Australia, Victoria, New South Wales, Queensland, and Papua. The Papuan material was from Island Exploration Co. Omati bore, and included *Balmeisporites holodictyus* Cookson & Dettmann sp. nov. and *Perotriletes striatus* Cookson & Dettmann sp. nov. The Omati Bore strata are Lower Cretaceous (Aptian). (Auth./W.M.)

(g) Cainozoic Invertebrates

See also entry 04-a-4.

04-g-1 Belford, D. J., 1960 — Micropalaeontology of samples from Kaufana Bore No. 1. (*In* Papuan Apinaipi Petroleum Co. Ltd. — Kaufana No. 1 bore, Papua. *Bur. Miner. Resour. Aust. Petrol. Search Subs. Acts Publ.* 1, 20-7).

Faunal lists are given for several interval samples of cuttings from Kaufana No. 1, east of Yule I. In the upper 30 m Pliocene forms are present; below 40 m Miocene forms are present. It is not possible to subdivide the Miocene into f stages but the hole probably bottomed in f_{1-2} stage at 1020 m. (W.M.)

04-g-2 Belford, D. J., 1962 — Miocene and Pliocene planktonic Foraminifera, Papua-New Guinea. *Bur. Miner. Resour. Aust. Bull.* 62(1), 50 pp.

12 genera and 34 species of planktonic forams are recorded and illustrated from the Miocene-Pliocene of Papua New Guinea; some species are recorded from this area for the first time (localities in entry 04-g-3). (W.M.)

04-g-3 BELFORD, D. J., 1966 — Miocene and Pliocene Smaller Foraminifera from Papua and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 79, 306 pp.

58 genera and 156 species of forams are recorded and illustrated; 35 species are new. Where possible, species have been given their attribution as recorded in the collection of the Australasian Petroleum Company, Port Moresby, and the known stratigraphical range within Papua and New Guinea is indicated. Corrigenda are included in entry 04-a-5. (Auth./W.M.)

04-g-4 BELFORD, D. J., 1967a — Paleocene planktonic Foraminifera from Papua and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 92, 1-33.

Palaeocene forams recorded for the first time from Papua New Guinea were found in the Wabag and the C. Vogel areas; 14 planktonic species referred to the genera *Subbotina, Globigerina, Globorotalia,* and *Chiloguembelina* are recorded and illustrated. (Auth./W.M.)

04-g-5 BELFORD, D. J., 1967b — Additional Miocene and Pliocene planktonic Foraminifera from Papua and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 92, 35-48.

Three additional species of planktonic forams are recorded and figured from Papua New Guinea. (Auth./W.M.)

04-g-6 BRADY, H. B., 1877 — Supplementary note on the Foraminifera of the Chalk(?) of the New Britain Group. *Geol. Mag.*, 4, (*Decade* 2), 534-6.

The list of forams in entry 08-b-9 is revised. Systematic notes are included, and comparisons made between the New Britain material and faunas collected on the *Challenger* and *Porcupine* cruises. The strong resemblance of faunas and lithology is noted, and a depth of formation of 2750 to 7500 m (1500 to 2500 fathoms) suggested. (W.M.)

04-g-7 BRAZIER, J., 1884 — List of some recent shells found in layers of clay on the Maclay Coast, New Guinea. *Proc. Linn. Soc. N.S.W.*, 9, 988-92.

38 specimens are listed, but many are determined only to the generic level. (W.M.)

04-g-8 CHAPMAN, F., 1914 — Description of a limestone of lower Miocene age from Bootless Inlet, Papua. *J. Proc. Roy. Soc. N.S.W.*, 48, 281-301.

The distribution of fossiliferous Mesozoic and Cainozoic strata in the Gulf of Papua is outlined. The detrital limestone at Bootless Inlet, east of Port Moresby is described. Fossil debris includes plant, echinoid, and fish debris, and a variety of well presrved arenaceous forams; the age given is lower Miocene. (W.M.)

04-g-9 CHAPMAN, F., 1930f — Note on derived faunas in the Yule Island and Port Moresby areas. Appendix I, pp. 71-72, *in* MONTGOMERY, J. N. — A contribution to the Tertiary geology of Papua. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.*, 4, 3-80.

Abundant well preserved derived micro-fauna elements in sediments in the Yule I. and Port Moresby successions are noted. (W.M.)

04-g-10 CHAPMAN, F., & CRESPIN, I., 1932 — Rare Foraminifera from deep borings — Part III. *Proc. Roy. Soc. Vic.*, 44, 315-24.

New rare forams from various drill holes in Victoria and New Guinea, as well as from outcrops in Papua and New Guinea, are described. They are mainly lower to middle Miocene. (W.M.)

04-g-11 CRESPIN, I., 1938a — The occurrence of *Lacazina* and *Biplanispira* in the Mandated Territory of New Guinea. *Bur. Miner. Resour. Aust. Bull.* 3, 1-8 (also issued as part of *Palaeont. Bull.* 3 by Dep. Interior, Melbourne.)

The site and faunas of known Eocene foraminiferal limestones in Papua New

Guinea are listed. Localities include the Vanimo and Aitape areas, the headwaters of the Yalingi R., Port Moresby, and the headwaters of the Fly R. A new site at Chimbu aerodrome is documented, the fauna listed, and its significance discussed. (W.M.)

04-g-12 CRESPIN, I., 1938b — A Lower Miocene limestone from the Ok Ti River, Papua. *Bur. Miner. Resour. Aust. Bull.* 3, 9-16 (also issued as part of *Palaeont. Bull.* 3 by Dep. Interior, Melbourne).

The location, stratigraphic setting, and lithology are described and the flora and forams listed. A lower Miocene (e stage) age is assigned. (W.M.)

04-g-13 CRESPIN, I., 1942 — Reports by Commonwealth Palaeontologist on fossil collections from New Britain. *New Guinea Bull.* 3, 36-9.

Faunal lists are given for specimens from New Britain, and ages from lower Miocene to Recent assigned. Most specimens were limestones or mudstones, mainly with foraminiferal species. (W.M.)

04-g-14 CRESPIN, I., 1962 — *Lacazinella,* a new genus of trematophore Foraminifera. *Micropalaeontology,* 8, 337-9.

Lacazinella is proposed for the ovoid, prolate, spheroid form of trematophore forams from the upper Eocene of New Guinea. *L. wichmanni* Schlumberger, 1894, is taken as the type species. (Auth.)

04-g-15 CRESPIN, I., KICINSKI, F. M., PATERSON, S. J., & BELFORD, D. J., 1956 — Papers on Tertiary micropalaeontology. *Bur. Miner. Resour. Aust. Rep.* 25.

Papers relevant to Papua New Guinea are each abstracted separately in entries 02-b-137, 02-d-33, and 03-d-15.

04-g-16 ETHERIDGE, R., Jr, 1892 — Our present knowledge of the palaeontology of New Guinea. *In* THOMPSON, J. P. — BRITISH NEW GUINEA. *London, George Philip,* 208-15.

A review is made of published notes on fossil localities in British New Guinea, including the Tertiary sites on Yule I. and Hall Sd. (entries 03-d-24, 03-e-27, 04-g-30), the Upper Mesozoic ammonite locality in the headwaters of the Fly R. (entry 03-a-19), and the north New Guinea coast limestones with post-Tertiary faunas (entries 04-g-7 and 14-a-38). Material collected by the Royal Geographic Society of Australasia Expendition in the Strickland River is described and affinities with Queensland and European species discussed.

The oldest faunas in New Guinea are homotaxial with European Upper Oolites, with some affinities with Indian faunas. Tertiary faunas from Yule I. indicate a lower Pliocene age as suggested in entry 04-g-30 rather than lower Miocene as in entry 03-e-27. (W.M.)

04-g-17 GREGORY, J. W., 1917 — *Octotremacis:* its structure, affinities and age. *Geol. Mag.* 4, (*Decade 6*), 9-12.

Re-examination of specimens of the Eocene coral *Polysolenia hochstetteri* from the Fly R. indicates the incorrect initial designation of some specimens from Java. (W.M.)

04-g-18 GREGORY, J. W., & TRENCH, J. B., 1916 — Eocene corals from the Fly River, central New Guinea. *Geol. Mag.*, 3, (*Decade 6*), 481-8 and 529-36.

Some samples of fossiliferous limestone collected by Macgregor during his 1889-1890 explorations in the Fly R. are listed. Samples of alluvial debris near Macrossan I. (6°5′S) and at the Black-Palmer Rs junction, and a coralline fauna from Macrossan I. are described. An Eocene, possibly middle Eocene, age is assigned. (W.M.)

04-g-19 HANZAWA, S., 1947 — Note on an Eocene foraminiferal limestone from New Britain. *Jap. J. Geol. Geogr.*, 20, 59-61.

The foraminiferal assemblage in a limestone erratic in stream gravels in the

Nakanai area of New Britain contains forms closely resembling Eocene faunas from Palau I. (W.M.)

04-g-20 NEWTON, R. B., 1918 — Foraminiferal and nullipore structures in some Tertiary limestones from New Guinea. *Geol. Mag.*, 5, (*Decade 6*), 203-12.

Microfossils are described from float limestone collected in the Fly R. by Macgregor, and for which data on the corals have been published (entry 04-g-18). Systematic descriptions of the more common determinable forms are given. Eocene and Miocene faunas are recognized. (W.M.)

04-g-21 PALMERI, V., 1970 — Tropical planktonic foraminiferal biostratigraphy, 1 — Danian at Port Moresby, 2 — Neogene in the Capricorn Basin. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

A lower Palaeocene planktonic foraminiferal assemblage is recorded from marls that crop out in the Bogoro Inlet area, about 12 km east of Port Moresby. The marls were collected near outcrops of the Upper Cretaceous (Maastrichtian) Bogoro Limestone and are considered to belong to the basal part of the lower Port Moresby Group. The assemblage is compared with others described from Danian strata of Trinidad, Texas, and northern and southern Europe. (Auth./part.)

04-g-22 SCHUBERT, R. J., 1910a — Über Foraminiferen und einen Fischotolithen aus dem fossilen Globigerinenschlamm von Neu-Guinea (Foraminifera and a fish otolith from the fossil *Globigerina* shales of New Guinea, in German). *K.K. geol. Reichsanst., Wien, Verh.*, 14, 318-28.

48 species of forams (40 of them new), and 1 fish otolith from the Tertiary strata of New Ireland and New Hanover are described and correlated provisionally with Pliocene faunas of the East Indies. (W.M.)

04-g-23 SCHUBERT, R. J., 1910b — Über das Vorkommen von *Miogypsina* und *Lepidocyclina* in pliocänen Globigerinergesteinen des Bismarckarchipels (On the occurrence of *Miogypsina* and *Lepidocyclina* in Pliocene *Globeigerina*-bearing rocks in the Bismarck Archipelago, in German). *K.K. geol. Reichsanst, Wien., Verh.*, 14, 395-8.

Miogypsina is known to occur only in Oligocene and upper Miocene sediments, in which *Lepidocyclina* and *Heterostegina* are not found. Fossiliferous limestone in New Ireland contains *Miogypsina* and *Lepidocyclina* in association with a Pliocene foraminiferal assemblage of about 40 species. (W.M.)

04-g-24 SCHUBERT, R. J., 1911 — Die fossilen Foraminiferen des Bismarckarchipels und einiger angrenzender Inseln (Fossil Foraminifera from the Bismarck Archipelago and nearby islands, in German). *Abh. Ost. geol. Bundesanst.* 20(4), 1-130.

Fossiliferous limestones in New Ireland and the Gazelle Pen. contain forams suggesting an Eocene to Oligocene age. The fauna is described and correlation with nearby Asian localities discussed. (W.M.)

04-g-25 SKWARKO, S. K., 1967d — The first report of *Neotrigonia* from New Guinea. *Bur. Miner. Resour. Aust. Bull.* 92, 191-4.

Neotrigonia novaguineana sp. nov. is described from the Central Highlands; *Neotrigonia* was known only from Australia, where its stratigraphic range is Miocene to the present. The age of the New Guinea species is not known with certainty, but may be Eocene or Miocene. (Auth.)

04-g-26 TATE, R., 1894 — Note on the Tertiary fossils from Hall Sound, New Guinea. *Proc. Linn. Soc. N.S.W.*, 9(n.s.), 213-4.

Material from Hall Sd, previously examined by Tenison Woods (entry 04-g-30) is re-examined. A Pleistocene age is assigned and the affinities of Woods' genera and species are discussed. (W.M.)

04-g-27 THALMANN, H. E., 1942 — Occurrence of the genus *Lacazina* Munier-Chalmas in the East Indies. *Bull. geol. Soc. Amer.*, 53, 1838-9.

In Europe *Lacazina* is restricted to the Upper Cretaceous. However, the fact that at many places in the East Indies (especially New Guinea) *Lacazina* limestones are stratigraphically above beds rich in *Camerina* and *Diecocyclina* is clear evidence for the Eocene age of these rocks. No other Eocene occurrences of *Lacazina* rocks are known outside the eastern half of the East Indian Arch.; they seem to be restricted to Celebes, Dutch New Guinea, Mandated Territory of New Guinea, and Great Kei I. *Lacazina* rocks have been reported from many localities including Chimbu Aerodrome (entry 04-g-11). (Auth./W.M.)

04-g-28 VAVRA, W., 1901 — Die Ostracoden vom Bismarckarchipel (Ostracods of the Bismarck Archipelago, in German). *Arch. Naturgesch.*, 67, 179-86.

Ostracods from the Rabaul area are systematically described. (W.M.)

04-g-29 WILKINSON, C. S., 1877 — Miocene in southern New Guinea. *Amer. J. Sci. Arts,* 13, 157-8.

Lower Miocene strata cropping out in Halls Sd and Torres Str. represent the first record of these strata in Australia outside Victoria and South Australia. The New Guinea species are mostly identical with those of Victoria. A land connexion with Australia is postulated on the evidence of this fauna, the shallowness of the present sea in Torres Str., and the known post-Palaeozoic tectonic history of the Australian continent. (W.M.)

04-g-30 WOODS, J. E. TENISON, 1878b — On some Tertiary fossils from New Guinea. *Proc. Linn. Soc. N.S.W.*, 2, 267-8.

Pectens collected from Yule I. during the *Chevert* cruise include one new species *P. novae-guinae*. (W.M.)

04-g-31 WOODS, J. E. TENISON, 1880 — On some fresh-water shells from New Guinea. *Proc. Linn. Soc. N.S.W.*, 4, 24-6.

3 species of freshwater Mollusca from New Guinea are described and illustrated, and a Recent age assigned. (W.M.)

(h) CAINOZOIC VERTEBRATES

See also entries

02-a-7 02-c-26 02-c-39

04-h-1 ANDERSON, C., 1937a — Palaeontological notes — IV. Fossil marsupials from New Guinea. *Aust. Mus. Rec.*, 20(2), 73-8.

The first recorded fossil marsupial remains from New Guinea were found in lacustrine sediments in tributaries of the Watut R. near Wau. The name *Nototherium watutense* is assigned to two mandible fragments from an adult beast, and several fragmental macropod bones are recorded. An early Pleistocene or Tertiary age is suggested. (W.M.)

04-h-2 ANDERSON, C., 1937b — The discovery of fossil marsupials in New Guinea (Abstract). *23rd ANZAAS Cong., Auckland, Rep.* 98.

See entry 04-h-1.

04-h-3 FENNER, F. J., 1944 — Fossil human skull fragments of probable Pleistocene age from Aitape, New Guinea. *S. Aust. Mus. Rec.*, 6, 335-54.

Fossil human skull fragments found near Aitape are described more fully in entry 04-h-5. (W.M.)

04-h-4 GILL, E. D., 1953 — Catalogue des hommes fossiles — Australie et Nouvelle-Guinée (in English). *19th Int. geol. Cong. Algiers, C.R.* 5, 341-50.

A catalogue of sites of fossil hominid remains in Australia and New Guinea includes data on the Aitape site (entries 04-h-3 and 04-h-5). (W.M.)

04-h-5 HOSSFELD, P. S., 1949 — The stratigraphy of the Aitape skull and its significance. *Trans. Roy. Soc. S. Aust.*, 72, 201-7.

Human skull fragments in the Pleistocene *Upper Wanimo Group* west of Aitape are discussed. The sedimentation is outlined, and the fauna listed. The lithologies, faunas, and stratigraphic setting of the skull fragments are interpreted with regard to the onset of the Pleistocene Ice Age and to the advent of Man in Australia. (W.M.)

04-h-6 PLANE, M. D., 1967a — Two new diprotodontids from the Pliocene Otibanda Formation, New Guinea. *In* STIRTON, R. A., WOODBURNE, M. O., & PLANE, M. D. — Tertiary Diprotodontidae from Australia and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 85, 105-28.

Only one of 3 diprotodontids found in the Otibanda Formation has been previously named. This animal, the largest, and probably the least numerous, is *Nototherium watutense* and is known only from lower posterior molar teeth and one possible upper molar fragment. The lower molars enable some comparisons with diprotodontids from the Australian Alcoota and Palankarinna faunas. The second largest animal is not well represented, but its upper dentition bears striking resemblance to *Kolopsis torus* from the Alcoota fauna and shows similarities to a new species from the Palankarinna fauna. The smallest and best represented species is distinct in its upper premolar and may also be related to the Alcoota species *Kolopsis torus*. No late Pliocene or Pleistocene diprotodontids seem comparable. (Auth.)

04-h-7 RIDE, W. D. L., 1964 — A review of Australian fossil marsupials. *J. Roy. Soc. W. Aust.*, 47, 97-131.

The areal distribution, phylogeny, development, and temporal range of Australian fossil marsupials are reviewed, including Recent Dasyuridae, Pleistocene Thylacinidae, Recent Peramelidae, Recent Phalangeridae, Pliocene Diprotodontidae, and Pliocene to Recent Macropodidae from unspecified localities in New Guinea. (W.M.)

04-h-8 SIMPSON, G. G., 1961 — Historical zoogeography of Australian mammals. *Evolution,* 15(4), 431-46.

In discussing the distribution of the rodent element of the mammal population in Australia and New Guinea, several genera of Muridae are designated the 'Old Papuan genera'. They may have been present in New Guinea as early as the Pliocene, possibly even the Miocene. (W.M.)

04-h-9 STIRTON, R. A., 1963 — A review of the Macropodid genus *Protemnodon. Univ. Calif. Publ., Bull. Dep. geol. Sci.,* 44(2), 97-161.

Protemnodon Owen (1873) is considered generically distinct from the genus *Wallabia* Trouessart (1905). Most of the characters are described in detail, especially those in the teeth. In these features comparison is made with those in other genera of Macropodinae. *Protemnodon* is distinguished from *Wallabia* and *Prionotemnus* Stirton (1955), to which it is related probably through a common ancestry at some time in the late Tertiary. A revised generic diagnosis is given in which 31 characters are listed. Undescribed specimens of protemnodons in a Pliocene fauna from New Guinea differ from those in the late Pleistocene by as many as 7 characters. The sequence of discoveries of *Protemnodon* and opinions of the different authors are reviewed and citations to pages and figures of reference are given. (Auth.)

04-h-10 STIRTON, R. A., WOODBURNE, M. O., & PLANE, M. D., 1967 — Tertiary Diprotodontidae from Australia and New Guinea. *Bur. Miner. Resour. Aust. Bull.* 85, 160 pp.

6 papers record and describe diprotodontid faunas from South Australia, Northern Territory, and New Guinea, and integrate observations into an outline of the phylogeny of the Diprotodontidae and its significance in correlation. (W.M.)

04-h-11 VIS, C. W. de, 1904 — Fossil vertebrates from New Guinea. *Qld Mus. Ann.,* 6, 26-31.

Vertebrate fragmental remains from the southwest coast of Woodlark I. are described. They are Quaternary or Tertiary marine forms showing replacement by iron oxides and encrustation with detrital and calcareous material. Reconstruction of fragments of an incomplete skull indicate a *Halicore* (dugong), probably distinct from *H. australis*. Fragments of turtle, crocodile, and shark vertebrae are also preserved. (W.M.)

(i) CAINOZOIC PALAEOBOTANY

04-i-1 COOKSON, I. C., 1957 — On some Australian Tertiary spores and pollen grains that extend the geological and geographical distribution of living genera. *Proc. Roy. Soc. Vic.* 69, 41-53.

6 distinct fossil spore types referable to *Schizaea,* 3 from the lower Eocene of southeast Australia and 3 from upper Pliocene coals of Papua, are described and their affinities discussed. Some of the Australian species are no longer extant, but the Papuan flora includes many genera and species of the present flora. (Auth./W.M.)

04-i-2 COOKSON, I. C., 1964 — Some early angiosperms from Australia — the pollen record. *In* CRANWELL, L. M. (Ed.) — Ancient Pacific Floras — the pollen story. *Proc. 10th Pacific Sci. Cong., Hawaii,* 1961, 81-4.

Notes are made on the distribution of living and Tertiary forms of several families in Australia, New Zealand, and New Guinea. (W.M.)

04-i-3 COOKSON, I. C., & MANUM, S., 1960 — On *Crassosphaera,* a new genus of microfossil from Mesozoic and Tertiary deposits. *Nytt. Mag. Bot.,* 8, 5-8.

A new genus is proposed for microfossils, probably planktonic, from a Mesozoic deposit in New Guinea and Lower Tertiary deposits in Western Australia and in Spitszbergen. The material from New Guinea is Neocomian marine sediments intersected at 2080 m in Inland Exploration Co. Komewu No. 2 bore. (Auth./W.M.)

04-i-4 COOKSON, I. C., & PIKE, K. M., 1953 — A contribution to the Tertiary occurrence of the genus *Dacrydium* in the Australian region. *Aust. J. Bot.,* 1, 474-84.

A new sporomorph, *Dacrydiumites florinii,* is proposed for fossil pollen grains, similar to those of certain species of *Dacrydium,* from Tertiary deposits in Australia. Tasmania, and New Guinea. The New Guinea material is from (i) Pliocene coal penetrated in a drill hole at Shu Cr., a tributary of the Era R., (ii) upper Pliocene carbonaceous clay from Wana well on the Era R. and (iii) Pliocene coal from the Era R. north of the Kikori-Purari delta region. (Auth./W.M.)

04-i-5 COOKSON, I. C., & PIKE, K. M., 1954 — Some dicotyledonous pollen types from Cainozoic deposits in the Australian region. *Aust. J. Bot.,* 2, 197-219.

Pollen types referable to several families are described from Cainozoic deposits in the Australian region; New Guinea material was from Pliocene coals from Shu Cr., Era R., and the Orloli area east of the lower Purari R. (Auth./W.M.)

04-i-6 COOKSON, I. C., & PIKE, K. M., 1955 — The pollen morphology of *Nothofagus* Bl. subsection Bipartitae Steen. *Aust. J. Bot.,* 3, 197-206.

Pollen descriptions of 12 New Guinea species and 3 New Caledonian species are given. The usefulness of pollen morphology is species determination within the subsection Bipartitae is considered. (Auth./W.M.)

04-i-7 KHAN, A. M., 1970 — Palynology of Tertiary sediments of the lowlands of Papua. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

78 samples represent a depth range of 2150 m within the stratigraphic limits of Miocene to Pleistocene and Recent. Some of the boundaries Miocene-Pliocene, lower Pliocene-upper Pliocene and upper Pliocene-Pleistocene are discussed on the basis of spore/pollen analysis. Some stratigraphic and geographic pollen and spore distributions are also reported. Pteridophyte flora was dominant over angiospermic flora and gymnosperms were rare. (Auth./W.M.)

04-i-8 SHIRLEY, J., 1899a — Note on a fossil wood from Mount Astrolabe, New Guinea. *Brit. N. Guinea ann. Rep. for 1897-98,* App. BB, 133.

Two specimens of fossil conifer wood from Mt Astrolabe are recorded. (W.M.)

04-i-9 SHIRLEY, J., 1899b — Note on a fossil wood from Mt Astrolabe, New Guinea. *Proc. Roy. Soc. Qld,* 14, 3-4.

This is a re-issue of entry 04-i-8 *Pitixoxylon palaeolaris.*

05 GEOMORPHOLOGY

(a) General and Descriptive

See also entries:

01-a-13	01-b-43	02-c-29	05-c-38
01-a-14	01-b-59	02-d-29	05-c-39
01-a-20	01-b-64	05-b-19	**05-c-50**
01-a-21	02-a-18	05-c-10	05-d-4
01-a-39	02-b-149	05-c-13	12-a-11
01-b-19	02-b-176	05-c-20	12-b-96
01-b-20	02-c-3	05-c-32	12-d-2
01-b-37	02-c-8	05-c-37	12-i-31

05-a-1 Anonymous, 1876a — Flussfahrten im südlichen Neu Guinea — 1. Reise der Barke *Chevert* nach Neu-Guinea; Macleays Fahrt auf dem Katau-Ströme (River exploration in southern New Guinea — 1. Visit of the *Chevert* to New Guinea; Macleay's journey up the Katau River, in German). *Petermanns Mitt.*, 22, 84-7.

The Katau R. is a short broad stream flowing between low banks through flat swampy country east of the Baxter (Mai Kussa) R. (W.M.)

05-a-2 Anonymous, 1889d — (Expedition into the Finisterre mountains, in German). *Nachr. Kaiser Wilhelmsl.*, 5(1), 3-15.

An expedition followed the upper Kabenau R. to a point about 65 km from the coast. The topography of this area of the Finisterres is described. (C.F.)

05-a-3 Anonymous, 1890d — Sir William Macgregor's discoveries in New Guinea. *Scott. geogr. Mag.*, 6, 245-54.

This summarizes entry 05-a-108.

05-a-4 Anonymous, 1891a — The Finisterre Mountains in German New Guinea. *Scott. geogr. Mag.*, 7, 40-1.

This summarizes entry 02-c-51.

05-a-5 Anonymous, 1894b — The Brandenberg Coast, New Guinea. *Geogr. J.* 4, 365.

Short swift streams feed the coast of New Guinea north of the Torricelli Ra. which rises up to 900 m. (W.M.)

05-a-6 Anonymous, 1897b — The German expedition to New Guinea. *Geogr. J.*, 9, 94-5.

A party under Lauterbach surveyed the upper and middle reaches of an unnamed river (Ramu) north of the Bismarck Ra. The valley of the Ramu is up to 48 km wide and extends west to the Kaiserin-Augusta (Sepik) R. coastal plains. The Ramu is separated from the Gogol R. basin by low ridges. (W.M.)

05-a-7 Anonymous, 1897e — German New Guinea. *Scott. geogr. Mag.*, 13, 212.
This abstracts entry 05-a-99.

05-a-8 Anonymous, 1898b — Explorations in the Owen Stanley Range. *Geogr. J.*, 12, 318.

Work on the Wharton Ra. north of Mt Victoria by Giulianetti (entry 01-b-36) is abstracted. The upper Vanapa was mapped and found to head west of Mt Thynne. (W.M.)

05-a-9 ANONYMOUS, 1898c — Sir Wm Macgregor's second journey across New Guinea. *Geogr. J.*, 12, 417-8.

Macgregor's crossing from the Vanapa R. to Mambare Bay (entry 01-b-54) is noted, and observations are made on topography of the Wharton Ra. and nearby river systems. (W.M.)

05-a-10 ANONYMOUS, 1898d — Exploration by Catholic missionaries in British New Guinea. *Geogr. J.*, 12, 418-9.

Work by Jullian and De Rycke inland from Yule I. is reported. The upper reaches of the St Joseph (Angabunga), Aroa, Kubuna, and Veida Rs were examined, and observations made on associated mountain chains and divides. (W.M.)

05-a-11 ANONYMOUS, 1913a — The Kaiserin-Augusta River expedition, German New Guinea, *Geogr. J.*, 41, 170.

The lower and middle reaches of the April and Wogamus Rs were seen from Mt Hunstein whose height is 1380 m. The lower and middle reaches of the Leonhard Schultze, April, Wogamus, and Korosameri Rs were charted, and the map accompanying Behrmann's report (entry 01-b-20) is noted. (W.M.)

05-a-12 ANONYMOUS, 1913c — Nachrichten von der deutschen Neuguinea-Expedition — III (Report from the German New Guinea expedition — III, in German). *Z. Geos. Erdk.*, 48, 138-45.

The account and sketch maps give an idea of the terrain in the valley and fall of the April R. Spot heights and geographic co-ordinates of several peaks are recorded. (The author is sometimes quoted as H. Spethmann.) (W.M.)

05-a-13 ANONYMOUS, 1914 — The Kaiserin-Augusta River Expedition, German New Guinea. *Geogr. J.*, 42, 574.

This records the completion of the expedition, and notes Behrmann's work south of the river (entry 02-c-8). The Toppen-fluss (Keram) R. was discovered in a swampy tract between the Sepik and Ramu Rs and the range was partly surveyed. (W.M.)

05-a-14 ALBERTIS, L. M. d', 1879c — Die Colonisations-Fähigkeit Neu-Guineas (New Guinea — its fitness for colonization, in German). *Petermanns Mitt.*, 25, 275-80.

The major physical regions of Papua and mainland New Guinea are described and related to climatic and agrarian considerations of settlement by people from more temperate climates. (W.M.)

05-a-15 ALBERTIS, L. M. d', 1880 — NEW GUINEA: WHAT I DID AND WHAT I SAW. *London, Sampson & Low,* 2 vols.

This describes d'Albertis' exploration in the Fly R. and nearby areas of western Papua and eastern Dutch New Guinea. (W.M.)

05-a-16 ALLIED FORCES SOUTHWEST PACIFIC AREA, 1941-45 — ALLIED GEOGRAPHICAL SECTION, 1942e — Goldfields Area — Wau and Bulolo Valley. *Spec. Rep. Allied geogr. Sec.*, 6, 15 pp.

Topographic notes are made on airfields and prewar mining camps. (C.F.)

05-a-17 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942i — Rabaul District, Gasmata, New Ireland. *Terrain study Allied geogr. Sec.*, 1, 36(8).

Information in this study was superseded by:
Rabaul District — Terrain Study No. 74 (entry 05-c-37).
Gasmata — Terrain Study No. 60 (entry 05-d-7).
New Ireland — Terrain Study No. 52 (entry 05-c-28).

05-a-18 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942k — In the vicinity of Buna, New Guinea, preliminary. *Terrain study Allied geogr. Sec.*, 4, 7 pp.

Information in this study was superseded by Terrain Study No. 27 (entry 05-a-22).

05-a-19 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942n — New Ireland, preliminary. *Terrain study Allied geogr. Sec.*, 8, 12 pp.

Information in this report was superseded by Terrain Study No. 52 (entry 05-c-28).

05-a-20 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942o — Area study of plains of Northern Division of Papua with notes on coastline from Buna district to China Strait and the overland route from Port Moresby to Kokoda. *Terrain study Allied geogr. Sec.*, 12, 32 pp.

Information in this report was superseded by Terrain Study No. 27 (entry 05-a-22). (C.F.)

05-a-21 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942t — Area study of D'Entrecasteaux and Trobriand Islands. *Terrain study Allied geogr. Sec.*, 23, 55 pp.

The three main islands of the D'Entrecasteaux group (Goodenough, Fergusson, and Normanby) are high mountainous islands surrounded by shallow offshore reefs. The Trobriands and Lusancays are raised coral islands. Kiriwina, the main Trobriand island, is the raised eastern edge of a coral atoll with high coral cliffs down the eastern coast; its centre is the flat raised bed of a coral lagoon and is now swamp interspersed with rich garden land. (C.F.)

05-a-22 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942u — Area study of Buna and plains of Northern Division. *Terrain Study Allied geogr. Sec.*, 27; 42, 8, and 12 pp.

The area is almost wholly level, mostly of low elevation, and enclosed on the landward side by mountains rising steeply to the west. In many places the land degenerates into swamp. River valleys close to the mountains have alluvial deposits of many heavy minerals indicating rich outcrops in the interior. The plains are bounded on the southwest by rugged mountains of 'fold' character rising to more than 4000 m. (C.F.)

05-a-23 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942v — Main routes across New Guinea. *Terrain study Allied geogr. Sec.*, 28.

13 tracks crossing the main divide south and east of Menyamya are described, together with several tracks along the north fall of the divide and on the northern plains of Papua. Some idea can be gained of the landforms, stream valley forms, and occasional outcrops. Maps and photographs are included. (W.M.)

05-a-24 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943b — Overland routes Lae-Markham valley to Wewak and to Finschhafen, Saidor, Madang, Bogia. *Spec. Rep. Allied geogr. Sec.*, 14.

Topographic descriptions are given of the country surrounding the main tracks across a wide area of northeast New Guinea. (C.F.)

05-a-25 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943c — Lindenhaven and vicinity. *Spec. Rep. Allied geogr. Sec.*, 15, 10 pp.

Lindenhaven, 18 km east of Gasmata on the south coast of New Britain, is a flat coastal area fringed with mangroves. The seaward shores of the adjacent islands are fringed with coral reefs, which drop off into deep water. (C.F.)

05-a-26 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943h — Inland track information: Huon Peninsula. *Spec. Rep. Allied geogr. Sec.*, 23, 7 pp.

This describes track conditions in the area and supplements Terrain Study No. 36 (entry 05-d-4). (C.F.)

05-a-27 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943i — Route Lae-Boana-Kaiapit. *Spec. Rep. Allied geogr. Sec.*, 24, 11 pp.

Brief topographic information is given. (C.F.)

05-a-28 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943j — Routes across New Britain. *Spec. Rep. Allied geogr. Sec.*, 25, 4 pp.

Brief topographic information is given on the main routes. (C.F.)

05-a-29 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943l — Fly River area. *Spec. Rep. Allied geogr. Sec.*, 28, 55 pp.

The area is bounded to the north by high mountains which slope steeply southward and phase into swamps, lagoons, and low hills. The largest sheet of water in southwest Papua is Lake Murray which is surrounded by swampy country. (C.F.)

05-a-30 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943o — Wewak. *Spec. Rep. Allied geogr. Sec.*, 32, 104 pp.

This is superseded by Terrain Study No. 76 (entry 05-c-38).

05-a-31 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943an — Area study of Madang. I — Text and Maps, II — Photographs. *Allied geogr. Sec. Terrain Study* 59, 152 pp.

The Ramu valley passes across the area and is flanked on the south by the Bismarck Ra. In the east the Finisterre Ra. forms a divide between the Ramu-Markham Valley and the Rai coast. The area west of Madang and south of Astrolabe Bay does not carry a main range, but a broken divide between the Ramu and the coast is a series of hills. Large crescent-shaped lagoons are found near the Ramu and a large swampy area lies close to its mouth. The area between the Ramu and the Sepik is an enormous grass swamp. Descriptions are given of the adjacent islands including Long and Manam (see also entry 05-c-31). (C.F.)

05-a-32 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943as — Area study of the Sepik District. I — Text and Maps, II — Photographs. *Terrain study Allied geogr Sec.*, 65, 192 pp.

A description is given of the river and range systems of the Sepik R., the coastline between the mouth of the Ramu R. and the border with Dutch New Guinea, and the islands of the Schouten, Kairiru, and Tumleo Groups off Aitape. Descriptions of the coastline, river valleys, tracks, and offshore islands give an idea of the landforms and note some outcropping rock types. Maps, sketches, and photographs are included. (W.M.)

05-a-33 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944d — Wewak *Terrain Hbk, Allied geogr. Sec.*, 17, 64 pp.

This describes the coastal area for about 25 km east and west of Wewak, the offshore islands of Kairiru and Mushu, and the Prince Alexander Ra. The range is about 300 m high, deeply dissected, and rising sharply to the highest point, Mt Turu; in the south it drops through steep broken country to sharp ridges and rolling downs which pass into the Sepik plains. The coastal fall is sharp, with a narrow coastal plain widening westward to 20-25 km. The coast is described in detail. Reef patches are of limited extent, and shoreline mangrove swamps occur. Oblique and vertical air-photographs are included. (W.M.)

05-a-34 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944e — But. *Terrain Hbk, Allied geogr. Sec.*, 18, 90 pp.

This describes the north coast from Matapau to Dagua, the coastal plains, the northern foothills of Prince Alexander Ra., its southern fall east of Maprik, and the offshore islands of Tarawai and Walis. A narrow coastal plain is developed, but the area is mostly rugged and mountainous. Some small lakes have developed behind landslide debris. The offshore islands are low and swampy. Photographs, mostly oblique air-photographs, are included. (W.M.)

05-a-35 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944g — Kavieng and New Hanover. *Terrain Hbk, Allied geogr. Sec.*, 20, 58 pp.

This describes northern New Ireland around Kavieng, New Hanover, and many nearby small islands south to Djaul I. The physical features of this low-lying partly swampy area are outlined, and oblique and vertical air-photographs are included. (W.M.)

05-a-36 ANAS, N., 1960 — The highlands of Australian New Guinea. *Geogr. Rev.*, 50, 467-90.

The geology and geomorphology of the highlands of east New Guinea are described. Geological notes follow Rickwood (entry 02-c-45) and geomorphic data are from a CSIRO survey (entry 05-a-86). (W.M.)

05-a-37 ANDREWS, E. C., 1910 — Geographical unity of eastern Australia in late and post-Tertiary time, with applications to biological problems. *J. Proc. Soc. N.S.W.*, 44, 420-80.

The geomorphic evolution of eastern Australia since the early Mesozoic is outlined, and comparison made with the post-Mesozoic geological and tectonic evolution of New Guinea and nearby Asian countries. (W.M.)

05-a-38 ANDREWS, J., 1957 — Landforms of New Britain. *Aust. Geogr.*, 7(1), 15-26.

The geomorphology of New Britain is outlined, with emphasis on the geological and tectonic causes of the median mountain range, and on the north coast volcanic landforms. (W.M.)

05-a-39 ARCHBOLD, R., & RAND, A. L., 1940 — NEW GUINEA EXPEDITION, FLY RIVER, 1936-37. *New York, McBridge,* xviii + 206 pp.

This describes the 2nd (1936-37) expedition in the Fly-Strickland area and around Lake Daviumbu, and notes the flat, low-lying, swampy country of the middle and lower reaches of the Fly R. Oblique air-photographs of Lake Margarita and Mt Leonard Murray (Mt Bosavi) are included. (W.M.)

05-a-40 ATKINSON, O. J., 1926 — Divisional report — Baniara district. *Papua ann. Rep. for 1924-25,* 40-42 (also issued as *Aust. parl. Pap. 41, Sess. 1926-28,* 2, 2104-6).

The country in the C. Vogel Pen. area is described with comments on its potential for development as an agricultural and grazing area. (W.M.)

05-a-41 AUSTEN, L., 1923b — The Tedi (Alice) River country and the people inhabiting it. *Papua ann. Rep. for 1921-22,* App. 1, (2nd Part), 134-40 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 1984-2090).

Geographical notes mention the synonymy of nomenclature of rivers draining the Star Mts into the Alice and Fly Rs system. The lower stretches of the Fly flow through flat to undulating extensive alluvial plains, passing upstream through rolling sandstone hills into the rugged foothills of the Star Mts. (W.M.)

05-a-42 AUSTEN, L., 1923c — The Tedi River district of Papua. *Geogr. J.*, 62, 335-49.

The Tedi (Alice) R. flows south from the Star Mts to join the Fly R. at Moorhead I. about 740 km above the mouth of the Fly. In the upper reaches of the Tedi R. late Tertiary marine sandstone and fossiliferous mudstone crop out, with abundant basaltic volcanics in river float. This is the first use of 'Star Mountains' as the English translation of the Dutch 'Sterrengebergte'. (W.M.)

05-a-43 AUSTEN, L., 1934 — The Delta Division of Papua. *Aust. Geogr.*, 2(4), 20-8.

The extent, boundaries, and physical features of the Delta Division of Papua are outlined. Three topographic divisions are recognized — deltaic flats, hills of the delta, and mountainous hinterland. The major rivers are the Gama, Turama, Paibuna, Omati, Kikori, Era, Pie, and Purari. (W.M.)

05-a-44 Austen, L., 1936 — The Trobriand Islands of Papua. *Aust. Geogr.*, 3(2), 10-23.

The exploration, history, geology, fauna, flora, physical features, and potential population and agriculture of the Trobriand Is are outlined. Much of Kiriwina is composed of raised coral reefs surrounding a lagoon in which clays and loams have accumulated; nearly 3000 hectares of swamps are in the northeast. Volcanic ash has enriched soils in the southern outlier island of Vakuta. (W.M.)

05-a-45 Australia. Parliament, 1923 — Geographical description of the Territory. *New Guinea ann. Rep. for 1921-22,* 5-24 (also issued as *Aust. parl. Pap. 18, Sess. 1923-4,* 4, 1337-56).

The principal physical features of the mainland and islands are sketchily outlined, and notes included on climate, inhabitants, and development. (W.M.)

05-a-46 Australia. Parliament, 1926b — Report by the District Officer for Morobe on the patrols to the Bubu, Ono and Upper Waria Rivers, and north therefrom to the Bialolo River. *New Guinea ann. Rep. for 1924-25,* App. C, 97-108 (also issued as *Aust. parl. Pap. 40, Sess. 1926-28,* 2, 1623-34).

Dissected high country forming the watershed of the upper Waria, Biaru, Bulolo, and Lakekamu Rivers is described. It could prove rich in gold. (W.M.)

05-a-47 Australia. Territories, Department of, 1949 — Annual report — Mining. *Papua ann. Rep. for 1948-49,* 16-17 and 58 (also issued as *Aust. parl. Pap. 14, Sess. 1950-51,* 2, 875-6 and 917).

Major geomorphic features of New Guinea are summarized, including a gross descriptive classification of soils. The section on mining records prospecting and exploration around the gold mines on Misima I., the production of a small amount of alluvial gold from Tagula I. and the Milne Bay area, and attempts to rehabilitate the Astrolabe mines near Port Moresby. Gold production for the year was only 800 g. (W.M.)

05-a-48 Bearup, A. J., 1936 — The Ramu and Wahgi valleys of New Guinea. *Aust. Geogr.*, 3(1), 3-14.

The physical features of the area are noted. (W.M.)

05-a-49 Behrmann, W., 1914 — Geographische Ergebnisse der Kaiserin-Augusta-fluss- Expedition (Geographical results of the Sepik River Expedition, in German). *Z. Ges. Erdk.* 49, 254-77.

Exploration of the middle and upper reaches of the Sepik R. and its north-flowing major tributaries revealed large tracts of mountainous country dissected by swift-flowing, deeply-incised streams. The country around the Schraeder Ra. and westward to the upper reaches of the May R. is described for the first time. (W.M.)

05-a-50 Behrmann, W., 1917 — Der Sepik und sein Stromgebiet (The Sepik and its basin, in German). *Mitt. dtsch. Schutzgeb., Ergh.,* 12, 1-100.

The expedition to the Sepik R. valley during 1910-1913 covered the area of German New Guinea east from the Dutch border to east of the mouth of the Ramu R., and south from the coast to the foothills of the main cordillera. A regional map at 1 : 1 500 000 and a map at 1 : 250 000 in three sheets show details along stream courses and in some foothill and riverine ranges. Regional meta-morphics are the main outcropping rock type with minor plutonic intrusives and volcanics. (W.M.)

05-a-51 Behrmann, W., 1919 — Detzners Forschungen in Neuguinea (Detzner's exploration in New Guinea, in German). *Z. Ges. Erdk.,* 54, 371-6.

Detzner's exploration of much of eastern German New Guinea is outlined, with general decriptions of the Bowutu, Kaindi, Menyamya-Aseki, Huon Pen., and Bismarck Ra. areas. (This supposed exploration has since been held to be largely fanciful.) (W.M.)

05-a-52 BEHRMANN, H., 1922 — IM STROMGEBIET DES SEPIK (In the Sepik basin, in German). *Berlin, Scherl,* 359 pp.

The Sepik landforms are described, and reference is made to outcropping metamorphics and to the volcanic activity of Manam I. Included is a 1 : 1 000 000 topographic sketch map of western mainland New Guinea between 141°E and 145°E between 3°10′S and 5°30′S. (W.M.)

05-a-53 BEHRMANN, W., 1942a — Die Stammeszersplitterung in Sepikgebiet (Neuguinea) und ihre geographischen Ursachen (The tribal groups of the Sepik region and their geographic distribution, in German). *Petermanns Mitt.,* 70, 61-6.

An impression is given of some of the middle and upper Sepik valley and range systems such as Hunstein Ra. and some of the north-flowing Sepik tributaries west of this range. (W.M.)

05-a-54 BEHRMANN, W., 1924b — Das westliche Kaiser-Wilhelmsland in Neu-Guinea (Western Kaiser-Wilhelms Land in New Guinea, in German). *Z. Ges. Erdk.,* 1, 1-72.

This collates previous reports on exploration in the Sepik and Ramu Rs and tributaries, together with new data on the coastal Torricelli, Prince Alexander, Adelbert, and Finisterre Ras. It is mainly geographic with minor reference to geological features such as rock types and structures evident in landscape. (W.M.)

05-a-55 BEHRMANN, W., 1927 — Das Zentralgebirge Neuguineas im westlichen Kaiser Wilhelmsland (The central mountain ranges of New Guinea in western Kaiser-Wilhelmsland, in German). *Mitt. dtsch. Schutzgeb.,* 35, 1-43.

Parts of New Britain and German New Guinea are described and illustrated with sketches and photographs. Areas discussed include ranges in the headwaters of the Korosameri, Karawari, April, Leonard Schultze, and Frieda Rs; coastal ranges along the north coast west from Wewak; the upper reaches and plains of the Sepik R.; and volcanic islands off the coast of New Guinea and west New Britain. (W.M.)

05-a-56 BEHRMANN, W., 1928 — Die Insel Neuguinea (The island of New Guinea, in German). *Z. Ges. Erdk, Sonderbd. Hndetjahr,* 191-207.

This summarizes knowledge of the gross geographic features of New Guinea and several offshore islands. It is illustrated with maps and schematic profiles. (W.M.)

05-a-57 BIK, M. J., 1967 — Structural geomorphology and morphoclimatic zonation in the central highlands, Australian New Guinea. *In* JENNINGS, J. N., & MABBUTT, J. A. (Eds) — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press,* 26-47.

In the Wapenamanda-Kagua-Mt Rentoul area there is a strong relationship between landforms and underlying geological structures. A series of fault-block mountains are separated by high basins, with modification by sub-Recent volcanic activity. Palaeogeographic reconstruction of the regional depositional environment during Late Jurassic to Recent time indicates the continual existence and influence of the Erave-Wana Swell. (W.M.)

05-a-58 BLACKWOOD, B., 1931 — Report on field work in Buka and Bougainville. *Oceania,* 2, 199-219.

Off the west coast of Buka is a string of coral islets. The north coast of Bougainville is rocky and precipitous, with occasional narrow sandy beaches and a fringing reef. The peninsula which forms the northwest point of Bougainville is almost flat, rising through foothills to the main axial range. (W.M.)

05-a-59 BLAIR, D., 1881 — New Guinea: Its geography, physical features and natural history, with the history of attempts to settle the island. *In* CYCLOPAEDIA OF AUSTRALASIA, I. *Melbourne, Fergusson & Moore,* 250-263.

This collates what was then known of New Guinea's extent, physical features, early history and exploration, geology and natural history, animal life, the Papuan race, and local divisions. The central high range of the western end of the island is not known to extend east of the head of the Fly R., though a range up to 3000 m high extends from 147°E to the eastern end of the island. Little is known of the geology of the island. (W.M.)

05-a-60 BLAKE, D. H., 1971 — Geology and geomorphology of the Morehead-Kiunga area. *In* PAIJMANS, K., et al. — Land resources of the Morehead-Kiunga area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 29, 56-68.

4 main geographic regions are recognized: (i) the coastal plain; (ii) the Oriomo plateau, a flat to undulating feature less than 30 in above sea level; (iii) flood plains of the Fly R. and its tributaries; (iv) dissected plateau of the Fly-Digoel Shelf. Outcrop geology is limited almost entirely to unconsolidated detrital sediments of Pleistocene to Recent age. These are underlain by Pliocene terrestrial detrital sediments in the Strickland Basin, Miocene limestone and marine detrital sediments, Cretaceous detrital sediments, and Jurassic feldspathic sandstone. A crystalline basement of Upper Carboniferous granite, exposed on the coast at Mabaduan, probably extends beneath much of the survey area. Geological data are from surveys by Australasian Petroleum Company (entry 03-a-3). A small area of mudstone of possible Pliocene age is recorded from near Weam. Pleistocene strata are divided into three units: the Elevala Beds, the Kiunga Beds, and the Lake Murray Beds, all dominantly non-marine. The geomorphic evolution of the area is traced through continuous but spasmodic subsidence, and uplift by warping. (W.M.)

05-a-61 BLAYNEY, J. A., 1902 — Report of the Resident Magistrate, Central Division, on an expedition to the Doriwaidi tribes. *Brit. N. Guinea ann. Rep. for 1900-01,* App. H, 42-6.

The main divide in eastern Papua, from which the north-flowing Domara and Adau Rs and the south-flowing Mori R. fall, is rugged though not very high, and rubbly stream beds and precipitous interfluve ridges are typical. (W.M.)

05-a-62 BRIGHAM, W. T., 1900 — AN INDEX TO THE ISLANDS OF THE PACIFIC OCEAN. *Honolulu, Bishop Mus. Press,* 172 pp.

An alphabetic partial list is given of the islands of the Pacific Ocean, in which major island groups and islands are considered. Data are recorded for each island, including alternative names, geographic co-ordinates, extent and altitude, type and extent of cultivation and occupation, and derivation of its inhabitants. Many Papua and New Guinea islands are included. (W.M.)

05-a-63 BROWN, I. A., 1944 — Some aspects of the natural history of New Guinea: physiography and geological history. *Proc. Linn. Soc. N.S.W.,* 69, xxi.

This is 1 of 3 papers read to a section meeting of the society and is known only by title. (W.M.)

05-a-64 BROWN, M. J. F., 1970a — Landforms. *In* WARD, R. G., & LEA, D. A. M. (Eds) — AN ATLAS OF PAPUA & NEW GUINEA. *Port Moresby & Glasgow, Univ. Papua New Guinea* and *Collins-Longman,* 38-9.

The variety of landforms recognized in Papua New Guinea include many of at least Pleistocene age and some which are Pliocene. Mountain chains and river systems strongly reflect geological and structural influences, and volcanic landforms are a feature of many areas. Extensive deltas and coastal plains are built up on the Gulf of Papua coast, and the Sepik, Ramu, and Markham Rs in New Guinea all have extensive alluvial plains. (W.M.)

05-a-65 BROWN, M. J. F., & PAIN, C. F., 1970 — Introduction to physical environment. *In* WARD, R. G., & LEA, D. A. M. (Eds) — AN ATLAS OF PAPUA & NEW GUINEA. *Port Moresby & Glasgow, Univ. Papua New Guinea* and *Collins-Longman,* 29-31.

The distribution of ranges and rivers is largely controlled by gross geological structure, which trends across the late Palaeozoic geosynclinal zone of eastern Australia. Several sigmoid seismic and volcanic belts within the Melanesian structural belt can be recognized in mainland New Guinea, the New Guinea islands, and in several bathymetric deeps. Landforms and soils reflect a gross altitudinal zonation superimposed on geological structure, usually showing a strong dependence on rainfall. (W.M.)

05-a-66 CAMPBELL, S., 1938 — The country between the headwaters of the Fly and Sepik Rivers in New Guinea. *Geogr. J.*, 92, 232-58.

The history of exploration of the Fly R., the first crossing of the island from south to north by Karius and Champion, and German investigations in western New Guinea, are noted. Exploration in western Papua New Guinea in 1935 by a group of mineral company geologists and prospectors is recorded. (W.M.)

05-a-67 CAREY, S. W., 1938 — The morphology of New Guinea. *Aust. Geogr.* 3(5), 3-31.

7 distinct physiographic provinces, which are also structural zones concentric with the Australian continent, are recognized in New Guinea: the south littoral, main cordillera, central intermontane trough, northern ranges, northern littoral, active volcanic arc, and outer island festoon. The features, age, origin, and development of each are discussed. (W.M.)

05-a-69 CHAMPION, I. F., 1938 — The Bamu-Purari expedition. *Papua ann. Rep. for 1936-37,* 21-2 (also issued as *Aust. parl. Pap. 27, Sess. 1932-40,* 3, 1100-1).

This summarizes entry 01-b-30.

05-a-70 CHESTER, H. N. 1899 — Abstracts from diary. *Brit. N. Guinea ann. Rep. for 1897-98,* Encl. 1 in App. A, 7-9.

The gentle slopes on the plateau around the Sogeri area, and the precipitous cliffs which mark its edge, are noted. (W.M.)

05-a-71 COLDHAM, J. C., 1928 — A reconnaissance map of the Bulolo Goldfields, Territory of New Guinea. *Proc. Australas. Inst. Min. Metall.*, 71, 73-9.

Methods of collecting and calibrating topographic data used in preparing this first map of the Bulolo Goldfields indicate the rugged terrain between Wau and Salamaua, and the contrast between this area and the valley of the Bulolo and Watut Rs. (W.M.)

05-a-72 DETZNER, H., 1920 — VIER JAHRE UNTER KANNIBALEN (Four years among the cannibals, in German). *Berlin, Scherl,* 341 pp.

Traverses were made through the Finisterre, Saruwaged, Cromwell, and Bismarck Ras and the Wau-Morobe region, and glacial landforms in the Saruwaged Ra. are described. Until recently this account had been regarded largely as a fanciful creation, partly because of the mention of glacial features, but recent verification of them (entry 06-d-3) may gain credibility for other aspects of the book. (W.M.)

05-a-73 DETZNER, H., 1928 — Das westliche Bergenzungsgebiet der Stammesgemeinschaften des 'Zentralgebirges' (The mapping of the western limit of tribal groups in the Central Ranges, in German). *Mitt. dtsch. Schutzgeb.,* 36(2), 125-8.

The country around Mt Joseph (Mt Chapman) is deeply dissected, immature, and traversed by steep-falling, fast-flowing streams to the south. The fall to the north into the Watut and Markham river systems is less severe. (C.F.)

05-a-74 DETZNER, H., 1935 — MOEURS ET COUTUMES DES PAPOUS — QUATRE ANS CHEZ LES CANNIBALES DE NOUVELLE-GUINEA, 1914-1918 (Customs and habits of the Papuans — four years among the cannibals of New Guinea, 1914-1918, in French). *Paris, Payout,* 315 pp.

This is a translation of entry 05-a-72.

05-a-75 FORBES, H. O., 1890 — The Owen Stanley Range, New Guinea. *Proc. Roy. geogr. Soc.*, 12 (n.s.), 558-63.

Discrepancies between reports by Forbes (entry 02-b-46) and Macgregor (entry 05-a-111) on traverses to Mt Owen Stanley (Mt Victoria) are discussed. A sketch profile of the crests on Mt Owen Stanley is included and descriptions are given of the summit area and near surrounds of Mt Owen Stanley. (W.M.)

05-a-76 FORBES, H. O., 1897 — Sir William Macgregor's journey across New Guinea. *Nature,* 56, 247.

In reply to an article recording the second ascent of Mt Victoria by Macgregor (entry 01-b-64), Forbes defends his unsuccessful attempts to climb Mt. Owen Stanley (Mt Victoria) and adds further details about the terrain on its southern approaches. (W.M.)

05-a-77 FREY, G., 1916 — Der Nordosten Papuas, der britischen Kolonie in Neu-Guinea (Northeastern Papua, the British colony in New Guinea, in German). *Z. Ges. Erdk,* 51, 716-7.

This abstracts entry 05-a-161 describing the country around Collingwood Bay.

05-a-78 FROHLICH, O., 1908 — Durch das Innere von Kaiser-Wilhelms-Land von Huon-Golf bis zur Astrolabe-Bai (Through the interior of Kaiser Wilhelms Land from Huon Gulf to Astrolabe Bay, in German). *Mitt. dtsch. Schutzgeb.,* 21, 200-13.

The Markham R. flows in a wide valley of low easterly gradient. It heads in the Rawlinson Ra., emerging as a narrow, fast, boulder-strewn stream. The divide to the Ramu is low and ill defined. North of the Ramu a rugged range rises abruptly and is dissected by deep rapid streams. (W.M.)

05-a-79 GUISE, R. E., 1894 — Report on expedition despatched from Collingwood Bay to the main range. *Brit. N. Guinea ann. Rep. for 1893-94,* App. X, 78-97.

An attempt was made to climb Mt Suckling and nearby peaks in the main range and data are recorded on the range, spur ridges, and streams. (W.M.)

05-a-80 HAANTJENS, H. A., 1961 — Commonwealth Scientific and Industrial Research Organisation land surveys in Papua and New Guinea. *Aust. Terr.* 1, 11-7.

The philosophy and methods of CSIRO Land Research Surveys in Papua-New Guinea are discussed, and survey techniques outlined. A summary is given of areas covered in the 1953-1960 field seasons. The use of the surveys is to indicate the size, location, and nature of areas of development potential, and the nature and degree of hazards to be overcome. (W.M.)

05-a-81 HAANTJENS, H. A., 1963 — Land capability classification in reconnaissance surveys in Papua and New Guinea. *J. Aust. Inst. agric. Sci.,* 29, 104-7.

The land capability classification system used by the U.S.A. Department of Agriculture is outlined and its advantages are listed. Modifications made to the system for surveys in Papua New Guinea are discussed, and their advantages noted. (W.M.)

05-a-82 HAANTJENS, H. A., 1964a — Summary description of the Buna-Kokoda area. *In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 10, 10-7.

This collates summaries of specialist reports on landforms (entries 05-a-91 and 05-a-121), soils (entry 07-a-5), geology (entries 02-b-126 and 09-b-29), climate, vegetation, utilization, and land-use potential of the area. (W.M.)

05-a-83 HAANTJENS, H. A., 1964c — General description of the Wanigela-Cape Vogel area. *In* HAANTJENS, H. A. (Ed.) — (b). General report on lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 12, 10-6.

This summarizes specialist reports of the geomorphology (entry 05-a-88), soils (entry 07-a-6), vegetation, forest resources, climate, land use, and land-use potential of the area. (W.M.)

05-a-84 HAANTJENS, H. A., 1965b — Practical aspects of land system surveys in New Guinea. *J. trop. Geogr.*, 21, 12-20.

The nature of the CSIRO Land Research Surveys is discussed, and survey procedures outlined. Examples of data presentation methods are given, with photographic illustrations. (W.M.)

05-a-85 HAANTJENS, H. A. (Ed.), 1964a — General report on lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 10, 1-115.

The area is described in outline (entry 05-a-82), and specialist descriptions are given for the geology (entries 02-b-136 and 09-b-29), landforms (entries 05-a-92 and 05-a-121), soils (entry 07-a-5), vegetation, climate, land use, and land-use potential. (W.M.)

05-a-86 HAANTJENS, H. A. (Ed.), 1968 — Lands of the Wewak-Lower Sepik area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 22, 1-150.

A study of the land-use potential of the area deals mainly with geomorphology (entry 05-a-130) and outlines landforms (entry 05-a-90), vegetation, climate, and present land use: The relationship between geology, land systems, and soils is outlined with descriptive and analytical data on soils (entry 07-a-9). (W.M.)

05-a-87 HAANTJENS, H. A. (Ed.), 1970 — Lands of the Goroka-Mount Hagen area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 27, 1-160.

The report covers geology and geomorphic history (entry 02-c-22), land systems (entry 05-a-91), climate, soils, entry (07-a-10), vegetation, forest resources, population and land use, and agricultural potential. (W.M.)

05-a-88 HAANTJENS, H. A., & TAYLOR, B. W., 1964 — Land systems of the Wanigela-Cape Vogel area. *In* HAANTJENS, H. A. (Ed.) — (b). General report of the lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 12, 21-43).

25 land systems are recognized on the basis of inter-relationships of lithology, structure, soils, landforms, and vegetation. The geology, soils, physical features, and vegetation of each system are outlined. (W.M.)

05-a-89 HAANTJENS, H. A., PAIJMANS, K., & RUXTON, B. P., 1967 — Land systems of the Safia-Pongani area. *In* RUXTON, B. P., et al., — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 17, 19-78.

45 land systems are recognized on the basis of correlations between lithology, landforms, soils, and vegetation. Each is described in terms of altitude, extent, geology, geormorphology, soils, drainage, vegetation, and features of recognizable units. Correlations are suggested with land systems in the Buna-Kokoda area (entry 05-a-92) and the Wanigela-C. Vogel area (entry 05-a-88). (W.M.)

05-a-90 HAANTJENS, H. A., REINER, E., & ROBBINS, R. G., 1968 — Land systems of the Wewak-lower Sepik region. *In* HAANTJENS, H. A. (Ed.) — Lands of the Wewak-lower Sepik area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 22, 15-48.

27 land systems have been recognized, on the basis of natural patterns of rock, soil, landforms, and vegetation. Descriptions of each system include a summary of geomorphology and geology, and a description of the extent, nature, soil types, drainage, and vegetation of each landform unit. (W.M.)

05-a-91 HAANTJENS, H. A., REINER, E., & ROBBINS, R. G., 1970 — Land systems of the Goroka-Mount Hagen area. *In* HAANTJENS, H. A. (Ed.) — Lands of the Goroka-Mount Hagen area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 27, 24-65.

39 land systems are recognized on the basis of regional variations in rock type, soil, landform, and vegetation. Systems are grouped on the basis of gross landform type, so that the land systems map also serves as a geomorphic map. The land systems are described, usually with a block diagram sketch, in terms of geology, physical features, soils and drainage systems, vegetation, land utilization class, population, and land use. (W.M.)

05-a-92 HAANTJENS, H. A., PATERSON, S. J., TAYLOR, B. W., & STEWART, S. A., 1964 — Land systems of the Buna-Kokoda area. *In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 10, 18-44.

30 land systems are recognized on the basis of rock type, soil, vegetation, and landforms. Tabular descriptions of each land system include notes on the site, geology, and geomorphology, as well as data on landforms, extent, soils, vegetation, and land-use potential. (W.M.)

05-a-93 HOLLRUNG, M., 1888b — (Report of paper to Geographical Society of Berlin, concerning the geography of New Guinea). *Proc. Roy. geogr. Soc.,* 10 (n.s.), 600-3.

The north coast of New Guinea has many more natural harbours than the map outline would suggest. Offshore reefs are close to the shore and few ocean shoal reefs are developed. The Empress Augusta (Sepik) R. flows in a sinuous river bed over broad extensive alluvial plains and is navigable by ocean-going vessels for 160 km. The mountains south of the coastal plain are rugged, high, and deeply dissected by swift rivers in narrow beds that fall rapidly from the range to the plains. The coastal zone of Kaiser Wilhelms Land (New Guinea) is coralline, and volcanics make up much of the main range. Sedimentary strata are exposed in the coastal ranges north and east of the Empress Augusta R. (W.M.)

05-a-94 HOMBRON, J. B., 1845 — Apercu géologique et ethnologique de l'Australie et de la Nouvelle-Guinée (Geological and ethnological outline of Australia and New Guinea, in French). *N. Ann. Voyages,* 106, 381-7.

The scenic grandeur of the axial cordillera of New Guinea is due partly to the underlying geological formations and structures. The south coast is being built up by large swift rivers in the west. Active faulting accounts for seismic disturbances on the north coast and in the New Guinea islands. (W.M.)

05-a-95 JENA, L. SCHULTZE, 1912 — Die deutsche Grenz-expedition in das Kaiser Wilhelms Land (The German Border Expedition in Kaiser Wilhelms Land, in German). *Mitt. Ges. Erdk. Lpz.,* 2, 23-35.

Original mapping of the Dutch/German border has increased the detailed knowledge of the Bewani Mts and the upper Sepik R. (W.M.)

05-a-96 JENNINGS, J. N. & MABBUTT, J. A., 1967 — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press,* 434 pp.

The New Guinea content covers studies of wet tropical morphoclimatic zonation in the highlands (entry 05-a-57), coral reefs (entry 05-d-21), spectral analysis of river meanders (entry 05-b-55), landslides in earthquake-affected mountain ranges (entry 05-b-52), and wet-tropic weathering and erosion (entry 05-b-50). (W.M.)

05-a-97 JUKES, J. B., 1847a — Geology of Torres Strait. *Naut. Mag.,* 16, 648-50.

The western Torres Str. islands are of continental-type rocky, high outcrops, reminiscent of drowned hills. Small fringing reefs may be developed, but true coral shoal reefs are found only to the east. Coralline reefs are not found in the detritus-enriched, freshwater-fed seas along the New Guinea coast. Murray, Darnley, and

Bramble Cay are volcanic islands with fringing reefs, and Aird Hills in New Guinea is probably volcanic as it lies on a continuation of this chain. The effect of the New Guinea volcanic range and the continental-type hills farther west is to force drainage of a large part of New Guinea into the coastal tract between 143°E and 147°E. (W.M.)

05-a-98 KEYSSER, C., 1913 — Die erste Ersteigung der östlichen Gipfel des Finisterregebirges, Kaiser-Wilhelms-Land (The first ascent of the eastern peaks of the Finisterre Ranges, German New Guinea, in German). *Petermanns Mitt.*, 59, 177-81.

A traverse from Sattelberg mission west to Mt Sarawaket followed the upper reaches of the south fall of the Cromwell Ra. to the eastern limit of the Saruwaged Ra., but did not reach what is now known as the Finisterre Ra. The steep-sided streams and dissected ridges are described, and photographs, sketches, and a route map are included. (W.M.)

05-a-99 LAUTERBACH, C., 1897a — Bericht über die Kaiser-Wilhelms-Land-Expedition im Jahre 1896 (Report on the German New Guinea Expedition during the year 1896, in German). *Ges. Erdk., Verh.*, 24, 51-69.

A joint geographical-ethnological survey explored the Ramu Valley region, and mapped the ranges and valleys, and some of the northern foothill ranges of the central divide. (W.M.)

05-a-100 LAUTERBACH, C., 1897b — Die Kaiser-Wilhelms-Land Expedition (The mainland German New Guinea Expedition, in German). *Dtsch. Kolonztg.*, 14, 434.

The middle reaches of the Ramu R. flow along the foot of the Bismarck Ra. at the southern edge of a wide alluvial plain. The southern flanking range rises to about 2000 m and is backed by a higher cordillera up to 4000 m. (W.M.)

05-a-101 LAWES, W. G., 1880 — Notes on New Guinea and its inhabitants. *Proc. Roy. geogr. Soc.*, 2 (n.s.), 602-16.

The physical geography of Papua around and east of Port Moresby is described. The presence of the median mountain chain of the Owen Stanley Ra. and the southern foothill ranges and slopes makes it difficult to explain the absence of large rivers in this area. The discovery of gold in the area is noted. (W.M.)

05-a-102 LAWES, W. G., 1889 — Sir Wm Macgregor's ascent of Mount Owen Stanley. *Proc. Roy. geogr. Soc.*, 11 (n.s.), 605-6.

Several peaks in the Owen Stanley Range were climbed, and their elevations noted. The highest peak climbed was Mt Victoria at 4000 m (13 121 ft), and several peaks over 3350 m were scaled. (W.M.)

05-a-103 MABBUTT, J. A., 1965b — Geomorphology of the Port Moresby-Kairuku area. *In* MABBUTT, J. A., et al., — Lands of the Port Moresby-Kairuku area, Papua-New Guinea. *CSIRO, Land Res. Ser.* 14, 106-28.

The area comprises the coastal lowlands from Kapa Kapa to the mouth of the Biaru R. and inland to the foothills of the main range. Geology and tectonism (entry 02-b-156) have strongly influenced relief and landforms (entry 05-a-105) in developing both present landscape features and the pre-Pliocene terrain upon which the Sogeri conglomerates were deposited. A 1:250 000 map of land systems is included. Geomorphologic features are discussed in detail. (W.M.)

05-a-104 MABBUTT, J. A., & STEWART, G. A., 1963 — The application of geomorphology in resources surveys in Australia and New Guinea. *Rev. Geomorph. Dyn.*, 14, 97-109.

Geomorphology is applied in reconnaissance resources surveys by CSIRO in Australia and New Guinea. The mapping unit is the land system, an area with a recurring pattern of landforms, soils, and vegetation, and mapping is done on air-photographs. Geomorphic criteria used in land systems mapping include morphology, genetics, chronology, and dynamics. The land system approach is analytical: complexes are recognized and broken into component land units. Survey results are expressed in a land system map, which can be interpreted as a relief-type map, and in a general report which includes tabular descriptions of land systems and a chapter on the geomorphology of the area and its land systems. Land system boundaries can be grouped for specialist maps, such as land surface and surface drainage maps. (Auth.)

05-a-105 MABBUTT, J. A., HEYLIGERS, P. C., PULLEN, R., SCOTT, R. M., & SPEIGHT, J. G., 1965 — Land systems of the Port Moresby-Kairuku area. *In* MABBUTT, J. A., et al., — Lands of the Port Moresby-Kairuku area, Papua-New Guinea. *CSIRO, Land Res. Ser.* 14, 19-82.

The 49 land systems in the coastal lowlands of the eastern part of the Gulf of Papua are discussed in tabular form, and are grouped by erosional or depositional environmental zones (entry 02-b-67). Descriptions of each land system include geological formations underlying the system, geomorphology, altitude at which the system is developed, and the soil, vegetation, and land-use potential for each unit within the system. (W.M.)

05-a-106 MABBUTT, J. A., HEYLIGERS, P. C., SCOTT, R. M., SPEIGHT, J. G., FITZPATRICK, E. A., MCALPINE, J. R., & PULLEN, R., 1965 — Lands of the Port Moresby-Kairuku Area, Papua-New Guinea. *CSIRO, Land Res. Ser.* 14, 1-182.

Descriptions are given of the geomorphology (entry 05-a-103), land systems (entry 05-a-105), soil types and their distribution (entry 07-a-19), and vegetation. These are related to underlying geology (entry 02-b-156), and the land-use potential is discussed. (W.M.)

05-a-107 MACFARLANE, S., 1877 — Voyage of the *'Ellangowan'* to China Straits, New Guinea. *Proc. Roy. geogr. Soc.*, 21, 350-60.

Dundee R., Marshall Lagoon, Devitt R. and Shallow Bay, Mullins Har., Pumice Rock and Isabel Cove, and Stacey I. were examined and mapped. The reef around Eugenie I. in Cloudy Bay was explored. (W.M.)

05-a-108 MACGREGOR, W., 1890k — Despatch reporting tour of inspection extending from Manu-Manu on the coast of the possession to the Owen Stanley Range in the interior. *Brit. N. Guinea ann. Rep. for 1888-89, (Qld)*, App. R, 35-46 (also issued as *Brit. N. Guinea ann. Rep. for 1888-89, (Vic.)*, App. D, 37-48).

The course and features of the Vanapa R. and surrounding hill country are described. Several peaks, including Mt Victoria, were climbed and their altitudes calculated. Most of the country was low-grade slate and schist, veined with quartz and intruded by granite. The range is a more-or-less continuous range with most peaks rising about 3350 m and some (e.g. Mt Victoria) rising to 4000 m. (W.M.)

05-a-109 MACGREGOR, W., 1890m — Despatch in further reference to inspection tour of Fly River. *Brit. N. Guinea ann. Rep. for 1889-90,* App. F, 43-9.

A description is given of the broad flat alluvial plains of the coastal tract of the Fly R. for about 280 km in from the mouth. (W.M.)

05-a-110 MACGREGOR, W., 1890o — Despatch reporting visit of inspection to the districts lying west of the island of Dauan. *Brit. N. Guinea ann. Rep. for 1889-90,* App. I, 69-75.

About 25 km up the Mai Kussa R. are outcrops of 'half calcined clays containing much silica and iron'. Soils on nearby river flats are poor and argillaceous, and there are several ridges up to 10 m high across the trend of the river. Much of the coastal country west to Thomson Bay is low-lying and flat, with occasional coral sand beaches and red soils which often contain pisolitic iron ores. The river feeding into Heath Bay (Morehead R.) was surveyed for about 160 km. (W.M.)

05-a-111 MACGREGOR, W., 1890p — Journey to the summit of the Owen Stanley Range, New Guinea. *Proc. Roy. geogr. Soc.*, 12 (n.s.), 193-223.

The most easterly distributary of the Vanapa R. is readily navigable for about 25 km when rapids are met and the country passes from wide flat flood plains to steep hills with slaty quartz-veined outcrops. Numerous conglomerate and basalt boulders are present in the stream bed, and the river becomes un-navigable about 55 km from the mouth. Mt Victoria is the eastern end of the Owen Stanley Ra. (a convention not now accepted), which extends westward to Mt Thyme and Mt Lilley. The heights and positions of peaks climbed are noted. (W.M.)

05-a-112 MACGREGOR, W., 1894e — Despatch reporting visit of inspection to the Purari River district. *Brit. N. Guinea ann. Rep. for 1893-94,* App. E, 22-9.

The Purari R. was explored for about 80 km, with geographic and geological notes given on flow characteristics, surrounding country, stream-bed debris, and outcrops in hills in the upper Aure R. For most of the traverse the Purari is a broad stream flowing through flat swampy land. In the upper reaches, debris and outcrops of sandstone, conglomerate, and limestone are seen. Some quartz, basalt, and serpentinite in the stream debris are probably derived from the main range. The rate of flow of the Purari R. below its junction with the Aure R. was measured at 300 million m^3 per day; coal debris was found here. (W.M.)

05-a-113 MACGREGOR, W., 1895b — British New Guinea. *J. Manch. geogr. Soc.*, 10, 271-85.

A main axial cordillera ranging up to 3650 m and with its highest peak in Mt Victoria in excess of 4000 m, extends the entire length of the Territory. Several large rivers run from the range, and many are navigable for some distance from the coast. Gold is found in many rivers. (W.M.)

05-a-114 MACGREGOR, W., 1897c — Despatch reporting expedition undertaken to effect the ascent of the Musa River. *Brit. N. Guinea ann. Rep. for 1895-96,* App. E, 22-8.

The coastal tract of the Musa R. is free of debris other than fine silt and vegetable fragments. Through the western foothills of Mt Victory the river flows swiftly through steep-sided valleys. Farther south the Musa splits to form the Moni and Adaua Rs which drain a large plain-like valley and rise in the northern flank hills of the Owen Stanley Ra. Colours of gold were seen in all three rivers wherever tested near rapids. (W.M.)

05-a-115 MACGREGOR, W., 1897g — BRITISH NEW GUINEA. *London, Murray,* 100 pp.

The gross relief and physical features of British New Guinea are outlined and refer to the source and reliability of data. Much of the record of early exploration in the territory may be inaccurate or fanciful. (W.M.)

05-a-116 MORESBY, J., 1876 — NEW GUINEA AND POLYNESIA: Discoveries and surveys in New Guinea and the D'Entrecasteaux Islands — a cruise in Polynesia and visits to the pearl shelling stations in Torres Straits of HMS *Basilisk. London, Murray,* 327 pp.

Moresby's surveys in the *Basilisk* in 1871-72 are described including much data previously presented (entries 01-a-30 and 01-a-32 to 01-a-35). Lawson's book *'Wanderings in the Interior of New Guinea'* (entry 01-b-52) is critically examined. (W.M.)

05-a-117 MORTON, M. H., 1893 — Report on expedition from Phillips Harbour in Collingwood Bay, towards Mount Suckling. *Brit. N. Guinea ann. Rep. for 1891-92,* App. C, 11-5.

Geomorphic descriptions are given of some northern flank hills of Mt Suckling and their drainage systems. A map and sketches of the country traverses, and a table of determined altitudes are included. (W.M.)

05-a-118 PAIJMANS, K., & BLAKE, D., 1970 — Land type mapping in east Papua. *42nd ANZAAS Cong., Port Moresby,* Sec. 21 Abs., 8-9.

The complexity of east Papua, the scarcity of field data, and the need to correlate previously surveyed areas made it desirable to use a broader more general mapping unit than land systems (areas or groups of areas with a recurrent pattern of topography, soils, and vegetation). The broad mapping unit used, provisionally termed a land type, is mapped by the geomorphologist and defined in terms of relief and landform. The vegetation is mapped by the plant ecologist. Correlations and relationships between landforms, lithology, vegetation, soils, and climate, are discussed in the descriptions of the land types. Land types are subdivided regionally, by superimposing major climatic boundaries, into separate parts, each of which has a limited range in climate, vegetation, and soils. They can be mapped more objectively and more quickly than land systems, and enable previously mapped land systems to be readily correlated. Using this method east Papua has been mapped into about 50 land types, in contrast to over 200 land systems that would have been required. (Auth.)

05-a-119 PAIJMANS, K., BLAKE, D. H., & BLEEKER, P., 1971a — Summary description of the Morehead-Kiunga area. *In* PAIJMANS, K., et al. — Land Resources of the Morehead-Kiunga area, Territory of Papua and New Guinea. *CSIRO, Land. Res. Ser.* 29, 12-7.

The area consists of low ridges and plateaux, broad major floodplains, narrow minor valleys, and many swamps and lakes. It is divided into 4 major geographic divisions listed in entry 05-a-60. (W.M.)

05-a-120 PAIJMANS, K., BLAKE, D. H., BLEEKER, P., & MCALPINE, J. R., 1971 — Land resources of the Morehead-Kiunga area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 29, 1-124.

Semi-technical papers are given on landforms (entry 05-a-119), geology (entry 05-a-60), soils (entry 07-a-3), vegetation, and land used in southwest Papua. (W.M.)

05-a-121 PATERSON, S. J., 1964b — Geomorphology of the Buna-Kokoda area. (*In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 10, 62-8).

The Buna-Kokoda area contains 4 geomorphic regions — main cordillera, Mambare foothills, Mt Lamington-Hydrographers Ra. volcanic region, and Kumusi-Mambare deltaic lowlands. The area is divided into geomorphic units characterized by a common structure and common processes acting on the structure. These units have been subdivided into sub-units, and related to geology (entry 02-b-136), and land systems (entry 05-a-92). Late Pliocene-early Pleistocene deformation started the development of a landscape of fold ranges and fault troughs. Most present features are erosional or depositional modifications of that landscape, upon which Pleistocene and Recent volcanic products and landforms have been superimposed. (W.M.)

05-a-122 PENK, A., 1913 — Zurückkehr der Expedition zur Erforschung des Kaiserin Augusta-fluss (The return of the expedition sent to examine the Kaiserin Augusta (Sepik) River, in German). *Z. Ges. Erdk.*, 48, 713-9.

Detailed mapping of the Sepik and many north-flowing tributaries is reported and form-line maps are produced for the May R. area, the Sepik valley, and nearby coast ranges. Reference is made to more detailed reports (entries 05-a-50 and 05-a-166). (W.M.)

05-a-123 PERRY, R. A., 1965a — Summary description of the Wabag-Tari area. *In* PERRY, R. A., et al., — General report on the lands of Wabag-Tari area, Territory of Papua and New Guinea, 1960-61. *CSIRO, Land Res. Ser.* 15, 10-3.

This summarizes specialist reports on geology and geomorphology (entry 02-c-38), soils (entry 07-a-18), vegetation, land systems (entry 05-a-125), forest resources, population, land use, and land-use potential of the area. (W.M.)

05-a-124 PERRY, R. A., BIK, M. J., FITZPATRICK, E. A., HAANTJENS, H. A., MCALPINE, J. R., PULLEN, R., ROBBINS, R. G., RUTHERFORD, G. K., & SAUNDERS, J. C., 1965 — General report on the lands of the Wabag-Tari area, Territory of Papua and New Guinea, 1960-61. *CSIRO, Land Res. Ser.* 15, 1-142.

This collates specialist reports on geomorphology (entry 05-a-125), climate, geology (entry 02-c-38), soils (entry 07-a-18), vegetation, forest resources, population, land use and land-use potential of the area. (W.M.)

05-a-125 PERRY, R. A., BIK, M. J., HAANTJENS, H. A., MCALPINE, J. R., PULLEN, R., ROBBINS, R. G., & RUTHERFORD, G. K., 1965 — Land systems of the Wabag-Tari area. *In* PERRY, R. A., et al., — General report on the lands of the Wabag-Tari area, Territory of Papua and New Guinea, 1960-61. *CSIRO, Land Res. Ser.* 15, 14-55.

In the Wabag-Tari area, 39 land systems are recognized on the basis of recurring patterns of lithology, topography, soils and vegetation. They are described in tabular form, illustrated with block diagrams, with notes on geology, landscape, landscape dynamics, altitude, and land use of each system, and soils, landforms, vegetation, and land-use potential of units in each system. The landforms are grouped into major types related to lithology (entry 02-c-38). (W.M.)

05-a-126 PILHOFER, G., 1911b — Eine Reise von Finschhafen nach dem Markhamfluss, Deutsch-Neuguinea (A journey from Finschhafen to the Markham River, German New Guinea, in German). *Petermanns Mitt.* 58, 143-7.

In the Cromwell and Hahl Ras dissected mountains rising to about 1800 m are deeply incised by numerous streams falling rapidly to the coast. Many waterfalls are seen on the terraced eastern end of the Huon Pen. and streams are choked with boulders and cobbles. A possible volcanic crater was seen in Cromwell Ra. (W.M.)

05-a-127 POWELL, W., 1881 — Observations on New Britain and neighbouring islands during six years exploration. *Proc. Roy. geogr. Soc.,* 3 (n.s.), 84-97.

The original charting of New Britain and the Duke of York Group is revised, and their coastlines and harbours and the west coast of New Ireland are described. A new volcanic island in Blanche Bay (Vulcan) was formed during a month-long eruption in May 1878. Points and bays along the east and south coast of the Gazelle Pen. west to 150°2.5′E are described, and Henry Reid Bay is named. Active volcanoes seen on the north coast include The Father, South Son, and Mt Duportail. (W.M.)

05-a-128 POWELL, W., 1883b — WANDERINGS IN A WILD COUNTRY; or Three years amongst the cannibals of New Britain. *London, Sampson & Lowe,* vii + 283 pp. (Re-issued 1884).

This includes data presented in earlier articles (entries 01-a-38, 01-b-60, and 05-a-127), and new information on the charting of islands and passages in eastern Papuan waters and the Louisiade Arch. The volcanic features of the Gazelle Pen., Rabaul Har., the Duke of York Is, and the west coast of New Ireland are described. (W.M.)

05-a-129 POWELL, W., 1884 — UNTER DEN KANNIBALEN VON NEU-BRITANNIEN: drei Wanderjahre durch ein Wildesland (Translated by F. M. Schroter, in German). *Leipzig, Hirt,* 262 pp.

This is a translation of entry 05-a-128.

05-a-130 REINER, E., & MABBUTT, J. A., 1968 — Geomorphology of the Wewak-Lower Sepik area. In HAANTJENS, H. A. (Ed.) — Lands of the

Wewak-Lower Sepik area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 22, 61-71.

6 physical regions are recognized in the area north of the Sepik R. downstream from Chambri Lake: Sepik flood plains, upper plains, hill zone, Prince Alexander Mts, coastal plains, and offshore islands. The two types of offshore island are the volcanic Kairiru and uplifted coral reef islands such as Mushu. The geology and the geologic and geomorphic history of the area are traced. Schist and gneiss in the Prince Alexander Ra. represent metamorphic basement on which upper Miocene and Pliocene marine sediments and coral limestones accumulated. Late Pliocene tectonism, and intrusion of amphibolites destroyed the depositional basin and developed asymmetric anticlinal features expressed in the Prince Alexander Ra. Tectonism was accompanied by localized volcanism. Marine terrigenous beds formed north of the emergent Pleistocene landmass, and terrestrial and marine sediments to the south. Later tectonism caused further uplift and dissection of the Pleistocene erosion surface to below present base level, and aggradation of terrestrial clay and sand to form the present upper plains and flood plains. (W.M.)

05-a-131 Rochas, V. de, 1860 — Ile Rossel (Archipel de la Louisiade). *Bull. Soc. de geogr.*, 20, 247-53.

Streams on Rossel I. are not very large, but appear to be actively eroding their narrow sinuous valleys. Hills rise steeply to 800-1000 m. Along the north coast is an almost continuous reef. (W.M.)

05-a-132 Rochfort, F. A., 1899a — Report on expedition from Tupuselei towards Mount Scratchley. *Brit. N. Guinea ann. Rep. for 1897-98,* Encl. 3 in App. A, 9-11.

The physiography of Astrolabe Ra. and southern foothills of the Owen Stanley Ra. are noted in this report of an unsuccessful attempt to climb Mt Scratchley in 1896. (W.M.)

05-a-133 Rochfort, F. A., 1899b — Report on survey of road from Port Moresby towards Mt Victoria. *Brit. N. Guinea ann. Rep. for 1887-98,* Encl. 4 in App. A, 11-3.

The country around Mt Lawes and for about 30 km north on the upper reaches of the Laloki R. is described during an unsuccessful attempt to cross the Owen Stanley Ra. in 1897. (W.M.)

05-a-134 Ruxton, B. P., 1967a — Introduction and regional description of the Safia-Pongani area. *In* Ruxton, B. P., et al., — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 17, 7-18.

This summarizes specialist reports on geology (entry 02-b-143), geomorphology (entries 05-a-89 and 05-a-135), soils (entry 07-a-8), vegetation, forest resources, and agricultural potential of the area. 6 physiographic regions are recognized: Musa Coastal Plain, Musa Basin, Guaya-Didana Ras, Volcanic Mountains and Plateau, Owen Stanley Foothills, and Owen Stanley Ra. The *Musa Coastal Plain* extends 40 km inland from Dyke Ackland Bay; the *Musa Basin* is an intramontane trough between the Owen Stanley foothills and the eastern end of the Guaya-Didana Ras; the *Guaya-Didana Ras* form a linear arcuate group extending across the area from northwest to east, and represent the eastern end of the Morobe Arc; the *Volcanic Mountains and Plateau* form a complex group of landscapes in the north, ranging from sea level to over 1800 m; the *Owen Stanley Foothills* are a group of high hills up to 1500 m in the south; and the *Owen Stanley Ras* are a series of rugged mountains up to 3600 m in the southeast and west. (W.M.)

05-a-135 Ruxton, B. P., 1967c — Geomorphology of the Safia-Pongani area. *In* Ruxton, B. P., et al., — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 17, 86-97.

The 6 regions noted in entry 05-a-134 are discussed in more detail. They correspond closely with tectonic regions (entry 02-b-143). (H.M.)

05-a-136 RUXTON, B. P., 1969a — Regional description of the Kerema-Vailala area. *In* RUXTON, B. P., et al., — Lands of the Kerema-Vailala area, Teritory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 23, 9-16.

This collates specialist reports on climate, geology (entry 02-b-144), geomorphology (entries 06-a-15 and 05-a-138), forest resources, soils (entry 07-a-2), agricultural potential, population, and land use of the area, and is illustrated with photographs. (W.M.)

05-a-137 RUXTON, B. P., HAANTJENS, H. A., PAIJMANS, K., & SAUNDERS, J. C., 1967 — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 17, 1-205.

A general survey was made of the terrain and land-use potential of the area west and southwest of Mt Victory. The area lies between the Buna-Kokoda survey area (entry 05-a-85) and the Wanigela-C. Vogel survey (entry 02-b-60), and covers the valley of the Musa, Domara-Adau, and upper Kumusi river systems north of the Owen Stanley Ra. Specialist reports on land systems (entry 05-a-89), geology (entry 02-b-143), geomorphology (entry 05-a-135), pedology (entry 07-a-8), vegetation, forest resources, and agricultural potential are summarized and collated in a general description of the area (entry 05-a-134). (W.M.)

05-a-138 RUXTON, B. P., PAIJMANS, K., BLEEKER, P., & LEACH, B. J., 1969 — Land systems of the Kerema-Vailala area. *In* RUXTON, B. P., et al., — Lands of the Kerema-Vailala area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 23, 17-49.

29 land systems are recognized in the Kerema-Vailala area on the northeast coast of the Gulf of Papua and in the backing foothills of the Owen Stanley Ra. Land units are defined in terms of parameters used in the Bougainville-Buka survey (entry 05-a-147) and some are an extension of units recognized in the Port Moresby-Kairuku survey (entry 05-a-105). Each land system description summarizes the principal elements, with outlines of geology, geomorphology, terrain parameters, population and land use, agricultural and forest potential, and number of data points. Land units within each system are described. (W.M.)

05-a-139 RUXTON, B. P., BLEEKER, P., LEACH, B. J., MCALPINE, J. R., PAIJMANS, K., & PULLEN, R., 1969 — Lands of the Kerema-Vailala area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 23, 1-159.

Specialist reports are given on land systems (entry 05-a-138), climate, geology (entry 02-b-144), geomorphology (entry 06-a-15), soils (entry 07-a-2), vegetation and ecology, forest resources, population and land use, and agricultural potential. They are summarized and synthesized in a general account (entry 05-a-136). (W.M.)

05-a-140 SATO, H., 1939 — On New Guinea. (In Japanese). *J. Geogr., Tokyo,* 51, 269-77.

The Tertiary and Quaternary historical geology of east and west New Guinea is outlined, with discussion on geomorphology, land use, fauna, and flora. (W.M.)

05-a-141 SCHLEINITZ, G. E. G. von, 1887 — Berichte über Rekognoscirungs-fahrten (Report on Reconnaissance trip, in German). *Nachr. Kaiser Wilhelmsl., for 1887,* 1, 5-20; 2, 32-66; 4, 151-2.

A survey voyage was made along the coasts of New Guinea, New Britain, and the outlying islands in the *Samoa* and the *Ottilie*. Descriptions are given of the shores of Huon Gulf south of the Markham R. to Hercules Bay, the north coast between Madang to beyond the mouth of the Sepik R. and the Purdy Is. (C.F.)

05-a-142 SCHNEE, H., 1904 — BILDER AUS DER SUDSEE (Pictures of the South Seas, in German). *Berlin, Reiner* (Vohsen), 394 pp.

This describes German activity in the New Britain region, particularly in the Gazelle Pen., and includes a description of the known geomorphology of much of the German colony. It is accompanied by a coloured map at a scale of 1 : 2 000 000 with 1 : 300 000 inserts of the Madang and Gazelle areas. (W.M.)

05-a-143 SCOTT, R. M., & AUSTIN, M. P., 1971 — Numerical classifications of land systems using geomorphological attributes. *Aust. geogr. Stud.*, 9, 33-40.

A numerical system of classifying land mapping units recognizable on air-photo properties is developed as the first stage in the integration of land surveys in eastern Papua. (W.M.)

05-a-144 SCOTT, R. M., HEYLIGERS, P. C., MCALPINE, J. R., SAUNDERS, J. C., & SPEIGHT, J. G., 1967a — Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 1-144.

This collates specialist reports on geomorphology (entries 05-a-145, 05-e-19 and 05-a-147), geology (entry 02-d-54), climate, soils (entry 07-a-20), vegetation and ecology, forest resources, population and land use, and land-use potential of the area. These specialist reports are summarized in entry 05-a-149. (W.M.)

05-a-145 SCOTT, R. M., HEYLIGERS, P. C., MCALPINE, J. R., SAUNDERS, J. C., & SPEIGHT, J. G., 1967b — Land systems of Bougainville and Buka Islands. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 20-61.

40 land systems have been recognized, within each of which it has been possible to recognize several land units which closely approximate sites in that they are associated with landform elements such as slopes and flats rather than with landforms. The land system and unit descriptions in this report are more rigorously quantified and categorized than in earlier reports in this Series, and the parameters used are described in an appendix (entry 05-a-148). For each land system a summary is made of the terrain, geomorphology, terrain parameters, geology, population and land use, forest potential, and number of data-collection sites. (W.M.)

05-a-146 SMITH, T. LANGFORD, 1951a — Physiography. Chapter I, *in* THE RESOURCES OF THE TERRITORY OF PAPUA AND NEW GUINEA (prep. by Div. Regional Devel., Dep. Nat. Devel., Canberra). *Melbourne, Govt Printer,* 1-24.

The geomorphology and geomorphic evolution are outlined for mainland New Guinea, the Inner Volcanic Island Arc to the north, the Papuan Islands in several groupings, New Britain, New Ireland and neighbouring islands, the Admiralty Is, the Western Is, and for Bougainville and Buka. Mainland New Guinea is divided into Main Ranges, Northern Mountains, Central Depression, Southern Foothills, and Southern and Northern Coastal Plains and Swamps. The morphology and development of each is discussed, and the mainland lake and river system outlined. The morphology and development of the Island areas are outlined. (W.M.)

05-a-147 SPEIGHT, J. G., 1967c — Terrain of Bougainville and Buka Islands. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 98-104.

The physical landscapes of Bougainville and Buka which have been discussed in terms of their genesis and relationships (entry 05-e-19), are here considered from the purely descriptive point of view and classified on the basis of the morphological parameters altitude, relief, slope, grain, and plan-profile. Definitions of terms and schemes of categorization are set out in an Appendix (entry 05-a-148), and values for the parameters assigned to each land system, as recorded in the tabular land system descriptions (entry 05-a-145). A summary of the terrain data is tabulated. (W.M.)

05-a-148 SPEIGHT, J. G., 1967d — Explanation of land system descriptions. Appendix I. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 174-84.

The land systems and units of Bougainville and Buka have been described as part of a general survey (entry 05-a-144). In these descriptions (entry 05-a-145), geomorphic forms and elements are described more rigorously than in previous surveys. This appendix describes the content, terms, and parameters used in the land system and unit descriptions, and tabulates details of erection and limits of parameters. (W.M.)

05-a-149 SPEIGHT, J. G., & SCOTT, R. M., 1967 — General description of Bougainville and Buka Islands. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 13-9.

This report summarizes and integrates specialist reports on geology (entry 02-d-54), land systems (entry 05-a-145), geomorphology (entries 05-a-147 and 05-e-19), soils (entry 07-a-20), population, climate, land use, and land-use potential, and is illustrated with photographs. (W.M./Auth.)

05-a-150 SPINKS, K. L., 1934 — Mapping the Purari Plateau, New Guinea. *Geogr. J.*, 84, 412-6.

The location, elevation and relief, peaks and river systems, vegetation, and occupation of the Purari Plateau are described. The plateau is about 1500 m above sea level, with some peaks and spurs rising to 4500 m. It is drained by headwater streams of the Purari R. (the Karmanuntina, Bena, Garfuku, Mairifuteikar, Wahgi, and Kaugel Rs). The discovery in 1930 of the Ramu Goldfield, and early phases of its exploration are outlined. (W.M.)

05-a-151 SPINKS, K. L., 1936 — The Wahgi Valley of central New Guinea. *Geogr. J.*, 87, 222-5.

The history of exploration of east New Guinea since settlement in 1884 is outlined. Late Miocene to late Pliocene folding and faulting has produced the main range and many large rivers mark major shear zones. Mapping in the Purari Plateau suggests the Bismarck Ra. is a separate range parallel to the main range, and not a continuation of it as suggested by Stanley. Many features of the Purari Plateau are attributed to block normal faulting. (W.M.)

05-a-152 STANLEY, E. R., 1923c — The topographic features of New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 683-6.

The central range of Dutch and east New Guinea is a block-faulted uplifted pile of metasediments, schist, and granitic rocks on which later volcanic pyroclastics and lavas accumulated on dissected peneplanes. It is now being actively dissected. Between the main range and the coastal foothills are dissected plateaux in which volcanic conglomerates and uplifted coralline reefs are exposed. Ranges such as the Goropu Ra. appear to be offset by transverse block-faulting, and often are as much as 1000 m above the main range because of recent superposition of a thick pile of volcanic rocks.

Several long broad valleys with fault boundaries trend parallel to the main range, including the Sepik, Ramu, Markham and Purari Rs. Oblique-fault valleys are recognized in the Yodda-Chirima-Kumusi-Musa system in eastern Papua. Fault-influenced regional drainage patterns are seen in western Papua. Terraced coastline and headlands in which raised coral platforms are seen are recorded from much of the coast and many of the islands. They are up to 1200 m high and developed by spasmodic isostatic compensation to volcanism during the Pleistocene. (W.M.)

05-a-153 STANLEY, E. R., 1924a — A contribution to the physiography of New Guinea. *17th Australas. Ass. Adv. Sci., Cong. Rep., Adelaide,* 326-46.

The mountain chain and drainage systems of east and west New Guinea are discussed, and attempts made to relate them to structural features and alignments in the underlying geological units. The main axial range with several side and cross chains is traced east from west New Guinea. The extension of mountain chains into the Papuan Is, the Solomons, and the Philippines, and the tectonic significance of these crustal trends are discussed. (W.M.)

05-a-154 STANLEY, G. A. V., 1934 — The Matapau region near Aitape, New Guinea. *Aust. Geogr.*, 2(3), 3-8.

The following topographic divisions are recognized: (i) coastal plain, up to 5 km wide; (ii) coastal hills, rising abruptly to over 300 m; (iii) Damiem-Mima lowland, a re-entrant of the coastal plain; (iv) Torricelli and Prince Alexander Mts and the Sepik Divide, up to 1200 m high; (v) Sepik slopes, which form the southern fall of the Divide to the Sepik R.; (vi) Sepik valley plains. (W.M.)

05-a-155 STANLEY, G. A. V., 1949 — The geography of the Central Highlands. *Papua-New Guinea Sci. Soc., ann. Rep. for 1949,* 14.

A series of basin valleys at an average height of 1500 to 1800 m is surrounded by rugged ranges up to 3000 m. Several peaks reach 3600 m and Mt Wilhelm, the highest peak in eastern New Guinea, reaches 4700 m. The basin valleys were formerly occupied by large lakes, and the drainage system is complex. (W.M.)

05-a-156 STONE, O. C., 1875a — Discovery of the Mai-Kassa, or Baxter River, New Guinea. *Proc. Roy. geogr. Soc.,* 20, 92-109.

In 1875 the *Ellengowan* went nearly 100 km up the Mai-Kassa R. The course and flow of the river are described, and it is said to be navigable by small boats for at least 145 km from the mouth. (W.M.)

05-a-157 STONE, O. C., 1875c — Description of the country and natives of Port Moresby and neighbourhood, New Guinea. *Proc. Roy. geogr. Soc.,* 20, 330-43.

This summarizes entry 01-b-61.

05-a-158 STONE, O. C., 1876a — Description of the country and natives of Port Moresby and neighbourhood, New Guinea. *J. Roy. geogr. Soc.,* 46, 34-62.

The coralline hills around Anuapata (Port Moresby) are described, and their recent elevation above sea level is postulated on the evidence of marine shells similar to living forms being found up to 180 m above sea level. The course of the Lanoki (Laloki) R., and Mts Astrolabe (Variata) and Vetura are described. A seam of plumbago is recorded from the east shore of Fairfax Har. (W.M.)

05-a-159 STONE, O. C., 1876b — Prima navigazione del flume Mai-Kassa o Baxter, dei sigg. MacFarlane ed O. C. Stone a bordo dell' *Ellengowan.* (First survey of the Mai-Kassa or Baxter Rivers by Messrs. MacFarlane and O. C. Stone on the Ellengowan, in Italian. *Cosmos (Turin),* 3, 452-8.

This is a summary of entry 05-a-156.

05-a-160 STRACHAN, J., 1886 — Explorations in New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.,* 1, 84-99.

Mabudauan Hill on the western coastal plains of the Fly delta is of volcanic origin. The coastal tract west of this hill near Strachan I. was surveyed and charted. The west boundary of Strachan I. is Prince Leopold (Wasi Kassa) R., and the east boundary is the Mai Kassa R. The island and surrounding country are low, flat, and muddy. (W.M.)

05-a-161 STRONG, W. M., 1916 — Notes on the North-eastern Division of Papua (British New Guinea). *Geogr. J.,* 48, 407-11.

The broad swampy coastal tracts of rivers draining the northern fall of the Owen Stanley Ra. into Collingwood and Dyke Ackland Bays pass sharply into foothills of the main range. Hydrographers Ra. and Mts Victory and Trafalgar break the plains, and smaller ranges form C. Vogel. The upper reaches of the Musa R. pass through the main range in a rejuvenated tract to the coastal swamps, indicating recent uplift of the main range. Mts Victory and Trafalgar are a volcanic complex, with solfataric activity seen in 1911 and eruptive activity reported to have occurred some 40 years earlier. (W.M.)

05-a-162 TAPPENBECK, E., 1901 — DEUTSCH NEUGUINEA (German New Guinea, in German). *Berlin, Susserolt,* 178 pp.

Descriptions of New Guinea and the Bismarck Arch. cover general features — location, main geographic features, population, agricultural potential, and development. The geomorphology of New Britain, as seen on coastal traverses and traverses in the Gazelle Pen., reflects the influence of active and recently active volcanoes in the north, and what is thought to be an emergent coastline in the south. Volcanic activity is reported on Bam in 1890, Manam in 1895, and Balbi late in the 19th century. (W.M.)

05-a-163 THOMPSON, J. E., 1954 — The physiography of the Port Moresby region. *Papua-New Guinea Sci. Soc., ann. Rep. and Proc. for 1954,* 14-21.

Along the strip of coast from Galley Reach to the Kemp Welch R. and inland for about 30 km, 7 physiographic zones are recognized on the basis of the landforms present — Brown-Vanapa delta and flood plain; Moresby parallel strike ridge and valley zone; Bomana monadnock zone; Laloki valley; Sogeri plateau; Astrolabe escarpment; and the coastline and islands. The principal features of each zone are described. (W.M.)

05-a-164 THOMSON, J. P., 1888a — Mr Cuthbertson's journey in New Guinea. *Scott. geogr. Mag.,* 4, 57.

The report of the ascent of Mt Obree by Cuthbertson (entry 02-b-35) is discussed, but the re-calculated heights of several peaks are not accepted. (W.M.)

05-a-165 THOMSON, J. P., 1890a — His Honour Sir William Macgregor's ascent of Mount Victoria, and explorations of the Owen Stanley Range, British New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.,* 5, 2-25.

An account of Macgregor's ascent of Mt Victoria in 1889 draws heavily on the official report (entry 05-a-108). (W.M.)

05-a-166 THURNWALD, R., 1913 — Eine Durchquerung des Gebiets zwischen Kaiserin-Augustafluss und Küste (A crossing of the mountains between the Sepik River and the coast, in German). *Mitt. dtsch. Schutzgeb.,* 26, 357-63.

A traverse was made from the Sepik R. near Angoram to the north coast near C. Moem. The route mostly followed the valleys of two streams draining the low eastern ridges of Prince Alexander Ra. A wide alluvial plain on the Sepik R. passes through undulose low hills to the low main divide, which falls rapidly to the coast. (W.M.)

05-a-167 THURNWALD, R., 1914 — Vom mittlern Sepik zur Nordwestküste von Kaiser-Wilhelmsland. (From the middle Sepik to the northwest coast of New Guinea, in German). *Mitt. dtsch. Schutzgeb.,* 27, 81-4.

The data supplement entry 05-a-166.

05-a-168 TROTTER, C., 1890 — On recent exploration in New Guinea. Report of the Proceedings of the Geographical Section of the British Association for the Advancement of Science. *Proc. Roy. geogr. Soc.,* 12 (n.s.), 687-99.

Geographical and geomorphic notes are given in a summary of exploration in New Guinea in the interval 1885-1890. An attempt is made to reconcile the discrepancies between the data recorded by Macgregor and Forbes for the geomorphic features at the summit of Mt Owen Stanley (entry 01-b-65). (W.M.)

05-a-169 VERNON, G. H., 1946 — The interior of eastern Papua. *Qld Geogr. J.,* 50, 91-7.

An outline is given of the mountainous terrain of the Owen Stanley Ra. and the range system of the island. A sketch profile from Port Moresby to Buna illustrates the topography of the war campaign areas along the Kokoda Trail. (W.M.)

05-a-170 WALKER, A. L., 1902b — Report of visit to the head of the Kumusi River, British New Guinea. *Brit. N. Guinea ann. Rep. for 1900-01,* App. L, 54-9.

The report of a patrol in the Kumusi and upper Mambare Rs near the present site of Kokoda includes a map which recorded the route and major features mapped. (W.M.)

05-a-171 WICHMANN, H., 1911b — Abschluss der deutsch-niederlandischen Grenz-expedition in Neuguinea (Conclusion of the German-Dutch border expedition in New Guinea, in German). *Petermanns Mitt.*, 57, 138.

Work by Schultze-Jena (entry 05-a-95) in the upper Sepik R. near the Dutch border is reported. These reaches were traversed and surveyed, and the Sepik was shown to head in the Victor Emmanuel Ra. (W.M.)

05-a-172 YULE, C. B., 1864 — THE AUSTRALIA DIRECTORY — Vol. II. *H.M. Hydrogr. Office, Brit. Admir.*, 436 pp.

Geomorphic notes on the islands and coastlines and ocean-current data are given for an area including the east Australian coast from Sydney to Torres Str., the south Papuan coast, the islands and reefs of the Coral Sea, and the islands and reefs of the Louisiade Arch. The extent of the Coral Sea and Louisiade Arch. are defined in terms of geographic co-ordinates and island masses. (W.M.)

05-a-173 ZOLLER, H., 1891a — Die deutschen Salomon-Inseln Buka und Bougainville (The German Solomon Islands of Buka and Bougainville, in German). *Petermanns Mitt.*, 37, 8-11.

The islands are described in terms of situation, extent, main physical features, vegetation and settlement, and possibility for settlement. (W.M.)

(b) FLUVIAL

See also entries

02-b-16	02-c-49	05-c-9	05-c-33
02-b-22	05-a-32	05-c-23	05-d-6
02-b-58	05-a-109	05-c-24	05-e-6
02-c-24	05-c-4	05-c-25	06-d-3

05-b-1 ANONYMOUS, 1878b — Herr Chester auf den Mai-Cussar oder Baxter Fluss an der Südostküste von Neu-Guinea (Mr Chester on the Mai-Cussar or Baxter River on the south-east coast of New Guinea, in German). *Petermanns Mitt.*, 24, 242-3.

The mouth of the Mai Kassa (Baxter) R. was free of sandbanks or similar obstructions in early 1875. (W.M.)

05-b-2 ANONYMOUS, 1878c — D'Albertis Vordringen in das Innere von Neu-Guinea und Aufnahme des Fly-Flusses, 1876 und 1877 (D'Albertis' expedition into the interior of New Guinea, and the exploration of the Fly River, 1876 and 1877, in German). *Petermanns Mitt.*, 24, 423-6.

In 1876 and 1877 D'Albertis charted the Fly R. for about 1000 km from its mouth to above the junction with the Alice R. Notes on size and flow volume, nature and presence of islands and sand banks, and the surrounding low-lying country accompany an annotated map at a scale of 1 : 1 800 000. (W.M.)

05-b-3 ANONYMOUS, 1878d — Esplorazione di L. M. D'Albertis nella Nuova-Guinea (Exploration by Mr D'Albertis in New Guinea, in Italian). *Boll. Soc. geogr. Ital.*, 3 (n.s.), 105-8.

D'Albertis' second journey 725 km up the Fly R. in 1877-78 is noted: the lower reaches are broad and flat-bottomed, and there is strong current. The river bed is muddy, and there is considerable suspended load of silt and sand. River banks stand not far above the stream. (W.M.)

05-b-4 ANONYMOUS, 1888a — The Mai Kassa or Baxter River, New Guinea. *Proc. Roy. geogr. Soc.*, 10 (n.s.), 708-9.

The Baxter R. is independent of the Fly R., of which it was previously thought to be one of the deltaic outlet streams. Strode Hall's survey reduces the earlier estimates of the size of tributaries and of distance travelled up the Fly by Strachan (entry 05-a-160). (W.M.)

05-b-5 ANONYMOUS, 1909c — The Kaiserin Augusta River, German New Guinea. *Geogr. J.* 34, 458.

The mouth of the Kaiserin Augusta (Sepik) R. has no bar and is about 1.5 km wide. It is 250-400 m wide for about 300 km upstream, with well delineated banks. The coastal tract runs through swamps and lagoons which develop 65 km upstream. A clean river bed up to 12 m deep was recorded. (W.M.)

05-b-6 ANONYMOUS, 1909f — Deutsch-Neuguinea: eine Fahrt auf dem Kaiserin Augustafluss (German New Guinea: a journey up the Kaiser-Augusta (Sepik) River, in German). *Dtsch. Kolonblt.,* 20, 739-43.

This account gives an idea of the large volume of water flowing in the Sepik R., and of the extensive, often swamp, river-built flood plains. (C.F.)

05-b-7 ALBERTIS, L. M. D', 1879b — Discorso (. . . concerns journeys up the Fly River and in other parts of New Guinea, in Italian). *Boll. Soc. geogr. Ital.,* 4 (n.s.), 11-26.

The Fly R. banks are clayey and sandy, and often stand up to 6 m above the river. The backing plains are flat and swampy. (W.M.)

05-b-8 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942f — Markham Valley. *Spec. Rep. Allied geogr. Sec., 7,* 7 pp.

This was superseded by Terrain Study No. 32 (entry 05-c-9).

05-b-9 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942g — Country immediately north of Hydrographers Range. *Spec. Rep. Allied geogr. Sec.,* 8, 7 pp.

The main axis of Hydrographers Ra. is east-west, and it extends about 30 km inland from the coast. The main peaks are higher than 1800 m and the general area is one of extremely broken topography. North of the range the country is practically flat and subject to seasonal flooding in areas. A small lake system lies at the northern foot of the main range and all lakes drain into Emboga Cr., one of the main drainage channels. (C.F.)

05-b-10 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942r — Locality study, Lae. *Terrain study Allied geogr. Sec.,* 17, 32 pp.

The coastline of Huon G. around Lae is described, with notes on the lower reaches of the Markham R. and nearby flood plains. (C.F.)

05-b-11 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942w — Area study of southwest Papua and the Fly River. *Terrain Study Allied geogr. Sec.,* 29, 21 pp.

This was superseded by Special Report 28 (entry 05-a-29).

05-b-12 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943d — Road — Nadzab to Lae. *Rep. Allied geogr. Sec.,* 17, 15 pp.

The report covers the level areas of the lower Markham Valley and includes photographs and plans. Topography is described in relationship to the establishment of a motor road through the area. (C.F.)

05-b-13 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943e — Overland route from Lae to Madang. *Spec. Rep. Allied geogr. Sec.,* 18, 18 pp.

The general topography of the Markham and Ramu Valleys is described, with some notes on tracks in the area. Oblique air-photographs are included. (C.F.)

05-b-14 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943p — Ramu River to Sepik River coastal area. *Spec. Rep. Allied geogr. Sec.,* 43, 49 pp.

The area is bounded on the east by the Ramu R. north of Annanberg and on the west by the Sepik R. upstream to Angoram. It is low-lying seasonal and permanent swamplands. Plans are given of the Sepik estuary and associated lagoon complexes to the west. (C.F.)

05-b-15 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943s — Wau and the goldfields area. *Terrain Hbk Allied geogr. Sec.*, 1, 29 pp.

The Markham R. is fed from the southeast by the Snake, Bulolo, and Watut Rs, which are braided in narrow steep-sided valleys. The river forms are shown in oblique air-photographs used to illustrate the report on tracks through the area south of the Markham R. to the head of the Bulolo R. and Edie Cr., and east to the coast from the Watut valley. (W.M.)

05-b-16 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943t — The Markham River valley. *Terrain Hbk Allied geogr. Sec.*, 2, 25 pp.

The Markham and Leron valleys are described, using vertical and oblique air-photographs to illustrate stream-channel characteristics. Subjacent foothills of the Finisterre and Saruwaged Ras, and the tracks through them, are noted. Strip maps show topographic features and locate photo sites. (W.M.)

05-b-17 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943v — Lae and the Lower Markham valley. *Terrain Hbk Allied geogr. Sec.*, 4, 34 pp.

The lower coastal reaches of the Markham R., Lae, the coastal tract of the Huon Pen. east of Lae, and the seaward approaches to Lae are described. The Harzog, Atzera, and Rawlinson Ras and tracks through them are described briefly. Several large rivers, lakes, and swamps are in the area. Strip maps and vertical and oblique air-photographs are included. (W.M.)

05-b-18 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ab — The Middle Ramu. *Terrain Hbk Allied geogr. Sec.*, 10.

This summarizes entry 05-b-20.

05-b-19 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943aj — Area study of the Markham catchment 1 and 2. *Terrain study Allied geogr. Sec.*, 49, 30 pp. and 35 pp.

This covers the Markham valley, south-flowing tributary streams draining the Saruwaged Ra., north-flowing streams draining the Kratke Ra., and the Bulolo-Wau valley. Stream-bed forms, stream-sediment types, road and track systems, and some geological and mining features are described and illustrated with photographs and maps. (W.M.)

05-b-20 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943at — Locality study of the Ramu-Markham valley with link to Madang. *Terrain study Allied geogr. Sec.*, 66, 57 pp.

Tracks through the Markham and Ramu valleys, and through the Finisterre Ra. to Madang, are described and illustrated with vertical and oblique air-photographs and mosaics which show the river courses and systems. Meandering and braided stream channels are typical. (W.M.)

05-b-21 ANDEXER, H., 1914 — Der untere Lauf des Watut in Deutsch-Neuguinea (The lower reaches of the Watut River in German New Guinea, in German). *Z. Ges. Erdk.*, 49, 277-80.

Before joining the Markham R. the Watut R. flows sinuously through a partly incised valley between rounded hills rising to about 800 m. On the Markham plains the river is flanked by abandoned channel swamps and lakes. Stream-bed load includes granite, reef quartz, schist, and marble. (W.M.)

05-b-22 AUSTEN, L., 1923a — Report of a patrol to the Tedi (Alice) River and the Star Mountains, Western Division. *Papua ann. Rep. for 1921-22,* App.

1, (1st part), 122-34 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 1072-84).

The course of the Alice R., and the changes in the course of the Fly and Alice Rs at their confluence are described. (W.M.)

05-b-23 AUSTRALIA. WORKS, COMMONWEALTH DEPARTMENT OF, 1967a — REPORT ON STREAM GAUGING ACTIVITIES, PAPUA AND NEW GUINEA, YEAR ENDING 30 JUNE 1967. *Port Moresby, Comm. Dep. Works,* 21 pp.

More stream-gauging and rainfall-recording stations were set up throughout Papua New Guinea and several stations discontinued. Stations established and discontinued are listed, and a summary of results is given. (W.M.)

05-b-24 AUSTRALIA. WORKS, COMMONWEALTH DEPARTMENT OF, 1967b — PAPUA AND NEW GUINEA RIVER GAUGING TO 31 DECEMBER 1964. *Maribyrnong, Dep. Supply,* 81 pp.

The first stream-gauging stations in the Papuan network were set up in 1951 on the Vanapa, Angabunga, Tauri, Oreba, and Purari Rs in western Papua. The records list the name and location number of each station with geographic details, tables of maximum and minimum flows for each month of the station years, and a table of monthly and annual discharges in calendar years. (W.M.)

05-b-25 AUSTRALIA. WORKS, COMMONWEALTH DEPARTMENT OF, 1968a — REPORT STREAM GAUGING ACTIVITIES IN PAPUA AND NEW GUINEA, YEAR ENDING 30 JUNE, 1968. *Port Moresby, Comm. Dep. Works,* 23 pp.

The network of stream-gauging stations and rainfall-recording stations in Papua New Guinea has been expanded, and much information collected on the Laloki R. catchment near Port Moresby. Data from all active recording stations are tabulated. (W.M.)

05-b-26 BAKER, G. H. MASSEY, 1911 — Report on trip up the Fly and Strickland Rivers in search of the Kikori Expedition. *Papua ann. Rep. for 1910-11,* App. A (3), 187-202 (also issued as *Aust. parl. Pap. 67 Sess. 1911,* 3, 751-66).

Attempts to reconcile early charts of the Fly R. upstream from its junction with the Strickland R. with observations by this expedition suggest that these rivers have changed course considerably since the early charts were constructed. The width and course of the river, and the position and size of islands, appear to have altered. (W.M.)

05-b-27 BARTON, F. R., 1902b — Special report — Doriri expedition. *Brit. N. Guinea ann. Rep. for 1900-01,* App. U, 94-100.

Streams draining east into Collingwood Bay, and the middle reaches of the Musa R., carry a heavy suspended load and flow in broad cobbly river beds. In places the stream bed contains extensive thick clay. Flash-flooding and the supply of abundant unsorted debris to these streams may be related to landslips in source areas, particularly in streams draining the Goropu Ra. Conglomerates crop out on the western fall of the divide east of the lower Musa R., and appear to provide a sandy sediment to it. In streams draining south from Mt Victory, red and grey rocks (?andesites) were the major contribution to the stream-bed deposit. (W.M.)

05-b-28 BEAVER, W. N., 1914b — A description of the Girara District, western Papua. *Geogr. J.,* 43, 407-13.

The Girara District is between the east bank of the Fly R. and the headwaters of the Bamu R., southwest of Mt. Bosavi. The bed of the Fly about 100 km from its mouth is composed of shelly sand and mud, cemented with iron oxides; the banks are red clay, and nearby alluvial flats are usually waterlogged clays. Several low northeast-trending ridges east of the Fly may form the Fly-Bamu tributaries divide. East of them the Bamu valley is largely swamp and passes into numerous stream beds. (W.M.)

05-b-29 BESWICK, T., 1880 — The Kemp Welch River of New Guinea. *Proc. Roy. geogr. Soc.*, 2 (n.s.), 511-2.

In the lower 30 km, the Kemp Welch R. is about 100 m wide and up to 5 m deep. Two islets partially block the mouth. Farther upstream the river bed is cobble strewn, and in places lakes are developed. (W.M.)

05-b-30 BEVAN, T. F., 1887 — Discovery of two new rivers in British New Guinea. *Proc. Roy. geogr. Soc.*, 9 (n.s.), 595-608.

The discovery and initial charting of the Jubilee and Philip Rs in western Papua are documented. The Philip is one of the coastal tracts of the Kikori, and was charted up broad well defined channels for about 40 km until flat deltaic plains gave way to undulose low country. The Jubilee (Purari) was charted for 180 km across deltaic coastal plains and through low undulose country. Both streams are broad and shallow with well defined but not deeply-incised banks in the coastal tracts, and are up to 180 m wide at the upper limit of penetration. (W.M.)

05-b-31 BEVAN, T. F., 1898 — The discovery of the Aird and Purari Rivers, Gulf of Papua, British New Guinea. *Trans. Proc. Roy. geogr. Soc. Australas., Vic. Br.*, 15, 12-5.

The nature of the deltaic mouth of the Purari and Aird (Kikori) Rs is outlined. (W.M.)

05-b-32 BOORE, F. A., 1889 — Description of the exploration of the Aird River, New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld. Br.*, 3(1), 21-32.

Some of the channels at the mouth of the Aird (Kikori) R. and the lower reaches of the main channel were charted in 1887. An idea is given of the river system and coastal lowlands. (W.M.)

05-b-33 BREW, R., 1885 — Explorations while pearl-shelling in Torres Strait. *Proc. Roy. geogr. Soc. Australas., S. Aust. Br.*, 2, 87-96.

The lower reaches of the Chester (Wassi Kussa) R. are 150-180 m wide and 15-20 m deep. Many small creeks feed into it. Small islands at the mouth are composed of debris brought down by the river, and there is considerable discoloration of the sea. The coast farther west is flat and low lying. (W.M.)

05-b-34 BROWN, M. J. F., 1970b — Geomorphology of the Myola Lakes region, Owen Stanley Range, Papua. *42nd ANZAAS Cong., Port Moresby*, Sec. 21 Abs., 33.

The Myola Lakes are 2 broad alluvial-filled basins close to the main watershed of the Owen Stanleys. Their juxtaposition with the more characteristic deeply-incised V-shaped mountain valleys poses the problem of origin. The landforms of the 2 'lakes' are described, including terraces, alluvial fans, and mass movement features in the grassland and under rainforest. These and similar basins are located in the headwaters of valleys that drain, or formerly drained, towards the Owen Stanley Fault on the northern side of the range. It is thought that uplift along the fault zone, in late Pleistocene or Recent time, resulted in the partial infilling of the headwaters of the valleys, and some drainage diversions took place. (Auth.)

05-b-35 CHAPPELL, J., 1970b — Mathematical models applied to drainage basins in a tectonically rising region: North Huon Peninsula, New Guinea. *42nd ANZAAS Cong., Port Moresby*, Sec. 21 Abs., 34.

Creep of thick soil on moderate to steep slopes appears to conform with a plastic flow law, which leads to an equation for slope recession —

$$\frac{\alpha y}{\alpha t} = \frac{\alpha}{\alpha x}\left(Ch - kx + f(x)\right)\sqrt{1 + \frac{(\alpha y)^2}{\alpha x}}$$

A specific solution shows fair agreement with an age-sequence of valley slopes developed in extensive coral terraces on north Huon Pen. A constrained branchingprocess model for drainage net development yields a relative chronology, for 4 terraces, which is within 16% of the radiometric chronology. (Auth.)

05-b-36 DOWSETT, T. J. L., 1925 — The Rouna Falls of Papua. *Geogr. J.*, 66, 522-7.

The Rouna Falls, the valley of the Laloki R. below the falls, and the ridges north and south of the river, are described. Large conglomerate boulders in the Laloki valley may be ejectamenta from a now-overgrown crater on the south flank of Hombrom Bluff. The height of the falls is 65 m, with a further 100 m drop in the steep river bed over 100 m from the foot-pool. The elevation of the top of the falls is 400 m.

It is noted that a concession has been granted to instal a hydro-electric power station on the falls, the electricity produced to be used in processing the auriferous copper ores from the Astrolabe mineral field. Surplus power will be available for domestic use. (W.M.)

05-b-37 EDELFELT, E. G., 1889 — Notes on New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.*, 3, 92-102.

The St Joseph (Purari) R. rises near Mt Yule and empties into the G. of Papua near Yule I. It has 7 channels in its mouth, and appears navigable for about 30 km. Colours of gold were found in the middle reaches. (W.M.)

05-b-38 FRASER, J. B., 1968 — Laloki River flows. (Appendix B, *In* FRASER, J. B., — REPORT ON FURTHER REGULATION OF LALOKI RIVER FOR POWER GENERATING PURPOSES. *Canberra, Comm. Dep. Works,* 39-110).

Rainfall, river flow rates, flow characteristics, and predicted flow characteristics of the Laloki R. near Port Moresby are noted in reference to extensions planned for the Laloki hydro-electric generating station. Daily river flows at two gauging stations, and estimated mean flow rates are tabulated for the period July 1955 to June 1967. (W.M.)

05-b-39 FRASER, J. B., & VALLANCE, D. B., 1966 — UPPER RAMU HYDRO-ELECTRIC SCHEME: NO. 1 POWER STATION AND ASSOCIATED WORKS. *Melbourne, Comm. Dep. Works.*

The feasibility and requirements of establishing the hydro-electric scheme on the Ramu R. near the gorge are assessed. Appendices give data on the site geology (entry 12-f-3), hydrology, electrical and mechanical aspects, and economic aspects of the undertaking. (W.M.)

05-b-40 HALL, C. E. STRODE, 1889 — The Mai Cussa. *Brit. N. Guinea ann. Rep. for 1888, (Qld)*, App. G., 36-8 (also issued as *Brit. N. Guinea ann. Rep. for 1888, (Vic.)*, App. G, 39-41.

The coastal lowlands around the mouths of the Mai Cussa and Chester Rs are described, and earlier surveys by Chester, Brew, and Strachan modified. (W.M.)

05-b-41 HENNESSY, J. M., 1889 — Report on a trip to the western part of the south coast of New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.*, 3(2), 64-71.

The lower reaches of the Vailala R. upstream to Orokolo are broad and deep with muddy bed and bars. The Arere and Aivai Rs farther west are similar to the Vailala and, with the Panarora, are distributory channels of the Wikham (Kikori) R. (W.M.)

05-b-42 HENNESSY, J. M., 1890 — Notes made on the Fly River, British New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.*, 5, 61-6.

A bar of mud partly blocks the mouth of the river channel used to enter the Fly R. south of Kiwai I. Kiwai is an island of mud standing less than 1 m above the high-water line, is cut by several small creeks, and is being actively eroded by the Fly channels. Tidal and current eddy effects cause rapid erosion on Kiwai and other low islands near the mouth. The lower reaches of the Fly are broad, but only a narrow navigable channel can be found. (W.M.)

05-b-43 JENNINGS, J. N., 1963 — Floodplain lakes in the Ka valley, Australian New Guinea. *Geogr. J.*, 129, 187-90.

Some 20 lakes are developed in the elevated river plains of the Ka R., a tributary of the Purari R. They are typical of many such lakes, ranging in size from ponds 100 m across to lakes 1 km wide, developed on the Ka and several other nearby river systems. Their relation to present and earlier river channels, and to adjacent peat bogs, is discussed. These lakes and nearby volcanic crater lakes may be an ideal site for the investigation of the form and genesis of this type of natural lake, which superficially resembles the peat-digging fill lakes of the Norfolk Broads. (W.M.)

05-b-44 LYONS, A. P., 1922 — Report of an expedition to the Upper Fly River. *Papua ann. Rep. for 1920-21,* App. I, 112-24 (also issued as *Aust. parl. Pap. 49, Sess. 1922,* 2, 3080-92).

Several recent natural changes in the bed and course of the Fly and Alice Rs are noted. (W.M.)

05-b-45 MACFARLANE, S., 1876 — Ascent of the Fly River, New Guinea. *Proc. Roy. geogr. Soc.*, 20, 253-66.

The ocean approaches to the mouth of the Fly R. are marked by numerous mud banks and shoals through which narrow tortuous channels are cut. The river is about 8 km wide at the mouth, is a little wider about 15 km up, and is very wide with multiple channels 50 km up. There are several low muddy islands in the lower reaches. Steep red clay blanks are present about 150 km up, but for the most part the river banks are low, swampy, and ill defined. (W.M.)

05-b-46 MIDDLETON, S. G., 1929 — A short description of the territory occupied by the Turama police camp. *Papua ann. Rep. for 1927-28,* 22-3 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 477-8).

The Turama R. is a large, shallow river feeding into the Gulf of Papua. Its mouth is split by 2 low alluvial islands, and there are several islands in the lower reaches of the river. It is connected by a narrow passage with the Gama R. which reaches the coast 1.5 km west of the westernmost branch of the Turama. Banks and shoals with narrow passages characterize both river mouths. Currents and 'freshes' cause frequent changes in the position of navigable passages. (W.M.)

05-b-47 MONTGOMERY, D. E., 1960 — Patrol of Upper Chimbu census division, Eastern Highlands. *Papua-New Guinea agric. J.*, 13, 1-9.

The upper reaches and headwaters of the Chimbu R. near Kundiawa are bounded by steep ranges — the Bismarck Ra., the Kerowagi Ra., and the Chimbu/Asaro divide. Relief is about 750 m from valley floor to ridge tops, with slopes frequently in excess of 50%. Soils are heavy clay or clay-loam of reasonable fertility developed in thin veneers on limestone. There are no areas of alluvial soil. (W.M.)

05-b-48 PAIJMANS, K., 1970 — Land evaluation by air-photo interpretation and field sampling in Australian New Guinea. *Photogrammetria,* 26, 77-100.

Air-photograph patterns of 2 areas in New Guinea surveyed at a reconnaissance level are described, analysed, and related to ground truth. The possibilities and limitations of predicting land capability from air-photographs are discussed. Cut-outs from air-photographs illustrate the descriptions. The areas discussed are the Kerema-Vailala and Morehead-Kiunga survey areas covered by CSIRO land survey teams. It is concluded that stream patterns cannot be recognized under some conditions of forest cover, and that prior stream channels are frequently difficult to identify. (Author/W.M.)

05-b-49 PAIJMANS, K., BLAKE, D. H., & BLEEKER, P., 1971b — Land systems of the Morehead-Kiunga area. *In* PAIJMANS, K., et al., — Land resources of the Morehead-Kiunga area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 29, 18-45.

The area was mapped in 20 land systems, each with a recurring pattern of landforms, soils, and vegetation. These land systems are described in tabular form, illustrated with profiles and sketch plans. The principal features of most areas are the lack of relief, predominance of features indicative of frequent periodic inundation, and the relative lack of dissection. In these features they contrast with all other surveyed areas in Papua New Guinea. (W.M.)

05-b-50 RUXTON, B. P., 1967e — Slope wash under mature primary rain forest in northern Papua. *In* JENNINGS, J. N., & MABBUTT, J. A., (Eds) — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press,* 85-94.

In the tropic rainforest areas around Pongani in eastern Papua, the main processes of slope erosion are sheet rills and droplets of rain water. Their erosive effect on humus-enriched fine soils derived from sediments and Recent volcanic ashes is discussed. It is concluded that most breaking-up of the soil is caused by droplets, but erosion is mostly by sheet rills which develop when rate of supply of water is greater than rate of infiltration. The effect of these processes is noticed in the landforms developed. (W.M.)

05-b-51 SCHRADER, C., 1888 — Expedition nach dem Augusta-Fluss. (Expedition to the Sepik River, in German.) *Nacht. Kaiser Wilhelms für 1888,* 4(1), 23-32.

An expedition ascended about 600 km up the Sepik R. in the *Samoa.* The possibility of navigating both the Sepik and some of its tributaries is noted. (C.F.)

05-b-52 SIMONETT, D. S., 1967 — Landslide distribution and earthquakes in the Bewani and Torricelli Mountains, New Guinea. *In* JENNINGS, J. N., & MABBUTT, J. A., (Eds) — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press,* 64-84.

An attempt is made to quantify the study of landslides in the wet tropic area in northwest New Guinea. The relative influence and importance of the following parameters are discussed and analysed: nature and structure of parent rock; frequency and type of landslides on different rock types; relationship between type, size, frequency of landslides and slope angle, length of slope, degree of cohesion of weathered mantle, stream gradient at base of slope, vegetation cover, and other factors; minimum critical angle for initiation of slide on a variety of parent rock materials and under a range of annual rainfall; rate of surface lowering as result of slides on a variety of parent rocks. Data were collected from field work and air-photograph studies on 400 slides, and processed statistically. Several conclusions on the relative influence of the parameters are listed, and related to earthquake shocks in the area. (W.M.)

05-b-53 SPEIGHT, J. G., 1965a — Meander spectra in the Angabunga River. *J. Hydrol.,* 3, 1-15.

Three sets of air-photographs spanning 24 years are used in an analysis of the dominant modes of meandering of the Angabunga R. in central Papua, using the method of the power spectrum. Spectra are constructed for successive reaches of the stream based on the auto-correlation of the direction of flow measured at equi-spaced points on the talweg of the channel. Such spectra display the meander intensity associated with each band of frequency, where frequency is the reciprocal of meander wavelength, measured along the talweg. It is shown that the subjectively chosen characteristic meander wavelength used by previous workers is a poor indicator of the dominant frequencies of oscillation. All spectra show a number of stable peaks of meander intensity, of which the dominant one corresponds to a wavelength about 90 times the root of the bankfull discharge, that is, about 50% longer than the expected 'characteristic' wavelength. The most prominent spectral peaks are more stable in a downstream direction than are other parameters, such as channel width. However, the relative intensities of the various peaks are subject to rapid change associated with change in channel cross-sectional shape. Parts of the channel with a lower width-depth ratio have a relatively high intensity associated with high-frequency peaks, a fact which strongly influences the subjective judgement of meander wavelength. (Auth.)

05-b-54 SPEIGHT, J. G., 1965b — Flow and channel characteristics of the Angabunga River, Papua. *J. Hydrol.*, 3, 16-36.

The Angabunga R. leaves its 2500 km^2 mountainous catchment to cross a broad alluvial plain in an unstable meandering channel. Since a crevasse occurred in 1954, shortening the lower course, the gradient of the total plains course is about 5×10^{-4}. From a short record the mean flow is found to be 112 m^3 per second and the variability 0.33. The two types of channel cross-sections of the plains course are migrating wide triangular sections dominated by point-bars, characteristic of the upstream reaches which have a gravel bed and sandy banks, and fixed narrow rectangular sections dominated by levees, characteristic of the downstream reaches with a sandy bed and silt-clay banks. The former can carry the most probable annual flood, 400 m^3/s, between bank-tops but the latter could carry only 170 m^3/s.

Width varies with distance, and unvegetated width is more nearly constant with distance than bank-top width. There is no relation between sinuosity and either width-depth ratio or percent of silt-clay. Model meander wavelengths of about 3000 m and about 1800 m, both diminishing downstream, are characteristic, with additional minor modes at 600 to 900 m contributing to the pattern where the channel has a lower width-depth ratio. Meander wavelengths have remained almost constant in time. Meander cut-offs are common, but downstream migration of meanders does not occur. (Auth.)

05-b-55 SPEIGHT, J. G., 1967e — Spectral analysis of meanders of some Australasian rivers. *In* JENNINGS, J. N., & MABBUTT, J. A., (Eds) — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press*, 48-63.

The application of power spectral analysis to stream meander wavelength measurements indicates that each stream is characterized by multiple wavelengths of lateral oscillation, related to each other and to stream flow in a remarkably orderly fashion. The meander pattern of a stream is shown to depend not only on wavelengths of meanders, but also on the relative intensity of spectral peaks. The precise relationship between wavelength and flow rate, channel shape, stream gradient, and bed and bank material has yet to be demonstrated. The discussion of the technique of spectral analysis includes a mathematical introduction and survey of theories, and is illustrated with examples and processing of measurements from streams in Australia and New Guinea. (Auth./W.M.)

05-b-56 TAPPENBECK, E., 1897 — Kurze Übersicht über den Verlauf der Kaiser-Wilhelms-Land-Expedition. (Brief note on the progress of the Kaiser-Wilhelmsland expedition, in German). *Dtsch. Kolonztg,* 10(4), 21-4.

An account is given of traverses on the lower reaches of the Ramu R. and some idea is gained of the meandering stream channels and wide riverine plains. (W.M.)

05-b-57 WILSON, H. M., 1968 — Hydrology of the Upper Ramu River hydro-electric scheme. *In* FRASER, J. B., & VALLANCE, D. B., — UPPER RAMU RIVER HYDRO-ELECTRIC SCHEME: NO. 1 POWER STATION AND ASSOCIATED WORKS. *Canberra, Comm. Dep. Works,* 53-74.

Rainfall, stream flow, and discharge rates from 1957 to 1965 indicate a range from 7 to 4260 m^3/s in the Ramu R. near the proposed dam site. The flow rates relate very closely to localized thunderstorm activity of short duration in the catchment area. Summaries of recorded data are tabulated. (W.M.)

05-b-58 WINTER, F. P., 1901 — Notes on a government expedition to the main range, British New Guinea. *Qld geogr. J.,* 16 (n.s.), 63-8.

The Adau R. heads north through a narrow gorge in the main range, and may join the Masu R. north of the range. (W.M.)

(c) Coastal

See also entries

01-a-6	02-d-48	05-d-4	05-d-14
01-a-34	05-a-25	05-d-5	05-e-4
02-a-10	05-a-33	05-d-7	
02-d-12	05-b-10	05-d-9	

05-c-1 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942a — Report on Mullins Harbour: Gilgili locality (revised). *Spec. Rep. Allied geogr. Sec.*, 1, 6 pp.

This study of the approach to Milne Bay via Mullins Har. includes notes on the topography of the area. (C.F.)

05-c-2 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942b — Courses and anchorages, Milne Bay to Buna coast. *Spec. Rep. Allied geogr. Sec.*, 3, 13 pp.

Notes are supplied on possible anchorages, and topographic data given on the area near the coastal margins. (C.F.)

05-c-3 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942c — Finschhafen and the Huon Peninsula. *Spec. Rep. Allied geogr. Sec.*, 4, 9 pp.

The general topography of the coastal region is described with details of offshore conditions opposite potential anchorages on the coast and among the small offshore islands. (C.F.)

05-c-4 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942d — Morobe district — south of Salamaua. *Spec. Rep. Allied geogr. Sec.*, 5, 12 pp.

The southern portion of the Nassau Bay area is fronted by a coastal plain with some extensive swamps and mountainous country behind. Farther north the mountains drop sheer to the sea. The littoral regions and major river systems are described. (C.F.)

05-c-5 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942h — Madang and Alexishafen — coastline and tracks. *Spec. Rep. Allied geogr. Sec.*, 12, 14 pp.

Oceanographic data, coral reefs, and mangrove-fringed harbours are noted, and Madang Har. is described. Coastal roads are recorded with some comments on their surfaces. (C.F.)

05-c-6 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942l — Notes on the Territory of New Guinea. I. Salamaua-Lae District; II. Madang; III. Wewak. *Terrain study Allied geogr. Sec.*, 5, 33 pp.

This was superseded by entries 05-c-10, 05-c-31, and 05-c-38.

05-c-7 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942b — Mandated Solomons and the Shortland Islands, with special attention to Buka Passage, Kieta, and Faisi. *Terrain study Allied geogr. Sec.*, 15, 6, and 44 pp.

A barrier reef is developed around the northern coast of Bougainville I., and Buka I. is a raised coral islet. Sea-bed lies at 10-40 or 30-80 m inside the reef, and drops to 900-1000 m outside. Several coral and volcanic islets stud Bougainville Str. The southern end of the west coast shelves gently westward for 25 m before scattered and incomplete barrier reefs are encountered, but farther north reefs are closer inshore. Several small anchorages are recognized in the indented coast. Occasional small narrow sandy beaches fringed with mangrove are present, but for much of its length the coast is cliffed. (W.M.)

05-c-8 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942q — Locality study of Salamaua. *Terrain study Allied geogr. Sec.*, 16, 33 pp.

The coastline south from Salamaua is indented, precipitous, and fringed with a broken barrier reef and offshore islands rising from a deep sea bed; to the north it is less indented and precipitous and lacks offshore islands. The coastline and associated offshore reefs are described, supported by oblique air-photographs. (W.M.)

05-c-9 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942x — Locality study of Lae (revised) and lower Markham Valley. *Terrain study Allied geogr. Sec.*, 32, 48 pp.

Geomorphic descriptions of rivers, lakes, mountains, and coasts include landforms, rates of sedimentation, and coastal development. Oblique air-photographs are included. (W.M.)

05-c-10 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942y — Locality study of Salamaua (revised). *Terrain study Allied geogr. Sec.*, 33, 47 pp.

Coastal approaches, anchorages, and tracks between Salamaua and the Bulolo goldfields are described. The report is illustrated with vertical and oblique air-photographs of the coasts and maps of road systems. (W.M.)

05-c-11 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942z — Area study of Louisiade Archipelago. *Terrain study Allied geogr. Sec.*, 34, 26 pp.

The form, approaches, and anchorages of several islands in the eastern Louisiade Arch. are described, including Misima, Deboyne, Torlesse, Renard, Calvados, Sudest (Tagula), and Rossel Is. Gold mining activity on Misima is outlined and illustrated. (W.M.)

05-c-12 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942aa — Area of Woodlark Island with the Marshall Bennett, Laughlan, Egum and Alcester groups. *Terrain study Allied geogr. Sec.*, 35, 22 pp.

Descriptions are given of anchorages and coastal approaches to Woodlark and nearby islands, and the track access on Woodlark is noted. Widespread reef development is a feature of the Woodlark offshore lagoons and bays. (W.M.)

05-c-13 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942ac — Area study of Morobe-Waria valley and adjacent catchment area. *Terrain study Allied geogr. Sec.*, 42, 35 pp.

Descriptions of anchorages between Hercules Bay and Salamaua indicate the indented nature of the coast, the general lack of barrier reef, and the numerous fringing reefs. Descriptions of tracks and streams reflect the dissected nature of the Bowutu Ra. (W.M.)

05-c-14 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943a — Coastline — Hopoi to Finschhafen. *Spec. Rep. Allied geogr. Sec.*, 13, 9 pp.

A narrow flat coastal strip is squeezed between the coast and the foothills of the main range. Coastal features are detailed and rough plans included. (C.F.)

05-c-15 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943f — Beach from Hopoi to Lae, with particular attention to Singuan locality. *Spec. Rep. Allied geogr. Sec.*, 19.

This report is a continuing series with Special Reports Nos 13 (entry 05-c-14) and 21 (entry 05-c-16). (C.F.)

05-c-16 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943g — Beach from Markham River to Bumbu River. *Spec. Rep. Allied geogr. Sec.*, 21, 11 pp.

Notes are given on coastal topography and the sea bed around the Markham estuary. (C.F.)

05-c-17 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943n — South coast of New Britain from Itni River to Ablingi Harbour. *Spec. Rep. Allied geogr. Sec.,* 31, 47 pp.

The western half of the coastline is low with flat country running inland and bordered on the coast by a fringe of mangrove swamps. To the east the coastline is more hilly and presents a series of alternating steep bluffs and low-lying areas. (C.F.)

05-c-18 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943r — Cape Croisilles to Tobenan Point. *Spec. Rep. Allied geogr. Sec.,* 52, 53 pp.

The narrow coastal strip west of Karkar I. between the Adelbert Ra. and the sea comprises two distinct regions: the northern slopes of the Adelbert Ra. and the coastal plains. The Adelbert Ra. lies 25 km inland rising to about 1200 m in places with most of its northeast slopes cut into an elaborate system of steep spurs. Descriptions of the coral-fringed shores and potential harbour sites include photographs. (W.M.)

05-c-19 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943u — Salamaua. *Terrain Hbk Allied geogr. Sec.,* 3, 25 pp.

The coast of Huon Gulf around Salamaua is marked by many indentations, the almost complete absence of reefs, the sudden rise to coastal hills, and the occasional submarine deltaic deposit off the mouths of large streams draining the coastal range. Some of these features are shown in oblique air-photographs. (W.M.)

05-c-20 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943w — Finschhafen. *Terrain Hbk Allied geogr. Sec.,* 5, 30 pp.

The south and east coast of the Huon Pen., and the eastern foothills of the Saruwaged Ra. are described, with strip map and oblique air-photographs. (W.M.)

05-c-21 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943x — Gasmata. *Terrain Hbk Allied geogr. Sec.,* 6, 28 pp.

The south coast of New Britain near Gasmata on Thilenius Har. is almost free of reefs because of the steep fall of the coastal hills and sea floor. At the mouths of large rivers, debris is building up thick sediments which are occasionally reworked into spits and bars by longshore currents. (W.M.)

05-c-22 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943x — Gasmata. *Terrain Hbk Allied geogr. Sec.,* 6, 28 pp. 11, 50 pp.

This summarizes entry 05-a-31.

05-c-23 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ad — Sio. *Terrain Hbk Allied geogr. Sec.,* 13, 68 pp.

The Rai coast, including river mouths and reefs, the Saruwaged, Finisterre, and Cromwell Ras, and the main rivers and lakes are described. Strip maps, stereopairs of photographs, and vertical and oblique air-photographs illustrate the report. (W.M.)

05-c-24 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ae — Saidor. *Terrain Hbk Allied geogr. Sec.,* 14, 64 pp.

The coastal plains around Saidor are restricted, the dissected foothills of the Finisterre Ra. coming down almost to the sea. Some large bird-foot deltas being built at the mouths of large rivers are shown in oblique air-photographs. The terrain of the Finisterre Ra. is rugged and deeply dissected. Broken coralline barrier reef patches develop along the coast, but never near river mouths. (W.M.)

05-c-25 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943af — The Admiralty Islands. *Terrain Hbk Allied geogr. Sec.,* 17, 48 pp.

The Admiralty Is and outlying islands to the west are described, using oblique air-photographs. Except Manus Is, most are coralline atolls or reefs. Barrier reefs are developed on parts of the Manus coast which is discussed in terms of suitability for anchorages and seaplane bases. (W.M.)

05-c-26 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ah — Locality study of Gasmata, New Britain. *Terrain study Allied geogr. Sec.*, 26, 20 pp.

Numerous reef patches lie immediately offshore and stretches of coast have sand and mud beaches shelving to reef shoal patches. (W.M.)

05-c-27 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ai — Locality study, Madang. *Terrain study Allied geogr. Sec.*, 31, 36 pp.

The 5-8 km wide coastal strip near Madang is raised platform coral, and offshore the 200 m line lies within 2.5 km of the shore; small shoal and patch reefs are developed discontinuously within this line. The coastline is characterized by low coral cliffs, some offshore reef patches, and occasional sandy beaches in the heads of bays and indentations; a large sandy isthmus is developed near the mouth of the Gogol R. The backing hills of the Adelbert Ra. are mountainous and precipitous; the hills behind Bogadjim are gentle and non-mountainous, passing easterly into the mountainous Finisterre Ra.

Karkar I. is an active volcano, with a crater of 25 km circumference standing 200-600 m above sea level. The crater is 360 m deep with three active cones, one smoking, in its base. Offshore reefs develop 6-7 km from the coast. Bagabag Island is crescent-shaped, rises preciptously to 600 m, and is almost encircled by a barrier reef 3 km offshore. The coast is cliffed, except for a beach inside the crescent. (W.M.)

05-c-28 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943al — Area study of New Ireland. *Terrain study Allied geogr. Sec.*, 52, 52 pp.

The coastline and coastal approaches including Djaul I. are described including the form and extent of reefs and notched coastline cliffs. Large areas of limestone crop out on Lelet Plateau, and Weitin valley is a major transverse break in the dissected, mountainous, southern part of the island. Maps, sketches, and photographs are included. (W.M.)

05-c-29 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943am — Area study of western New Britain excluding Cape Gloucester. *Terrain study Allied geogr. Sec.*, 57, 72 pp.

Coastlines and coastal approaches of New Britain west of about 149°E are described together with the offshore islands Witu (Vitu), Umboi, Tolokiwa, Sakan, Ritter, Siassi, and Arawe. Whiteman Ra. forms the backbone of much of New Britain and is separated by the low Lamogai Plateau from the volcanic C. Raoult. The south coast faces deep sea, and the north coast is reef-rimmed and shelving. The Lamogai Plateau is composed of limestone, partly capped with detrital sediments. Numerous volcanic centres are recorded in the C. Raoult Pen. and the offshore islands. (W.M.)

05-c-30 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943ar — Locality study of Talasea (revised). *Terrain study Allied geogr. Sec.*, 64, 31 pp.

This deals mainly with the coastline of the Willaumez Pen. and Kimbe and Eleonora Bays. Offshore reefs are few and the bays are mostly deep. The volcanic origin of the peninsula and nearby areas is noted. Active centres are recorded at Mt Bango (Pago) and fumarolic centres on the peninsula. Maps and photographs are included. This supersedes entry 05-a-22. (W.M.)

05-c-31 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943av — Locality Study of Madang. *Terrain study Allied geogr. Sec.*, 69, 88 pp.

A characteristic steep drop to coastline lies on the edge of a narrow coastal plain intersected by many small rivers which drain mainly eastward. Immediately west of the coastal plain, foothills rise into a confused hill system covering the hinterland. Small swampy areas are scattered throughout the region. (C.F.)

05-c-32 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943aw — Locality study of Hansa Bay — I. Text and Maps, II. Photographs. *Terrain study Allied geogr. Sec.*, 72, 98 pp.

The mainland coast and Manam I. have limited development of fringing reefs, and most offshore areas are deep water. Anchorages, coastlines and ridge and river systems are described. The abundance of earthquake-triggered landslips is noted. The geology and mineral resources of the area are outlined. (W.M.)

05-c-33 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944a — Bougainville. *Spec. Rep. Allied geogr. Sec.*, 65 53 pp.

This describes the coastal topography of the entire island. (C.F.)

05-c-34 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944b — Hansa Boy. *Terrain Hbk Allied geogr. Sec.*, 12, 82 pp.

The New Guinea coast opposite Manam I. has numerous submerged reef patches, but these are not sufficiently interconnected to form a barrier. There is a very narrow coastal plain, except near the mouth of the Ramu R., passing into the dissected rugged Adelbert Ra. Manam I. is an active volcano, and most beaches are composed of ash and pumice debris. Most of the coastline is cliffed on lavas, with rare coral reef patches. Oblique air-photographs are included. (W.M.)

05-c-35 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944f — Gazelle Peninsula. *Terrain Hbk Allied geogr. Sec.*, 19, 85 pp. + pictorial supplement.

The coast of the Gazelle Pen. is described from Wide Bay in the south to Open Bay in the north, including the Blanche Bay-Rabaul Har. area. The peninsula is mostly high broken country with restricted development of coastal plains. The lower reaches of most rivers are navigable. Vertical and oblique air-photographs illustrate the report. (W.M.)

05-c-36 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944h — Aitape-Vanimo. *Terrain Hbk Allied geogr. Sec.*, 21, 95 pp.

The coast of New Guinea for about 30 km east and west of Aitape is described using vertical and oblique air-photographs and strip maps. The rivers draining the Torricelli Ra., the range itself, and tracks across it are outlined. The country immediately surrounding Vanimo is described, especially the coast and harbour. (W.M.)

05-c-37 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944i — Area study of Gazelle Peninsula — I. Text and Maps; II. Photographs. *Terrain study Allied geogr. Sec.*, 74, 88 pp.

The coast, coastal approaches, and tracks along stream and ridge systems are described. Long stretches of sandy beach occur, and the coast is almost completely rimmed by fringing reefs. Around Rabaul the ranges are volcanic but most of the peninsula is rugged and not of volcanic origin. Iron ore and gold have been assessed in the Talele Goldfield, and one orebody is described. One volume contains maps and photographs. (W.M.)

05-c-38 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944k — Locality study of Wewak. *Terrain study Allied geogr. Sec.*, 76, 99 pp.

The coastline, anchorages, coast approaches, and Prince Alexander Ra. are described and numerous tracks through the area listed. Photographs and maps are included. (W.M.)

05-c-39 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 19441 — Locality study of Aitape-Vanimo. *Terrain study Allied geogr. Sec.*, 77, 80 pp.

The coast near Aitape, the offshore islands of Angel, Selio, Asi, and Tumleo, and the north fall of the Torricelli Ra. are described using map and photographic illustrations. Tracks, landing beaches, offshore reefs, anchorages, the drainage system off the Torricelli Ra., and access using this system, are discussed. (W.M.)

05-c-40 BROWN, L. N., 1925a — Gulf division. *Papua ann. Rep. for 1923-24,* 19-2C (also issued as *Aust. parl. Pap., 3, Sess. 1925,* 2, 2646-7).

Kerema Bay is a shallow expanse of muddy water with many shifting sand and mud banks. Short broad streams feed into it; the beaches are black (lithic) sands, passing inland to swampy flat sandy country. (W.M.)

05-c-41 DOUGLAS, J., 1886 — The islands of Torres Straits. *Proc. Roy. geogr. Soc. Australas., Qld Br.,* 1, 70-83.

A shallow mud bar blocks access through the mouth of the Katow R. opposite Saibai I. in western Papua. The Torres Str. islands, and their rock-types, origin, and vegetation are described. (W.M.)

05-c-42 FAIRBRIDGE, R. W., 1968a — Atlantic and Pacific type coasts. (*In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF GEOMORPHOLOGY. Encyclopedia of Earth Sciences Series, Vol. 3. *N.Y., Reinhold,* 34-5).

The recognition by Suess, von Richthofen, and Gregory of coastal types controlled by gross continental tectonics and continent limits is recorded, and their two systems of classification outlined. The coasts of New Guinea are an example of Suess' Pacific type, and of von Richthofen's Longitudinal and Alluvial types. The south coast of New Britain is an example of Gregory's Secondary Pacific type. (W.M.)

05-c-43 HUNTE, G. R. le, 1901c — Despatch reporting visit of inspection to the western portion of the possession. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. E, 21-30.

The rugged volcanic spine of Dauan I. contrasts sharply with the extensive muddy littoral plains of southwest Papua. These plains, broken only by Mabadauan Hill, extend east to Aird Hills and beyond, and north almost 1000 km to the upper reaches of the Fly R.

The lower reaches of the Mai Kussa and Wassi Kussa Rs are wide channels through low muddy plains. They are connected by Altu Cr. north of Strachan I. and their lower reaches anastomose considerably. The lower reaches of the Morehead R. were charted. Maps of southwest Papua (12 miles to 1 inch) and the Morehead R. (2 miles to 1 inch) are included. (W.M.)

05-c-44 JENNINGS, J. N., 1955 — The influence of wave action on coastal outline in plan. *Aust. Geogr.,* 6(4), 36-44.

The relative effects of ocean currents, wind-generated waves, and wind in the genesis of coastal forms are discussed. It is argued that waves have greater effect than currents. The nature of wave action on sand and shingle beaches is discussed, and an outline given of the effect of wave incidence on shoreline configuration. Moila Pt on the southern tip of Bougainville is cited as an example of a cuspate foreland, developed under the current-deflecting protective effect of Shortland I. to the south. (W.M.)

05-c-45 JENNINGS, J. N., 1965 — Further discussion of factors affecting coastal dune formation in the tropics. *Aust. J. Sci.,* 28, 166-7.

The relationship between wind velocity, wind direction relative to coastline, abundance and dryness of sand, and extent of cohesive vegetation cover is discussed in an attempt to explain the paucity of coastal sand dunes in humid tropic areas. It is concluded that their inter-relationship is complex and not yet understood. (W.M.)

05-c-46 JUKES, J. B., 1847b — NARRATIVE OF THE SURVEYING VOYAGE OF HMS FLY . . . DURING THE YEARS OF 1842-46. *London, Boone,* 2 vols.

First contact with mainland New Guinea was opposite Bristow I., near the present site of Daru. Large mudbank shoals and areas of muddy fresh water were encountered up to 15 km out to sea off the mouth of a large river (Fly). The mouth of this arm of the Fly is 8 km wide and about 6 m deep. The sea floor off the mouth is generally flat, shallow, and muddy or sandy for up to 25 km offshore. The nearest island on which coralline reefs survive is the volcanic Bramble Cay. A discontinuous barrier extends westward, where no major river debouches into the sea.

Aird Hills were sighted and named on 9 May, 1845. The sea bed is flat and muddy some 8 km offshore, beaches are of black sand, and there are extensive low flat coastal lowlands broken into islands by stream channels at the mouth of a large river (Kikori). These channels were charted. In some beaches dark mud is underlain by 'stiff blue clay'. (W.M.)

05-c-47 MORESBY, J., 1874b — Hydrography — Torres Strait and the south-east coast of New Guinea. *Naut. Mag.,* 43, 57-62.

Large rivers feeding the Gulf of Papua bring down sufficient detritus to discolour the sea around their mouths, and prevent the extensive development of coralline reefs. Such reef patches as are developed are of limited extent and rise with sheer boundaries from the sea floor. Single patches of reef shoals were seen in Fairfax Har. (W.M.)

05-c-48 MORESBY, J., 1889 — (extract of letter to the editor of 'The Times', in (?) 1875). *Brit. N. Guinea ann. Rep. for 1888 (Vic.),* Encl. 8 in App. F. 38 (also issued as *Brit. N. Guinea ann. Rep. for 1888 (Qld),* Encl. 8 in App. F, 35).

The coast from north of Torres Str. to Yule I. is uniformly low and swampy. Between Yule I. and Redscar Head a coastal swampy plain lies in front of the foothills of the Owen Stanley Ra. East from Redscar Head rounded foothills extend to the coast, which is fringed with a barrier reef lying 6-16 km offshore. These reefs fall rapidly to deep ocean floor, and are backed by shelving lagoons. (W.M.)

05-c-49 ROMILLY, H. H., 1886 — New Guinea. *Proc. Roy. geogr. Soc. Australas., Qld Br.,* 1, 46-54.

The Aird and Mai Kussa Rs in western British New Guinea (Papua) are little known and only their lower reaches have been explored. They are broad and shallow and reported to be salty for some distance upstream. The coast of Papua has many bays and large rivers, affording safe anchorages at any season. This is in contrast with the German New Guinea coast, which has relatively few harbours or large rivers. (W.M.)

05-c-50 SCHLEINITZ, G. E. G. von, 1888 — Untersuchungsreise (Exploratory survey). *Nachr. Kaiser-Wilhelmsl. für 1888,* 1, 34-41; 2, 64-71, 193-5; 5 (n.p.).

Several surveys were made: (i) the New Britain coast in the *Samoa.* The general topography is described, particularly the relationship between rivers and landform; (ii) the coast between Finschhafen and C. Croisilles. Much of the land consists of grassy plains or rises in 4 or 5 successive terraces intersected by rivers. The soil, the product of erosion, usually consists of the debris of volcanic and coralline and older rocks; (iii) the northeast coast from C. Croisilles to Hatzfeldthafen; (iv) the Huon Bay coast. (C.F.)

05-c-51 SCHLEINITZ, G. E. G. von, 1889 — Beschreibung der Nordküste von Kaiser-Wilhelmsland von Kap Cretin bis zu den Legoarant Inseln. (Description of the north coast of Kaiser Wilhelmsland from Cape Cretin to Legoarant Islands, in German). *Nachr. Kaiser-Wilhelmsl. für 1889,* 5(11), 48-86.

The north coast was surveyed from C. Cretin on the Huon Pen. to beyond Legoarant Is near Manam. Several coral patches and sand-beach stretches lie at the foot of rapidly-rising backing hills. Islands associated with this stretch of coast (Long, Rich (Bagabag), and Dampier) are listed. (C.F.)

(d) Reef and Limestone

See also entries

01-a-10	02-b-67	05-c-11	05-c-50
01-a-34	02-b-146	05-c-12	05-e-3
02-a-10	02-d-41	05-c-20	05-e-6
02-b-6	05-a-19	05-c-28	12-b-88
02-b-24	05-a-21	05-c-29	14-a-35
02-b-27	05-a-35	05-c-37	
02-b-30	05-a-128	05-c-39	
02-b-43	05-a-129	05-c-40	

05-d-1 Anonymous, 1892a — British New Guinea. *Scott. geogr. Mag.*, 8, 496-7.

A report by Macgregor describing the raised coral atoll forms of many of the Trobriand Is (entry 05-d-32) is quoted. (W.M.)

05-d-2 Anonymous, 1892c — Upraised coral islands off New Guinea. *Proc. Roy. geogr. Soc.*, 14 (n.s.), 415.

This summarizes entry 05-d-32.

05-d-3 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942j — Admiralty Islands, preliminary. *Terrain study Allied geogr. Sec.*, 3, 3 pp.

This was superseded by Terrain Study 67 (entry 05-d-10). (C.F.)

05-d-4 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942ab — Area study of Finschhafen and Huon Peninsula. *Terrain study Allied geogr. Sec.*, 36, 22 pp.

Descriptions of walking track access, illustrated with photographs and maps, give clear impressions of the Finschhafen terraces, the dissected backing ranges, and the subdued south coast of the Huon Pen. (W.M.)

05-d-5 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1942ad — Area study of Manus and Western Islands. *Terrain study Allied geogr. Sec.*, 43, 22 pp.

The Admiralty Is, and the Hermit, Ninigo, Wuvulu, and Purdy Groups are described. Most are coral or coral-debris islets, fringed with coral reefs. The presence of phosphate in the Purdy Is, and the earth tremor and tsunami effects of earthquakes, are noted. (W.M.)

05-d-6 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943m — Track system: Satelberg-Sio area. *Spec. Rep. Allied geogr. Sec.*, 29, 12 pp.

Cromwell Ra. is a continuation of Saruwaged Ra. which ends in the southeast at Mt Salawaket (3800 m). The northern and eastern slopes of Cromwell Ra. are a series of coral terraces recognizable up to 600 m. They are deeply fissured by fast mountain streams. Tracks over and through the ranges are described. (C.F.)

05-d-7 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943ao — Locality study of Gasmata (revised). *Terrain study Allied geogr. Sec.*, 60, 37 pp.

Descriptions of the coastline and approaches include the nature and extent of fringing and barrier reefs, the low-lying coastal tract, and the low backing ranges. Oblique air-photographs accompany the report. (W.M.)

05-d-8 Allied Forces Southwest Pacific Area (1941-45). Allied Geographical Section, 1943ap — Area study of New Hanover and islands north and east of New Ireland. *Terrain study Allied geogr. Sec.*, 62, 14 pp.

Reef island groups around New Ireland, and the volcanic islands of Tabar and

Lihir, are described and illustrated with maps and photographs. Boat passage approaches to islands give some idea of reef structures. (W.M.)

05-d-9 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943aq — Locality study of Cape Gloucester (revised). *Terrain study Allied geogr. Sec.*, 63, 27 pp.

Dampier Str. is studded with reefs, which are also common on the nearshore flats around C. Gloucester. Descriptions of anchorages and their approaches give some idea of reef distribution and forms. The volcanic nature of the mountains on C. Gloucester — Tangi, Talawe, Bulu, Langila, and Munlulu — is noted; Langila is semi-active. Oblique air-photographs illustrate the report, which supersedes Terrain Study 25 (entry 05-a-28). (W.M.)

05-d-10 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943au — Area study of the Admiralty Islands. *Terrain Study Allied geogr. Sec.*, 67, 50 pp.

The islands are a northwest extension of the Bismarck Arch., volcanic in origin, and with frequent seismic disturbances. The smaller coral islands and atolls surrounding the main Manus I. are described. The whole group consists of 160 islands, mainly coral or basalt covered with weathered products. The constant occurrence of submerged coral reefs is noted, and the coastline and potential harbours are described. Manus I. contains a central axial mountain range running east-west with peaks of 600 m. (C.F.)

05-d-11 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1944c — Madang. *Terrain Hbk Allied geogr. Sec.*, 15, 81 pp.

The coast near Madang is mostly elevated coral reef, giving way near river mouths to mangrove swamps. A very narrow coastal plain largely of elevated limestone is developed, passing rapidly into the dissected coastal hills. (W.M.)

05-d-12 ATKINSON, O. J., 1927 — Divisional report — Baniara, North-East Division. *Papua ann. Rep. for 1925-26*, 53-4 (also issued as *Aust. parl. Pap. 100, Sess. 1926-28*, 2, 2199-200).

Limestone caves are recorded from outcrops on the coast of Goodenough Bay between Wabubu and Daboro villages. (W.M.)

05-d-13 BEAVER, W. N., 1911 — Report on the search party in connection with the Kikori Expedition. *Papua ann. Rep. for 1910-11*, App. A (2), 178-87 (also issued as *Aust. parl. Pap. 67, Sess. 1911*, 3, 742-51).

The country on the east and northeast fall to the Kikori R. is rugged and precipitous, and almost impenetrable in places. Limestone crops out over most of the area, and many classical karst features are developed. (W.M.)

05-d-14 BRITISH ADMIRALTY, 1933 — PACIFIC ISLAND PILOT — VOLUME I. (6th Edn). *London, H.M.S.O.*, xxxviii + 608 pp.

Descriptions are given of the coastlines and offshore reefs and similar hazards of mainland Papua New Guinea, New Britain, New Ireland, Solomon Is, the Louisiade Arch. and eastern Papua islands, and the north coast of Dutch New Guinea. Notes on reef positions, sea-floor depth and sediment, shapes and widths of passages, living condition of reefs, tidal and ocean currents, and beaching facilities are included. (W.M.)

(NOTE: This was reviewed not for the value of its contained data, but to indicate the style of information contained in Pilot Instructions or Sailing Directions issued by several authorities, such as U.S. Navy Hydrographic Office, Australian Navy, British Admiralty, German Navy, Japanese Naval Intelligence, German New Guinea Company).

05-d-15 CHAMPION, C. R., 1968 — Caving and karst areas in Papua and New Guinea. *In* MATTHEWS, P. (Ed.) — SPELEO HANDBOOK, *Sydney, Speleological Fed.*, 188-95.

The location of known caves throughout Papua New Guinea is given, with descriptions of most of the cave systems. All are in limestone ranging from Eocene to Recent, and several are archaeological sites for which isotopic ages have been determined. (W.M.)

05-d-16 CHAMPION, I. F., 1928 — North-west patrol — report of sub-patrol. *Papua ann. Rep. for 1926-27,* App. B, 102-16 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28,* 2, 2372-86).

One aspect of the exploration of the headwaters of the Fly, Strickland, Palmer, and Sepik Rs (entry 05-d-30) was a traverse up the Palmer R. into the Victor Emmanuel Ra. and down the Fly R. The inhospitable limestone country is described. (W.M.)

05-d-17 CHANCE, S. H., 1928 — Description of the Foi-I or Mobi River district of the Delta Division. *Papua ann. Rep. for 1926-27,* 35-6 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28,* 2, 2305-6).

This district, 145 km northwest of Kikori, is in rugged limestone country. The Mobi (Mubi) is a broad stream for some of its length, and passes into rapids, through narrow defiles and underground channels, and over falls in response to the limestone topography. (W.M.)

05-d-18 DAVIS, W. M., 1922a — Coral reefs of the Louisiade Archipelago. *Proc. nat. Acad. Sci.,* 8, 7-13.

This summarizes entry 05-d-19.

05-d-19 DAVIS, W. M., 1922b — The barrier reef of Tagula, New Guinea. *Ann. ass. Amer. Geogr.,* 12, 97-151.

The gross morphology of the Tagula barrier reef and associated islands is discussed. The various features recognized are used to evaluate the applicability of the Darwin theory of reef growth and of the Glacial Control theory of reef growth. It is concluded that the Glacial Control theory is not applicable to the Tagula reef, and it is suggested that it probably is not applicable to any reefs. (W.M.)

05-d-20 DAVIS, W. M., 1928 — The coral reef problem. *Amer. geogr. Soc., spec. Publ.* 9, 596 pp.

The theories of formation of coral reefs are outlined, discussed, and assessed in the light of observations of reef systems in the Pacific basin. Examples include the barrier, atoll, and fringing reefs of the mainland and islands of Papua New Guinea. It is concluded that the theories of Darwin on reef growth are generally applicable. (W.M.)

05-d-21 FAIRBRIDGE, R. W., 1967 — Coral reefs of the Australian region. *In* JENNINGS, J. N., & MABBUTT, J. A. (Eds) — LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Camb. Univ. Press,* 386-417.

The Australian continental margin seas contain representatives of almost every type of coral and related reefs. Types recognized include fringing reefs, platform and patch reefs, barrier reefs, and a variety of atolls; associated reef islands include sand cays, shingle cays, sand cays with shingle ramparts, and emerged reef islands. Included in the examples are many in Papua New Guinea coastal waters.

Ecological control of reef growth environments include temperature, salinity, aeration, chemical factors, sediment, light, exposure, aspect, and nutrients; the range of these parameters on Australian reefs is noted. The distribution of reef types in several reef provinces is discussed, and their significance in interpreting the tectonic history of the province assessed. The Coral Sea province is a subsiding region with areas of local uplift; coastal New Guinea is largely fringed with elevated reefs. (W.M.)

05-d-22 FAIRBRIDGE, R. W., 1968b — Coral reefs — morphology and theories. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF GEOMORPHOLOGY. Encyclopedia of Earth Sciences Series, Vol. 3 *N.Y., Reinhold,* 186-97.

The terminology of reefs is outlined, types of reefs are described, and their origin discussed. Four geotectonic settings of reefs are recognized: epicontinental areas, mobile belts, quasicratonic areas, and oceanic volcanic areas. The reefs of the Louisiade Arch. and Papua are examples of reefs formed in gently-subsiding mobile areas. The reefs on the north coast of New Guinea are examples of reefs in strongly-mobile uplifting areas. (W.M.)

05-d-23 GUPPY, H. B., 1884 — Suggestions as to the mode of formation of barrier reefs in Bougainville Straits, Solomon Group. *Proc. Linn. Soc. N.S.W.*, 9, 949-59.

A fringing barrier reef 25 km off the east coast of Bougainville lies on the edge of the submerged eastward extension of the island. To the east the sea falls away rapidly, and a broad backreef shoal is present. The Shortland Is, part of this reef system, are the product of isostatic uplift. Their relation to reefs on Choiseul I. indicates gradual uplift associated with southeast migration of the Shortland reefs with changing sea level. (W.M.)

05-d-24 GUPPY, H. B., 1886 — Notes on the characters and mode of formation of the coral reefs of the Solomon Islands. *Proc. Roy. Soc. Edin.*, 31, 857-904.

Features of barrier and fringing reefs, reef shoals, and atolls in the Solomon Is, and the origin of barrier and fringing reefs in subsiding areas of shallow sea-floor slope, are described. Evidence of fluctuations in sea level during the Quaternary is cited in cavernous and notched weathering of uplifted or sunken reefs. (W.M.)

05-d-25 GUPPY, H. B., 1887a — Observations on the Recent calcareous formations of the Solomon Group made during 1882-84. *Proc. Roy. Soc. Edin.*, 32, 545-81.

The terraced coral platforms, uplifted and exposed reef platforms, and notched cliff lines in the Solomon Is are examples of reef systems developing in tectonically active regions. Irregular uplift indicated by the reef systems of this region is evident in both areal distribution of adjusting blocks and in periodicity of uplift. (C.F.)

05-d-26 GUPPY, H. B., 1888 — A criticism of the theory of subsidence as affecting coral reefs. *Scott. geogr. Mag.*, 4, 121-37.

Darwin's theory of the environment and origin of coral reefs is reviewed in the light of experience in the Solomon and Coral Seas east of New Guinea. It is argued that many atolls of shallow-water reefs have basement of deep-water forms, and that early ideas of coral reef formation must be reviewed as further data become available. (W.M.)

05-d-27 HERBERT, C. E., 1911 — Report on the search for the Kikori Expedition. *Papua ann. Rep. for 1910-11,* App. A(1), 171-7 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 735-42).

The country in the watershed of the Kikori R. is mostly rugged and precipitous, with many karst sinks developed on the extensive limestones. (W.M.)

05-d-28 HIDES, J. G., & O'MALLEY, J., 1936 — Expedition from the Strickland to the Purari. *Papua ann. Rep. for 1934-35,* 23-4 (also issued as *Aust. parl. Pap. 243, Sess. 1934-37,* 2, 1312-3).

The terrain developed on limestones in the upper reaches of the Strickland and Purari Rs includes sinkholes, underground channels, deep steep-sided gorges, rapids, cliffs, and terraced plateaux. (W.M.)

05-d-29 JENNINGS, J. N., & BIK, M. J., 1962 — Karst morphology in Australian New Guinea. *Nature,* 194, 1036-8.

Development of karst topography on limestones at elevations ranging from sea level to above 3000 m is discussed. Strata discussed include (1) the lower Miocene limestone at less than 200 m around Kikori, in which 'Kegelskarst' and 'crevice' relief are recognized, (2) the Miocene limestone around 1600 m elevation in the Southern Highlands, and Pliocene limestone at 1500 m in the Eastern Highlands, in which doline karst predominates, and often is accompanied by rounded residual hill topography, (3) Upper Cretaceous to Eocene limestone at 2600-3700 m in the Western Highlands, on which doline karst, pyramid and doline karst, and knife-edged aretes and pinnacles are developed. The significance of these features at different elevations in wet tropical areas in terms of solution and weathering rates, and several theories of limestone weathering are discussed. (W.M.)

05-d-30 KARIUS, C. H., & CHAMPION, I. F., 1928 — Report of northwest patrol. *Papua ann. Rep. for 1926-27,* App. A, 91-101 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28,* 2, 2361-71).

A patrol up the Fly R. through the limestone country around Mt Blucher and Mt Donaldson, up the Palmer R. and across the main divide to a long valley (probably the head of the Sepik R.), returned to the south coast via the Strickland and Fly Rs. The rugged inhospitable limestone country is described. Several earth tremors were felt in the Victor Emmanuel Ra. (W.M.)

05-d-31 KARIUS, C. H., & CHAMPION, I. F., 1929 — Report on the crossing of New Guinea. *Papua ann. Rep. for 1927-28,* App. D, 90-108 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 545-63).

The log of a traverse up the Fly R., through the western end of the Victor Emmanuel Ra., and down the upper reaches of the Sepik R., includes a description of some of the severe terrain in the limestone on the southern approaches to the main range. (W.M.)

05-d-32 MACGREGOR, W., 1893b — Despatch continuing report of visit of inspection to the eastern portion of the possession. *Brit. N. Guinea ann. Rep. for 1891-92,* App. G, 27-31.

This refers to the form and origin of Kitava I. in the Trobriand Group, and of Kwaiawata and Gawa Is near Woodlark I., and to the extent of the barrier and fringing reefs on the east coast of Rossel I. in the Louisiade Arch.

Kitavia is 12-15 km^2 in area. Peripheral hills rise to 90-120 m, surrounding a a plateau about 30 m lower. The hills are of coral, the forms present indicating recent uplift. The island may be an uplifted atoll. Kwaiawata and Gawa have similar forms to Kitava, and may have similar origins. (W.M.)

05-d-33 OLLIER, C. D., & HOLDSWORTH, D. K., 1968 — Caves of Kiriwina, Trobriand Islands, Papua. *Helictite,* 6, 63-72.

Surveys were made of solution and collapse caves in the uplifted reef limestones which constitute Kiriwina I. Plans and profiles of several caves and cave systems are presented, and caves visited are described. The caves appear to be normal karst-type caves developed near the water-table, and no evidence was recognized to suggest they represent original reef cavities. (W.M.)

05-d-34 OLLIER, C. D., & HOLDSWORTH, D. K., 1969 — Caves of Vakuta, Trobriand Islands, Papua. *Helictite,* 7, 50-61.

The caves on Vakuta are karst features formed by solution by brackish water at or near the present water-table. The island is an uplifted reef limestone, but no original reef cavity features are recognized. All caves are described, and some plans and profiles presented. (W.M.)

05-d-35 OLLIER, C. D., & HOLDSWORTH, D. K., 1970a — Some caves of Kitava, Trobriand Islands, Papua. *Helictite,* 8, 29-38.

Kitava is an uplifted coral atoll, with atoll form readily recognizable in landforms; the old reef rim stands 142 m above present sea level. Uplift was spasmodic, as indicated by the presence of at least 5 steep-walled terraces representing prior fringing reefs. The morphology, content and history of 6 caves are described. These caves differ from other Trobriand examples in that they contain deep phreatic forms and sinkholes. They are modified extensively by calcite deposition and cave breakdown. (W.M.)

05-d-36 OLLIER, C. D., & HOLDSWORTH, D. K., 1970b — Cave paintings from Kitava, Trobriand Islands, Papua. *Helictite,* 8, 79-84.

Inakebu cave in which the art was found is a solution cave in elevated reef limestone of uniform massive texture and cream colour. The map of the cave system indicates sinuous channels, belled chambers and sinkholes. (W.M.)

05-d-37 OLLIER, C. D., HOLDSWORTH, D. K., & HEERS, G., 1971a — Inakebu, cave art at Kitava in the Trobriand Islands. *Archaeology*, 24, 22-7.

A floor plan of the Inakebu cave is included in the description. (W.M.)

05-d-38 OLLIER, C. D., HOLDSWORTH, D. K., & HEERS, G., 1971b — Caves of Kaileuna and Tuma, Trobriand Islands. *Helictite*, 9, 29-48.

Kaileuna and Tuma Is in the Trobriand group are elevated reef coral limestone patches of which Kaileuna is an atoll and Tuma part of a barrier. Only one period of uplift is postulated. 15 small caves on Kaileuna and 4 on Tuma are described and their origin discussed. Solution of limestone near the water-table of a fresh-water lens may account for the origin of all caves, though subsequent collapse and modification have made reconstruction of original form difficult. (W.M.)

05-d-39 PILHOFER, G., 1911a — Eine Reise in das Hinterland von Finschhafen, Kaiser-Wilhelms-Land (A journey inland from Finschhafen, German New Guinea, in German). *Petermanns Mitt.*, 57, 187-91.

Numerous terracettes with cliffed margins mark the rise to Cromwell Ra. from the eastern end of the Huon Pen., rising to 900 m before passing into more steeply-dissected country rising to 2300 m. The north coast fall is not similarly terraced. (W.M.)

05-d-40 SCHNEIDER, C., 1886 — No title — (Survey of Finschhafen and coast west to Madang, in German). *Nachr. Kaiser-Wilhelmsl. für 1886*, 2(3), 83-90.

Coral reefs are found along almost the entire length of the coast. Coral building is discussed. A short distance from Finschhafen a soil profile is recorded down to a depth of 6 m. (C.F.)

05-d-41 STANLEY, E. R., 1923h — Coral reefs of New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia*, 2, 1101-4.

The roles of wind, ocean currents, and freshwater rivers are discussed in the distribution and mode of formation of coral reefs around the coastline of the New Guinea mainland and the islands off Papua and New Britain. Reefs are divided into 6 classes — (1) fringing reefs and shelves, (2) barrier reefs, (3) cays and flat low-lying coral islets, (4) atolls, (5) raised coral blocks, and (6) detached groups of islands. (W.M.)

05-d-42 VERSTAPPEN, H. Th., 1964a — Geomorphology of the Star Mountains. Scientific Results of Netherlands New Guinea Expedition 1959. *Nova Guinea*, 11(5), 101-58.

'Labyrinth karst' in the limestone of the Star Mts of Dutch New Guinea is investigated in the Sikil valley and is known to extend eastward into Australian New Guinea. Prior erosion surfaces were recognized in glaciated areas on the limestone and granodiorite along the range, where the influence of lithologies on landforms is considerable. The main glaciation was probably Würm. (W.M.)

05-d-43 VERSTAPPEN, H. Th., 1964b — Karst morphology of the Star Mountains (Central New Guinea), and its relation to lithology and climate. *Z. Geomorph.*, 8, 40-9 .

The influence of climate and lithology on the development of karst topography in limestones was studied during the Netherlands Scientific Expedition 1959 to the Star Mountains. Mogote, morne, and labyrinth karsts are recognized, and the vertical zoning of karst types in the Oligocene New Guinea Limestone Group is related to lithology, altitude, and climate. Above 4000 m, large caves and lapies are characteristic. Between 2000 and 4000 m, mornes are developed in coralline limestone, and mogotes in finer denser foraminiferal limestone. Labyrinth karst is developed at 1000-2000 m. (W.M.)

05-d-44 VIAL, L. G., 1938 — Extract from report of patrol in the interior of the Huon Peninsula, Morobe District. *New Guinea ann. Rep. for 1936-37*, 143-6 (also issued as *Aust. parl. Pap. 84, Sess. 1937-40*, 3, 498-501).

Severe gorge and pinnacle country is developed on limestone south and east of Finisterre Ra. Occasional lakes are developed on plateau terraces, and deep gorges are common on the rivers. The terrain of the Saruwaged and Finisterre Ras is outlined. (W.M.)

05-d-45 WILLIAMS, P. W., 1971 — Illustrating morphometric analysis of karst with examples from New Guinea. *Z. Geomorph.*, 15, 40-61.

The paper reports work-in-progress and illustrates methods being tested. Two areas in New Guinea are used as examples: one at 2895 m on Mt Kaijende and the other at 945 m in the Darai Hills. The geology, climate, and morphology of each site is discussed to provide background against which morphometric results may be judged. Methods adopted in the planimetric analysis of vertical aerial photographs are explained, inadequate height data preventing complementary hypsometric treatment. Results are presented in 9 graphs and 2 rose diagrams for each locality.

Both areas are well organized and show similar basic trends. This organization is summarized by 2 graphs: first, the plot of depression order against percentage frequency of depressions, and second, the log-log plot of mean distance between neighbours of a given order v. percentage frequency of occurrence of depressions of that order.

From the measurements made, idealized depressions of different order may be constructed for the 2 districts. Systematic variations in internal and external symmetries of depressions are shown to occur as the basins grow in order, and it can be seen that should an increase in depression order take place without change in symmetry, then a kind of 'dynamic equilibrium' in basin form could be shown to exist. Neither area shows dynamic equilibrium, but for different reasons. (Auth.)

(e) VOLCANIC

See also entries

02-d-29	05-a-128	05-c-34	05-d-9
05-a-17	05-a-129	05-c-37	07-d-3
05-a-52	05-c-29	05-d-8	

05-e-1 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942m — Rabaul and Gasmata, Preliminary. *Terrain study Allied geogr. Sec.*, 7, 39, 16 and 6 pp.

This was superseded by entries 05-c-37 and 05-d-7.

05-e-2 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1942s — Area study of Gazelle Peninsula and Rabaul. *Terrain study Allied geogr. Sec.*, 22, 53 pp.

This was superseded by Terrain Study 74 (entry 05-c-37).

05-e-3 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943k — Umboi (Rooke) Island. *Spec. Rep. Allied geogr. Sec.*, 26, 24 pp.

Umboi is volcanic and large peaks are in its centre. The extreme south is flat and swampy. The island is almost surrounded by coral reefs, some of which are above low-water mark. (C.F.)

05-e-4 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943q — Karkar Island. *Spec. Rep. Allied geogr. Sec.*, 44.

Karkar is a semi-active volcanic island whose central feature is a large volcanic cone 1200 m high with a double rim at the summit. Within the crater are several secondary craters showing signs of recent volcanic activity. The outer slopes of the central cone are deeply scored by old lava beds and numerous watercourses radiating towards the coast. The coastal flats are mainly composed of porous volcanic loam with gravel and wash beds ensuring excellent drainage. Photographs of the main features, and charts of most of the coastline are included. (C.F.)

05-e-5 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943y — Cape Gloucester. *Terrain Hbk Allied geogr. Sec.*, 7, 35 pp.

The westernmost point of New Britain is made up of the volcanic complex of active Mts Talawe and Langila. The coastal plains are extensive and low-lying, broken by occasional volcanic cones, and pass into marine shoals with abundant small reef patches. Cliffs up to 15 m high are developed on some resistant lava flows and cones. The terrain in the volcanic area reflects the influence of rock types and structures. (W.M.)

05-e-6 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943z — Talasea (New Britain). *Terrain Hbk Allied geogr. Sec.*, 8, 41 pp.

Willaumez Pen. is a narrow tongue of volcanic land 55 km long, its backbone dotted with volcanic peaks. To the west, the southeast shores of Riebeck Bay are low-lying with large swamps backed by high mountains. Offshore the waters are deep, but strewn with coral reefs. West from C. Hoskins is a narrow coastal flat backed by low mountainous country. Evidence of extinct or dormant volcanoes is found from C. Hollman to Mt Krummel at the base of Willaumez Pen. Mt. Bamgo (725 m) was emitting steam in the early 1940s and the rows of basalt ridges around it have patches of hot ground and active fumaroles, steam vents, and boiling mud. Fumaroles, hot springs, and steaming sulphur areas are a feature of Garbuna Ra. on the peninsula. (C.F.)

05-e-7 ALLIED FORCES SOUTHWEST PACIFIC AREA (1941-45). ALLIED GEOGRAPHICAL SECTION, 1943aa — Umboi (Rooke) Island. *Terrain Hbk Allied geogr. Sec.*, 9, 31 pp.

This summarizes entry 05-e-3.

05-e-8 BLAKE, D. H., & BLEEKER, P., 1971 — Volcanoes of the Cape Hoskins area, New Britain, Territory of Papua and New Guinea. *Bull. Volc.*, 34, 385-405.

1 active and 10 extinct Quaternary volcanoes are described from the C. Hoskins area. They are mostly strato volcanoes built up of lava flows, lava domes, pyroclastic flows, lahars, tephra and derived alluvial sediments. The volcanic products range from basalt to rhyolite, but basaltic andesite and andesite predominate. Much of the area is covered by tephra several metres thick, consisting mainly of rhyolite pumice.

The active volcano Pago is built up of several glacier-like lava flows, the last of which was formed during an eruption in 1914-18. Pago lies within a well preserved caldera forming the central part of a broad low-angle cone (Witori) which consists largely of welded and unwelded pyroclastic flow deposits; C^{14} dates obtained on charcoal indicate that the caldera eruption occurred about 2500 years B.P. Another caldera of similar age lies south of Witori. Of the other 8 volcanoes, 4 are relatively well preserved steep-sided cones formed mainly of lava flows, 1 is a remnant of a low-angle cone with a caldera and 3 are deeply eroded cones which have none of their constructional surfaces preserved. (Auth.)

05-e-9 BLAKE, D. H., & LOFFLER, E., 1970 — Development of volcanic and glacial landforms on Mt Giluwe. *42nd ANZAAS Cong., Port Moresby*, Sec. 21 Abs., 14-5.

Mt Giluwe is a large, dome-shaped extinct volcano built mainly of many thin basaltic lava flows. It rises from 2000 to 4367 m above sea level, and was formerly covered by an ice cap down to about 3500 m. Although densely dissected by a radial drainage system, there are well preserved adventive cones, craters, lava flows, and volcanic debris slopes below 3500 m. Above this the original volcanic landforms have been destroyed by glacial activity, and well preserved lateral moraines, unique groups of recessional moraines, glacial valleys, cirques, rock basins, and *roches moutonnes* are present. During the maximum glaciation, valley glaciers up to 300 m thick protruded from the edge of the ice cap down pre-existing valleys to terminate between 2750 and 3000 m. In the east, fluvioglacial deposits formed fans extending onto the Kaugel plain, which is deeply incised by the present Kaugel R. This incision seems to be entirely post-glacial.

Palagonitic basalt masses overlying and interlayered with normal lava flows in the summit area of the volcano indicate that some volcanic activity took place under ice and that there were probably two main periods of glaciation. The last glaciation, the most extensive, was responsible for the glacial landforms that are preserved. Most of the volcanic landforms are older than this glaciation. The age of the glaciation is uncertain. However, a C^{14} date of 23 000 years$\pm$1100 years B.P. for peat from immediately below the upper level of the Kaugel plain gives a probable maximum age for the youngest fluvioglacial deposits and hence for the final phase of the last glaciation. (Auth.)

05-e-10 BLAKE, D. H., & LOFFLER, E., 1971 — Volcanic and glacial landforms on Mt Giluwe, Territory of Papua and New Guinea. *Bull. geol. Soc. Amer.*, 82, 1605-14.

This is similar to entry 05-e-9.

05-e-11 COLE, J. W., 1968 — Crater lakes. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF GEOMORPHOLOGY. Encyclopedia of Earth Sciences Series, 3, 218-22. *N.Y., Reinhold.*

The formation of crater lakes in both active and extinct volcanoes is discussed. The crater lakes of Bagana on Bougainville are cited as an example of lakes formed in the collapse crater of an extinct volcano, and an oblique air-photograph of these lakes is printed. (W.M.)

05-e-12 INGELBY, I., 1966 — Mount Lamington 15 years later. *Aust. Terr.*, 6(6), 28-34.

The geomorphology and eruptive history of Mt Lamington before and during the 1951 eruption is compared with the present summit area and surrounding dust- and ash-mantled foothills and plans. It appears that the most significant geomorphic changes were effected in the summit area, and that little change is evident due to ash deposition. (W.M.)

05-e-13 MASSEY, C. H., 1923 — Notes on the physiography of Eastern New Guinea and surrounding island groups. *Proc. Roy. Soc. Qld,* 35, 85-108.

The marked parallelism of trend directions of the New Guinea mainland and the New Ireland-Solomon Island chain, and the cross-cutting trend of New Britain are noted. These trends are related to mountain chains on the mainland and the New Ireland-Solomon Is chain in the first instance, and to the mountain ranges of the Huon Pen.-New Britain alignment in the second.

The history of the development of the Rabaul volcanic system is outlined, assuming the original crater is represented by Simpsonhaven (Rabaul wharf area). The present condition of volcanic and seismic activity in the Rabaul area is outlined, and its tectonic significance assessed. (W.M.)

05-e-14 OLLIER, C. D., 1969 — VOLCANOES. *Canberra, ANU Press,* xiv + 177 pp.

Volcanoes are considered as landforms, both as constructive units and as centres of subsequent erosive modification. Examples of eruption types, landforms, drainage systems, and volcanic effects are drawn from around the world. New Guinea examples are a photograph of the *nuée* eruption of Manam I. volcano on 17 March 1960, mention of the agglomerates of the Sogeri plateau near Port Moresby as an example of pyroclastic flow deposit, a photograph of the early stages of development of radial drainage on Vulcan cone at Rabaul, the citing of Ruxton's work on rates of weathering of ashes around Mt Lamington (entries 07-d-7 and 07-d-5) and of work on erosion rates of Vulcan cone at Rabaul (entry 07-d-3) and Hydrographers Ra. (entry 07-d-4). (W.M.)

05-e-15 Poch, R., 1908b — Reisen an der Nordküste von Kaiser-Wilhelms-Land. (Journey to the north coast of German New Guinea, in German.) *Globus,* 93, 139-43; 149-55; 169-73.

This includes a brief description of Manam, a steep conical volcanic island with cliffed coastlines and a blanket of dense vegetation. A fringing reef partly encircles the island. (W.M.)

05-e-16 Romilly, H. H., 1887 — The islands of the New Britain group. *Proc. Roy. geogr. Soc.,* 9 (n.s.), 1-18.

The principal geologic features considered are the form and volcanic origin of Blanche Bay, the abundance of earth tremors around Blanche Bay and Matupi, the eruptive growth of a volcanic island (Vulcan) in 1878 and associated wide distribution of pumice, the fumarolic activity of Matupi crater, and the abundance of shoal reefs off the north coast of New Britain and in St Georges Channel. (W.M.)

05-e-17 Sapper, K., 1914 — Über Abtragungsvorgange in den Regenfeucht den Tropen und ihre morphologischen Wirkungen (Concerning erosion processes in the wet tropics and their effects on landforms, in German). *Geogr. Z.* 20, 5-16, 81-92.

Landforms on recent, active, and deformed volcanics are quoted from Bougainville and mainland New Guinea. (C.F.)

05-e-18 Schlagenhaufen, O., 1908a — Ein Besuch auf den Tanga-Inseln, von der Deutchen Marine — Expedition 1907-09 (A visit to the Tanga Islands by the German Marine Expedition 1907-09, in German). *Globus,* 94, 165-69.

Enir, Tanga, and Lihir Is lie off the east coast of New Ireland. The Tanga Group contains 4 larger islands and several islets. All are steepsided with cliffed shores. (W.M.)

05-e-19 Speight, J. G., 1967b — Geomorphology of Bougainville and Buka Islands. *In* Scott, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua New Guinea). *CSIRO, Land Res. Ser.* 20, 78-97.

The mountains forming the main watershed of Bougainville are the Emperor Ra. in the northwest and the Crown Prince Ra. in the southeast, each with a number of peaks 1200 to 1500 m high. Active and dormant volcanoes in clusters down the axis of the island include numerous peaks over 1500 m high, culminating in the 2600 m Mt Balbi.

The principal geomorphic processes that have combined to produce landforms on the islands include: tectonism, which has had the most notable effect by warping of Recent limestone reef terraces, and tilting older strata; volcanism, which throughout the history of the island has produced lava flows, ash falls and ash flows, and mud flows or lahars; weathering and solution due to high rates of weathering, subdued by rapid rate of removal of products; slope processes such as rock fall, debris avalanche, earth flow, soil creep, slope wash, and gullying; fluvial processes; and littoral processes.

Landscapes produced include: volcanic landscapes and volcano-alluvial fans; erosional landscapes such as erosional mountains and hills and basin floors; alluvial and swamp landscapes; coastal landscapes; and limestone landscapes. (W.M.)

(f) Glacial

See also entries

02-c-11	02-d-17	04-g-28	05-e-9
02-d-5	03-e-26	05-a-72	05-e-10

05-f-1 Bik, M. J., 1964 — Glaciation on Mt Giluwe and Mt Hagen, New Guinea. *37th ANZAAS Cong., Canberra,* Sec. C Abs., (listed by title in *Aust. J. Sci.,* 26, 205).

This paper is known by title only. (W.M.)

05-f-2 LOFFLER, E., 1970a — Evidence of Pleistocene glaciation in eastern Papua. *Aust. geogr. Stud.* 8, 16-26.

On Mts Victoria and Albert Edward alpine valley glaciation geomorphic features are recognized above 3500 m. Both peaks are composed of mica schist. The summit area of Mt Victoria is an elongate narrow ridge, on which 2 cirques and glacial valleys, a median moraine, and 2 recessional moraines are recognized on the Mambare R. (eastern) fall, and some cirques on the summit ridge. Both flanks of the summit ridge are smoothed by glacial erosion to below present tree-line. Mt Albert Edward summit plateau area shows evidence of glaciation in its many cirques, terminal and recessional moraines, glacial valleys, over-deepened rock basins, and glacially-smoothed surfaces. The snowline of extensive glaciation can be reconstructed at about 3600 m. Present periglacial activity is restricted to areas above 3700 m, and the lower limit of Pleistocene periglacial solifluction may have been about 3000 m. (W.M.)

05-f-3 LOFFLER, E., 1970b — Pleistocene glaciation of Papua and New Guinea. *42nd ANZAAS Cong., Port Moresby,* Sec. 21 Abs., 14.

Traces of Pleistocene glaciation are more widespread than previously thought. New evidence of glaciation is described from Mts Victoria, Scratchley, Albert Edward, Kumbivera, the Kubor Ra., and the Finisterre Ra. Nearly all glacial features are well preserved and probably originated during the last glacial period. Evidence of earlier glaciations is still patchy, but there is good evidence of 2 glaciations on Mt Giluwe, where palagonitic breccia is overlain by normal lava flows, and sediments that may be from an older glaciation have been found on Mt Kumbivera and the Saruwaged Ra.

The depression of the snowline during the last glaciation was about 1000-1100 m, which corresponds to a probable lowering of temperature by 5-6° in the mountainous areas of Papua New Guinea, with a similar temperature gradient to that at present. The only other tropical areas with similarly low Pleistocene snowlines are the northernmost parts of the Andes. Snowlines in New Guinea and the northern Andes are at present also at the same height and are the lowest for tropical mountains. This conformity indicates that the Pleistocene climate in both areas was similar to the present, except for the lower temperatures. (Auth.)

05-f-4 LOFFLER, E., 1971 — The Pleistocene glaciation of the Saruwaged Range, Territory of New Guinea. *Aust. Geogr.,* 11, 463-72.

The summit areas consist mostly of Miocene limestone unconformably overlying volcanics. Fault-bounded plateau areas are present, but karst is poorly developed on them. Features developed by a single plateau glacier are found on the Bangeta Plateau in the eastern part of the range; the west appears not to have been glaciated. Several lobes extended northeast and east from the sheet glacier, and to the south it terminated in ice avalanches. On the smaller and lower Uruwa Plateau small cirque and valley glaciers were developed. Landforms indicative of glacier extent and type include glacial valleys, cirques, smoothed rock surfaces, and moraines. During maximum glaciation, the snowline on Bangeta Plateau was 3650 to 3700 m; evidence on Uruwa Plateau is inconclusive but suggests a similar altitude for snowline. (W.M.)

05-f-5 PETERSON, J. A., 1970 — Aspects of the morphology and distribution of glacial landforms of the Mt Wilhelm area, Eastern Highlands. *42nd ANZAAS Cong., Port Moresby,* Sec. 21 Abs., 16-7.

Mt Wilhelm (4510 m) is the highest part of the Bismarck Ra., the summit ridges and slopes of which are part of the granitic batholith intruded into late Palaeozoic and/or early Mesozoic sediments in Upper Triassic or Lower Jurassic time. Pleistocene glacial modification of the upper valley tracts has taken place above the 3050 m level of the range, the main physiographic features of which were formed by horst and graben faulting. Faulting has continued since the Pliocene orogeny and both these tectonic factors have contributed to the uplift which is responsible for the elevation of the Bismarck Ra.

The size of the moraines, depth of rock basins, and apparent general modification of the pre-glacial topography as evidenced by well marked valley-in-valley forms, suggest that high accumulation and ablation rates prevailed in an environment of high glacial energy characteristically found in present maritime glaciers. As such, the Pleistocene glaciers of Mt Wilhelm can be compared with modern samples of equatorial glaciers in the Ruwenzori Ra. rather than those in environments like that of Mt Kilimanjaro where glaciers are thin. (Auth.)

05-f-6 REINER, E., 1960 — The glaciation of Mt Wilhelm, Australian New Guinea. *Geogr. Rev.*, 50, 491-503.

Mt Wilhelm rises to over 4500 m. The summit area lies above 2700 m, at which elevation slopes steepen and the zone of alpine vegetation begins. Pre-Permian gabbro, Miocene marine sediments, and later intrusives are exposed, reflecting the results of Pliocene orogenic disruption. Glacial moraines, cirques and rock basins, incipient cirques, and periglacial features are described and illustrated. They are interpreted as indicating that the Mt Wilhelm summit area underwent post-Pliocene alpine-type glaciation, with the ends of glacial lobes reaching down to 3000 m. Glacial ice thickness reached 65-70 m with valley-head cirque glaciers persisting after retreat of the main glacier. Cirque floors lie at 3000-3500 m on the southern fall, but are of restricted development at higher altitudes on the northern fall. (W.M.)

06 QUATERNARY GEOLOGY

(a) Tectonics

06-a-1 Blake, D. H., & Ollier, C. D., 1970a — Geomorphological evidence of Quaternary tectonics in southwestern Papua. *Rev. Geomorph. Dyn.*, 19, 28-32.

In the broad low-lying platform area of southwest Papua evidence of Quaternary structures is given by present summit levels of low ridges and plateaux and by river courses. Summit levels represent the surface of an upper Pleistocene piedmont alluvial plain which sloped consistently southwards from the central ranges to the coast. Regional undulations of this surface indicate gentle warping along 2 synclinal and 2 anticlinal axes. The most northerly is a synclinal axis along which flows the lower course of the Fly R. (Auth.)

06-a-2 Blake, D. H., & Ollier, C. D., 1970b — Quaternary tectonics in southwestern Papua. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

Southwest Papua is a broad platform area less than 100 m high extending over 350 km from the mountains to the coast. Topographically it consists, from south to north, of a coastal plain, the flat to slightly undulating Oriomo Plateau, the flood plains of the Fly, Strickland and Alice Rs, and the Fly-Digoel Shelf, which is an intricately dissected low plateau made up of many closely spaced narrow ridges and valleys. The whole area is underlain by unconsolidated Pleistocene to Recent clay, silt, sand, and gravel.

Erosion by the Morehead R. kept pace with uplift along the southern anticlinal axis, producing an antecedent drainage gorge at Morehead Patrol Post. The different degrees of dissection north and south of the Fly syncline may be caused by differences in tectonic history, complicated by climate variation. (Auth.)

06-a-3 Chappell, J., 1970a — Neotectonics of northern Huon Peninsula, N.G. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

Uplifted coral reef complexes, forming an extensive flight of terraces northwest of Finschhafen, are the basis of an analysis of neotectonics of northeast Huon Pen. There are 15 major terraces and over 40 minor ones, and the altitude of each varies greatly along 70 km of coastal strip. The pattern of deformation during the last 350 000 years is determined from the terrace sequence, which is well dated by U^{234}/Th^{230} and C^{14}. These results are the main basis of a computer simulation of a model of possible crustal stress configurations for the north Huon-Vitiaz Str. region. (Auth.)

06-a-4 Christiansen, S., 1963 — Morphology of some coral cliffs, Bismarck Archipelago; indicators of the eustatic 1.5 metres (5 ft) level. *Geogr. Tidsskr.*, 62, 1-23.

Morphological elements of some double-notched coral cliffs on New Ireland are described and origin of zonation is discussed. Upper notches of the cliffs indicate an emergence of about 1.5 m. Widespread occurrence of the 1 m level in coastlines of the Pacific and Indian Oceans, often interpreted as an indication of eustatic origin, allows no conclusive explanation. Other modes of origin are discussed. (Auth./W.M.)

06-a-5 Christiansen, S., 1964 — The lagoons of Nuguria and its neighbour atolls, a field reconnaissance. *Geogr. Tidsskr.*, 63, 237-8.

The lagoon of Nuguria, an atoll east of the Bismarck Arch., was investigated in an attempt to find phenomena comparable to terraces previously seen in the archipelago. Specific levels were found to occur in echograms from Nuguria and its neighbour atolls Kilinailau Tauu, and Nukumanu. (Auth./W.M.)

06-a-6 Fairbridge, R. W., 1950b — Recent and Pleistocene coral reefs of Australia. *J. Geol.*, 58, 33-401.

Contemporary and Pleistocene coral reefs of the Australian shelf region illustrate reef development in a relatively stable epicontinental environment. All reef forms and 5 varieties of coral island are found. Vertical distribution of corals is controlled mainly by light, a function of turbidity, and areal distribution mainly by temperature. The shape of coral reefs is generally controlled by wind, wave, and current, although complex forms due to old geomorphologic or structural controls later modified by wind, etc., are also common. Normally, a small reef patch in a region of a single dominant wind and current will grow into a horseshoe form, then to an atoll, and will eventually fill up to become a large platform. Coral islands are due either to accumulation of sand or shingle, in which case they tend to have an oval or streamlined shape, or to a Recent eustatic drop in sea level, leading to emerged coral limestones that tend to be eroded into irregular scalloped patterns. 'Negroheads' may be formed by such erosion and by jetsam-like accretion on the reef margin. (Auth.)

06-a-7 Fairbridge, R. W., 1969 — Quaternary tectonics disclosed by New Guinea Barrier Reef Complex (Abstract only). *Geol. Soc. Amer., 65th ann. Mtg,* Abs., 7, 62.

An almost continuous barrier reef extends from the Huon Gulf and around the Trobriand Is and Louisiade Arch. to the Gulf of Papua, a linear extent of 1210 nautical miles (2240 km) and is comparable to but more varied than that of Queensland. It includes extensive emerged reefs, 'drowned' sectors, shelf atolls, faros, and insular barrier reefs within the overall complex.

The Darwin subsidence theory, with the Daly eustatic modulation, is demonstrated. Most reefs facing north are asymmetrically tilted up to the north, down to south and southeast, recalling Brouwer's theory of rolling anticlines in the Indonesian arcs. Except in the D'Entrecasteaux Is (currently seismic and volcanic) the area has been relatively stable during the last 100 000 years or so. The tilting was approximately middle Pleistocene. High islands all disclose deep weathering profiles with inherited dissection reflecting semi-arid glacial climates and streams graded to a lower eustatic sea level. Limestone islands show karst features also descending below sea level. (Auth.)

06-a-8 Fairbridge, R. W., 1970 — Eustacy and tectonics in the Trobriands and Louisiade Islands. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Three main types of island include: (a) Holocene sand clays (with beach rock and cemented coral breccia, of doubtful eustatic significance); (b) late Tertiary-early Quaternary reef limestone islands (tectonically uplifted and frequently tilted) often disclose double or triple under-cut notch, believed to be mid-Holocene; (c) middle Tertiary continental islands of folded, geosynclinal, igneous, and metasedimentary rocks (locally veneered, as on Misima, by emerged and tilted reef limestones).

The tilting of the various island blocks may be approximately mid-Quaternary, well after the emergence and erosional stripping of the orogenic belt. Their geomorphology and pedology show a mature stage that has been modified by the mid-Quaternary reef building and tilting, and further by inter-glacial and Holocene reef-building. Valleys are mostly graded to glacial low sea levels and suggest amplified erosion energy related to reduction in vegetational cover during the cooler low sea level stages. (Auth.)

06-a-9 Gill, E. D., 1967 — Significance of Aitape (New Guinea) radio-carbon dates for eustasy and tectonics. *Aust. J. Sci.,* 30, 142.

Age determination from 4 samples from the Aitape skull locality (entry 04-h-5) are listed and their relative values discussed. Determined ages range from 4400±85 years B.P. from mollusc shells to 5070±140 years B.P. from carbonized wood. An age of 4555 years from coconut shell remains seems the most reliable result. The site was probably intertidal mangrove swamp, in which abundant shells neutralized natural acids and reduced the rate and extent of destruction of the cranial fragments. In the light of the Aitape ages, the mean rate of uplift of the north New Guinea coast may have been up to 12 mm per annum. (W.M.)

06-a-10 HOHNEN, P. D., & PIETERS, P. E., 1970 — The Dayman Dome: a structure in metamorphic rocks caused by Pliocene to Recent uplift. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

The Dayman Dome is that part of the Dayman-Suckling mountain block east of the Mahu R. It is a hemi-ellipsoid, block-faulted to the west. The faulting and subsequent erosion have largely obliterated the ellipsoidal shape in this area. Elsewhere the surface of the dome is generally only superficially dissected. The metamorphic (S_1) foliation in low-grade greenchist facies basic rocks generally is parallel to the smooth, curviplanar surface of the dome.

Other domes with similar west-northwest-trending long axes have been recognized in basalts south of C. Frere in eastern Papua, and in volcaniclastic and biogenic sedimentary rocks on the Huon Pen. Domes with other orientations have been recognized in high-grade metamorphic rocks on Goodenough and Fergusson Is, and in low-grade metamorphic rocks on eastern Normanby. The dome structures are thought to result from rapid Pliocene to Recent uplift. (Auth.)

06-a-11 JENNINGS, J. N., 1966 — Territory of Papua and New Guinea. (*In* GILL, E. D. — Australasian research in Quaternary shorelines. *Aust. J. Sci.,* 28, 407-8).

Mention is made of earlier work in the Aitape district (entries 04-h-5 and 17-b-8), and current work in the New Guinea islands (entries 06-a-4 and 06-a-5). (W.M.)

06-a-12 MANSER, W., 1971 — New Guinea. *In* ANZAAS QUATERNARY SHORELINES COMMITTEE: Latest research on the Quaternary shorelines of Australia. *Search,* 2, 58-9.

Recent investigations of Quaternary geology in Papua New Guinea are summarized. Epeirogenic uplift has been recognized in Louisiade Arch., New Ireland, eastern Papua, and Huon Pen., and broad undulose folding of probable epeirogenic origin in southwest Papua is reported. (W.M.)

06-e-13 NEWMAN, W. S., 1968 — Coastal stability. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF GEOMORPHOLOGY. Encyclopedia of Earth Sciences Series, 4, 150-6. *N.Y., Reinhold.*

The north coast of New Guinea is recognized as a rising coast, and most of the south coast and Louisiade Arch. as a subsiding coast. The exception on the south coast is west of the Digoel R. which is rising. These changes of coast position are attributed to eustatic response to endogenic crustal and sub-crustal processes. (W.M.)

06-a-14 PANZER, W., 1933 — Junge Kustenbebung im Bismarck-Archipel und auf Neu-Guinea (Recent uplift of the coastlines of the Bismarck Archipelago and New Guinea, in German). *Erg. Ges. Erdk.,* 5-6, 175-90.

Evidence of recent uplift in several stages can be recognized on the coastlines of the Gazelle Pen. north and west of Rabaul, the Duke of York Is, and on the west coast of New Ireland. Notched limestone cliffs and terraced coastal alluvial plains are cited as examples of 2.3, 3, 4.5, and 7 metre prior sea levels. (W.M.)

06-a-15 RUXTON, B. P., 1969c — Geomorphology of the Kerema-Vailala area. *In* RUXTON, B. P., et al., — Lands of the Kerema-Vailala area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 23, 65-76.

The Kerema-Vailala area is divided into 3 major elements — the Delta Embayment, Lakekamu Embayment, and Kukukuku Lobe (entry 05-a-67). They reflect structural modification due to earth movement initiated during the Miocene. The development of the present drainage pattern is traced from early Pliocene superimposition on the Kukukuku Lobe through Plio-Pleistocene diversion and modification due to tectonic activity. Subdued relief in upland areas is interpreted as indicating slow tectonic uplift and deformation since mid-Pliocene.

The up-doming of the Kukukuku Lobe and complementary subsidence of adjacent embayments in the Plio-Pleistocene have led to denudation of decreasing severity outwards from the centre of the lobe and rapid aggradation in the embayments. This is reflected in land systems and their distribution, with systems dominated by erosional processes and features concentrated on the emergent lobe, and systems dominated by depositional processes and features in the embayments and along the present coast. (W.M.)

06-a-16 SMITH, I. E., 1970b — Evidence of late Cainozoic uplift in southeastern Papua. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Southeast Papua has been an area of active tectonism since mid-Tertiary and there is evidence for associated vertical movements continuing into very recent geological time. The main evidence is the presence of uplifted coral reefs, erosion surfaces, and late Cainozoic sediments.

Raised coral reefs occur in many coastal areas throughout southeast Papua. The amount of uplift is variable and reaches a maximum of 430 m in the Louisiade Arch. In the Milne Bay area small plateaux of low relief in an otherwise mountainous topography have been interpreted as uplifted remnants of an extensive Plio-Pleistocene erosion surface. Parts of this surface now stand at elevations of over 1200 m. A gently sloping surface of low relief surrounding the central mountain on Sudest I. is possibly a raised wave-cut platform, indicating an uplift of about 120 m. Pliocene and younger sediments in southeast Papua have been raised as much as 900 m since the end of the Tertiary. (Auth.)

06-a-17 TESTER, A. C., 1950 — Marine terraces of the Pacific Ocean area. *18th Int. geol. Cong., Lond.,* 8, 72.

Terraces or benches at uniform levels can be correlated in an area of over 50 million km^2. This report is based on studies of terraces and benches from New Zealand to Japan and from Hawaii to the Philippines and includes observations from New Caledonia, New Hebrides, Solomon group, Marianas group, and Japan. The evidence for marine formation of benches is described and illustrated with photographs of the various physiographic features. Comparison of bench elevations in New Caledonia, Marianas group, and Hawaiian group shows that at least 8 levels can be correlated: 1.5-2 m, 7.5-8.5 m, 20-21 m, 27-30 m, 75-76 m, 99-100 m, 114-115 m, and 172-177 m, above present mean sea level. They are characteristically prominent in most Pacific islands of appropriate elevation.

The cause of uniform elevations of benches in such widely separated areas is considered. The evidence indicates that most, if not all, benches were formed by successive movements which lowered sea level without intervals of resubmergence and that each new level was accomplished in a short time. The only plausible explanation of the development of eustatic benches known at this time is found in a hypothesis of oceanic basin subsidence. (Auth.)

(b) VOLCANISM

06-b-1 RUXTON, B. P., 1970a — Reconstruction of events from ash-fall layers in northeastern Papua. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

The eastern Managalase Plateau in northeast Papua is a complex volcanic field of mainly basalt and rhyodacite with minor dacite. Volcanic forms include ash cones, lava cones, flow domes, lava flows, explosion craters, and scoria mounds. Stratigraphy and radiocarbon dating of associated Recent ash layers reveal that eruptions of rhyodacite magma occurred 9150, 6460, and about 500 years ago. The activity 500 years ago was compound. It began with rhyodacite ash followed by basalt ash and the building of a line of basalt cinder cones. These were succeeded by a basalt mud and boulder bed derived from the formation of some of the explosion craters. The final episode was the deposition of dacite ash, probably from a local source. (Auth.)

06-b-2 RUXTON, B. P., & MCDOUGALL, I., 1967 — Denudation rates in northeast Papua from potassium-argon dating of lavas. *Am. J. Sci.*, 265, 545-61.

The Hydrographers andesitic strato-volcano is in a late planeze-early residual mountain stage of dissection, and the original surface on the eastern flanks can be reconstructed by drawing generalized contours. The amount of ground lowering of concentric sectors, distant from the centre, has been measured as the difference of the present cross-sectional areas of the sectors from the original cross-sectional areas.

Potassium-argon dates of fresh massive lavas from near the original surface range from 650 000 to 700 000 years. Assuming an age of 650 000 years for the beginning of dissection of the volcano, denudation rates range from 8 cm per 1000 years at a relief of 60 m to 75 cm per 1000 years at a relief of 760 m. These rates are similar to those estimated by conventional methods in West Irian, Indonesia, the Philippines, Guatemala, and northeast Queensland in comparable hot-moist climates and hilly and mountainous terrain. (Auth.)

06-b-3 SMITH, I. E., 1970a — Eastern Papua — late Cainozoic volcanism. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Terrestrial volcanism has played an important role in the late Cainozoic geological development of eastern Papua. Volcanic rocks can be divided into a high-K calcalkaline suite along the north coast, and a shoshonitic suite south of the calcalkaline suite. Rocks of both suites have been erupted within the past 30 years.

Eastern Papua is an oceanic area of recent tectonism, although it lacks the trench and Benioff zone characteristic of a typical island arc. The distribution of K_2O in the volcanic rocks of eastern Papua compares with that observed in circum-Pacific island arcs but K_2O contents are significantly higher. Eastern Papua may be an island arc type of volcanic environment in a final stage of development. The alternative is that some current hypotheses on the relationship of the Benioff zone to magma generation may need revision. (Auth.)

(c) STRATIGRAPHY AND PALAEONTOLOGY

06-c-1 FLENLEY, J. R., 1967 — The vegetation at Lake Inim, New Guinea. *39th ANZAAS Cong., Melbourne,* Sec. C Abs., 02.

Lake Inim lies at the lower end of a swamp-filled valley at 2500 m in the western highlands of New Guinea. The upper end of the valley contains a mud volcano. Pollen diagrams (the first from New Guinea) have been prepared and cover at least the last 8000 years. (Auth.)

06-c-2 FUNNELL, B., 1970 — Oceanic micropalaeontology of the South Pacific. *In* WOOSTER, W. S. (Ed.) — SCIENTIFIC EXPLORATION OF THE SOUTH PACIFIC, 133-51. *Washington, Nat. Acad. Sci.*

Knowledge of the micropalaeontology of the South Pacific, from the equator southward to the position of the Antarctic Convergence, is reviewed. Consideration is restricted to oceanic occurrences, although pelagic microfossils are also found in marine sequences on islands and other landmasses in the South Pacific. Quaternary stratigraphic zones are recognized in cores from various sites, and an attempt is made to correlate zonations on the basis of different faunal elements. Zones could not be recognized in 3 m of sediment obtained at 0°55′S, 140°30′E. (Auth./W.M.)

(d) SEDIMENTATION AND PALAEOGEOGRAPHY

06-d-1 HAANTJENS, H. A., MABBUTT, J. A., & PULLEN, R., 1965 — Anthropogenic grasslands in the Sepik Plains, New Guinea. *Pacif. Viewpt,* 6, 215-9.

The northern fall of the valley of the Sepik R. downstream from Ambunti has been subdivided into coastal range, southern foothills, middle Sepik grassland plain, and flood plain (entry 06-d-6). Extensive grasslands in the middle Sepik grassland plain, here termed Upper Sepik Plains, are thought to be anthropogenic.

The Upper Sepik Plains are composed of Pleistocene and Recent alluvial deposits laid down by south-flowing tributaries of the Sepik R. in cut-and-fill phases activated by uplift of the coastal ranges relative to the subsiding Sepik trough. The depositional history may have been complicated by Pleistocene sea-level flunctuations. Soil and sediment horizons, together with land surfaces and terraces in the upper plains indicate several spasms of alternation of active and quiescent conditions. (W.M.)

06-d-2 HOSSFELD, P. S., 1951 — Calcareous tufa deposits in northern New Guinea. *Trans. Roy. Soc. S. Aust.*, 74, 108-14.

The present widespread occurrence and formation of calcareous tufa deposits in many torrential streams of the coastal ranges of northern New Guinea are described, as are features produced by these deposits. The severe dissection by those streams which at present are building up their channels was accomplished during a time when the climate exhibited a marked differentiation into wet and dry seasons. The advent of more evenly distributed precipitation resulted in the formation of numerous springs which, because of their small catchment areas, are made permanent only by the almost daily rainfall. The climatic change may coincide with the end, or recession from its maximum, of the Würm glaciation. (Auth.)

06-d-3 LOFFLER, E., 1970c — Aerial photography. Bewani Mountains, New Guinea. *Die Erde,* 101, 165-70.

The geomorphic history and processes of a densely forested mountainous area on the Bewani Mts southwest of Vanimo are deduced from photo-studies and ground checks. Three zones are recognized — a smooth flat Pual Plain in the north, separated from a zone of high mountain ridges by an irregular heterogeneous foothill zone. The Pual Plain is an incised alluvial fan deposit of stratified cross-bedded sands and silts. In the foothill zone, irregularities are related to lithology and structure, as dipping siltstone, conglomerate, sandstone, and limestone crop out and are partly covered by a dissected old fan. The mountain zone is developed on 'basement' intrusive plutonics. Rapid erosion by swift-flowing streams, active fault movement, solution weathering of limestone, continuing uplift, and frequent landslides have contributed to the development of the present landforms. (W.M.)

06-d-4 MACGREGOR, W., 1890l — Despatch respecting visit of inspection to island of Kiwai at mouth of Fly River. *Brit. N. Guinea ann. Rep. for 1889-90,* App. E, 36-43.

Kiwai I. about 50 km long by 4 km wide, is elongate northwest-southwest, and at no point is more than 2 m above high-water mark. The southeast two-thirds of the island are being encroached by the sea to an extent that suggests the land is slowly subsiding. The northwest one-third is less than 1 m above sea level and does not show evidence of sinking. (W.M.)

06-d-5 QUINN, W. H., 1971 — Late Quaternary meteorological and oceanographic developments in the equatorial Pacific. *Nature,* 229(5283), 330-1.

Climatic conditions in tropical regions during the most recent Quaternary glaciation were such that abundant bird life accumulated the guano-type phosphates on the Purdy Is near the Admiralty Group, and on several other tropical islands. A dry tropical climate is inferred, both on the evidence of presence of these deposits and on their form. These conditions developed during periods of extended glaciation, when shallow sea areas in the New Guinea region emerged as land masses. (W.M.)

06-d-6 REINER, E., & ROBBINS, R. G., 1961 — the middle Sepik plains, New Guinea: A physiographic study. *Geogr. Rev.*, 54, 20-44.

The middle reaches of the Sepik Valley began as a shallow marine bight extending inland south of the coast range for about 150 km. It was progressively silted up by fans shed from the mountains and by the deposition of marine and alluvial silts. In the present plains, an upper dry grassland plain in the north developed on the alluvial fans, and the lower swampy plains of the Sepik flood plain on the marine silts. The line of junction of the two units is markedly irregular and fretted. The two surfaces in the Sepik Valley plains are discussed and the geological evolution of the valley since the upper Miocene is outlined. (W.M.)

06-d-7 SPRIGG, R. C., 1947 — Submarine canyons of the New Guinea and South Australian coasts. *Trans. Roy. Soc. S. Aust.*, 71, 296-310.

Submarine canyons opposite the mouth of the Waria, Eia, and Gira Rs east of Morobe, and 3 canyons south of Kangaroo I., South Australia, are recorded. The New Guinea canyons are cut into volcanic mud or shoal coral reef, on a continental shelf 15 km wide which descends from 100-125 m at its outer edge. Distribution of coralline reefs on the continental edge and the canyons is interpreted as indicating that at the time of canyon formation late in the Pleistocene, sea level had fallen 75-100 m. (W.M.)

06-d-8 STUIVER, M., 1969 — Yale natural radiocarbon measurements. *Radiocarbon,* 11, 545-658.

Charcoal samples from the floor of Kiowa rock shelter near Chuave, in the Chimbu District of New Guinea, range in age from 4840±140 years to 10 350±140 years. (W.M.)

06-d-9 VEEH, H. H., & CHAPPELL, J., 1970 — Astronomical theory of climate change: support from New Guinea. *Science,* 167 (3919), 862-5.

Radiocarbon and thorium-230 dates of uplifted coral reef terraces in New Guinea appear to support theories of glaciation which utilize Milankovitch cycles as a controlling trigger mechanism. In addition to high sea-level stands recognized by other workers, the New Guinea data clearly indicate a marine transgression between 50 000 and 35 000 years B.P. A eustatic sea-level curve reconstructed from field observations and isotopic dates shows a close correlation with temperature fluctuations in high latitudes as predicted by astronomical data. (Auth./W.M.)

07 SEDIMENT AND SOILS

(a) Areal and General

See also entries

02-a-8	05-a-47	05-b-45	05-d-40
02-a-10			

07-a-1 ANONYMOUS, 1887b — Explorations in New Guinea. *Scott. geogr. Mag.*, 3, 542.

The soils on the Owen Stanley Ra. at the head of the Musa Valley are of stiff reddish or yellowish clay, overlying broken flinty rocks. (W.M.)

07-a-2 BLEEKER, P., 1969 — Soils of the Kerema-Vailala area. (*In* RUXTON, B. P., et al. — Lands of the Kerema-Vailala area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 23, 77-94).

The soils in the Kerema-Vailala area are characteristically formed on materials that have not been subjected to intense weathering. In hills and mountains, weathering products are rapidly removed by erosion, preventing the formation of mature soils; in valleys and plains the rate of deposition is more rapid than the rate of soil formation, and young soils dominate. The effects of mature weathering are found only on stable land surfaces such as dissected terraces and low undulating hills. Seven orders of soils have been recognized — entisols, inceptisols, histosols, mollisols, alfisols, ultisols, and oxisols. (W.M.)

07-a-3 BLEEKER, P., 1971 — Soils of the Morehead-Kiunga area. *In* PAIJMANS, K., et al. — Land resources of the Morehead-Kiunga area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 29, 69-87.

Soils in the Morehead-Kiunga area are developed on Pleistocene to Recent detrital sediments and range from well developed texture-contrast soils to undeveloped alluvial soils. Most differences in soils are attributed to climate and age, as there is little relief and little variation in parent material. Systematic descriptions, chemical data, notes on chemical soil fertility and comments on soil-type distribution are included. Each of the 4 geographic divisions (entry 05-a-60) has a characteristic suite of soils: young and very poorly drained marine and alluvial soils on the coastal plains; young swampy fluviatile soils in flood plains of major rivers; texture-contrast soils on Pleistocene sediments on the Oriomo Plateau under monsoonal climate influence; uniform texture subsoils on Pleistocene sediments of the Fly-Digoel Shelf plateau where climate is less monsoonal. (W.M.)

07-a-4 BRYCE, G., 1925 — Plantation soils. *New Guinea ann. Rep. for 1923-24*, 37-40 (also issued as *Aust. parl. Pap. 22, Sess. 1925*, 2, 2181-4.

Coral soils are usually fertile in the beach strip, passing landward into swampy poorly-drained soil in depressions. They vary from a reddish heavy type of some depth on elevated areas to sandy and shelly types in depressions. Small amounts of decomposing vegetable debris are present. Thin veneers of infertile black soils develop on some coral surfaces.

Volcanic soils are developed in thin horizons on tuff, pumice, and volcanic sand. Depth of profile showing decomposition of volcanics to soil is nowhere very great. Where admixed with coral soils they are very fertile. (W.M.)

07-a-5 HAANTJENS, H. A., 1964b — Soils of the Buna-Kokoda area. *In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of the Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 10, 69-88.

Soils in the Buna-Kokoda area are placed into 7 major soil groups of convenience that suit local conditions, and 1 group of miscellaneous land types. The relationship between soils and the geology and topography of site are noted in terms of distribution within landform systems and units in the area (entry 05-a-92). Descriptions of soils in each group and family outline pedogenic and textural features, and include chemical data. (W.M.)

07-a-6 HAANTJENS, H. A., 1964e — Soils of the Wanigela-Cape Vogel area. *In* HAANTJENS, H. A. (Ed.) — (b). General report on the lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 12, 55-68.

Soil profiles in the Tufi-Cape Vogel area are classified into 11 morphogenetic groups. Descriptions of major soil groups are confined to the characteristics that are typical of soils of the group. The relationship of each family to parent rock, landforms, and vegetation is outlined, and the principal distinguishing features of each family discussed. Analytical data on some soils are tabulated in an appendix (entry 07-b-1). (W.M.)

07-a-7 HAANTJENS, H. A., 1965a — Morphology and origin of patterned ground in a humid tropical lowland area, New Guinea. *Aust. J. Soil Res.*, 3, 111-29.

2 types of patterned ground occur on rolling to undulating plains consisting of weathered Pleistocene deposits under a warm climate with an annual rainfall between 1650 and 2000 mm and low seasonality. Pitted soils occur on gentle slopes and are characterized by sharply defined holes or unconnected trenches developed in coarser-textured upper-soil horizons, above slowly permeable, finer-textured subsoils. Sorted stripes are found locally on moderate slopes and consist of a network of gravel strips aligned at about 25° to the maximum slope and separating low earthen rises. There are strong indications that this microrelief is produced by large earthworms. Worms are also considered to build up the earthen rises of the sorted stripes, but in this case are likely to act upon a pre-existing pattern of gravel distribution and differentiation in gleying caused by denudation, and minor deformation due to differential swelling and shrinking, loading, and reotropic disturbance. It is suggested that the microrelief caused by worms is not older than 400-800 years. (Auth.)

07-a-8 HAANTJENS, H. A., 1967 — Pedology of the Safia-Pongani area. *In* RUXTON, B. P., et al. — Lands of the Safia-Pongani area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 17, 98-141.

In the Safia-Pongani area dominant soils are unweathered to moderately weathered; deeply weathered soils occur only on dissected prior terraces and land surfaces. They are described in tabular form, with accompanying diagrams relating soil family properties such as depth, drainage, texture and consistence, topsoil characteristics, pH, and chemical properties. Pedological aspects of soil formation, distribution, and classification in the light of field and laboratory data on material from the Safia-Pongani area are discussed. (W.M.)

07-a-9 HAANTJENS, H. A., 1968 — Pedology of the Wewak-Lower Sepik area. *In* HAANTJENS, H. A. (Ed.) — Lands of the Wewak-lower Sepik area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 22, 72-108.

The soils of the north Sepik plains downstream from Chambri Lake, and north to the New Guinea coast, are grouped into 16 major soil groups. Descriptions of the 55 soil families are given, and demonstrate a much greater textural differentiation and less response to lithology than has been recorded from soils in other areas of New Guinea. The development of soil sequences is outlined, and the relation between major soil groups and land systems analysed. (W.M.)

07-a-10 HAANTJENS, H. A. (Ed.) — Lands of the Goroka-Mount Hagen area. *In* HAANTJENS, H. A. (Ed.) — Lands of the Goroka-Mount Hagen area, Territory of Papua-New Guinea. *CSIRO, Land Res. Ser.* 27, 80-103.

14 major soil groups and 1 group of miscellaneous land types have been recognized. 13 of the major groups have been subdivided into 37 soil families. Associations of major soil groups are shown on a map at scale 1 : 500 000. The major soil groups are described and the constituent soil families described with each major group. Humic brown clay soils are largest in extent and are found throughout the area in well drained positions on relatively stable slopes between 900 and 2700 m, particularly on volcanic ash plains and on some alluvial fans. Because of widespread slope instability various kinds of colluvial soils (regosolic soils) are common, particularly on hills and mountains. Organic soils occur in depressions in the ash plains in the wetter western part of the area and are common on the very wet high mountain summits where they occur as alpine peat and humus soils, locally associated with rock outcrop. (Auth.)

07-a-11 HAANTJENS, H. A., 1970c — Soils. *In* WARD, R. G., & LEE, D. A. M. (Eds) — AN ATLAS OF PAPUA AND NEW GUINEA. *Port Moresby & Glasgow, Univ. Papua New Guinea* and *Collins-Longman,* 40-1.

3 regions of soil associations are recognized. In the High Mountains, 5 soil association groups are recognized as relating to altitude, parent rock type, climate, and landform on which they developed. In the Low Mountains and Hills, 6 groups are recognized, each containing a variety of soil types reflecting the wide range of parent materials and soil-forming conditions. In the Plains, 6 groups of residual and accumulation soils are recognized. For each soil group, a summary of soil types and formation site is given. (W.M.)

07-a-12 HAANTJENS, H. A., 1970d — New Guinea soils: their formation, nature and distribution. *Search,* 1, 233-8.

New Guinea soils most closely resemble soils developed in wet tropical and temperate climates, and differ from soils developed in dry tropical climates. The relative influences of rate and extent of rock weathering, composition of parent rock, and efficiency of subsoil and subsurface drainage are discussed with regard to soil development.

The range of soil types and groups present in Papua New Guinea are listed, and comment made on the relatively large range in view of the limited area and latitudinal extent of the island. Some dominant characteristics of New Guinea soils are noted. The distribution of soils is discussed in terms of physiographic environment, which is thought to be the most important factor in influencing the development and distribution of soil types. (W.M.)

07-a-13 HAANTJENS, H. A., REYNDERS, J. J., MOUTHAAN, W. L. P. J., & van BAREN, F. A., 1967 — MAJOR SOIL GROUPS OF NEW GUINEA AND THEIR DISTRIBUTION. (Communication No. 55 of the Department of Agricultural Research, Amsterdam). *Zaltbommel, K. drukkerij v.d. Garde N.V.,* 87 pp.

The area covered includes West Irian and Papua New Guinea. The physiographic, geological, climatic, and cultural environment is outlined, and the distribution of 3 soil associations discussed. These are the associations of the High Mountains, the Low Mountains and Hills, and the Plains and Valleys. Their distribution is discussed in relation to their environment and major soil groups present. A classification of major soil groups, and their relationship to the Great Soil Groups, are outlined and tabled. Descriptions include granulometric analyses and data on chemical properties, including pH, cation exchange properties, C.E.C. and base saturation. 3 maps — a soil map of New Guinea, a climatological map and a sample location map — are included. (W.M.)

07-a-14 KLAMMER, G., 1966 — Die Land Search Series der Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Canberra, Australien. *Z. Geomorph.*, 10, 341-4.

The method and philosophy of the CSIRO Land Search studies in Australia and New Guinea are outlined. (W.M.)

07-a-15 LEE, K. E., 1967 — Microrelief features in a humid tropical lowland area, New Guinea, and their relation to earthworm activity. *Aust. J. Soil Res.*, 5, 263-74.

Haantjens reported patterns of microrelief on lowland soils bordering the Sepik river floodplain in New Guinea and has attributed their formation primarily to excavation and heaping of casts by *Pheretima tumulifaciens* Lee, a large earthworm associated with the microrelief features (entry 07-a-7). Evidence is presented to show that the microrelief is probably not due to earthworm activity, but to a combination of wind and water erosion, acting on a landscape partly bared by man-made fires. The physical and chemical composition of the casts and soil are discussed and evidence is presented to show that the ridges and mounds observed are composed of material from the upper and not from the underlying soil horizons. (Auth.)

07-a-16 MABBUTT, J. A., & SCOTT, R. M., 1966 — Periodicity and morphogenesis of soil formation in a savannah landscape near Port Moresby, Papua. *Z. Geomorph.*, 10, 69-89.

In 2 small areas in the coastal hill zone east of Port Moresby, studies were made of the form and evolutionary history of inselberg hillslopes and the footslope margins of the plains. Profiles and sections down to weathered rock are presented and the profiles from hillslopes, footslopes, and drainage plains compared. Genetic relationships of layers in each profile are outlined, and the surface history of each site is reconstructed on the assumption that the original G layer was uniformly thick in all sites. Phases of climatic change from more humid than the present climate, through long periods of climatic conditions similar to those prevailing today, and to more arid conditions have been recognized. (W.M.)

07-a-17 MACGREGOR, W., 1899c — Despatch reporting visit of inspection to the lower part of the Brown River. *Brit. N. Guinea ann. Rep. for 1897-98*, App. D, 42.

The soils on the plains in lower reaches of the Laloki and Brown Rs are stony and gravelly sands, passing locally into swamps. (W.M.)

07-a-18 RUTHERFORD, G. K., & HAANTJENS, H. A., 1965 — Soils of the Wabag-Tari area. *In* PERRY, R. A., et al. — General report of the lands of the Wabag-Tari area, Territory of Papua and New Guinea, 1960-61. *CSIRO, Land Res. Ser.* 15, 85-99.

Soils apart from skeletal soils have been grouped into 8 morphogenetic groups in terms of local conditions of parent material and weathering. The distribution of major soil groups and families is outlined. The general environmental conditions and profile characteristics of each major soil group are discussed, and the distinguishing features of each family noted. The dominant soil-forming factor appears to be the very wet climate with moderate temperatures. Deep and severely leached acid soils are developed on soft base-rich parent rocks, even on steep slopes. The soils have high organic content, uniform clayey textures, high cation exchange capacity but small amounts of exchangeable bases, and a strong predominance of 1 : 1 clay minerals. Gleyed and peaty soils are common in poorly drained areas. (W.M.)

07-a-19 SCOTT, R. M., 1965 — Soils of the Port Moresby-Kairuku area. *In*

MABBUTT, J. A., et al. — Lands of the Port Moresby-Kairuku area, Papua New Guinea. *CSIRO, Land Res. Ser.* 14, 129-45.

Soils developed in the coastal lowlands on the east coast of the Gulf of Papua show considerable variation in pedogenesis. They are described in 13 groups based on profile form and drainage, each group reflecting effects of environment and genesis. In moderate to high-rainfall areas, pedalfer weathering prevails, and the consistence and base-exchange capacity of the soils suggest that they are dominated by 1 : 1 clay minerals. In the lower-rainfall areas, the soils show a greater affinity with the underlying rock and tend to exhibit pedocal weathering. Their consistence and cation exchange capacity suggest that they are dominated by 2 : 1 clay minerals. This range in rainfall is reflected in the percentage saturation of cations of the soils, those in the higher-rainfall areas being excessively leached in contrast to those of the lower-rainfall areas, which are moderately to fully saturated.

Along the coast and in estuaries the soils are greatly influenced by wind and by wave and tidal action, which generally give rise to sandy and saline soils. Alluvial soils show a textural relationship to their source. Those derived from volcanic and sedimentary rocks are fine-textured, while those derived from metamorphic rocks, which mainly occur outside the area, show a textural range from sand to clay according to the landform. (Auth./W.M.)

07-a-20 SCOTT, R. M., 1967 — Soils of Bougainville and Buka Islands. *In* SCOTT, R. M., et al. — (a). Lands of Bougainville and Buka Islands, Papua-New Guinea. *CSIRO, Land Res. Ser.* 20, 105-20.

Parent materials for soils on Bougainville and Buka are of two kinds — those of volcanic origin which vary in texture but not composition, and coral limestone material. Resultant soils are a product of the time the climate has had to affect these materials. In many areas soils are mantled by varying thicknesses of Recent andesitic volcanic ash in varying early stages of modification. 11 soil groups are recognized on the basis of profile morphology and parent material. The relationship of soil types to parent material and landform unit is tabulated, and a soil engineering properties classification is included. (W.M.)

07-a-21 SMITH, T. LANGFORD, 1951c — Soils — Chapter V, *in* THE RESOURCES OF THE TERRITORY OF PAPUA AND NEW GUINEA (prep. by Div. Regional Devel., Dep. Nat. Mapping, Canberra). *Melbourne, Govt Printer,* 61-4.

Little is known of the areal distribution of soils in Papua New Guinea, though some small-area studies have been made. Because of the rugged topography, a relatively small area of the soil in Papua New Guinea is available for utilization, and the available soils are adversely affected by leaching, erosion, and loss of fertility on clearing. Notes are made on several soil types, including skeletal soils, soils of the central mountains and southern foothills, of the limestone mountains and coastal plains, swamp soils, alluvial soils of the river valleys, and volcanic soils. (W.M.)

07-a-22 WIJK, C. L. van, 1959 — Reconnaissance soil survey, east coast New Ireland. *Papua-New Guinea agric. J.*, 11, 95-100.

The main central range of New Ireland is the Lelet Plateau, a limestone mass up to 1200 m thick and characterized by precipitous western (dip-scarp) limits and karst topography. The island is almost completely fringed with uplifted coral platforms, with areas of calcareous tuff and volcanics on the west coast and northern lowland peninsula. Soils are developed and dominated by the limestone parent material, with some modification by admixture of volcanic detritus. The principal soil types are described and soil distribution on the range and east coast is mapped. (W.M.)

07-a-23 WIJK, C. L. van, 1963 — The soils of Bougainville Island — their distribution and main characteristics in relation to agricultural development. *Papua-New Guinea agric. J.*, 15, 123-32.

This soil survey is limited to areas of potential agricultural development, so does not cover most of the central ranges. Soils developed in areas studied show close correlation to parent material, often with a mantle or admixture of recent volcanic ash.

Profiles and agricultural potential of soils in each environment are discussed, and a soil distribution map is presented. (W.M.)

(b) Pedology and Mineralogy (including Analyses)

See also entry 11-b-1.

07-b-1 Anonymous, 1964 — Analytical data of soil samples. Appendix 1, *in* Haantjens, H. A. (Ed.) — (b). General report on the lands of the Wanigela-Cape Vogel area, Territory of Papua and New Guinea. *CSIRO, Land Res. Ser.* 12, 96-7.

For some soil samples, mechanical size analyses, percentage organic matter and nitrogen, C/N ratio, percentage P-HCl, pH, and exchangeable action properties are listed. (W.M.)

07-b-2 Baseden, S. C., & Southern, P. J., 1959 — Evidence of potassium deficiency in coconut palms on coral-derived soils in New Ireland from analysis of nut waters, husks, fronds and soils. *Papua-New Guinea agric. J.,* 11, 101-15.

The main soil types on the east coast are red-brown clay loams and brown-yellow clays derived from uplifted coral limestones. Some coral sands and alluvial soils occur in small areas. The alluvial soils include magnetite and appear to be partly of volcanic origin. Soils on the coast are shallow red-brown loam of irregular depth, frequently with parent limestone exposed. Farther inland the influence of parent limestone decreases, the soils are thicker and more acid orange to yellow clay loams. Analyses of several soils are included. (W.M.)

07-b-3 Bleeker, P., & Austin, M. P., 1970 — Relationships between trace element contents and other soil variables in some Papua-New Guinea soils as shown by regression analysis. *Aust. J. Soil Res.*, 8, 133-43.

Multiple linear regression has been used to examine the relationships between total trace element content and a number of other soil variables in horizons of 6 texture-contrast soils developed on Pleistocene marine mudstone, and greywacke, siltstone at Safia in eastern Papua. Trace elements can be divided into 3 groups on the basis of both regression analyses and profile distribution: copper, zinc, and nickel; cobalt and manganese; and chromium. With the copper concentration in the soil as the dependent variable a regression equation having an index of determination (R^2) of 0.89 was obtained containing as major independent variables copper concentration in the parent material and percentage clay of the soil horizon. Zinc and nickel showed a similar relationship to percentage clay as copper but the major variability of these elements remains unexplained. Manganese and cobalt were found to be mainly related to the presence of a fluctuating water table occuring in 3 of the 6 profiles (R^2=0.59), while chromium was principally related to the percentages of the 50-75, 150-210, and 420-1200 sand fractions (R^2=0.84). (Auth./W.M.)

07-b-4 Dwyer, R. E. P., 1939 — Some investigations on coconut diseases associated with soil conditions in New Guinea. *New Guinea agric. Gaz.*, 5(3), 31-53.

Thin friable soil layers are developed on limestone near Namatanai in New Ireland. An upper humic layer overlies a thin clay loam which passes into a heavy clay subsoil on bedrock. These soils are thought to be residual in origin, derived largely in situ from uplifted coral. In some areas in-washed topsoil is admixed. These are figured, and their role in plant growth discussed. An analytical report on these profile samples and Gazelle Pen. samples is included (entry 07-b-14). The problem of relation of diseases in coconuts to soil types is discussed. (W.M.)

07-b-5 GRAHAM, G. K., & BASEDEN, S. C., 1956 — Investigation of soils of the Warangoi Valley. *Papua-New Guinea agric. J.*, 10, 73-94.

A soil survey in the Warangoi valley on the Gazelle Pen. showed that the principal soil series is an immature sandy loam developed from Recent andesitic volcanic pumiceous ash overlying a buried profile developed from andesitic tuffs which overlie unconsolidated conglomerates. Analysis of several profiles indicates that these soils have a high nutrient status. The levels of available phosphorus, potassium, calcium, magnesium, total nitrogen, and organic matter are substantially greater than those found in most soils, including other volcanic ash soils. The high nutrient status depends largely on the high organic matter content which has developed under forest conditions on a base-rich parent material. Analysis of many soils from other parts of the Gazelle Pen. reveals similar characteristics. (Auth./W.M.)

07-b-6 GREENLAND, D. J., WADA, K., & HAMBLIN, A., 1969 — Imogolite in a volcanic ash soil from New Guinea. *Aust. J. Sci.*, 32, 56-7.

In predominantly allophane-rich soils derived from volcanic ash in the Buna-Kokoda area, the fibrous material imogolite has been recognized. Results of D.T.A. and diffractometer studies of this material are presented, and it is suggested that the material is not well crystallized. (W.M.)

07-b-7 GUILCHER, A., 1966 — Coarse river deposits in some humid tropical islands of Polynesia and Melanesia (Tahiti, Guadalcanal, New Britain and New Guinea). *Proc. 11th Pacif. Sci. Cong., Tokyo,* 10(6), VI, 18.

In some regions pebbles are absent or infrequent in the river beds of the humid tropics, but the opposite is found in several places in Polynesia and Melanesia, where the rainfall usually ranges from 2 to 5 m. At Tahiti, basaltic pebbles and sands are abundantly carried to the sea and reworked by waves on exposed beaches. At Guadalcanal fresh unweathered volcanic pebbles are common in the rivers. In the Gazelle Pen. the same features occur in the Warangoi R., with more weathering in the terraces. The Markham rift valley includes a very recent thick filling of pebbles and sands; higher up in the mountains, fine Pleistocene terraces are found in Arona, Aiyura, Kainantu, Goroka, and Wahgi basins, sometimes with weathering zonations from top to bottom; present-time pebbles are as fresh as in the other islands. The environment resulting in such coarse deposits includes: high mountains whose altitude is sometimes preserved by uplift which is still going on; heavy rainfall, not necessarily typhoons; and prevailing sedimentary or volcanic rocks, although granites, which are more readily weathered, may be present. (Auth.)

07-b-8 HAANTJENS, H. A., 1969 — Fire and wind erosion, or earthworms, as the cause of microrelief in the Lower Sepik Plains, New Guinea. *Aust. J. Sci.*, 32, 52-4.

Micro-relief of pitting and channelling is developed in meadow-podsolic soils under grassland or forest in the lower Sepik R. Field evidence is interpreted in terms of two possible modes of formation of this micro-relief; burrowing by the large earthworm *Pheretima tumulifaciens* Lee, or volume changes due to complete removal on burning of grass root systems. It is argued that the wind-fire mechanism is not applicable in the settings recognized in this example from the Sepik. (W.M.)

07-b-9 HAANTJENS, H. A., & RUTHERFORD, G. K., 1964 — Soil zonality and parent rock in a very wet tropical mountain region. *Trans. 8th Int. Cong. Soil Sci., Bucharest,* 5, 493-500.

In the wet environment of the highlands of Papua New Guinea morphologically similar zonal soils have developed in well drained positions on such different parent rocks as volcanic ash, siltstone, and limestone. The soils are yellow-brown to strong brown clay soils with little structure but marked porosity and lack of plasticity. They have very dark organic A_1 horizons. Minor morphological differences and marked differences in chemical properties and clay mineralogy suggest that the effect of climate on soil formation is intensified on volcanic ash and minimized on limestone. Soils on siltstone occupy an intermediate position and represent the true zonal soils. There are indications that advanced weathering of ash soils promotes the formation of kaolin, but soil formation on sedimentary rocks upward of 2700 m produces gibbsite. (Auth.)

07-b-10 HARTLEY, A. C., ALAND, F. P., & SEARLE, P. G. E., 1967 — Soil survey of New Britain — the Balima-Tiaru area. *Papua-New Guinea. Dep. Agric. Stock Fish., Soil Surv. Rep.*, 1, 1-170.

The soil types and land-use potential of the western slopes and foothills of Mt Galloseulo in east New Britain are surveyed. Many soil units are mapped, and data on each are tabulated, including physical description and codified expressions of components and use potential. Detailed descriptions of several representative profiles record physical properties of horizons, field colour and cohesion, site of development, and constituents. Chemical data measured include moisture percent, pH, conductivity, salt content, cation exchange potenial for Ca, Mg, K, and Na, total exchange capacity, base saturation, loss on ignition, carbon content, nitrogen content, and carbon/nitrogen ratio. (W.M.)

07-b-11 HOSKING, J. S., 1938a — Some recent volcanic deposits and volcanic soils from the islands of New Britain in the Territory of New Guinea. *Trans. Roy. Soc. S. Aust.*, 62, 366-77.

A suite of volcanic sediments resulting from the recent eruptions at Rabaul, and a series of soils developed upon similar parent materials from Talasea, Kokopo, and Rabaul has been examined. All samples fall within a characteristic grouping with respect to the mechanical composition of the mineral fraction, with soils derived from andesitic and basaltic sources containing marginally more clays in the essentially sandy soils than soils derived from pumiceous and rhyolitic sources.

While the recent deposits may contain up to 5% soluble salts, the soils, despite their possible proximity to continuous solfataric or fumarole activity, are particularly free of salt. This is probably due to intense leaching effects under heavy rainfall conditions. The rocks and soils vary from slightly acid to neutral in reaction, and the soils are notable for their natural fertility. (Auth./W.M.)

07-b-12 HOSKING, J. S., 1938b — Report on soil samples forwarded by the Director of Agriculture, Rabaul, New Guinea, to Division of Soils, CSIRO. *New Guinea agric. Gaz.*, 4(1), 21-4.

24 samples from 5 profiles to a depth of 1.8 m in the Talesea District of New Britain consist of immature soils developed on very young volcanic ash. At least 3 distinct phases of eruption of andesitic glass and pumice are recognized. Abundance of pumice increases with depth to 30% at 1.2 m, and then decreases. The top 60 cm of soil consists of 30 cm of dark brown to grey-yellow-brown sandy loam to clay loam rich in organic matter, overlying a light brown to yellow-brown sandy loam to clay loam. Below 60 cm the soil consists of andesitic to dacitic pumiceous sandy deposits. Surface samples are slightly more acid (pH=6.2) than deep soils (7.3).

Two podsolized soil profiles from the upper Ramu Valley were collected from the valley floor and hill slopes. They consist of a surface black to grey-black sandy loam rich in organic matter, overlying a grey to yellow-brown mottled sandy clay or light clay subsoil. Ferruginous gravels occur in both samples. The surface pH is 5.0-5.5 in each soil, and 6.0-6.3 in the subsoil. (W.M.)

07-b-13 HOSKING, J. S., 1939a — Report on soil samples from Aiyura Agricultural Station, Upper Ramu, New Guinea. *New Guinea agric. Gaz.*, 5(1), 74-5.

18 soil samples from 3 profiles were collected from alluvial flats and undeveloped

bush country. They are podsolized acid soils, pH at surface 5.2-6.3, rising to 6-7 at a depth of 30 cm, and falling off slightly with depth. They consist of a thin layer of litter and a surface soil layer of dark brown to grey loam rich in organic matter, overlying grey-brown to light yellow-brown mottled sandy clay or light clay subsoil in which the yellow shade increases with depth. (W.M.)

07-b-14 HOSKING, J. S., 1939b — Report on soil samples from New Guinea — New Ireland District. *In* DWYER, R. E. P. — Some investigations on coconut diseases associated with soil conditions in New Guinea. *New Guinea agric. Gaz.*, 5(3), 41-2.

2 profiles developed on limestones near Namatanai in New Ireland are red-brown heavy clays in which surface layers are darkened with organic matter. Clay content of surface layers is 62 and 79%, rising to 90% in the subsoil. In one shallow profile on a raised area, a thin regolith layer is preserved with 70% parent limestone fragments. The coarse sand, fine sand, silt ratio for all samples is 1 : 3 : 6, and some eluviation of the surface layer is inferred. The soils are acid near the surface (pH=6.7), increasing in acidity to pH=5.1 in depth; the limestone regolith is distinctly alkaline (pH=8.3). (W.M.)

07-b-15 HOSKING, J. S., 1939c — Report on soil samples from New Guinea — New Britain District. *In* DWYER, R. E. P. — Some investigations on coconut diseases associated with soil conditions in New Guinea. *New Guinea agric. Gaz.*, 5(3), 50-51.

7 samples from 2 profiles near Kokopo on the Gazelle Pen. were collected from immature soils developed on very recent andesitic to dacitic pumiceous volcanic ash. These soils are extremely porous. The upper 30 cm are dark grey-brown to grey-brown clay loam to light clay rich in organic matter, and overlie either a light grey-brown loam to 105 cm, or a light grey loam to 60 cm over a grey to white pumiceous sand. Both profiles contain neutral soils (pH=6.9-7.3). (W.M.)

07-b-16 HOSKING, J. S., 1939d — Report on some dust and mud deposits resulting from the recent volcanic eruptions at Rabaul, island of New Britain, New Guinea. Appendix II, *in* FISHER, N. H. — Geology and vulcanology of Blanche Bay and the surrounding area, New Britain. *New Guinea geol. Bull.*, 1, 52-3.

Sand, mud, and ash samples from Vulcan and Matupi I. contain decreasing amounts of mud fraction in the more water-eroded samples. pH ranges 5.0 to 7.7, but is as high as 7.9 in well washed samples, which also have less soluble salts. The main soluble salts are calcium sulphate of volcanic origin and sodium chloride of seawater origin. (W.M.)

07-b-17 HOSKING, J. S., 1940 — The soil clay mineralogy of some Australian soils developed on granitic and basaltic parent material. *CSIRO J.*, 13, 207-16.

The colloidal fractions separated from the subsoils of a number of Australian soils have been examined by X-ray diffraction technique and their soil clay minerals identified. 2 immature soils developed on pumiceous volcanic ash at Rabaul were included. 1 sample, a light brownish grey soil, contained 11% clay fraction, mostly in the topsoil, with kaolinite being identified as the only species. The other sample, a surface grey soil, contained 21% clay, both montmorillonite and possible kaolinite being identified. All specimens are poorly crystalline, and some crystalline silicate minerals may be present. (Auth./W.M.)

07-b-18 HOSKING, J. S., 1948a — The cation exchange capacity of soils and soil colloids: 1. Variation with hydrogen ion concentration. *CSIRO J.*, 21, 21-37.

An immature volcanic ash soil from Rabaul, containing kaolinite-type clays and only little organic material, was one of a suite of soils on which cation exchange characteristics were tested.

A rapid method for determining the cation exchange capacities of clay minerals, soils, and soil colloids, and their variations with hydrogen ion concentrations, is described; it involves the leaching of samples as small as 0.1 g with ammonium acetate solutions adjusted to pH values from 5 to 10, and the subsequent estimation of the ammonium absorbed. (Auth./W.M.)

07-b-19 HOSKING, J. S., 1948b — Cation exchange capacity of soils and soil colloids: 2. The contribution from the sandy silt clay fractions and organic matter. *CSIRO J.*, 21, 38-50.

One of the samples included in this survey was an immature soil on pumiceous volcanic ash from the Rabaul area. It contained kaolinite-type clays. The cation exchange capacity of the clay fraction at pH 9 ranged from 89.3 m.e.% from the finer (colloid) to 57.7 m.e.% for the coarser clays and for the silt fraction a rate of 32.7 m.e.%. (Auth./W.M.)

07-b-20 LEASK, M. F., 1943 — Geological reconnaissance in the quartzite ranges, New Guinea. *Vic. Nat.*, 59, 208-9.

The soil profile in a pit sunk in a hilltop exposure of Port Moresby Beds cherty sediments near Port Moresby yielded 2 distinct soil types. The topsoil is dull dark grey to black; the subsoil is brown to reddish brown, and contains abundant angular quartzite fragments. At lower levels a crumbly friable clay, greenish to bluish in colour, contains abundant quartzite boulders. (W.M.)

07-b-21 PAIN, C. F., 1970 — Some relationships between soil properties and geomorphology, with an example from Kokoda, Papua. *42nd ANZAAS Cong., Port Moresby,* Sec. 21 Abs., 32.

Although soils in the humid tropics appear to change more rapidly after burial than those in temperate areas, they have been used at Kokoda for correlation of depositional surfaces. A large fan debouching into the Kokoda valley has been incised in stages so that there are 4 major surfaces, named from oldest to youngest, Savaia, Mamba, Komo, and Faiwani. The two oldest surfaces have soils formed from volcanic ash, the Savaia soil differing from the Mamba soil in that the former has a buried soil at about 1 m deep. The Faiwani surface has alluvial soils with limited profile development. Komo soils appear to be formed from a mixture of alluvial and rewashed volcanic ash. Recognition of volcanic ash soils is facilitated by the fact that the S-matrix is isotropic in thin sections, while the S-matrix of the alluvial soils, and of soils formed on in situ Owen Stanley metamorphics is markedly birefringent.

Having established the characteristics of the soils on the 4 fan surfaces it was possible to correlate them with fan and terrace remnants not continuous with the main fan. (Auth./W.M.)

07-b-22 PAIN, C. F., 1971 — Micromorphology of soils developed from volcanic ash and river alluvium in the Kokoda valley, Northern District, Papua. *J. Soil Sci.*, 22, 275-80.

This is similar to 07-b-21.

07-b-23 RUTHERFORD, G. K., 1962 — The yellow-brown soils of the highlands of New Guinea. *Trans. Int. Soc. Soil Sci., New Zealand Mtg,* 434-9.

Yellow and strong brown soils are developed on detrital sediments, argillaceous limestone, and volcanic ash in the western and southern highlands on sites between 880 and 3000 m above sea level in an area of warm humid to cold humid climate without marked seasonality, and where the mean annual rainfall generally exceeds 2500 cm. Soils formed from ash are weakly structured and friable in the subsurface horizons and have firm, subplastic, slightly sticky subsoil horizons which contain appreciable amounts of readily weatherable minerals and which on drying become almost powdery. Soils formed from sedimentary rocks have more plastic and sticky massive subsoil horizons which have a higher bulk density and become hard and remain massive on drying. (W.M.)

07-b-24 RUTHERFORD, G. K., 1964 — The tropical alpine soils of Mt Giluwe, Australian New Guinea. *Canad. Geogr.*, 8, 27-33.

Tropical alpine soils occurring on the glaciated grassland summit area of Mt Giluwe are described morphologically and some analytical data are presented. They are developed from andesitic till and are generally shallow. Except for minor areas around tarns, all the soils have a characteristic unusual morphology which consists of brown organic topsoils overlying black organic subsoils which rest on polished rocks or fluvioglacial sediments. The soils are low in clay and high in fine sand. They are strongly acid, high in organic matter and total phosphorus, and low in base saturation. (Auth.)

07-b-25 RUTHERFORD, G. K., 1968 — Observations on a succession of soils on Mt Giluwe. *Ann. Ass. Amer. Geogr.*, 58, 304-12.

The effects of altitude and a period of summit glaciation on the andesitic ash deposits of Mt Giluwe have resulted in spatial distribution of soils in semi-parallel zones around the mountain. Field and laboratory analyses of typical soils from the 5 major zones were undertaken. Micrographs of thin sections, some electron microscope diffractograms, and the results of some chemical-physical analyses are presented. With increasing altitude the A horizon deepens and the yellowish brown subsurface horizon becomes mottled olive-brown. In some parts of the upper slopes, mottled clay gleysolic soils have been formed on the fluvioglacial deposits and shallow, highly organic mineral soils have developed on the summit moraine. Remnants of the original ash soils are present (Auth.)

07-b-26 WALLACE, K. B., 1970 — Systematic description of soils for road construction in Papua and New Guinea. *42nd ANZAAS Cong., Port Moresby*, Sec. 5 Pap., 6.

In a developing country such as Papua New Guinea it is important that soils and related site conditions for road construction projects be described in a systematic and relevant manner. Description should include information on parent material, drainage, vegetation, and climate. For compatability with terrain classification, details of landforms and topography must also be included.

The relevance of the Unified System of soil classification is satisfactory for coarse-grained tropical soils provided that it is supplemented by description of mineralogy and degree of weathering. The Unified System (which was developed for sedimentary soils in temperate climates) should not be used for classification of the fine-grained residual soils which are widespread in Papua New Guinea. To overcome the limitations of traditional methods of classification, a comprehensive procedure for description of soils for road construction in Papua New Guinea is presented. (Auth./W.M.)

(c) TRANSPORTATION AND ACCUMULATION

See also entries

05-b-12	05-c-9	18-a-4	18-a-6
05-b-19	15-c-58		

07-c-7 ANONYMOUS, 1897f — The Huon Gulf, New Guinea. *Scott. geogr. Mag.*, 13, 495.

This is a brief English summary of entry 07-c-2.

07-c-2 RUDIGER, H., 1897 — Der Huon-Golf in Sudosten von Kaiser-Wilhelms-Land (The Huon Gulf in southeastern Kaiser Wilhelms Land, in German). *Verh. Ges. Erdk.*, 24, 280-95.

Several large rivers feed into the Huon Gulf, bringing large amounts of detritus and building deltaic fans in places. (W.M.)

07-c-3 SILVESTER, R., 1968 — Sediment transport — long-term net movement. *In*

FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF GEOMORPHOLOGY. Encyclopedia of Earth Sciences Series, Vol. 3, 985-9. *N.Y. Reinhold.*

Sediment is moved along shorelines mostly by longshore swell waves, often after having been mobilized by storm waves. The net long-term direction of movement of detritus and the resultant shore features are outlined for several areas. For New Guinea and the islands to the east the net long-term direction of sediment transport is from southeast to the north and northwest under the influence of the southeast trade winds early in the year. (W.M.)

(d) WEATHERING AND EROSION

See also entry 06-b-2.

07-d-1 HAANTJENS, H. A., & BLEEKER, P., 1970 — Tropical weathering in the Territory of Papua and New Guinea. *Aust. J. Soil Res.*, 8, 157-77.

Pure physical weathering is rare in New Guinea, but 3 main types of physico-chemical weathering are recognized. These are skeletal weathering, in which physical changes such as fragmentation, exfoliation, disaggregation, and softening outweigh the associated chemical/mineralogical changes, and immature and mature weathering in which chemical/mineralogical changes predominate. Immature and mature weathering are subdivided, according to the kind of clay minerals formed, into smectite weathering (montmorillonite, illite, vermiculite), kandite weathering (kaolinite, halloysite, allophane), and sesquox weathering (gibbsite, goethite).

In New Guinea mature weathering is uncommon despite the generally favourable climatic and lithological conditions. This is due to youthful unstable landforms, and in the highest areas also to low temperatures. Equilibrium between rapid weathering and erosion maintains skeletal to immature weathering profiles on most slopes, and outcrops of fresh rock are rare. Kandite weathering is by far the most common type, and is often associated with gibbsite sesquox weathering in very wet areas and mainly in immature stages. Only 2 instances of goethite sesquox weathering have been observed, both on ultrabasic rock. Smectite weathering is rare and associated with low rainfall, basic or calcareous rock, and low topographic position. Strong weathering can mostly be related to old land surfaces, and is characterized by parallel zonation from mature weathering down to bedrock. More complex patterns can arise from renewal of weathering after dissection, differential weathering of rocks, burial of weathered profiles, or remain unexplained. (Auth.)

07-d-2 MCMAHON, T. J., 1918 — Papua (British New Guinea) — The wonderland of the great central mountains. *Qld geogr. J.*, 32-3, 81-8.

Macgregor traversed from Yule I. up the Alabule R. to the area of Mt Yule and Kunimaipa. Near Mafulu the red-brown soils are often subject to earth-slips of considerable size. (W.M.)

07-d-3 OLLIER, C. D., & BROWN, M. J. F., 1971 — Erosion of a young volcano in New Guinea. *Z. Geomorph.*, 15, 12-28.

The New Guinea volcano Vulcan was formed in 1937 and originally had smooth slopes. It is now dissected by radial gullies with steep headwalls which are neither simple surface watercourses nor 'discontinuous gullies' but are probably formed by a process of particle extrusion and sapping. The maximum rate of erosion over the whole slope is 19 m per 1000 years. The rates are based on the assumption that erosion has been uniform over the past 31 years, but probably almost all erosion took place in 5 years so the rates could be 6 times higher. The erosion rates on Vulcan are much higher than those described elsewhere, and indicate that caution is needed in extrapolation of erosion rates over long periods of time. (Auth.)

07-d-4 RUXTON, B. P., 1966c — The measurement of denudation rates. *Pap. 5th Conf. Inst. Aust. Geogr.*

Modern isotopic dating techniques, and the large number of isotopic dates now available, provide a basis for new methods of assessing denudation rates. If in dissected landscapes earlier or 'original' forms can be reconstructed and dated, then by measuring the volume of material removed denudation rates can be computed. 3 types of original landscape which have relatively smooth even surfaces and may sometimes be dated are erosion surfaces, newly emergent or upraised surfaces, and volcanic landforms.

The Hydrographers andesitic strato-volcano is an example. It is in a late planeze-early residual mountain stage of dissection and the original surface on the eastern flanks can be reconstructed. Postassium-argon dates of fresh massive lavas from near the original surface range in age from 650 000 to 700 000 years B.P. The calculated denudation rates are directly related to the relief and range from 8 cm/1000 years at a relief of 60 m to 80 cm/1000 years at a relief of 760 m. These rates are similar to those calculated by conventional methods in West Irian, Indonesia, the Philippines, and northeast Queensland, in comparable hot-moist climates and hilly mountainous terrain. (Auth./W.M.)

07-d-5 RUXTON, B. P., 1967d — Rates of weathering of Quaternary volcanic ashes in north-eastern Papua. *39th ANZAAS Cong., Melbourne,* Sec. C. Abs., N5-6.

12 to 16 m of weathered dacite ash mantles the flatter ridge crests 750-1000 m above sea level on the western Managalase plateau. 16 layers are recognized in the ash, and charred wood fragments at 4 levels in the upper 4 layers have been dated, giving ages from 6800 to 20 100 years B.P. All the ash layers are well sorted, and composed mainly of crystals of plagioclase and hornblende and micro-vesicular fragments of microlitic glass partly weathered to allophane gel and minor vermiculite. All but 2 sub-layers of the ash were derived by ash-fall from Mt Lamington 20-28 km northwest, at a fairly uniform accumulation rate of between 12 and 19 cm/1000 years over about the last 90 000 years.

18 samples of the weathered ash were chemically and mineralogically analysed, and by assuming both that alumina has remained constant during weathering and that the original ash had a similar composition to that erupted from Mt Lamington in 1951, the loss of mobile elements, mainly silica, for specific time periods can be computed. The average rate of loss of mobile elements, i.e. the rate of weathering, decreases exponentially with time up to at least 20 000 years. (Auth./W.M.)

07-d-6 RUXTON, B. P., 1968 — Measures of the degree of chemical weathering of rocks. *J. geol.,* 76, 518-27.

In humid regions, silica-to-alumina ratios provide an easy way to quantify the degree of rock weathering. The reliability of this index depends on the uniformity of the bedrock, the constancy of the alumina content during weathering, the degree of correlation between silica loss and total-element loss, and on the magnitude of the difference between the silica-to-alumina mole-ratio values of fresh and thoroughly weathered rock. Examination of total silicate analyses of fresh and derivative weathered rock from 64 non-quartz-bearing volcanic rocks in northeast Papua and 48 igneous and metamorphic rocks (some quartz-bearing) from other humid areas showed good correlation, with a high degree of significance, between the silica loss and the total-element loss, and between the silica-to-alumina mole-ratio and total-element loss. The silica-to-alumina mole-ratio also correlates well with the more complex absolute and relative weathering indices calculated from total-silicate analyses. The simple index should provide a useful guide to the physical, chemical, and engineering properties of weathered rocks. (Auth.)

07-d-7 RUXTON, B. P., 1969d — Rates of weathering of Quaternary volcanic ash in north-east Papua. *Trans. 9th int. Cong. Soil Sci., Adelaide,* 4, 367-76.

Numerous C^{14} dates from layers of weathered dacitic ash mantling ridge crests around Mt Lamington volcano range from 4000 to 20 000 years B.P. Several samples of the weathered ash were mineralogically and chemically analysed and by assuming both that alumina has remained constant during weathering and that the original ash had a similar composition to that erupted from Mt Lamington in 1951 the loss of mobile constituents, principally silica, for specific time periods can be computed. Since the crystals are little etched in ashes less than 20 000 years old the weathering rate can be measured as the rate of leaching loss from the glass.

Plots of logarithmic concentration of glass against time give straight lines of the form $C=C_0e^{-kt}$.

Where C is the concentration of glass at time t

C_0 is the initial concentration of glass at time zero

k is a constant, and

e is the base of natural logarithms.

Derivative calculations suggest that the rate of weathering is limited by rainfall and is not primarily determined by temperature. (Auth.)

07-d-8 WOOLNOUGH, W. G., 1933 — Pseudotectonic structures. *Bull. Amer. Ass. petrol. Geol.,* 17, 1098-1106.

In parts of Australia and New Guinea, what are apparently normally folded rock structures have been encountered in areas where exposures are poor, owing either to profound weathering or to dense jungle. It has been shown that much of this false folding is due not to tectonic forces but to local effects including (1) swelling of argillaceous members, (2) plastic flow of bentonitic beds, and (3) concretionary development on an unprecedented scale. Possibly certain anomalous 'folds' in other regions may be of the same nature.

Some of the folding in the Popo and Hohoro Anticlines in western Papua is attributed to the lubricating and expansion effects of bentonite interbedded with marl and sandstone. The apparent contortion in crestal regions of anticlines is recognized as occasionally being the result of shattering and collapse above a hydrated bentonitic layer. (Auth./W.M.)

08 SEDIMENTARY ROCKS

(a) Areal and General

See also entry 08-d-1.

08-a-1 Hosking, J. S., 1967 — Limestone and lime in the Territory of Papua and New Guinea. *CSIRO, Bldg Res. Div., tech. Pap.* 21, 36 pp.

Papua New Guinea is rich in limestones which are well distributed throughout the mainland and associated islands. The limestones range in age from Permian to the present, in composition from almost pure to highly arenaceous and argillaceous calcium carbonate, in texture from coarsely crystalline to very fine-grained, in compaction from soft coralline (coronus) varieties to hard, dense, massive, and bedded types, and in colour from white to almost black.

Excellent limes can be produced from many limestones. The potentialities of the limes for replacing Portland cement in building construction, in stabilizing earths for road surfaces, in building bricks and blocks, and for industrial purposes, are discussed. The present and future uses of both limestone and lime throughout the Territory are considered. (Auth.)

(b) Petrology (including Rock Analyses)

See also entries

02-b-141	02-c-17	08-a-1	09-b-11

08-b-1 Chappell, B. W., 1968 — Volcanic greywackes from the Upper Devonian Baldwin Formation, Tamworth-Barraba district, New South Wales. *J. geol. Soc. Aust.*, 15, 87-102.

A suite of andesitic greywackes is described, and petrographic and chemical details presented. Included for comparison are analyses of 6 greywackes from areas other than the topic area, including Aure Trough and Purari Valley. Data for the Papuan examples are averaged from published analyses (entries 08-b-2 and 08-b-3). (W.M.)

08-b-2 Edwards, A. B., 1950a — The petrology of the Miocene sediments of the Aure Trough, Papua. *Proc. Roy. Soc. Vic.*, 60, 123-48.

Miocene strata in the Aure Trough consist of about 4500 m of greywacke and mudstone, in about equal proportions, with minor grit, conglomerate, and limestone. The greywackes are ill-sorted rocks that show prominent graded bedding, and occasional slump structures. They consist essentially of angular grains of basic plagioclase, hornblende, and pyroxene, with minor amounts of other minerals and numerous rounded rock fragments in a clay matrix. The rock fragments consist largely of a variety of andesites and schist, mudstone, reef quartz, and other rock types. Most of the mineral grains and rock fragments are fresh, but every thin section reveals some that are weathered. The mineral grains closely resemble those of Tertiary andesitic lavas in adjacent parts of New Guinea, and the andesite fragments can be matched with them. Both greywackes and mudstones closely approximate the average andesite in chemical composition. They appear to be derived from a mountainous terrain by the erosion of widespread andesitic tuffs under climatic conditions similar to those now prevailing. They were deposited in still, moderately deep water (within the neritic zone), free from all but weak current action, and close to a shore line. Deposition was probably accompanied by subsidence of the floor of the receiving area. (Auth.)

08-b-3 EDWARDS, A. B., 1950b — The petrology of the Cretaceous greywackes of the Purari valley, Papua. *Proc. Roy. Soc. Vic.*, 60, 163-71.

The petrography of 6 specimens of greywacke from the Purari Valley is described, chemical analyses and compositional micrometric and grainsize analyses are listed, and comparisons made with greywackes from the Aure Trough. The Purari greywackes contain quartz and alkali feldspar, acid and intermediate plagioclase (An_{20} and An_{45-50}) and mafics of granitic provenance, and fragments of sedimentary, metamorphic, and minor andesitic rocks in an argillaceous chloritic matrix. Glauconite is common. Heavy minerals separated include apatite, zircon, tourmaline, garnet, leucoxene, black iron oxides, rutile, pyroxene, marcasite, and (?) corundum.

It is concluded that these rocks and the interbedded limestone and shale accumulated under shallow marine conditions north of the source area which included exposures of the pre-Permian Kubor granite and metamorphic rocks, with only a small contribution from transported lithic debris from contemporaneous andesitic volcanic activity. (W.M.)

08-b-4 JACK, R. L., 1892 — Report on geological specimens. *Brit. N. Guinea ann. Rep. for 1890-91,* App. Z, 90-1.

A suite of detrital pebbles from the Fly, Wasi Kussa, and Mai Kussa Rs is described, and it is concluded that the drainage area contains outcrops of sandstone, clay, limestone, lignite, slate, metamorphosed greywacke, and some plutonic and volcanic rocks. Several wood and invertebrate fossils are recorded. Unlocated greenstone axe heads are identified as being made from material resembling New Zealand jade. (W.M.)

08-b-5 JACK, R. L., & CLARKE, A. W., 1890 — Report on geological specimens. *Brit. N. Guinea ann. Rep. for 1888-89, (Qld),* App. V, 53-5 (also issued as *Brit. N. Guinea ann. Rep. for 1888-89, (Vic.),* App. F, 52-4).

A suite of located samples from the Louisiade Arch. includes low-grade regional metamorphics and basaltic lavas, limestone and calcareous tufa, lithic-fragment beach sands, reef quartz (some of which is auriferous), acid porphyries and lavas, and obsidian. Stream gravel samples contain dominantly mica schist and decomposed igneous rocks. Petrographic notes are made on a basalt from Goodenough I. and on a pitchstone from Fergusson I. Appended are reports by Rands (entry 02-b-141) and Wilkinson (entry 08-b-18) on samples from mainland New Guinea. (W.M.)

08-b-6 JACK, R. L., & RANDS, W. H., 1894 — Report on geological specimens. *Brit. N. Guinea ann. Rep. for 1893-94,* App. BB, 91-6.

A suite of sediments, volcanics, metamorphics, and auriferous vein quartz specimens from British New Guinea is listed and identifications given. A large number of analyses of coal from western British New Guinea are tabulated. Several volcanics and metamorphics from Mt Victory are listed and identified, as is a suite from the Louisiade, D'Entrecasteaux, and Woodlark Is. (W.M.)

08-b-7 JOPLIN, G. A., 1965 — Chemical analyses of Australian rocks. Part II: Sedimentary rocks. *Bur. Miner. Resour. Aust. Bull.* 78.

A compilation of analyses of sedimentary rocks from Australia and its Territories includes material from several localities in Papua New Guinea (W.M.)

08-b-8 LIVERSIDGE, A., 1877a — On the occurrence of chalk in the New Britain group. *J. Proc. Roy. Soc. N.S.W.*, 11, 85-91.

A foraminiferal limestone from New Ireland (entry 02-d-17) is described. It is richly fossiliferous, and a partial faunal list and chemical analysis are given. Comparisons are made with Cretaceous chalk and Recent marine oozes, and it is concluded that the New Ireland sample probably represents a true Cretaceous chalk. (W.M.)

08-b-9 LIVERSIDGE, A., 1877b — On the occurrence of chalk in the New Britain group. *Geol. Mag.*, 4 (*Decade* 2), 529-34.

This is a re-issue of entry 08-b-8.

08-b-10 LIVERSIDGE, A., 1882 — Rocks from New Britain and New Ireland. *J. Proc. Roy. Soc. N.S.W.*, 16, 47-51.

Specimens from New Ireland and New Britain are described and analyses of some are quoted. New Ireland specimens include porphyry, diorite, limestone, volcanic ash, amygdaloidal lava, river gravels, sandstone, jasper, and epidote rock. New Britain specimens include volcanic agglomerate and pumice, lava, obsidian, and sulphur apparently from the volcanoes at Rabaul, as well as sandstone, limestone, gypsum, and aragonite from unspecified localities. (W.M.)

08-b-11 LIVERSIDGE, A., 1886 — Notes on some rocks and minerals from New Guinea, etc. *J. Proc. Roy. Soc. N.S.W.*, 20, 227-30

Described specimens are of quartz, a variety of sediments including lignite and limestone, basalt, porphyry, and iron ores from the Fly R. about 400 km from the coast, some pebbles of quartz and quartzite from Yule I., basaltic lavas and tuffs from Darnley I., and stream-bed debris from the Baxter R. (W.M.)

08-b-12 LIVERSIDGE, A., 1888a — Preliminary notes on some rocks and minerals from New Guinea. (*In* LIVERSIDGE, A. — THE MINERALS OF NEW SOUTH WALES. *Sydney, Dep. Min.*, 248-52).

This is a re-issue of entry 08-b-11.

08-b-13 LIVERSIDGE, A., 1888b — Rocks from New Britain and New Ireland. (*In* LIVERSIDGE, A. — THE MINERALS OF NEW SOUTH WALES. *Sydney, Dep. Min.*, 253-7).

This is a re-issue of entry 08-b-10.

08-b-14 LIVERSIDGE, A., 1888c — On the occurrence of chalk in the New Britain group. (*In* LIVERSIDGE, A. — THE MINERALS OF NEW SOUTH WALES. *Sydney, Dep. Min.*, 264-70).

This is a re-issue of entry 08-b-8.

08-b-15 MACGREGOR, W., 1892d — Despatch reporting visit of inspection to the Koiari district. *Brit. N. Guinea ann. Rep. for 1890-91,* App. G, 26-7.

The Astrolabe Ra. is conglomerate-capped, and sheds much debris along the precipitous southwest face. The conglomerate is composed of angular pebbles in a granular matrix, yields a rich soil, and where dissected gives precipitous narrow valleys and gullies. (W.M.)

08-b-16 RANDS, W. H., 1892 — Report on geological specimens from New Guinea. *Brit. N. Guinea ann. Rep. for 1890-91,* App. AA, 92.

A suite of located rock samples from around Port Moresby and shells from the Wasi Kussa R. are listed. Petrographic notes are given for the granitic and basaltic samples near Port Moresby, and the limestone and conglomerate are described. (W.M.)

08-b-17 RUXTON, B. P., 1970b — Labile quartz-poor sediments from young mountain ranges in northeast Papua. *J. sediment. Petrol.*, 40, 1262-70.

The young mountain ranges of northeast Papua have sharp crests and steep-sided slopes mantled by shallow weakly weathered soils. Rock debris from slope denudation and stream corrosion is rapidly transported by streams and deposited as alluvial fans and plains and littoral deltas and beaches.

The sediments range from coarse conglomerate in some fans to clay in freshwater and some tidal swamps. The present study has concentrated on the fine sand fractions which have about 4% quartz and 1% opaque minerals. Of the remainder one-half is rock fragments in various stages of weathering, one-quarter is unstable light minerals (mostly plagioclase), and one-quarter is unstable heavy minerals (mostly ferromagnesian minerals). These sediments have a dioritic and gabbroic chemical composition and are classed as plagioclase-rich litharenites. It is concluded that the terrestrial part of the sedimentary cycle is extremely rapid in the active orogenic portions of the humid tropics. Only the beach sands have reached a mature stage but the grains are mostly angular. (Auth.)

08-b-18 WILKINSON, C. S., 1890 — Report on auriferous and other specimens from New Guinea. *Brit. N. Guinea ann. Rep. for 1888-89, (Qld)*, App. V, 57-8 (also issued as *Brit. N. Guinea ann. Rep. for 1888-89, (Vic.)*, App. F, 56-7).

Auriferous stream-bed samples collected around Port Moresby by Goldie and Lawes, by Macleay during the *Chevert* cruise, and by D'Albertis on the Fly R. are noted. Most detrital fragments are of chert, greenschist, and serpentinite, with some lavas and limestone. The probability of rich gold deposits in New Guinea is recognized on the resemblance between the New Guinea samples and material from the goldfields of central New South Wales. (W.M.)

(c) DIAGENESIS

08-c-1 BANNER, F. T., & WOOD, G. V., 1964 — Recrystallization in microfossiliferous limestones. *J. Geol., Liverpool*, 4, 21-34.

The microfauna and microflora of the lower Miocene limestones of the Darai Complex of Papua have been found to recrystallize in a constant order related to the biological affinities of the fossil genera. Recrystallization is independent of the sparry or micritic nature of the interstitial material. Dolomitization also destroys the fossil skeletons in a comparable order except that coralline algae appear to be relatively more resistant to replacement by dolomite.

Only when the skeletons of the most resistant fossil groups have been recrystallized can the occurrence of interstitial sparry calcite be suspected to have originated from recrystallization of an original micritic matrix. Obliteration of fossil remains by recrystallization presents an additional hazard in the interpretation of biofacies in limestones of this type. (Auth.)

08-c-2 CROOK, K. A. W., 1961 — Diagenesis in the Wahgi valley sequence, New Guinea. *Proc. Roy. Soc. Vic.*, 74, 77-81.

The Wahgi Valley sequence consists of Permian and Upper Jurassic to Miocene sediments on a Palaeozoic basement. In the Chim and Wahgi Valleys 7560 m of strata are present below the base of the Miocene, and these were overlain by a probable 3000 m of Miocene sediments. The Cretaceous portions of the sequence contain andesitic tuff and greywacke which have been diagenetically modified as a result of deep burial.

Sediments buried to 4000-8500 m exhibit modifications characteristic of the laumontite facies of diagenesis. Plagioclase is albitized and locally replaced by laumontite, which also replaces radiolaria and organic carbonate and acts as a cement. At depths in excess of 8500 m prehnite is found as a cement, and replaces radiolaria and plagioclase. This represents the prehnite-pumpellyite facies of diagenesis. Throughout the sequence, rock fragments are modified to chlorite and albite, often without destruction of fabric.

Load pressures of 2-2.5 kilobars appear to be necessary for strong development of prehnite-pumpellyite facies under normal conditions of epigenetic diagenesis. (Auth.)

08-c-3 WHITE, W. C., 1964 — The formation of insular phosphate rocks. (*In* WHITE, W. C., & WARIN, O. N. — A survey of the phosphate deposits in the southwest Pacific and Australian waters. *Bur. Miner. Resour. Aust. Bull.* 69, 156-70).

Four broad classes of insular phosphate deposits are recognized: (1) Avian guano deposits, (2) phosphatized sands on cays and atoll islands (phosphatic guano), (3) ferruginous-aluminous deposits on elevated limestone islands, and (4) high-grade phosphate rock deposits on elevated limestone islands.

The origin of each is considered in terms of rock type, climate and its seasonality, chemistry of weathering, and bird colonization. New Guinea examples include the phosphatized sands on islands in the Purdy Group. All 4 classes of deposit are concluded to have developed from avian guano, with difference between deposits of different classes being related to post-depositional modification. (W.M.)

(d) PALAEOENVIRONMENTS

08-d-1 CROOK, K. A. W., 1970 — Geotectonic significance of greywackes: relevance of recent sediments from Niugini. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

The significance of mineralogical and chemical variation in ancient and modern greywackes (i.e., arenites in flysch sequences) is being studied. For thick flysch sequences to accumulate, deep water adjacent to a source area is necessary. Thus greywackes should mark significant discontinuities or disturbances in the Earth's crust. This suggests the possibility that mineralogical and chemical variation in greywackes may reflect the nature of such discontinuities of disturbances.

Ancient greywackes containing about 15% and about 65% quartz in the framework are much rarer than other varieties. These discontinuities divide greywackes into three major groups, Quartz-poor greywackes with 15% quartz, Intermediate-quartz greywackes with 15-65% quartz, and Quartz-rich greywackes with 65% quartz. The inferred geotectonic setting in which ancient quartz-poor greywackes accumulated is that of the Island Arcs. Ancient intermediate greywackes are believed to have accumulated adjoining tectonically active margins of continents or microcontinents. The depositional setting of ancient quartz-rich greywackes has received little attention. However their modern equivalents are represented by the western North Atlantic petrographic province, indicating that they accumulate adjacent to tectonically-inactive continental margins.

From these considerations, palaeogeotectonic configurations in the Niugini region, and their relationship to the presence or absence of Benioff Zone, are reconstructed on the evidence of greywacke types preserved in the record in the Gulf of Papua, the Torricelli Mts, and New Britain. (Auth./W.M.)

08-d-2 HAUPT, O., 1906 — Ein kreideähnlicher wahrscheinlich jungtertiärer Mergel aus Kaiser-Wilhelmsland, Deutsch Neuguinea. (A chalky, probably Upper Tertiary Limestone from Kaiser-Wilhelms Land, in German.) *Z. dtsch. geol. Ges.*, 57, 565.

A chalky marl reported from the Huon Pen. near Finschhafen contains forams, radiolaria, diatoms, and sponge spicules, and is probably Upper Tertiary. The fauna suggests a depth of formation of less than 1000 m. (W.M.)

08-d-3 LUDBROOK, N. H., 1961 — Rock specimens with mollusca from the Musa valley area, Papua. *In* SMITH, J. W., & GREEN, D. H. — The geology of the Musa valley area, Papua. *Bur. Miner. Resour. Aust. Rep.* 52, 40-1.

Greywacke and calcareous mudstone from the Domara River Beds in the Musa R. area contain waterworn fragments of molluscs. Generic determinations are made and the material compared with samples from Australian localities. The host rocks are probably non-marine and of Pleistocene age. (W.M.)

08-d-4 TAN SIN HOK, 1926 — Over de samenstelling en het onstann van krijti en mergelgesteenten van de Molukken (Concerning the origin and composition of chalk and marl of the Moluccas, in Dutch.) *In* BROUWER, H. A. — Geologische enderzoekingen in den oostelijken Oost-Indischen Archipel. (Geological surveys in eastern East Indian Archipelago, in Dutch). *Jaarb. Mijnw. Ned. Indie. Verh.*, 3, 5-165.

Near Finschhafen, a chalk-marl is reported to underlie raised coral chalks (entry 08-d-2). Chalk quality is 47.9-67%, and hence it is thought to be a hemi-abyssal type formed at depths of no more than 1000 m. The presence of radiolaria suggests a late Tertiary age, as no radiolaria are yet known from early Tertiary strata. Possible Recent chalks have been reported from New Britain (entries 04-g-6 and 08-b-8). (W.M.)

(e) Pyroclastic Rocks

See also entries

14-a-43 14-a-57

08-e-1 Blake, D. H., 1970 — Features of Quaternary tephra and welded and unwelded pyroclastic flow deposits of the Cape Hoskins area, New Britain. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Pumiceous tephra several metres thick covers much of the C. Hoskins area. It forms well defined layers of different thicknesses, colours, compositions, and textures, and mantles the pre-existing topography. Unwelded, moderately welded, and densely welded pumiceous pyroclastic flow deposits make up most of one extinct volcano. The unwelded types are mainly loose chaotic deposits up to 30 m thick. The moderately welded types are similar but are coherent, and they show some karst-like erosional features. Both types are well exposed on the volcano flanks. Densely welded types are exposed in a caldera wall; they appear to be less than 10 m thick and are massive, glassy, and felsitic deposits. Both moderately and densely welded types show megascopic eutaxitic textures. (Auth.)

08-e-2 Ruxton, B. P., 1965b — Correlation and stratigraphy of dacitic ash-fall layers in north-east Papua. (Abstract only). *Int. volc. Ass., New Zealand Symposium,* Abs. Vol., 153-4.

This is similar to 08-e-3.

08-e-3 Ruxton, B. P., 1966b — Correlation and stratigraphy of dacitic ash-fall layers in northeastern Papua. *J. geol. Soc. Aust.,* 13, 41-67.

A thick cover of weathered dacitic ash that mantles the flatter ridge crests on hills and mountains for up to 50 km from Mt Lamington thins with distance from it, being about 12 m thick 32 km away. Its mineralogy is similar to that of the oldest lavas exposed in Mt Lamington crater and to the ash and pumice erupted in 1951. The sorting, mineralogy, and accordance of the layers with the present topography indicate an ash-fall origin. Dating of charred wood fragments indicates that the upper ash layers were deposited at average rates of 12 to 20 cm per 1000 years for periods of 4000 to 5500 years 30 km south of the vent. The age of Mt Lamington is estimated at about 90 000 ± 10 000 years, and throughout its life explosive activity producing ash showers has involved disruption of a green hornblende-bearing dacite magma. (Auth.)

09 IGNEOUS ROCKS

(a) Areal and General

09-a-1 Davies, H. L., 1967b — The Papuan ultramafic belt. *In* Ringwood, A. E. (Ed.) — International Council of Scientific Unions Upper Mantle Project — Second Australian Progress Report 1965-67. *Canberra, Aust. Acad. Sci.*, 126-30.

This is similar to entries 02-b-36 and 37; 09-c-4, 5 and 6.

09-a-2 Johnson, R. W., & Davies, R. A., 1971 — Petrology of the Bismarck volcanic arc. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 72.

Known only by title.

09-a-3 Johnson, R. W., Mackenzie, D. E., Smith, I. E., & Taylor, G. A. M., 1971 — Distribution and chemistry of Quaternary volcanoes in Papua and New Guinea. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 455.

There are 4 groups of Quaternary volcanoes of Papua New Guinea: 1. The Solomons Group extending from Bougainville through the islands northeast of New Ireland to the Admiralty Is; 2. The New Britain-New Guinea group which extends from Rabaul, along the north coast of New Britain, west to the Schouten Is near Wewak; 3. An eastern Papua group consisting of centres on the north coast of Papua and on the D'Entrecasteaux Is; 4. The Highlands group, distributed along the southern side of the central Papua-New Guinea cordillera.

Volcanoes of the Solomons and eastern Papuan groups have produced calc-alkaline, high-potash calcalkaline, and some 'shoshonitic' rocks. Products of the Bismarck volcanic arc range from 'island arc' tholeiites to dacites and rhyolites, with some high-potash lavas represented. The highlands volcanoes are composed of high-potash calcalkaline to high-potash basic (shoshonitic') rocks. (Auth.)

09-a-4 Taylor, G. A. M., 1971 — High-alkaline lavas from the New Ireland volcanics. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 73.

This is known by title only.

(b) Mineralogy and Petrography (including Rock Analyses)

See also entries

03-a-7	09-c-3	09-c-15	12-a-17
08-b-16	09-c-6	10-b-1	14-c-1

09-b-1 Alexander, K. M., & Vivian, H. E., 1953 — Pozzolanic activity of ash produced by the eruption of Mt Lamington, New Guinea. *Nature,* 172 (4387), 1002-3.

Andesitic ashes from the January and February 1951 eruptions of Mt Lamington were tested for pozzolanic properties. Results indicate that these and possibly other local ashes could be used, at least locally, to blend with portland cement. (W.M.)

09-b-2 Baker, G., 1949 — Notes on volcanic rocks, with special reference to plagioclase feldspars from Mt Bagana, Bougainville Island, Solomon Islands. *Trans. Amer. geophys. Un.*, 30, 250-62.

Andesitic lava flows, scoria, and pebbles in ejectamenta from Mt Bagana are discussed, and the origin of zoned andesine phenocrysts in hornblende andesites is considered. Lava flows from Bagana are porphyritic hornblende and augite andesites with evidence of deuteric alteration. Scoria is vesicular augite-hornblende andesitic basalt, whereas ejecta pebbles include serpentinite, dolerite, granophyre, and epidote rock. (W.M.)

09-b-3 BAKER, G., 1954 — Volcanic rocks of Aitape, New Guinea. *Proc. Roy. Soc. Qld,* 64, 15-44.

Volcanic rocks at Aitape are lower Miocene andesitic agglomerates with occasional andesitic lavas and limited areas of basalt. The basalts verge on basic andesite; they are partly submarine flows and in places are soda-rich. The Aitape volcanic suite belongs to the earliest period of formation of the Bismarck Arch. Inner Volcano Arc of Neogenic to Quaternary age and is at the northwest end of the arc. The volcanic rocks are members of the extensive andesite-basalt group of lavas and ejectamenta that encircles the Pacific Basin. The basaltic rocks reveal some similarities and certain marked differences compared with Central Pacific (Hawaiian) basalts, but the suite is characteristically allied to the Circum-Pacific volcanic rocks. Both basaltic and andesitic rocks in the Aitape volcanic suite have been subjected in parts to strong deuteric alteration and solfataric action. (Auth./W.M.)

09-b-4 CLARKE, A. W., 1889a — Petrological notes on two samples of rock from New Guinea — 1. Pitchstone, Fergusson Island, Dawson Strait. *Brit. N. Guinea Govt Gaz.,* 2(10), 39.

A lustrous black pitchstone comprises flow-textured glass with phenocrystic quartz and sanidine. Radiating septate cracks are sites for quartz microcrystallite growth. (W.M.)

09-b-5 CLARKE, A. W., 1889b — Petrological notes on two samples of rock from New Guinea — 2. Basalt, Goodenough Island, Moresby Strait. *Brit. N. Guinea Govt Gaz.,* 2(10), 39.

This vesicular basalt contains phenocrystic augite and zoned sanidine in a vitrophyric groundmass which shows incipient devitrification. (W.M.)

09-b-6 CLARKE, A. W., 1892 — Petrographical notes on specimens from Queensland and adjacent colonies. (*In* JACK, R. L., & ETHERIDGE, R. — THE GEOLOGY AND PALAEONTOLOGY OF QUEENSLAND AND NEW GUINEA. *Brisbane, Govt Printer,* 699-736.)

Petrographic notes on some igneous rocks include vitrophyric rhyolite from Fergusson I., a basaltic glass from Nell I., vesicular basaltic lava from Goodenough I., and porphyritic andesite from Mitre Rock. (W.M.)

09-b-7 DALLWITZ, W. B., 1967 — Clinoenstatite-bearing rocks, Cape Vogel, Papua. (*In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.,* 123-4.)

13 major-element analyses of clinoenstatite-bearing rocks from C. Vogel show unique features which cannot be explained in terms of differentiation processes inferred from detailed field, petrographic, and chemical studies on the one hand, or from experimental studies on fractional melting of mantle-type rocks, on the other. The main features of the chemistry of these rocks may be summarized as follows:

1. Magnesia contents range from 12.5 to 25.3%; concomitantly, the clinoenstatite contents range from several to about 70%;
2. Alumina and lime contents vary inversely with magnesia contents; Al_2O_3 ranges from 11.7 to 5.7%, and CaO from 6.1 to 2.3%;
3. Iron oxides remain fairly constant at about 9.5%;
4. Contrary to all expectations silica remains constant, to within about $\pm 1\%$, at about 57.5%.

Calculations show that the composition of each analysed rock could be explained by assuming that it is a hybrid between enstatite pyroxenite containing about 56%

SiO_2 and 34.5% MgO, and quartz dolerite containing about 58.5% SiO_2 and 5.5% MgO, but the main difficulty with this suggestion is that enstatite pyroxenite magma is unlikely to exist. Alternatively, the variations in composition could be explained by gravitational settling of crystals of clinoenstatite, whose silica content is very nearly the same as that of the rocks as a group; this means that clinoenstatite could be removed from the liquid without causing appreciable change in the silica percentage of the residual magma. Even with this mechanism the starting magma would have an unusual composition, the main requirements being very high magnesia content relative to silica, and an Mg/Ca ratio high enough to inhibit early crystallization of calcic clinopyroxene. (Auth.)

09-b-8 DALLWITZ, W. B., & ROBERTS, W. M. B., 1965 — Petrographic and mineragraphic examination of nickeliferous rocks from Mebulibuli Creek, Fergusson Island. *In* DAVIES, H. L., & IVES, D. J., — The geology of Fergusson and Goodenough Islands, Papua. *Bur. Miner. Resour. Aust. Rep.* 82, 62-3.

Two samples of nickeliferous rocks from Mebulibuli are described. In one, a talc-bearing opalized serpentinized dunite, sulphide minerals include pyrite and marcasite which are accompanied by fine-grained chromite and magnetite. In the other sample, a sulphide-bearing chalcedonic silicified dunite, magnetite is accompanied by marcasite, pyrite, and chromite. Nickel was detected only in the magnetites of each sample by X.R.F. and microchemical techniques. (W.M.)

09-b-9 DALLWITZ, W. B., GREEN, D. H., & THOMPSON, J. E., 1966 — Clinoenstatite in a volcanic rock from the Cape Vogel Area, Papua. *J. Petrol.*, 7, 375-402.

A porphyritic volcanic rock from C. Vogel contains abundant phenocrysts of multiple-twinned clinoenstatite, and less common phenocrysts of orthopyroxene, set in a groundmass of pyroxene microlites, glass, and zeolites. The rock contains 54% SiO_2, 13-16% MgO, and 6-7% FeO, but only 7-8% Al_2O_3, 4.5-5% CaO, and 0.6-0.8% Na_2O. Microprobe analyses show the clinoenstatite phenocrysts range from En_{92} to En_{87}, and have very low Al_2O_3 and extremely low CaO contents. Their composition differs consistently from that of the orthopyroxene phenocrysts, which range from En_{87} to at least as Fe-rich as En_{78}. The clinoenstatite phenocrysts are a metastable inversion-product from primary protoenstatite. The crystallization of protoenstatite as the liquidus phase is attributed directly to the unique magma composition. (Auth.)

09-b-10 GLAESSNER, R., 1915 — Beitrage zur Kenntnis der Eruptivgesteine des Bismarck-Archipelo und der Salomon Inseln (A contribution to the knowledge of the volcanic rocks of the Bismarck Archipelago and the Solomon Islands, in German.) *Beitr. geol. Erforsch. dtsch. Schutzgeb.*, 10, 1-85.

Petrographic descriptions are given for a large suite of intrusive and extrusive igneous rocks, including pyroclastics, collected in New Britain, New Ireland, Manus, Bougainville, and the Solomon Islands by Sapper. (W.M.)

09-b-11 GLAESSNER, R., 1923 — Petrographische Untersuchungen von Gesteinsproben aus Deutsch-Neuguinea (Kaiser-Wilhelmsland (Petrographic studies on rock samples from German New Guinea, in German.) *Beitr. geol. Erforsch. dtsch. Schutzgeb.*, 18, 1-25.

Suites of samples from several expeditions in western mainland New Guinea are described. Material is located by source region only. Petrographic notes are given on each rock type. (W.M.)

09-b-12 JOPLIN, G. A., 1963 — Chemical analyses of Australian rocks — Part I: Igneous and Metamorphic. *Bur. Miner. Resour. Aust. Bull.* 65.

A compilation of analyses of igneous and metamorphic rocks includes 51 analyses of igneous rocks, 3 of xenoliths in igneous rocks, and 12 of serpentinite from Papua New Guinea. (W.M.)

09-b-13 KEY, C. A., 1968 — Trace element identification of the source of obsidian in an archaeological site in New Guinea. *Nature,* 219 (5152), 360.

Obsidian artefacts on Watom I. north of the Gazelle Pen. were analysed for trace element content and compared with outcropping obsidians from Pleistocene to Recent eruptive sources at Talasea, Rabaul, Baluan, Lou, and Fergusson I. Spectrographically determined values for 12 elements are presented. It is concluded that the Watom artefacts were prepared from Talasea obsidian. (W.M.)

09-b-14 KEY, C. A., 1969 — The identification of New Guinea obsidians. *Oceania,* 4, 47-55.

Spectrographic determinations of the minor-element content of prehistoric obsidian artefacts are compared with those of natural glasses from known volcanic sources in Papua New Guinea. Watom I. artefacts were made from Talasea obsidian and artefacts found on the Trobiand Is and at Collingwood Bay from Fergusson I. obsidian. (Auth.)

09-b-15 KLAUTZSCH, A., 1909 — Geologisch-petrographische Mitteilungen aus den deutschen Kolonien: 1. Die Gesteine des Wariagebietes und das dortige Gold-vorkommen, Kaiser-Wilhelms-Land, Neu Guinea (Geological and petrographic notes on the German colonies: 1. The rocks of the Waria region and gold occurrences in that area, Kaiser-Wilhelms-Land, New Guinea, in German.) *Jb. preuss. geol. Landesanst.. Berg. Akad.,* 29, 432-8.

The lower and middle reaches of the Waria R. near the border between German and British New Guinea at 8°S contain sandy sediments in which fine flaky gold has been observed. Outcropping rocks include gabbro, basalt, dolerite, porphyritic augite basalt, altered diorite, and quartz diorite. (W.M.)

09-b-16 LEHMANN, E., 1908 — Petrographische Untersuchungen en Eruptivgesteinen von der Insel New-Pommern, unter besonderer Berücksichtigung der eutektischen Verhaltnisse pyroxänandesitischer Magmen (Petrographic investigations of volcanic rocks from New Britain with special reference to the eutectic mixtures of pyroxene-andesite magmas, in German.) *Tschermaks miner. petrogr. Mitt.,* 27(3), 200-43.

Suites of igneous rocks from several places in New Britain include two generations of material — older intrusives which include monzonite, diorite, diorite-porphyrite and augite porphyrite, and younger volcanics including dacite and andesite.

Details are given of andesitic rocks in the volcanic centres of the Mother and Daughter, Matupi, and Mt Varzin near Rabaul, Watom I., the Father, Hanna Bay (Talasea), French Is (St Matthias Group), and Deslaco I. (Mussau), Merite, and North Is.

The theory of andesitic rock genesis is discussed in the light of evidence from these and similar rock types. The New Britain rocks are thought to have been derived by partial crystal fractionation in a shallow magma chamber. (Auth.)

09-b-17 LOVERING, J. K., 1957 — Petrology of volcanics from Mt Langila. *In* TAYLOR, G. A. M., BEST, J. G., & REYNOLDS, M. A. — Eruptive activity and associated phenomena, Langila Volcano, New Britain. *Bur. Miner. Resour. Aust. Rep.* 26, 50-3.

Olivine-hypersthene basalts from Langila volcano are vitrophyric in texture, and are commonly vesicular; all have approximately the same percentage of phenocrysts of plagioclase (20%-30%), orthopyroxene (6-7%), clinopyroxene (2-5%), magnetite (3-5%), and olivine (1% or less). They are divided into 3 main types, based on the nature of the orthopyroxenes in the groundmass, and correspond generally with the ages of the material.

The crystallization of the Langila volcanics appears to have followed a normal petrogenetic trend, particularly in the progressive enrichment of the pyroxenes in iron. This trend can be observed in the phase relations within individual rocks as well as in chronologically successive lava-types. (W.M.)

09-b-18 LOVERING, J. K., 1958 — Petrological examination of Mt Lamington volcanic rocks. *In* TAYLOR, G. A. M., — The 1951 eruption of Mount Lamington, Papua. *Bur. Miner. Resour. Aust. Bull.*, 38, 110-7.

Three types of andesitic lavas are found in the remaining walls of the old crater of Mt Lamington — green hornblende andesite from the south wall, pyroxene andesite from the stratified composite western wall and magnetite-lamprobolite andesite from the east wall which resembles a shattered plug with a dense inner core and more glassy outer shell. Three types of andesitic lavas extruded in the 1951 eruption are temperature variants of the same magma.

The petrogenesis of the two generations of lava is discussed, and it is concluded that 'assimilation of sialic rocks by basaltic magma probably explains the features of the Lamington volcanics'. (W.M.)

09-b-19 LOWDER, G. G., 1970 — The volcanoes and caldera of Talasea, New Britain: Mineralogy. *Beitr. Miner. Petrol.* 26, 324-40.

The Talasea Pen. is composed of a chain of Quaternary volcanoes whose lavas range from basalt to rhyolite. It is situated in an orogenic environment and the lavas, while essentially calcalkaline, show some differences from other orogenic suites on the Pacific rim. The most distinctive feature of the Talasea series is absolute iron enrichment in some lavas. The mineralogical evidence supports the hypothesis of a crustal fractionation origin for this series and there is a possibility that the oxygen fugacity was more or less constant during the early stages of its evolution. The iron-enriched lavas may be an offshoot from the main line of descent, resulting from near-surface fractionation, with the dominance of plagioclase in the crustal residuum producing an iron-rich liquid. (Auth./W.M.)

09-b-20 LOWDER, G. G., & CARMICHAEL, I. S. E., 1970 — The volcanoes and caldera of Talasea, New Britain: geology and petrology. *Bull. geol. Soc. Amer.*, 81, 17-38.

The Talasea Pen. is in the New Guinea island arc complex which represents the tectonically active margin of the Australian continent. The peninsula is composed of a chain of Quaternary composite volcanoes and a caldera, with lavas ranging in composition from basalt to rhyolite, although andesite is the dominant variety. Within the caldera are 2 fault-bounded blocks which appear to be remnants of the ancestral mountain. Post-collapse volcanic activity is found at Mt Makalia, an andesitic volcano which developed in the central part of the caldera and last erupted about 80 years ago. The other volcanoes of the peninsula are largely andesitic composite cones, some of which almost certainly have been active in the last few hundred years. A large area of the peninsula is composed of acid extrusions with an average thickness of 100 m. Numerical evaluation of crystal fractionation of a possible basaltic parent shows that this process could account for all but the acid lavas of the Talasea series; it is only the dominance of andesite that suggests that the series was generated at a depth where andesite is the low-melting composition. (Auth./W.M.)

09-b-21 MACKENZIE, D. E., 1970 — Petrology of Pleistocene volcanoes, New Guinea highlands. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Preliminary work on samples from 6 Pleistocene strato-volcanoes in the central and southern highlands indicates a high potash calcalkaline to shoshonitic chemistry. In the tectonic and seismic setting of the highlands, this can only be related to crustal thickness and Plio-Pleistocene crustal movements. (Auth.)

09-b-22 MAITLAND, A. G., 1892a — Notes on some geological specimens collected in British New Guinea in 1890-91. *Brit. N. Guinea ann. Rep. for 1890-91,* App. BB, 92-3.

A suite of andesitic volcanics from Mt Yule is described, and some mica schist and vein quartz samples are noted. (W.M.)

09-b-23 MIYAKE, Y., & SUGIURA, Y., 1949 — On the chemical compositions of the eruptives of volcanoes in New Britain, Pacific Ocean. *Bull. chem. Soc. Japan.* 22, 57-60.

Chemical analyses are quoted for samples of lava, lapilli, and volcanic sand from Tavurvur (Matupi), Kombiu (The Mother), and Baluan (Vulcan). The samples from Tavurvur are basaltic; those from Kombiu and Baluan are quartz andesite. The analyses are compared with earlier analyses of samples from New Britain (entry 09-b-34) and with other eruptives in Japan. (W.M.)

09-b-24 MIYAKE, Y., & SUGIURA, Y., 1953 — On the chemical compositions of the volcanic eruptives in New Britain Island, Pacific Ocean. *Proc. 7th Pacif. Sci. Cong., New Zealand,* 2, 361-3.

Lava, lapilli, and volcanic sand from eruptive centres around Rabaul are compared with eruptives from Mount Fuji in Japan. A gross resemblance between volcanic groups at Rabaul and Fuji is recognized. (W.M.)

09-b-25 MORGAN, W. R., 1966 — A note on the petrology of some lava types from east New Guinea. *J. geol. Soc. Aust.,* 13, 583-92.

Quaternary and upper Tertiary lavas from volcanic islands along the northeast coast of New Guinea consist of pyroxene andesites, andesitic basalts, and basalts; many contain accessory olivine. The lavas of Mts Lamington, Yelia, and Victory are rather more acid hornblende and lamprobolite andesites. Peralkaline obsidian and rhyolite occur at Fergusson and Dobu Is. Chemical analyses show that most of the lavas are of the calcalkaline type, although some from Karkar and Long Is appear to have tholeiitic tendencies. (Auth.)

09-b-26 MORGAN, W. R., 1967a — Olivine basalt from the April 1964 eruption of Manam Volcano. Appendix 1, *in* BRANCH, C. D. — April 1964 eruption of Manam Volcano. (*In* BRANCH, C. D., — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG 2*), 27-34.)

A porphyritic olivine basalt from Manam volcano, 1964 flow, contains a few cognate xenoliths of pyroxene and olivine. The sample was analysed and the results are quoted. (W.M.)

09-b-27 MORGAN, W. R., 1967b — Lavas from Quaternary and Upper Tertiary volcanoes, east New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.,* 152.

This is similar to entry 09-b-25.

09-b-28 OFFERMAN, J., 1916 — BEITRAGE ZUR PETROGRAPHIE DER INSEL NEUPOMMERN (Report on the petrography of the island of New Britain, in German.) *Berlin, Hansa-Buchdruckerei,* 48 pp.

All samples were igneous material from the Gazelle Pen., collected mostly from the Mother, Matupi, and Vulcan at Rabaul, and from the southwest fall of the Baining Mts. The geographic and geological setting of material is given, drawing mostly on published accounts. The geology of the peninsula is considered mainly in terms of the distribution of volcanic centres around Rabaul, and the extent of resultant pumiceous pyroclastic deposits and of prior limestones. (W.M.)

09-b-29 PATERSON, S. J., & GREEN, D., 1964 — Petrography and petrology. *In* HAANTJENS, H. A. (Ed.) — (a). General report on the lands of Buna-Kokoda area, Territory of Papua and New Guinea. *CSIRO, Lands Res. Ser.* 10, App. 1, 107-13.

Petrographic data on 8 thin sections of samples from the Owen Stanley Metamorphics west of Kokoda indicate metamorphism under conditions of low to moderate temperatures, mostly low hydrostatic pressure, and moderate to high directed pressure. Regional low- to medium-grade metamorphism modified in some areas by contact metamorphism accounts for observed textures and mineral assemblages. Mineralogical data are tabulated, and show features of mineralogical constancy with rock type and time, and variations with time and position within the series. The rocks in this province belong to the ultrabasic, basic, and intermediate ranges of the granodiorite-andesite kind, a typical example of the calcalkali series. (W.M.)

09-b-30 RUXTON, B. P., 1965a — A late Pleistocene to Recent rhyodacite-trachybasalt volcanic association in north-east Papua (Abstract only). *Int. volc. Ass., New Zealand Symposium,* Abs. Vol., 151-2.

The Managalase Plateau is a fault-bounded block of fractured basement metabasalt and basic plutonic rock overlain in the east by interfingering basaltic lava flows and rhyodacitic ash cones. Some 30 small volcanic structures occur in an area of only 500 m^2. They include trachybasalt lava cones, cinder cones, scoria mounds with widespread lava flows, rhyodacite domes and ash cones, less common trachyandesitic flow domes, and scattered explosion craters. They range from late Pleistocene to Recent and two small centres have been active within village memory.

The petrology and chemistry of some of the rocks suggests a transition, probably by fractional crystallization, from alkali basalt through trachybasalt towards trachyandesite. But others including the 'andesitic' and dacitic rocks of the adjacent large strato-volcanoes are highly porphyritic and show the typical features of calcalkali 'orogenic andesites' including xenoliths and xenocrysts which suggest contamination.

Most of the rhyodacite cones occur along the eastern margin of a small horst block which appears to form the northern portion of an uplifted 'basalt arc'. The rhyodacite-trachybasalt complex is situated near the cusp of two major arcuate structures, which are concave towards the northeast; this basalt arc and the Kokoda fault complex probably continue under the volcanic piles of Mt Lamington and the Hydrographer Ra. Both these arcs are but a small part of the much larger Morobe Arc which probably represents the result of early Tertiary thrusting of the mantle southwest over the Owen Stanley metamorphic rocks. (Auth.)

09-b-31 RUXTON, B. P., 1966a — A late Pleistocene to Recent rhyodacite-trachybasalt-basaltic latite volcanic association in northeast Papua. *Bull. volc. (Ser. 2),* 29, 347-74.

This is similar to entry 09-b-30.

09-b-32 TAYLOR, S. R., CAPP, A. C., GRAHAM, A. L., & BLAKE, D. H., 1969 — Trace element abundances in Andesites : 11. Saipan, Bougainville and Fiji. *Beitr. Miner. Petrol.,* 23, 1-26.

Abundance data for Cs, Rb, Tl, Ba, Pb, Sr, the rare earths, Th, U, Zr, Hf, Sn, Nb, Mo, Mn, Cu, Co, Ni, Sc, V, Cr, Ag, Sb, and the major elements are reported for 2 andesites and a dacite from Saipan, 9 andesites and a dacite from Bougainville, and 2 andesites from Fiji. The Saipan rocks are low-K varieties and contain notable low abundances of Rb, Ba, Th, and U anl have rare-earth patterns subparallel to chondritic patterns. The Bougainville andesites include low-Si and high-K varieties which have higher concentrations of the large cations. The Fijian samples are close to the average circum-Pacific andesite and have rare-earth patterns subparallel to those of sedimentary rocks.

These data preclude derivation of calcalkaline rocks by mixing of upper crustal material or by fractional crystallization from basaltic parents. A two-stage model is proposed involving sea-floor spreading and transportation of the oceanic crust down the dipping seismic plane into the mantle where it is remelted to form andesites. (Auth.)

09-b-33 TILLEY, C. E., YODER, H. S. Jnr, & SCHAIRER, J. F., 1964 — New relations on melting of basalts. *Carnegie Inst. Wash. Ybk,* 63, 92-7.

The 'tholeiitic' clinoenstatite-bearing basaltic rock from C. Vogel (entry 09-b-9) contains enstatite and clinoenstatite phenocrysts in a glassy groundmass. Chemical analysis reveals a tholeiitic composition; thermal treatment indicates protoenstatite as the liquidus phase at 1385°C with clinoenstatite produced as a metastable phase on rapid cooling at 1250°C; on a plot of liquidus temperature against iron enrichment it falls close to a hypersthenic picrite basalt. Inversion from protoenstatite to clinoenstatite occurs with greater ease than the heat-induced reverse inversion. (W.M.)

09-b-34 WASHINGTON, H. S., 1917 — Chemical analyses of igneous rocks. *U.S. geol. Surv., prof. Pap.* 99, 1180.

Analyses of several rocks from Papua New Guinea include andesites and hornblende gabbro from Tumleo (New Guinea), Simpson Har., Rabaul, and Watom I. near Rabaul; monzonite from the Baining Mts; hornblende gabbro from the Torricelli Mts; and unlocated andesitic lava and andesitic pumice from New Britain. (W.M.)

(c) PETROGENESIS AND GEOCHEMISTRY

See also entries

09-b-16 09-b-32 14-c-1

09-c-1 DALLWITZ, W. B., 1968 — Chemical composition and genesis of clinoenstatite-bearing volcanic rocks from Cape Vogel, Papua: A discussion. *23rd int. geol. Cong., Prague,* Abs. Vol. 43 and *Proc.,* 1, 229-42.

This is similar to entries 09-b-7 and 09-b-9.

09-c-2 DALLWITZ, W. B., THOMPSON, J. E., GREEN, D. H., & TILLEY, C. E., 1965 — The possible petrogenic significance of clinoenstatite-bearing rocks from Cape Vogel, Papua. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT, 1960-65. *Canberra, Aust. Acad. Sci.,* 102-3.

This is preliminary to entry 09-b-7.

09-c-3 DAVIES, H. L., 1970a — Peridotite-gabbro-basalt complex in eastern Papua: an overthrust plate of oceanic mantle and crust. *Diss. Abstr. int.,* 31, 2062-B.

This is similar to entry 09-c-4.

09-c-4 DAVIES, H. L., 1970b — Peridotite-gabbro-basalt complex in eastern Papua: an overthrust plate of oceanic mantle and crust. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

The Papuan Ultramafic Belt (entries 02-b-36 and 37) is a peridotite-gabbro-basalt complex which from top to bottom consists of

Basalt zone	Basalt and spilite, massive and as pillow lavas, some dacite	4-6 km
Gabbro zone	High-level gabbro (ophitic), to 1 km Granular gabbro, some cumulates	4 km
Ultramafic zone	Cumulates, up to 0.5 km Noncumulates: Harzburgite etc. with metamorphic textures	4-8 km

The basalts have tholeiitic affinities but contain more SiO_2 (52%) and less K_2O (.07%) than typical oceanic tholeiites; average Mg/Fe ratio is .64. The gabbros are rich in CaO (14.5%) and MgO (12.2%) and poor in alkalies (Na_2O 0.07%, K_2O 0.04%); average Mg/Fe ratio is 2.35. The cumulus ultramafics have variable Mg/Fe in contrast with the noncumulus ultramafics which consist mainly of olivine Fo_{93} and enstatite En_{93}.

The complex may be part of an overthrust sheet of oceanic crust and mantle. The noncumulus ultramafics might represent pre-existing (convecting?) mantle, while the basalt, gabbro, and cumulus ultramafics are the products of intrusive-extrusive activity at a tensional zone in the ocean floor. If the basalt and gabbro are related, the parent magma must have been richer in Mg and poorer in alkalies than supposed typical tholeiite melts, and the basalts must have crystallized from residual liquids by crystal fractionation in the crust. (Auth.)

09-c-5 DAVIES, H. L., 1971a — Ophiolite suites: a genetic relationship between ultramafic rocks and associated gabbros and submarine basalts. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 71-2.

The ophiolite suite consists of serpentinized peridotite overlain by gabbro which is in turn overlain by spilite or basalt. Some proposed that ophiolite complexes originate as very thick differentiated extrusions onto the ocean floor. Results of recent work often support the hypothesis that ophiolite complexes are upfaulted oceanic mantle and thrust. In the Papuan Ultramafic Belt (PUB), 2 types of ultramafic rock have been recognized: 'cumulus ultramafics' which originated by crystal settling from basaltic magma; and 'tectonic ultramafics' which have metamorphic texture. The same 2 types can be recognized in ultramafic rocks from the Mediterranean ophiolites. The tectonite ultramafics may be pre-existing refractory upper mantle material; the cumulus ultramafics are related to the overlying gabbro and overlying basalt may or may not be related; at least in the case of the PUB they differ in major-element chemistry. However, the great volume of each, their close spatial relationship, and their gradational contacts are arguments of common origin. Using MgO-variation diagrams a possible fractionation process can be traced for the PUB rocks: this requires the settling out of crystals of olivine, clino and orthopyroxene, and bytownite from a hypothetical parent magma of composition between average PUB gabbro and average PUB basalt. These 4 minerals (and chrome-spinel) are known to occur as cumulus phases in PUB gabbros. (Auth.)

09-c-6 DAVIES, H. L., 1971b — Peridotite-gabbro-basalt complex in eastern Papua: an overthrust plate of oceanic mantle and crust. *Aust. Bur. Miner. Resour. Bull.* 128, 48 pp.

This is similar to and integrates entries 02-b-36 and 37; 09-c-4.

09-c-7 GREEN, D. H., 1961 — Ultramafic breccias from the Musa valley, eastern Papua. *Geol. Mag.,* 98, 1-26.

In the Musa valley, rocks of the Papuan Ultramafic Belt are part of a folded layered sequence ranging from magnesian dunite and peridotite to olivine gabbro and bytownite gabbro. Agglomerate-like breccias consisting of fragments of ultramafic rock in a variable matrix occur as irregular vent-like bodies in the peridotite and dunite and as horizontal sheets in a Pleistocene-Recent sedimentary sequence. The breccias are interpreted as vent and extrusive breccias resulting from the penetration, brecciation, and local entrainment (fluidization) of peridotitic country rock by volcanic gases. Olivine alkali basalt was probably the parental magma responsible for the gaseous activity. There is no evidence of the presence of an ultramafic serpentine magma in the genesis of the breccias. (Auth.)

09-c-8 GREEN, D. H., 1970 — Peridotite-gabbro complexes as keys to petrology of mid-oceanic ridges: Discussion. *Bull. geol. Soc. Amer.* 81, 2161-6.

For some ultramafic complexes, a history is postulated with high-pressure, high-temperature crystallization, and high-temperature emplacement at shallow levels as hot, crystalline ultramafic diapirs. The peridotite-gabbro complexes of eastern Papua are thought to be a pyrolite or partly depleted pyrolite diapir of part liquid, part residual, mantle material reaching very shallow levels. They typically contain fragmentary rock types and both crystalline-flow and recrystallized rock types, and simple gravity accumulates from basic melts. (Auth./W.M.)

09-c-9 HEDGE, C. E., & PETERMAN, Z. E., 1969 — Sr^{87}/Sr^{86} of Circum-Pacific Andesites (Abstract only). *Geol. Soc. Amer., 65th ann. Mtg,* Abs., 7, 96.

The following Sr^{87}/Sr^{86} data for andesites and associated volcanic rocks of the Circum-Pacific volcanic province have been determined ($Sr^{87}/Sr^{86}=0.7080$ for E. and A. standard):

		Sr^{87}/Sr^{86} Mean and s.d.	Number
Washington	Quaternary (Glacier Peak)	0.7035±0.0002	(5)
Oregon	Quaternary (Mt Hood)	0.7035±0.0003	(3)
	Pliocene and Miocene (Sardine Fm)	0.7036±0.0003	(5)
	Eocene (Umpqua Fm)	0.7030	(1)
	Oligocene and Eocene (Clarno Fm)	0.7034	(2)
California	Quaternary (Mt Shasta)	0.7030±0.0001	(5)
	do (Mt Lassen)	0.7039±0.0001	(5)
	do (Medicine Lake)	0.7037±0.0004	(6)
Japan	Quaternary (Hakone)	0.7033±0.0004	(5)
	do (Northern Honshu)	0.7034±0.0006	(8)
New Guinea	Quaternary (New Britain)	0.7035±0.0001	(12)

That Sr^{87}/Sr^{86} in these andesites and associated rocks does not differ significantly from the mean of 0.7037 for oceanic basalts implies an upper mantle source with minimal crustal involvement. The Tertiary and Quaternary andesites from the Cascade Ra. of Washington, Oregon, and California do not show any significant variations whether a pre-Cainozoic basement is present in the region or not; this further suggests a sub-crustal origin for these rocks. These data and interpretations are in accord with earlier studies by Hedge and by Pushkar but contrast with that of Ewart and Stipp, who suggest assimilation of crustal rocks to explain Sr^{87}/Sr^{86} in andesites from New Zealand. (Auth.)

09-c-10 JAKES, P., & GILL, J., 1970 — Rare earth elements and the island arc tholeiitic series. *Earth planet. Sci. Lett.*, 9, 17-28.

It is chemically inappropriate to call many of the rocks in island arcs calc-alkaline and it is suggested that they be known as the 'island arc tholeiitic series'. They differ from calcalkaline rocks by having a lower silica mode, more iron enrichment, higher Na_2O/K_2O ratios, less K and associated trace elements, K/Rb about 1000, Th/U about 1-2, and chondritic REE patterns with La/Yb of 1-2. When erupting concurrently, rocks with these characteristics occur above shallower earthquake foci on the trenchward side of the island arcs than do the calcalkalines. They, and not rocks of the traditional calcalkaline series, are the most dominent in many western Pacific and Atlantic island arcs and represent the earliest stages in arc evolution.

Although sharing some tholeiitic features, they differ from normal tholeiitic series by having a higher percentage of intermediate and acid members and too little normative olivine, for example, to have been in equilibrium with peridotite. In such distinctive features as REE, Th, and U contents and La/Yb, Th/U, and K/Rb ratios, they are more like mid-ocean ridge tholeiites than any other terrestrial rocks, but they differ from them in silica mode, alkali content, and isotopic composition, and MgO, REO, Ni, and Cr contents. Some of their spatial, temporal, and chemical characteristics may be explained by mixing of the partial melting products of resorbed lithosphere and overlying upper mantle.

Included in samples studied are 4 tholeiites from Bougainville, 3 tholeiites from eastern Papua (C. Nelson?), 2 tholeiites from New Britain (Talasea), an andesite from eastern Papua (C. Nelson) and 2 shoshonites from the New Guinea highlands (Mts Lalibu and Giluwe?). (Auth./W.M.)

09-c-11 JAKES, P., & SMITH, I. E., 1970 — High potassium calcalkaline rocks from Cape Nelson, eastern Papua. *Beitr. Miner. Petrol.*, 28, 259-71.

High-K calcalkaline rocks from C. Nelson are dominated by andesites containing numerous basic inclusions. High-Al basalts and dacites are subordinate. The slight iron enrichment and a systematic variation in K_2O/SiO_2 correlation observed in these rocks suggests a relationship to nearby rocks of a shoshonite association. The chemical composition of the inclusions illustrates the trends of major and minor element evolution which contradicts the idea of complementariness of high-K calc-alkaline rocks and alpine ultramafic rocks. The chemical character of the lavas (high K, Rb, and Ba, as well as high Cr and Ni) can be explained by fractional melting involving a mica phase. (Auth.)

09-c-12 JAKES, P., & WHITE, A. J. R., 1969 — Structure of the Melanesian arcs and correlation with distribution of magma types. *Tectonophysics.* 8, 223-36.

Chemical data on Cainozoic lavas from Melanesia indicate a zonal arrangement of lava types in the New Guinea-New Britain arc. Tholeiitic rocks occur on the oceanic side of New Guinea (Manam, Karkar), and north of New Britain. Calcalkaline rocks occur on the east Papuan coast (Mts Lamington and Victory). The shoshonitic rock association of the New Guinea highlands (Mts Hagen and Giluwe) and east Papua probably represents the equivalent of the alkali-basalt association, or a further zone of magma variation across island arcs.

Zonation is not distinct within the Solomon Island Arc. Lavas of the New Georgia Group show tholeiitic as well as calcalkaline affinities, and rocks from Bougainville and Guadalcanal are calcalkaline. The equivalent of the alkali-basalt association has not been found in the Solomons. The position of the seismic zone may be correlated with the chemistry of the rocks and in the New Guinea Arc the plane dips towards the continent. In the Solomon Arc (Bougainville section) the seismic zone dips steeply towards the continent: in the southern section (New Georgia-Guadalcanal) it is almost vertical. (Auth.)

09-c-13 JAKES, P., & WHITE, A. J. R., 1970 — K/Rb ratios of rocks from island arcs. *Geochem. cosmochim. Acta,* 34, 849-56.

The abundances of K and Rb have been determined in andesites and shoshonitic rocks from island arcs, inclusions from calcalkaline rocks and alkali basalts, and in mineral separates from these rocks. Across island arcs there is an increase of K_2O content with decrease of K/Rb ratio from tholeiites to low-K calcalkaline rocks, calcalkaline rocks, high-K calcalkaline rocks, and finally to shoshonites. This is explained by the different K/Rb ratios of amphibole and biotite and different mutual proportions of these minerals involved in fractional melting (decomposition) of a sinking slab of oceanic crust undergoing transformation from amphibolite to eclogite.

Included in materials tested were calcalkaline hornblende andesites and dacites from Bougainville which have high K and low K/Rb, tholeiitic basaltic lavas from Talasea in New Britain which have high K/Rb values, and shoshonitic lavas from Mt Giluwe and Mt Hagen which have medium to low K/Rb values. (Auth./W.M.)

09-c-14 KUNO, H., 1966 — Lateral variation of basaltic magma across continental margins. *In* POOLE, W. H. (Ed.) — Continental margins and island arcs — report of Symposium. *Geol. Surv. Canada Pap.,* 66(15), 317-36.

Quaternary basalt magmas in the Circum-Pacific belt and island arcs change continuously from a less alkalic and more siliceous type (alkali olivine basalt) on the continental side. A lateral variation of magma type is characteristic of the transitional zone between the oceanic and continental structures. Because the variation is continuous, the physico-chemical process attending basalt magma production should also change continuously from the oceanic to continental mantle. 3 alternative suggestions explaining the lateral variation are presented (assuming a homogeneous mantle): 1) Close correspondence between depth of earthquake foci in the mantle and the basalt magma types in the Japanese islands indicates that tholeiite magma is produced where the earthquakes are generated by stress relief at depths of 100 km, high-alumina basalt magma by the same mechanism at depths from 100 to 200 km, and alkali olivine basalt magma at depths greater than 200 km; 2) inferred steep thermal gradient in the oceanic mantle and gentle gradient in the continental mantle suggest that the temperature of initial melting of mantle peridotite is reached at shallow depth on the oceanic side of the continental margins producing tholeiite magma, and at great depth on the continental side producing alkali-olivine basalt magma, and that the 2 regions are linked by an intermediate depth of magma production (high-alumina basalt); and 3) Primary olivine tholeiite magma is produced at some depth in the mantle (100-150 km), and then on the oceanic side of the continental margin the magma leaves the source region immediately after its production and forms a magma reservoir at shallow depth, perhaps in the crust where it undergoes fractionation to produce SiO_2-oversaturated tholeiite magma, whereas on the continental side the primary magma forms a reservoir near the source region and stays there long enough for fractionation to produce alkali-olivine basalt magma. In the intermediate zone, the primary olivine tholeiite magma forms a reservoir at intermediate depth where it fractionates to produce high-alumina basalt magma. (Auth./W.M.)

09-c-15 LOWDER, G. G., 1969 — Mineralogy of the basalt-rhyolite series of Talasea, New Guinea (Abstract only). *Geol. Soc. Amer. 65th ann. Mtg,* Abs, 7, 137-8.

The mineralogy is given for a suite of volcanic rocks (entry 09-b-19).

09-c-16 LOWDER, G. G., & CARMICHAEL, I. S. E., 1968 — Volcanism along the continental margin in New Guinea: the Talasea Caldera. *Geol. Soc. Amer., 81st ann. Mtg, Mexico City,* Abs., 180-1.

Volcanic rocks from Talasea (entry 09-b-20) are described.

09-c-17 MACKENZIE, D. E., & SMITH, I. E., 1971 — Shoshonitic, calcalkaline and peralkaline magma types in eastern Papua and the New Guinea highlands. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 70-1.

2 areas of Late Cainozoic volcanoes (central and western highlands, and eastern Papua) are described. In contrast to the Bismarck Arc volcanoes, which lie on oceanic crust, the mainland volcanoes are underlain by continental crust which underwent major orogenic movements in the late Cainozoic. The highland volcanoes are underlain by 30-40 km of sialic crust, including 5-10 km of Jurassic to Miocene sediments. The eastern Papua volcanoes are built to an unknown thickness of crust which is partly sialic and partly composed of tholeiitic basalts and pelagic sediments. Both areas are almost aseismic, and lack the intermediate and deep-focus earthquakes which define Benioff zones in other volcanic arcs such as New Britain.

Shoshonitic and high-potash calcalkaline lavas occur in both the eastern Papua and highlands volcanic areas; calcalkaline and siliceous peralkaline lavas are present in the D'Entrecasteaux Is. In the highlands volcanoes, shoshonitic and calcalkaline lavas are spatially and temporally inseparable, and there is complete petrographic and chemical graduation between them. In eastern Papua the suites are spatially distinct, except for interfingering on the Managalase Plateau area, but overlap in time.

Since the highlands and eastern Papua areas are seismically and tectonically comparable, the differences between the Quaternary lavas of the 2 areas may be related to differences in the crust and underlying mantle in these areas. The presence of a Benioff zone does not appear to be a necessary prerequisite for volcanic activity in such environments. (Auth.)

09-c-18 PEIVE, A. V., & MARKOV, M. S., 1971 — 'Basaltic' layer of the earth's crust in the western part of the Pacific. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 382.

Basement of the island arcs of the western Pacific is metamorphic, mostly basic, and sometimes medium, rocks. It consists mainly of amphibolite, garnet amphibolite, eclogite-like rocks, and pyroxene gneisses. On Kamchatka are amphibolitic rocks;

in Japan the rocks of a structural belt of Kurosegawa; in Malaysia amphibolites and pyroxene gneisses. Similar rocks occur in the Philippines, Solomons, Yap, New Guinea, and some other regions.

These rocks are usually closely associated with ultramafics and gabbros, and together with the latter they compose either uplifted blocks or the basements of overthrust sheets. The age of these formations is not known, as they are usually separated from the overlying geosynclinal Mesozoic and Cainozoic deposits by zones of fracture. Their pre-Silurian age (the Kurosegawa zone) on Honshu I. is confirmed by isotopic determinations as 424-406 m.y. However, in other parts of the region these complexes may be of a different age, up to Mesozoic (Solomon Is.).

09-c-20 PETERMAN, Z. E., LOWDER, G. G., & CARMICHAEL, I. S. E., 1970 — Sr^{87}/Sr^{86} ratios of the Talasea Series, New Britain, Territory of New Guinea. *Bull. geol. Soc. Amer.*, 81, 39-40.

Quaternary lavas constituting the Talasea Pen. range from basalt through andesites and dacites to rhyolites, with rhyolite and rhyodacite dominating. Strontium isotope ratios for these lavas are all in the range 0.7034 to 0.7038. This ratio is compared with other Pacific volcanic suites and it is concluded that values for the Talasea suite indicate each lava resulted from partial melting of a common source, or from fractional crystallization from a basaltic parent. (W.M.)

09-c-21 THAYER, T. P., 1969 — Gabbro-peridotite complexes as keys to petrology of mid-oceanic ridges. *Bull. geol. Soc. Amer.*, 80, 1515-22.

2 suites of olivine-rich ultramafic and feldspathic rocks appear to be present in the Mid-Atlantic Ridge: one with alkalic affinities, and one similar to the chromitite-bearing alpine peridotite-gabbro complexes. The similarities of rocks in the 2 environments — continental and oceanic — imply that much about the petrology of mid-oceanic ridges may be learned from studies of continental complexes, and that silicic rocks have been formed in the mantle. Although gabbros in St Paul Rocks and similar rocks at Tinaquillo (Venezuela), and Lizard (England), have been interpreted as not comagmatic with intimately associated peridotite by some petrologists, evidence to the contrary at Lizard is discussed. Association of fresh gneissic gabbro, some containing quartz, with talcose serpentinite, amphibole schist, quartz diorite, and epidotic but unsheared basalts along the Mid-Atlantic Ridge is believed to indicate the presence of alpine-type rocks that occur normally in eugeosynclinal belts.

Gabbro, described as partly interlayered with peridotite by gravitational differentiation, forms major parts of 3 widely-separated ultramafic complexes which have been interpreted as slices of oceanic crust and upper mantle: the Troodos massif in Cyprus, the Bowutu Mts in Papua, and the Camaguey complex in central Cuba. If peridotite and related rocks in eugeosynclines represent fragments of ocean rind formed along mid-oceanic ridges and moved laterally by ocean-floor spreading, gabbro must be an essential constituent of the upper mantle. This could account for many geophysical anomalies, but would complicate some postulated mechanisms involved in ocean-floor spreading. (Auth.)

10 METAMORPHIC ROCKS

(a) Areal and General

10-a-1 Ryburn, R. J., 1970 — Glaucophane schist metamorphism in New Guinea. *42nd ANZAAS Cong., Port Moresby,* Sec. 3, Abs.

High-pressure low-temperature metamorphic rocks containing glaucophane, lawsonite, and sodic pyroxenes, together with associated eclogite, were found in southern tributaries of the Sepik R. They are locally developed within regionally metamorphosed, lower Tertiary sediments and volcanics of greenschist facies and are associated with alpine-type ultrabasic rocks. Their environment and mineral composition is similar to the glaucophane schists of California, Japan, Celebes, and New Caledonia.

In eastern Papua, glaucophane has been recognized in low-grade metamorphic rocks from 6 widely scattered areas. However, with 1 possible exception the glaucophane has not been found to coexist with lawsonite and may have formed under metamorphic conditions transitional between the greenschist and glaucophane schist facies. (Auth.)

(b) Mineralogy and Petrology (including Rock Analyses)

See also entries 09-b-11, 09-b-29.

10-b-1 Baker, G., & Coulson, A., 1948 — Metamorphic and volcanic rocks from the D'Entrecasteaux Islands. *Trans. Amer. geophys. Un.,* 29, 656-63.

Acid and basic regional metamorphic rocks are described from Goodenough and Fergusson Is. Quaternary volcanism has broken through the metamorphic complex to form a basaltic lava cone at Oiava-ai in northern Goodenough I., and basaltic lava flows on the eastern side of the island. Northeast of Fergusson I. the islands of the Amphlett Group are exclusively andesitic. (Auth.)

10-b-2 Fisher, N. H., 1939d — Metasomatism associated with Tertiary mineralization in New Guinea. *Econ. Geol.,* 34, 890-904.

The alteration of the country rocks that is associated with the Tertiary mineralization in the Wau-Edie Cr. area, New Guinea's principal gold-mining district, possesses certain peculiar features. The porphyries and phyllites of the district have been more or less uniformly altered over a considerable area, corresponding closely to the limits within which the small quartz-gold stringers occur, whence have been derived the rich alluvials of Edie Cr. and adjacent streams. The larger lodes of the district are directly accompanied by only comparatively slight metasomatic effects. An outline is given of the geology of the area, and the 4 principal types of lodes and the general and local metasomatism are described. (Auth.)

10-b-3 Fisher, N. H., 1939e — Metasomatism associated with Tertiary mineralization in New Guinea (Abstract only). *24th ANZAAS Cong., Canberra,* Sec. C. Abs., 89.

An outline is given of the geology of the Wau-Edie Cr. area, the principal gold-bearing portion of the Morobe Goldfield. The lodes are divided into 4 categories: the small rich Edie Creek stringers which furnished the bulk of the alluvials, the Edie lodes, the Day Dawn Lode, and the orebodies of the Golden Ridges area. The main metasomatism associated with the lodes is a regional hydrothermal alteration which has transformed the phyllite of the old metamorphic series into a chloritoid schist, locally known as 'mudstone', over a large area and which has also profoundly affected the intrusive Tertiary porphyries. This metasomatism is closely associated with the gold-bearing region and apparently delimits the area over which prospecting is likely to be profitable. Of purely local metasomatism affecting the country rock in the immediate vicinity of the lodes very little evidence exists except to a minor degree in a few places. (Auth.)

(c) Serpentinite

See also entry 09-b-12.

10-c-1 Coleman, R. G., 1917a — Plate tectonic emplacement of Upper Mantle peridotites along continental edges. *J. geophys. Res.*, 76, 1212-22.

In plate theory, compressional zones associated with island arcs represent plate boundaries where oceanic lithosphere is subducted. Subduction zones are characterized by lithospheric underthrusting, andesitic volcanoes, and deep seismic activity that generally dips under the continental edge (Benioff zone). The presence of large oceanic-mantle crustal slabs thrust over or into continental edges contemporaneously with blueschist metamorphism in New Caledonia and New Guinea establishes an important variant of plate tectonics in zones of compression. 'Obduction' zones are characterized by a complete lack of volcanic activity and by high-pressure metamorphism. During formation, they can be represented by shallow seismic zones dipping oceanward. The common association of peridotites and blueschists in these orogenic belts may result from the initial stage of compressional impact (or orogeny) between an oceanic and a continental lithospheric plate. Disturbed zones combined with a lack of high-temperature contacts at boundaries between cold mantle-peridotite slabs and trench sediments provide geologic evidence of emplacement by obduction (tectonic over-riding).

The Papuan Ultrabasic Belt is one of the examples of ophiolite masses discussed, using data from Davies (entry 13-b-27), which are interpreted as indicating a situation where oceanic crust and mantle is obducting over continental crust. (Auth./W.M.)

10-c-2 Coleman, R. G., 1971b — Petrologic and geophysical nature of serpentinites. *Bull. geol. Soc. Amer.*, 82, 897-918.

Many large young masses of peridotite appear to be slabs of oceanic mantle overthrust onto continental edges. Subsequent sedimentation, serpentinization, and tectonism have greatly modified these original slabs so that their recognition in older orogenic zones is equivocal. The concept of the tectonic evolution of ultramafic rocks from oceanic crust-mantle slabs invading continental margins and being incrementally serpentinized and moved by later tectonic events provides a working hypothesis that allows a better explanation of the many peculiar and varied occurrences of serpentinite. The serpentinites of the Papuan Ultrabasic Belt are included as an example of a tectonic serpentinite, emplaced as a thrust sliver of oceanic mantle material. (Auth./W.M.)

10-c-3 Lockwood, J. P., 1971 — Sedimentary and gravity emplacement of serpentinite. *Bull. geol. Soc. Amer.*, 82, 919-36.

Large deposits of serpentinite in alpine-type orogenic areas have been formed by sedimentary processes ranging from the detrital accumulation of bedded serpentinite sandstone and shale to the emplacement of chaotic breccias and gigantic slide blocks. Known occurrences of sedimentary serpentinite are listed, and 8 deposits from the circum-Pacific, Caribbean, and Mediterranean areas are described. The serpentinitic peridotite breccias of eastern Papua (entry 09-c-7) are included as an example of a chaotic talus-like deposit of Quaternary age.

Sedimentary serpentinites range in age from early Paleozoic to Quaternary, although most are Cretaceous or Tertiary. Most were deposited in eugeosynclinal environments, early in the geosynclinal cycle. Individual beds range in thickness from a few centimetres to nearly 3 km, and several extend laterally for tens of kilometres. Graded bedding is common, and marine fossils are common.

Several features suggest that most sedimentary serpentinites were deposited very rapidly by submarine landslides, mudflows, or turbidity currents. The sources of this serpentinite debris are postulated to be upward-migrating serpentinite protrusions which penetrate the seafloor or Earth's surface upslope from eventual depositional sites.

Sedimentary serpentinites are much more abundant in alpine-type orogenic areas than is commonly thought, and many ultramafic masses presently regarded as igneous intrusions or tectonic protrusions may be coeval with, instead of younger than, their enclosing sedimentary or meta-sedimentary rocks. In eugeosynclinal sequences such as the Franciscan Formation, some elongate bodies now regarded as serpentinite sills may be beds of ultramafic detritus whose sedimentary features have been masked by post-depositional shearing; isolated masses may be exotic slide blocks. A sedimentary origin can explain some of the most persistent and perplexing characteristics of many alpine serpentinites: their conformity with enclosing sedimentary rocks, their grossly planar shapes, and the absence of metamorphism along their contacts. (Auth./W.M.)

11 MINERALOGY AND CRYSTALLOGRAPHY

(a) DESCRIPTIVE (INCLUDING ORE PETROGRAPHY)

11-a-1 ANONYMOUS, 1927a — New Guinea Gold. *Min. Mag.*, 37(4), 255-6.

This is a reprint of entry 11-a-5.

11-a-2 BAKER, G., 1952 — Opaque oxides in some rocks of the basement complex, Torricelli Mountains, New Guinea. *Amer. Miner.*, 37, 567-77.

A study of polished surfaces of the plutonic and metamorphic rocks that form part of the basement complex exposed in the Torricelli Mts reveals magnetite, ilmenite, hematite, rutile, and spinel in various associations and showing a range of textural relationships. Apart from simple crystallization, complex intergrowths have arisen in parts from the unmixing of solid solutions of different pairs of some oxides and from eutectic crystallization of others. Among these are well-known intergrowths, also examples of the rarely observed (insofar as they occur in parent rocks) ex-solution intergrowth of magnetite and hematite and the hitherto unrecorded ex-solution intergrowth of ex-solved rutile lamellae in ilmenite proper. The relationships of the opaque oxides to one another and to the silicate minerals in the rocks reveal that the oxides have various positions in the crystallization sequence. (Auth.)

11-a-3 BAKER, G., 1953 — Ilvaite and prehnite in micropegmatitic diorite, southeast Papua. *Amer. Miner.*, 38, 840-4.

Ilvaite and prehnite occur in hydrothermally altered portions of micropegmatitic diorite outcropping in southeast New Guinea. The ilvaite replaces some of the pyroxenes in the diorite, while prehnite occurs nearby in narrow veinlets cutting through the diorite. Ilmenite is an abundant accessory component. Marked textural features of the micropegmatitic diorite are well-developed micrographic intergrowths between the components of a quartz-orthoclase mesostasis, and micrographic intergrowths between pyroxene and ilmenite. (Auth.)

11-a-4 JACK, R. L., & DUNSTAN, B., 1899 — Notes on mineralogical specimens. *Brit. N. Guinea ann. Rep. for 1897-98,* App. EE, 145-6.

A suite of minerals, igneous and metamorphic rocks, and vein quartz from the watershed of the Vanapa R. is listed and the samples named. A sample of calcite from Kiriwina contains some strontium. (W.M.)

11-a-5 LAW, R., 1927 — Some characteristics of certain New Guinea gold. *Chem. Engng Min. Rev.*, 19, 370-1.

Parcels of gold received were of 4 types: (a) melted gold in ingots, buttons, etc., (b) unmelted gold recently separated from quartz and gangue, (c) waterworn stones and pebbles carrying precious metals, (d) alluvial slugs, dust grains, or small nuggets with a fine gold colour. The low fineness of the gold, and the presence of small amounts of sulphide and iron in types b, c, and d is noted. The decrease in fineness of gold towards the centre of slugs, and in disintegrating detrital grains, is noted and attributed to enrichment due to etching or plating of the surface of slugs rather than to heat annealing of the impurities. (W.M.)

11-a-6 LIVERSIDGE, A., 1907 — Gold nuggets from New Guinea showing a concentric structure. *J. Proc. Roy. Soc. N.S.W.*, 40, 161-2.

Lobose concentric structure on the periphery of 2 unlocated gold nuggets from New Guinea is attributed to inheritance of the form of the surface of the cavity in which each was formed. The inner parts of the nuggets are spongy and show no crystalline or concentric structure. (W.M.)

11-a-7 PONTIFEX, I. R., 1967 — Descriptions of ore specimens. (*In* YATES, K. R., & de FERRANTI, R. Z. — Geology and mineral deposits, Port Moresby/ Kemp Welch area, Papua. *Bur. Miner. Resour. Aust. Rep.* 105 (*Rep. PNG* 1), 107-17.)

Ore samples from several copper-iron mines in the Astrolabe Mineral Field contain abundant pyrite and marcasite as primary iron sulphides, and chalcopyrite as the major copper mineral. Subordinate amounts of sphalerite, galena, and hematite may be accompanied by such gangue minerals as quartz, calcite, and chlorite. Gold occurs in minor amounts in some samples from the Laloki mine. (W.M.)

11-a-8 RANDS, W. H., 1901a — Report on samples of gold from Woodlark Island. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. GG, 132.

Samples of auriferous quartz, auriferous galena, and auriferous pyrite-galena ore in a quartz gangue are described, and gold and silver assay values quoted for some samples. (W.M.)

11-a-9 RANDS, W. H., 1901b — Report on alluvial gold from Gira and Yodda Valley, British New Guinea. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. HH, 132.

Rounded discoid flakes of gold from the Gira R. near the foot of Mt Albert Edward occur free of host quartz, and may have travelled some distance from the source.

Rounded and richer-coloured gold from the Yodda valley at the head of the Kumusi and Mambare Rs is thought to have been found close to the source. Quartz is found in association with gold in some specimens. (W.M.)

(b) MINERAL ANALYSES (INCLUDING HOT SPRING WATERS)

11-b-1 FERGUSON, J., & LAMBERT, I. E., 1970 — Geochemical investigations of the thermal area at Matupi Harbour, near Rabaul. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Thermal springs are entering Matupi Har. at its eastern and northern margins. The springs are enriching the sediments in iron, manganese, and zinc, but not copper or lead. The metals are disseminated through the sediments, but could conceivably be concentrated to ore grade by diagenetic or metamorphic processes. The environment is oxidizing and only minor amounts of the metals are being fixed as sulphides. The absence of bacterially-generated sulphide irons in the harbour sediments is possibly due to a general lack of organic nutrients for bacterial activity. (Auth.)

11-b-2 HEMING, R. F., 1969 — The mineral and thermal waters of the Territory of Papua-New Guinea. *Proc. 23rd int. geol. Cong., Prague,* 19, 293-304.

The major concentrations of thermal areas and springs are coincident with the volcanic arcs of the Territory and are intimately connected with dormant or extinct volcanism. Other thermal springs are found along the Owen Stanley Ra. in Papua and its continuation into New Guinea. This difference in geological setting is reflected in the type of thermal activity found, and makes possible a major division of thermal waters on the basis of apparent composition and occurrence. (Auth.)

11-b-3 LIVERSIDGE, A., 1880a — Water from a hot spring, New Britain. *J. Proc. Roy. Soc. N.S.W.,* 14, 145.

An analysis of the residue on evaporation to dryness of an unlocated sample of hot spring water from New Britain is quoted. (W.M.)

11-b-4 LIVERSIDGE, A., 1880b — Water from a hot spring, New Britain. *Chem. News* (*Lond.*), 42, 324.

This is a re-issue of entry 11-b-3.

11-b-5 LIVERSIDGE, A., 1890a — Note upon the hot spring waters, Fergusson Island, D'Entrecasteaux Group. *Brit. N. Guinea ann. Rep. for 1888-89,* (*Qld*), App. U, 52-3 (also issued as *Brit. N. Guinea ann. Rep. for 1888-89, (Vic.)*, App. B, 31-2).

Partial chemical analyses of 4 samples of hot spring water from Seymour Bay, Fergusson I., are quoted and the composition of the fixed solids fraction is noted. The source fumarolic area is described. (W.M.)

11-b-6 LIVERSIDGE, A., 1890b — Notes on some hot spring waters — (a) Note upon the hot spring waters, Fergusson Island, D'Entrecasteaux Group. *Rep. 2nd Australas. Ass. Adv. Sci., Cong., Melbourne,* 2, 388-92.

This is a re-issue of entry 11-b-5.

11-b-7 LIVERSIDGE, A., 1892 — Note upon samples of hot spring water, Fergusson Island, British New Guinea, procured by Sir Wm Macgregor. (*In* THOMPSON, J. P. — BRITISH NEW GUINEA. *London, George Philip,* 215-7.)

This reproduces part of entry 11-b-5.

11-b-8 MURRAY, J. H. P., 1934 — Annual report, Lieutenant-Governor. *Papua ann. Rep. for 1932-33,* 1-30 and 37 (also issued as *Aust. parl. Pap. 220, Sess. 1932-34,* 3, 1826-56 and 1863).

Osmiridium from the Milne Bay district was analysed, and found to contain Pt 82.71%, Ir 0.79%, Os 3.36%, Au 0.94%, Pd 0.74%, Ph 1.79%, and 9.94% of undetermined base metals.

Some mineral production statistics for the various mineral and gold fields are given, and export figures indicate the amount and value of exports of copper, gold, gold ore and concentrates, and osmiridium for each of the preceding 5 years. (W.M.)

12 ECONOMIC GEOLOGY

(a) General

See also entries

01-b-19	02-b-168	03-d-12	13-b-24
02-a-18	02-b-170	12-a-21	13-b-51
02-b-102	02-b-176	12-c-6	17-a-2
02-b-151	02-c-5	12-i-33	
02-b-152	02-c-46	12-i-36	
02-b-166	03-a-15	12-i-76	

12-a-1 ANONYMOUS, 1915b — The economic resources of the German colonies — IV — Pacific possessions. *Bull. imp. Inst. Lond.,* 13, 559-81.

The mineral, agricultural, and forestry resources of the German possessions of Samoa, New Guinea, and Kiaochow, and the trade of all German possessions in Africa and the Pacific are described.

The general geography and geology of the islands are outlined, including river and mountain systems and land-use potential. Resources of phosphate, gold, petroleum, coal, and minor other minerals are noted. Phosphate was mined and exported from Nauru and Angaur; gold in economic deposits is not known from German New Guinea; petroleum may be found in the northwest; brown coal is reported in small amounts near Astrolabe Bay; other minor minerals mentioned are copper, rare and gem minerals associated with ultramafics, graphite, limestone, and clay. (W.M.)

12-a-2 AUSTRALIA. PARLIAMENT, 1928 — Annual report — mining. *New Guinea ann. Rep. for 1926-27,* 76-77 (also issued as *Aust. parl. Pap. 238, Sess. 1926-28,* 2, 1832-3).

Gold is being exploited in the Morobe District, where it occurs in alluvial deposits and in north-northwest-trending lodes. Copper in payable quantities was found at Nakanai in New Britain, and a large deposit of hematite and magnetite at Rangarere on the south coast of New Britain. Osmiridium was found on the Ramu R., and silver in the Bulolo R. Coal has been found on the Markham R., and near Aitape and Namatanai in New Ireland. Exports are given for gold over the previous 3 years. (W.M.)

12-a-3 AUSTRALIA. PARLIAMENT, 1951 — Annual report — land and natural resources. *New Guinea ann. Rep. for 1950-51,* 35-6 and 167 (also issued as *Aust. parl. Pap. 86, Sess. 1951-53,* 4, 1220-1 and 1452).

Gold deposits in the Warambu R. area of the Gazelle Pen. are not economic because of the high cost of transport. Sulphur is present around the active volcano Mt Balbi on Bougainville, but not in economic quantities. The active volcano Mt Bogana was inspected. Production figures for the preceding 5 years for gold and gold bullion, osmiridium, platinum, iridium, and silver are appended. (W.M.)

12-a-4 AUSTRALIA. PARLIAMENT, 1952 — Annual report — mining and geology. *New Guinea ann. Rep. for 1951-52,* 71-4 and 167 (also issued as *Aust. parl. Pap. 178, Sess. 1951-53,* 4, 1530-3 and 1626).

A small rich quartz-gold reef was located in the Waria R. near Garaina, intrusive into ultrabasic rocks and serpentinite containing disseminated chromite and platinum. Alluvial gold is shed from numerous quartz bodies associated with an irregular intrusive contact of granodiorite and schist at the head of Yanki (Yonki) Cr. near Kainantu. Production figures for the year for gold and gold bullion, osmiridium, platinum, and silver are appended.

Several minor earth tremors were recorded at Rabaul, where solfataric activity on Tavurvur appears to be declining. Bogana and Balbi on Bougainville showed a slight increase in activity, as did Langila in western New Britain. Small submarine volcanic disturbances are noted from near Karkar I. and Mt Vulcan near Madang. (W.M.)

12-a-5 AUSTRALIA. PARLIAMENT, 1956 — Mineral resources. *New Guinea ann. Rep. for 1955-56,* 71-2 and 172 (also issued as *Aust. parl. Pap. 64, Sess. 1957,* 5, 162-3 and 263).

Gold is the principal mineral product, and by-product silver, platinum, and osmiridium are recovered. Minor deposits of manganese, lead, copper, zinc, bauxite, sulphur, and iron ore are known. Production figures for gold, platinum, silver, osmiridium, and iridium over the previous 5 years are appended.

Alluvial and lode mining are the main methods of extracting gold, but activity and returns decreased during the last year. A total of 2420 kg gold was produced, including 1040 kg from dredging and 400 kg from lode mining. (W.M.)

12-a-6 AUSTRALIA. PARLIAMENT, 1961 — Annual report — mineral resources. *New Guinea ann. Rep. for 1959-60,* 84-7 and 214 (also issued as *Aust. parl. Pap. 35, Sess. 1961,* 4, 229-32 and 359).

Gold and platinum are being won by alluvial methods, and copper is known to occur, between Wabag and Aiome. Alluvial and reef gold is widespread around Kainantu. Copper mineralization in the Crown Prince Ra. near Kieta on Bougainville and magnetite beach sands on Bougainville are not presently economic. Low-grade bauxite occurs on the northern coastline and hinterland of New Hanover Is.

The amount and value of gold, silver, and platinum exported in each of the previous 5 years are tabled. At times Manam and Bam volcanoes have been active. (W.M.)

12-a-7 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1954 — Annual report — mining and geology. *Papua ann. Rep. for 1953-54,* 39-40 and 132 (also issued as *Aust. parl. Pap. 121, Sess. 1954-55,* 4, 966-7 and 1059).

There are no coals in Papua suitable for coking or smelting. Small parcels of copper carbonate from the Astrolabe field and manganese dioxide (pyrolusite) from Rigo have been exported. Magnetite, secondary copper minerals, and gold on the south coast of Woodlark I. are being assessed. Hematite with a low content of copper is reported from between Rigo and the Kemp Welch R. Tables of export figures give amounts and values of exports of gold, silver, platinum, copper, and manganese for the year. Prospecting activity by petroleum exploration companies, and current geological surveys are listed. (W.M.)

12-a-8 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1958 — Annual report — mining and geology. *Papua ann. Rep. for 1957-58,* 48-50 and 140 (also issued as *Aust. parl. Pap. 76, Sess. 1959-60,* 4, 599-601 and 691).

Several reported shows of oil and gas in exploration wells in western Papua are noted. Nickel has been prospected in the soils on the ultrabasic rocks in the Musa Valley, but results were disappointing. Geological investigation of these areas revealed large areas of low-grade nickel-cobalt mineralization. Outlying islands have been prospected unsuccessfully for phosphate. Tables list production for the preceding 5 years for gold, silver, platinum, copper, and manganese. (W.M.)

12-a-9 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1960 — Annual report — mining and geology. *Papua ann. Rep. for 1959-60,* 56-8 and 174 (also issued as *Aust. parl. Pap. 84, Sess. 1961,* 4, 803-5 and 921).

Shows of oil were encountered in the Puri well in western Papua. Nickeliferous laterites in the Ajura Kujura Mts were tested but proved uneconomical because of low nickel content and thick overburden. On Goodenough and Fergusson Is potential economic deposits of mica and pumice are being assessed. Tables show production for gold, silver, platinum, osmiridium, and manganese ore for the previous 5 years. (W.M.)

12-a-10 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1964a — Annual report — mining and geology. *Papua ann. Rep. for 1962-63,* 67-9 and 201.

Alluvial gold accumulation at Javerare near Port Moresby were found to be too small to be economic. Copper deposits at C. Vogel, Goodenough Bay, and on Woodlark I. were investigated, with similar results. Tables list production over the preceding 5 years for gold, silver, platinum, osmiridium, and manganese ore. (W.M.)

12-a-11 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1966a — Annual report — mining and geology. *Papua ann. Rep. for 1964-65,* 57-9 and 195-6 (also issued as *Aust. parl. Pap. 279, Sess. 1964-66,* 21, 638-40 and 776-7).

No large mineral deposits are known, but small quantities of gold, platinum, osmiridium, manganese, nickel, copper, lead, iron, coal, sulphur, pottery clays, and gemstones have been located. Small amounts of copper, manganese, and gold have been mined. Production figures for 1964-65 are given for gold, and a summary is given of prospecting for gold, copper, magnetite, and petroleum. Geological and geophysical activity is reported. Tables give production for the years 1961 to 1965 for gold, silver, platinum, osmiridium, and manganese ore. (W.M.)

12-a-12 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1966b — Annual report — mining and geology. *Papua ann. Rep. for 1965-66,* 76-9 and 265.

Black sands on beaches between the Fly and Purari Rs contain abundant magnetite, but also have a high titanium content. Rutile and zircon are present in small amounts. Phosphate and industrial clay were unsuccessfully prospected inland from the Gulf of Papua. Production figures for the previous 5 years for gold, silver, platinum, osmiridium, and manganese ore are appended. (W.M.)

12-a-13 AUSTRALIAN INSTITUTION OF ENGINEERS, 1924 — THE POWER RESOURCES OF THE COMMONWEALTH OF AUSTRALIA AND MANDATED TERRITORY OF NEW GUINEA — REPORT TO THE WORLD POWER CONFERENCE, LONDON, 1924. *Sydney, Govt Printer* (also issued as pp. 1-145 in *Vol. 1* of *Transactions First World Power Cong.,* London, 1924).

Water resources of Papua New Guinea are assessed by E. R. Stanley who briefly discusses the geomorphology and rainfall data. Rates of flow from the Fly, Strickland, Alice, and Palmer Rs are quoted as examples of power available. The establishment of a power station on the Laloki R. near Port Moresby is noted.

Coal resources of Papua New Guinea are regarded as almost nil. An average of several analyses is quoted, and localities of lignite and the possibility of reserves of higher-rank coals in inland areas are described. Petroleum has not been found in commercial quantities. The history of discovery of the Pliocene to Miocene oil occurrences, and their affinities to the Borneo deposits, are noted. (W.M.)

12-a-14 BROOKFIELD, H. C., 1965 — An assessment of natural resources. (*In* FISK, E. K. (Ed.) — NEW GUINEA ON THE THRESHOLD. *Canberra, ANU Press,* 44-79.)

Among the resources of Papua New Guinea are a small number of unexploited mineral reserves. Gold resources have been developed in the Bulolo Valley but now appear to be a waning resource. Lateritic soils on ultrabasic rocks may contain nickel and 3 low-grade deposits are known. Natural gas is known in the Gulf of Papua region but its extent has yet to be demonstrated. Other unassessed resources in large amounts include limestone, and water as a source of hydro-electric power. (W.M.)

12-a-15 CARNE, J. E., 1913a — Notes on the occurrence of coal, petroleum and copper in Papua. *Papua Bull.* 1, 1-116.

3 papers are given on the history of discovery and assessment of potential economic deposits or accumulations of coal, petroleum, and copper in parts of Papua, and of

the development of the copper mines in the Astrolabe Mineral Field. Each is abstracted separately (entries 12-d-2, 12-c-24 and 12-e-10). (W.M.)

12-a-16 CUMBERLAND, K. B., 1960 — SOUTHWEST PACIFIC. *Christchurch, Witcombe & Toombs,* xviii + 369 pp.

In New Guinea the major mining development has been the exploitation of alluvial gold in the Bulolo and Watut Rs. Production up to 1960 was valued at $A60 million. Most gold is produced by dredging placer deposits, with some alluvial sluicing and minor lode mining. Small quantities of gold have been won from the Sepik, Ramu, and Purari Rs. Small amounts of silver, manganese, and platinum are reportedly mined. (W.M.)

12-a-17 DAVIES, H. L., 1971c — Ultramafic rocks and associated mineralization in Papua New Guinea. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 423-4.

Nickel-enriched soils occur over both tectonite and cumulus types of ultramafics. Nickel and copper sulphides occur in the gabbro layer within 1 km of the gabbro-ultramafic contact, and copper sulphides occur with pyrite in the overlying basalts. In both cases sulphide mineralization may have been located by younger (Eocene and late Miocene) intermediate and acid intrusives, which have also introduced some gold. Small quantities of alluvial platinum and osmiridium are associated with the Papuan ultramafics and have possibly shed from Bushveld-type concentrations in the cumulus rocks. Chromite is disseminated throughout the tectonite ultramafics and in several instances is concentrated in lenses up to 15 cm thick; rare thin chromite-rich layers are also known from the cumulus ultramafics. Nickel-enriched soils are also known to occur over the Marum ultramafics, and alluvial gold and platinum have been found in streams draining the April ultramafics. (Auth.)

12-a-18 EDWARDS, A. B., & GLAESSNER, M. F., 1947 — The mineral resources of the Western Pacific Islands. *Proc. Australas. Inst. Min. Metall.,* 147, 75-227.

The geological and tectonic setting of the islands of the southwest Pacific are outlined, and they are regarded as a homogeneous mineral province. Mineral resources are described under substance, and their occurrence, exploitation, and potential discussed. (W.M.)

12-a-19 FISHER, N. H., 1965 — Economic geology of New Guinea, other than Petroleum. *38th ANZAAS Cong., Hobart,* Sec. C Abs. (listed by title in *Aust. J. Sci.,* 28, 312).

Except for detrital deposits, known metalliferous orebodies in Papua New Guinea are closely associated with igneous intrusives which fall generally into 3 groups: (1) granite or granodiorite bodies, pre-Permian to middle Tertiary; (2) basic and ultrabasic rocks, Cretaceous to Miocene; (3) minor intrusives and volcanics, andesites, dacites, and porphyries mainly from Miocene onwards.

Mineralization associated with the granodiorites consists mainly either of silicified contact zones containing pyrite, other metallic sulphides, and small amounts of gold, or of small gold-bearing quartz stringers in favourable structural situations near the granitic bodies, which give rise to payable alluvial concentrations of gold. Copper is present in places, and is being prospected.

Basic and ultrabasic intrusives are related to occurrences of nickel, cobalt, chromite, and asbestos, as well as copper and gold. The rough terrain and rapid erosion are not favourable for the accumulation in the soil profile of the nickel magnesian silicates but testing has shown values of up to 1 percent in several areas. Massive sulphide lodes containin a few percent of copper and minor gold occur in the Astrolabe field, associated with gabbro intrusive in Oligocene strata.

Most orebodies that have been worked are gold lodes associated with late Tertiary intrusives; they are all epithermal-type fissure veins, containing quartz, pyrite, and manganese. Gold is of low fineness, 560-750, silver content is high, secondary enrichment is evident, and grades worked were up to 15g Au/tonne. The rich alluvials of the Edie and Bulolo areas were derived largely from the weathering of small rich gold-bearing stringers associated with late Tertiary porphyries and volcanics. On Bougainville gold-copper veins and disseminated copper mineralization occur in a porphyry mass. (Auth./W.M.)

12-a-20 FISHER, N. H., 1966 — Metallogenic provinces in Papua and New Guinea. *Proc. 11th Pacif. Sci. Cong., Tokyo,* 4, II/9.

3 main metallogenic provinces can be distinguished in Papua New Guinea: (1) The 'Papua New Guinea Synorogenic' Metal Province; (2) The 'Oceanic' Metallogenic Province; (3) The 'Solomons Synorogenic' Metal Province.

The first, which contains the main gold fields, is characterized by repeated magmatic activity, starting with the emplacement of granodiorite, adamellite, etc., in early Mesozoic to early Tertiary time, followed by medium acid porphyries, and later by andesitic and rhyolitic volcanics, some of which have been intruded by later porphyries. Gold fineness ranges from above 800 for granodioritic gold through 750 for the deeper porphyries, down to 500 for the latest epithermal deposits, which are the most productive.

The 'Oceanic' metallogenic province includes the Papuan Basic Belt, copper-gold deposits near Port Moresby, and occurrences of basic and ultrabasic rocks in northwest New Guinea and the outer part of the Solomons Chain. The ultrabasic rocks of the Papuan Basic Belt, which were probably emplaced in early Tertiary time, are associated with copper-bearing sulphides, nickel minerals, gold, platinum and osmiridium, chromite, asbestos, and manganese, but no commercial deposits have been found.

The 'Solomons synorogenic' metal province includes the Central Solomons, and parts of New Britain and New Ireland. Dioritic masses of Miocene or earlier age are overlain by andesitic agglomerates and breccias. Important 'porphyry-type' copper-gold deposits have been discovered on Bougainville. (Auth.)

12-a-21 FORT, G. S., 1886 — Report on British New Guinea from data and notes by the late Sir Peter Scratchley, Her Majesty's Special Commissioner. Issued as *Qld parl. Pap.*, 4-20 and 21-42.

Gold is the most likely source of mineral wealth. Samples from near Port Moresby and Milne Bay have been examined, and the eastern ranges may be a possible site for discoveries of gold. Mercury has been seen at several places along the south coast. Mica slate, quartzite, sandstone, greenstone, jasperoid rocks, granite, and gneiss occur as debris in streams draining the eastern ranges.

12-a-22 JONES, O. A., 1947 — Ore genesis of Queensland. *Proc. Roy. Soc. Qld,* 59, 2-91.

The metallogenetic epochs in Queensland are compared with those of other areas, and it is noted that two main epochs were the cause of most of the mineralization in New Guinea. The late Permian-early Triassic Gympie Phase of the Gympie Epoch gave rise to gold and copper mineralization in the central cordillera and north coast region, and an unnamed Oligocene or Miocene phase gave rise to gold mineralization throughout the island. (W.M.)

12-a-23 KOWALD, C., 1897 — Report by Mr C. Kowald of a visit to villages in the Mount Yule Ranges, September 1895. *Brit. N. Guinea ann. Rep. for 1895-96*. App. V, 87-9.

In streams near Mt Drew in the Mekeo Ra., colours of gold were washed but no payable deposits located; these streams are the tributaries and lower reaches of the Biaru River south from Mt Yule. (W.M.)

12-a-24 LETT, L., 1938 — Mining. (*In* LETT, L. — THE OFFICIAL HANDBOOK OF PAPUA. *Port Moresby. Govt Printer,* 40-4.)

Mineral resources exploited include gold deposits on Woodlark and Misima Is, and on mainland fields at Milne Bay, Lakekamu and Tauri Rs, Yodda Valley, Kiveri Valley, and Gira R. An extensive low-grade copper field near Port Moresby was assessed and exploited on a small scale before 1927, and recently has been re-opened. A small field on Sideia I. has not been exploited. Gold should be sought on Sudest, Misima, and Normanby Is, and tin and wolfram on Fergusson I. The search for petroleum in western Papua is outlined and the presence of coal in this region noted. The distribution of gypsum, manganese, lead, zinc, and osmiridium are mentioned. (W.M.)

12-a-25 LYONS, A. P., 1911a — Warden's report, Lakekamu Goldfield, for year ended 30th June 1910. *Papua ann. Rep. for 1909-10,* 123-6.

The proclamation of the goldfield, and the initial developmental prospecting are recorded. All production is by alluvial methods. An estimated 85 kg gold was produced. (W.M.)

12-a-26 MCLEOD, I. R., 1965a — Australian Mineral Industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull. 72.*

This contains summaries, each listed and abstracted individually, on the source and estimated reserves of the following natural mineral resources in Papua New Guinea: aluminium and bauxite (entry 12-c-44), bentonite and Fuller's earth (entry 12-c-14), chromium and chromite (entry 12-c-45), brown coal (entry 12-d-3), cobalt (entry 12-c-46), copper (entry 12-c-15), gold (entry 12-b-76), graphite (entry 12-c-34), iron (entry 12-c-16), limestone (entry 12-c-47), manganese (entry 12-c-48), mercury (entry 12-c-35), mica (entry 12-c-36), nickel (entry 12-c-17), petroleum (entry 12-e-29), natural phosphates (entry 12-c-18), platinum and osmiridium (entry 12-c-19), silver (entry 12-c-49), stone, sand, and gravel (entry 12-c-20), sulphur (entry 12-c-37), titanium and zirconium (entry 12-c-50).

12-a-27 MURRAY, J. H. P., 1908 — Papuan mining — parts 1 and 2. *Aust. Min. Stand.,* April 1908, 331-2 and 358-9.

Gold was known before 1852. The first goldfield discovered was on Woodlark I. in 1888. Gold has since been found in the Mambare, Fly, Yodda, and Gira Rs, at Milne Bay, and in the Louisiade Arch. In all cases the gold has been shed from the metamorphic rocks of the highlands. All deposits except Woodlark and Louisiade are alluvial, and lie north of the main range. Most are worked by ground sluicing methods. The situation, development, and production of the Woodlark field is outlined. The gold occurs in lodes trending northeast through volcanics partly covered by coralline limestone and intruded by granitic rocks. Most alluvial production of gold has been from the Aikora, Gira, and Yodda fields in the Mambare and Gira Rs. Production figures are tabulated.

A payable copper field, the Astrolabe Mineral Field, is at the western edge of a large area of basalt and coarse conglomerate exposed in and east of the Astrolabe Ra. Copper also is known from Woodlark and St Aignan (Misima) Is. Galena and sphalerite accompany the copper in the Woodlark ore. Cinnebar is known from Normanby I., Cloudy Bay near Abau, and from the Mambare R. near Mt Scratchley. Osmiridium has been found in the Mambare and Gira Rs. Sulphur occurs on Fergusson and Dobu Is. Coal of low grade is known from several sites in the Purari R., at the mouth of the Oriomo R., near the Upper Fly R., and in the Strickland R. The only precious stones so far discovered are topaz and beryl from the upper Fly R. (W.M.)

12-a-28 NYE, P. B., 1954 — Territory of Papua. *In* NYE, P. B., & FISHER, N. H. — The mineral deposits and mining industry of Papua New Guinea. *Bur. Miner. Resour. Aust. Rep.* 9, 1-19.

Mineral deposits in Papua include gold, copper, and manganese, and from them gold, silver, copper, copper matte and copper ore, manganese ore, osmiridium, and platinum have been produced. The gold has been obtained from alluvial deposits and lodes and from copper deposits. Silver has been obtained along with the gold, but no separate record has been kept. The osmiridium and platinum have been won during the mining of alluvial gold deposits. A fairly intensive search is being made for petroleum, but there has not been any commercial production. The total value of mineral production to 30 June 1951, is estimated at $A8 million. (Auth./W.M.)

12-a-29 NYE, P. B., & FISHER, N. H., 1954 — The mineral deposits and mining industry of Papua New Guinea. *Bur. Miner. Resour. Aust. Rep.* 9.

This consists of two papers, which are abstracted separately (entries 12-a-28 and 12-b-58).

12-a-30 RAGGATT, H. G., NYE, P. B., & FISHER, N. H., 1946 — The mineral resources and industries of the Commonwealth of Australia and the Mandated Territory of New Guinea. *Proc. Australas. Inst. Min. Metall.,* 143, 188-282 (also issued separately by the Bureau of Mineral Resources, Geology and Geophysics, Canberra).

The known, exploited, and potential resources of minerals, metals, non-metals, coal, and petroleum are listed, and data are supplied for exploration expenditure and for tonnage and value of production and import for the period 1840-1944. For Papua New Guinea, products listed include gold and silver, and potential producing areas of phosphate and alluvial platinum and osmiridium are recorded. The expenditure on petroleum exploration is more than half the total for Australia and its Territories for the period 1840-1944. (W.M.)

12-a-31 SMITH, M. STANIFORTH C., 1909a — Geology and mining. *In* SMITH, M. STANIFORTH C., — HANDBOOK OF THE TERRITORY OF PAPUA (2nd Edn). *Melbourne, Govt Printer,* 62-67.

The main geological features of Papua are outlined, based on entry 02-b-112. The discovery of gold during the cruise of the *Rattlesnake* in 1852 is recorded, and the history of development and exploitation outlined. Annual production figures are listed for the period 1888-1889 to 1908-1909.

The Astrolabe copper field near Port Moresby covers about 2500 km² on the southwest slopes and foothills of the Astrolabe Ra. The copper mineralization occurs in altered shale and slate with indurated sandstone. These overlie steeply-dipping shale, sandstone, and limestone and are overlain by basalt and breccia in the Astrolabe Ra. In the 3 years of operation prior to 1909 about 380 tonnes of ore worth about $A16 000 were exported. (W.M.)

12-a-32 SMITH, M. STANIFORTH C., 1911b — Annual report — Department of Mines. *Papua ann. Rep. for 1910-11,* 20-3 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 584-7).

The investigation of coal deposits in western Papua is noted, and reports by Stanley on the Mt Yule area (entry 02-b-157) and the Astrolabe Mineral Field (entry 02-b-158) are mentioned. Comments on mining activity are extracted from appended mining wardens' reports (entries 12-b-61, 12-b-69, 12-b-90, 12-b-104), and summarized in tables listing gold production for the year for each goldfield, total gold production from the Territory each year since 1888, estimated total output for each field since 1888, and copper ore production figures from the Astrolabe Mineral Field since 1906. (W.M.)

12-a-33 SMITH, M. STANIFORTH C., 1912a — General report of the Director, Department of Mines. *Papua ann. Rep. for 1911-12,* 33-43 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 719-29).

Petroleum has been discovered in the Gulf of Papua coast area, between Kerema and the Purari R. The extent of the petroliferous area may be about 2300 km². Details of the original inspection are quoted from appended reports (entries 12-e-9, 12-e-18, and 02-b-159). Its composition is noted (entry 12-e-22).

Unsuccessful gold prospecting has been conducted at the head of the Tiveri and Tauri Rs, and from a base 200 km up the Vailala R. Total and annual production from all goldfields since proclamation and copper production from the Laloki Mineral Field are quoted. Appended reports from wardens of each field include production and mining activity data (entries 12-b-24, 12-b-102, 12-i-105). (W.M.)

12-a-34 SMITH, M. STANIFORTH C., 1912b — Geology. (*In* SMITH, M. STANIFORTH C. — HANDBOOK OF THE TERRITORY OF PAPUA (3rd Edn). *Melbourne, Govt Printer*, 88-96.)

The discovery and production of gold is outlined, with tables of output and value, and goldfields and gold-dredging rivers are delineated. Data are given on the Astrolabe Mineral Field. The petroleum field in western Papua is described, and entries 12-e-9 and 02-b-159 are quoted. (W.M.)

12-a-35 SMITH, M. STANIFORTH C., 1913 — Report of the Director, Department of Mines. *Papua ann. Rep. for 1912-13,* 31-44 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 417-31).

The Vailala oilfield was inspected and stratigraphic drill holes on 2 sites near the Vailala R. had reached about 75 m in shale and sandstone. An analysis of light petroleum from one bore is quoted.

Reports from wardens give data on prospecting and production in the gold and mineral fields (entries 12-b-91, 12-b-106, and 12-i-103), which is shown in 3 tables — gold production for the year by goldfield, total annual gold production since 1888, and total production since 1888 of each goldfield. A report on the Astrolabe copper deposits (entry 12-c-24) is quoted. (W.M.)

12-a-36 SMITH, M. STANIFORTH C., 1914a — Annual report from the Department of Mines. *Papua ann. Rep. for 1913-14,* 150-59 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1670-9).

The progress of the first geological survey of the Vailala Petroleum Field is reported, and entry 12-e-30 is quoted. Drilling of the field is progressing, but no results are to hand. Gold production figures for each field are tabulated, together with annual totals since 1888. Reports from wardens of gold and mineral fields (entries 12-b-92, 12-c-53, 12-c-60, 12-i-50, and 12-i-93) record production statistics and activity. The report on Murua (Woodlark) is hopeful. (W.M.)

12-a-37 SMITH, M. STANIFORTH C., 1917 — Report of the Director of Mines. *Papua ann. Rep. for 1914-15,* 137-44 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1341-8).

Entries 12-i-116 and 12-b-64 are quoted. Statistics from wardens (entries 12-i-51, 12-i-95, 12-i-104, 12-i-105, and 12-i-119) give gold production figures, and data on copper production and activity in the Astrolabe Mineral Field. (W.M.)

12-a-38 SMITH, M. STANIFORTH C., 1923 — Annual report from the Department of Mines. *Papua ann. Rep. for 1921-22,* 89-99 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 2031-41).

Mining development and production are limited to gold on Misima I., copper from the Astrolabe field, and petroleum drilling by the Anglo-Persian Oil Co. at Popo. Wardens' reports (entries 2-i-112 and 12-i-122) detail mining activity and production statistics. Stanley's report (entry 02-b-171) is incorporated. (W.M.)

12-a-39 SMITH, M. STANIFORTH C., 1926 — Report of Director, Department of Mines. *Papua ann. Rep. for 1924-25,* 54-5 (also issued as *Aust. parl. Pap. 41, Sess. 1926-28,* 2, 2118-9).

General progress of prospecting and development in the oilfields and the gold and mineral fields is reported. Tables list production of gold and copper for the year, and indicate total gold exported to date and annual production of copper since 1906. (W.M.)

12-a-40 SMITH, M. STANIFORTH C., 1927a — Report of Director, Department of Mines. *Papua ann. Rep. for 1925-26,* 64-5 (also issued as *Aust. parl. Pap. 100, Sess. 1926-28,* 2, 2210-1).

Development and exploration activities on the oilfields in the Vailala and C. Vogel areas, and on gold and mineral fields are reported. Tables show volume and value of production of gold and copper for the year together with annual totals for gold since 1888 and copper since 1906. (W.M.)

12-a-41 SMITH, M. STANIFORTH, C., 1927b — Economic geology. (*In* SMITH, M. STANIFORTH C. — HANDBOOK OF THE TERRITORY OF PAPUA (4th Edn). *Canberra, Govt Printer,* 138-52.)

A report on the geology of Papua (entry 02-b-171) is quoted and mineral production data are updated. Information is given on the occurrence of gold, petroleum, lead, zinc, copper, mercury, osmiridium, iron, sulphur, manganese, phosphates, gypsum, coal, mica, pottery clays, diatomaceous clays, and thermal spring deposits. Included is a list of rivers declared for gold dredging. (W.M.)

12-a-42 SMITH, M. STANIFORTH C., 1928 — Report of Director, Department of Mines. *Papua ann. Rep. for 1926-27,* 61-2 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28,* 2, 2331-2).

Exploration and development activity in oil, gold, and mineral fields are reported. Production figures for the year for each goldfield, production of copper and osmiridium, total production for each goldfield since 1888, and total annual gold production since 1888 are listed. (W.M.)

12-a-43 STANLEY, E. R., 1917b — Extract of remarks on the geology of Cape Vogel Peninsula. *Papua Govt Gaz.,* 12(8), 75.

The highlands of the C. Vogel Pen. are metamorphosed sedimentary rocks intruded by dykes with which copper, manganese, chromium, and nickel mineralization is developed. They are worth further investigation, particularly the nickel, chromite, manganese, and cobalt prospects in serpentinites. Petroleum may be found. Geological data are given for the lowlands. (W.M.)

12-a-44 STANLEY, E. R., 1918a — Annual report of the Government Geologist, Papua, for the year ending June, 1917. *Papua ann. Rep. for 1916-17,* 23 and 37-8 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1463 and 1477-8).

In the C. Vogel Pen. manganese, copper, and chromite occur in altered igneous rocks, overlain by Tertiary detrital sediments and Pleistocene limestone. Brown coal and lignite occur, and natural gas seepages have been reported. Copper deposits on Sideia I. run at 6.73 to 17.87% Cu, but proved less extensive than thought. Production from the Astrolabe field continues. Copper is being worked on Woodlark I. and some analyses are quoted. In Cannac or Inene I. near the Laughlan Is, a small deposit of phosphate was investigated.

Gold production for the year by goldfield, and volume and value of copper production, are listed. Wardens' reports (entries 12-b-66, 12-i-77, 12-i-106, and 12-i-107) give details of mining and exploration activity and production for each field. A table of exports give figures for the preceding 10 years for copper ore, gold and gold ore, and concentrates. (W.M.)

12-a-45 STANLEY, E. R., 1923e — Ore provinces in New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 805-6.

The location and field setting of major known deposits of gold, copper, osmiridium, tin, and manganese are discussed. It is suggested that most deposits developed in association with the pre-Mesozoic deformation. (W.M.)

12-a-46 THOMPSON, J. E., & FISHER, N. H., 1965 — Mineral deposits of New Guinea and Papua, and their tectonic setting. *Proc. 8th Comm. Min. metall. Cong. Australas.,* 6, 115-48.

Known mineral deposits in Papua New Guinea, mainly gold lodes and some copper, are associated with intrusions of (1) granodiorite, (2) basic and ultrabasic rocks, and (3) late Tertiary porphyries and andesite; 9 principal structural units are distinguished, of which the Owen Stanley Metamorphic Belt contains most of the important mineral deposits.

On the basis of the distribution of pre-Miocene plutonic rocks, 4 metallogenic provinces or regimes can be approximately defined: (1) Pre-Mesozoic continental metallogenic province, with a little high-fineness gold near granite contacts but no important lode deposits; (2) Oceanic metallogenic province, including areas of basic and ultrabasic rocks and their characteristic mineral associations; (3) Papua New Guinea synorogenic province, which contains the main goldfields, characterized by a history of repeated granodioritic magmatic activity; (4) Solomon synorogenic metal province (including New Britain), differing from (3) in the less acid composition of the older plutonic rocks and the close association of copper and gold.

The known hydrothermal gold, copper, lead and zinc mineralization occurs mainly within orogenic zones emergent since pre-Miocene time and characterized by andesitic volcanism and granodioritic to dioritic intrusives. The thick lower Miocene to Recent accumulations are virtually unmineralized. (Auth.)

(b) Gold Mineralization and Mining

See also entries

01-a-36	02-b-69	02-b-170	12-c-12
01-b-54	02-b-80	02-b-176	12-i-36
02-a-15	02-b-84	05-a-113	12-i-48
02-a-16	02-b-95	05-a-114	12-i-57
02-b-9	02-b-101	05-b-19	12-i-75
02-b-13	02-b-106	05-c-11	12-i-79
02-b-15	02-b-151	09-b-15	12-i-80
02-b-22	02-b-152	11-a-1	12-i-118
02-b-29	02-b-160	12-a-10	12-i-121
02-b-34	02-b-164	12-a-16	
02-b-67	02-b-166	12-a-32	

12-b-1 Anonymous, 1878a — ('Colonist' expedition near Port Moresby). *Nature,* 19, 15-6.

Prospectors found colours of gold in the Goldie R. near Port Moresby in early 1898, but none for about 80 km upstream from the first find. (W.M.)

12-b-2 Anonymous, 1917 — Annual report — Department of Mines. *Papua ann. Rep. for 1915-16,* 35 (also issued as *Aust. parl. Pap. 15, Sess. 1914-17,* 6, 1438).

Alluvial gold was found in the Imila R. west of the Kiveri R. Annual production figures for each goldfield are tabulated; a total of 10 930 oz valued at £43 248 was recovered. (W.M.)

12-b-3 Anonymous, 1927b — New Guinea goldfield. *Chem. Engng Min. Rev.,* 20(229), 24.

The Kaili alluvial prospect on the Bulolo R. is reported to contain 400 000 cu. yards of 5s. gold per cu. yard and 410 000 cu. yards of 2s. 4d. gold per yard, as well as a further 2 million cu. yards of untested alluvial deposits. (W.M.)

12-b-4 Anonymous, 1927c — New Guinea gold. *Chem. Engng Min. Rev.,* 20(230), 56.

A persistent 8-km long auriferous quartz reef in the Edie Cr. area is reported to carry £44 gold per ton. (W.M.)

12-b-5 Anonymous, 1928a — The Bulolo Goldfields, New Guinea. *Chem. Engng Min. Rev.,* 20, 153-6.

The early development of gold leases on the valleys and raised terraces of Edie Cr., Bulolo R., Koranga Cr. and tributary streams is traced. The Bulolo field is near the axis of the central fold of the Kratke Ra., flanked to the south by the Owen Stanley Ra., and to the north by the Markham-Ramu Trough and the Rawlinson and Finisterre Ras.

The exposed rocks are faulted and folded graphitic schist and slate intruded by granite and felsite. Auriferous quartz veins occur in crush zones in slate and felsite on the Edie Cr. field. Reef gold and quartz gold stockwork debris both appear in stream sediments, which have been the main centre of interest and development. (W.M.)

12-b-6 ANONYMOUS, 1928b — New Guinea goldfields, *Chem. Engng Min. Rev.*, 20(236), 258.

The discovery of an auriferous quartz lode at Edie Cr., on the line of the Day Dawn lode and cutting the trend of the Kaindi 1 and 4 lodes, is reported; 2 other small adjacent lodes carrying an estimated £4 gold per ton are noted in a shear zone near a slate-porphyry contact. (W.M.)

12-b-7 ANONYMOUS, 1928c — New Guinea gold. *Min. Mag.*, 38(1), 31.

A rich auriferous reef on Mears Cr. near Bulolo is reported to be 9 m wide and 8 km long, and to carry 29 oz gold per ton. (W.M.)

12-b-8 ANONYMOUS, 1928d — New Guinea gold. *Min. Mag.*, 38(5), 289.

Proven reserves of auriferous gravels on the Bulolo R., in the Guinea Gold South lease held by New Guinea Gold N.L., are 40 000 cu. yards carrying 5s. gold per yard and 5 million cu. yards carrying 2s. 6d. gold per yard. In the Kaili 4 lease, about 1 million cu. yards proven probably carry an average of 20s. gold per yard. The Keranga lease yielded 14s. gold per yard from material processed (1902 oz gold from 7042 yards, including overburden). (W.M.)

12-b-9 ANONYMOUS, 1928e — The Bulolo goldfield, New Guinea. *Min. Mag.*, 38(5), 310-3.

This is a re-issue of entry 12-b-5.

12-b-10 ANONYMOUS, 1929a — New Guinea. *Min. Mag.*, 40(2), 101.

The auriferous quartz reef in the Golden Peaks No. 4 lease in the Edie Cr. area, operated by New Guinea Goldfields Exploration Ltd, is reported to be up to 12m wide and to be the richest lode discovered in the area. (W.M.)

12-b-11 ANONYMOUS, 1929b — Another New Guinea venture. *Min. Mag.*, 40(6), 355.

An unlocated unnamed reef situated near the top of an unnamed mountain in the Edie Cr. area is reported to be 2 m wide, and carrying 3 oz gold per ton. (W.M.)

12-b-12 ANONYMOUS, 1930a — New Guinea. *Min. Mag.*, 42(5), 268.

On the New Guinea Goldfields lease in the Bulolo valley, the main ore zone is reported to have been traced for 2100 m, with values of 84s. 2d. gold per ton over 1.1 m ore reported from 360 m. Another lode is thought to contain 100 000 tons of ore assaying 103s. gold per ton. (W.M.)

12-b-13 ANONYMOUS, 1930b — Gold in New Guinea. *In* CONGRESS ORGANIZING COMMITTEE: THE GOLD RESOURCES OF THE WORLD — an enquiry made on the initiation of the Organizing Committee of the XV International Geological Congress, South Africa, 1929. *Pretoria, Bur. XV int. geol. Cong.*, 247-50.

Alluvial gold has been worked in the Waria, Markham, Bulolo, and Watut Rs, particularly in Edie Cr. where reef mining has begun. Host country rocks in the Edie Cr. area are micaceous and graphitic schists, quartzite, and mica diorite, as dykes and bosses. Mineralization is auriferous quartz veins genetically related to the diorite intrusives. A previously unpublished report by Schultze on the potential of the Waria R. alluvial deposits is quoted. It indicated small amounts of gold in lacustrine and fluviatile gravels derived from regional metamorphics, diorites, and related porphyry, granite, and serpentinite. Most rocks carry sulphide mineralization to some extent.

Production figures and values of gold exported for the period 1923-1929 are listed; 285 563 ozs worth £609 221 were exported. (W.M.)

12-b-14 ANONYMOUS, 1930c — Gold in Papua. *In* CONGRESS ORGANIZING COMMITTEE: THE GOLD RESOURCES OF THE WORLD — an enquiry made on the initiation of the Organizing Committee of the XV International Geological Congress, South Africa, 1929. *Pretoria, Bur. XV int. geol. Cong.*, 275-7.

Reef gold in Papua occurs as auriferous quartz veins in decomposed porphyries and diorites; intruded schists may occasionally contain workable quantities of disseminated gold. Most gold worked has been won from alluvial deposits shed from supposed Precambrian metamorphics.

Production figures for each year of the period 1888-89 to 1925-26 are quoted: a total of 541 931 oz worth £1 707 212 have been produced. The date of proclamation and estimated output of each field are tabulated. (W.M.)

12-b-15 ANONYMOUS, 1932a — A New Guinea gold mine. *Min. Mag.,* 5, 58-9.

This is a re-issue of entry 12-b-84.

12-b-16 ANONYMOUS (W. F. WHITE), 1932b — Transporting dredges by air. *Min. Mag.,* 47, 66-7.

This article abstracts and comments on entry 12-b-36.

12-b-17 ANONYMOUS, 1932c — The air transport of dredges. *Min. Mag.,* 47, 113-17.

This summarizes entry 12-b-35.

12-b-18 ANONYMOUS, 1933b — Gold mining in New Guinea. *Min. Mag.,* 49(3), 183-5.

This summarizes entry 12-b-107.

12-b-19 ANONYMOUS, 1937b — Tiveri gold dredge. *Chem. Engng Min. Rev.,* 29, 44-5.

A small-capacity dredge, which could be broken down to pieces weighing less than 0.4 tonne, was set up on Fish Creek near Bulldog on the Lakekamu River. 34 buckets each of capacity 1¼ cu. ft moved auriferous gravels to sluice and riffle boxes, the gold and associated abundant heavy black sand being accumulated in boxes lined with expanded metal and coir matting. Gold was then amalgamated from the concentrate. About 1750 oz gold has been won in the 2 years 1935 and 1936, at an average cost of 8.0 pence per cu. yard handled. (W.M.)

12-b-20 ANONYMOUS, 1940b — Gold in New Guinea. *Min. Mag.,* 62(5), 305-8.

This summarizes entry 12-b-56.

12-b-21 ANONYMOUS, 1944b — Gold mining in New Guinea, industry's development reviewed. *Min. J.,* 223(5698), 677.

The history of gold prospecting and mining in the Watut-Bulolo area is outlined, and glowing predictions are made on the mineral wealth to be discovered throughout New Guinea after the war. (W.M.)

12-b-22 ANONYMOUS, 1946 — Fineness of gold. *Min. Mag.,* 74(4), 265-6.

This summarizes entry 12-b-57.

12-b-23 ANONYMOUS, 1952 — Gold-bearing clay ore in New Guinea. *Min. Mag.,* 87(1), 53-5.

This summarizes entry 12-b-67.

12-b-24 ARMIT, L. P. B., 1912 — Warden's report, Lakekamu Goldfield, for 1911-12. *Papua ann. Rep. for 1911-12,* 38-40 (also issued as *Aust. parl. Pap. 87, Sess, 1912, 3,* 724-6).

Principal production was from Ironstone, Rocky, Cassowary, and Robertsons Crs; most operations are concentrating on creek banks and terraces. An estimated 6500 oz gold were produced. The upper reaches of the Vailala R. were unsuccessfully prospected for gold. (W.M.)

12-b-25 ARMIT, W. E., 1900 — Report of the Resident Magistrate for the North-east coast and Mambare district. *Brit. N. Guinea ann. Rep. for 1898-99,* App. U, 89-92.

Some 2000 oz gold were won from Colemans Gully, a tributary of the Gira R.; an estimated 6000 oz were taken from 4 small rich gullies feeding into Tamata Cr. It is thought that as much as 10 000 oz were produced on the Gira field during the year. The gold is derived from schist and slate which are intruded by diorite and 'rotten granite'; numerous so-called terraces on Finnegans Hill may contain gold as the source of present stream deposits. (W.M.)

12-b-26 ARMIT, W. E., 1901a — Report of Resident Magistrate, Northern Division. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. Q, 84-6.

Small rich pockets of alluvial gold have been found on the eastern slopes of Mt Albert Edward. The extent of gold-bearing gravels in the Yodda valley has been greater than previously thought; the use of hydraulic sluicing as the mining method is advocated. It is thought that the river terraces in the Gira R. carry a good quantity of gold. (W.M.)

12-b-27 AUSTRALIA. PARLIAMENT, 1924 — Lands, mines and forestry. *New Guinea ann. Rep. for 1922-23,* 52-3 (also issued as *Aust. parl. Pap. 89, Sess. 1923-24,* 4, 671-2).

Prospecting and assessment of alluvial gold deposits in the Bulolo and lower Waria Rs is reported, and an application to mine coal and related minerals on the Lai coast of Huon Pen. is noted. (W.M.)

12-b-28 AUSTRALIA. PARLIAMENT, 1927 — Lands, mining and forestry. *New Guinea ann. Rep. for 1925-26,* 23-4 and 43 (also issued as *Aust. parl. Pap. 117, Sess. 1927-28,* 2, 1670-1 and 1690).

The discovery of gold on Edie Cr. is noted, and the nature of the report suggests the deposits are alluvial and of high quality. A total of 10 067.5 oz gold, valued at £25 169, was exported during the year. (W.M.)

12-b-29 AUSTRALIA. PARLIAMENT, 1929 — Mining. *New Guinea ann. Rep. for 1927-28,* 56-8 (also issued as *Aust. parl. Pap. 53, Sess. 1929,* 2, 2787-9).

Alluvial gold has been found in a north-northwest-trending belt, in the Waria, Markham, Bulolo, and Watut Rs, and has been exploited mainly in Edie and Koranga Crs which flow into the Watut. Gold export figures for the years 1924-25 and 1927-28 are tabulated; 113 874 oz, valued at £256 216, were exported in 1927-28. (W.M.)

12-b-30 AUSTRALIA. PARLIAMENT, 1931 — Annual report — Mining. *New Guinea ann. Rep. for 1929-30,* 91-4 (also issued as *Aust. parl. Pap. 242, Sess. 1929-31,* 4, 226-9).

The discovery of low-grade alluvial deposits of gold at Kupei near Keita, and on the Yonat (Yuat) R., is reported. Lode gold was found in Hidden Valley, at the head of the Watut R. (W.M.)

12-b-31 AUSTRALIA. PARLIAMENT, 1932 — Annual report — Mining. *New Guinea ann. Rep. for 1930-31,* 86-91 (also issued as *Aust. parl. Pap. 88, Sess. 1932-34,* 3, 1647-52).

Gold was discovered and worked in the coastal fall of the Kupu Ra. east of Wau. Payable gold deposits were located on Ornapinka Cr., a tributary of the upper Ramu R. Gold also was discovered near Kavieng and on the Guam R. west of Madang. Several new lodes in the Edie Cr. field were located and prospected. (W.M.)

12-b-32 AUSTRALIA. PARLIAMENT, 1934 — Annual report — Mining. *New Guinea ann. Rep. for 1932-33,* 104-8 (also issued as *Aust. parl. Pap. 220, Sess. 1932-34,* 3, 1929-33).

Several new payable deposits of alluvial gold are reported from the upper Ramu R. and from the headwaters of the Purari R. Payable lode gold was found near Kieta on Bougainville and at Talele in the Bainings district of New Britain. Production and exploration activity in the Morobe Field around Wau and Edie Cr. are outlined; a total of 195 623 oz gold and silver bullion, valued at £928 438, was produced by alluvial, dredge, and lode mining methods. (W.M.)

12-b-33 AUSTRALIA. PARLIAMENT, 1935 — Annual report — Mining. *New Guinea ann. Rep. for 1933-34,* 94-6 (also issued as *Aust. parl. Pap. 145, Sess. 1934-37,* 2, 937-9).

New discoveries of gold are reported from unlocated sites in the Morobe and Sepik districts, and from Tatau I. east of New Ireland. The gold from the Sepik contained small amounts of platinum. A total of 257 058 oz gold and silver bullion, valued at £1 365 334, was produced during the year, mostly from the Morobe and Sepik fields. (W.M.)

12-b-34 AUSTRALIA. PARLIAMENT, 1937 — Annual report — Mining. *New Guinea ann. Rep. for 1935-36,* 76 and 90-3.

A new discovery of payable alluvial gold in the Wampit R. in the Morobe District is reported. The streams inland from Wewak have been successfully prospected for gold by small operators. Gold bullion produced was 302 060 oz, valued at £1 704 498, almost all of which was produced in the Morobe Field. (W.M.)

12-b-35 BANKS, C. A., 1932a — Air transportation of gold dredges in New Guinea. *Trans. Instn Min. Metall.,* 41, 616-31, with discussion 631-8.

The geological and physiographic setting of the auriferous gravels of the Bulolo R. warranted the air-lifting of dredging equipment to the site, which consisted of a 7-km stretch of the bed and flats averaging 600 m in width and with an average depth of 7 m of gravel. 40 million cu. yds of gravel carrying 5s. gold per yard were proven recoverable. The gold was 650 fine and is distributed throughout the gravel with some concentration near the bottom. A further 60 million cu. yds of gravel carrying 3s. gold per yard were proven immediately downstream from the original project site in early 1930.

The reasons for, and method of, air transportation of dredging and ancillary equipment to the site are discussed. (Further information on air movement of larger dredges to this site during 1930 and 1931 is given by this author in a paper 'Air transportation and operation of gold dredges in New Guinea' in *Trans. Instn Min Metall.,* 46 (1937), 803-13.) (W.M.)

12-b-36 BANKS, C. A., 1932b — Air transportation of gold dredges in New Guinea, *Bull. Instn Min. metall.,* 334-5, 1-16.

This is a re-issue of entry 12-b-35.

12-b-37 BELL, L. L., 1908 — Annual report on Gira Goldfield. *Papua ann. Rep. for 1906-07,* 84-6 (also issued as *Aust. parl. Pap. 160, Sess. 1907-08,* 2, 1508-10).

The distribution and general profitability of the worked alluvial claims on creeks in this field are discussed. An estimated 5000 oz gold were won during the year. (W.M.)

12-b-38 BLANCHARD, R., 1933 — Chemical migration — post-mine phenomena in New Guinea. *Engng Min. J.,* 134, 365-8, 425-8.

The mines at Edie Cr. are used in a case-history study of the chemical migration of gold and silver in manganese-bearing groundwater and mine water. (W.M.)

12-b-39 BRAITHWAITE, J. B., 1938 — Gold mining in New Guinea. *Chem. Engng Min. Rev.,* 30(151), 167-73.

4 auriferous reefs are being worked at Edie Cr. by adit and shaft methods to depths of as much as 150 m. At Golden Ridges mining of reefs is by open-pit method, but reserves are considered almost worked out; drilling at Upper Ridges has proven ore at depth which will be mined by underground methods. Only one payable reef is being worked at the Day Dawn mine complex, where 1 oz gold per ton with 'appreciable' silver occurs. Several small unproven veins are known in the area.

Alluvial working of gold is being carried out on the Wau, Watut, and Bulolo Rs and their headwater streams. Large volumes of low-grade reserves have been proven, and current and recent alluvial working has mostly used free-sluicing techniques. The existence and early-stage development of small 'shows' in Yonki and Sepik fields are noted. (W.M.)

12-b-40 BUCHANAN, W. E., 1898 — Report of proceedings of prospecting party to the Kemp Welch district, May to November 1897. *Brit. N. Guinea ann. Rep. for 1896-97,* App. V, 72-3.

Good colours of gold were found in the east branch of the Kemp Welch R. near its junction with the west branch. Traces of gold were found in the upper reaches of the east branch, but not in any of its tributaries. The country northwest of Mt Obree is quartz-veined slate, but is barren of gold. Promising colours were found in a terraced stretch of the Kemp Welch R. west of Mt Nesbitt, though the bottom of these deposits could not be reached. (W.M.)

12-b-41 CAMPBELL, A. M., 1899 — Report of the Resident Magistrate for the South-Eastern Division. *Brit. N. Guinea ann. Rep. for 1897-98,* App. O, 99-101.

Alluvial gold digging on Tagula (Sudest) I. is producing very small amounts of gold as a result of reduced activity and lower grade of ore. Reef mining continues with moderate success on Mt Adelaide. On Misima (St Aignan) I. alluvial gold digging is continuing with moderate success, but no payable reefs have been found. Woodlark (Murua) I. is being worked for alluvial gold at Suloga Cr. and Kalamadau. (W.M.)

12-b-42 CAMPBELL, A. M., 1904 — Report on Eastern Division. *Brit. N. Guinea ann. Rep. for 1902-03,* 23-9 (also issued as *Aust. parl. Pap. 13, Sess. 1904,* 2, 23-9).

Some alluvial work is done on gold-bearing sediments in tributaries of the Sagarai R.; no estimate of production is made. (W.M.)

12-b-43 CAMPBELL, A. M., 1905 — (No title — annual report on Eastern Division). *Brit. N. Guinea ann. Rep. for 1903-04,* App. B, 24-8 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 2, 24-8).

The Milne Bay goldfield is near Gibera, where all workings are alluvial; some alluvial production from the Kiveri R. occurs spasmodically. An estimated 14 976 oz gold, valued at £52 083, were produced during the year. (W.M.)

12-b-44 CHESTER, H. N., 1894 — Report of the Resident Magistrate for the Louisiades. *Brit. N. Guinea ann. Rep. for 1892-93,* App. L, 47-50.

Some alluvial gold mining continues on Misima I. but no reefs have been located. Most mining on Sudest I. is alluvial, though a gold-bearing reef near the western end of the island is being worked on a small scale and another nearby is being opened out. (W.M.)

12-b-45 CHINNERY, E. W. P., 1919 — Stonework and goldfields in British New Guinea. *J. Roy. anthrop. Inst.,* 49, 271-91.

The sites of discovery of a suite of stone mortars and pestles, carvings, pottery and implements from Papua are recorded. The implements are often described as being formed from shell, ophicalcite, granite, sandstone, a jade-like rock, quartz, or obsidian. Stone circles and stonework are recorded from Goodenough Bay, and D'Entrecasteaux and Rossel Is. Several stone objects from German New Guinea are recorded. These articles are recognized as having religious uses, though many may have been used in early exploration and exploitation of gold deposits by a cultural group different from and antedating the present Papuan peoples. (W.M.)

12-b-46 DECOTO, L. A., 1930 — Tapping a new gold field of potential importance. *Engng Min. World,* 129, 250-1.

The location and topography of the Morobe goldfield is outlined, and methods of access discussed. Prospecting and pegging procedures and costs are mentioned. The first discovery of gold was made on Koranga Cr., and this find produced gold for about a year before Edie Cr. was discovered. Edie Cr. gold was coarse and associated with abundant quartz in small very rich alluvial deposits. Source reefs were located and exploited in the Day Dawn Mine. Initial surveys suggest other workable lodes are present in this area. (W.M.)

12-b-47 DICKINSON, A., 1933 — New Guinea. *Min. Mag.*, 48, 265-77.

Gold workings of New Guinea Goldfields Ltd in the Bulolo-Wau-Edie Cr. area in 1928-29 are described. (W.M.)

12-b-48 DOUGLAS, J., 1889 — Sudest and the Louisiade Archipelago. *Proc. Roy. geogr. Soc. Australas., Qld Br.*, 4, 2-16.

The history of discovery and exploration of the eastern Papuan islands is traced from Torres through Dampier, Bougainville, D'Entrecasteaux, and D'Urville, to Owen Stanley. The discovery of gold on Sudest in 1889 is noted. (W.M.)

12-b-49 DUNKIN, H. H., 1950a — Operations of the Bulolo Gold Dredging Ltd. *Chem. Engng Min. Rev.*, 42, 177-89, 222-34, 269-79, and 308-18.

The discovery of gold at Edie Cr. in 1924 is noted, and an outline given of the early exploration, assessment, and site development of the dredging sites on the Watut R. at Wau. The report deals mainly with engineering aspects of site development, maintenance, and post-war rehabilitation. Structure of early mining companies, and some production figures are included. (W.M.)

12-b-50 DUNKIN, H. H., 1950b — OPERATIONS OF THE BULOLO GOLD DREDGING LTD. *Melbourne, Tait,* 52 pp.

This is a re-issue of entry 12-b-49.

12-b-51 EMMONS, W. H., 1937 — Australasia-British East Indies. *In* EMMONS, W. H. — GOLD DEPOSITS OF THE WORLD. *N.Y.* and *London, McGraw-Hill,* 454-7.

The main gold-producing area in New Guinea is the Edie Cr. field, where 285 563 oz gold were won in the period 1922-March 1929. 211 099 oz were won in 1934 from New Guinea. At Edie Cr. the gold mineralization occurs as auriferous quartz reefs cutting porphyry intruding faulted mudstone and schist. The ore is oxidized and consists of quartz and calcite with some rhodochrosite, wad, and limonite; gold-silver ratio is 1 : 30. The ore is brecciated and there is evidence of supergene enrichment of gold. Nearby alluvial deposits in the Waria R. contain a reputed 915 million cu. yards of wash carrying 4d. gold per yard.

In Papua, gold is won mainly from alluvial placers, and is thought to be derived from schist, porphyry, and diorite of supposed Precambrian age. On Woodlark I. production is from auriferous quartz lodes which intrude volcanics and carry pyrite and galena. From 1888 to July 1926, Papua produced 541 931 oz gold; in 1934 it produced 7438 oz gold. (W.M.)

12-b-52 ENGLISH, A. C., 1905 — Assistant Resident Magistrate's report for Rigo District of the Central Division. *Brit. N. Guinea ann. Rep. for 1904-05,* App. C, 22-24 (also issued as *Aust. parl. Pap. 79, Sess. 1905,* 2, 111-3).

The unsuccessful prospecting of the upper Kemp Welch R. for gold is reported. (W.M.)

12-b-53 FISHER, M. S., 1935a — The origin and composition of alluvial gold, with special reference to the Morobe Goldfield, New Guinea. *Trans. Instn Min. Metall.*, 44, 337-82 (with discussion 382-6, 400-1, 411-20, 559-63).

Alluvial gold samples from various parts of the world have been examined. Most came from alluvial deposits of the Edie-Bulolo-Watut river system where most of the gold was derived from veins near the upper Edie Cr. The microstructure of the gold, and the character of the quartz in the auriferous pebbles and in the nuggets and flakes from the New Guinea deposits prove that the gold has been derived mechanically from denuded gold-quartz veins or lodes.

In most fields gold in alluvial deposits is purer than that in neighbouring veins, and the purity of the metal increases in inverse proportion to the size of the alluvial grains. It is thought that these effects are caused by an electrolytic corrosion process taking place in the alluvial deposits, which results in silver being removed from the gold-silver alloy, and the gold being re-deposited on the surface of the nuggets and flakes as a thin film of 'fine' gold. In the New Guinea placer deposits the average purity of the alluvial metal increases considerably in descending from the upper Edie Cr. to the Watut R. but only a small part of this change is due to an increase in the proportion of re-deposited 'fine' gold caused by the decrease in the average size of the alluvial grains and by the more prolonged action of the stream water on the gold-silver alloy. Most of the change is due to the fact that the gravels are fed at various points by new supplies of gold, each of which happens to be purer than the metal brought down from farther upstream. (Auth./W.M.)

12-b-54 FISHER, M. S., 1935b — The origin and composition of alluvial gold, with special reference to the Morobe gold field, New Guinea. *Bull. Instn Min. Metall.*, 365, 1-46; with discussion in 366, 1-27; 367, 23-4; 369, 31-2; and 270, 5-14.

This is a re-issue of entry 12-b-53.

12-b-55 FISHER, N. H., 1939c — Ore geology of the Day Dawn mine. *Econ. Geol.*, 34, 173-89.

The Day Dawn mine is representative of late Tertiary mineralization, the alluvials derived from which have yielded 900 000 oz of gold since their discovery in 1926. The ore body is contained mainly within phyllite but is intimately connected with a quartz-biotite porphyry intrusion that has been subjected to intense hydrothermal alteration. In its inner portion the lode follows the porphyry-phyllite contact, but the richest ore occupies a fissure that cuts obliquely across the phyllite and then turns to conform to the strike and dip of the host rock, where the mineralization begins to die out. The average fineness of the gold is about 520 parts per thousand, and decreases with depth from the surface. The gold is contained in a series of small quartz stringers that traverse the payable mineralized zone, which averages 1 m in thickness and ranges from 60 to 180 m in length. Principal associated minerals are pyrite, and manganiferous oxidation products in the upper levels. Silver values are high, the silver-gold ratio being 30 : 1, but silver is probably mostly contained in an insoluble manganite. Secondary enrichment has had some influence on the distribution of the gold, and even more on that of the silver. Gold values, phenomenally rich in places near the surface, decrease with depth, very rapidly just near No. 2 level, below which no exploration has been carried out. (Auth.)

12-b-56 FISHER, N. H., 1940 — Gold occurrences in New Guinea. *Chem. Engng Min. Rev.*, 32, 232-7.

Gold occurrences in New Guinea are few, and the dominant producers are alluvial deposits. The main producing field is in the Wau-Bulolo-Edie Cr. area, where rich alluvial deposits, derived from lodes in quartz veins and disseminations through host igneous rocks, are concentrated behind resistant bars in the rivers and in broad alluvial-fan flood sheets. Some gold is produced from small mines in lode exposures on Edie Cr., notably the Day Dawn mine. Lesser amounts of gold are produced from alluvial fields in Wewak (Sepik), Mt Hagen, Bainings District (New Britain), Tabar I. (New Ireland), and Kieta (Bougainville). (W.M.)

12-b-57 FISHER, N. H., 1945 — The fineness of gold, with special reference to the Morobe goldfield, New Guinea. *Econ. Geol.* 40, 449-95 and 537-63.

Gold fineness varies in different parts of the Morobe field. As most of the gold output is from alluvial operations and the workings are spread over streams in the Bulolo and Watut valleys and adjacent areas, a complete record is obtainable of the distribution of gold of different grades. This was largely responsible for this attempt to correlate the sheds of various types of gold with geological features and to discover the determining factors governing gold fineness. The facts relating to gold fineness in other districts have also been investigated, to discover whether the principles established for the Morobe goldfield are generally applicable. Comparisons are made of gold-bearing areas of various types in other parts of the world and the distribution of gold fineness in relation to conditions of ore deposition examined.

In the light of the conclusions, the probable causes governing gold fineness are discussed, explanations are sought for outstanding anomalies, and applications of the subject to various problems and to practical prospecting are indicated. Consideration is given to the question of the refinement of gold by stream action or by lying long immersed in placers, also to the effects on gold fineness of removal from the original outcrop, and variations within lodes due to secondary enrichment and redeposition of the gold. (Auth.)

12-b-58 FISHER, N. H., 1954b — Territory of New Guinea. *In* NYE, P. B., & FISHER, N. H., — The mineral deposits and mining industry of Papua-New Guinea. *Bur. Miner. Resour. Aust. Rep.* 9, 20-35.

Gold and silver are the only minerals that have been produced in New Guinea. The total value of gold production up to 30 June 1951 is £2 648 151. More than 90% has been won from alluvial workings, and about 60% of the total by the dredges of Bulolo Gold Dredging Ltd along the Bulolo and Watut Rs. Gold reefs of epithermal type and late Tertiary age have been worked at Edie Cr. and Golden Ridges near Wau. Outside the Bulolo and Watut valleys and adjacent areas, gold has been produced from the Sepik district, the upper Ramu R. and Mt Hagen, and small amounts from the upper Purari R., Tabar I., and Bougainville. (Auth.)

12-b-59 GRAHAM, J. W., 1894 — Report of the Resident Magistrate for the Louisiades Division. *Brit. N. Guinea ann. Rep. for 1893-94,* App. L, 50-1.

A small amount of gold is being won by alluvial work on Misima and Sudest Is. but most activity is in opening up the newly-discovered Caledonian reef on Sudest. (W.M.)

12-b-60 GREEN, J., 1897 — Report of the Government agent for the north-east coast. *Brit. N. Guinea ann. Rep. for 1895-96,* App. Q, 75-7.

The middle Mambare R. was prospected for gold with moderate success, and no payable alluvial deposits were located. A small tributary in the upper reaches has been successfully worked, and produced 200 oz gold between April and June, 1896. Earth tremors are often felt and may originate from Mt Victory. (W.M.)

12-b-61 HENNELLY, J. P., 1911 — Warden's report, Kerema. *Papua ann. Rep. for 1910-11,* 27 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 591.)

Only the Lakekamu area produces gold (entry 12-b-69). An unsuccessful attempt to prospect for gold in the Keuru Hills is reported; traces but not payable quantities of gold were found in the Vailala R. as far as the border. Small quantities of coal are reported in the Keuru Hills. (W.M.)

12-b-62 HIGGINSON, C. B., 1908 — Annual report, Gulf Division. *Papua ann. Rep. for 1907-08,* 50-5 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2092-7.)

Traces of gold were located in the Vailala and Tiveri Rs, but no other ores were located during an extensive prospecting survey of this area. (W.M.)

12-b-63 HIGGINSON, J. B., 1905 — Report on the Yodda and Gira Goldfields from the warden of the Northern Division, in January 1904. *Brit. N. Guinea ann. Rep. for 1903-04,* App. H, 47-9 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 2, 47-9.)

A considerable depth of barren overburden has to be removed before reaching auriferous sediments in the Yodda R. Small patches of the gold-bearing sediments also carry osmiridium. On the Gira and Aikora Rs, gold is won from river beaches which are covered when the river floods. An estimated 5000 oz gold were won from both fields in the last year. (W.M.)

12-b-64 HOOPER, R., PITMAN, & BLACK, A. B., 1953 — MINING METHODS IN AUSTRALIA AND ADJACENT TERRITORIES. (*5th Empire Min. metall. Cong., Aust. New Zealand Publ.,* Vol. 2,) A.I.M.M., Melbourne, xvi + 374 + 4 pp.

The early development and mining methods used on dredging sites on the Bulolo R. by Bulolo Gold Dredging Ltd during the late 1920s and 1930s are outlined. Initial reserves in 1929 when the decision to dredge the river alluvials was made, were 40 million cubic yards of ground carrying payable gold over a depth of 7 m and 600 m width. Equipment was air-transported (entry 12-b-35) and 2 dredges were operating by the end of 1952. Drilling indicated payable gold-bearing gravelly alluvials in the Bulowat Flats and Watut Flats, and a depth of alluvium exceeding 90 m on the Bulolo with payable horizons as far as 60 m down. Production figures for the years 1932 and 1942 are tabulated, and indicate volume of ground dredged and the weight of bullion, gold, and silver recovered. (W.M.)

12-b-65 Hovig, P., 1934 — De goudmijnbouw in Britisch Nieuw-Guinea (Gold mining in British New Guinea, in Dutch). *Ing. Ned. Indie,* 49, 1-14.

Gold was first discovered in 1887 in Papua in the Laloki R. and later in several other places. They were all alluvial deposits; only on Misima and Murua Is are mineral veins mined. Although since the discovery Papua produced regularly, mining did not develop into a modern big industry, due at least partly to an almost insurmountable transport problem, which did not attract large capital investment. In New Guinea, particularly in the Morobe District, mining developed rapidly after the discovery of the rich alluvial and mineral veins in 1926 and following years. Now financially-strong companies are active. The difficult transport problem was solved by using aeroplanes on a large scale. Dutch New Guinea shows sufficient geological similarity to the British part to hope for the presence of workable gold. (Auth.)

12-b-66 Humphries, W., 1918 — Annual report (Lakekamu Goldfield). *Papua ann. Rep. for 1916-17,* 41 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1481.)

Active prospecting of the country between the Tauri and Bipolo Rs revealed no payable gold; similar results are recorded from prospecting in the Williams, Arabi, and Tauri Rs. The only production was from the Sunset area, but no figures are available. (W.M.)

12-b-67 Jensen, E. B., 1951 — Mining and treatment of gold-bearing clayey ores at Golden Ridge, New Guinea. *Proc. Australas. Inst. Min. Metall.,* 160, 97-109.

A successful method of extracting gold from clayey ores is described. Cyanidation of 90 tonne vats of ore proved the only practical method of extraction, after calcining and crushing had proved unsuccessful. The parent orebody occurred in a large earth slip, and was a subhorizontal tabular body 3-8 m thick, with an overburden of up to 20 m of decomposed breccia and porphyry. The ore consisted of oxides of manganese and iron with quartz and clayey decomposed breccia, through which gold was irregularly scattered. Assays of around 25 g Au and 90-110 g Ag per tonne are noted. (W.M.)

12-b-68 Lock, A. G., 1882 — Gold: its occurrence and extraction. *London, Spon,* 477-9.

Gold is recorded from the Fly R. (entry 12-b-114). An unlocated sample of auriferous black sand is described, and the presence of gold in streams near Port Moresby noted. (W.M.)

12-b-69 Lyons, A. P., 1911b — Warden's report, Lakekamu Goldfield. *Papua ann. Rep. for 1910-11,* 24-6 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 588-90.)

Claims worked on Rocky, Fish, Ironstone, and Cassowary Crs, and Olipai R. yielded an estimated 8000 oz gold, all won by alluvial methods. Dredging of parts of the Tiveri R. was investigated but deemed not feasible. The general location of alluvial sites is outlined, and the use of sluicing methods recommended. (W.M.)

12-b-70 Macfarlane, S., 1879 — Gold digging at Port Moresby. *Mission Mag. for 1879,* 62.

Gold is present in most major streams near Port Moresby and for up to 80 km inland, but no auriferous outcrops have yet been located. (W.M.)

12-b-71 MACGREGOR, W., 1897d — Despatch reporting ascent of Kumusi River. *Brit. N. Guinea ann. Rep. for 1895-96,* App. F, 29-30.

In the upper Kumusi R., colours of gold can be got with difficulty from the quartz shingle in the river bed. (W.M.)

12-b-72 MACGREGOR, W., 1897e — Despatch reporting visit of inspection to the Louisiades and neighbouring groups. *Brit. N. Guinea ann. Rep. for 1895-96,* App. G, 30-3.

In the streams on the mainland of Murua (Woodlark) I., small amounts of gold are found in the brown decomposing shingle, and some gold is dispersed in the firm blue clays in which the stream bed has been cut. Gold has also been recovered from streams on nearby Makwas I. (W.M.)

12-b-73 MACGREGOR, W., 1898a — Despatch reporting visit of inspection to various places in the east end of the possession. *Brit. N. Guinea ann. Rep. for 1896-97,* App. A, 1-2.

Auriferous quartz veins were found 5-6 km west of Mt Rattlesnake on the south side of Sudest (Tagula) I. and a crushing plant is being installed. In the low hill country behind Suloga Bay on Woodlark I. coralline limestone and quartzite outcrop in the ridges. The streams bear alluvial gold which is being worked by about 100 miners. (W.M.)

12-b-74 MACGREGOR, W., 1898c — Despatch reporting upon the gold-bearing districts of the possession. *Brit. N. Guinea ann. Rep. for 1896-97,* App. E, 22-3.

The level of activity and reserves of several gold-bearing areas is assessed. Woodlark I. is overmanned and almost worked out, and Misima and Sudest are practically abandoned by the surface worker. The headwaters of the Mambare R. around Mt Scratchley bear colours of gold, with traces of osmiridium and cinnabar in almost all streams, but a workable economic deposit has yet to be proven. Parties are prospecting with little success in the headwaters of the Musa and Mambare Rs. (W.M.)

12-b-75 MACLAREN, J. N., 1908 — GOLD: ITS GEOLOGICAL OCCURRENCE AND GEOGRAPHICAL DISTRIBUTION. *London, Mining Journal,* xxiii + 687 pp.

The intruded regional metamorphics which constitute the axial range of New Guinea and several eastern offshore islands are the source or host strata for reef and alluvial gold deposits. Reef gold has been worked on the mainland only at Gibara near Milne Bay, but has been more successfully exploited on Woodlark I., where it is won from the Kulamadau reef, an irregular 4-m wide gold-impregnated quartz seam in clays which also carry metal sulphide mineralization. Alluvial deposits have been worked on Tagula and Misima Is, and in several sites on the mainland, notably Milne Bay, Keveri, Yodda, and Gira fields, with major production coming from the Kumusi, Mambare, and Gira Rs. Recorded production, which is less than actual production, between 1888 and 1907 is 258 622 oz worth £935 831. In German New Guinea, only alluvial gold is known; the main carrying streams are the Sepik R., and streams draining the eastern fall of the Bowutu Ra. (W.M.)

12-b-76 MCLEOD, I. R., BARRIE, J., & CORBETT, D. W. P., 1965 — Gold. *In* MCLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 249-87.

Gold is by far the most important mineral product in Papua New Guinea. Production commenced in 1888, and up to June 1962 amounted to an estimated 4 064 000 oz. The fields have been the Morobe, Murua, and Louisiade fields. Production from the Morobe field has been from alluvial and lode deposits in the Wau-Edie Cr. area. The rocks are schist, phyllite, slate, limestone, and possible tuff of the (?)Palaeozoic Kaindi Metamorphics, and Tertiary agglomerate and breccia. The metamorphic rocks are intruded by granitic masses and Tertiary quartz porphyry stocks. The main gold mineralization occurs as lodes and high-grade stringers which are thought to be the source of the alluvial gold in Edie Cr. Most of the production from this field has been from extensive alluvial deposits of the Bulolo R.

In the Murua field, gold has been produced from Woodlark I. The gold occurs in lodes associated with Tertiary basic volcanics, or with rocks intrusive into them. In the Louisiade field, most production was on Misima I. with small quantities being won from alluvial deposits on Sudest I. On Misima the gold occurs in lodes in shears through greenschist, porphyry, phyllite, and mica schist.

Minor amounts of gold have been won, mostly by alluvial dredging, from the Yodda field northeast of Port Moresby, the Gira field southeast of Morobe, and from many places on the mainland and islands. (W.M.)

12-b-77 MAGUIRE, H. R., 1902 — Impressions of a year's sojourn in British New Guinea. *Qld geogr. J.*, 17, 117-43.

The north coast of Papua is drained by several short large rivers, including the Mambare, Gira, Ope, Kumusi, and Musa. On several rivers and creeks gold-dredging claims are registered, with good prospects of producing large amounts of fine gold from the lower reaches and less but good chances of producing coarser alluvial gold upstream.

The main goldfields in Papua are the Yodda, Gira, Gibara, and Cloudy Bay fields. 700 oz of gold were won from the Cloudy Bay field in 6 weeks by 2 men, but it now appears to be worked out. Production on the other fields is only just starting, and reserves are thought to be large. Gold is also produced from mines on Woodland I. (W.M.)

12-b-78 MONKTON, C. A. W., 1904a — Northern Division. *Brit. N. Guinea ann. Rep. for 1902-03,* 31-2 (also issued as *Aust. parl. Pap. 13, Sess. 1904,* 2, 31-2.)

River-bed beaches on the Aikora R. have yielded a good return of gold, as is the case with deposits in the Yodda and Gira Rs. (W.M.)

12-b-79 MONKTON, C. A. W., 1904b — Report on affairs of Northeastern Division. *Brit. N. Guinea ann. Rep. for 1902-03,* 32-5 (also issued as *Aust. parl. Pap. 13, Sess. 1904,* 2, 32-5.)

The Ruaba R. was unsuccessfully prospected for gold during a traverse to the foot of the Tam Tam Ra. (W.M.)

12-b-80 MONKTON, C. A. W., 1905b — Resident Magistrate's report — Northern Division. *Brit. N. Guinea ann. Rep. for 1904-05,* App. G, 33-8 (also issued as *Aust. parl. Pap. 79, Sess. 1905,* 2, 122-7.)

Most gold is being won by working alluvial terraces in the Gira and Aikora Rs; an estimated 12 000 oz were won during the year. (W.M.)

12-b-81 MONKTON, C. A. W., 1905c — Yodda and Gira Goldfields. *Brit. N. Guinea ann. Rep. for 1904-05,* App. L, 59 (also issued as *Aust. parl. Pap. 79, Sess. 1905,* 2, 148.)

This is a transcript of entry 12-b-80.

12-b-82 MORETON, M. H., 1900 — Report of the Resident Magistrate for the Eastern Division. *Brit. N. Guinea ann. Rep. for 1898-99,* App. S, 81-5.

Gold was discovered in payable quantities about 10 km inland from the head of Milne Bay, in or near Gibara Cr. (W.M.)

12-b-83 MORETON, M. H., 1908 — Annual report on the Louisiade Goldfield. *Papua ann. Rep. for 1906-07,* 83-4 (also issued as *Aust. parl. Pap. 160, Sess. 1907-08,* 2, 1507-8.)

Alluvial gold is worked on a small scale on both Misima and Sudest Is, and the presence of gold-bearing quartz reefs on Misima is noted. Copper lodes on Mt Sesa were prospected during the year. (W.M.)

12-b-84 MORLEY, I. W., 1931 — The Daydawn Mine, New Guinea. *Chem. Engng Min. Rev.*, 24(277), 7-8.

Daydawn (New Guinea) Ltd is exploiting the first known reef gold in the Morobe Goldfield at the junction of Merri and Edie Crs 2000 m above M.S.L. Auriferous quartz veins occur associated with quartz porphyries intrusive into slate, and 3 veins are worked. The ore is locally manganiferous, and said to be high-grade. (W.M.)

12-b-85 MURRAY, J. H. P., 1930 — Annual report by the Lieutenant-Governor. *Papua ann. Rep. for 1928-29,* 1-12, 17, and 21.

Prospecting activity in the goldfields and the Astrolabe mineral field is outlined, and the lack of evident rewards noted. The amount and value of copper, gold, gold ore and concentrates, osmiridium, and silver exported during each of the preceding 5 years are tabulated. Gold production for each field during the year, total production to date for each field, production of osmiridium and copper from the territory for the year, and total copper production to date are also tabulated. (W.M.)

12-b-86 MURRAY, J. H. P., 1931 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1929-30,* 3-19, 27, and 31 (also issued as *Aust. parl. Pap. 272, Sess. 1929-31,* 4, 596-612, 620, and 624.)

The occurrence of alluvial gold at the head of the Kunimaipa Valley, on the border north of Mt Yule, is reported. Only small amounts of gold were found. The amount and value of export over each of the preceding 5 years for gold, gold ore and concentrates, osmiridium, and silver, the amount and value of production of gold for the year for each goldfield, and total production to date from each goldfield, are tabulated. (W.M.)

12-b-87 MURRAY, J. H. P., 1935 — Annual report, Lieutenant-Governor, 1933-34. *Papua ann. Rep. for 1933-34,* 1-30 and 37.

A continuation of gold prospecting throughout the goldfields is reported, and production figures quoted for the territory as a whole. There was very little gold and copper produced. The summit areas of Mts Scratchley and Victoria are noted to be quartz-veined slates, and gold is thought likely to be present. The amount and value of exports of copper ore, gold, gold ore and concentrates, osmiridium, and platinum for each of the previous 5 years are tabulated. (W.M.)

12-b-88 MURRAY, J. H. P., 1936 — Annual report, Lieutenant-Governor, 1934-35. *Papua ann. Rep. for 1934-35,* 1-36 and 44 (also issued as *Aust. parl. Pap. 243, Sess. 1934-37,* 2, 1291-326 and 1334.)

Alluvial gold prospecting and testing in the Lakekamu and Fly Rs and at Misima is reported, and results noted. Wardens' reports indicate that most activity was small-scale alluvial prospecting with limited production. Production figures are appended. (W.M.)

12-b-89 MUSCUTT, C. R., 1920 — Lakekamu Goldfield. *Papua ann. Rep. for 1918-19,* 84-5.

Many gold-bearing areas exist in the stream systems of this field, but prospecting has not shown any spectacular concentrations. (W.M.)

12-b-90 NICHOLLS, G. H., 1911 — Warden's report, Gira Goldfield. *Papua ann. Rep. for 1910-11,* 28 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 592.)

3 gold-bearing reefs are reported from near Ioma, supposedly carrying 15 dwt per ton; only an unknown small amount of gold was produced by alluvial methods during the year. (W.M.)

12-b-91 OLDHAM, E. R., 1913 — Report on the Lakekamu Goldfield for year ended 30 June 1913. *Papua ann. Rep. for 1912-13,* 40-1 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 424-5.)

The headwaters of the Tauri and Tiveri Rs were unsuccessfully prospected for gold, as also were the St Joseph (Angabunga) and Miaru Rs. Most production was from alluvial working of Cassowary and Fish Crs. About 5000 oz gold were produced. (W.M.)

12-b-92 OLDHAM, E. R., 1914 — Report on the Lakekamu Goldfield for the year ended 30 June 1914. *Papua ann. Rep. for 1913-14,* 157 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1677.)

The upper Tiveri R. was prospected, but gold values were considered too small to warrant working the river. Several tributary streams on the left branch of the Tauri R. were prospected with similar results. The Williams and Arabi Rs were barren of gold. New auriferous gravels and sands located in streams near Fish Cr. and the Tauri R. have been partly worked. About 4000 oz gold, valued at £15 000, were produced during the year. (W.M.)

12-b-93 PECK, A., 1897 — Recollections of the Maclay coast, Astrolabe Gulf, north-eastern New Guinea. *Trans. Proc. Roy. geogr. Soc. Australas., N.S.W. Br.,* 6, 117-9.

On the coast of Astrolabe Bay near Garagassi several small streams were prospected near their mouths for gold, without success. (W.M.)

12-b-94 PINDER, C. R., 1902 — Woodlark Island (British New Guinea). *Trans. Instn Min. Metall.,* 10, 87-92.

Woodlark is of volcanic origin, with elevated coral reefs forming the lowlands. Most of it is mangrove-covered lowlands, with some wooded hills. Gold has been mined by sluicing and pit mining at Kulumadau for some years, but there is no record of the estimated large output. The gold occurs in disseminations and reefs in country rock. Pockets of lead and copper-bearing carbonates occur. (W.M.)

12-b-95 RANGE, P., 1938 — Die mineral vorkommen der deutschen schutzgebiete in Afrika und in der Sudsee (The mineral occurrences in the German protectorates in Africa and in the South Seas, in German). *Z. prakt. Geol.,* 46, 139-50; 171-5; 179-89.

This summarizes the mineral resources of several German colonies including New Guinea. Production of gold from the Bulolo-Wau and Sepik goldfields is noted. (W.M.)

12-b-96 RHYS, L., 1932 — HIGH LIGHTS AND FLIGHTS IN NEW GUINEA. *London, Hodder & Stoughton,* 253 pp.

The history is given of the discovery and exploitation of the Morobe Goldfield in the Wau-Bulolo-Edie Cr. area, including photographs of site development in the Wau and Edie Cr. areas. Work in the Sepik R. region by Thurnwald and Behrmann, exploration by Hides in the limestone country west and southwest of Mt Hagen, the considerable seismic activity in the Aitape region, and the frequent resultant landslips, are noted; the effects of the earthquakes on 20 and 21 September, 1935, are described. The unsuccessful gold prospecting of the Sepik fall of the main range is outlined. (W.M.)

12-b-97 SCHMEISSER, C., 1906 — Uber geologische untersuchungen und die entwickelung des bergbaues in den deutschen schutzgebieten (Geological investigations and the development of mining in the German colonies, in German). *Z. prakt. Geol.,* 14, 73-81.

Alluvial gold was discovered in Mambare R. in British New Guinea and 1900 oz had been won by 1900. German prospectors found alluvial gold in the Ramu and lower Markham Rs, and English prospectors found it in the Waria R. and several tributaries. Workable reef gold has not been found. Coal has been reported from New Guinea and phosphate deposits are known from a small island off the northwest coast. No economic materials are known from the Bismarck Arch. (W.M.)

12-b-98 SCHUMAKER, F., 1939 — Die goldvorkommen der deutschen kolonien (The gold resources of the German colonies, in German). *Tropenpflanzer,* 42, 140-7.

The gold resources of the German Pacific and African colonies are discussed and production figures for 1937 tabulated. In German New Guinea, the major gold producer, most gold was produced from the Bulolo area with limited production from some coastal range alluvial fields. (W.M.)

12-b-99 SHANAHAN, M. W., 1899a — Report of the Assistant Resident Magistrate for the Mambare District. *Brit. N. Guinea ann. Rep. for 1897-98,* App. P, 102-4.

Considerable alluvial gold is being won from the Gira River, 1222 oz having been obtained in 3 months by 23 men in one locality. A provisional goldfield has been proclaimed. (W.M.)

12-b-100 SHANAHAN, M. W., 1899b — Report of the Assistant Resident Magistrate for the Mambare District on gold-mining developments on the Gira River. *Brit. N. Guinea ann. Rep. for 1897-98,* Addendum to App. P, 104-5.

The establishment and early exploitation of payable gold in the Gira River is outlined. Good returns were obtained in two streams tested, and 52 claims have been established. (W.M.)

12-b-101 SIMPSON, W., 1898 — Despatch reporting prospecting activities in the Moni Valley. *Brit. N. Guinea ann. Rep. for 1896-97,* Encl. 1 in App. D, 20-1.

Unrewarding gold prospecting in the Moni R. system is reported. Colours of gold were obtained in some streams, but prospects of an economic workable field appear poor. (W.M.)

12-b-102 SMITH, M. STANIFORTH C., 1911a — Annual report of the Department of Mines. *Papua ann. Rep. for 1909-10,* 117-28.

The discovery of the Lakekamu Goldfield is reported, and production of copper ore from the Astrolabe field over the last 4 years is tabulated.

Activity and production statistics of gold and mineral fields are recorded in reports from mining wardens (entries 12-a-25 and 12-i-94.) (W.M.)

12-b-103 STRUBEN, R., 1961 — CORAL AND COLOUR OF GOLD. *London, Faber & Faber,* 259 pp.

Alluvial gold leases in the Edie Cr. and Bulldog-Lakekamu fields, and the prospecting of several creeks north and east of Mt Lawson are described. Gold sluicing and prospecting methods, and maps of the geology and gold distribution in these areas are discussed. (W.M.)

12-b-104 SYMONS, A. H., 1911 — Warden's report, Murua Goldfield. *Papua ann. Rep. for 1910-11,* 28-31 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 592-5.)

The development of reef mining and alluvial working sites on Woodlark I. is reported. 8631 oz gold, valued at £32 276, were produced during the year. (W.M.)

12-b-105 SYMONS, A. H., 1912a — Annual report on the Louisiade Goldfield, *Papua ann. Rep. for 1911-12,* 41 (also issued as *Aust. parl. Pap. 87, Sess. 1912*, 3, 727.)

A major gold-bearing lode 24 m wide is exposed and being exploited in Cooktown Cr. on Misima I. Only 600 oz gold were recovered during the year from the entire island. (W.M.)

12-b-106 SYMONS, A. H., 1913b — Annual report on the Louisiade Goldfield, Southeastern Division. *Papua ann. Rep. for 1912-13,* 41 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 425.)

Gold is present in almost every creek on Misima I., and a new company, Mt Sesa Gold Mining Co., was established to work a lease on Engubinina Cr. Little or no mining or prospecting was carried out on Misima, but small parcels of gold are being taken on Sudest by alluvial working. (W.M.)

12-b-107 TAYLOUR, H., & MORLEY, I. W., 1933a — The development of gold mining in Morobe, New Guinea. *Proc. Australas. Inst. Min. Metall.*, 89, 1-81.

The history of gold mining activities in the Wau-Edie Cr. area in the period 1926-1933 is outlined, including discovery and production, geography and geology, legislation, labour, mining practice, metallurgical practice, power and transportation, and the status of the industry.

In the Morobe Goldfield unfossiliferous low-grade metamorphics and fine marine sediments are intruded by quartz-feldspar porphyry with which the auriferous quartz veins are associated. Considerable faulting has occurred, and its effect on geomorphic forms and stream systems is exemplified by the valley of Edie Cr. and the ranges around Mt Kaindi. The valley-fill alluvium along the Watut and Bulolo Rs and Edie Cr. is a source of much alluvial gold, probably derived from exposed reefs around Mt Kaindi. These valley-fill gravels may be of part glacial origin. In the alluvial accumulation, the fineness of the gold shows a pattern of geographic distribution. The ore deposits occur on Mt Kaindi, and are discussed as the Edie Cr. deposits and the Golden Ridge deposits. The former tend to steep-dipping veins, the latter are flatter-lying veins, with consequent differences in exploitation techniques. Crystalline limestone for use in the cyanide plant is quarried locally. (W.M.)

12-b-108 TAYLOUR, H., & MORLEY, I. W., 1933b — The development of gold mining in Morobe, New Guinea. *Proc. Australas. Inst. Min. Metall.*, 90, 247-53.

Entry 12-b-107 is updatd by production figures, mine development, bibliographic notes, and corrigenda. (W.M.)

12-b-109 TAYLOUR, H., & MORLEY, I. W., 1933c — The development of gold mining in Morobe, New Guinea. *Min. J., Lond.*, 182, 624-6, 644-6, 660-2, 678-9, 693.

This abstracts entries 12-b-107, 12-b-108, and 12-b-112.

12-b-110 TAYLOUR, H., & MORLEY, I. W., 1933d — Gold mining in New Guinea. *Chem. Engng Min. Rev.*, 25(299), 359-62, and 26(300), 401-4.

Mining activity on the Wau-Edie Cr. and Bulolo areas is discussed, including geology, extraction and exploitation techniques, and metallurgical recovery with data abstracted from entry 12-b-107. (W.M.)

12-b-111 TAYLOUR, H., & MORLEY, I. W., 1933e — The development of gold in Morobe, New Guinea. *Bull. Instn Min. Metall.*, 347, 1-61; 348, 9-10; 349, 9; 359, (1934), 7-10.

This is a re-issue of entries 12-b-112, 12-b-107, and 12-b-108.

12-b-112 TAYLOUR, H., & MORLEY, I. W., 1934 — The development of gold mining in Morobe, New Guinea. *Trans. Instn Min. Metall.*, 43, 81-145.

This is a re-issue of entries 12-b-107 and 12-b-108.

12-b-113 THOMSON, J. P., 1887 — British New Guinea. *Scott. geogr. Mag.*, 3, 648-9.

The coastal lowlands at the foot of Mt Yule are relatively flat and easy of access. Auriferous quartz is present in the upper reaches of the St Joseph (Purari) R. (W.M.)

12-b-114 WILKINSON, C. S., 1879 — Report on auriferous and other specimens from New Guinea. *N.S.W. Mines Dep. ann. Rep. for 1878*, 157-9.

Press reports of gold finds in New Guinea are substantiated, and comments made on the terrain around the Fly R. An assay of auriferous quartz, and a list of specimens collected, are appended. (W.M.)

(c) OTHER MINERALIZATION (INCLUDING NON-METALS)

See also entries

02-b-151	05-c-39	12-b-21	12-d-6
02-b-158	05-d-5	12-b-83	12-i-5
02-d-34	12-a-12	12-b-94	12-i-59
05-a-22	12-a-32	12-b-96	12-i-63

12-c-1 ANONYMOUS, 1933a — Platinum in Papua. *Min. Mag.*, 48(3), 164.

A rich deposit of platinum with gold is reported from an unspecified locality '120 miles from Samarai' in eastern Papua. (W.M.)

12-c-2 ANONYMOUS, 1966 — Mining in Papua-New Guinea; some recent developments. *Aust. Min.*, 58(12), 467.

A major stimulus to mineral exploration in the Territory has been the success at Panguna on Bougainville I. A program of 22 diamond-drill holes on 120 m centres to a depth of 180 m (average) has indicated 67 million tonnes of ore with a grade of 0.68% copper and 0.8 g gold per tonne. The extension of ore to depth is indicated but as yet is unproven. (W.M.)

12-c-3 ANONYMOUS, 1968a — What's going on in world mining: Oceania — Territory of Papua and New Guinea. *World Min.*, 21(9), 77-8.

A new drive is to be pushed through the orebody at Panguna on Bougainville I., to allow testing of underground rock conditions and grade of ore and to provide large-scale samples for assay and metallurgical testing. Over 230 million tonnes of ore assaying 0.63% copper and 0.64 g/tonne gold have been proved. (W.M.)

12-c-4 ANONYMOUS, 1968b — Mineral traces in New Guinea. *Qld Govt Min. J.*, 69, 418.

A deposit of disseminated porphyry-type copper sulphide mineralization on a tributary of the Freida R. appears to cover 20 km^2 and gives stream sediment assays of up to 1000 ppm copper (average 300 ppm). Extensive areas of ultrabasic rocks also were located in this area. Shedding streams give values of 1000 to 2000 ppm nickel in sediments. (W.M.)

12-c-5 AUSTRALIA. PARLIAMENT, 1930 — Annual report — mining. *New Guinea ann. Rep. for 1928-29,* 82-5 (also issued as *Aust. parl. Pap. 113, Sess. 1929-31,* 4, 83-6.)

Mining for opals on a small scale is reported from New Hanover I. The Rangarere iron ore deposits west of Rabaul were found to be non-commercial. Alluvial gold produced from the Morobe field around Bulolo was 87 542 oz, valued at £188 177; total production from this field to date is 308 054 oz, valued at £664 729. (W.M.)

12-c-6 AUSTRALIA. PARLIAMENT, 1938 — Annual report — mining. *New Guinea ann. Rep. for 1936-37,* 116-8 (also issued as *Aust. parl. Pap. 84, Sess. 1937-40,* 3, 371-3.)

Tin is present in southern Bougainville, but it is not known whether the deposit will prove economic. Alluvial and reef gold in the Sepik field is being prospected. 367 311 oz gold were produced, mostly from the Morobe Goldfield; production figures by field are tabulated. (W.M.)

12-c-7 AUSTRALIA. PARLIAMENT, 1959 — Annual report — mineral resources. *New Guinea ann. Rep. for 1957-58,* 77-80 and 176 (also issued as *Aust. parl. Pap. 75, Sess. 1959-60,* 4, 214-7 and 313.)

Soils developed on ultrabasic rocks in the Waria Valley and along the Morobe coast contain sub-economic concentrations of nickel. The value and amount of export, for each of the previous 5 years, of gold, platinum, silver, and osmiridium are tabulated. Volcanic activity is noted from Manam, Bam, and Langila. (W.M.)

12-c-8 AUSTRALIA. PARLIAMENT, 1969b — Mineral resources. *New Guinea ann. Rep. for 1968-69,* 95-9 and 274.

A large low-grade copper deposit on Bougainville I. contains at least 770 million tonnes of ore containing at least 0.47% copper and 0.6 g gold per tonne.

The quantity and value of gold and silver produced by indigenous miners working alluvial deposits in several districts, and the quantity and value of gold, silver, and platinum produced during the last 63 years are tabulated. (W.M.)

12-c-9 AUSTRALIA. PARLIAMENT, 1970 — Mineral resources. *New Guinea ann. Rep. for 1969-70,* 109-12 and 275.

Gold and silver are the only mineral products at present, mostly being won by alluvial methods in the Wau-Bulolo area, by open-cut mining near Wau, and by alluvial methods in numerous small 'shows' throughout the mainland. There have been reports and investigations of occurrences of copper, iron, lead, zinc, silver, nickel, chrome, sulphur, coal, and petroleum. Production over the last 6 years for gold, silver, and platinum is tabulated. Manam volcano was active during 1970, and Ulawun in early 1970. (W.M.)

12-c-10 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1952a — (No title — Report from government geologist.) *Papua ann. Rep. for 1950-51*, 20-1 and 79 (also issued as *Aust. parl. Pap. 129, Sess. 1951-53*, 4, 795-6 and 854.)

Sulphur deposits in solfataric areas between Iamelele and Fagulolu on Fergusson I. are only superficial. About 4000 tonnes were concentrated around fumarolic vents, of which 1000 tonnes could be obtained by hand sorting. The possibility of commercial-grade mica and piezoelectric quartz crystals occurring in the pegmatites on Fergusson I. was noted. Exports of manganese, gold, platinum, and silver are tabulated.

12-c-11 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1953 — Annual report — mining and geology. *Papua ann. Rep. for 1952-53*, 42-3 and 119 (also issued as *Aust. parl. Pap. 90, Sess, 1954-55*, 4, 819-20 and 896.)

Bauxite in the Kuni area, Central District, occurs as low-grade ferruginous deposits developed by the decomposition of basaltic components of coarse piedmont deposits of Pleistocene age. In one locality on Kubuna Cr. a 1-m bed of immature bauxite is exposed.

Exports of copper ore, copper oxide, gold, silver, and manganese are tabulated. (W.M.)

12-c-12 BALBERYSZSKI, T., 1970 — Bougainville — a new venture in mining and metallurgy. *Mines Mag.*, 60, 14-5.

The history of investigation at Panguna is outlined. Mineralization was first reported from this site in 1934, BMR geologists conducted the first serious investigation in 1960, and mining companies started assessments in 1963. By 1966, 67 million tonnes of 0.68% copper had been proven, and by 1969 reserves had been proven to be 10 times as great. Feasibility studies are reported to have indicated annual plant production of 150 000 tonnes of copper as concentrates and 14 170 kg of gold. (W.M.)

12-c-13 BARNES, C. E., 1967 — The mineral industry in Papua and New Guinea. *Aust. Min.*, 59(12), 17-22.

At Panguna on Bougainville I., C.R.A. has shown that to a depth of 300 m there are reserves of 200 million tonnes of copper ore averaging 0.63% Cu and 0.64 g gold per tonne, with known mineralization extending at depth. The legislation and planning involved in developing this mine site, and the advantages to the Territory arising from the resultant inflow of capital are outlined. On Misima I., Pacific Island Mines and Cultus Exploration are investigating gold and silver mineralization at the Umuna site, worked during the 1930s; low-grade copper mineralization is being investigated near the Warangoi R. on the Gazelle Pen. and near Bundi in New Guinea. Petroleum exploration activity has delineated large gas bodies but no oil; the search is continuing. (W.M.)

12-c-14 BARRIE, J., 1965a — Bentonite and Fullers Earth. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 73-81.

Mudstone of the upper Miocene Marua Group, with bentonitic properties, was quarried from Orobeda Cr., a tributary of the Vailala R., for use in oil drilling at nearby Kariava. Because of the high ratio required to produce a satisfactory colloidal base for the drilling mud, use of the mudstone proved uneconomic. (Auth.)

12-c-15 BARRIE, J., 1965b — Copper. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 171-203.

Copper has been reported from various areas, e.g. Waria valley, central Nakanai in New Britain, and Bougainville, but has not been found in sufficient quantity to be of commercial interest.

The only deposit of any importance is at Laloki, near Port Moresby. The Laloki orebody is a lens of massive fine-grained sulphides enclosed in fine-grained, partly calcareous, sediments of the Eriama Series. About 42 000 tonnes of ore have been extracted from open-cut and underground workings; copper content was about 4.5% and gold content about 2.6 dwt per ton. Diamond drilling during 1959-60 defined the lateral limits of the lode, except to the southeast, and showed that the lode grades laterally from massive sulphides up to 6 m thick into pyritic pug and then into weakly pyritic shale. Copper content ranges between 2.3 and 10.9%, zinc between 0.3 and 25.2%, gold between 0.3 and 45 g per tonne, and silver between 2 and 82 g per tonne. (Auth.)

12-c-16 BARRIE, J., 1965c — Iron. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 309-28.

No large deposits of iron ore are known in Papua New Guinea. Lenses of iron occur in parts of the Suloga Pen. on Woodlark I. The ore is generally magnetite (in places oxidized to hematite) with some pyrite and in places chalcopyrite. An aerial magnetometer survey gave no suggestion of any major deposit of magnetite, either at the surface or under thin cover. Copper associated with these lenses is probably of more economic importance than the iron.

Small bodies of iron ore crop out on and near Rangarere plantation, near C. Lambert, New Britain. The ore consists of magnetite with some hematite, and carries amounts of pyrite ranging from 1 to 20% locally. The ores contain from 50 to 70% Fe, and the deposit has been estimated to contain 82 000 tonnes of ore indicated, with an additional 92 000 tonnes inferred. (Auth.)

12-c-17 BARRIE, J., 1965d — Nickel. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 453-7.

Large low-grade nickeliferous lateritic deposits occur near Kokoda in Papua, and near Lake Trist in New Guinea. They overlie peridotites of the Papuan Basic Belt, which extends southeast from Salamaua for about 370 km to the Musa R. Other lateritic deposits are known within this belt, but access and prospecting conditions are difficult.

Nickel silicate minerals have frequently been seen in fractured weathered serpentinized peridotite of the Papuan Basic Belt. At Koreppa in the Waria Valley, green nickel silicate fracture-fillings have been exposed in small landslips and in test pits. Green nickel silicate minerals have been noted in fractures in brecciated serpentinite near Wowo Gap at the east end of Didana Ra., and in the eastern end of the Musa Valley. Nickel silicate deposits may be concealed beneath the thick nickeliferous laterites in the Lake Twist and Kokoda areas, but prospecting for these would be difficult. (Auth.)

12-c-18 BARRIE, J., 1965e — Natural phosphates. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 479-86.

Phosphate deposits occur on several islands off New Guinea, but no production is recorded. The largest deposit, on Nauna I., an elevated coral atoll at the eastern end of the Admiralty Is, consists of oolitic phosphate and phosphatic clay between pinnacles of limestone. The deposit contains about 130 000 tonnes of phosphatic clay averaging 15.9% P_2O_5, and 15 000 tonnes of oolitic phosphate averaging 32.5% P_2O_5.

Phosphate deposits consisting of a crust of cemented sand on low-lying sand çays occur on Purdy, Sae, Manu, Aua, and Wuvulu Is. The phosphate has been formed directly from the coral sand by solutions leaching downwards from bird guano. Their approximate quantities and average grade are: Purdy Is — 50 000 tonnes, 23.4 to 38.0%; Sae — 70 000 tonnes, 23.0%; Manu — 15 000 tonnes, 26.0%; Aua and Wuvulu — small. Manu also contains 1000 tonnes of phosphatic mud with an average grade of 31.5% P_2O_5. Bat guano occurs in caves in many parts of New Guinea. The Kaut caves on western New Ireland contain 5000 to 10 000 tonnes of guano. None of these deposits is likely to be economic. (Auth.)

12-c-19 BARRIE, J., 1965f — Platinum group metals. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 487-94.

Alluvial platinum and osmiridium have been recorded from most of the alluvial gold workings in areas where ultrabasic rocks are known. These include Timun R. in the Western Highlands, the Ramu headwaters, Bitoi R., and middle and lower reaches of the Waria R. in the Morobe District; the Gira, Aikora, and Mambare Rs in the Northern District; Dawa Dawa and Sagarai Rs and small streams near Waga Waga in the Milne Bay District. However, little development has been done and the small production obtained was mainly incidental to the production of alluvial gold. Total production has been 9.5 kg of platinum and 27.5 kg of osmiridium. (Auth.)

12-c-20 BARRIE, J., 1965g — Stone, sand and gravel. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 559-68.

Owing to the small size of the main towns and the sparse distribution of the European population, large tonnages of stone, sand, and gravel are not in demand. Most requirements are met by the quarrying of small, frequently inferior deposits as close as possible to the particular work projects. Large amounts of coral and shell detritus from raised beaches are used in coastal areas for road-making. Crushed Eocene limestone from near Goroko and Chuave is used for the same purpose in the Western Highlands. (Auth.)

12-c-21 BOLDT, J. R., Jnr, & QUENEAU, P., 1967 — THE WINNING OF NICKEL: ITS GEOLOGY, MINING AND EXTRACTIVE METALLURGY. *London, Methuen,* 487 pp.

Lateritic bodies near Lake Trist, Kokoda, and the Ramu R. have been partly explored and appear to be neither large nor high-grade. (W.M.)

12-c-22 BOWDEN, N. H. M., 1908 — Annual report, Mekeo District. *Papua ann. Rep. for 1907-08,* 55-7 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2097-9.)

Amethyst of sub-commercial value was found in the Kuni area during an unsuccessful prospecting survey seeking mineral deposits in the foothills of the main range. (W.M.)

12-c-23 BRITISH SULPHUR CORPORATION, 1964 — Territory of Papua and New Guinea. *In* A WORLD SURVEY OF PHOSPHATE DEPOSITS (2nd Edn). *London, Brit. Sulphur Corp.,* 182 pp.

The existence of phosphate deposits on Nauna, Purdy, Sae, Manu, Aua, and Wuvulu Is and in New Ireland is recorded. (W.M.)

12-c-24 CARNE, J. E., 1913d — Astrolabe copper field, Central Division, Papua. *Papua Bull.* 1, 83-111.

Mine workings in the Astrolabe field in 1910-13 are described, including the development, type, and potential of the various mines. Many analyses of ores and sedimentary rocks are included. (W.M.)

12-c-25 CASEY, J. N., 1956 — Manganese in Australia. *20th int. geol. Cong., Mexico, 1956, Symposium Sobre vacinentos de manganeso,* 4 (*Asia v oceanea*), 247-77.

In eastern Australia and Papua commercial manganese deposits are associated with jasperoid bodies close to granitic intrusives, and are usually small. The Papuan deposits are at Rigo and Edie Cr. The Rigo deposits are in a roof pendant of Upper Cretaceous to Eocene marine sediments on a gabbro intrusive. The manganese occurs in several small lodes in the siliceous argillites. A core of high-grade pyrolusite is surrounded by lower-grade siliceous ore. The Edie Cr. ores occur as black earthy masses associated with gold lodes. There has been limited production from the Rigo occurrences since 1937. Reserves are very small. (Auth./W.M.)

12-c-26 DIMMICK, T. D., & LUDBROOK, N. H., 1947 — Phosphates. *Bur. Miner. Resour. Aust., Miner. Resour. Summ. Rep.* 29, 34 pp.

Deposits of phosphate rock, estimated to be at least 80 000 tonnes, occur on the islands of Wuvulu (Maty), Aua (Durour) and Manu (Allison) in the Admiralty Group. On the Purdy Islands are deposits estimated to contain 27 000 tonnes of phosphate rock, with 21.8% tricalcium phosphate. Bat guano occurs in caves in many parts of New Guinea. The Kaut caves on western New Ireland were estimated to contain 5000 to 10 000 tonnes of guano. Both the phosphate rock and guano could be used as a fertilizer only for direct application to the soil to meet local requirements, as the deposits are small and the grade low. (Auth.)

12-c-27 DIMMICK, T. D., & LUDBROOK, N. H., 1948 — Sulphur, (including pyrite and other sulphur-bearing minerals). *Bur. Miner. Resour. Aust., Miner. Resour. Summ. Rep.* 31, 35 pp.

Pyritic orebodies on the Astrolabe Mineral Field have been mined for the recovery of copper and gold. The main ore reserves exist in the Laloki mine, where proved ore is estimated at 270 000 tonnes, assaying about 40% sulphur, 37.5% iron, 4.5% copper, and 6 g gold per tonne; of this some 60 000 tonnes could be mined by open cut. The ore is subject to combustion on exposure. Smaller bodies of sulphide ore near Laloki are in the Moresby King-Sapphire mine and in the Dubuna mine. The oxidized portions of the Moresby King-Sapphire orebodies were worked prior to December 1941 for their gold content, but the Dubuna mine has not been worked since 1925 and is now collapsed.

Sulphur deposits occur on Lolobau Mt, a volcanic cone in western Lobelau I. Thin layers of sulphur are associated with fumarolic areas on the flanks of a central cone within the main crater, and to a lesser extent on the inside of the main crater wall. The probable sulphur content of the deposits is 12 000 tonnes. Beneficiation would be necessary to remove fragments of pumice and rock.

Deposits of sulphur of limited extent, formed by the interaction of volcanic gases, occur on several volcanoes along the north coast of New Britain.

On the north-northeast and northeast slopes of Mt Pago, both inside and outside the crater, are deposits of sulphur, averaging 8 cm in thickness, formed by the interaction of escaping gases. The deposits were estimated to contain 4000 tonnes of sulphur. At Mt Garbuna near the base of Willaumez Pen., deposits of sulphur forming mounds around fumaroles and surface layers of up to 30 cm thick were estimated to contain 1700 tonnes of sulphur. (Auth./W.M.)

12-c-28 FISHER, N. H., 1942a — Geological report on the sulphur deposits of New Britain. *New Guinea geol. Bull.* 3, 40-5.

Deposits of chemically precipitated sulphur associated with fumarolic activity in the abundant volcanoes in New Britain are discussed. Deposits on the South Son, Mt Langila, Mt Tavurvur, Rabalanakaia, in the Talasea area, and on Mts Pago and Garbuna are documented. Only the Pago and Garbuna deposits are considered potential economic sources of sulphur in small-scale operations. (W.M.)

12-c-29 FISHER, N. H., 1942b — Geological report on the sulphur deposits of Lolobau. *New Guinea geol. Bull.* 3, 46-9.

Lolobau is a complex basaltic volcanic island off the north coast of New Britain. The main island originated as a submarine volcano of considerable size, much of which was probably removed by explosive activity, and is modified by parasitic crater and flank pumice cones. Sulphur is concentrated mainly near active steam vents on the crater subsidiary cone and inside the south rim of the main crater. It is chemically precipitated, and some has been spread on the flanks of the cone by surface waters. The deposits may prove workable for a small-scale operator. (W.M.)

12-c-30 FISHER, N. H., 1958 — Notes on lateritization and mineral deposits. *Australas. Inst. Min. Metall., Stilwell Anniv. Vol.*, 133-42.

The process and products of lateritization under tropical and sub-tropical conditions are discussed, and a typical lateritic profile is tabulated. The significance of laterites as indications and sites of a concentration or leaching of a range of ores in Australia and Papua New Guinea is outlined. Examples cited include the Weipa bauxite deposits and the nickel-bearing laterites developed on ultrabasic rocks in the Papuan Ultramafic Belt. (W.M.)

12-c-31 FISHER, N. H., MATHESON, R. S., IVANAC, J. F., BARRIE, J., & KALIX, Z., 1959 — Silver. *Bur. Miner. Resour. Aust., Min. Resour. Summ. Rep.* 37, 40 pp.

Most of the silver produced in Papua New Guinea has been contained in gold concentrates from alluvial and underground mining. Lode mining has contributed only about 10% of the total gold production but has given a considerably higher proportion of the total silver output. Bullion obtained by cyanidation at Edie Cr. was predominantly silver, the silver content sometimes rising as high as 92%.

The chief production of silver in Papua has come from the gold bullion from the lodes of Misima I., where production to the end of 1954 was 49 062 oz. Silver was present in copper matte produced (until 1941) at Laloki on the Astrolabe field. In the 2 years ended 30 June 1941, the Laloki matte yielded 16 521 oz of silver. Annual production of silver contained in gold bullion in the Territory of New Guinea before World War II was nearly 200 000 oz, and total silver production to June 1957 was 1 960 970 oz. Most of this came from the alluvial gold of the Morobe field. (Auth.)

12-c-32 GARDNER, D. E., & LUDBROOK, N. H., 1945 — Mercury. *Bur. Miner. Resour. Aust., Min. Resour. Summ. Rep.* 20, 20 pp.

Cinnabar is associated with pyrite in quartz lodes in the lower levels of the Enterprise mine at Edie Cr., Morobe Goldfield, and has also been found in the alluvial deposits of upper Edie and upper Webiak Crs, but there has been no production of mercury. (Auth.)

12-c-33 GEARY, J. K., BARRIE, J., HAYCRAFT, J. A., MORGAN, J. W., & KALIX, Z., 1956 — Platinum group metals. *Bur. Miner. Resour. Aust., Min. Resour. Summ. Rep.* 39, 25 pp.

Osmiridium is found in Papua in alluvial deposits along the streams running off the serpentine belts of the Owen Stanley and subordinate ranges. The serpentine belts extend into New Guinea, and osmiridium, usually associated with alluvial gold, has been found in several localities. Platinum-bearing alluvial deposits have been located in isolated regions of the Central and Eastern Highlands, but little development work has been done. Small quantities have been included in parcels of alluvial gold forwarded from the Waria and Ono Rs and from the Sepik goldfield. Total production to the end of 1954 was 971 oz of osmiridium and 254 oz of platinum. (Auth.)

12-c-34 GOURLAY, A. J. C., 1965a — Graphite. *In* MCLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 289-95.

Graphite has been reported near Edie Cr. and from the Eastern Highlands District, but details are not available. (Auth.)

12-c-35 GOURLAY, A. J. C., 1965b — Mercury. *In* MCLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 417-21.

Cinnabar occurs with pyrite in quartz in the lower levels of the Enterprise Mine and in quartz veins at the Merri Creek Mine at Edie Cr., Morobe Goldfield. It has also been found in the alluvial deposits of upper Edie and upper Webiak Crs, and the head of the Little Ramu R. (Auth.)

12-c-36 GOURLAY, A. J. C., 1965c — Mica. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.*, 72, 423-33.

Coarse-grained pegmatites containing large mica plates and quartz crystals occur on Fergusson I. and elsewhere in the D'Entrecasteaux Group, but the occurrences have not been investigated in detail. (Auth.)

12-c-37 GOURLAY, A. J. C., & McLEOD, I. R., 1965 — Sulphur. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 559-83.

A deposit on Fergusson I. contains about 4000 tonnes of native sulphur, of which 1000 tonnes is clean sulphur that could be hand-picked. This updates entry 12-c-27. (W.M.)

12-c-38 HAMILTON, L. H., 1962 — First record of a garnet boxwork from Papua. *Trans. Papua-New Guinea Sci. Soc.*, 3, 1-4.

A garnetiferous gossan occurs at Loluai on Woodlark I. Primary, secondary, and tertiary boxwork elements are recognized. (W.M.)

12-c-39 HOLLRUNG, M., 1888a — Phosphat aus den Purdy Inseln (Phosphate on the Purdy Islands, in German.) *Nachtn. uber Kaiser-Wilhelms-Land,* 4(IV), 237-41.

Analyses were made of rock samples collected on the Purdy Is. Short tables provide a rough guide to the chemical constituents. Phosphates were abundant in most samples. (C.F.)

12-c-40 HUTCHINSON, G. E., 1950 — Survey of existing knowledge of biogeochemistry: 3. The biogeochemistry of vertebrate excretion. *Bull. Amer. Mus. nat. Hist.*, 96, 1-554.

New Guinea data are based largely on entry 12-c-41. Recalculated estimated reserves are given for the Purdy Is: Mole I. — 12 200 tonnes guano with 1200 tonnes P_2O_5, Mouse I.—5100 tonnes guano with 570 tonnes P_2O_5. North Bat I.—2450 tonnes guano with 250 tonnes P_2O_5, and South Bat I. — 9600 tonnes guano with 960 tonnes P_2O_5. Alim I. is probably not a phosphatic limestone island, on the evidence of entry 12-c-41, and contrary to entry 21-c-51 which suggests that the island bears phosphate or guano. (W.M.)

12-c-41 HUTCHINSON, R. C., 1941 — Phosphate deposits in New Guinea. *New Guinea agric. Gaz.*, 1, 239-48.

Deposits of low-grade rock phosphate of at least 100 000 tonnes are found on several islands, notably in the Purdy Is in the Admiralty Group, and in the islands west of the Admiralty Group. Bat guano is present in many caves.

Rock phosphate deposits on Wuvulu (Maty), Aua (Durour), and Manu (Allison) Is are developed on low coralline limestone platforms. Deposits are all small and thin. The deposits on the Purdy Is, which are described and illustrated, are also small areas of rock phosphate on coralline reef limestones. Bat guano from the Kaut Caves on the west coast of New Ireland, and in caves near Madang are of good quality but there are only small reserves — e.g., 5000 to 10 000 tonnes in the Kaut Caves.

Prior phosphate surveys (entries 12-c-39 and 12-c-23) are summarized, and some analytical data tabulated. Deposits would be useful as fertilizer for local requirements, but do not warrant export exploitation. (W.M.)

12-c-42 JIEAR, A. H., 1908 — Annual report on the Astrolabe Mineral Field. *Papua ann. Rep. for 1906-07,* 87 (also issued as *Aust. parl. Pap. 160, Sess. 1907-08,* 2, 1511.)

Limited open-cut mining and a shallow (18 m) shaft have produced 89 tonnes of copper ore averaging 27% copper and carrying a small amount of silver. (W.M.)

12-c-43 KNIGHT, C. L., & LUDBROOK, N. H., 1947 — Manganese. *Bur. Miner. Resour. Aust., Min. Resour. Summ. Rep.* 7, 35 pp.

2 of the 5 known deposits of manganese ore near Rigo, southeast of Port Moresby, have been exploited. High-grade pyrolusite is surrounded by low-grade siliceous ore in elliptical, flat-lying, tabular orebodies up to 4.5 m long. (W.M.)

12-c-44 McLEOD, I. R., 1965b — Aluminium. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull. Bull.* 72, 19-29.

Several deposits of bauxite, consisting of aluminous clays containing scattered hard nodules, occur on Manus I. Only one is large enough to be of economic interest; it contains about 600 000 tonnes of bauxite, with an average thickness of 2 m and alumina content of about 50%. Highly aluminous clays occur on New Hanover I. and at many other places in Papua New Guinea where residual weathering of aluminium-rich volcanic rocks is active, but no deposits of economic size are known. (Auth.)

12-c-45 McLEOD, I. R., 1965c — Chromium and chromite. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 105-11.

All known chromite occurrences originated from the Papuan Basic Belt. In peridotite areas, chromite forms a residual concentrate on the soil surface; at Koreppa in the Waria Valley it occurs as lumps up to 7 cm across. Chromite is a constituent of the heavy-mineral concentrations in streams draining from the ultrabasic rocks and in beach sands on the northeast coast; specimens of beach sand northwest of Vanimo contained 87.6 and 87.9% of opaque minerals, mainly chromite with minor ilmenite. (Auth.)

12c-46 McLEOD, I. R., 1965d — Cobalt. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 163-9.

The only known occurrences of cobalt in Papua New Guinea are traces in the nickeliferous laterites of the Papuan Basic Belt. Less than 0.1% cobalt is normally present, but cobalt would be a useful by-product should the laterites be worked for their nickel content. (Auth.)

12-c-47 McLEOD, I. R., 1965e — Limestone. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 349-73.

Unlimited quantities of limestone and lime material are available in Papua New Guinea, but they are little used and no production figures are available. Most of the output is used as road metal and aggregate and in gold treatment.

Large amounts of coral and shell detritus from raised beaches and Pleistocene deposits are used in coastal areas for road-making. Crushed Eocene limestone from near Goroka and Chuave is used for the same purpose in the Western Highlands. Between Wau and the Snake R., extensive but largely inaccessible beds of limestone now completely recrystallized to marble) up to 120 m thick occur in the Kaindi Metamorphics of probable Palaeozoic age. The marble is used in gold cyaniding at Wau. Large outcrops of good-quality limestone occur on the western side of Ataliklikun Bay, at the north end of New Britain. Two samples taken about 1 km apart contained 98.8% $CaCO_3$. (Auth.)

12-c-48 McLEOD, I. R., 1965f — Manganese. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 401-15.

Manganese mineralization occurs sporadically in lower Tertiary chert and mudstone in a coastal strip about 8 km wide from Boera, 18 km northwest of Port

Moresby, to Hula, 100 km southeast of Port Moresby. The deposits are small, with width rarely exceeding 1 m and length usually less than 30 m. The manganese content generally decreases from the centre outwards and the ore grades into the enclosing sediments. 5 deposits, now almost exhausted, were opened up near Rigo, 60 km southeast of Port Moresby. The ore is gamma-MnO_2 of battery grade. Known reserves are small, but the area has not been thoroughly tested. Total production to the end of 1961 was 2000 tonnes, all from Rigo. (Auth.)

12-c-49 McLEOD, I. R., 1965g — Silver. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 543-58.

Total recorded production of silver in Papua New Guinea to the end of 1961 was 2 018 880 oz. Most came from the Morobe Goldfield. The silver content of the gold is generally high — some of the gold in the Edie Cr. area contains upwards of 50% silver. The fineness of the gold can be correlated with the areal geological associations of the lodes in which it occurs.

Silver is a constituent of the gold lodes on Misima I., from which a total of about 49 000 oz of silver has been produced. The lodes are in shear zones traversed by numerous veins of quartz containing gold and a little sulphides.

The copper matte produced at Laloki, near Port Moresby, contained silver. The total silver content of matte produced is not known; the 925 tonnes of matte produced in the two years 1939-40 and 1940-41, contained 16 521 oz of silver. The silver content of diamond-drill core at the mine ranged from 0.07 to 2.63 oz per ton. (Auth./M.W.)

12-c-50 McLEOD, I. R., 1965h — Titanium and zirconium. *In* McLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 623-34.

Numerous occurrences of sands containing heavy minerals have been reported from the mainland and islands of Papua New Guinea, but they are mainly iron oxides or silicate minerals and contain rutile, ilmenite, and zircon in only minor and uneconomic amounts. (Auth.)

12-c-51 MEISE, W., 1938 — Guano und anderer Vogeldung (Guano and other bird-dung deposits, in German). *In* PAX, F., & ARNDT, W. — DIE ROHSTOFFE DES TIERREICHES (The raw materials of the animal kingdom; organic material resources). *Berlin, Borntraeger,* 1(2), 2113-72.

Alim I. is a low uplifted limestone islet carrying phosphate or guano deposits; others for which better records are available (entry 12-c-41) include Purdy, Ninigo, and Wuvulu Is. (W.M.)

12-c-52 NOAKES, L. C., & LUDBROOK, N. H., 1948 — Asbestos. *Bur. Miner. Resour. Aust., Miner. Resour. Summ. Rep.* 17, 40 pp.

Ultrabasic rocks occur in Papua New Guinea, but as yet there is no reliable evidence that they contain deposits of asbestos. (Auth./W.M.)

12-c-53 NORRIE, C. P., 1914b — Annual report on the Murua Mineral Field, Southeastern Division. *Papua ann. Rep. for 1913-14,* 159 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1679.)

The presence of copper on Woodlark I. is reported, and the suggestion made that it exists in exploitable quantities. (W.M.)

12-c-54 NYE, P. B., & MEAD, G. F., 1952 — Australian resources of sulphur-bearing minerals. *Bur. Miner. Resour. Aust. Bull.* 5, 76 pp.

Papua New Guinea is the only area in Australia in which possible economic deposits of native sulphur occur. All are associated with active volcanic and solfataric areas, and contain only small reserves. The main deposits are in New Britain at Mt Garbuna (solfatara, estimated reserves 1750 tonnes), Mt Pago (crater flank deposits, about 4000 tonnes), Lolobau (not more than 1000 tonnes), Pangalu (a few hundred tonnes) and Kasolali (a few tonnes). Reserves of about 4000 tonnes sulphur, including 1000 tonnes clean hand-picked ore, are known from solfataric fields on Fergusson I. Small amounts of sulphur are found in the craters of South Son, Rabalankaia, and Tavurvur on New Britain, and on Mt Balbi on Bougainville I. Pyritic copper orebodies have been mined for copper and gold in the Astrolabe Mineral Field but have not been exploited for sulphur. (W.M.)

12-c-55 OWEN, H. B., 1954 — Bauxite on Manus Island, Territory of Papua and New Guinea. (Appendix III, *in* OWEN, H. B. — Bauxite in Australia. *Bur. Miner. Resour. Aust. Bull.* 24, 222-34.)

Bauxite was found on Manus I. in 1952 at three separate localities. At Lepatuan a dacite flow overlies bedded tuff and both have been bauxitized. The former parent rock yields a porous granular bauxite containing about 1% silica, 55% alumina, 10-13% ferric oxide and 1% titania. The composition of a sample of the nodular bauxite developed on the tuff is 11.7% silica, 51% alumina, 10.8% ferric oxide, and 1% titania.

The bauxite is forming at the present day by direct alteration of the dacite without an intervening clay zone, but the tuffs are kaolinized in the first stage of alteration. It is significant that bauxite can develop on small flat elevated areas (20 hectares at Lepatuan) during the present weathering cycle. Essential conditions for bauxitic alteration to take place appear to be — (a) high mean temperature, high rainfall, and dense vegetation, (b) relatively flat terrain, and (c) elevation above immediate surroundings to ensure adequate groundwater movement.

Total resources of bauxite at Lepatuan are about 600 000 tonnes but are negligible at the other localities. Difficulties of access and distance from markets militate against commercial exploitation, but prospects of finding more bauxite in the Bismarck Arch. cannot be lightly dismissed. (Auth./W.M.)

12-c-56 OWEN, L., 1923 — Notes on the phosphate deposits of Ocean Island: with remarks on the phosphates of the equatorial belt of the Pacific Ocean. *Quart. J. geol. Soc. Lond.*, 79, 1-15.

Most phosphatic deposits on islands in the tropical belt of the Pacific Ocean are rich in calcium phosphate derived by one or more natural leaching processes from bird droppings. Most deposits are on a basement of raised coralline limestone. Sydney Shoal (146° 50′E, 3° 20′S) south of the Admiralty Group is one of the phosphate deposits previously exploited, but no other data about the island are recorded. (W.M.)

12-c-57 PYE, A. N., 1910 — The copper deposits of Papua. *Aust. Min. Engng Rev.*, 3, 389-90.

The Laloki copper deposit cropped out as a soft sulphide with black oxide, in a band up to 6 m wide and 30 m long within wall rock of ironstone. To a depth of 8 m it was worked by open cut, and below that by shaft into the footwall of the main reef which dipped 45° and into which cross-cuts were made. Cut-off grade was 8% copper when operations ceased. Several small nearby bodies range 8 to 15% copper, but have not been worked.

Laloki Mines work the largest known copper deposit in Papua. Soft sulphide crops out over a width of 28 m and has been traced for some distance; depth has not been proved because of water problems. Abundant iron ore and calcite occur in the mine vicinity. A group of small lodes crops out south of the Laloki mines and within 8 km of the coast. They are sulphide and oxide of copper with small amounts of gold. On some lodes red iron gossans are developed. (W.M.)

12-c-58 SKEWES, H. R., WADSLEY, A. D., & WALKLEY, A., 1952 — The suitability of manganese dioxides and graphites for use in Leclanche-type dry cells — IV. The behaviour of manganese oxides in Leclanche-type dry cells. *Aust. J. Appl. Sci.*, 3, 368-83.

Manganese oxides have been compared as depolarizers in Leclanche-type dry cells. Of the three crystal structures identified by X-ray diffraction, γ-MnO_2 was the best under heavy test conditions, cell life being considerably lower with cryptomelane and pyrolusite, in that order. Under conditions of light service the importance of crystal structure was not so apparent. For best cell performance a relatively coarse oxide having the γ-MnO_2 structure is required together with a carbon network of fine particles. Tests were run using industrial products and waste products, and ores from most known Australian manganese deposits. These included γ-MnO_2 from the Kapa-Kapa mine near Port Moresby. (Auth./W.M.)

12-c-59 SMITH, M. STANIFORTH C., 1908a — Report on Astrolabe Copper Field. *Aust. parl. Pap. 14, Sess. 1907-08,* 2, 1567-9.

The Astrolabe Mineral Field was proclaimed on 21 December 1906, with an area of about 2500 km^2. The principal geological elements are the limestone, shale, and sandstone in the central and western portions of the field, and volcanic basalts and conglomerate in the east.

14 prospects have been taken up, but because little work has been done it is not possible to delineate the extent of copper mineralization. The prospects of the field are considered excellent. Some assay results for ore from the Hector Mine are quoted, and comments made on the sites and activities of the Hector Copper Mine, Gordon Mine, and the Astrolabe Copper Syndicate Mine. (W.M.)

12-c-60 SMITH, M. STANIFORTH C., 1914b — Astrolabe Copper Field. *Papua ann. Rep. for 1913-14,* 158-9 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1678-9.)

Prospecting and assessment of the Dubuna and Laloki mine areas east of Port Moresby have delineated good reserves of high-grade copper ore; about 1200 tonnes valued at £19 733 were recovered during the year. (W.M.)

12-c-61 STANLEY, E. R., 1923j — OSMIRIDIUM: ITS OCCURRENCE IN PAPUA AND THE POSSIBILITY OF ITS BEING WORKED COMMERCIALLY. *Port Moresby, Govt Printer,* 16 pp.

To encourage search and collection of osmiridium by gold prospectors, the occurrence of osmiridium in Papua, its properties, origin, method of separation from gold or parent rock, and commercial uses are described. Osmiridium is mined almost exclusively from river deposits derived from basic and ultrabasic igneous rocks, and rarely from the parent serpentinites or pyroxenite. The extent of serpentine belts associated with the Owen Stanley Ra. is outlined. (W.M.)

12-c-62 THEIME, P., 1970 — AUSTRALIAN MINERAL INDUSTRIES: BAUXITE DEPOSITS. *Canberra, Dep. Nat. Devel., Bur. Miner. Resour.,* 17 pp.

Several minor deposits of aluminous clays occur on Manus I. The only deposit likely to be of economic interest contains about 600 000 tonnes of bauxite with aluminium content around 50%, in accumulations averaging 1.8 m thickness. The discovery of terra rossa type soil on limestones in New Ireland has led to considerable exploration for bauxite in several areas, especially where the weathering of aluminium-rich volcanic rocks is known to have produced highly aluminous clays. No deposits of economic importance have been found. (W.M.)

12-c-63 WARD, J., & BARRIE, J., 1962 — Nickel. *Bur. Miner. Resour. Aust., Miner. Resour. Summ. Rep.* 40, 28 pp.

Large low-grade nickeliferous laterite deposits occur near Kokoda and near Lake Trist, and overlie periodotites of the Papuan Ultrabasic Belt. Other lateritic deposits may exist within the Belt, but access and prospecting conditions are difficult.

Nickel silicate minerals have frequently been seen in fractured and weathered serpentinized peridotite of the Papuan Ultrabasic Belt. At Koreppa in the Waria Valley, green nickel silicate fracture-fillings have been exposed in small landslips and in test pits. At the eastern end of the Didana Ra., green nickel silicate minerals have been noted occupying fractures in brecciated serpentinite. Neither of these occurrences appears to be of economic dimensions. Nickel silicate deposits may be concealed beneath the thick nickeliferous laterites in the Lake Trist and Kokoda areas but prospecting for these would also be difficult. (Auth.)

12-c-64 WARIN, O. N., 1964 — Islands in Papua-New Guinea. *In* WHITE, W. C., & WARIN, O. N. — A survey of phosphate deposits in the south-west Pacific and Australian waters. *Bur. Miner. Resour. Aust. Bull.* 69, 40-63.

22 island groups in Papua New Guinea were surveyed as potential phosphate rock sources. Phosphate was found in small quantities on Sae, Manu, Aua, Wuvulu, Purdy, Nauna, and Cannac. All except Cannac are raised coralline masses on which detrital coralline sand has accumulated. The upper few centimetres of the sands have been phosphatized by chemical precipitation and residual accumulation on weathering of bird guano. Some deposits have been worked, and reserve estimates are small.

On Cannac, fresh guano and phosphatized slate and igneous rocks form the deposit which rests on metamorphics and fine-grained basic intrusives similar to rocks exposed on the south coast of Woodlark. Traces of phosphate were found in the lagoon clays of uplifted coralline atolls in the Marshall Bennet Group and in Alim and Rambutyo Is in the Admiralty Group. Islands found to be barren of phosphate include Alcester, Laughlan, Sable, St Matthias, Pak, and Tong. (W.M.)

12-c-65 WHITE, W. C., & WARIN, O. N., 1964 — A survey of phosphate deposits in the south-west Pacific and Australian waters. *Bur. Miner. Resour. Aust. Bull.* 69, 173 pp.

In 1955 a program of search for phosphate, to supplement the diminishing reserves of Ocean, Nauru, and Christmas Is, was agreed by the Australian and New Zealand Governments, and was undertaken in the islands of the Southwest Pacific and Australia by the Bureau of Mineral Resources. Islands off the north coast of Australia were investigated in 1957, the British Solomon Is and islands off Papua New Guinea in 1958, and Fiji, Tonga, and the Gilbert and Ellice Is in 1959.

Deposits on Bellona I., B.S.I.P., are the only ones that could be exploited and exported; they contain about 500 000 tonnes of grade 30.3% P_2O_5 and 4 500 000 tonnes of grade 22.3% P_2O_5. Other smaller deposits were found on Purdy, Sae, and Manu (New Guinea); Tamana, Vaitupu, Abemama, Nukufetau, Tabiteuea, and Nui, in the Gilbert and Ellice; Vanua, Vatu, Ogea Driki, and Tuvuca in Fiji; and islands in the Ashmore Reef, Northern Territory. The deposits of the islands of Papua New Guinea are discussed in entry 12-c-64. (Auth./W.M.)

(d) COAL

See also entries

01-b-55	02-b-28	02-b-145	12-b-61
02-a-66	02-b-52	12-a-32	12-b-96
02-b-24	02-b-131	12-b-27	

12-d-1 CARNE, J. E., 1912b — Report on Purari coal expedition. *Papua ann. Rep. for 1911-12,* 181 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 687.)

Coal samples from the Purari R. include Tertiary high-moisture lignite. 2 seams examined in Coal Cr. about 11 km up from its junction with the Purari are thinner than originally reported and much disturbed by folding and faulting. Similar coal is found in deep gorges between the Purari and Kikori Rs, interbedded with sandstone and mudstone and overlain unconformably by extensive lavas and volcanic agglomerates. The thinness and disturbed nature of the seams suggest the area is not a potential coal-producing basin, though further prospecting is warranted. (W.M.)

12-d-2 CARNE, J. E., 1913b — Coal in the Western Division of Papua. *Papua Bull.* 1, 1-33.

The history of exploration and investigation of coal and lignite occurrences in western Papua and an examination of the Purari Coalfield are described. Recorded geological data from the area and the geology of the area traversed are summarized. Most strata are fossiliferous Tertiary or late Mesozoic marine sediments, and intrusive igneous rocks. The coal-bearing strata are Tertiary, and the outcrops, distribution, and analyses of coals from western Papua are noted. (W.M.)

12-d-3 Corbett, D. W. P., 1965 — Brown coal. *In* McLeod, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 155-61.

Many occurrences of Tertiary brown coals are known in Papua New Guinea but, because of their location, thinness, and grade, none are of economic significance. In Papua seams are known on the upper Purari R., the head of Kemwaiera Cr. (a tributary of the lower Purari) and the head of the Era R., and in the North Eastern Division. In New Guinea, deposits have been investigated at Matakan, on the southwest coast of New Ireland; on the Toriu R. on the west coast of the Gazelle Pen., and at Rano on the south coast of New Britain; and at Astrolabe Bay in the Madang District. (Auth.)

12-d-4 Little, W. J., 1911 — Expedition from the Kikori River to the Purari. *Papua ann. Rep. for 1910-11,* 202-3 (also issued as *Aust. parl. Pap. 67, Sess. 1911,* 3, 766-7.)

Coal seams outcropping in the western headwater streams of the Purari R. were traced towards the coast. 2 seams were traced, as well as associated shale, sandstone, and limestone. (W.M.)

12-d-5 Murray, J. H. P., 1925a — Annual report by the Lieutenant-Governor. *Papua ann. Rep. for 1923-24,* 5-9 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2632-6.)

A coal seam 40 m wide was found in Smoky Cr., a west-flowing tributary of the Era R. An analysis is quoted. (W.M.)

12-d-6 Smith, M. Staniforth C., 1909b — Annual report of Director, Department of Mines. *Papua ann. Rep. for 1908-9,* 128-36 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2080-8.)

Samples of coal were collected from seams exposed in the Purari R. Mining and prospecting activity in the goldfields and mineral fields are reviewed in mining wardens' reports (entries 12-i-49, 12-i-55, 12-i-75, 12-i-76, and 12-i-101.) (W.M.)

12-d-7 Standards Association of Australia 1955 — Australian Territories (Chapter VIII *in* POWER SURVEY REPORT No. 3 — A REPORT ON THE COAL RESOURCES OF THE COMMONWEALTH OF AUSTRALIA. (Report of Coal and Lignite Panels of the Power Survey Sectional Committee). *Sydney, Standards Association,* 102-3.)

Seams of lignite and brown coal from some Tertiary strata in Papua New Guinea are noted, and proximate analyses given for samples from the upper Purari R., Matakan (New Ireland), and Torui R. (New Britain). (W.M.)

12-d-8 Stanley, E. R., 1923a — Annual report of Government Geologist. *Papua ann. Rep. for 1921-22,* 91-4 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 2041-4.)

Comparisons are made between the Mesozoic geology of New Guinea, Queensland, and Northern Territory, largely on the basis of coal-bearing successions. It is thought, as one consequence, that extensive economic fields of coal could be found in Papua. (W.M.)

(e) Petroleum

See also entries

02-a-6	02-b-57	02-c-21	12-h-4
02-b-11	02-b-159	03-a-20	12-i-33
02-b-19	02-b-162		

12-e-1 ANONYMOUS, 1938b — Search for oil in Papua. *Petrol. Times,* 40, 70-2.

Exploration work by the Papuan Apinaipi Petroleum Co. is reviewed. The logistic reasons for concentrating initial efforts on the Oiapu Anticline are justified by the probable returns in geological data and by the fact that this structure is thought to have the best reservoir potential. The structure and form of the Oiapu Anticline, Jokea-Apinaipi Dome, and Apinaipi Anticline are outlined. Some sediments and overlying lavas and agglomerates of unstated age crop out and appear to form reasonably satisfactory stratigraphic and structural traps. Source rocks at depth are predicted on the basis of surficial data in nearby areas and on the results of preliminary drilling of the structures. (W.M.)

12-e-2 ANDREWS, E. C., 1932 — Prospecting for 'oil' in Australia and New Guinea. *Econ. Geol.,* 27, 365-79 and 471-86.

The site, nature, and extent of oil prospecting in Australia, Papua, and New Guinea during the preceding 8 years are outlined, and estimates of expenditure are given. In Papua New Guinea there had been considerable activity, mostly by the Anglo-Persian Oil Co. in western Papua and northwest New Guinea. A more favourable reassessment of the petroleum potential of the island is given. The results and progress are assessed and interpreted on the basis of comparison with the broad-scale stratigraphy and structure of known oil-producing areas in other countries. It is deduced that there is reasonable potential for finding major oil fields in Australia. (W.M.)

12-e-3 ANGLO-PERSIAN OIL COMPANY, 1921a — Oilfields in Papua — reports of operations of the Anglo-Persian Oil Company during January and February 1921. *Aust. parl. Pap. 104, Sess. 1920-21,* 2017-20.

This report is the first of a series prepared during 1921, noting the progress of petroleum exploration work in western Papua. The series was not continued after 1921. Monthly operational reports for January and February 1921 are accompanied by geological and logistic reports of work in the Kira-Ie Hills district of western Papua. (These reports are abstracted and listed separately as entries 02-b-48, and 12-e-13 to 12-e-17.) (W.M.)

12-e-4 ANGLO-PERSIAN OIL COMPANY, 1921b — Oilfields in Papua — reports of operations of the Anglo-Persian Oil Company during March to July 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2021-24.

This is the second of 3 reports in 1921. (W.M.)

12-e-5 AUSTRALIA. BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, 1960 — Summary of oil search activity in Australia and New Guinea to June 1959. *Bur. Miner. Resour. Aust. Rep.,* 41A, 68 and 24 pp.

This supersedes entry 12-j-9. Information on history of investigation for petroleum, and expenditure and present status on exploration are updated. There is no significant change in the geological summary for Papua New Guinea, nor in the status of current exploration and petroleum potential. (W.M.)

12-e-6 BASTARD, E. M., 1929 — Magisterial reports — Gulf Division. *Papua ann. Rep. for 1927-28,* 23-5 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 478-80.)

Shows of gas are reported at 350 to 365 m in an unlocated hole being drilled by New Guinea Oil Co. (W.M.)

12-e-7 BELTZ, E., 1944 — Principal sedimentary basins in the East Indies. *Bull. Amer. Ass. petrol. Geol.,* 28, 1440-54.

An outline is given of the Mesozoic and Tertiary stratigraphy of the major depositional basins in Sumatra, Java, Borneo, Indonesian Arch., and mainland New Guinea. In Papua New Guinea potential oilfields are recognized in the Matapu and Oriomo-Kikori area. (W.M.)

12-e-8 BROWN, L. N., 1913 — Report of Warden, Gulf District. *Papua ann. Rep. for 1912-13,* 34-5 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 420-1.)

The positions of several surface indications of petroleum in the Vailala valley are recorded, but host rocks do not crop out. (W.M.)

12-e-9 CARNE, J. E., 1912a — Report on petroleum oilfield, Vailala River. *Papua ann. Rep. for 1911-12,* 174-5 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 860-1.)

Bubbling and boiling muds are reported at several localities in the Vailala-Purari basins. The oldfield indicated by these ebullition points may extend westward into Dutch New Guinea. (W.M.)

12-e-10 CARNE, J. E., 1913c — Petroleum and natural gas in Papua. *Papua Bull.,* 1, 34-82.

The discovery and sample testing of petroleum material from volatile hydrocarbon bubbling pools in and near the Vailala R. in 1911, and other reported indications of petroleum in New Guinea, are recorded. Sites of petroleum showings in western Papua and sample test reports are discussed. Comparisons are made between the Papuan petroleum indications and those in the Dutch East Indies. (W.M.)

12-e-11 CASEY, J. N., & KONECKI, M. C., 1967 — Natural gas: A review of its occurrence and potential in Australia and Papua. *Proc. 7th World petrol. Cong., Mexico.* 2, 265-88.

Significant oil and gas discoveries have been made in 15 of the 25 main sedimentary basins in Australia and in Papua. Altogether 1269 wells were drilled to 30 September 1966; 47 wells were completed for oil production and 93 for gas; of these, 23 oil and 2 gas wells are currently producing. The cost of this effort to the end of 1965 was $US414 million including $US90 million spent in Papua. Proved and probable gas reserves found to date are about 7 trillion (million millions) cu. ft.

Natural gas will make a significant contribution to the Australian primary energy consumption in competition with coal and petroleum products. Potential markets for gas are few but they will grow and indigenous natural gas may capture the share of the market presently dominated by petroleum products, including residual fuels. Gas reservoirs are predominantly sandstones, ranging in age from the Lower Ordovician (Amadeus Basin), through Middle Devonian (Adavale Basin), Permian (Perth, Cooper, Bowen Basins), Jurassic (Perth, Surat, Papuan Basins), to Tertiary (Gippsland Basin); limestone forms the reservoirs in the Tertiary of the Papuan Basin. (Auth.)

12-e-12 EMMONS, W. H., 1931 — Oceania and Asia, except Russia — New Guinea. *In* EMMONS, W. H. — GEOLOGY OF PETROLEUM. *N.Y.* and *London, McGraw-Hill,* 694.

Northwest of Port Moresby mud volcanoes and gas vents appear above anticlines in Tertiary strata and shallow wells have yielded a few thousand gallons of light oil. On the north coast near the Torricelli and Prince Alexander Ras, oil seepages are found in folded Tertiary beds and shallow wells near Aitape have yielded a little oil. (W.M.)

12-e-13 GILLESPIE, A., 1921b — General report for February 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields of Papua: reports of operations of the Anglo-Persian Oil Company during January and February 1921. *Aust. parl. Pap. 104, Sess. 1920-21,* 3, 2019.

Indications of petroleum in the Aipa-Ie Hills area are promising but the structure is unfavourable because of the amount of disturbance of strata. Operational logistics and preparation for drilling at Popo are discussed. (W.M.)

12-e-14 GILLESPIE, A., 1921c — General report for March 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua — report of operations of the Anglo-Persian Oil Company during March to July 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2023.

Results of geological mapping of the Popo anticline are noted. The tentative site for drilling this structure is confirmed. (W.M.)

12-e-15 GILLESPIE, A., 1921d — General report for April 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua — reports of operations of the Anglo-Persian Oil Company during March to July 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2024.

The geological survey was suspended during April, and this report summarizes general field development and logistic movements. (W.M.)

12-e-16 GILLESPIE, A., 1921e — General report covering the period May to July 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua — Reports of operations of the Anglo-Persian Oil Company during March to July 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2024.

Coastal exposures around Kerema, and the desirability of detailed mapping in this area are discussed. Expectations of finding oil in a test well seem reasonable. (W.M.)

12-e-17 GILLESPIE, A., 1921f — Oil fields in Papua, report of operations of the Anglo-Persian Oil Company during August and September 1921 — general report covering the period August and September 1921. *Aust. parl. Pap. 171, Sess. 1920-21,* 3, 2025-6.

Mapping in the Aipa-Ie Hills area continued, and faults cutting the major anticlinal feature were delineated. Prospects of finding petroleum are reassessed, and seem less favourable than previously thought. (W.M.)

12-e-18 HENNELLY, J. P., 1912 — Report of Warden, Kerema, Gulf Division, for 1911-12. *Papua ann. Rep. for 1911-12,* 37-8 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 723-4.)

Petroleum occurrence is indicated by gas-bubbling green muds in 6 localities spread over about 1500 km^2 in the Kerema-Purari R. area. The vents occur in stream beds and resemble the boiling volcanic muds of New Zealand. An inflammable gas escapes, and residual surficial scums have a petroliferous odour. Nearby deposits include mudstone, sandstone, and limestone. The area covered by petroleum prospecting parties is delineated. (W.M.)

12-e-19 HUMPHRIES, W. R., 1926 — Divisional report — Gulf District. *Papua ann. Rep. for 1924-25,* 31-4 (also issued as *Aust. parl. Pap. 41, Sess. 1926-28,* 2, 2095-8.)

Numerous 'blows' of natural gas are known in the area between the Lakekamu and Vailala Rs. Prospecting and drilling activities are being carried out by Anglo-Persian Oil Company, New Guinea Oil Co., Nabo Oil Development Co., and Papuan Oil Exploration Co. in several areas along and between these rivers. (W.M.)

12-e-20 MCKILLOP, G. F., 1930 — Analysis of sample of natural gas from Duene River, Barum River Oil Company's concession, Mandated Territory of New Guinea. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.,* 2, 49.

The composition of the natural gas is: dry or hard gas (uncondensable hydrocarbons, methane, and ethane) 87.4%; CO_2 1.9%; O_2 0.9%; wet gas (condensable hydrocarbons) 6.2%; H_2S trace. (W.M.)

12-e-21 MAYO, H. T., 1921a — Geological survey, Papua: progress report Popo area, January 1921. *In* ANGLO-PERSIAN OIL COMPANY — Oilfields in Papua — reports of operations of the Anglo-Persian Oil Company during March to July 1921. *Aust. parl. Pap. 140, Sess. 1920-21,* 3, 2023.

Results of detailed mapping of the Popo anticline indicate it is not 'approximately symmetrical' as previously thought. Prospects of finding oil in this structure seem reasonable at this stage of exploration, provided the test drill is located on careful assessment of the results of accurate mapping. (W.M.)

12-e-22 MINGAYE, J. C. H., 1912 — Report on a sample of petroleum collected by Mr J. E. Carne on the Vailala River. *Papua ann. Rep. for 1911-12,* 180 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 866).

A sample of blackish-brown petroleum from the Vailala R. yielded no 150°C boiling fraction, 20.8 wt% of 150-300°C fraction, 74.2 wt% lubricating and solid hydrocarbons, and 5.0 wt% coke. Specific gravity was 0.9744, and sulphur content 0.04%. The sample was atypical, as it was a contaminated surface accumulation. (W.M.)

12-e-23 RAGGATT, H. G., 1955a — Search for oil in Australia and New Guinea: the geological background. (*In* Oil, Australia and the future. *Symposium Roy. Soc. N.S.W.,* S5-S21.

The theory of petroleum accumulation in natural reservoirs is illustrated by considering producing American fields and related to structural and stratigraphic features being investigated in Australia and Papua New Guinea. A resume of the geology and petroleum prospects of the sedimentary basins in Australia and Papua, including the Aure Trough, expresses confidence in the petroleum potential in Papua New Guinea. (W.M.)

12-e-24 READ, J., & ANDREWS, A. C. P., 1920 — Note on a Papuan natural petroleum — II. *J. Soc. chem. Ind.,* 29, 289-91.

Natural hydrocarbons from Upoia contain an unusually large low-boiling fraction (entry 12-e-26). The crude oil has S.G.=0.7965 at 22°C, and yields 44.65% by weight as 180° boiling fraction. The 180° solid residue was distilled and four fractions tested. Aliphatic and aromatic compounds were identified, and there was no evidence of 'cracking' at 300°C. Physical and optical properties of the various fractions are tabulated and recorded. (W.M.)

12-e-25 READ, J., & WILLIAMS, M. M., 1919a — Note on Papuan natural petroleum. *Chem. Engng Min. Rev.,* 11, 259.

2 samples of petroleum from the Vailala oilfield were analysed, and weight percent of different distillation fractions recorded. The oil is unusually high in aromatic compounds, and unusually free of sulphur and nitrogen compounds, in which properties it is said to closely resemble Burmese petroleum. (W.M.)

12-e-26 READ, J., & WILLIAMS, M. M., 1919b — Note on a Papuan natural petroleum. *Trans. Soc. chem. Ind.,* 38, 319-20.

2 samples of natural petroleum are tested for composition and availability of aromatic hydrocarbons. Several fractions are distilled off, and the nitration of each fraction investigated. The samples, one from Vailala and one from Upoia, are both light-fraction petroleums, with less than 5% natural benzene. Re-distillation of the 170° fraction up to 120° will increase benzene production to about 10% by weight of the parent sample. (W.M.)

12-e-27 SMITH, M. STANIFORTH C., 1929 — Annual report from Department of Mines. *Papua ann. Rep. for 1927-28,* 46-9 (also issued as *Aust. parl. Pap. 13, Sess. 1929-31,* 4, 501-4.)

Oil and gas shows were found in drill holes at Hohoro and Oriomo in the Gulf District, and at Kukuia on C. Vogel. In the Kukuia hole mudstone, sandstone, and limestone were intersected, and oil shows were seen in the sandstone. Oil seeps at Aipa in the Gulf District have been sampled. (W.M.)

12-e-28 SPINKS, R. B., 1970 — Offshore drilling operations in the Gulf of Papua. *APEA J.,* 10(2), 108-14.

Phillips Australian Oil Co. and partners drilled 11 offshore wells between October 1967 and June 1969, in Exploration Permits PNG/2P and PNG/3P, using Global Marine Inc. self-propelled drilling vessel *Glomar Conception* largely because of its mobility and large storage capacity. The wells were drilled in water 10-100 m deep and the total footage drilled was 99 658 (30 370 m). Sea water was used for drilling before setting the marine riser system, and then a freshwater-base gel mud, with weight material added as required, for the rest of the hole. Well costs showed considerable variation with drilling conditions, but the daily average cost throughout the operation was about $23 000.

The major difficulties encountered were drilling problems created by 2 different formations (the Pliocene plastic mudstone series, which was overpressured in most wells, and the Miocene reefal limestones, which were characterized by complete loss of circulation and contained gas in three wells). Drilling in the overpressured mudstone required mud weights of up to 18 lb/gal in some instances to contain the bottom hole pressures, and to keep the hole from collapsing. Common problems experienced were balling of the bit and drill-collars, hole collapse, and loss of circulation. Time delays due to these problems made drilling these sections expensive, but contributing more to the high cost was the excessive use of drilling chemicals, particularly barytes.

5 wells were drilled into Miocene reefal limestones, and on all wells loss of circulation was complete and returns were not regained. One test, Borabi, was drilled from 4959 to 9442 ft (1512 to 2878 m) blind with sea water, this being possible as no hydrocarbons were encountered. The remaining wells, 3 of which penetrated overpressured gas zones, were drilled with a floating mud-cap technique. This method of drilling involves the use of sea water as drilling fluid, with a mud column in the annulus for pressure control. Mud must be added to the annulus continually to counteract the flow of gas up through the column, causing the well to kick. Floating mud-cap drilling was used only after all efforts to seal the formation and drill with a balanced mud column had failed, and it became obvious that attempts to drill in the conventional manner were dangerous owing to the frequency and severity of well kicks. The major operational problem was again excessive mud consumption. Other problems associated with this method of drilling were formation evaluation which was seriously hampered, and the relatively high risk of a blow-out owing to the unstability of the annulus, and frequency of well kicks. (Auth.)

12-e-29 TOWNSEND, F. L., & KONECKI, M. C., 1965 — *Petroleum. In* MCLEOD, I. R. — Australian mineral industry: the mineral deposits. *Bur. Miner. Resour. Aust. Bull.* 72, 469-77.

In the Papuan Basin, oil and condensate were produced at a maximum rate of about 1610 barrels per day on production tests in Puri No. 1 well in 1958. The tested interval was from 7460 to 7508 ft (2274 to 2310 m) in a repeated section of lower Miocene limestones below a thrust fault. Water appeared very soon during production tests and could not be eliminated despite progressive reduction of choke size. Tests have shown that on continuous production a small quantity of oil would be produced together with large quantities of water. No reserves have been established in the Puri area, though traces of oil have been recorded from other drills in the Papuan Basin.

Natural gas has been found in abundance in several wells in the Papuan Basin. Drill-stem tests show flow rates of 8 MMcfD in Puri No. 1, 9 MMcfD in Barikewa No. 1, 28 MMcfD in Bwata No. 1, and 31 MMcfD in Iehi No. 1, Kuru No. 1 blew out, with an estimated flow of 50 to 100 MMcfD. The gas in all except the Puri well was 'dry'. Gas was intersected in several horizons in Cretaceous and Miocene strata. (Auth./W.M.)

12-e-30 WADE, A., 1914a — Preliminary report on Vailala petroleum field. *Papua ann. Rep. for 1913-14,* 151-2 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1671-2.)

Known oil and gas seepages have been inspected, and the associated structures mapped. Regional structure is favourable for the accumulation of petroleum, but much detailed field study is needed to assess the prospects of the area. A large number of rock specimens and fossils have been collected, and drilling is proceeding. (W.M.)

12-e-31 WADE, A., 1914b — REPORT ON PETROLEUM IN PAPUA. *Canberra, Govt Printer,* 47 pp.

An account is given of the investigation methods, the small amount of previously published data is listed, and the geology of several small areas in western Papua is discussed. Physical and chemical properties of samples of petroleum from Upoia are presented, and the high content of light petroleum and kerosene is noted. A bibliography of works related to the geology of Papua New Guinea is appended.

Regional structural features, general stratigraphic succession, and geological history of the area, are outlined. Lithostratigraphic units include: (i) Recent surface deposits of estuarine, delta, and river detrital sediments, (ii) Pliocene and Pleistocene *I-e Hills Series* of elevated terraced coralline limestone with interbedded mudstone low in the unit. These rest unconformably on (iii) Pliocene *Cape Possession Beds* (including the *Kivori Grits*) of coarse detrital sediments and fossiliferous limestone, (iv) Miocene *Vaiviri Series* (including *Biai Grits*) which resemble the Cape Possession strata and contain abundant plant debris and a basal coal seam at Vaiviri, (v) Miocene *Upoia Beds* of mudstone, sandstone, and limestone, which are petroliferous, (vi) Lower Tertiary *Morupo-lovo Beds* of carbonaceous and fossiliferous coarse detrital sediments, which rest unconformably on (vii) *Port Moresby Series* of deep-water chert, mudstone, and limestone of unknown age. (W.M.)

12-e-32 WADE, A., 1917b — Report on Petroleum in Papua. *Aust. parl. Pap. 61, Sess. 1914-17,* 2, 1727-4.

This is a re-issue of entry 12-e-31.

12-e-33 WOOLNOUGH, W. G., 1934 — Natural gas in Australia and New Guinea. *Bull. Amer. Ass. petrol. Geol.,* 18, 226-42.

According to the indications, natural gas in these regions may be classified as (i) derived from recent and subrecent sediments, (ii) derived from carbonaceous strata, (iii) associated with artesian water, (iv) derived from metamorphic rocks, and (v) presumably associated with petroleum. In Papua New Guinea types (ii) and (v) account for all known occurrences. The examples cited are in areas investigated by the Anglo-Persian Oil Company near Aitape and Vanimo in New Guinea and along the Gulf of Papua coast. In solfataric and fumarolic areas in New Guinea are examples of natural gas emanations associated with volcanic rocks. (W.M.)

12-e-34 WYLLIE, B. K. N., 1930a — Drilling operations at Popo, 1922-29. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-29. *London, H.M.S.O.,* 1, 90-7.

The siting, intent, and effect of 5 wells in the Popo Anticline are assessed, and core stratigraphic data outlined. (W.M.)

(f) ENGINEERING

See also entries

02-c-24 07-b-26

12-f-1 AUSTRALIA. WORKS, COMMONWEALTH DEPARTMENT OF (Central Testing and Research Laboratory), 1968b — Sampling and testing of damsite materials for the Upper Ramu hydro-electric scheme. *In* FRAZER, J. B., & VALLANCE, D. B. — UPPER RAMU RIVER HYDRO-ELECTRIC SCHEME: NO. 1 POWER STATION AND ASSOCIATED WORKS. *Canberra, Comm. Dep. Works,* 47-52.

Stage triaxial tests on unconsolidated sediments in the dam and reservoir site for the Upper Ramu hydro-electric scheme were conducted to test foundation and fill properties. Tests suggest these sediments would prove adequate for fill, and have sufficient strength and low permeability to be acceptable as foundation materials. Field geophysical testing of depth of sediment overburden, basal sediment conglomerate, and weathered bedrock were conducted. Seismic velocity, electrical resistivity, and magnetic variation were measured. (W.M.)

12-f-2 BAUMER, A., 1970 — Engineering geological investigation of the Panguna copper prospect. *42nd ANZAAS Cong., Port Moresby,* Sec. 5 Pap., 22, 27 pp.

As one aspect of planning the development of the open-cut mine at Panguna, careful assessment of the stability of proposed pit slopes was undertaken using engineering geological and rock mechanics studies. Slope instability at Panguna is a function of depth and type of overburden, intensity of weathering of bedrock to variable and often considerable depths, the alteration of host igneous rocks, fracture systems in the host orebody and country rock, intense local seismic activity, high and continuous rainfall, and the fact that the open pit was so sited as to overdeepen a natural topographic depression.

As a means of collecting and assessing data, outcrop and overburden distribution was mapped in detail, fracture systems were identified on air-photographs and surveyed in detail in exposures and drill cores, the pit site and associated lineaments and suspected faults were drilled, rock and drill core samples tested mechanically, water-pressure tests run on drill holes, a network of seismic instruments set up and monitored, and meteorological and hydrological data continuously recorded. (W.M.)

12-f-3 GARDNER, D. E., & CARTER, E. K., 1968 — Geological aspects of the Upper Ramu River hydro-electric scheme (No. 1 power station and storage dam). *In* FRAZER, J. B., & VALLANCE, D. B. — UPPER RAMU RIVER HYDRO-ELECTRIC SCHEME: NO. 1 POWER STATION AND ASSOCIATED WORKS. *Canberra, Comm. Dep. Works,* 35-46.

At the present stage of investigation there appears to be no impediment arising from geological conditions to the construction of the scheme as planned. If the underground head-station layout is adopted, with access and pressure shafts in the south bank of the river, it should be possible to site the machine hall in siltstone, which is a strong rock and preferred to the marble which also occurs in the area. The tailrace tunnel will be in marble, greywacke, and unknown underlying rocks. The known rocks are strong and the underlying rocks are probably similar, or are equally strong igneous rocks. Drill DD20, in progress, should fill in all, or most, of the gaps in knowledge of rock types present. Some sheared and faulted zones will probably need full support; water-control may, and lining will, be needed over parts of the tunnel. Location of access and intake on the south bank should minimize problems of slope stability but, owing to the nature of the sediments overlying the metamorphics, establishment and maintenance of access and service roads will be expensive.

The storage damsite area, downstream of the Ramu bridge, is in soft, slightly compacted but not lithified, lake sediments (mainly silty clay and conglomerate). Bedrock, of dolerite intruded into metasediments, occurs from 1.5 to 14 m below the level of the river and is deeply weathered. The lake sediments, though rather plastic, are strong enough and impermeable enough to form satisfactory abutments for a gravity dam and to provide the embankment material. Owing to the flow characteristics of the Ramu R. and the deeply weathered bedrock, requiring massive diversion works and some form of concrete spillway for an earth dam, or deep excavation to expose adequate foundations for a concrete dam, or a higher embankment to provide large flood surcharge capacity, any dam built in the area would be expensive. Erection of the required storage dam is, nonetheless, practicable. (Auth.)

12-f-4 MOFFITT, R. B., & KAY, R. L., 1970 — Evaluation and development of a copper orebody on Bougainville Island, T.P.N.G. *42nd ANZAAS Cong., Port Moresby,* Sec. 5 Pap., 21, 27 pp.

The Panguna copper orebody is mainly in the form of chalcopyrite in quartz veins and disseminated through altered acid to intermediate plutonics intrusive into andesitic volcanics. An oxidized zone and zone of secondary enrichment partly cover the primary ore, which also is overlain in part by a variety of barren overburden materials. Extensive intense fracturing in the region is the major engineering problem.

A program of diamond drilling, adit driving and rising enabled estimation of ore resources (900 million tons of 0.49% Cu and 0.36 dwt gold per ton) and initial engineering testing from which pit design could be determined. The history of exploration, evaluation, testing, feasibility study, method investigation, operation design and strategy, and mine development are traced. (W.M.)

12-f-5 READ, J. L. R., 1970 — Some aspects of the investigation of low-quality construction materials from mineralized rock. *42nd ANZAAS Cong., Port Moresby,* Sec. 5 Pap., 32, 10 pp.

The break-down of road aggregate owing to the presence of 'deleterious minerals' is discussed, with examples from a study of 7 rock types investigated during development at the Panguna mine site on Bougainville. Rock types considered are propylitized andesite, andesitic lapilli crystal tuff, sulphide-bearing quartz diorite, hornblende microdiorite, weathered hornblende andesite, porphyritic dacite, and basalt. The 'deleterious minerals' recognized include chlorite, zeolite, sericite, uralite, epidote, leucoxene, and carbonate. There is a strong correlation between road pavement deterioration and the abundance of 'deleterious minerals' in the basement aggregate. (W.M.)

(g) HYDROGEOLOGY

See also entry 02-b-19.

12-g-1 HAMILTON, L. H., 1965 — Some considerations on shallow groundwater supply problems in the coastal region of Papua. *Trans. Papua-New Guinea Sci. Soc.,* 6, 5-12.

High rainfall is widespread over much of Papua, but water supply problems are neither few nor simple. The dispersed distribution pattern of the population has a marked effect on the water-supply situation, which is also affected by rapid technological development, population growth, and a tendency towards coalescence of the population.

The usual methods of well-site selection depend largely on the amount of geological information available and for villages with alternative means of water supply (e.g. rainwater storage), the expense of investigating and selecting a well site may outweigh the value of the results. However, rapid assessment of shallow groundwater potential can be made using a method based on geological interpolation. The area under investigation is related to the surrounding country, divided into regions, and then sub-divided into hydrogeologically similar zones. Data in each zone are generalized and related to the area of investigation.

Individual groundwater problems throughout the coastal part of Papua can be investigated more efficiently by relating them to the overall situation than by investigating each one as if it were an isolated case. This would enable the formulation of generalizations, the selection of type problems, and a reduction in the expense of investigating similar problems. (Auth.)

12-g-2 MACGREGOR, J. P., & READ, J. R. L., 1969 — Village water supply investigation, Territory of Papua and New Guinea. *Engng Geol.,* 3, 217-32.

Papua New Guinea has water supply problems despite its high rainfall. The population lives mostly in villages and obtains its drinking water from streams and wells that are subject to pollution and drought. To improve the standard of water supplies the Administration has set up a Village Water Survey Team to review the present position district by district and make recommendations for the development of water supplies.

Any village water supply scheme recommended must be cheap to install and maintain, and should provide an adequate supply of fresh water which cannot readily be polluted. Deep drilling is too expensive at this stage of development. Supplies of fresh water can be obtained in, or near, most villages by sinking a protected well or by tapping a sandy aquifer by a spear. Water from surface streams can be gravitated to a village in appropriate situations provided bacterial contamination can be avoided. Where suitable groundwater cannot be located, an artificial rainwater catchment and storage is generally the best alternative.

The problem of adequate, safe, and cheap village water supplies has to be faced in many developing countries, and the approach adopted in Papua New Guinea may be applicable elsewhere. (Auth.)

12-g-3 STANLEY, E. R., 1924b — Water resources of New Guinea. *In* AUSTRALIAN INSTITUTION OF ENGINEERS — THE POWER RESOURCES OF THE COMMONWEALTH OF AUSTRALIA AND MANDATED TERRITORY OF NEW GUINEA. *Sydney, Govt Printer,* 24-9) (also issued as *Trans. 1st World Power Cong., London,* 1, 34-9.

The many large swift rivers in Papua New Guinea represent an enormous potential source for hydro-electric power, but rainfall stations and stream-gauging stations are not numerous enough or appropriately situated to allow accurate assessment of this potential. Rainfall increases with altitude up to 2100 m, above which it decreases. Rainfall and temperature data from a variety of stations are tabulated. The Fly and Sepik Rs are the two largest in New Guinea and flow data from them and the Ramu R. are quoted. (W.M.)

(h) PROSPECTING (INCLUDING GEOPHYSICAL AND GEOCHEMICAL)

12-h-1 ANONYMOUS, 1965b — Geochemical sampling programme. *In* DAVIES, H. L., & IVES, D. J. — The Geology of Fergusson and Goodenough Islands, Papua. *Bur. Miner. Resour. Aust. Rep.* 82, 64-5.

404 stream sediment samples were collected at about 0.4 km spacings on streams, and analysed for nickel, cobalt, copper, lead, molybdenum, zinc, tin, chromium, vanadium, and beryllium using spectographic techniques. No economically interesting anomalies were detected, but distinctive values were obtained on areas of different rock types. (W.M.)

12-h-2 AUSTRALASIAN PETROLEUM COMPANY, 1961c — Puri seismic survey, Papua, 1959. *Bur. Miner. Resour. Aust., Petrol. Search Subs. Acts Publ.* 21, 36 pp.

The survey was undertaken to determine the structural pattern of the Tertiary limestones in order to define any closed structures that may have economic oil accumulations. Altogether about 120 km of continuous reflection traverses were observed and a single refraction in-line profile of 2 spreads.

An anticlinal feature was observed along one line but as there was no evidence of any significant pitch reversal along the strike line it seems there is no structure worth drilling south of the Puri and Kereru Anticlines. The overall quality of the reflection data was poor but was considered adequate to disprove the presence of any major closed structures. (Auth.)

12-h-3 HOWARD, E. J., 1964 — Results of spectrographic analysis of stream sediment samples. *In* DOW, D. B., & DEKKER, F. E. — The geology of the Bismarck Mountains, New Guinea. *Bur. Miner. Resour. Aust. Rep.* 76, 42-5.

Spectrographic analyses of stream sediment samples from most large streams in the Bismarck Mts were conducted to detect concentrations of Ni, Co, Cu, V, Mo, Pb, Sn, and Be. Abundances are tabulated of all except Sn and Be which were not detected. A trace of phosphorus was detected in two samples from the Jimi R. near Tabibuga airstrip. (W.M.)

12-h-4 LAWS, M. J., 1971 — The use of the seismic refraction method in Papua. *APEA, J.*, 11(2), 107-14.

The refraction method has been used with success in areas where the primary drilling target is an interface at which there is a large increase in seismic velocity. This condition exists in Papua where the Miocene limestone was an early target and Australasian Petroleum Company, with the Anglo Iranian Oil Company as partner, began a program of refraction exploration in Papua. As the program progressed a pattern of refractors became recognized. In the Eastern Delta, basement is recorded at depths of over 6000 m and an unreliable refractor from within the Miocene is evident. Moving westwards, the top of the Miocene limestone becomes apparent as a refractor, increasing in intensity westwards until multiple limestone refractors become evident in the Western Delta area. In the Western District the main high-velocity refractors were correlated with limestone and basement over the Oriomo basement uplift. It was shown that the area southwest of the exposed fold belt of the Southern Highlands formed a relatively stable platform. A limitation of the refraction method in Papua was that in only 2 areas had horizons from within the prospective Mesozoic sequence been recorded — the Morehead sub-basin, and between the mouths of the Bamu and Turama Rs where the Mesozoic sequence increases to over 3000 m thick.

Transference of the main exploration interest to the fold belt, where the presence of massive pinnacled limestone at the surface prevents the drilling of shot-holes for reflection surveys, has led to renewed interest in the refraction method which can be used to cover areas where shot-hole drilling may be impossible. A pilot survey along one line between Lake Kutubu and the Wage R. produced good refraction arrivals from the limestone but these were of such high velocity and intensity that any refractions from basement or from within the Mesozoic were masked. The survey thus failed to determine whether the surface features shown by the limestone were an expression of subsurface structure. A similar refraction line was observed over the Libano Anticline, where the limestone has a cover of Pliocene and conditions are more akin to those of the western plains. The limestone refractors were attenuated sufficiently to allow basement to be recorded. It is concluded that refraction has been successful in determining the structure of the Miocene limestone and basement, except where the limestone is exposed at surface, even in the fold belt. (Auth.)

12-h-5 MAFFI, C. E., SIMPSON, C. J., SIMONETT, D. S., DAVIES, H. L., & RYBURN, R. J., 1971 — Geological interpretation of radar imagery of the western central ranges of Papua New Guinea. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 24.

During 1970 the Department of Army obtained, under contract, side-looking airborne radar imagery over parts of New Guinea which had not previously been suitably photographed by conventional techniques because of excessive cloud cover. Imagery from the Porgera-Lake Kopiago area is being used by the Bureau of Mineral Resources in the planning of regional mapping programs in mid-1971. The area of interest is known to contain Miocene limestone overlying folded Mesozoic sediments, and has attracted interest from petroleum and base metal exploration companies. (Auth.)

12-h-6 OVINGTON, J. J., 1971 — Remote sensing: recent experiences in Australia and Papua New Guinea. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 25.

Remote sensing projects — involving imagery (natural colour, infra-red false-colour, multi-band photography) and also thermal mapping in 8-14 micron band —

carried out in 1970-71 are described. The role of optical imagery (conventional photography) in the field of remote sensing is discussed. (Auth.)

12-h-7 Papuan Apinaipi Petroleum Company Limited, 1961 — Wira Anticline gravity survey, Papua, 1959. *Bur. Miner. Resour. Aust., Petrol. Search Subs. Acts Publ.* 28, 7 pp.

2 gravity surveys were conducted in 1959. The purpose of a detailed gravity survey over the Wira Anticline was to confirm closure in the Wira Culmination and to obtain information on the possibility of limestone occurring in the sediments below the culmination. A regional gravity traverse from the Wira Anticline down the Purari R. sought to extend the gravitational trends shown in the Purari area by a previous survey.

No gravity anomaly was established that could be correlated with the surface geological structure of the Wira Anticline. The results indicate that the largest negative anomaly occurs east of the Purari R., below the Aure Scarp. Similar conclusions were drawn from gravity work carried out farther south along the Purari and Vailala Rs in 1958. (Auth.)

12-h-8 Phillips Australian Oil Company, Sunray DX Oil Company, Canadian Superior Oil (Aust.), & Anacapa Corporation, 1969 — Permit No. 39, Papua — Marine seismic survey, 1966. *Bur. Miner. Resour. Aust., Petrol. Search Subs. Acts Publ.* 84, 27 pp.

A detailed marine reflection seismic survey carried out in 1966 covered 2420 line km over the Papuan Basin, in the Gulf of Papua, within Oil Permits Nos. 39 and 42, and Oil Licence No. 4. The objective of the seismic survey was to obtain more detailed information on structures indicated by previous reconnaissance seismic work, with a view to determining drilling sites, and to extend the reconnaissance in the area.

Interpretation of the seismic survey data has delineated 3 areas of particular interest, including a shelf area associated with what may be reef limestone development in the west, and a tectonically disturbed area in the east. An attempt has also been made to postulate the eastern limit of Miocene limestone development. The detailed seismic survey was successful in outlining favourable structural and assumed reef prospects for drilling and several areas have been mapped in sufficient detail for the selection of drilling sites. These areas include probable reef developments along the margin of the western shelf and in the Deception Bay area — considered very favourable prospects — and anticlinal structures of the tectonically disturbed area of the eastern slope. (Auth.)

12-h-9 Rimmer, W. G., 1965 — An application of the DESRA multiple subsurface coverage technique in Papua. *APEA. J.*, 5(2), 103-6.

A case history is given of the successful application of the Double Ended Spread Roll-Along multiple subsurface coverage technique (DESRA) in a survey of the Papuan Basin. (W.M.)

(i) Mineral and Petroleum Statistics

See also entries

02-b-19	02-b-166	12-a-7	12-a-33
02-b-42	02-b-168	12-a-8	12-a-34
02-b-103	02-c-5	12-a-9	12-a-35
02-b-121	02-c-6	12-a-10	12-a-36
02-b-126	02-c-7	12-a-11	12-a-37
02-b-128	05-a-47	12-a-12	12-a-38
02-b-129	11-b-8	12-a-25	12-a-39
02-b-130	12-a-3	12-a-27	12-a-40
02-b-131	12-a-4	12-a-31	12-a-41
02-b-151	12-a-6	12-a-32	12-a-42

12-a-44	12-b-49	12-b-92	12-i-36
12-b-2	12-b-51	12-b-102	12-i-78
12-b-13	12-b-61	12-b-104	12-j-11
12-b-14	12-b-63	12-b-105	12-j-16
12-b-24	12-b-64	12-b-108	14-a-5
12-b-28	12-b-69	12-c-5	14-a-6
12-b-29	12-b-77	12-c-6	14-a-7
12-b-30	12-b-80	12-c-7	14-a-8
12-b-31	12-b-85	12-c-8	14-a-9
12-b-32	12-b-86	12-c-9	14-a-10
12-b-33	12-b-87	12-c-10	14-a-11
12-b-34	12-b-88	12-c-11	14-a-12
12-b-37	12-b-90	12-d-6	14-a-14
12-b-43	12-b-91	12-e-27	14-a-15

12-i-1 ANONYMOUS, 1920 — Kiveri Goldfield and Upper Musa. *Papua ann. Rep. for 1918-19,* 83.

An estimated 28 kg gold were won from this field during the year. (W.M.)

12-i-2 ANONYMOUS, 1926a — New Guinea Oil. *Min. Mag.,* 34(1), 31.

Matapau No. 1 bore being drilled by Mandated Development Co. Ltd, encountered traces of oil at 60 ft, and a flow of oil with some gas at the rate of 50 gallons per day was reported at 79 ft; drilling is continuing. (W.M.)

12-i-3 ANONYMOUS, 1926b — New Guinea oil prospecting. *Min. Mag.,* 34(3), 163.

In 2 drill holes being sunk by Mandated Development Co. Ltd at Matapau, traces of oil and gas were recorded at shallow depths: in hole No. 2, oil and gas traces were recorded above 60 ft; in hole No. 3 oil flowed at 50 gallons per day at 79 ft, and oil with a little gas was evident between 250 and 318 ft. (B.M.R.)

12-i-4 ANONYMOUS, 1926c — New Guinea Oil. *Min. Mag.,* 35(2), 95-6.

Matapau No. 6 bore encountered traces of oil and gas in sandy shales at 470 ft, flowing at a rate of 10 gallons per hour. All 6 bores have encountered small amounts of oil and gas at shallow depths. (W.M.)

12-i-5 ANONYMOUS, 1941 — Mandated Alluvials. *Min. Mag.,* 64(3), 140.

This company in 1939-40 treated 5100 tonnes of oxidised ore and 3075 tonnes of sulphide ore from the Laloki field near Port Moresby, yielding 122 tonnes copper, 81 kg gold, and 222 kg silver. (W.M.)

12-i-6 ANONYMOUS, 1958a — Success at Puri and Papuan review. *Aust. Oil Gas J.,* 5(2), 7-11.

Gas flowed from the 7460 to 7508 ft interval of Puri No. 1 well. Original flow rate was 3 million cubic feet of gas and 70 BPD condensate. Acidising tests yielded a flow of crude oil and condensate at a rate of 1000 BPD, with further testing inducing a flow of formation water with crude petroleum. It is deduced that the hole penetrated a zone of crude oil with dissolved gas. Hole-testing techniques are summarized, and the oil search in Papua to date is reviewed. Holes drilled to date, with notes on results, are tabulated. (W.M.)

12-i-7 ANONYMOUS, 1961a — Papua — recent discoveries indicate gas reserves, but no oil found. *World Oil,* 153(3), 243.

Puri No. 1 in 1959 changed from a flow of 1000 BOPD to a flow of 100% salt water in a few days, and was abandoned. Bwata No. 1 was completed at 7302 ft, and a flow rate of 20 MMcfd obtained from an acidised Tertiary limestone at 4750 ft; the ratio gas to condensate exceeded 200 000; the hole was plugged and abandoned. Iehi No. 1 ended at 10 042 ft, with flows of dry gas in excess of 30 MMcfd reported from sandstone at about 4710 ft. The hole was plugged and abandoned. (W.M.)

12-i-8 ANONYMOUS, 1961b — Australia — flowing oil and two good gas wells in Queensland encourage exploration. *World Oil*, 153(3), 244-50.

A small amount of geological and seismic exploration was conducted in Papua during 1960; A.P.C. Iehi No. 1 was abandoned dry at 10 042 ft, in December 1960 after a show of oil. The accompanying map records most holes in Papua and New Guinea as dry holes except Puri No. 1. (W.M.)

12-i-9 ANONYMOUS, 1961c — Oil search hopes vary. *Petrol. Gaz.*, 10(1), 6.

A flow of gas at the rate of 31 MMcfD was encountered in sandstone below 4708 ft, in Iehi No. 1 well. No condensate or oil accompanied the gas. (W.M.)

12-i-10 ANONYMOUS, 1968c — Phillips Group rocks first gas strike off north Australia. *Offshore*, 28(3), 32.

Uramu No. 1A well flowed gas at the 6169 ft level at the rate of 22.4 MMcfd through a 19/32 inch choke; the nearby Uramu No. 1 well had been abandoned at 6433 ft because of high gas pressure, and the Borabi No. 1 well was plugged after drilling to 9442 ft. All three wells were sunk using the *Glomar Conception*. (W.M.)

12-i-11 ANONYMOUS, 1968d — Gulf of Papua. *In* ANONYMOUS — Aussie oil hunt pushes into new areas. *Offshore*, 28(7), 184.

The drilling of 4 offshore wells using the *Glomar Conception* in the Gulf of Papua is recorded. Uramu No. 1 was a gas blow-out, and was abandoned; Uramu No. 1A showed a gas flow of 22.4 MMcfd at 6169 ft; Orokolo 1 was abandoned dry at 11 999 ft; Maiva No. 1 was commenced. (W.M.)

12-i-12 ANONYMOUS, 1968e — Esso's Ini No. 1 yields gas shows in Papuan Gulf. *Offshore*, 28(11), 50.

Drill-stem tests showed gas-cut salty water between 6257 and 6401 ft. Earlier, shows in Pasca No. 1 were recorded but not tested, and Uramu No. 1A flowed gas at 22.4 MMcfd. Ini No. 1 is 20 km north of Uramu 1A. (W.M.)

12-i-13 ANONYMOUS, 1968f — Phillips probes Gulf of Papua. *In* ANONYMOUS — Gales hamper Aussie exploration offshore. *Offshore*, 28(10), 54-6.

Uramu No. 1A was plugged and abandoned at 10 106 ft; Orokolo No. 1 was abandoned dry at nearly 12 000 ft; Maiva No. 1 was suspended before target depth of 12 000 ft; Iokea No. 1 was abandoned dry at 4840 ft after passing through volcanic sediments; Kapuri No. 1 was abandoned dry at 5572 ft. Pasca No. 1 was spudded in with target depth of 11 800 ft. Ini No. 1 has been spudded in. Ini is being drilled by Esso; all other holes were drilled by Phillips Petroleum. (W.M.)

12-i-14 ANONYMOUS, 1968g — Phillips gauges oil and gas strikes in Egypt, off Papua. *Oil Gas J.*, 66(7), 88-9.

The Papuan strike was in Uramu No. 1A well, 16 km off the coast and 320 km northwest of Port Moresby. A flow of gas at a rate of 22.6 MMcfd is reported from the 6169 ft horizon in a 5 ft-thick reef structure. (W.M.)

12-i-15 ANONYMOUS, 1968i — Phillips scores again in offshore Papua. *Oil Gas J.*, 66(39), 94.

The strike of gas in Pasca No. 1 well in the Gulf of Papua is recorded. A flow of 6.85 MMcfd of gas, with 51°-67° gravity fluid at a rate in excess of 100 bbl/MMcfd, was reported from the interval 7215-7245 ft in a Miocene reef structure. The earlier flow of gas in a similar Miocene situation in the nearby Uramu No. 1A well is noted. The presence of 1-2 bbl/MMcfd, or 40 BPD of condensate in the Uramu 1A flow is recorded. The position of several Phillips holes in western Papua and the Gulf of Papua are shown on an accompanying map. Most holes were dry. (W.M.)

12-i-16 ARMIT, L. P. B., 1919 — Gira Goldfield, *Papua ann. Rep. for 1917-18*, 48 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19*, 4, 1568).

Level of activity was low, and production amounted to an estimated 14 kg gold, valued at £1850, and a little osmiridium. (W.M.)

12-i-17 AUSTRALIA. PARLIAMENT, 1925 — Lands, mining and forestry. *New Guinea ann. Rep. for 1923-24,* 43-4 and 71 (also issued as *Aust. parl. Pap. 22, Sess. 1925,* 2, 2188-9 and 2216.)

The Morobe Goldfield and the Aitape, Madang, Kieta, and Namatanai Mineral Fields have been declared. 187 kg gold, valued at £16 542, from the Morobe field was exported. (W.M.)

12-i-18 AUSTRALIA. PARLIAMENT, 1926a — Lands, mining and forests. *New Guinea ann. Rep. for 1924-5,* 33 and 57 (also issued as *Aust. parl. Pap. 40, Sess. 1926-28,* 2, 1559 and 1581.)

Alluvial gold discovered on the Watut is said to be of better quality than that in the nearby Bulolo Field. A total of 210 kg gold, valued at £18 512, was won during the year. (W.M.)

12-i-19 AUSTRALIA. PARLIAMENT, 1933 — Mining. *New Guinea ann. Rep. for 1931-32,* 82-5 (also issued as *Aust. parl. Pap. 192, Sess. 1932-34,* 3, 1793-6.)

Mining and prospecting activity in the Morobe Goldfield around Wau and Edie Cr. is reported. Methods used include alluvial, dredge, and lode mining techniques. Production for the year was 5100 kg gold, valued at £398 587, most of which was won by alluvial methods. (W.M.)

12-i-20 AUSTRALIA. PARLIAMENT, 1936 — Mining. *New Guinea ann. Rep. for 1934-35,* 89-92 (also issued as *Aust. parl. Pap. 243, Sess. 1934-37,* 2, 1056-9.)

Production of gold and silver bullion during the year was 8500 kg, valued at £1 894 203, almost all of which was produced in the Morobe Field; production figures by field are tabulated. Gold in the Morobe Field was produced by alluvial (1162 kg), dredge (3450 kg), and lode (840 kg) mining. (W.M.)

12-i-21 AUSTRALIA. PARLIAMENT, 1939 — Mining. *New Guinea ann. Rep. for 1937-38,* 120-2 (also issued as *Aust. parl. Pap. 169, Sess. 1937-40,* 3, 641-3.)

Mining in the Morobe Goldfield around Wau is by alluvial, sluicing, dredging, and lode mining methods; a total of 11 350 kg gold-silver bullion with higher than usual silver content was produced. Territory gold production figures by fields are tabulated; a total of 11 700 kg was produced. (W.M.)

12-i-22 AUSTRALIA. PARLIAMENT, 1941 — Mining. *New Guinea ann. Rep. for 1939-40,* 118-22 (also issued as *Aust. parl. Pap. 63, Sess. 1940-43,* 2, 1261-5.)

Geological investigations were carried out in the Morobe Goldfield near Wau and the Waria R. A volcanological observatory was established in Rabaul, and some seismometers and tiltmeters installed.

7900 kg of gold, valued at £2 954 199, was produced during the year, and production from each field is tabulated; gold exports amounted to 91 200 kg, valued at £16 422 755. Mining on the Morobe Field was both alluvial and lode working; operations in other fields were alluvial and produced only small amounts of gold. (W.M.)

12-i-23 AUSTRALIA. PARLIAMENT, 1948 — Land and natural resources. *New Guinea ann. Rep. for 1947-48,* 18 and xxvii (also issued as *Aust. parl. Pap. 50, Sess. 1946-48,* 4, 1067 and 1128.)

Geological investigations before 1940 and the significance of gold and associated silver and platinum as the sole exploited mineral are noted; 3550 kg gold as native gold and bullion, valued at £851 570, was exported for the year. (W.M.)

12-i-24 AUSTRALIA. PARLIAMENT, 1950a — Territory of New Guinea — Annual Report for 1948-49. *New Guinea ann. Rep. for 1948-49,* 8-93 and 124 (also issued as *Aust. parl. Pap. 13, Sess. 1950-51,* 2, 671-756 and 787.)

The geomorphology of the mainland and islands, and geological activity are described. Exports of copper ore, gold, and silver for the year are noted. (W.M.)

12-i-25 AUSTRALIA. PARLIAMENT, 1950b — Land and natural resources. *New Guinea ann. Rep. for 1949-50,* 26 and 114 (also issued as *Aust. parl. Pap. 8, Sess. 1951-53,* 4, 1133 and 1221.)

The volcanological observatory and monitoring equipment were re-established at Rabaul. 2410 kg native gold and bullion, valued at £1 211 569, and 1020 kg silver, valued at £10 129, were exported during the year. (W.M.)

12-i-26 AUSTRALIA. PARLIAMENT, 1953 — Mineral resources. *New Guinea ann. Rep. for 1952-53,* 57-8 and 161 (also issued as *Aust. parl. Pap. 23, Sess. 1954,* 6, 1634-5 and 1738.)

Minerals in production are gold with associated by-product silver, platinum, and osmiridium; most is produced on the Morobe Goldfield around Wau and Bulolo, with lesser amounts from the Sepik, Kainantu, and Bougainville areas. A total of 3900 kg gold, valued at £2 149 766, was produced during the year. Production figures for the year are listed by field, for gold, platinum, silver, and osmiridium. (W.M.)

12-i-27 AUSTRALIA. PARLIAMENT, 1954 — Mineral resources. *New Guinea ann. Rep. for 1953-54,* 58-9 and 175 (also issued as *Aust. parl. Pap. 89, Sess. 1954-55,* 4, 1247-8 and 1316.)

Gold was won by lode mining, dredging, and other alluvial methods, mostly in the Wau region; 22 kg gold was won by alluvial methods in headwater streams of the Ramu R. Production figures for the year are listed by field, for gold, silver, and platinum. (W.M.)

12-i-28 AUSTRALIA. PARLIAMENT, 1955 — Mineral resources. *New Guinea ann. Rep. for 1954-55,* 61-2 and 167 (also issued as *Aust. parl. Pap. 17, Sess. 1956-57,* 3, 156-7 and 262.)

Gold production was less than in the previous year, owing mainly to the reduced amount won by dredging; lode mining and alluvial working other than by dredging produced increased yields. Production figures are listed over the previous 5 years for gold, platinum, silver, osmiridium, and iridium; gold is the main product, with 2430 kg, valued at £1 339 473, being won in the year. (W.M.)

12-i-29 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1941 — Annual report — mining. *Papua ann. Rep. for 1940-41,* 12-3, 30 and **9.**

The limited mining activity in the gold mines on Misima I., and the start of sluicing operations near Griffin Pt on Tagula I. are noted. Copper mining continued in the Astrolabe field. Limited production of alluvial gold is recorded from the Murua, Milne Bay, Gira, and Yodda fields. Production and export figures for the years 1934-35 to 1940-41 are appended. (W.M.)

12-i-30 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1948 — Annual report — mining. *Papua ann. Rep. for 1947-48,* 15 and 57-8.

The major geomorphic features, including a gross descriptive classification of soils, are noted. Prospecting and exploration activity around the gold mines on Misima I., the production of a small amount of alluvial gold from Tagula I. and the Milne Bay area, and attempts to rehabilitate the Astrolabe mines are recorded. A petroleum test well was drilled to 12 000 ft at Kariava in the Gulf District. Gold worth £2229 (7.7 kg), and manganese from Rigo worth £579, were exported. (W.M.)

12-i-31 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1950 — Annual report — mining. *Papua ann. Rep. for 1949-50,* 19-21 and 71 (also issued as *Aust. parl. Pap. 57, Sess. 1951-53,* 4, 672-5 and 724.)

Increased exploration drilling activity and gold production from the mines on Misima I., and the development of alluvial gold workings on Tagula I. and in the Milne Bay area are noted. Exploration of copper shows on the Astrolabe field near

Port Moresby continued, and some manganese ore was mined near Rigo. Exports of gold, copper, and manganese are recorded. (W.M.)

12-i-32 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1952c — Annual report — mining and geology. *Papua ann. Rep. for 1951-52,* 39-41 and 115 (also issued as *Aust. parl. Pap. 16, Sess. 1953-54,* 6, 556-8 and 632).

Production of gold on Misima, and the winning of small parcels of alluvial gold on Tagula and Woodlark Is are noted. High-grade manganese ore (MnO_2=86%) was mined near Rigo east of Port Moresby, and some re-working of copper slags and residues on the Astrolabe field produced encouraging results. Petroleum exploration is reviewed: Hohoro No. 2 was abandoned dry at 10 642 ft and Omati No. 1 was abandoned dry at 8962 ft.

Production of gold, manganese, copper, zinc, platinum, and silver for the year is tabulated. (W.M.)

12-i-33 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1955 — Annual report — mining and geology. *Papua ann. Rep. for 1954-55,* 42-4, 117-8, and 128 (also issued as *Aust. parl. Pap. 88, Sess. 1956-57,* 3, 502-4, 476-8 and 488).

Mineral exploration activity was restricted to small-scale mining of alluvial gold, and exploration or prospecting of iron ore, manganese, copper, and petroleum prospects. Omati No. 1 was abandoned dry at 14 352 ft, and Omati No. 2 abandoned dry at 10 840 ft; regional seismic and gravity surveys in western Papua have begun. Production volumes and values for copper, gold, manganese ore, platinum, and silver are listed for the year, with comparative figures for the period 1950-51 to 1954-55. (W.M.)

12-i-34 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1962a — Mining and geology. *Papua ann. Rep. for 1960-61,* 77-8 and 205 (also issued as *Aust. parl. Pap. 132, Sess. 1962-63,* 8, 272-3 and 400).

Gold and silver to the value of £1002 were produced during the period; 76 tonnes of manganese ore, worth £2397, was produced from the Rigo area; copper deposits at Woodlark I. and the Astrolabe field were drilled, and iron ore on Woodlark I. was inspected. Production of gold, silver, platinum, osmiridium, copper ore, and manganese ore over the preceding 5 years is listed.

Geological activity included engineering studies associated with the Laloki hydro-electric scheme near Port Moresby, magnetic survey of areas on Woodlark I., and investigation of pumice on Fergusson I. and copper mineralization on Misima I. Abnormal volcanic activity is reported from Mt Lamington, Mt Victory, Mt Dayman, and Goropu Crater in eastern Papua. (W.M.)

12-i-35 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1962b — Mining and geology. *Papua ann. Rep. for 1961-62,* 74-6 and 215 (also issued as *Aust. parl. Pap. 264, Sess. 1962-3,* 8, 565-7 and 706.)

Gold and silver valued at £356 were produced during the year. Prospecting for gold and copper began on Misima I., 2 tonnes of manganese ore worth £73 was exported from the Rigo area, investigation of copper deposits east of Port Moresby continued, some drilling of copper deposits on Woodlark I. and near Port Moresby was carried out, the area south of Mt Bosavi was tested and auger-sampled to examine the possibility of bauxite occurring in economic quantities, copper deposits on Sideia I. were inspected, pumice from Dobu and Fergusson Is was collected for study, and engineering investigations related to the Laloki hydro-electric scheme continued. Quantity and value of gold, silver, platinum, osmiridium, and manganese ore produced over the preceding 5 years are tabulated. (W.M.)

12-i-36 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1964b — Annual report — mining and geology. *Papua ann. Rep. for 1963-64,* 70-2 and 205 (also issued as *Aust. parl. Pap. 203, Sess. 1964-66,* 21, 359-61 and 494).

During the year, gold and silver worth £425 were produced, and testing of copper-gold lodes on Misima I. was being carried out. Geological, geophysical, and volcanological activities are noted. Drilling and geochemical surveys of the Astrolabe Mineral Field gave disappointing results, and testing of volcanic ash from near Popondetta indicates its suitability for making cement blocks. Quantity and value of gold, silver, platinum, osmiridium, and manganese ore for the preceding 5 years are tabulated. (W.M.)

12-i-37 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1967 — Mining and geology. *Papua ann. Rep. for 1966-67,* 46-9 and 139.

The nature of geological activities and services is noted, and production of gold, silver, platinum, osmiridium, and manganese ore for each of the previous 5 years is tabulated. (W.M.)

12-i-38 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1968 — Mineral resources. *Papua ann. Rep. for 1967-68,* 41-4 and 118.

The nature of geological and related investigations and services is noted; annual production figures of the preceding 5 years for gold, silver, platinum, osmiridium, and manganese ore are tabulated.

12-i-39 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1969 — Mineral resources. *Papua ann. Rep. for 1968-69,* 40-2 and 115.

The nature of geological and related activity and services is noted, and annual production for the preceding 5 years of gold, silver, platinum, osmiridium, and manganese ore is tabulated. (W.M.)

12-i-40 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1970 — Mineral resources. *Papua ann. Rep. for 1969-70,* 38 and 91.

The nature of geological and volcanological services provided is outlined, but tables listing volume and value of mineral production are absent. (W.M.)

12-i-41 BARNWELL, G. F., 1950 — Petroleum developments in Far East in 1949. *Bull. Amer. Ass. petrol. Geol.,* 34(7), 1492-501.

Oroi No. 1 was abandoned dry at 5500 ft. Upoia No. 1 and Hohoro No. 1 are drilling ahead, despite difficulties with heaving clays; shows of gas are reported from both holes. (W.M.)

12-i-42 BARNWELL, G. F., 1951 — Petroleum developments in Far East in 1950. *Bull. Amer. Ass. petrol. Geol.,* 35(7), 1652-9.

Upoia No. 1 well at 5326 and Hohoro No. 1 at 4721 ft were both abandoned dry; Wana No. 1 at 9866 ft and Omati No. 1 at 318 ft were both drilling ahead. Support ground geological, gravity, and seismic teams were active. (W.M.)

12-i-43 BARNWELL, G. F., 1952 — Petroleum developments in Far East in 1951. *Bull. Amer. Ass. petrol. Geol.,* 36(7), 1445-53.

Wana No. 1 well was abandoned dry at 9866 ft in Cretaceous strata; Omati No. 1 was drilling ahead at 7789 ft in the Miocene limestone in which it collared; Hohoro No. 2 was at 9973 ft in mudstone. Ground geological, seismic, and gravity surveys continued. (W.M.)

12-i-44 BARNWELL, G. F., 1953 — Petroleum developments in Far East in 1952. *Bull. Amer. Ass. petrol. Geol.,* 37(7), 1700-11.

Seismic refraction surveys were conducted in the western Papua plains areas, and geological surveys were made in the backing range foothills. Hohoro No. 2 well was abandoned dry at 10 642 ft, and Omati No. 1 was drilling ahead at 11 839 ft. (W.M.)

12-i-45 BARNWELL, G. F., 1954 — Petroleum. *Bull. Amer. Ass. petrol. Geol.,* 38(7), 1526-34.

A show of high-pressure gas was encountered in Cretaceous sand at 13 740 ft in Omati No. 1 well on the Darai Anticline west of Kikori. Ground geological, seismic and gravity teams were active in western Papua, and an airborne-magnetometer survey of the Papua basin was flown. (W.M.)

12-i-46 BARTON, F. R., 1907 — Report on British New Guinea for year ending 30 June 1906. *Brit. N. Guinea ann. Rep. for 1905-06,* 3-20 and 68.

The general level of mining activity is noted, and production figures from wardens' reports (entries 02-b-42, 02-b-121, 12-i-47, 12-i-62, and 12-i-114) are mentioned. The amount and value of exports of gold, gold ore and concentrates, lead, and sulphur for the year are tabulated. (W.M.)

12-i-47 BEAVER, W., 1907 — (No title — report on the Yodda Goldfield for 1905-06). *Brit. N. Guinea ann. Rep. for 1905-06*, 72-3.

Alluvial mining in the Yodda R. and Finnegans Cr. yielded an estimated 168 kg gold during the year. No lodes have been discovered. (W.M.)

12-i-48 BEAVER, W., 1908 — Report on the Kiveri Goldfield for the year 1907-08. *Papua ann. Rep. for 1907-08,* 108 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2150.)

This field is on the Musa fall on the main range, and all production is from alluvial deposits. The presence of auriferous quartz debris is thought to indicate reef or lode outcrops. An estimated 3 kg gold was produced, and the area of the Musa, Kiveri, and upper Adau Rs warrants further prospecting. The headwaters of the Kemp Welch R. near Mt Nesbitt is gold-bearing, and copper occurs throughout the area between the Astrolabe Mineral Field and the Upugau R. (W.M.)

12-i-49 BEAVER, W., 1909 — Report on the Yodda Goldfield for year 1908-09. *Papua ann. Rep. for 1908-09,* 132 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2084.)

This field is believed to be 'drying out', owing mainly to high maintenance costs. An estimated 100-110 kg (3400-4000 oz) gold, valued at £3/12/6 per oz, was produced during the year. (W.M.)

12-i-50 BEAVER, W. N., 1914a — Annual report on the Yodda Mineral Field, Buna, Kumusi Division. *Papua ann. Rep. for 1913-14,* 156 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1676.)

Alluvial operations have yielded about 12 kg gold during the year. Dredging operations are being considered for parts of the Yodda R., where hydraulic sluicing might be an effective mining method. (W.M.)

12-i-51 BEAVER, W. N., 1917 — (No title — annual report on Yodda Goldfield). *Papua ann. Rep. for 1914-15,* 142 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1346.)

An estimated 40-50 kg gold was thought to have been won from alluvial workings in the Yodda Goldfield during the year. (W.M.)

12-i-52 BLYTH, A. L., 1920 — Yodda Goldfield. *Papua ann. Rep. for 1918-19,* 84.

Alluvial mining yielded only 1.5 kg gold, worth about £200, during the previous year. (W.M.)

12-i-53 BRAMELL, B. W., 1905a — Extracts from returns from the Murua Goldfield. *Brit. N. Guinea ann. Rep. for 1903-04,* in App. H, 49 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 5, 49.)

On Murua (Woodlark) I. 12 400 tonnes of ore was crushed, yielding 173 tonnes concentrate and 223 kg gold-silver bullion valued at £26 586. A further 85 kg gold was won from alluvial workings during the year. (W.M.)

12-i-54 BRAMELL, B. W., 1905b — Resident Magistrate's report for Central Division, 1904-05. *Brit. N. Guinea ann. Rep. for 1904-05,* App. B, 20-2 (also issued as *Aust. parl. Pap. 79, Sess. 1905,* 2, 109-11.)

4.5 kg gold, valued at £630, was produced during the year. (W.M.)

12-i-55 BRAMELL, B. W., 1909 — Annual report on the Astrolabe Mineral Field. *Papua ann. Rep. for 1908-09,* 135-6 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2087-8.)

5 mineral leases and one prospecting claim yielded only 68 tonnes copper ore, mostly from open-cut mining. Tonnage and value of copper ore produced in each of the previous 3 years are tabulated. (W.M.)

12-i-56 CAMPBELL, A. M., 1898 — Report of the Resident Magistrate for the South-eastern Division. *Brit. N. Guinea ann. Rep. for 1896-97,* App. 0, 56-8.

There was a 'rush' to the alluvial goldfields on Murua (Woodlark) I. out of all proportion to the known resources; no estimate can be made of the amount of gold produced. Alluvial mining of gold on Sudest I. is carried out on a limited scale by native miners, and the Mt Adelaide reef is being worked. On Misima some gold-reef leases are being taken up, but no payable deposits have been reported. (W.M.)

12-i-57 CAMPBELL, A. M., 1900 — Report of the Resident Magistrate for the South-eastern Division. *Brit. N. Guinea ann. Rep. for 1898-99,* App. T, 85-9.

Principal gold-mining activity on Woodlark I. is at Kulumadau, where the Ivanhoe reef is being exploited. This lode is 'of a loose, soft friable nature, heavily mineralized with occasional patches of good specimen quartz'. On Misima I. a small amount of alluvial mining is being done by white and native miners. On Sudest a few natives are working alluvial deposits sporadically; development of the reef mine has been suspended because of storm damage. An estimated 131 kg gold was produced during the year. (W.M.)

12-i-58 CAMPBELL, A. M., 1901 — Report of the Resident Magistrate, South-eastern Division. *Brit. N. Guinea ann. Rep. for 1899-1900.* App. P, 81-3.

On Sudest I. the only activity is a limited amount of alluvial gold mining by native miners. On Misima I. alluvial gold is being produced on a small scale, and copper of unknown potential has been found. Most activity at Woodlark I. is along the Ivanhoe reef at Kulumadau. (W.M.)

12-i-59 CAMPBELL, A. M., 1902 — Report of the Resident Magistrate and warden, South-eastern Division. *Brit. N. Guinea ann Rep. for 1900-01,* App. P, 74-80.

On Sudest I. a small amount of alluvial gold is being won by native miners. On Misima a small amount of alluvial gold is being won; copper has been discovered but not tested. On Woodlark I. reef gold is being mined at Kulumadau and reefs at Busai are being tested. Hydraulic sluicing of alluvials at Suloga has produced unknown results. (W.M.)

12-i-60 DOWDNEY, G., 1908 — Report on the Yodda Goldfield for the year 1907-08. *Papua ann. Rep. for 1907-08,* 107-8 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2149-50).

An estimated 100 kg (3600 oz) gold, valued at £3/12/6 per oz, was produced entirely from alluvial deposits, during the year. Some specimens of osmiridium from Finnegans Cr. are reported. (W.M.)

12-i-61 GILL, F., 1905 — Warden's report on Murua (Woodlark Island) Goldfield for the year 1904-05. *Brit. N. Guinea ann. Rep. for 1904-05, in* App. L, 55-8 (also issued as *Aust. parl. Pap. 79, Sess. 1905,* 2, 144-7.)

8 quartz and alluvial mines are operating on Woodlark I. and activity of the larger and more active mines is noted. A total of 275 kg gold was produced, 228 kg from lode mining and 47 kg from alluvial mining. (W.M.)

12-i-62 GILL, F., 1907 — Warden's report on Woodlark Island (Murua) Goldfield for the year 1905-06. *Brit. N. Guinea ann. Rep. for 1905-06,* 70-1.

The Kulumadau mine yielded increased returns of ore and gold, and more equipment was installed at this mine as well as at Busai and Karavakum. Alluvial prospecting continued. 298 kg gold was won, 237 from quartz lode mining, 45 from alluvial workings, and 16 from cyaniding of tailings. Comparative figures for the previous 2 years are given. (W.M.)

12-i-63 GILL, F., 1908 — Annual report on the Murua Goldfield. *Papua ann. Rep. for 1906-07,* 81-3 (also issued as *Aust. parl. Pap. 160, Sess. 1907-08,* 2, 1503-5.)

Volume and grade of ore treated were less than in the previous year, and less alluvial gold was won. Most production was from mining of auriferous quartz lodes, and mining activity is recorded. 149 kg gold, valued at £16 658 was produced. Malachite was recorded from 'the south end of the island', but no primary ore was located. (W.M.)

12-i-64 HENDERSON, W., 1911 — Warden's report, Yodda Goldfield. *Papua ann. Rep. for 1909-10,* 126-7.

Major production was during the first half of the year, before most operators moved to the newly-proclaimed Lakekamu Goldfield on the Williams (Lakekamu) R. (entry 12-a-25). An estimated 28 kg gold was produced, all by alluvial methods. (W.M.)

12-i-65 HUMPHRIES, W., 1921 — Annual report: Warden's office, South-eastern Division, 1919-20. *Papua ann. Rep. for 1919-20,* 96-7.

240 kg gold, worth £13 158, was won from mining and alluvial activity on Misima I. during the year, and development work was carried out on some mines on Woodlark I. (W.M.)

12-i-66 KAUFMANN, G. F., 1955 — Petroleum developments in Far East in 1954. *Bull. Amer. Ass. petrol. Geol.,* 39(7), 1385-402.

Drilling in Omati No. 1 continued in a diversion to 13 780 ft; a show of gas in Cretaceous sand at 13 740 ft had previously been recorded (entry 12-i-45). Omati No. 2 was drilling ahead at 7875 ft at the end of the year. Ground geological, seismic refraction, and gravity surveys were continued in western Papua. (W.M.)

12-i-67 KAUFMANN, G. F., 1956 — Petroleum developments in Far East in 1955. *Bull. Amer. Ass. petrol. Geol.,* 40(7), 1657-77.

Ground geological surveys covered the area north and east of Kikori, and geophysical crews worked in southwest Papua. In New Guinea a geological survey of the upper Sepik R. continued. Omati No. 1 well, in which a high-pressure but non-commercial gas flow was encountered at 13 740 ft, was abandoned at 14 352 ft; Omati No. 2 was abandoned dry 10 880 ft; Aramia No. 1 was abandoned dry at 6628 ft in granite. (W.M.)

12-i-68 KAUFMANN, G. F., 1957 — Petroleum developments in Far East in 1956. *Bull. Amer. Ass. petrol. Geol.,* 41(7), 1616-32.

Kuru No. 1 well blew wild on gas, and was killed and abandoned at 950 ft; Morehead No. 1 was abandoned dry at 8087 ft; Kuru No. 2 at 5838 ft and Barikewa No. 1 at 1591 ft were both drilling ahead at the end of the year. Ground geological mapping in western Papua continued. (W.M.)

12-i-69 KAUFMANN, G. F., 1958 — Petroleum developments in Far East in 1957. *Bull. Amer. Ass. petrol. Geol.,* 42(7), 1709-26.

Ground geological and seismic surveys were conducted north from the Gulf of Papua and east of Yule I. Kaufuna No. 1 was drilling ahead at 2728 ft at the end of the year. Progress of drilling in Kuru No. 2, Barikewa No. 1, Komewu No. 1 and No. 2, Puri No. 1, and Sireru No. 1, all near the Gulf of Papua, is noted; gas was recorded at 960 ft in Kuru No. 2 and at 6310 ft in Barikewa No. 1. Ground gravity surveys were conducted in the Sepik Valley and around the headwaters of the Sepik R. (W.M.)

12-i-70 KAUFMANN, G. F., 1959 — Petroleum developments in Far East in 1958. *Bull. Amer. Ass. petrol. Geol.,* 43(7), 1714-32.

Drilling in Puri No. 1 was stopped at 10 100 ft in mudstone, and gas condensate and petroleum flow tests were conducted at 7500 ft. Initial good flows gave way to salt water, and a deviation hole was planned to test structures. Kaufuna No. 1 was abandoned dry at 3380 ft. Tests in Kuri No. 1 at 960 ft, in Barikewa No. 1 at 6310 ft, and in Komewu No. 1 were all disappointing. Some gravity traverses and drilling were carried out in the Sepik valley near the western New Guinea border. (W.M.)

12-i-71 KAUFMANN, G. F., 1960 — Petroleum developments in Far East in 1959. *Bull. Amer. Ass. petrol. Geol.*, 44(7), 1179-204.

Gas flow tests at 7425 ft in Puri No. 1 well showed strong gas flows initially, giving way to salt water; the well was abandoned as non-commercial. Puri No. 1A, offset at 6090 ft in Puri No. 1, drilled to 7927 ft before being abandoned; Puri No. 1B, offset at 3870 ft in Puri No. 1, drilled to 8520 ft before abandonment. A good show of gas and gas condensate was encountered at 4780 to 5207 ft in Bwata No. 1, which was drilling ahead at 7088 ft at the end of the year. Support geological and seismic work continued at a reduced level of activity. (W.M.)

12-i-72 KAUFMANN, G. F., 1961 — Petroleum developments in Far East during 1960. *Bull. Amer. Ass. petrol. Geol.*, 45(7), 1224-43.

Testing of gas zones in Bwata No. 1 well indicated a flow of 20 MMcfd of gas with some salt water, but this is considered non-commercial because of its remoteness in western Papua. Iehi No. 1 encountered gas, but was abandoned as non-commercial; support geological and geophysical surveys in western Papua and the Gulf of Papua were conducted. (W.M.)

12-i-73 LEONARD, C. A., 1922 — Report on the Louisiades and Murua Goldfields for the year ended 30 June 1921. *Papua ann. Rep. for 1920-21,* 90-1 (also issued as *Aust. parl. Pap. 49, Sess. 1922,* 2, 2759-60.)

Production and mining activity on Misima was restricted to the operations of the Block 10 mine, which handled only 2600 tonnes of ore for a return of £2704. No mining or alluvial work was carried out on Woodlark I. (W.M.)

12-i-74 LYONS, A. P., 1908 — Annual report for the Gira Goldfield for the year ended 30 June 1908. *Papua ann. Rep. for 1907-08,* 106-7 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2148-9.)

Considerable prospecting of the Waria R. has indicated large areas of probably payable ground. About 85 kg gold was won by alluvial methods from the Waria R., and 55 kg from the Gira and Aikora Rs. (W.M.)

12-i-75 LYONS, A. P., 1909 — Report on the Mambare Goldfield for year 1908-09. *Papua ann. Rep. for 1908-09,* 134-5 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2086-7.)

Alluvial mining in the Gira and Aikora Rs, mostly in beaches and terrace sediments, yielded about 125 kg gold. The gold from the Waria R. is reported as very fine and of poor quality. (W.M.)

12-i-76 MACALPINE, A., 1909 — Report on the Milne Bay Goldfield for the year 1908-09. *Papua ann. Rep. for 1908-09,* 135 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2087.)

Only 4.8 kg gold was won during the year, when the level of activity was low. Some prospecting in the area and on Normanby I. has so far been unsuccessful. (W.M.)

12-i-77 MILLER, T., 1918 — Warden's annual report on the Yodda Goldfield for the year ending 30 June 1917. *Papua ann. Rep. for 1916-17,* 41 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1481.)

All workings are alluvial, and an estimated 28 kg gold was produced. (W.M.)

12-i-78 MONCKTON, C. W. A., 1905a — Northern Division. *Brit N. Guinea ann. Rep. for 1903-04,* App. E, 35-40 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 2, 35-40.)

Alluvial work on river beaches in the Gira, Aikora, and Yodda Rs yielded an estimated 350 kg gold during the year. No lodes or new gold-bearing alluvials were located, and the true 'bottom' of river deposits has not yet been proven. Small amounts of osmiridium are found in some localities. (W.M.)

12-i-79 MORETON, M. H., 1901 — Report of the Resident Magistrate, Eastern Division. *Brit. N. Guinea ann. Rep. for 1899-1900,* App. O, 78-81.

The Milne Bay Goldfield yielded only 165 kg gold and 210 tonnes of gold ore during the year. A new alluvial deposit and several promising lodes are reported. (W.M.)

12-i-80 MORETON, M. H., 1902 — Report of the Resident Magistrate, Eastern Division. *Brit. N. Guinea ann. Rep. for 1900-01.* App. O, 70-4.

Alluvial gold mining activity on the Milne Bay field has fallen off considerably. Two reefs have been found and partly tested.

Only 258 kg gold was declared during the year, but at least another 28 kg was exported; production is thought to have been about 510 kg. (W.M.)

12-i-81 MORETON, M. H., 1904 — Report upon the South-Eastern Division. *Brit. N. Guinea ann. Rep. for 1902-03,* 29-31 (also issued as *Aust. parl. Pap. 13, Sess. 1904,* Vol. 2, 29-31.)

2 mines on Woodlark I. produced 136 kg gold from 15 950 tonnes ore, and 60 tonnes concentrates valued at £885. (W.M.)

12-i-82 MORETON, M. H., 1905 — (No title — report on South-Eastern Division). *Brit. N. Guinea ann. Rep. for 1903-04,* App. C, 28-31 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 2, 28-31.)

Mining activity recorded is entirely on Murua (Woodlark) I. where 11 872 tonnes of ore were treated and yielded 218 kg gold, valued at £27 134, as well as concentrates valued at £2903. A small amount of gold was won by natives working alluvial deposits on Sudest I. (W.M.)

12-i-83 MOTT, W. D., 1957 — An Australasian survey — a view of exploration in Australia, New Guinea and New Zealand. *Australas. Oil Gas J.,* 3, 3-11.

In Papua New Guinea, Australasian Petroleum Co. abandoned Kuru No. 1 at 1000 ft after striking a gas blow. Kuru No. 2 encountered gas in the same horizon at 1640 ft, and was drilling on at 5838 ft. Island Exploration Co. was drilling at 1591 ft in limestone at Barikewa. Exploration activity of several other companies is reported. (W.M.)

12-i-84 MURRAY, J. H. P., 1917 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1915-16,* 5-7 and 23 (also issued as *Aust. parl. Pap. 15, Sess. 1914-17,* 6, 1408-10 and 1426.)

Developments are reviewed. The amount and value of exports of gold, gold ore and concentrates, and copper ore over the preceding 10 years are tabulated. (W.M.)

12-i-85 MURRAY, J. H. P., 1922 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1920-21,* 5-13 and 77 (also issued as *Aust. parl. Pap. 49, Sess. 1922,* 2, 2673-81 and 2745.)

Comments are made on production of gold, osmiridium, and copper ore; wardens' reports (entries 12-i-73 and 12-i-121) summarize prospecting and production in the various goldfields. Exports of copper ore, gold, gold ore and concentrates, and osmiridium are tabulated for the previous 5 years. (W.M.)

12-i-86 MURRAY, J. H. P., 1925b — Mining. *Papua ann. Rep. for 1922-23,* 11 and 54-5 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2573 and 2617-8.)

The Block 10 gold mines on Misima I. closed during the year. 482 kg gold, valued at £22 494, was won during the year; total to date since 1888-89 is 14 920 kg valued at £1 655 734. Exports for the 10-year period 1913-14 to 1922-23 of copper ore, gold, gold ore and concentrates, and osmiridium are tabulated. (W.M.)

12-i-87 MURRAY, J. H. P., 1928 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1926-27,* 1-18 (also issued as *Aust. parl. Pap. 230, Sess. 1926-28,* 2, 71-89.)

The failure of the New Guinea Copper Mine, the increased possibility of prospecting for and production of copper in the Laloki area, of gold on Misima I., and of petroleum in western Papua are noted. Expeditions by Champion (Fly R.), Humphries (Vailala R.), and Chance (Kikori R.) are summarized. (W.M.)

12-i-88 MURRAY, J. H. P., 1932 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1930-31,* 1-20, 31, and 35.

Production figures for the goldfields indicate little activity in the Murua and Gira fields; gold production figures for and until 1931 are appended, together with annual production figures for osmiridium and copper. (W.M.)

12-i-89 MURRAY, J. H. P., 1940 — Annual report of the Lieutenant-Governor. *Papua ann. Rep. for 1938-39,* 5-28 and 36 (also issued as *Aust. parl. Pap. 27, Sess. 1940,* 6, 778-80 and 809.)

Exports for 1937-38 and 1938-39 are tabulated for copper ore, gold, gold ore and concentrates, osmiridium, platinum, and manganese ore. Gold bullion production figures for mines on Misima and Woodlark Is, in the Milne Bay area, and on the Astrolabe Mineral Field are tabulated. Dredging production figures for the Yodda Goldfield are included. (W.M.)

12-i-90 MUSCUTT, C. R., 1921 — Lakekamu Goldfield. *Papua ann. Rep. for 1919-20,* 98-9.

Some 14 kg gold, worth £1812/10/-, was won by alluvial working of Fish Cr. and tributaries. (W.M.)

12-i-91 NAYLOR, E. H., 1908 — Annual report from Yodda Goldfield. *Papua ann. Rep. for 1906-07,* 86-7 (also issued as *Aust. parl. Pap. 160, Sess. 1907-08,* 2, 1510-1.)

Re-working of stream-bed gravels near Yodda store, and initial working of deposits 3-5 km upstream, have yielded an estimated 140 kg gold during the year; some sites 15-25 km to the northwest are being worked. (W.M.)

12-i-92 NEWMAN, A., 1919 — Yodda Goldfield. *Papua ann. Rep. for 1917-18,* 49 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19,* 1569.)

An estimated 14 kg gold was won from alluvial deposits during the year. (W.M.)

12-i-93 NORRIE, C. P., 1914a — Annual report on the Murua Goldfield, South-eastern Division. *Papua ann. Rep. for 1913-14,* 154-5 (also issued as *Aust. parl. Pap. 40, Sess. 1914-17,* 2, 1674-5).

Prospecting and early development operations on Woodlark I. indicate considerable gold and copper potential. The operations of 6 shows is outlined; gold valued at £29 840 is reported to have been produced. (W.M.)

12-i-94 OELRICHS, A. E., 1911 — Warden's report, Murua Goldfield. *Papua ann. Rep. for 1909-10,* 119-21.

The level of activity and production at each gold mine and alluvial site on Woodlark I. is reported. An estimated total of 280 kg gold was produced, mostly from mining. (W.M.)

12-i-95 OLDHAM, E. R., 1917 — (No title — annual report on the Lakekamu Goldfield). *Papua ann. Rep. for 1914-15,* 143-4 (also issued as *Aust. parl. Pap. 40, Sess. 1917-19,* 6, 1347-8.)

The middle and lower reaches of the Tiveri R. and its tributaries have been worked by alluvial methods; some 110 kg gold, valued at £15 000, was won during the year. Dredging operations are being considered on parts of Tiveri R. and Cassowary Cr. (W.M.)

12-i-96 OLDHAM, E. R., 1920 — Gira Goldfield. *Papua ann. Rep. for 1918-19,* 84.

An estimated 6 kg gold, worth about £1050, was won during alluvial prospecting activities. (W.M.)

12-i-97 RANGE, P., 1935 — (No title — note on gold production in New Guinea, in Dutch). *Geol. Zbl., Abt. A. (Geol.),* 55, 268.

This abstracts entry 12-i-20. Most mining is alluvial; for 1933-34 some 7300 kg gold, worth £1 365 334, was produced. It is estimated that total gold production to date is 27 350 kg, worth £3 620 372. (W.M.)

12-i-98 SEIDEL, H., 1891 — Die Erforschung der Purdy-Inseln (The investigation of the Purdy Islands, in German.) *Globus,* 59, 303-4.

Phosphatic guano deposits on several of the Purdy Is have been exploited, and have so far produced 1000 tonnes. (W.M.)

12-i-99 SMITH, M. STANIFORTH C., 1925 — Department of Mines. *Papua ann. Rep. for 1923-24,* 29-31 (also issued as *Aust. parl. Pap. 3, Sess. 1925,* 2, 2656-8.)

A total of 610 kg gold, valued at £6702, was won during the year, mostly from alluvial workings; some was recovered by cyaniding tailings and uncrushed ore at the now-abandoned Block 10 mines on Misima I. In the Astrolabe area exploration has proven 295 000 tonnes of ore containing 13 500 tonnes copper and 1030 kg silver; development projects produced 1 tonne of copper ore valued at £120. Osmiridium produced totalled 3.4 kg, valued at £3553. Gold production figures for the year for each field, total production from all fields each year and cumulative to date since production started, and annual total copper production figures are tabulated. (W.M.)

12-i-100 SMITH, W. R., 1920 — Annual report, Department of Lands, Mines and Agriculture. *Papua ann. Rep. for 1918-19,* 69-70.

Vigorous mining exploration in the Laloki mineral field and on Misima I. is reported. Alluvial gold was proven from the headwaters of the Musa R., but the deposits have not been exploited. (W.M.)

12-i-101 SYMONS, A. H., 1909 — Report on the Murua Goldfield for the year 1907-08 (sic). *Papua ann. Rep. for 1908-09,* 131-2 (also issued as *Aust. parl. Pap. 76, Sess. 1909,* 2, 2083-4.)

During 1908-09, both mine development and alluvial prospecting yielded gold; mining produced 1000 kg gold and alluvial methods 51 kg. Mining activity at Kulumadau, Woodlark King (Karavakum), and Busai is outlined. (W.M.)

12-i-102 SYMONS, A. H., 1912b — Annual report on the Murua Goldfield, South-eastern Division. *Papua ann. Rep. for 1911-12,* 41-3 (also issued as *Aust. parl. Pap. 87, Sess. 1912,* 3, 727-9.)

Development work on the mines on Woodlark I. is reported, and production by mining and alluvial methods tabulated; comparative figures for the preceding year are given. For 1911-12, 286 kg gold, valued at £32 333, was won. (W.M.)

12-i-103 SYMONS, A. H., 1913a — Annual report on the Murua Goldfield, South-eastern Division. *Papua ann. Rep. for 1912-13,* 39-40 (also issued as *Aust. parl. Pap. 76, Sess. 1913,* 3, 423-4.)

The operations and production of the 8 mines on Woodlark I. are summarized; 343 kg gold, valued at £39 082, was recovered, almost entirely from lode mining. (W.M.)

12-i-104 SYMONS, A. H., 1917a — Annual report on the Murua Goldfield. South-eastern Division. *Papua ann. Rep. for 1914-15,* 140-1 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1344-5.)

Major production was from the Kulumadau mine on Woodlark I., with some small production from alluvial workings; 175 kg gold, valued at £24 499, was won. (W.M.)

12-i-105 SYMONS, A. H., 1917b — Annual report on the Louisiade Goldfield, South-eastern Division. *Papua ann. Rep. for 1914-15,* 142 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1346.)

Mine development on Misima I. recommenced during the year, and 38 kg gold was won; a further 17 kg of gold was won from alluvial workings. Small parcels of gold were taken from Four-Mile Cr. on Sudest by alluvial workings. (W.M.)

12-i-106 SYMONS, A. H., 1918a — Annual report of the Murua Goldfield, South-eastern Division. *Papua ann. Rep. for 1916-17,* 39 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1479.)

Major activity was in the Kulumadau mine on Woodlark I., where 128 kg gold, valued at £15 167, was won. Development work continued at the Federation Lease and Marua United Lease at Busai and at the Woodlark King mine at Karavakum. (W.M.)

12-i-107 Symons, A. H., 1918b — Annual report, 1916-17, of the Louisiade Goldfield. *Papua ann. Rep. for 1916-17,* 40 (also issued as *Aust. parl. Pap. 32, Sess. 1917-19,* 6, 1480.)

Major activity was in the Block 10 mines on Misima, where development work yielded 5 kg gold. Alluvial working on Misima yielded $12\frac{3}{4}$ kg, valued at £1575, and alluvial working on Sudest yielded 3 kg, valued at £412. (W.M.)

12-i-108 Symons, A. H., 1919a — Murua Goldfield. *Papua ann. Rep. for 1917-18,* 48 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19,* 4, 1568.)

The Kulumadau mine on Woodlark I. closed down during the year after treating some hauled ore and dumped ore. 51 kg gold, valued at £6504, was won, together with some silver. (W.M.)

12-i-109 Symons, A. H., 1919b — Louisiade Goldfield. *Papua ann. Rep. for 1917-18,* 49 (also issued as *Aust. parl. Pap. 130, Sess. 1917-19,* 4, 1569.)

At the Block 10 mine on Misima, development and extraction continued, and ore reserves have been revised to 127 000 tonnes ore assaying 38s. per ton. Total production for the year was valued at £13 996. Alluvial workings produced a further 18 kg valued at £1750. On Sudest 3 kg gold, valued at £420, was won by alluvial methods. (W.M.)

12-i-110 Symons, A. H., 1920a — Annual report on the Murua Goldfield, South-eastern Division. *Papua ann. Rep. for 1918-19,* 82.

The low level of production and exploration activity is noted; 113 kg of gold, valued at £1316/5/-, was won. (W.M.)

12-i-111 Symons, A. H., 1920b — Louisiade Goldfield. *Papua ann. Rep. for 1918-19,* 82-3.

The mills at the Block 10 lease processed ore from which £12 534 worth of gold was produced; a further 14 kg, worth £1701/10/- was won from alluvial workings on Misima; 4.5 kg gold, worth £660, was won from alluvial workings on Sudest.

12-i-112 Symons, A. H., 1923 — Annual report on the Louisiade and Murua Goldfields. *Papua ann. Rep. for 1922-23,* 95 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 2037.)

On the Block 10 mine leases on Misima, mine development continued and yielded 45 870 tonnes of ore from which gold valued at £56 508 was extracted. (W.M.)

12-i-113 Turner, C. O., 1905 — Report on mines and mining. *Brit. N. Guinea ann. Rep. for 1903-04, in App.* H, 47 (also issued as *Aust. parl. Pap. 1, Sess. 1905,* 2, 47.)

In the Milne Bay goldfield gold valued at about £5880 is believed to have been won from alluvial workings during the preceding year. (W.M.)

12-i-114 Turner, C. O., 1907 — Report of the Warden of the Milne Bay Goldfield for year 1905-06. *Brit. N. Guinea ann. Rep. for 1905-06,* 72.

During a year when gold was scarcer and harder to win from the alluvial deposits, an estimated 28 kg gold was won. (W.M.)

12-i-115 Turner, C. O., 1908 — Milne Bay Goldfield. *Papua ann. Rep. for 1907-08,* 107 (also issued as *Aust. parl. Pap. 39, Sess. 1908,* 2, 2149).

During a year of little activity an estimated 6 kg gold was produced from alluvial deposits. (W.M.)

12-i-116 Wade, A., 1917a — The Vailala petroleum field. *Papua ann. Rep. for 1914-15,* 137-8 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1341-2.)

Oil was encountered at 250 ft in a shallow well near the Vailala R., and more is expected at greater depth. Samples resemble light oil found in Java and Sumatra. (W.M.)

12-i-117 WALKER, A. L., 1902a — Report of the acting Resident Magistrate, Northern Division, on the affairs of the Division. *Brit. N. Guinea ann. Rep. for 1900-01,* App. J, 48-52.

Gold production on the Yodda and Gira Rs is diminishing; parts of the Mamba, Gira, and Kumusi Rs and Tamata Cr. have been taken up for dredging. An estimated 425 kg gold was won during the year. (W.M.)

12-i-118 WINTER, F. P., 1903 — Annual report of the Acting Administrator. *Brit. N. Guinea ann. Rep. for 1901-02,* 7-38 (also issued as *Aust. parl. Pap. 1, Sess. 1903,* 2, 7-38.)

The discovery of a rich patch of gold-bearing alluvials, at the back of Cloudy Bay, is noted; this is probably the Kiveri R. deposit (entry 12-b-43). Some miners are making a living from alluvial gold mining on Sudest and Misima. On Woodlark, lode mining produced 10 000 tonnes of ore carrying 6-28 g gold per tonne. The possibility of dredging the lower Mambare and Gira Rs is under consideration; these rivers and the adjacent Yodda are being worked by alluvial methods. The upper Musa R. and the south fall of the main range near the head of this river were unsuccessfully prospected for gold. More than £42 214 worth of gold was exported during the year. (W.M.)

12-i-119 WUTH, C. T., 1917 — (No title — annual report on Gira Goldfield). *Papua ann. Rep. for 1914-15,* 142-3 (also issued as *Aust. parl. Pap. 4, Sess. 1917-19,* 6, 1346-7.)

An estimated 34 kg (1200 oz) gold, valued at about £3 per oz, is thought to have been won from the Gira and Aikora Rs in the Gira goldfields during the year. (W.M.)

12-i-120 WUTH, C. T., 1921 — Yodda and Gira Goldfields. *Papua ann. Rep. for 1919-20,* 98.

Alluvial mining during the year produced about 13 kg gold in the Yodda field and 6 kg in the Gira. (W.M.)

12-i-121 WUTH, C. T., 1922 — Yodda and Gira Goldfields. *Papua ann. Rep. for 1920-21,* 91 (also issued as *Aust. parl. Pap. 49, Sess. 1922,* 2, 2760.)

Prospecting for osmiridium in the Chirima, Aikora, and Gira Rs was moderately successful; an estimated 6 kg gold and 8.5 kg osmiridium were won. In the Yodda R. 10 kg gold and 1.5 kg osmiridium are believed to have been produced. (W.M.)

12-i-122 WUTH, C. T., 1923 — Yodda and Gira Goldfields. *Papua ann. Rep. for 1921-22,* 95-6 (also issued as *Aust. parl. Pap. 17, Sess. 1923-24,* 4, 2037-8.)

On the Yodda field, about 10 kg gold was won from sporadic alluvial prospecting; on the Gira field an estimated 3 kg gold and 3 kg osmiridium were won. (W.M.)

(j) HISTORY AND COMMENTARY

12-j-1 ANONYMOUS, 1915a — Petroleum in Papua. *Bull. Imp. Inst. Lond.,* 13, 185-9.

The discovery in 1911 and early assessment of petroleum seeps on the Vailala R., and the extensive finds of seeps in western Papua are outlined. An analysis of Vailala petroleum by the Imperial Institute is quoted, and its value as a fuel oil discussed unfavourably. (W.M.)

12-j-2 ANONYMOUS, 1931 — Compte-rendu des prospections accomplies en Nouvelle-Guinée et en Papoussie (Account of prospecting in New Guinea and Papua, in French.) *La Rev. petrol.,* 432, 937-8.

The Anglo-Persian Oil Company's report on its work during 1920-1929 (entry 02-a-2) is reviewed. (W.M.)

12-j-3 ANONYMOUS, 1937a — Progress of search for oil in Australia and Territories. *Petrol. Times,* 38, 333.

Petroleum exploration activities in Papua are summarized. Oil Search Ltd report a thick series of oil-impregnated sandy silt in the Miocene succession west of the middle Purari R. (W.M.)

12-j-4 ANONYMOUS, 1940a — Search for oil in Papua and New Guinea. *Chem. Engng Min. Rev.*, 32, 265-6.

Techniques and progress of field geological prospecting in Papua New Guinea by 2 exploration companies are outlined. Some of the field difficulties are mentioned, and the supporting laboratory facilities and techniques discussed. Expenditure to date by the 2 companies is noted. (W.M.)

12-j-5 ANONYMOUS, 1958b — 55 holes — £31 000 000. *Petrol. Gaz.*, 7(4), 103-6.

This traces the history of petroleum exploration in Papua New Guinea since 1911, and gives estimates of costs involved. Results of some drill programs are given and include stratigraphic data on the lower Tertiary succession in western Papua. (B.M.R.)

12-j-6 ANONYMOUS, 1968h — Far-flung search off Australia pushed. *Oil Gas J.*, 66(6), 128-9.

Uramu No. 1 was abandoned at 6433 ft after a gas blow, and Uramu No. 1A was begun. (W.M.)

12-j-7 AUSTRALASIAN PETROLEUM COMPANY, AND ISLAND EXPLORATION COMPANY, 1940 — OIL EXPLORATION WORK IN PAPUA AND THE MANDATED TERRITORY OF NEW GUINEA. *Melbourne, National Press,* 31, 31 pp.

The history of petroleum exploration in the territories is outlined with emphasis on the operations of these 2 companies in the Gulf of Papua and western New Guinea. (W.M.)

12-j-8 CONDON, M. A., 1967 — Petroleum exploration preview for 1967. *APEA J.*, 7(2), 16-9.

During the year offshore drilling should increase and it is expected that 5 mobile rigs will be drilling in the offshore area by the end of the year. The immediate structural targets available for these rigs are in the Gippsland, Bass, and Otway Basins (Victoria-Tasmania), the North West Shelf and Timor Sea-Bonaparte Gulf, and the Gulf of Papua.

The success or otherwise of the offshore drilling will determine the rate of exploration over the next few years. If important discoveries are made offshore, more intensive exploration of the same stratigraphic intervals onshore may result.

The exploration patterns of Australia and several other countries before and after first commercial discovery are compared. This indicates that Australian discovery came early, as compared with other countries, where production has developed since the war, but that post-discovery effort in Australia has been very much less. The main obvious differences appear to be that in Australia the average size of the exploration concession is very much larger, and the number of operators (having regard to the areas concerned) is much smaller, than in other successful countries. (Auth.)

12-j-9 CONDON, M. A., FISHER, N. H., & TERPSTRA, G. R. J., 1958 — Summary of oil search activities in Australia and New Guinea to the end of 1957. *Bur. Miner. Resour. Aust. Rep.* 41, 101 pp.

The summary includes, for each State and Papua New Guinea, a list of expenditure on exploration, an outline of stratigraphic geology, and a statement of the status of exploration.

It summarizes and updates previous similar summaries prepared by the Bureau of Mineral Resources, and by the Anglo-Persian Oil Company (entry 02-a-2); it is superseded by a summary issued by the Bureau in 1960 (entry 12-e-5.)

The 2 sedimentary basins in Papua New Guinea that are discussed are the 'Northern New Guinea Basin' in which most activity was concentrated in the Tertiary strata in the Sepik River, and the 'Southern Basin (Papua)' in which most activity was concentrated in the Tertiary strata of the Aure Trough and western Papua. (W.M.)

12-j-10 DALTON, H. W., 1969 — Petroleum developments in Far East in 1968. *Bull. Amer. Ass. petrol Geol.*, 53(8), 1789-807.

In Papua New Guinea most activity was in the Gulf of Papua where 9 holes were drilled offshore — 2 were gas wells, 5 were dry and abandoned, and 1 was junked and abandoned after a gas blowout; 1 was drilling on at the end of the year. The location, name, spud and completion dates, and total depth of each hole are tabulated. Geophysical prospecting and wild-cat drilling of Esso Ini No. 1 is recorded, and the magnetic and seismic work of several companies in western Papua noted. Field geological and photogeological surveys in the C. Vogel basin, and some field geological work in northern New Guinea are noted. (W.M.)

12-j-11 HEALY, A. M., 1967 — Bulolo — a history of the development of the Bulolo region, New Guinea. *New Guinea Res. Bull.*, 15, 1-143.

The assessment of the auriferous alluvials in the Bulolo and Wau Rs is outlined, with comments on their origin, distribution, and characteristics. The structure, development, and operations of the main dredging company, Bulolo Gold Dredging Ltd, is described. Methods of estimating ore reserves, and estimates of reserves at various stages of operation are discussed. (W.M.)

12-j-12 IDRIESS, I. L., 1933 — GOLD-DUST AND ASHES (2nd Edn). *Sydney, Angus & Robertson,* 285 pp.

The early stages of prospecting and development of the mining industry on the Bulolo Goldfield at Wau and Edie Cr. are described, including some impressions of the goldfield mining developments. (W.M.)

12-j-13 IDRIESS, I. L., 1935 — GOULDZOEKERS: HET ROMANTISCHE VERHAAL VAN DE GOULDWELDEN IN NIEUW-GUINEA (Gold searchers: the romantic history of the gold fields of New Guinea, in Dutch — translated from the English by E. J. Koppeschaar). *Amsterdam, Van Holdema & Warendorf N.V.,* 296 pp.

This is a Dutch translation of entry 12-j-12.

12-j-14 KAUENHOWEN, W., 1941 — Die erdol-aufschlussarbeiten in Deutsch Neuguinea (Petroleum exploration in German New Guinea, in German). *Oel u. Kohle,* 21, 399-405.

Petroleum exploration in Papua New Guinea up to 1940 is outlined, and a summary made of the major tectonic and structural features which are considered important in influencing the choice of search areas. Some data on the Matapau-Aitape area from Anglo-Persian work (entry 02-b-26) are discussed. Petroleum indications are noted in association with Eocene to Miocene strata in north New Guinea. (W.M.)

12-j-15 KESSAL, H. F., 1920 — Outlook for development of petroleum industry in Australia. *Min. Oil Bull.*, 6, 613-4.

The Australian Government has conducted all the petroleum search to date in Papua, but in 1919 entered into an agreement with the British Government whereby they jointly finance exploration, and appointed the Anglo-Persian Oil Company to conduct this search. The prospects of finding payable quantities of petroleum appear good. (W.M.)

12-j-16 MACGREGOR, W., 1897a — Annual report of the Lieutenant-Governor. *Brit. N. Guinea ann. Rep. for 1895-96,* v-xxxv and 93.

Tours of inspection are reported (entries 02-b-103, 02-b-104, 05-a-114, 12-b-71, 12-b-72.) Appended reports (entries 12-a-23, 12-b-60 and 12-j-18) detail exploration or gold prospecting and production. 39 kg gold, valued at £4735, was exported during the year. (W.M.)

12-j-17 MCKAY, T., 1954 — Oil exploration in New Guinea. *Qld geogr. J.*, 55, 28-32.

Prospects of finding petroleum in New Guinea — in particular around the Gulf of Papua — are thought to be good. Topographic and geophysical surveys followed by a drilling program in the area are outlined. (W.M.)

12-j-18 Moreton, M. H., 1897 — Report of the Resident Magistrate for the Eastern Division. *Brit. N. Guinea ann. Rep. for 1895-96.* App. O, 70-2.

The winning of a small amount of gold from the Mambare R., and the opening up of the Woodlark I. Goldfield are reported. (W.M.)

12-j-19 Mott, W. D., 1959 — An Australian survey — a review of exploration activity in Australia, Papua and New Guinea in 1958. *Australas. Oil Gas J.,* 5(4), 5-18.

Petroleum exploration and drilling activity during 1958 is reviewed. In Papua, Australasian Petroleum's Kuru No. 3, Papuan Apinaipi's Kaufuna, and Island Exploration's Puri No. 1 wells were completed, Papuan Apinaipi conducted geological and gravity surveys, and BMR made an underwater survey in the Papuan Gulf. Drilling results and a map of the area covered by concessions are included. (W.M.)

12-j-20 Owen, E. W., 1962 — Geological results of petroleum exploration in western Papua, 1937-61: a review. *Bull. Amer. Ass. petrol. Geol.,* 46(8), 1538-9.

Australasian Petroleum Company's report (entry 02-b-18) is reviewed. The article includes a synthesis of the regional geological structure and stratigraphy, notes on geological and geophysical techniques employed, and comments on the significance of results. (W.M.)

12-j-21 Pilcher, D. M., 1963 — The role of government in oil exploration in Australia. *In* Proceedings of the second Symposium on the development of petroleum resources of Asia and the Far East. *ECAFE Miner. Resour. Devel. Ser.,* 18(2), 281-7.

The nature and extent of co-operation between the Australian Government and overseas or local petroleum exploration companies is discussed. The history of petroleum exploration in Australia is traced with emphasis on expenditure. (W.M.)

12-j-22 Raggatt, H. G., 1954a — The search for oil in Australia and New Guinea. *Australas. Inst. Min. Metall., Rev. Lect. 2, Supp. to Bull. 172,* 26 pp.

A basin-by-basin summary of the stratigraphy, structure, petroleum exploration, and potential of the major sedimentary basins in Australia and New Guinea is presented. Activity reviewed in New Guinea includes the exploration of the Aure Trough and in southwest Papua. Summaries of activities, drilling, and expenditure are given. (W.M.)

12-j-23 Raggatt, H. G., 1954b — Search for oil in Australia and New Guinea. *Qld Govt Min. J.,* 55, 878-88.

This summarizes entry 12-j-22.

12-j-24 Raggatt, H. G., 1954c — The search for oil in Australia and New Guinea. *Australas. Oil Gas J.,* 1(3), 5-15.

This is a reprint of entry 12-j-22.

12-j-25 Raggatt, H. G., 1955b — The role of petroleum in the economy and defence of Australia. *In* Wills, N. R., (Ed.) — AUSTRALIA'S POWER RESOURCES. *Melbourne, Cheshire,* 22-56.

The history of petroleum exploration in Papua New Guinea is outlined. Main activity has been in the Aure Trough, where at least 4500 m of Miocene and younger marine sediments is present. 3 phases of exploration are recognized: (1) exploration in southern areas under Government auspices; (2) exploration by private companies north and west of the head of the Gulf of Papua, and (3) large-scale exploration by Australasian Petroleum Co., and Island Exploration Co. It is considered that there are good prospects for production of oil in Papua New Guinea. (W.M.)

12-j-26 RAYNER, J. M., & CASEY, J. N., 1965 — Petroleum exploration by the Bureau of Mineral Resources. *8th Comm. Min. metall. Cong. Australas. Publ.,* 5, 127-38.

Governmental policy on encouraging and assisting petroleum exploration in Australia and Papua New Guinea lies in 4 fields — (a) taxation concessions, (b) subsidies to exploration companies, (c) basic surveys and field and laboratory investigations by the Bureau of Mineral Resources, and (d) other forms of assistance such as relief from import duty, accelerated base-map production, and consultant services.

The exploration program for any particular survey, the exploration organization structure of BMR, and the scope of the exploration effort to date are outlined with supporting tables of expenditure and maps showing coverage of aeromagnetic, gravity, seismic, and geologic mapping surveys by BMR. Geological results of exploration in the major oil-potential sedimentary basins are summarized. (W.M.)

12-j-27 SCHILLER, E. A., & BERVEN, R. J., 1971 — Mineral exploration activities and potential of southeast Asia, Australia, and the southwest Pacific (Abstract only). *Econ. Geol.,* 66, 208-9.

Mineral exploration is taking place at unprecedented levels in Australia, southeast Asia, and the southwest Pacific. Intensive work by a few major companies in the south Pacific islands led to the successes of the Bougainville copper deposit and discoveries of nickel laterite deposits in New Caledonia. In New Guinea significant copper deposits have been delineated, and in West Irian Freeport Sulphur are placing their Erstberg copper property into production. Indonesia is witnessing large-scale exploration programs throughout its archipelago. (Auth.)

12-j-28 THOMSON, J., 1918 — Report from the joint committee of public accounts upon the Papuan oil fields. *Aust. parl. Pap. 33, Sess. 1917-19,* 6, 9-16.

An outline is given of the background to, and extent of, Commonwealth Government commitment to petroleum exploration in Papua. Prospects of finding petroleum are discussed and assessed to be 'distinctly good'. Some of the difficulties in the field exploration project are listed, with evidence. Recommendations are made that the prospecting activity be markedly increased, with the aim of starting production, and some recommendations on organization policy are included. (W.M.)

12-j-29 WADE, A., 1927 — The search for oil in New Guinea. *Bull. Amer. Ass. petrol. Geol.,* II, 157-76.

Some of the physical difficulties of petroleum exploration in Papua New Guinea are discussed, and the geological features and tectonic relations of the Archaean to Recent succession are described. The history of oil discovery and exploration in Papua, New Guinea, and Dutch New Guinea are outlined, and the stratigraphic geology of each is tabulated and discussed. Some areas in both Papua and New Guinea may prove to be petroleum fields. (W.M.)

12-j-30 WADE, A., 1940 — Search for oil in Australia and Territories in 1939. *Petrol. Times,* 43, 231-2, and 245.

Oil exploration drilling in Australia and its territories during 1939 is summarized. In Papua, Papuan Apinaipi Petroleum Co. Ltd drilled 3 shallow holes near Oiapu and conducted some intensive well-siting exploration. (W.M.)

12-j-31 WYLLIE, B. K. N., 1930b — A critical study of the geology and oil prospects of Papua and New Guinea as revealed by the work of the Anglo-Persian Oil Company, 1920-1929. *In* ANGLO-PERSIAN OIL COMPANY — THE OIL EXPLORATION WORK IN PAPUA AND NEW GUINEA CONDUCTED BY THE ANGLO-PERSIAN OIL COMPANY ON BEHALF OF THE GOVERNMENT OF THE COMMONWEALTH OF AUSTRALIA, 1920-1929. *London, H.M.S.O.,* 4, 95-125.

The results of the many exploration projects by this company are discussed but most areas are not prospective reservoirs. Areas in the Purari valley, in the south coast of Goodenough Bay, in the Ruaba valley, in the Ramu valley, and south of the Torricelli Mts are areas for possible future investigation. (W.M.)

13 STRUCTURAL GEOLOGY

(a) AREAL AND GENERAL

See also entries

02-d-59 03-a-15 03-c-15

13-a-1 CAREY, S. W., 1965 — Tectonics of New Guinea. *38th ANZAAS Cong., Hobart,* Sec. C Abs.

The plains of New Guinea south of the main cordillera and the shallow seas between the Aru Is and the Great Barrier Reef are part of the Australian pre-Mesozoic shield. Along the eastern edge the upper Palaeozoic orogenic belt forms C. York Pen., peaks of which continue as the Torres Str. islands, and outcrop in Papua as Mabadauan; this zone can be traced northward. West of this orogenic high is the Morehead Tannamerah Depression which is the northern continuation via the Gulf of Carpentaria of the Great Artesian Basin. This depression has more than 1500 m of Mesozoic sediments and continued to sag during the Tertiary. It is bordered on the west by the Arnhem-Aru-Frederik Hendrik block which has gently folded lower Palaeozoic rocks resting on an ancient core.

The stable regime started to break up in the Triassic and by the Jurassic taphrogenesis was widespread through the shield area, marginal blocks of which have been progressively dispersed and are now found in the Behrmann, Bismarck, and Kubor massifs, etc., and passive areas such as the Erava-Wana swell. Between these blocks a series of deep troughs were filled with Cretaceous greywacke accompanied by basic lavas and ultramafic injections from the mantle. The Palaeogene was a quiescent epoch when limestone and quasi-platform facies spread over the blocks and filled-troughs alike. The lower Miocene produced strong stretching with deep rapidly-filling troughs with renewed volcanism, and these conditions continued through the middle Miocene. In the upper Miocene the deeply-filled troughs started to regurgitate and became more strongly emergent during the Pliocene with concurrent marginal basins of sedimentation retreating before the uplifts and filling rapidly with recycled sediment stripped from the Palaeogene and early Neogene on the new tumours. The elevation of the cordillera is very young, much of it Quaternary, and this activity still continues.

New Guinea is a first-order transverse trend of the Pacific margin which is elsewhere nearly meridional. It is part of the complex tectonic belt between Malaya and Fiji where the meridional Andesite Line is interrupted and displaced eastwards 3000 km. Sinistral transcurrent faulting and fold patterns dominate the entire region.

13-a-2 STANLEY, E. R., 1923d — The structure of New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 764-72.

The tectonic significance and regional projection of the main structural trend expressed in the central range and the island areas to the north are discussed. Landmass connexions with Australia, Philippines, and Malaysia during the late Palaeozoic, Mesozoic, and early Tertiary are suggested, and a landbridge with Australia early in the Pleistocene is inferred.

It is suggested that the Finisterre-Saruwaged-Adelbert Ra. and the median range of New Britain are a geanticlinal feature younger than the main range geanticlinal feature, and separated from it by the fault-bounded Ramu-Markham-Huon G. synclinal depression. Their regional extension northwest into mainland Asia is discussed.

Dome and basin structures in southwest Papua are interpreted in terms of 2 contemporaneous or nearly contemporaneous stress systems approximately at right angles late in the Tertiary. The location and delineation of several major fault zones in Papua, New Guinea, and the New Guinea islands are discussed. (W.M.)

(b) GEOTECTONICS

See also entries

02-a-3	03-e-17	09-c-8	16-b-47
02-a-10	03-e-19	09-c-18	16-c-1
02-b-36	06-a-10	09-c-21	16-c-3
02-b-37	09-c-3	10-c-1	
02-d-32	09-c-4	14-c-7	
03-a-4	09-c-6	16-b-40	

13-b-1 ANDREWS, E. C., 1916 — Notes on the structural relations between Australasia, New Guinea and New Zealand. *J. Geol.*, 14, 751-77.

Structural and tectonic features, regional stratigraphic relationships and metallogenetic regions are used to reconstruct and compare the geological and tectonic evolution of Australia, New Guinea, New Caledonia, and New Zealand.

It is postulated that the Australian continental mass has grown by accretion to the east and northeast onto a stable cratonic shield since late Precambrian. There has been a succession of periods of diastrophism, becoming younger eastward, the last major diastrophism being late Carboniferous. In contrast, Papua New Guinea developed mostly in post-Permian time, and has grown south and southwest from the meridional schistose basement of basal Mesozoic age. New Caledonia and New Zealand have grown eastward towards Australia. (W.M.)

13-b-2 ANDREWS, E. C., 1922 — The present structure of the Pacific. *J. Proc. Roy. Soc. N.S.W.*, 56, 14-38.

The Pacific Ocean is a geographical unit which has responded as a unit to geologic phenomena in the ocean basin since early geological time. The controlling agency was related to the sagging of the suboceanic mass under its own weight, with consequent creep by undulations of the bordering continents towards the low-lying block constituting the Eastern or Main Pacific. Evidence in support is sought in the age, extent, and geographic distribution with time of such major crustal features as 'ocean deeps' or trenches, earthquake zones and volcanic belts, island arcs and plateaux, and the form of the Pacific ocean floor. The distribution and variable movements of Cainozoic coralline limestones and reefs in the Eastern Pacific is also considered. (W.M.)

13-b-3 ANDREWS, E. C., 1934 — The origin of modern mountain ranges, with special reference to the eastern Australian highlands. *J. Proc. Roy. Soc. N.S.W.*, 67, 251-350.

The origin of modern and ancient mountain ranges is discussed with examples from the Australasian island arcs, and the East Australian Highlands. Volcanic distribution, erosion, and stream patterns are discussed as lines of evidence of the structure of modern cordillera, including the New Guinea Cordillera. Some inferences are drawn about crustal strength and isostacy in the circum-Pacific zone. (W.M.)

13-b-4 ANDREWS, E. C., 1938 — Some major problems in structural geology. *Proc. Linn. Soc. N.S.W.*, 73, iv-x.

The philosophy and facts of geotectonic reasoning are outlined and discussed in terms of the consideration of evidence of continental growth and stability. The gross tectonic features of Australia (including the active area of New Zealand, New Caledonia, Fiji and Solomon Is) and the other continents are outlined, and the formation and significance of fold mountain ranges are described. (W.M.)

13-b-5 ANDREWS, E. C., 1939 — Structure of the Pacific Basin. *Proc. 6th Pacif. Sci. Cong., San Francisco,* 1, 201-4.

The permanence and relative instability of the Pacific Basin is reasoned by considering the Palaeozoic and Mesozoic tectonic history of circum-Pacific continental masses in terms of their development with time by accretion onto stable nucleic blocks. Gross similarities exist between each of the elements of the present circum-Pacific continent-sedimentary basin-island arc units. A non-continental history is demonstrated for the mid-oceanic island arcs. The larger island groups in the western Pacific may represent portions of continental masses. (W.M.)

13-b-6 BEMMELEN, R. W. van, 1932 — De Undatie-theorie — hare afleiding en hare toepassing op het westelijke deel van den Soendaboog (The Undation Theory — its deduction and its application to the western end of the Sunda arc, in Dutch with English Summary, pp. 89-94). *Natuurk. Tijdschr. Ned.-Indie,* 92, 85-242.

Theoretical aspects of the theory are considered and its applicability to the tectonic evolution of the western end of the Sunda arc is examined. The younger Tertiary and Quaternary strata and tectonics of southern Sumatra are discussed, and compared with nearby areas, including New Guinea. (W.M.)

13-b-7 BEMMELEN, R. W. van, 1933 — Versuch einer geotektonischen analyse australiens und des sudwest-pazifik nach der undationstheorie (Towards a geotectonic analysis of Australia and the southwest Pacific in terms of the Undation Theory, in German). *Proc. K. ned. Akad. Wet. Sec. Sci.,* 36, 741-9.

A series of northward-younger tectonic and volcanic zones in the Melanesia-Australia region are discussed and interpreted in terms of northward-moving tectonic mega-undation cycles. (W.M.)

13-b-8 BEMMELEN, R. W. van, 1939a — The geotectonic structure of New Guinea (Abstract only). *Rep. 24th ANZAAS Cong., Canberra,* 94-5.

This summarizes entry 13-b-9.

13-b-9 BEMMELEN, R. W. van, 1939b — The geotectonic structure of New Guinea. *Ing. Ned.-Indie,* 6(2), 17-27.

The Undation Theory attempts to explain the geological evolution of the Earth's crust as the result of geomagmatic processes at depth (magmatic differentiation in grand style and diffusion of emanations, causing sub-crustal mass displacements). Epeirogenetic or undatory crustal movements are the result of these endogenetic forces at depth. Geomagmatic processes at depth cause growth of the sialic crust during geological evolution. This growth is effected by the subsequent welding of newly consolidated orogenetic girdles to the old continental nuclei.

The Australian continental nucleus is framed at its eastern side by Devonian and Permo-Carboniferous mountain systems which have been welded to the central core and show a centripetal direction of the overthrusts and overfoldings. The epeirogenetic movements which caused the actual appearance of the Australian continent started in lower Tertiary time with geo-undatory uplift which caused a regression of the sea and its transgression in a geosynclinal zone of subsidence encircling the elevation. From this geosynycline in upper Tertiary and Quaternary time a mountain system arose.

The geotectonic structure of the different sections of the New Guinea central range is not the same, and there are 3 parts which perhaps show more or less gradual transitions but which are structurally neither similar nor equivalent. The Undation Theory divides tectonic processes into two main groups (1) primary vertical movements (undations) as the result of magmatic processes at depth, and (2) secondary gravitational reactions in the outer crustal zone and the sedimental cover. These secondary gravitational reactions cause compression phenomena in subsiding regions (such as overfolding and overthrusting) which are locally compensated by tension and stretching in the adjacent uplifted regions (normal faulting, thinning of strata). Therefore it is not necessary to assume continental drift and narrowing of the geosyncline by approach of its borders towards each other to explain the orogenetic or tectogenetic processes in the geosynclinal area. (Auth.)

13-b-10 BEMMELEN, R. W. van, 1965 — The evolution of the Indian Ocean Mega-Undation. *Tectonophysics,* 2(1), 29-58.

The geomechanical model of mega-undations is elaborated:

(1) The lower mantle may have a Newtonian viscosity, but the upper mantle, which is largely in a crystalline state, shows an Andradean viscosity, with hot-creep phenomena and the formation of lamellae separated by zones or planes of high strain rate.

(2) Reliable solutions of the mechanics in the fault planes of earthquake foci indicate that the spreading of the mega-undations is characterized in the outer 400 km by the farther advance of the higher structural levels with respect to the underlying ones; whereas movements in the foci of deep earthquakes underneath the Japan Sea and South America indicate a reverse process, the lower blocks moving faster towards the Pacific than the overlying ones.

(3) The crest of the mega-undations shifts in the course of time, either gradually or by steps.

(4) Four stages of evolution of mega-undations are distinguished: (a) young, (b) early mature or precocious, (c) late mature or ripe, and (d) fossil mega-undations.

In the development of the Indian Ocean Mega-Undation the geomechanical model is tested by analysis of the geotectonic evolution of the Indian Ocean and the surrounding shields. It appears that there is a good correspondence between the expectations according to the hypothetical model and the geotectonic observations. (Auth.)

13-b-11 BENSON, W. N., 1924 — The structural features of the margin of Australasia. *Trans. N.Z. Inst.,* 55, 99-137.

The tectonic features and geological history of the marginal zone of the Australasian continental mass are discussed, mainly the western and southern islands of the East Indies, New Guinea, and other islands of the First Australian Arc. Principal crustal structures are delineated and their genesis and significance discussed. (W.M.)

13-b-12 BENSON, W. N., 1925 — Stratigraphy and structure of the northern and eastern margin of Australasia. *Verh. Geol. mijnb. Genoot. Ned.,* 8, 53-72.

The Australian continental block developed by accretion of progressively younger belts on the east of a crystalline nucleic massif. The discussion is whether New Guinea, New Caledonia, and New Zealand represent discrete units, or whether they form part of a belt which will constitute the next easterly accretion onto the continental block.

The stratigraphy, palaeontology, volcanology, and post-Cretaceous tectonics of New Guinea, New Caledonia and New Zealand are assessed. The period of maximum crust movement becomes progressively younger, passing eastward across Australia and passing northward from New Zealand through New Caledonia to New Guinea where, passing westward, it increases in age. (W.M.)

13-b-13 BOGDANOV, N. A., 1967a — Palaeozoic geosynclines of the western part of the circum-Pacific belt (Abstract only). *Tectonophysics,* 4, 581.

Palaeozoic deposits are the oldest in island arcs of the circum-Pacific. Analysis of the structures and facies of these rocks suggests that the Palaeozoic geosynclines formed a single geosynclinal belt from Chukotka Pen. to Antarctica. 3 longitudinal zones recognized in this belt are different, both in their history of tectonic development and magmatic activity:

(1) The western zone (Tasman-Katasiatic) consists of miogeosynclines and eugeosynclines and is similar to the internal orthogeosynclines of the Asiatic continent.

The only difference between this zone and orthogeosynclines is that the eugeosynclines in the Pacific coasts of Asia and Australia are 5 or 6 times as wide as miogeosynclines. Apparently this zone was developed in Palaeozoic time on crust of the continental type.

(2) The central zone (Hokanoe-Kitakami) consists mainly of spilite-keratophyre lavas and their tuffs which interbed usually with shallow-water sediments. During Palaeozoic time this zone appeared to be somewhat analogous to contemporary volcanic island arcs.

(3) The eastern (Otago-Sakhalin) zone has many specific features. The geological formations are composed of greywacke and chert. Near the oceanic basin the stratigraphic sequence of the Palaeozoic does not contain acid lavas and arkose sandstone. The lithology of the sediments of this zone is very similar in many different areas from the Koryak Mountains to the South Island of New Zealand. Granitic intrusions are absent in most parts of the zone. It is possible that sediments of the zone have been accumulated within oceanic troughs on the simatic crust. It is evident that the basin of the Pacific is of Precambrian age. (Auth.)

13-b-14 BOGDANOV, N. A., 1967b — Paleozoy vostoka Avstralii i Melanezii (Palaeozoic of eastern Australia and Melanesia, in Russian). *Trudy geol. Inst. Mosk.*, 181, 171 pp.

The Middle Proterozoic to Upper Palaeozoic tectonic history of this region is traced, and description given of the major structural elements and their morphological features. Geosynclinal zones are delineated, associated intrusive and extrusive igneous activity related with time, and stratigraphic successions described. (W.M.)

13-b-15 BRUYN, W. H. K. F. de, 1921 — Contributions à la géologie de la Nouvelle-Guinée (Contributions to the geology of New Guinea, in French). *Bull. Lusanne Univ. Geol. Geogr. Miner. Palaeont.*, 30, 169 pp.

5 tectonic elements of New Guinea are recognized: (i) a chain of fold mountains from the Schouten Is and the Rees-Gauthier Mts in the west through the Bewani and Torricelli Mts to the Saruwaged Ra. in the east. In this chain are exposed crystalline metamorphics and schists, and intrusive and volcanic rocks; metamorphic basement is covered by Mesozoic and Tertiary sediments; (ii) a depression from Geelvink Bay in the west to Huon Gulf in the east, with a fault-bounded southern margin indicated by a line of basaltic eruptive centres; (iii) a central mountain chain from the Carstensz Mts in the west to the Owen Stanley Ra. in the east. In the west only Palaeozoic, Mesozoic, and Tertiary sediments are exposed; farther east metamorphic and intrusive rocks of Palaeozoic age are exposed, in places mantled by Tertiary to Recent volcanics; (iv) a geosynclinal depression south of the Central Range, represented by the Arafura Sea-Gulf of Papua depression, with a compensating anticlinal ridge in the Merauke-Madabauan plateau; (v) a branch of the central chain of mountains, distorted to form the Vogelkop.

Previous tectonic analyses are reviewed. It is proposed that the central mountain chain in western New Guinea started to emerge during the Pliocene as a northward-advancing fold on which the north coast chain represents a frontal plication. Uplift has been uneven at different places along this chain, and varying degrees of associated volcanic activity are expressed. (W.M.)

13-b-16 BRYAN, W. H., 1944 — The relationship of the Australian continent to the Pacific Ocean — now and in the past. *J. Proc. Roy. Soc. N.S.W.*, 78, 42-62.

The evolution of ideas on the structure, age, and significance of the Pacific Ocean Basin is outlined, and a summary is given of the structural, stratigraphic, geomorphic, seismic, and volcanic evidence leading to its recognition as a unique geotectonic unit. It is argued that the Australian continental mass includes the Pacific Ocean floor as far east as the inner line of the seismic belt, through New Guinea, New Caledonia, Fiji, Tonga, Karmadec, and New Zealand. The thickness of the sialic material on the present landmass area is about 40 km, and up to 25 km in the area west of the seismic belt. East of here seismic and volcanic evidence suggests a different composition for the ocean basin floor.

The palaeotectonic and palaeogeographic significance of the stable area east of the present continental landmass is discussed in terms of geosynclinal sedimentation and continental growth. It is concluded that the Australian continental mass existed as long ago as the early Palaeozoic, and that there was stable continental material east of the Tasman Geosyncline throughout its history. (W.M.)

13-b-17 CAREY, S. W., 1959 — The tectonic approach to continental drift. *In* CAREY, S. W. (Ed.) — CONTINENTAL DRIFT — A SYMPOSIUM. *Hobart, Univ. Tas.*, 177-356.

The present distribution of continental and oceanic crust materials on the Earth's surface is relocated to the pre-Mesozoic configuration by reversing all proven first-order post-Palaeozoic deformations. The resultant mosaic accords well with reconstructions based on stratigraphic, palaeontological, and geomagnetic methods. Most disturbed areas and mobile belts in the crust are considered. The Papua New Guinea region is considered along with the East Indies in discussing the Tethyan and the Melanesian Shear Zones with details on stress fracture and fold patterns in northeast New Guinea. The present relative positions of Australia and New Guinea is the product of dextral movement along the east-west North Pacific Megashear Zone. A reversal of deformation provides a configuration in which New Guinea lies elongate north-south off the east coast of Queensland. (W.M.)

13-b-18 CAREY, S. W., 1968 — Tectonic framework of the Sydney Basin. (Keynote address to 4th Newcastle Symposium on the Sydney Basin.) *Univ. Tas. Dep. Geol. Publ.*, 206, 12 pp.

The eastern half of the Sydney Basin, for which evidence indicates an easterly landmass source for detritus, appears difficult to account for and locate. A tectonic analysis of its history since the mid-Mesozoic suggests the extension of this basin be sought on the Lord Howe Rise.

The tectonic fabric of the southern Pacific Ocean-Australian Continent-Indian Ocean region is considered, with details on fracture systems of compression and tensional stress origin in northeast New Guinea. Major east-west crustal slices are fragmented by *en echelon* shears and associated sinusoidal folds, indicating sinistral transcurrent shear between slices. (W.M.)

13-b-19 CAREY, S. W., 1971 — Australia and the Melanesian area. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 385.

The central Pacific is indeed pacific in seismicity, volcanism, and tectonism. In contrast with other oceans, the Pacific rim is concordant, with orogenic grain parallel to the margin, progressing from youngest to oldest from margin into the continents. The Pacific has both east-west and north-south asymmetry. Along the eastern margin from Arctic to Antarctic the young orogens, the andesite line, and the trenches are separated from the continents by wide oceanic-crust basin which are disjunctive in a generally dispersive system. The western Pacific margin has significantly more seismicity and volcanism than the eastern. The southern Pacific, along with the associated southern continents, is displaced thousands of kilometres east with respect to the northern Pacific and its associated continents. This movement displaces hemisphere against hemisphere. Dispersive separation is greater in the south Pacific (and southern hemisphere generally) than in the north. These asymmetries recur in other geophysical characters — geodetic, magnetic, and continental zoning — and imply a rotational helm in global tectonics, if not a cause.

All crustal polygons ('plates') have increased in area, and each polygon has increased its distance from all other polygons since the Jurassic. This can only mean overall increases in the Earth's surface. (Auth.)

13-b-20 Coleman, P. J., 1965 — Stratigraphical and structural notes on the British Solomon Islands, with reference to the first geological map, 1962. *Brit. Solomon Is geol. Rec.*, 2, 17-31.

The stratigraphic and structural features of each major island and island group in the Solomon Is are outlined, and their regional tectonic setting and significance discussed. Bougainville is thought to constitute part of the chain, but little is known about its geology except that it is composed of Miocene and younger sediments on an andesitic lava basement and with several sub-Recent to Recent volcanic cones.

The Solomon Is stand on a sigmoid bathymetric high, with a depression separating an eastern and a western chain of islands. Minor linear deeps mark the smooth drop to the Pacific floor, with depths of 3000 m off Bougainville and other islands. A pronounced trough which includes the Planet Deep marks the passage to the oceanic floor to the southwest. This trough is roughly arcuate, convex towards the continent.

Seismicity of the area is high, with the seismic zone dipping towards the continent, suggesting the islands are not a normal ocean rim group; they fit the special type in which shearing and strike-slip faulting predominate and fault systems of great length are developed. Volcanicity of the area has been much greater in the past. (W.M.)

13-b-21 Coleman, P. J., 1966 — The Solomon Islands as an island arc. *Nature*, 211, 1249-51.

The Solomon Is, including Bougainville and the volcanic islands off the east coast of New Ireland, are an example of a 'fractured arc'. The axis of the Solomon bathymetric high is sigmoidal with a double chain enclosing a 2500 m deep in the centre of the arc; in the southeast there are complicating small rhomboid, linear, and pocket depressions. The eastern chain of islands and the deeps between the chains both are offset *en echelon,* whereas the western chain of islands is not. The chain is bounded on the Australian and continental side by the Solomon Trough which is convex towards the continent.

The islands represent an autochthonous stratigraphic system, much of the succession being volcanic or volcanigene. Strata range in age from Mesozoic, possibly Cretaceous, to Recent. There are more than 30 well preserved recent volcanoes some of which are still active. 3 distinct provinces are recognized — a Central and a Pacific Province separated by a Volcanic Province situated along a sigmoid major lineament.

The crustal thickness of the Solomons block has been calculated to be 15 km. Strong positive gravity anomalies characterize the block, passing rapidly to strong negative anomalies over the bathymetric deeps. A belt of high seismicity lies between the Solomon Trough and the axis of the Solomon Block, with shallow shocks predominating. Seismic zones are ill defined but appear to be vertical or dip steeply towards the Pacific. (W.M.)

13-b-22 Crook, K. A. W., 1969 — Contrasts between Atlantic and Pacific geosynclines. *Earth planet. Sci. Lett.*, 5, 429-38.

Significant differences exist between complex geosynclines of the circum-Pacific region ('Pacific geosynclines') such as the Tasman and New Guinea Geosynclines, and those of the Atlantic region ('Atlantic geosynclines'), such as the Alpine, Caledonian, and Appalachian Geosynclines.

Pacific geosynclines have the following characteristics: 1. they comprise a number of sub-parallel volcanic and non-volcanic troughs and highs with the non-volcanic elements suited near the kraton; 2. the volcanic troughs are characterized by volcanic-terrigenous flysch-like sediments (volcanic greywackes). The volcanic troughs and highs may lack serpentinite. Ophiolites have not been recognized; 3. sediment in the non-volcanic troughs is predominantly terrigenous flysch, of sialic derivation; 4. deformation structures are predominantly vertical, and terminal tectonism proceeds outwards from the kraton; 5. successive pairs of troughs do not display the alteration of 'polarity' required by Aubouin's model; 6. Pacific geosynclines do not occupy the sites of older geosynclines and probably develop on a largely simatic substrate; 7. Pacific geosynclines lie between sialic kratons and simatic ocean floors. (Auth.)

13-b-23 CULLEN, D. J., 1970 — A tectonic analysis of the south-west Pacific. *N.Z. J. Geol. Geophys.*, 13, 7-20.

The regional structure of the southwest Pacific is attributed to spreading and segmentation by sub-crustal convection currents of a Palaeozoic-Mesozoic geosynclinal belt marginal to the Australian kraton, with migration of the separated sialic fragments north and east into the Pacific Basin.

During Cainozoic time Australia has moved north relative to the New Zealand Plateau, whose migration had a greater eastward component that allowed opening of the Tasman Basin. As a result, the geosynclinal belt from New Zealand across the northeast margin of the Australian kraton has been subjected not only to crustal spreading and stretching in a northeast direction with anticlockwise rotation, but also to north-south extension and tensional rifting. The New Guinea section of the geosyncline has been separated by rifting with attenuation, and thrust north in advance of the Australian kraton, vacating the region now occupied by the Coral Sea Basin.

Independent, convergent movement of the Campbell Plateau-Chatham Rise section of the geosynclinal belt in a north-northeast to north direction has resulted in a clockwise rotation, through approximately 90°, of the intervening New Zealand segment, accompanied by large-scale flexuring and northeast shear-fracturing. The rotation has swung New Zealand into alignment with volcanic island arcs (the Kermadec-Tonga Ridge and the Macquarie Ridge) forming simultaneously to the north and south. (Auth.)

13-b-24 DAVID, T. W. E., 1950 — Tectonic history. *In* BROWNE, W. R. (Ed.) — GEOLOGY OF THE COMMONWEALTH OF AUSTRALIA, 1. *Lond., Arnold,* 1, 686-717.

Land-bridge connexions between Australia-New Guinea and Asia are recognized throughout the Palaeozoic and Mesozoic successions, and final severance is thought to have occurred at the close of the Mesozoic. The eastward extension of Australia to New Zealand and Fiji in the landmass of *Tasmantis* is accepted, and this mass is thought to have foundered early in the Pleistocene. The history of the Papuan Geosyncline is discussed in the light of this assumption, and post-Pliocene isostatic movement considered in outline. (W.M.)

13-b-25 DAVIES, H. L., 1965b — Papuan Basic Belt. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT, 1960-65. *Canberra, Aust. Acad. Sci.,* 115.

This is similar to entries 02-b-36 and 02-b-37.

13-b-26 DAVIES, H. L., 1967a — Papuan Ultramafic Belt (Abstract only). *39th ANZAAS Cong., Melbourne,* Sec. C Abs., M 6-7.

The Belt is probably mantle material which has been brought to the Earth's surface by Tertiary fault movements. These movements started in Palaeocene or Eocene time, perhaps grew to a climax in the Eocene (diorite intruding the Belt is 55 ± 2 m.y. old), and have continued on a lesser scale to the present. Emplacement of the northern part of the Belt may be explained by westward horizontal movement of a segment of suboceanic mantle forced upward by collision with the sialic core of ultramafic blocks emerging vertically through volcanic and alluvial cover.

The Belt is faulted against, and probably partly overlain by, basaltic volcanics with minor limestone. The basalt is locally intruded by the gabbro and diorite of the Belt. The volcanics and limestone are thought to represent the pre-emplacement oceanic crust; they are, at least in part, Upper Cretaceous. The northern and central parts of the Belt are faulted against the sialic greenschist facies Owen Stanley

Metamorphics which locally contain Middle Jurassic to Middle Cretaceous fossils. Greenschist facies metamorphics in the southeast (Goropu Mts) are mafic and calcic and may be related to the Upper Cretaceous volcanics and limestone rather than to the Owen Stanley Metamorphics. (Auth./W.M.)

13-b-27 DAVIES, H. L., 1968 — Papuan Ultramafic Belt. *23rd int. geol. Cong., Prague,* Abs. Vol., 15-6, and *Proc.,* 1, 209-20.

This is similar to entry 13-b-26.

13-b-28 DEWEY, J. F., & BIRD, J. M., 1970 — Mountain belts and the new global tectonics. *J. geophys. Res.,* 75(14), 2625-47.

It is proposed that mountain belts develop by the deformation and metamorphism of the sedimentary and volcanic assemblages of Atlantic-type continental margins. These assemblages result from events associated with the rupture of continents and the expansion of oceans by lithosphere plate generation at ocean ridges. The earliest assemblages thus developed are volcanic rocks and coarse clastic sediments deposited in fault-bounded troughs on a distending segmenting continental crust, subsequently split apart and carried away from the ridge on essentially aseismic continental margins. As the continental margins move away from the ridge, non-volcanic continental shelf and rise assemblages of orthoquartzite-carbonate, and lutite (shelf), slump deposits, and turbidites (rise) accumulate. This kind of continental margin is transformed into an orogenic belt in one of two ways. If a trench develops near, or at, the continental margin to consume lithosphere from the oceanic side, a mountain belt (cordilleran type) grows by dominantly thermal mechanisms related to the rise of calcalkaline and basaltic magmas. Cordillera-type mountain belts are characterized by paired metamorphic belts (blueschist on the oceanic side and high temperature on the continental side) and divergent thrusting and synorogenic sediment transport from the high-temperature volcanic axis. If the continental margin collides with an island arc, or with another continent, a collision-type mountain belt develops by dominantly mechanical processes. Where a continent/island arc collision occurs, the resulting mountains will be small (e.g. the Tertiary fold belt of northern New Guinea), and a new trench will develop on the oceanic side of the arc. Where a continent/continent collision occurs, the mountains will be large (e.g. the Himalayas), and the single trench zone of plate consumption is replaced by a wide zone of deformation. Collision-type mountain belts do not have paired metamorphic belts; they are characterized by a single dominant direction of thrusting and synorogenic sediment transport away from the site of the trench over the underthrust plate. Stratigraphic sequences of mountain belts (geosynclinal sequences) match those associated with present oceans, island arcs, and continental margins. (Auth.)

13-b-29 DOTT, R. H., 1969 — Circum-Pacific late Cainozoic structural rejuvenation — implications for sea-floor spreading. *Science,* 166(3907), 874-6.

The hypothesis of sea-floor spreading and lithosphere plates seems to unify the origins of both oceanic ridges and volcanic arc-trench systems; therefore, knowledge of land areas should shed light upon seafloor tectonics. Evidence of a major mid-Cainozoic discontinuity in the tectonic history of circum-Pacific land areas suggests a roughly synchronous change in sea-floor development. Included in the evidence cited are the relationships between large continental and oceanic crustal plates and possible mantle material in eastern Papua. (Auth./W.M.)

13-b-30 FAIRBRIDGE, R. W., 1950a — Problems of Australian geotectonics. *Scope, Perth,* 1, 22-8.

The geotectonic evolution of the Australian continent includes the consideration of the eastern limit of the present Australian continental block (Meso-Australia). The Mesozoic and Tertiary 'front' of the continental block is traced south of the main New Guinea Cordillera, west of New Caledonia, and west of the Southern

Alps of New Zealand. Strata beyond that line are considered part of Neo-Australia, and distinct from the main continental block. (W.M.)

13-b-31 FAIRBRIDGE, R. W., 1961 — Continental margin of the south-west Pacific: advancing or retreating? *Proc. 9th Pacif. Sci. Cong., Thailand,* 12, 69.

Progressively younger fold-belts have been welded onto the eastern margin of Australia, apparently increasing the width of the continent 3860 km in 600 million years (or 6 mm per year). These units represent successive belts of orthogeosynclinal character: the youngest is the present zone of deep-sea trenches coinciding with the 'Andesite Line' that marks the present limit of 'continental' andesites against the true thalassocratonic Pacific.

The problem arises to explain the nature of the fairly deep marine basins between eastern Australia and the Andesite Line ('Melanesian Subcontinent'). There is increasing palaeogeographic evidence that these basins (at least in part) represent former semi-continental areas that have been recently fragmented and have undergone differential subsidence. However, rocks older than younger Palaeozoic have not been identified in the central (New Caledonia) belt of islands; and nothing older than the Tertiary in the easternmost islands (Fiji, Tonga). Seismic work has shown that the typical subocean crustal thickness in the Fiji region is 10-20 km of basaltic characteristics, overlain by 1-2 km of sediment consisting essentially of reworked volcanic-type muds. Earthquake seismology and gravity data point to the same conclusion, viz. an absence of a thick acid rock continental-type basement.

In conclusion, the Melanesian region shows evidence of progressive expansion to the east, at the expense of the true Pacific, but repeated oscillations over the intervening area indicate 'regeneration' of imperfectly differentiated and consolidated crust of intermediate thickness. (Auth.)

13-b-32 GLAESSNER, M. F., 1950 — Geotectonic position of New Guinea. *Bull. Amer. Ass. petrol. Geol.,* 34, 856-81.

An attempt is made to organize available data on geotectonic relations in the New Guinea area to provide a basis for discussion of the fundamental structural features and dynamics of this part of the Pacific margin. A tentative division of the island of New Guinea into twelve structural zones is proposed and the differences between the northern and eastern zones and the main part of the island are emphasized. A review is made of the Pacific Border ('Andesite Line') and its most likely position, the Australian continental mass and its main components, the Asiatic and East Indian Island arcs, and the island belt southeast of New Guinea (Melanesian zones). The proximity of the Australian kraton and its outer geosynclinal belt affects the circum-Pacific structure, as the Melanesian zones differ from them in several important respects. In applying the results of the review of surrounding major earth features to the analysis of the structure of New Guinea, it is found that the northern and eastern parts of the island are essentially Melanesian, while western New Guinea is influenced by the Asiatic Banda arcs. The zones of southern and central New Guinea are essentially Australian and appear to continue as a submerged median mass southeast under the Coral Sea. The area eastward to the Pacific Border is a major geosynclinal belt but it is characterized by nuclear basins and surrounding sigmoidal structural trends. (Auth.)

13-b-33 GLAESSNER, M. F., 1956 — Recent advances in the study of mountain-building in the southwest Pacific region. *Proc. 8th Pacif. Sci. Cong., Philippines,* 24, 700-5.

Geological work in New Guinea since 1950 is outlined, and the data interpreted in terms of the tectonic setting and tectonic history of the island. A sequence of orogenic phases is recognized, dating back to late Palaeozoic time and culminating in a strong Plio-Pleistocene phase of folding with subsequent uplift of the mountain zones, and downwarping and downfaulting of longitudinal valleys and depressions.

The formation and composition of some of the mountain ranges and the present modifications to the north and south coasts are discussed. (W.M.)

13-b-34 GOOD, R., 1957b — Australasian floras. *Nature,* 179, 926.

If Australia and New Guinea have only recently assumed their present latitudes and relative positions as a result of independent convergent drift, many of the problems of accounting for geographic distribution of plant species in Australasia are removed. (W.M.)

13-b-35 GOOD, R., 1958 — The biogeography of Australia. *Nature,* 181, 1763-5.

Many biogeographic problems of Australasia are less confused if Australia and New Guinea have only recently assumed their present latitudes and relative positions as a result of independent convergent drift. It is assumed that this has resulted from drift of Australia towards New Guinea. Floristic evidence indicates Australia has drifted northeasterly from a position at least 20° further south than the present position. Palaeobotanical evidence is not sufficiently comprehensive to support or reject this proposal. (W.M.)

13-b-36 GROVER, J. C., 1955b — Structural geology. *In* Geology, mineral deposits and prospects of mining development in the British Solomon Islands Protectorate. *B.S.I.P. intm geol. Surv. Mem.,* 1, 24-6.

The bathymetric chart of the Solomon Is region shows large deep shoals to the west, separated from the islands by deep trenches. The main line of islands south of Bougainville splits and forms two chains in the Solomons. Most seismic activity is restricted to Bougainville and the western (inner) chain, along a shear zone that dips steeply towards the Pacific basin. A large continental landmass appears to have existed not far to the west of the present island chain during the Tertiary. (W.M.)

13-b-37 GROVER, J. C., 1966a — The British Solomon Islands — the present geological picture as a result of sixteen years of geological and geophysical exploration. *Proc. 11th Pacif. Sci. Cong., Tokyo.* 4, V/25.

A chain of mountainous islands stretching over 1500 km constitute the Solomons near the Pacific end of the world equatorial Tethyan Sinistral Shear Zone. The outer or Pacific Province is a folded sequence of basic lavas, Cretaceous to Eocene in age and partly submarine in origin, overlain by pelagic foraminiferal limestone (Upper Cretaceous to Miocene) and volcanic calcareous sediments (Pliocene to Quaternary). The Central Province is a faulted sequence of metamorphics, andesitic lavas, granitoid and gabbroic sub-plutons, isotopically aged as lower Eocene, and both reef and volcanic-derived lower Miocene to Recent sediments. A Volcanic Province is developed on the Australian side, overlapping into the Central Province.

The Pacific Province has been moved along sinistral strike-slip faults. A major tension fracture system has been intruded by ultramafic rocks dividing the Pacific Province from the basement Central Province. Boat-shaped basement outcrops, eclogitic in part (alnoites and ankaratrites), underlie the sediments on Malaita. Seismicity is high in the Volcanic and Central Provinces, but not 'haphazard'; earthquakes occur as distinct sequences. Tension effects are recognized between Malaita and Santa Isabel, Malaita and San Cristobal, and the New Britain and San Cristobal-Santa Cruz trenches. These all lie on the Australian side of the chain, contrasting with the Indonesia and Indian Ocean situation. The Vitiaz Trench north of Santa Cruz merges with vestigial troughs on the Pacific side of the island chain. (Auth./W.M).

13-b-38 HACKMAN, B. D., 1971 — The Solomons fractured arc. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 366.

The Solomons active primary fractured arc extends from Buka-Bougainville to San Cristobal. Seven major island groups form a double *en echelon* chain. The limits of the Solomons segment are defined by angular re-entrants in the trench system on the southwest margin. The system of trenches on the Pacific side is not so well developed. The Solomons coincide with an arcuate gravity low on the northeast side of a large Bouguer positive which extends over the Coral Sea; the estimated depth of the crust/mantle interface varies between 9 and 29 km. Individual islands are not isostatically compensated.

The fractured arc is considered to have evolved from a series of oceanic welts which started to shoal in the lower Miocene and sustained rapid uplift until the present. The oldest rocks, which appear on all major island groups except Bougainville and New Georgia, form a 'basement' of late Mesozoic basaltic lavas, pelagic limestone, and cognate minor intrusives, with gabbro emplacement at depth. In the Central Province, which excludes Malaita, basement rocks have been metamorphosed to greenschist or amphibolite grade and intruded by Alpine-type ultrabasics in the axial regions of geanticlinal structures.

The pattern of seismicity indicates that the Benioff zone dips towards the Pacific at either end of the Solomons arc where the trench system is well developed. Fracturing of the uplifted oceanic welts under the influence of deep-seated transcurrent faulting may have led to the rotation of discrete blocks, on which were periodically impressed the effects of a regional northeast-southwest stress system. The Solomons arc is compared with northern New Guinea and the Santa Cruz area of the New Hebrides arc. (Auth.)

13-b-39 HEIDECKER, E., 1971 — Structural control of fragmentation along the continental margin of northeastern Queensland. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 388.

A topographic high lay east of the present coast between Townsville and Cairns before the Pliocene. Geomorphic evidence associates fragmentation and collapse of this high with uplift and volcanicity along the Great Divide of northern Queensland. The attitudes and ages of lineaments traversing northeast Queensland are inferred from fabric studies. Fragmentation of the continental margin is shown to follow these lineaments in the development of coastal 'corridors', escarpments, trenches, and submarine plateaux. Areas of doming, volcanicity, and separation are related to multiple intersections of lineaments. These relationships are held to be consequences of crustal thinning associated with expansion of the continental margin towards the Papuan Trough. (Auth.)

13-b-40 HESS, H. H., & MAXWELL, J. C., 1953 — Major structural features of the south-west Pacific (A preliminary interpretation of H.O. 5484, bathymetric chart, New Guinea to New Zealand). *Proc. 7th Pacif. Sci. Cong., New Zealand,* 2, 14-8.

A series of 5 active arcs in the southwest Pacific is recognized: (i) Northern New Guinea-New Britain Arc, (ii) Solomons Arc, (iii) New Hebrides Arc, (iv) Tonga Arc, (v) Kermadec Arc. All began during the late Cretaceous, and the Solomons Arc is in the most advanced stage of development. Volcanism in the arcs is dominantly andesitic, and the ocean-side deeps probably are the geomorphic expression of tectogenes. More deeply dissected parts of the arcs reveal metamorphic rocks and serpentinized peridotites. The region is an example of progressive outward migration of belts of orogeny over geological time, and the present manifestations of this in the New Hebrides and Tonga Arcs are noted. (W.M.)

13-b-41 HILLS, E. S., 1961 — Pacific influences in the tectonics of eastern Australia. *Proc. 9th Pacif. Sci. Cong., Thailand,* 12, 64.

In Upper Proterozoic time tillites and rudaceous-arenaceous sediments were widespread. The tillites were in part deposited in geosynclinal troughs and the implication of both facies is that at that time parts of Australia were cratonic, while other belts were geosynclinal. The distinction is reflected in the present continental structure, which therefore bears a certain resemblance to that of the Upper Proterozoic. The broad pattern of Cambrian volcanicity and tectonic features in eastern Australia and New Zealand indicates a similarity to the present configuration.

Volcanicity and igneous intrusions in eastern Australia from Cambrian to Cainozoic show widely ranging magma types, but the distribution is always within the mobile eastern zone, suggesting a constant tectonic relationship with the main Pacific margin. Cainozoic volcanic trends and belts are clearly related with parallel features in the Tasman Sea, the Coral Sea, and the Pacific margin.

The former extension of Australia towards the east is unquestioned. The present boundaries and the elevation of the Eastern Highlands are tectonic, not due to isostatic uplift, so that the geological resemblances are a reflection over common tectonic origin geometrically related to the Pacific. Geological evidence indicates a thick stable shield lying to the west; a broad zone of thinner basement rock beneath the Great Artesian and Murray Basins; a complex geosynclinal zone on the east; and a subsided, probably thin, sialic area beneath the Coral and Tasman Seas. Thus the overall picture agrees with the major tectonic elements of the Australasian region, and, with variations, this has been so since the Upper Proterozoic. (W.M.)

13-b-42 HOBBS, W. H., 1944 — Mountain growth, a study of the southwestern Pacific Region. *Proc. Amer. phil. Soc.*, 88, 221-68.

The development of mountain chains is thought to be caused ultimately by shrinking of the earth's core, and proximally by compressional movement in the crust. The circum-Pacific mountain chains are thought of as recently emergent growing young mountains, and considered as evidence of the compressional origin of mountain chains. The origin and development of mountain chains in the southwest Pacific are considered, including the Bismarck Arch.-Solomons-New Hebrides Arc, the Tonga-Kermadec Arc, and the New Zealand Arc. (W.M.)

13-b-43 HOLMES, A., 1926 — Tectonic features of New Guinea. *Nature,* 118(2980), 848-9.

The geological and tectonic elements of the island of New Guinea were noted by Zwierzycki (*Philipp. J. Sci.*, 29, (1926), 505-13 — West Irian) and Stanley (entry 02-b-171). Their comments are summarized. From Halmahera to New Britain there are numerous relics of a crystalline foreland heavily injected with peridotite and serpentinite, probably towards the end of the Cretaceous, which served as the buttress against which Neocene formations to the south were folded and overthrust late in the Tertiary.

Correlation of tectonic elements of New Guinea with elements in the Alpine-Himalayan system and the East Indies islands are assessed, and cast into doubt until more data are available on the existence and direction of overfolding and overthrusting in the structural belt south of the axial Owen Stanley-Charles Louis Mountains. (W.M.)

13-b-44 JOHNSON, T., & MOLNAR, P., 1971 — Focal mechanisms and tectonics of New Guinea-New Hebrides region. *EOS,* 52(4), 279.

40 new focal mechanisms have been determined for earthquakes in the New Guinea-New Hebrides region. The Pacific and Australian plates are converging in a northeast-southwest direction. The Australian plate underthrusts the Pacific plate to the northeast under the Solomon Islands and New Hebrides, and the Pacific plate underthrusts the Australian plate to the southwest under northwest New Guinea. The relative motions of these plates near the Bismarck Arch. are modified by the presence of at least 3 additional small plates. The South Bismarck plate (best defined) underlies the southern part of the Bismarck Sea. It is bounded on the north by an east-west belt of seismicity at about 3°S that defines a left-lateral strike-slip fault. The New Britain arc forms the southern boundary, where the Solomon Sea floor underthrusts the South Bismarck plate to the northwest. There is some evidence for southwest underthrusting of the South Bismarck plate beneath northeast New Guinea. Focal mechanism data provide a consistent pattern of relative motions of these 3 small plates and demonstrate that plate tectonics is applicable even for regions with dimensions of only a few hundred kilometres.

13-b-45 JONGSMA, D., 1970 — Tectonic evolution and submarine topography of Milne Bay, T.P.N.G. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

Study of the bathymetry and continuous seismic profiles of Milne Bay shows a downward movement of the floor of the bay during Plio-Pleistocene and Quaternary time. The bay is a graben with steep-sloping, fault-controlled margins. The trend of a submarine canyon off the East Cape Pen. conforms with the structural trend on the D'Entrecasteaux Is. This trend is almost perpendicular to the main east-west lateral shearing trend of the region.

Tectonic activity associated with the Owen Stanley fault lineament and the Pocklington shear zone resulted in an *en echelon* series of rising and sinking fault blocks in the Milne Bay region. Ultramafic upper mantle material, risen during collision of the simatic oceanic material with the sialic core of Papua may underlie the Milne Bay graben structure and be sinking at present. (Auth.)

13-b-46 KARIG, D. E., 1971 — Origin and development of marginal basins in the western Pacific. *J. geophys. Res.,* 76, 2542-61.

Semi-isolated basins and series of basins of intermediate to normal oceanic depths behind island arc systems are termed marginal basins, and are believed to be extensional in origin. Marginal basins, although differing in size and amount of sediment fill, are all underlain by oceanic crust, and can be divided into actively spreading inter-arc basins and older inactive basins. The inactive basins are grouped on the basis of age as reflected by crustal heat flow; inactive basins with above-normal heat flow are apparently younger than those with normal heat flow. The Coral Sea basin is an example of an inactive marginal basin with normal heat flow. Volcanic-tectonic rift zones with associated silicic tuffs are found in the tectonic position of inter-arc basins in some continental trench-arc systems and are thought to have been formed by a similar extensional process. Large-scale crustal expansion and demonstrable trench migration imply displacement of the Benioff zone. However, the portion of the Benioff zone shallower than 150 km, and lying between the volcanic chain and the trench, remains relatively undeformed along the trend of arc systems in which the dip of the deeper segment of the Benioff zone changes markedly. Geometric relationships suggest that, as the inter-arc basin opens, the trench is forced to migrate and the Benioff zone is flattened, except in areas where crust can be consumed in a second trench behind the extensional zone. Active extension is restricted to arc systems with earthquakes deeper than about 350 km. The available data can be explained by a thermal diapir of shear-heated mantle material, buoyantly rising beneath the inter-arc basin from the upper surface of the underthrust lithosphere. Hydrostatic forces associated with such a diapir are felt capable of overcoming the compressional forces in the mantle produced by shearing along the upper surface of the lithosphere and by the bending of the lithosphere. The existence of low-density, high-temperature upper mantle is indicated by the lack of a large gravity anomaly over the shallow oceanic crust of the inter-arc basin, by high heat flow there, and by anomalously high attenuation of shear waves passing through the upper mantle beneath the extensional zone. (Auth./W.M.)

13-b-47 KING, L. C., 1967 — THE MORPHOLOGY OF THE EARTH (2nd Edn). *Edinburgh, Oliver & Boyd,* 720 pp.

A tectonic and stratigraphic reconstruction indicates the Australia-New Guinea landmass assumed its present position relative to southeast Asia between the Triassic and early Cainozoic, possibly by early Cretaceous. Total thickness of Mesozoic strata in New Guinea is 4800 m, with continuous Cainozoic sedimentation until mid-Oligocene when the coast and offshore region shallowed with much folding. The main Cainozoic eugeosyncline lies in north New Guinea, and a southern syncline is recognized only around Port Moresby as existing from Eocene to the end of the Pliocene. The ancestral forms of the present ranges were formed at the end of the Tertiary. The main deformation occurred in late Pliocene to early Pleistocene, but began in the Miocene and is still continuing.

New Guinea is considered part of the Australian continental block, flanked to the north and northeast by sub-Recent andesitic volcanoes. The Bismarck-Solomon-New Hebrides group is thought not to be an island arc, but a sheared distorted continental rim fold chain. (W.M.)

13-b-48 KLOMPE, H. F., 1961 — Pacific and Variscian orogeny in Indonesia: A structural synthesis. *Proc. 9th Pacif. Sci. Cong., Thailand,* 12, 76-115.

Tertiary and post-Tertiary tectonism in Indonesia, Malaysia, and West Irian is discussed. Tectonic features in northwest Australia and eastern New Guinea, and the effect of the Variscian orogeny in Australia and the southwest Pacific, are outlined. A new geotectonic evolutionary pattern in Australia and southeast Asia is summarized. (W.M.)

13-b-49 KRAUSE, D. C., 1965b — Equatorial shear zone (abstract only). *Trans. Amer. geophys. Un.,* 46, 159.

Broad, left-lateral, equatorial shear belts of east-west trend exist in the Atlantic and western Pacific Oceans. Deformation is generally confined between the equator and a great circle inclined to the equator by 12°. It is proposed that the second great circle represents a Mesozoic equator for a rotational north pole near lat. 78°N, long. 120°E, and that the pole shift to its present position is related to the equatorial shear. A postulated left-lateral displacement of 2800 km is shown by relationships in Australasia, the Atlantic Ocean, and Africa, and the relation of North America to South America. Major tests for the hypothesis are the establishment of the displacement in Africa and in the ocean floor near lat. O°, long. 150°W. The hypothesis also establishes: (1) relative ages for the mid-oceanic rises, (2) a reason for the assumed continental drift of India, and (3) an insight into the development of island arcs and trenches. The hypothesis is compatible with other postulated large-scale geologic processes such as mantle convection currents and continental drift, which can proceed independently. (Auth.)

13-b-50 KREBS, C. I., 1961 — NEW BRITAIN: A GEOMORPHOLOGICAL STUDY IN CONTINENTAL DRIFT. *Copenhagen, Auth.,* 35 pp.

It is contended that the present arcuate shapes of New Britain and the Moluccas are due to impact from a north-migrating Australian continental block which includes the island of New Guinea. As a consequence of this collision, New Britain is dislocated, stretched, bent, and tilted. Structural, tectonic, volcanic, seismic, stratigraphic, and geomorphic data on the south and southwest coast of New Britain are cited in support of this thesis. (W.M.)

13-b-51 KROPOTKIN, P. N., & SHAKHVARSTOVA, K. A., 1965 — Geologicheskoye strayenize Tikhookeanskogo podvizknogo poyasa (Geology of the Pacific Ocean mobile belt, in Russian). *Trudy geol. Inst. Mosk.,* 134, 1-366.

Descriptions are given of the main features of the structure and evolution of the Pacific Ocean mobile belt; tectonics of its northwest sector; tectonics of the Japanese islands; problems of the origin of the Japan Sea and tectonics of adjacent areas of East Asia; geology of the South China Sea, Taiwan, the Philippines, Indonesia, and New Guinea; geology of the basins and islands of Melanesia, New Caledonia, New Zealand, and the Tasman Sea. The tectonics of the Pacific Ocean mobile belt are attributed to movements in subcrustal layers, and the magmatism, metallogenetic problems, and the oil and gas possibilities of the belt are discussed. (Geophys. Abs./W.M.)

13-b-52 LINDEN, W. J. M. van der, 1966 — Southwest Pacific Ocean. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF OCEANOGRAPHY, Encyclopedia of Earth Sciences Series, Vol. 1, 846-52. *N.Y., Reinhold.*

The southwest Pacific Ocean contains several structural and depositional basins and submarine plateaux, punctuated by several elongate trenches of considerable depth and numerous terrestrial and reef islands and shoals. Most of the area lies inside (on the continental side of) the 'andesite line'. The tectonic evolution of the region is traced from the Palaeozoic to the present, and the development of present features explained in terms of a general fragmentation and northeasterly drift of an ancestral Australian landmass of which all the southwest Pacific continental islands and blocks formed part. (W.M.)

13-b-53 LINDEN, W. J. M. van der, 1969 — Rotation of the Melanesian complex and of west Antarctica: a key to the configuration of Gondwana. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 6, 37-44.

An anticlockwise rotation of the Melanesian complex with respect to Australia and an anticlockwise rotation of west Antarctica with respect to east Antarctica, both caused by active sea-floor spreading emanating from mid-ocean ridges, enables a reconstruction of Gondwanaland without the need to accept sunken land bridges. In this reconstruction Gondwana consisted of one Precambrian cratonic shield fringed by a continuous double-geosynclinal belt of Palaeozoic and Mesozoic age. The rotation proposed ties in with the evolution of the Scotia Arc and may also explain the anomalous structural position of the Ellsworth Mts. (Auth.)

13-b-54 MARSHALL, P., 1912 — *Oceania. In* STEINMANN & WILCKENS (Eds) — HANDBUCH DER REGIONALEN GEOLOGIE, Vol. 7, Pt 2, 1-36. *Heidelberg, Winters.*

Bougainville is one of the islands defining the western limits of Oceania, which extends east to the Sandwich Is. It is a long narrow island with high peaks, one of which is the active volcano Bagoma (Bagana). It lies in one of the major tectonic lineaments separating Oceania from continental Australia, a line which is characterized by active or recently-active andesitic volcanoes associated with uplifted fringing coral reefs. This line continues westward through New Britain and the north coast of New Guinea, and southeasterly through the New Hebrides. This line is thought to represent the margin of the Pacific Basin. (W.M.)

13-b-55 MITCHELL, A. H., & READING, H. G., 1971 — Evolution of island arcs. *J. Geol.*, 79, 253-84.

Modern active island arcs and their surroundings consist of 2 main physiographic zones—a volcanic ridge or arc and a submarine trench. Rocks in island arcs fall into 3 groups, the origin of which can be interpreted in terms of plate tectonics and of geological processes in the 2 zones and surrounding ocean floor. The groups are (1) volcanic arc deposits, consisting of undeformed subaerially-erupted volcanic rocks, block-faulted volcanic and volcaniclastic rocks, diorites, granites, and low-pressure/high-temperature metamorphic rocks; (2) submarine trench deposits, consisting of trench-fill sediments, represented by thick successions of quartz-deficient turbidites and pelagic sediments, and high-pressure/low-temperature metamorphic rocks and melange deposits indicating a Benioff zone; (3) ocean-floor oceanic crustal rocks consisting of tholeiitic lavas, spilites, gabbros, ultrabasic rocks, and pelagic sediments, and including fine-grained turbides rich in tholeiitic detritus. Most inland arcs originate on oceanic crust and have resulted from intermittent descent of lithosphere along older Benioff zones. Since the Permian, some lithospheric plate margins have remained near present island arcs. In the Papua New Guinea islands region, ocean floor material and deep trough sediments are recognized in low-pressure/high-temperature metamorphic environments. (Auth./W.M.)

13-b-56 MOBERLY, R., 1971 — Youthful oceanic lithosphere of marginal seas, western Pacific. *12th Pacif. Sci. Cong., Canberra,* Abs Vol., 393.

Evidence from geomagnetic patterns and drilling shows that the suboceanic lithosphere formed mainly along the oceanic rise system. However, lithosphere on the concave side of island arcs did not form on, and spread from, the oceanic rises.

Samples obtained by the Deep Sea Drilling Project confirm a youthful crust flooring marginal seas behind arcs.

Spontaneous sinking of lithosphere plates into less dense asthenosphere at island arcs results in slabs that plunge under trenches and arcs at angles steeper than the plane of earthquakes. Consequently, trench and arc migrate seaward against the retreating line of flexure where the lithosphere sags into the asthenosphere. Warmer parts of the asthenosphere, pushed aside by the descending slab, rise to become new lithosphere in the extensional region behind arcs. Geometrical restrictions of plate tectonics are revised to include both oceanic rises and marginal seas as regions in which new lithosphere is formed.

A series of maps shows the evolution of the western Pacific during the past 45 m.y. Major events resulted from the relative movements of the Australian, Asian, and main Pacific plates, and the effects of shear on the arcs and smaller plates. Advances of the Aleutian, Kurile, Japan, Bonin, and Mariana arcs are shown. An arc that migrated southward, forming the Caroline Basin in its wake, now is mainly welded against the leading edge of the Australian block in northern New Guinea, but its remnants extend from Halmahera into the Bismarck Arch. The deformation of the Solomons ahead of the Ontong Java Plateau, of thick crust, contrasts with the migration of the New Hebrides and Tonga-Kermadec arcs in the Fiji salient, where they generated the Fiji Plateau and the Lau-Havre and South Fiji basins. (Auth.)

13-b-57 PACKHAM, G. H., & FALVEY, D. A., 1971 — An hypothesis for the formation of marginal seas in the Western Pacific. *Tectonophysics,* 11(2), 79-109.

Most of the world's marginal seas are concentrated along the western side of the Pacific Ocean. They have the same types of continental margins as the ocean basins, and are usually bounded on the oceanic side by andesitic volcanic arcs and trenches. They also contain microcontinental blocks and have abyssal plains. The shallower plains occur in the narrower seas. Mid-ocean ridges are absent, but the seas contain seamounts, seamount chains, and fracture zones. Geological evidence indicates that most of the marginal seas date from early to late Tertiary and appear to have been formed by rifting. The crustal structures, from seismic refraction studies, indicate that the crustal layering is similar to that in ocean basins, but the sediment layer is thicker.

High regional gravity anomalies over marginal seas can be explained by the elevation of the sea floor owing to non-isostatic uplift or by an eclogite layer developed during outward migration of the arc and formed by phase transformation in the descending basaltic oceanic crust. New oceanic crust, assumed to be developed during the outward migration of the arcs, is formed immediately behind the andesitic arc by a process analogous to that on mid-oceanic ridges. The development of the new oceanic crust is attributed to mantle upwelling behind the arc as a result of major readjustments to plate boundaries. In the western Pacific this readjustment was occasioned by the collision between India and Eurasia and by rifting apart of Australia and Antarctica. Small basins developed by this process may be common within tectonic belts. They could, after the accumulation of about 14 km of sediments, be deformed with the accompanying arc and trench system into paired metamorphic belts. (Auth.)

13-b-58 RADE, J., 1953 — Tectonics and associated volcanic activity in the central part of Australian New Guinea. *Aust. J. Sci.,* 15, 115-7.

The distribution of volcanoes in central Papua is related to deep-seated crustal fractures developed during the Pleistocene. Volcanoes are developed at the intersections of the two systems of fractures trending west-northwest and north-northwest. These directions are approximately parallel to the present central New Guinea tectonic mountain chain and to the late Palaeozoic major structural trends in north Queensland as expressed in the Princess Charlotte Bay graben. The deformation in the fold mountain chain of New Guinea is related to folding events in Queensland on the evidence of style of folding. (W.M.)

13-b-59 Rade, J., 1954 — Geotectonics and volcanoes of Australian New Guinea. *Aust. J. Sci.*, 17, 83-7.

The origin of the northwest lineations of the Ramu-Markham depression, the Adelbert-Finisterre-Saruwaged Ras, the Bismarck Arch. and St George Str., and the alignments of active, dormant, and extinct volcanoes in the Bismarck Arch. and eastern Papua, are considered in terms of the geotectonic theory of 'Mobilismus', which involves crustal sculpturing by hyporheal construction and bathyrheal destruction.

Bathyrheal flow to the southeast is postulated, and consequent torsional stresses gave rise to the deep-seated fractures in the thin Earth's crust which are the attributed cause of the Ramu-Markham boundary faults, the alignment of centres of eruption in the inner volcanic arc of the Bismarck Arch., and the fragmentation of the non-volcanic arc of the Bismarck Arch. and of the Adelbert-Finisterre-Saruwaged Ras during the Pleistocene and Recent. Other consequences of this bathyrheal flow are the southeast migration of volcanic centres with time, the southeast migration of the Bismarck Islands, and the attenuation of the 'tail' of eastern Papua. (W.M.)

13-b-60 Ringwood, A. E. (Ed.), 1967 — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS, UPPER MANTLE PROJECT: SECOND AUSTRALIA PROGRESS REPORT, 1965-67. *Canberra, Aust. Acad. Sci.*, 211 pp.

Brief papers outline recent, current, and proposed research in many fields, including seismology, physics of the upper mantle, gravity, magnetism, geothermy, petrology, geochemistry, and tectonics. Papers on investigations in or around Papua New Guinea are abstracted separately (entries 02-c-13, 02-d-16, 09-a-1, 09-b-7, 09-b-27, 13-b-69, 16-b-10, 16-b-13, 16-b-28, 16-c-7, and 16-c-11). (W.M.)

13-b-61 Rod, E., 1966 — Clues to ancient Australian geosutures. *Ecl. geol. Helv.*, 59, 849-83.

The present rigid Australian Platform consists of at least 24 crustal blocks welded to form a solid assembly. Today, the ancient boundaries of the blocks, the geosynclines, geofractures, and geosutures are inactive and fossilized. However, the facts indicate great horizontal movements along the large geosutures in pre-Mesozoic time. Evidence for important lateral displacements of crustal blocks relative to each other is readily found. In several cases a cumulative horizontal displacement of a few hundred kilometres can be proved or strongly suggested.

These ancestral geosutures are characterized by a wide belt (up to 60 km) of large-scale strike-slip faults which between them enclose numerous huge slices of shattered rock and crushed wedges. Some of the rocks within the fracture belt might be slightly metamorphosed. Intensive shearing and silicification is widespread. As a general rule areas where ancient geosutures intersect were the most likely sites for rich mineralizations.

A palaeotectonic map for the close of the Palaeozoic shows some tentative restoration of the minor crustal blocks which were torn off from the eastern side of the Australian Platform during the late Jurassic or early Cretaceous. Some of the geosutures found in New Zealand and New Guinea were originally, in their primeval stage in pre-Mesozoic time, integral parts of Australian geosutures. The perfect fit of the traces of the ancient geosutures combined with the matching facies provinces, peridotite belts, and old structural axes, are further proof for the correctness of the postulated reconstruction. (Auth.)

13-b-62 Schuppli, H. M., 1946 — Oil basins of the East Indian Archipelago. *Bull. Amer. Ass. petrol. Geol.*, 30, 1-22.

The oilfields of the Tertiary basins of Sumatra, Java, and Borneo produced more than 1 billion barrels of oil to the end of 1940. The oil has been derived almost exclusively from sands of Miocene and Pliocene age, but commercial accumulations were discovered in Eocene beds in 1940. The Boela field, in Ceram, probably produces Triassic oil, accumulated in overlapping sands of Plio-Pleistocene age.

Rather gentle to moderately steep anticlines are the traps for accumulation of the oil. Stratigraphic traps have not yet been explored. The Tertiary geotectonics of the East Indian Arch. is complex. 2 major geosynclinal belts, folded into orogenes by subsequent mountain-building phases, meet in this area. They are the circum-Asiatic geosyncline, part of the world-wide Tethys geosyncline, and the Australo-Pacific geosyncline through New Guinea, Halmahera, and the Marianas. The Tertiary basins of Borneo are outside these 2 belts and lie within, and near the edge of the Asiatic continent, constituting intra-continental geosynclines. A geotectonic sketch map shows the location of the oil-producing areas of the East Indian Arch. (Auth./W.M.)

13-b-63 SMITH, J. G., 1965 — Orogenesis in western Papua and New Guinea. *Tectonophysics,* 2, 1-27.

The orogenic phase in the diastrophic evolution of western Papua New Guinea began in the upper Miocene and reached its culmination during the Pliocene and Pleistocene. Orogenesis was characterized by the uplift and partial inversion of the Mesozoic-Tertiary Papuan geosynclinal system to form the New Guinea cordillera and was accompanied by the formation of a Pliocene exogeosynclinal trough, andesitic volcanism, and development of 2 distinct types of folding which are reflected by the morphology of the main New Guinea cordillera and the Papuan foothills.

The heart of the orogen, the Kubor-Bismarck cordillera, consists of a system of large horst-like anticlinoria with cores of crystalline basement rocks. Their development was secular and their fundamental tectonic framework was established during the Mesozoic and early Tertiary taphrogenic phases of diastrophism. The anticlinoria are the primary manifestation of oscillatory vertical movements of the Earth's crust and are called primary folds.

On the other hand, the structure of the Papuan foothills is characterized by a linear belt of smaller continuous folds and associated faults that are typical of the 'foreland' type. The foreland folds formed during a restricted Plio-Pleistocene orogenic episode as the result of gravitational gliding off the southern flank of the rising Kubor-Bismarck cordillera. Because they are subordinate to the anticlinoria forming the heart of the orogen, both in size and duration of movement, the foreland structures are called secondary folds. (Auth.)

13-b-64 STILLE, H., 1944 — Geotektonische problemes des Pazifischen Erdraumes (Geotectonic problems in the Pacific region, in German). *Abh. preuss. Akad. Wiss.,* 11, 1-77.

The tectonic evolution of the Pacific Ocean and surrounding continental and island arc blocks is traced in a framework of 2 parental continents fragmenting and drifting to their present positions. New Guinea is thought to be part of the Australian Block and the volcanic-seismic belts of New Guinea are considered a separate entity from the mainland and part of the circum-Pacific rim zone. (W.M.)

13-b-65 SUESS, E., 1909 — DAS ANTLITZ DER ERDE (THE FACE OF THE EARTH, translated by H. B. C. SOLLAS). *Oxford, Clarendon Press,* Vol. 4, 673 pp.

The Australian Arcs are recognized north and east of the Australian continent. The First Australian Arc is the innermost and embraces two sub-arcs: one through New Guinea-Louisiade-New Caledonia-New Zealand, and another through New Ireland-Solomons-New Hebrides. The Second Australian Arc is formed by Caroline, Gilbert, Ellice, and Fiji Is. The Third Australian Arc includes Tonga, Kermadec, and northeast New Zealand.

In the First Arc, Palaeozoic and younger detrital and igneous rocks are exposed, and show evidence of several phases of deformation and uplift. The Second Arc is a chain of elevated atolls and related coralline reef masses. The Third Arc contains both reefs and landmasses. (W.M.)

13-b-66 TANNER, W. F., 1964 — The equatorial 'maximum deformation' belt. *Geol. Rdsch.*, 53(2), 779-88.

2 important structural types are distinguished for the Earth as a whole: (1) rotating blocks, such as the present Pacific block, with its associated rim of earthquake and volcanic activity; and (2) mirror-symmetric east-west strike-slip systems, such as in the area of the Caribbean Sea today. A third type, the large-scale dragfold system, is thought to develop from time to time along the margins of one of the others, especially when a reorientation occurs. Rearrangements of crustal blocks, in the various mechanisms listed above, may explain the opening and closing of major evaporite basins of the past. (Auth.)

13-b-67 THOMPSON, J. E., 1965a — Some new ideas in pre-Tertiary structural and stratigraphic relationships between Australia and New Guinea. *38th ANZAAS Cong. Rep., Hobart* (listed by title in *Aust. J. Sci.*, 28, 312).

This is known by title only.

13-b-68 THOMPSON, J. E., 1965b — Geotectonics of the New Guinea mobile belt. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT, 1960-65. *Canberra Aust. Acad. Sci.*, 112-3.

Structural units of the New Guinea mobile belt are mostly products of Pliocene to Recent lateral and vertical conflicts between the pre-Mesozoic Australian continent and the Pacific oceanic crustal plate. Intrusives and extrusives of granodioritic to dioritic composition which characterize the orogenic zones of the New Guinea mobile belt may be the products of anatexis of metasediments of sialic derivation in the roots of segments of the Tasman orthogeosyncline detached by tension after completion of the final orogenic phase. The intrusives (Jurassic to Recent) are the important mineralizing agencies in the mobile belt.

The active sialic components in which these magmas were generated are roughly aligned in 2 or 3 zones which have a recurrent history of intrusion, emergence, erosion, sub-aerial volcanism, and lacustrine deposition: (1) the main cordillera, extending southeast from the Eastern Highlands to about 149°E has been displaced to the northeast and is represented by the D'Entrecasteaux Is and the larger islands of the Louisiade Arch.; (2) a more fragmentary zone passes through the Solomon chain and may extend from Manus to Fiji. It appears to contain discrete segments or cells of sialic crust flanked on the northeast and southwest by oceanic crust and separated from each other by lineaments which are now seaways. These sialic segments may have had a prolonged orogenic history, started by the anatectic generation of magma from deep metasediments and later by recycling of earlier products of anatexis to yield the dioritic plutons and more acid differentiates which are emplaced at high levels or expelled as andesitic pyroclastics. Throughout the orogenic history of this sialic zone, conflict between the Pacific oceanic crustal plate and the Australian continental mass has resulted in fragmentation of the zone by left-lateral, strike-slip, displacements along northeast-striking lines of weakness. The northeastern limit of translation of the sialic segments would be the margin of the Pacific oceanic plate, along which they would be realigned and streamed out; (3) a zone intermediate in age and position between the others includes New Britain and the chain of active volcanoes off north New Guinea.

Along the northeast (leading) edge of these orogenic zones, the oceanic crust has been raised and in places imbricated along profound fault zones by a combination of underthrusting and buoyancy of the sialic wedge. The Papuan Basic Belt is an elevated segment of oceanic crust. Along the south or southeast (trailing) edge of the orogenic zones, deep graben structures formed in oceanic crust were filled by a flood of clastic sediments derived from the orogenic zone. (Auth.)

13-b-69 THOMPSON, J. E., 1967c — Geotectonic development of Papua-New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC

UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT, 1965-67. *Canberra, Aust. Acad. Sci.*, 186-7.

New Guinea straddles the contact zone between oceanic crust and continental crust. The zone approximates the axis of the Aure Trough, passes between the New Guinea highlands and the Owen Stanley Ra., and trends along the north flank of the highlands into West Irian. Since the Permian, 2 major marine transgressions inundated a continental platform area in southwest Papua. The first (Lower Cretaceous) was very wide, possibly global, and at least a third of continental Australia was covered by shallow sea; the second (lower Miocene) was less extensive, but is identified from extensive thick limestones in southwest Papua.

In the lower Miocene a new landmass, corresponding to the present Owen Stanley Ra., emerged orogenically. It was composed initially of oceanic crust which had arched, then thrust from the northeast over a thick accumulation of Cretaceous and older continental slope sediments. These sediments were metamorphosed, and from lower Miocene to Recent time have been rising to form the Owen Stanley Ra., erosion of which has supplied much clastic sediments to flanking eugeosynclinal basins. As the block rose to restore isostatic equilibrium, the adjacent thrust slice of oceanic crust to the northeast (Papuan Ultramafic Belt) sank.

The geological history of Papua New Guinea may be summarized as follows: (1) *Late Cretaceous to upper Miocene* — deposition of red shale, fine-grained pink limestone, and chert on the ocean floor beyond the reach of terrigenous clastic sediment. Submarine volcanism with the outpouring of pillow lavas and increase of silica concentration in sea water; (2) *Upper Eocene/Oligocene* — low arching of ocean floor beyond the limit of terrigenous clastic sedimentation; mass slumping of oceanic sediments and possibly also of pillow lavas, dolerite, and gabbro of the upper part of oceanic crust; (3) *Oligocene* — crestal rupturing of arched oceanic crust and thrusting of the northeast limb of the arch towards the Australian continent and over Mesozoic and older sediments accumulated at the base of the continental slope; (4) *Oligocene to lower Miocene* — metamorphism of Mesozoic and older continental slope sediments by the weight of the thrust slice of oceanic crust, compression, frictional heat, and magmatic heat; (5) *Lower Miocene* — metasediments reacted as a homogenous crystalline block and rose isostatically using the original thrust plane as a glide plane. The rapid emergence of the metamorphic block turned up the leading edge of the thrust plate of oceanic crust and exposed deep crust or upper mantle material (Papuan Ultramafic Belt); (6) *Lower Miocene onwards* — continued emergence of the metamorphic block and tight folding and faulting of Eocene and Upper Cretaceous sediments. Complementary northeasterly downward sliding of oceanic thrust plate as part of regional isostatic adjustment. Generation of granodiorite magma from anatexis of metamorphosed pre-Tertiary sediments and rise of magma. (Auth.)

13-b-70 WELLMAN, H. W., 1971 — The eulerian pole for the Melanesian suture. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 384.

Belts of rapid relative movement on the Earth's surface are termed sutures. The more rigid inter-sutural areas are termed cells. The total horizontal relative movement for any particular suture between any two moments of time can be expressed as a specific rotation about a specific pole. The relation is Euler's theorem, and an eulerian pole has a rotation as well as a position. For any part of the Earth's surface where there are more than 2 cells and more than 2 sutures, the eulerian pole for any one suture can be determined from the eulerian poles of the adjoining sutures.

The Melanesian Suture (Sm) is the tectonic line from New Guinea to Macquarie I. For the area considered there are 3 adjoining sutures: the South East Pacific Rise (Se), the Antarctic tectonic line (Ss), and the oceanic rise between Australia and Antarctica (Sa).

The rotation rate for the eulerian pole of Ss is thought to be negligibly small and Ss is neglected. The eulerian pole for Sm can thus be determined indirectly from the eulerian poles of Se and Sa, which are defined by ocean-floor spreading data. The eulerian pole for Sm can be directly and independently determined from the relative horizontal movement on the New Zealand Alpine Fault Zone (AFZ).

Number of Suture	Time movement in $\log_{10}$ years 2nd	1st	Rotation Rate/yr in $\log_{10}$ years	Lat.	Long.
Ss	—	—	?8.5	?60 °S	?120°E
Se	5.9	7	—7.85	10°S	130°E
Sa	5.9	7	—7.72	60°S	120°W
Sm (Se+Sa)	5.9	7	—7.62	37°S	142°W
Sm (AFZ)	0–1	1.5–4.0	—7.5–0.3	57°S	170°W

The difference in the rotational rates for the eulerian pole for Sm determined directly and determined indirectly are less than the observational errors. However, the position of the pole for the $10^{5.9\text{ to }7}$yr time interval is significantly different from its position for the $10^{0\text{ to }4}$yr time interval, and the Sm eulerian pole is inferred to have migrated southeast at the rapid rate of $10^{-6.8}$yr. Rapid southeastward migration of the Sm pole is in agreement with New Zealand's geological history, in particular with the southward movement of andesitic volcanicity and the $10^{5.5}$yr origin for the mountains of both islands.

For the whole length of Sm there is a direct relation between the local rate of decrease of surface area and the local rate of seismic energy release, the rate of andesitic volcanicity, and the number of deep and intermediate focus earthquakes. (Auth.)

13-b-71 Wiebenga, W. A., Finlayson, D. M., & Cull, J., 1971 — Structure of the Bismarck Archipelago. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 367.

New Britain and New Ireland, being in a transition zone between oceanic and continental crust, are suitable testing areas for the structures and mechanisms postulated for the Pacific margins. Both islands were formed by compressional stresses with deposition of marine volcanics and intrusions of basic to intermediate volcanic rocks on a subsiding crust. Development started in New Britain about 15 m.y. earlier than in New Ireland. South of New Britain and New Ireland a trench has been formed by crustal buckling and an associated active seismic shear zone dips steeply towards the north and northeast.

Crustal investigations indicate depths to the mantle under the Solomon and Bismarck Seas of about 10-20 km and depths of up to 35 km of high-density crust in the New Britain-south New Ireland region. Since the late Tertiary, New Ireland and the Gazelle Pen. have been subjected to block-faulting, graben-forming, and the development of volcanic intrusions. It may be that in this region, since the Tertiary, on the northern margin of a north-moving Australian 'plate' and in the shadow zone of a northwest-moving Pacific 'plate', active crustal buckling and thickening have been leading to the formation of continental-thickness crust. (Auth.)

13-b-72 Wiebenga, W. A., Finlayson, D., Cull, J., Webb, J., & Furumoto, A. S., 1971 — The Bismarck Archipelago, a structure formed by tensile stresses. *12th Pacif. Sci. Cong., Canberra,* suppl. Abs.

New Britain and New Ireland form the boundaries between 3 major units: the Bismarck Sea, the Solomon Sea, and the Ontong Java Plateau. In a larger context the structures and mechanisms deduced in this area form constraints for geological theories on the southwest boundary of the Pacific plate.

In early Tertiary or late Cretaceous time tensile stresses split the crust while rising mantle material filled major rifts and formed the backbone of New Britain. The outflow of material resulted in a collapse of the northwest boundary of the oceanic Solomon Sea crust, showing up as a ribbon of thick crust, trench formation bordering the southeast boundary, and a steeply dipping seismicity zone. Cross or transform faulting is superimposed on the rifting. Present activity continues in the Bismarck Sea where shallow seismicity zones coincide with an intrusive body in a rift, transform fault, and graben zone. At a later stage, possibly at the end of the Eocene, major rifting by tensile stresses developed in a northeast direction and resulted in the present structure of New Ireland and the graben structure between New Ireland and New Britain.

The Ontong Java Plateau may or may not be part of the Pacific plate, but the crust has a typical continental character, representing a sunken continental crust under 2.5 km of water, at present in near-isostatic equilibrium. This crust is intensively rifted. It is suggested that the quantity of partly-molten mantle material flowing to the surface explains the downward movement of crust and the resulting marine transgression. The Solomon Sea crust is oceanic in character, and stable. The Woodlark I. ridge, with its associated volcanism and seismicity, cannot be considered as a spreading centre, but represents a cross or transform fault. The Bismarck Sea crust may be considered as a sub-continental crust subject to the same processes as the Ontong Java Plateau. (Auth./W.M.)

13-b-73 WRIGHT, J. B., 1966 — Convection and continental drift in the southwest Pacific. *Tectonophysics,* 3, 69-81.

Structural units and petrographic provinces are reviewed and correlated, and linear belts of tensional and compressional character distinguished. Following the hypothesis that compressional zones occur over downturning convection currents and dilational features over upwelling ones, the following conclusions are drawn:

(1) A subsidiary convective well must have existed during part of the Tertiary within the elongate area delimited by New Zealand, New Caledonia, and southwest New Guinea on the south; New Britain, Solomons, New Hebrides, and Fiji on the north; and by the Kermadec-Tonga chain on the east.

(2) The Alpine fault displacement and growth of the Tasman Basin were interrelated processes consequent upon the disposition of two convection vectors: one, moving away from eastern Australia and separating the New Zealand landmass from it, met the other, separating the New Zealand landmass from Antarctica, at a high angle: adjustment of these conflicting forces resulted in the Alpine fault fracture.

(3) New Zealand was probably once part of Antarctica. Some evidence consistent with this idea is reviewed. (Auth.)

13-b-74 ZWIERZYCKI, J., 1929 — On tectonic movements in the East Indian Archipelago. *Proc. 4th Pacif. Sci. Cong., Batavia,* 1, 279-81.

The chronology and mechanisms of the tectonic disruptions in the East Indies-New Guinea area, which gave rise *inter alia* to the Sepik-Markham-Huon Gulf depression, are considered. A series of deformations is recognized, starting late in the Palaeozoic and repeated in the Cretaceous and Miocene. Folding and release block-faulting are the main mechanisms. A geotectonic map of the East Indies is included. (W.M.)

(c) GEOMETRIC AND KINEMATIC ANALYSES

See also entry 12-f-2.

13-c-1 POWELL, C. McA., 1956b — Folding at Port Moresby. *38th ANZAAS Cong., Hobart,* Sec. C. Abs.

Folding at Paga Point, Port Moresby, occurs in medium to fine sandstones which have been silicified and now have the appearance of cherts. The folding is part of a large soft sediment slide which moved from the northeast and in which sediments about 100 m thick are involved. The style of folding varies, but tends to be concentric upslope and more similar towards the toe where the strata are highly contorted and refolded. (Auth.)

14 VOLCANOLOGY

(a) Descriptive

See also entries

01-a-34	02-d-10	05-c-29	12-i-34
01-a-39	02-d-40	05-c-37	12-i-36
01-b-60	02-d-45	05-d-9	14-b-1
01-b-66	02-d-46	05-e-6	14-b-2
02-a-10	02-d-51	05-e-12	15-a-8
02-a-18	02-d-53	11-b-1	15-a-13
02-d-9	05-a-52	12-c-8	

14-a-1 Anonymous, 1887d — (Ash fall at Finschhafen.) *Nature,* 36, 136.

This reports a fall of volcanic ash at Finschhafen on 5 February 1887. The details are identical with entry 14-a-51 about an ashfall supposedly on 5 February 1876. (W.M.)

14-a-2 Anonymous, 1887g — Aschenfall in New Guinea (Ash fall in New Guinea, in German.) *Ann. Hydrog., May* 1887, 210-1.

Visibility at Finschhafen was poor on 2 and 3 February, and haloes around the moon and sun were noted. Falls of light grey ash were recorded on 5 February during a calm in the seasonal winds. Fluctuations in wind direction made projection to source impossible, but it is thought Lesson or Manam I. is the most likely. Slight seismic shocks were felt on 3 February. (W.M.)

14-a-3 A.A.A.S. Seismological Committee, 1902 — New Britain earthquake. *Rep. 9th Australas. Ass. Adv. Sci. Cong., Hobart,* 42.

An anonymous report from the Melbourne *Age* of 10 October 1900 describes the effects of the seismic disturbance in New Britain on 11 September 1900. (W.M.)

14-a-4 Allied Forces Southwest Pacific Area (1941-45), Allied Geographical Section, 1943ag — Locality study of Cape Gloucester, New Britain. *Terrain study Allied geogr. Sec.,* 25.

The northern slope of Mt Talawe (800 m) is gentle, with numerous outcrops of basalt. Talawe and Tangi (760 m) are reported to have been in violent eruption 'some 50 years ago'. (W.M.)

14-a-5 Australia. Parliament, 1962 — Annual report — mineral resources. *New Guinea ann. Rep. 1960-61,* 90-3, and 235 (also issued as *Aust. parl. Pap. 100, Sess. 1962-63,* 12, 371-4, and 516.)

Increased volcanic activity is reported from Bagana and Loloru on Bougainville; The Father, Lolobau, Garbuna, Talasea, and Langila on New Britain; Long Island and Mt Lamington. (W.M.)

14-a-6 Australia. Parliament, 1963 — Annual report — mineral resources. *New Guinea ann. Rep. for 1961-62,* 88-91, and 246 (also issued as *Aust. parl. Pap. 197, Sess. 1962-63,* 12, 715-8, and 873.)

Increased volcanic activity is reported from Tong I. and Tuluman in the Admiralty Is, Langila and Rabaul in New Britain, and on Ritter, Umboi, and Long Is. (W.M.)

14-a-7 Australia. Parliament, 1964 — Annual report — mineral resources. *New Guinea ann. Rep. for 1962-63,* 79-82, and 230.

Manam volcano erupted vigorously in February 1963 and The Father and Langila in New Britain have intermittently ejected fine ash and steam. (W.M.)

14-a-8 AUSTRALIA. PARLIAMENT, 1965 — Annual report — mineral resources. *New Guinea ann. Rep. for 1963-64,* 82-5, and 234.

Manam volcano was moderately active in February 1964 and violently active in April. Bagana on Bougainville was vigorously active in May 1964, and Langila in New Britain was mildly active in August 1963. (W.M.)

14-a-9 AUSTRALIA. PARLIAMENT, 1966 — Annual report — mineral resources. *New Guinea ann. Rep. for 1964-65,* 69-71, and 224.

Manam volcano activity was less than in early 1964, but Langila in New Britain showed greater activity. (W.M.)

14-a-10 AUSTRALIA. PARLIAMENT, 1967 — Annual report — mineral resources. *New Guinea ann. Rep. for 1965-66,* 94-8, and 313.

Manam volcano was active at intervals during the year, and there was an eruption of Bagana on Bougainville. Langila volcano in New Britain continued to be mildly active in the early part of the year. (W.M.)

14-a-11 AUSTRALIA. PARLIAMENT, 1968 — Annual report — mineral resources. *New Guinea ann. Rep. for 1966-67,* 95-9, and 315 (also issued as *Aust. parl. Pap.* 26, 95-9, and 315.)

Volcanic activity is noted from Ulawun (The Father) and Langila in New Britain, Bangana on Bougainville, and Manam I. (W.M.)

14-a-12 AUSTRALIA. PARLIAMENT, 1969a — Annual report — mineral resources. *New Guinea ann. Rep. for 1967-68,* 96-100, and 326.

Langila and Ulawun in New Britain, Bagana on Bougainville, Manam I., and Long I. volcanic centres were active in the previous 12 months. Considerable damage was caused by a severe earth tremor in the Kokopo area near Rabaul. (W.M.)

14-a-13 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1952b — Mount Lamington eruption. *Papua ann. Rep. for 1950-51,* 34-6 (also issued as *Aust. parl. Pap. 129, Sess. 1951-53,* 4, 809-11.)

Mt Lamington erupted with a Pelean-type eruption on 21 January 1951. Devastation was complete close to the vent, and much loss of life was reported. No more than 3 minutes' warning of the eruption was given. The effects of the blast on buildings, vehicles, and people at Higatura station are noted. It is thought the blast travelled at no greater than hurricane strength, and that temperatures about 200°C were experienced. (W.M.)

14-a-14 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1957 — Annual report — mining and geology. *Papua ann. Rep. for 1956-57,* 49-51, and 147 (also issued as *Aust. parl. Pap. 21, Sess. 1956-58,* 7, 492-4, and 580.)

Renewed seismic activity in the D'Entrecasteaux Is, centred on the volcanic area on the eastern end of Fergusson Is, is reported. Earth tremors associated with tectonic adjustments were recorded, particularly from the north coast. (W.M.)

14-a-15 AUSTRALIA. TERRITORIES, DEPARTMENT OF, 1959 — Annual report — mining and geology. *Papua ann. Rep. for 1958-59,* 49-50 and 141 (also issued as *Aust. parl. Pap. 49, Sess. 1960-61,* 3, 214-15, and 306.)

Increased seismic activity is reported from volcanic centres in the D'Entrecasteaux Is. (W.M.)

14-a-16 BAKER, G., 1946 — Preliminary note on volcanic eruptions in the Goropu Mountains, southeastern Papua, during the period December 1943 to August 1944. *J. Geol.,* 54, 19-31.

The phenomena and effects of new volcanic vents of the explosive type in the Goropu Mountains are described from reports by local observers. Petrological examinations of lapilli from the vents indicated that an andesitic volcano has broken through ultrabasic rocks forming part of the Owen Stanley Ra. (Auth.)

14-a-17 BEST, J. G., 1956 — Investigations of recent volcanic activity in the Territory of New Guinea. *Proc. 8th Pacif. Sci. Cong., Philippines,* 2, 180-92.

The areas of New Guinea in which active or suspected active volcanic centres occur are divided into 4 groups: (a) the island chain off the northwest coast, (b) New Britain, (c) Bougainville, and (d) the Admiralty Group. Volcanic and fumarolic activity in these groups during 1952-53 is outlined. Observations are made on phenomena at Langila, Long I., several centres in St Andrew Str., and Manam I. Photographs are included. (W.M.)

14-a-18 BEST, J. G., 1957 — Preliminary report — Tuluman volcano. *In* REYNOLDS, M. A., & BEST, J. S. — The Tuluman volcano, St Andrew Strait, Admiralty Islands. *Bur. Miner. Resour. Aust. Rep.*, 33, 1-7.

2 volcanic craters emerged above sea level in St Andrew Str. in July 1954, and the parent volcano was named Tuluman. Previous activity at this locality occurred in 1884, and on 3 occasions in 1953-54. The crater has built up from the sea floor over the years, finally emerging as 2 vents from which poured steam, ash, and lava. The ash deposited downwind from the vent in both cases, and was rapidly eroded by wave action. The main product was pumice and comminuted pumice, with abundant bombs of scoreaceous to glassy material. The southeast portion of west Tuluman crater is composed of flow lava which was liquid at time of extrusion. A broad low crater was formed around both vents, and there are numerous hot springs. Further eruption is predicted. (W.M.)

14-a-19 BRANCH, C. D., 1967a — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 42 pp.

This comprises reports on observations made during 1964, each of which is abstracted separately. Observations were made of volcanic and thermal activity at Balbi, Bougainville (entry 14-a-20), at Bogana and Lake Loloru on Bougainville (entry 14-a-21), at Lake Dakataua Crater on the Willaumez Pen. (entry 14-a-22), at Manam I. (entry 14-a-23) and at Yelia in the Kratke Ra. north of Menyamya (entry 02-c-10). The effect at Rabaul of seismic sea waves generated by the Great Alaskan Earthquake of 28 March 1964 is discussed (entry 15-a-4). (W.M.)

14-a-20 BRANCH, C. D., 1967b — Mount Balbi volcano complex, Bougainville, TPNG. *In* BRANCH, C. D. — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 1-9.

The Mount Balbi volcano complex, 2600 m high, at the intersection of 3 fault-controlled valleys, consists of 6 well preserved ash craters (A to F) surrounding an amphitheatre containing a solfatara field 1.6 km across. A prominent spine of augite andesite tuff has been extruded at the southern end of the volcano complex.

The most recent eruption was probably from crater B, between 1800 and 1850, and many were killed by *nuées ardentes*. Present activity is confined to moderate fumarole activity in crater B, and strong fumarole activity on the southern slopes of crater C, where temperatures range from 76°C to 145°C, and a large volume of vapour containing steam, hydrogen chloride, sulphur dioxide, and some hydrogen sulphide is issuing under high pressure. (Auth.)

14-a-21 BRANCH, C. D., 1967c — Mount Bagana and Lake Loloru, Bougainville, TPNG. *In* BRANCH, C. D. — Short papers from the Vulcanological Observatory, Rabaul, New Britain, *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 11-5.

Thermal areas around Lake Loloru crater are more overgrown and generally more quiescent than when inspected 9 years ago. Ground and steam water temperatures mostly are lower, and there is less sulphur dioxide escaping from fissures.

Mild stable solfataric activity around the summit crater of Bagana is described. There is continuous voluminous emission of steam from the summit area. The 1952 lava flow on the west flank is still steaming, and a new blocky flow is slowly advancing along the northern side of the 1952 flow. There is still sofataric activity associated with the 1947 flow on the north flank of Bagana. (W.M.)

14-a-22 BRANCH, C. D., 1967e — Volcanic activity at Lake Dakataua caldera, New Britain. *In* BRANCH, C. D. — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 21-5.

Lake Dakataua, at the northern end of Willaumez Pen., is a complex volcanic area consisting of an outer caldera about 11 km across, an inner caldera 6 km across, and a basaltic shield volcano, Mt Makalia. An explosion crater complex of at least 11 craters has torn out the southwest side of the shield volcano. The most recent eruption, 70-80 years ago, was a lava flow from an apical ash crater on Mt Makalia. Thermal areas in the crater range in temperature from 50°C to 58°C and thermal areas at the foot of Mt Makalia range from 35°C to 42°C. (Auth.)

14-a-23 BRANCH, C. D., 1967f — April 1964 eruption of Manam volcano. *In* BRANCH, C. D. — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 27-34.

A small climactic eruption from a new vent high in the southeast valley of Manam volcano in April 1964 was preceded by 5 months of sporadic weak ejection of ash, mainly from the main vent. Continuous mild emission of white vapour characterized activity at the southern vent.

Heavy emission of grey ash suddenly began from the southern vent on 16 April. Fountains of incandescent lava were seen and boulders cascaded down the upper southeast valley. Audible explosions occurred at the rate of 17 per hour next day, increased to 640 per hour, then declined and became irregular a week later. A large earthquake was felt on 24 April and explosive activity increased from a new vent high in the southeast valley (the southeast vent). Lava spatter was hurled 450 m above the new vent every 3-4 seconds, accompanied by innumerable boulder slides down the southeast valley. A blocky lava flow of olivine basalt descended 900 m below the southeast vent. Activity decreased to about 75 explosions per hour at the end of April and became irregular during May. On 30 May 1964, explosions ceased and the only evidence of the southeast vent was a widespread fumarole field steaming strongly in the general area of the vent. (Auth.)

14-a-24 CARDER, D. S., 1959 — Eruption of March 5-6, 1958, of Manam volcano off the north coast of New Guinea. (Abstract only.) *Bull. geol. Soc. Amer.*, 70, 1711-2.

Seismological evidence and triggering action by spring tides are used to predict renewed volcanic activity in New Guinea.

Manam is an almost circular island about 12 km off the north coast of New Guinea, 10 km across, and more than 1.5 km high. Late in 1957 it came to life after a decade of quiescence. The 3000 inhabitants were evacuated soon after activity began, and shortly thereafter a *nuée ardente* burst out of the south flank. Eruption was predicted for 5-6 March during the full moon. High activity began on 5 March with a *nuèe* which nearly reached the sea. Incandescent rocks were thrown vertically above the crater, and a lava flow began. A bomb fountain reached an estimated height of 1800 m above the crater by 6 March, when the volcanic cloud had reached an estimated height of 6000 m above the crater and the lava flow had reached the sea with explosive violence. The eruption was accompanied by almost continuous seismic activity and pulsating ground tilts. By May 1958 activity had died down. (Auth.)

14-a-25 CHALMERS, J., 1887b — PIONEERING IN NEW GUINEA. *London, Religious Tract Soc.*, vii + 343 pp.

Ritter (Sakar) I. off western New Britain was issuing a heavy pall of smoke on 13 January 1887. It is thought to be entirely volcanic in origin, with several peaks recognized as volcanic cones. (W.M.)

14-a-26 FINSCH, O., 1888 — SAMOAFAHRTEN: REISEN IN KAISER-WILHELMS-LAND UND ENGLISCH NEU-GUINEA IN DEN JAHREN 1884 UND 1885 (Journeys in German and English New Guinea during 1884 and 1885, in German.) *Leipzig, Hist.*, 390 pp.

In May 1885 Manam volcano was producing a considerable volume of glowing steam and smoke and ejecting glowing bombs of lava. In 1884 Bam volcano was smoking densely. (W.M.)

14-a-27 FISHER, N. H., 1939b — Report on the volcanoes of the Territory of New Guinea. *New Guinea Geol. Bull.* 2, 1-18.

The eruptive history and state of volcanic activity of all the recent volcanoes of New Guinea are recorded. The data are presented for the islands in 3 groups — all island volcanoes west of Karkar, New Britain, and Bougainville. The *en echelon* linear arrangement of the volcanic centres indicates an irregular major crustal fracture. (W.M.)

14-a-28 FISHER, N. H., 1939f — The volcanoes of the Mandated Territory of New Guinea. *Proc. 6th Pacif. Sci. Cong., San Francisco*, 2, 889-94.

Data on all active volcanic centres in New Guinea are collated. Active centres lie off the north coast of the mainland, and are described from west to east in 3 groupings. A map of volcanic centres indicating their position and state of activity is included. (W.M.)

14-a-29 FISHER, N. H., 1950 — Volcanoes of New Guinea, and beach sands. *Papua-New Guinea Sci. Soc., ann. Rep. 1950,* 11-3.

The 1937 eruption of Vulcan was sudden and catastrophic compared with the gradual building up to the 1941-42 eruptions which were of quite a different type. The period between the two eruptions was not characterized by a return to the normal state of dormancy that had existed before 1937 but was marked by much stronger emission of steam and other volcanic gases at Matupi volcano. At Vulcan the decrease in activity has been continuous ever since the 1937 eruption and this decrease was not interrupted by the 1941-42 outbursts at Matupi.

The 1941-42 eruption at Matupi followed a long period in which a classical evolution of volcanic phenomena was observed. Towards the end of 1938 hydrochloric acid was occasionally noticed in the gas, and from April 1939 onwards a strong smell of sulphur dioxide was present. In January 1940 increased fumarole activity was noticed on the east and northeast slopes, and in March 1940 small steam explosions occurred in the crater. Gas activity increased and in November 1940 a rise in temperature of some of the fumaroles above 100°C took place for the first time. Strong tilting movements took place about this time, and a severe earthquake occurred on 20 January 1941. By this time, the temperature of one of the fumaroles had reached 284°C and gas activity was increasing both in regard to temperature and composition of gases. Early in June, the temperature of one of the fumaroles reached 400° and active eruption began on 6 June. For the first 2 days, dust and solid rock were thrown out and numerous volcanic tremors were recorded each day. The eruption continued until about March 1942. Since then the volcano has reverted to the dormant condition that existed before 1937 and that is characteristic of long periods of quiescence. (W.M.)

14-a-30 FISHER, N. H., 1957 — CATALOGUE OF THE ACTIVE VOLCANOES OF THE WORLD, INCLUDING SOLFATARA FIELDS — PART V, MELANESIA. *Naples, Int. Volc. Ass.*, 105 pp.

Melanesia has been subdivided into 9 areas for discussion of the volcanic phenomena of the region. These are (i) Admiralty Group, (ii) islands off the northeast coast of New Guinea, (iii) New Britain, (iv) Papua and D'Entrecasteaux Is, (v) islands east of New Ireland, (vi) Solomon Is, (vii) Santa Cruz, (viii) New Hebrides, (ix) Matthew and Hunter Is. Within each area, volcanic centres are numbered and discussed in sequence from west to east, and types and intensities of volcanic activity are described symbolically. A brief description of the name and location, form and structure, history of volcanic activity, and petrography of each volcanic centre is given, and bibliographic and cartographic data included. (W.M.)

14-a-31 GRABOWSKY, F., 1895 — Der Bezirk von Hatzfeldthafen und seine Bewohner (The Hatzfeldthafen district and its inhabitants, in German.) *Petermanns Mitt.*, 41, 186-9.

Manam erupted on the night of 27-28 June 1887. Large flows of lava were produced in a spectacular eruption. (W.M.)

14-a-32 GRAEFE, E., 1939 — Ein Berg wachst aus dem Wasser (A mountain grows from the sea, in German). *Kosmos (Stuttgart)*, 36, 45-8.

The May 1937 eruption of Vulcan I. at Rabaul generated a considerable volume of steam and dacitic ash, and increased the size of the island to the extent that it became joined to the mainland. Considerable damage and loss of life were involved. Photographs of the eruption and of ash-devastated forest are included. (W.M.)

14-a-33 HEALY, J., 1961 — Report of the Chairman of the Standing Committee on Pacific Geology and Geophysics. *Proc. 9th Pacif. Sci. Cong., Thailand.* 12, 1-25.

The Australian report refers to volcanic surveillance in the New Guinea active areas in the 4 years preceding the congress. (W.M.)

14-a-34 HOLTKER, G., 1942 — Meine Beobachtungen über die Vulkantätigkeit in Kaiser-Wilhelms-Land (Neuguinea) 1936-39 (My observations on the volcanic activity in Kaiser-Wilhelms-Land (New Guinea) in 1936-39, in German.) *Z. dtsch. geol. Ges.*, 94, 550-60.

An account is given of the eruptive activity of Manam, Bam, and Karkar volcanoes during the period 1936-39, especially the form and previous eruptive history of Manam. Eruption of Kairiru I. near Wewak in 1907 is noted. (W.M.)

14-a-35 HUNTER, J., 1973 — AN HISTORICAL JOURNAL OF THE TRANSACTIONS AT PORT JACKSON AND NORFOLK ISLAND . . . *London, Stockdale.*, 580 pp.

On 22 May 1791 Matupi volcano at Rabaul was emitting vast columns of black smoke. On the western end of one of the larger islands in the Duke of York Group east of Rabaul, springs of fresh water were gushing from crevices in the rocks (limestone). (W.M.)

14-a-36 KLEIN, W. C., 1938 — De vulkanische uitbarstingen nabij Rabaul op 29 May 1937 en een paar volgende dagen (The volcanic eruptions near Rabaul on 29 May 1937 and on the following days, in Dutch). *Geol. Mijnb.*, 17(5), 23-40.

Volcanicity in the New Guinea area is described, including past eruptions on Karkar, Manam, Tumleo, Bagabag, Rooke, and previous volcanic activity on the Gazelle Pen. as recorded by D'Urville and Brown. Existing volcanoes on the Gazelle Pen. at the time of the eruption, 'Mother' and 'Daughters', and the evidence of past eruptions from topographic evidence and rock types are outlined. The description of the 1937 eruption is supported by photographs showing the evolution of Vulcan I. A bibliography of volcanic phenomena in Papua New Guinea and the Solomons is appended. (C.F.)

14-a-37 MACGREGOR, W., 1894c — Despatch reporting inspection of the northeast coast of the possession. *Brit. N. Guinea ann. Rep. 1893-94*, App. A, 1-8.

Mt Victory was actively emitting steam from many places on its summit on 25-26 September 1893. (W.M.)

14-a-38 MACLAY, N. VON MIKLUCHO, 1884 — On volcanic activity on the islands near the northeast coast of New Guinea, and evidence of rising of the Maclay coast in New Guinea. *Proc. Linn. Soc. N.S.W.*, 9, 963-7.

The severity, periodicity, and effect of several earthquake shocks on the Maclay coast of New Guinea during 1871-72 and 1876-77 are recorded. The observed eruptions of Vulcan and Lesson Is in 1877 and 1883 are noted, and their effect on local sea level and geomorphic forms outlined. Geomorphic and palaeontological evidence for the gradual uplift of the north coast of New Guinea in Pleistocene and Recent time is presented. (W.M.)

14-a-39 MARR, C. C., 1937 — Manam Island volcanic eruption. *New Guinea agric. Gaz.*, 3(2), 3-4.

During the October 1936 eruptions of Manam, a layer of 'grit resembling charcoal' 1-5 cm deep was scattered in open areas. (W.M.)

14-a-40 PFEIL, J. G. von, 1889 — STUDIEN UND BEOBACHTUNGEN AUS DER SUDSEE (Studies and observations in the South Sea, in German.) *Brunswickweig, Vieweg,* 322 pp.

A description is given of volcanism and volcanic landforms, including volcanic centres on Bougainville, New Britain, and nearby volcanic islands. Recent volcanic activity is outlined. (W.M.)

14-a-41 PFLUGER, A., 1901b — SMARAGDINSELN DER SUDSEE (Emerald Isles of the South Sea, in German). *Bonn, Emil Strauk,* ix + 244 pp.

In 1901 dense clouds of steam and smoke were rising from Manam volcano. (W.M.)

14-a-42 REYNOLDS, M. A., 1957a — Submarine vulcanism east of Tuluman volcano, St Andrew Strait, Admiralty Islands, October-November 1954. *In* REYNOLDS, M. A., & BEST, J. G. — The Tuluman volcano, St Andrew Strait, Admiralty Islands. *Bur. Miner. Resour. Aust. Rep.* 33, 8-11.

In October-November 1954 Tuluman volcano erupted from a submarine vent on the northeast flank. Blocks of lava and some fine fragmental debris were erupted explosively at 10-minute intervals in low-energy explosions. Steam released was due entirely to the lava mass above the water, and combined with large volumes of steam, vapour, and volatiles released from the cooling lava blocks to produce white cumulus clouds. The temperature of emitted lava was greater than in July 1954 eruption. The thermal areas on Tuluman west and east were revisited, and found Balyan and Lou Is showed an increase in temperature at the time of this submarine eruption. The thermal areas on Tuluman west and east were revisited, and found to have cooled considerably since the July eruptions. (W.M.)

14-a-43 REYNOLDS, M. A., 1957b — Volcanic activity and the formation of the Tuluman Islands. *In* REYNOLDS, M. A., & BEST, J. G. — The Tuluman volcano, St Andrew Strait, Admiralty Islands. *Bur. Miner. Resour. Aust. Rep.* 33, 12-38.

Islands and submarine vents of Tuluman volcano are numbered in sequence of their formation and emergence, and the complex re-named Tuluman Is. The sequence of developments causing their growth are outlined for the period June 1953 to May 1956. They are largely unconsolidated tephra deposits vulnerable to storm and wind erosion. Stable areas are recognized on lavas and blocky agglomerate deposits. The origin of the magma, the submarine volcanism and sea surface activity, and the sequence of activity during January to April 1957 are described. A strong correlation is seen between phases of the moon and sun and periodicity of activity on the Tuluman Is.

The lavas of Tuluman are pahoehoe flows, with 3 main rock types: pumiceous and vesicular dark grey material in the upper section of the flows, black tachylitic glass in the body of the flows, and a black dense rock (basalt?) which shows flow textures and forms most of the lower part of the flows. Agglomerates are recognized in crater 5. White and greyish dust forms massive deposits which mostly represent the final stage of activity. (W.M.)

14-a-44 REYNOLDS, M. A., & BEST, J. G., 1957 — The Tuluman volcano, St Andrew Strait, Admiralty Islands. *Bur. Miner. Resour. Aust. Rep.* 33.

The growth of the Tuluman Islands from 5 eruptive centres is traced for the period June 1953-May 1954. Early activity is described by Best (entry 14-a-18) and late activity by Reynolds (entry 14-a-42) who integrates and interprets observations (entry 14-a-43). (W.M.)

14-a-45 RIBBE, G., 1903 — ZWEI JAHRE UNTER DEN KANNIBALEN DER SALOMONINSELN (Two years among the cannibals of the Solomon Islands, in German). *Dresden, Beyer,* 329 pp.

Balbi volcano on Bougainville was periodically active in the period 1894-1896, mostly producing ash and smoke, and in 1890 Bagana erupted to produce lava and clouds of yellow smoke. (W.M.)

14-a-46 SAPPER, K., 1911 — Die Tätigkeit der Vulkane Ghaie und Ralaun, Neupommern (The eruptive history of Ghaie (Matupi) and Raluan (Vulcan) volcanoes, New Britain, in German). *Petermanns Mitt.*, 57, 135-9.

Volcanism in the Rabaul caldera area was very mild early in the 19th century, and continued spasmodically as mild eruptions. Occasional vigorous eruptions involved the production of large volumes of smoke and ash, usually accompanied by strong earthquakes and tidal waves. The history of eruption is traced. (W.M.)

14-a-47 SAPPER, K., 1917b — Melanesien-Melanesische Vulkanzone (Melanesia-Melanesian volcano zone, in German). (*In* SAPPER, K. — KATALOG DER GESCHICHTLICHEN VULKANAUSBRUCHE. *Strassberg, Taubrer,* 204-15) (first issued as Schrifter der wissenschaftlichen Gesellschaft im Strassburg, Heft 27.)

Eruptive episodes in recent historic times are tabulated for Bam (Lesson), Manam (Manumudar), Karkar (Dampier), Ritter, volcanoes on C. Gloucester, The Father and South Son, the Rabaul-Blanche Bay volcanoes, Ambilte and Lihir, Balbi, and Bagana. (W.M.)

14-a-48 SAPPER, K., 1921 — Die Vulkanberge Neu-Guineas (The Volcanoes of New Guinea, in German). *Z. Vulk.*, 6, 1-14.

A survey of the known active and recently active volcanoes of New Guinea includes notes on the known eruptive history and lithologies of several centres. Included are several centres in the D'Entrecasteaux Group, Mts Victory and Trafalgar on the Tufi Pen., Mt Dayman and Cloudy Mtn in eastern Papua which may be lava domes with no recognizable crater, and the north New Guinea coast volcanic islands. (W.M.)

14-a-49 SAPPER, K., 1937 — Vulkanausbrüche bei Rabaul, Neupommern (Volcanic eruptions at Rabaul, New Britain, in German). *Petermanns Mitt.*, 83, 279-80.

The eruptive history of Vulcan crater in Blanche Bay is traced, and the 1937 eruption described. (W.M.)

14-a-50 SCHLEINITZ, G. E. G. von, 1876 — Die Expedition SMS *Gazelle* (The voyage of the SMS *Gazelle,* in German). *Ann. Hydrogr. 1876,* 1-14.

On 25-26 August 1875, Bagana volcano was emitting clouds of smoke and ash. (W.M.)

14-a-51 SCHRADER, C., 1876 — Aschenfall in Neu-Guinea (Ash falls in New Guinea, in German). *Ann. Hydrogr. 1876,* 210-11.

A heavy fall of volcanic ash was recorded at Finschhafen on 5 February 1876. Vulcan (Manam) and Lesson (Bam) volcanoes to the northwest are the most likely source. (W.M.)

14-a-52 SMITHSONIAN INSTITUTION, CENTRE FOR SHORT-LIVED PHENOMENA, 1971 — Ann. Rep. 1970. *Camb. Mass., Smithsonian Instn,* 296 pp.

Included in the 1970 events are (1) the eruption of Mt Ulawun in New Britain in January, in which considerable volumes of *nuée ardente* ash and blocky lava devastated large areas during eruption in which 4 phases were recognized (a) vapour emission phase, (b) explosive phase which overlapped with (c) quiet effusive phase, then (d) a declining vapour emission phase. Eruption was Volcanian and Strombolian during phase (b); the lava and *nuée* products show tholeiitic affinities. Photographs are included; (2) the earthquake centred near Madang on 31 October, with epicentre near 5°S, 146°E and which caused considerable structural damage to buildings in Madang. The force of the earthquake at Madang was estimated at MM8. (W.M.)

14-a-53 STANLEY, E. R., 1923f — Volcanic action in New Guinea. *Proc. 2nd Pan-Pacif. Sci. Cong., Australia,* 1, 830-3.

4 phases of volcanic activity on Papua New Guinea are recognized — (i) extrusion of augite andesites during the late Mesozoic on the peneplain in the Owen Stanley Ra., (ii) pyroclastic activity and deposition of andesitic agglomerates during the Miocene, (iii) Pliocene andesitic effusive and explosive activity which passed into basaltic activity, and (iv) Pleistocene and Recent volcanism ranging from effusive to pyroclastic and from olivine basalt to trachyte and rhyolite. (W.M.)

14-a-54 STEHN, C. E., & WOOLNOUGH, W. G., 1938 — Report on vulcanological and seismological investigations at Rabaul. *New Guinea ann. Rep. for 1936-37.* 147-58 (also issued as *Aust. parl. Pap. 27, Sess. 1937-40,* 3, 1126-37.

The 1937 eruption of Vulcan (Baluan) volcano in Blanche Bay produced sufficient debris to greatly increase the height of the cone and weld the island to the mainland. At the same time, a considerable volume of material was produced by the nearby crater of Matupi (Tavurvur) volcano, causing most of the damage to Rabaul township in this eruptive episode.

The 1937 eruption produced volumes of pumice, ash, black mud, glowing blocks and bombs of lava, and clouds of volcanic dust consisting of pumice fragments. Material from Vulcan was dominantly pumiceous and that from Matupi essentially dense black mud. Several small craters opened up around Matupi vent and several subsidiary after-eruptions took place with diminishing violence. Eruption was preceded by activation of sulphurous springs and boiling mud-pools, earth tremors, heaving of large blocks of land, and increase in temperature around hot spring and vent areas. Eruption was followed by subsidence in some areas, considerable water damage from induced rainfall, and blocking of the harbour by pumiceous debris which eventually was carried out to sea by winds and currents.

Recent volcanic deposits mantle the country for a 50-km radius around the crater complex at Rabaul, and were produced by a series of cones and subsidiary vents in a pile which was initially submarine. A late-stage prehistoric Krakatoan eruption destroyed the pile and created Blanche Bay as a breached caldera. Historic eruptions at Rabaul appear to have been restricted to pyroclastic eruptions of Matupi and Vulcan. The 1878 eruption of Vulcan produced abundant ash, pumice, and smoke, and was accompanied by earth tremors. Several other minor eruptions and tremors in Blanche Bay between 1909 and 1936 are noted. (W.M.)

14-a-55 STUDT, F. E., 1961 — Preliminary survey of the hydrothermal field at Rabaul, New Britain. *N.Z. J. Geol. Geophys.,* 4, 274-82.

Many hot springs are located around the shoreline of the breached caldera in which Rabaul stands. Hydrology and chemical analyses suggest that there is convective circulation of sea water in a zone of subsidence close to 2 young volcanoes. The total heat flow is not known and there appears to be little thermo-artesian pressure of hotwater storage, but it may be possible to exploit part of the hydrothermal field to supply Rabaul's power requirements. Further investigation and test drilling are required before a final assessment can be made. (Auth.)

14-a-56 TAYLOR, G. A., 1953 — Volcanology in the Pacific: Australia. *In* HEALY, J. — Report of the Standing Committee on Volcanology. *Proc. 8th Pacif. Sci. Cong., Philippines,* 2, 30-2.

Volcanic activity in the New Hebrides, Solomons, and Papua New Guinea during 1950-52 is outlined. (W.M.)

14-a-57 TAYLOR, G. A., 1956a — An outline of Mount Lamington eruption phenomena (abstract only). *Proc. 8th Pacif. Sci. Cong., Philippines, Abs. Vol.*, 40-1.

Mt Lamington produced a Pelean eruption on 21 January 1951. There was no history of a previous eruption and the area has not been recognized as potentially active. The eruption was preceded by 5 days of earthquake swarms and increasing gas emission. The *nuée ardente* devastated a large area surrounding the mountain, reaching a maximum extent of 12 km on the northern slopes. All life perished within the zone of complete devastation. Subsequent activity was characterized by a dominantly explosive phase, soon replaced by an over-tapping effusive phase. Early in February a lava dome was extruded from the crater conduit at the rate of more than 30 m per day. The lava dome was partly destroyed by a major eruption on 5 March, but was rapidly rebuilt to much larger dimensions. Numerous large spines were formed during the latter half of 1951 and the dome summit attained a maximum height of about 580 m in January 1952. Considerable dome movement took place during the first half of 1952, but all activity declined markedly during the rest of the year. Major dome development in late 1952 was accompanied by a different seismic activity pattern. A close correlation between seismic phenomena and eruptive activity was shown. All major explosions were preceded by a rise in the intensity of earthquake swarms and the seismic intensity at any given period appeared to be a measure of the explosive potential. (Auth.)

14-a-58 TAYLOR, G. A., 1956b — Australia. *In* HEALY, J., Report of the Standing Committee on Volcanology. *Proc. 8th Pacif. Sci. Cong., Philippines,* 2, 30-2.

Mt Bagana on Bougainville I. is the most active volcano in the Territory, and produced severe eruptions in 1950 and 1952. Mt Lamington first expressed itself as an active volcano by violent Pelean eruptions in 1952. Increased activity was reported from Manam and Long Is, and explosive eruptive activity began during 1953 in St Andrew Str. in the Admiralty Is. (W.M.)

14a-59 TAYLOR, G. A., 1956c — An outline of Mount Lamington eruption phenomena. *Proc. 8th Pacif. Sci. Cong., Philippines,* 2, 83-8.

This is similar to entry 14-a-57.

14-a-60 TAYLOR, G. A., 1956d — Review of volcanic activity in the territory of Papua and New Guinea, the Solomon and New Hebrides Islands, 1951-53; Australian National Committee on Geodesy and Geophysics — report of sub-committee on volcanology, 1953. *Bull. volc. (Ser. 2),* 18, 25-37.

An account of volcanic activity at Mt Lamington, off Karkar I., Mt Langila, Manam I., Long I., St Andrew Str., and Mt Bagana during the preceding year is summarized. Summaries are also included for activity in the Solomons and the New Hebrides. (W.M.)

14-a-61 TAYLOR, G. A., 1958a — The 1951 eruption of Mount Lamington, Papua. *Bur. Miner. Resour. Aust. Bull.* 38, 117 pp.

This is similar to entry 14-a-57 but in more detail. The extruded dome of Mt Lamington was made up of 3 main types of lava: (1) lamprobrolite andesite, (2) olivine-pyroxene-anhydrite-lamprobrolite andesite, and (3) anhydrite-hornblende andesite. Type (2) is the most common and the others are localized in their distribution. Ultrabasic rocks are common among the inclusions in the lava. Extrusion processes in the dome yield fine-grained friction breccias and stressed rocks showing 'gneissic' banding and a lineation formed by pipes of shattered crystals. The fragmental material ejected by the volcano consisted of both new and old lavas. A glassy green hornblende andesite with a mineralogical composition similar to that of type (3) lava was the most active agent in the eruptive mechanism; it formed pumice and was the main constituent of the ash ejected great distances as well as of the ash which rose from a descending *nuée*. However, ash from the thick *nuée* deposits in the valleys was composed chiefly of old lavas.

Although tectonic earthquakes are not numerous in eastern Papua the broad picture of events in the adjacent island regions suggest that the Mt Lamington eruption was triggered by a crustal stress pulse. The stress pulse was manifest in an increase in the frequency of tectonic earthquakes and reactivation of volcanic centres in New Guinea, the Solomons, and the New Hebrides. (Auth./W.M.)

14-a-62 TAYLOR, G. A., 1958b — Notes on the current eruption at Manam (abstract only). *Rep. 38th ANZAAS Cong., Adelaide.*

Manam began a new cycle of activity in December 1956, ending a dormant period of 9 years. This basaltic volcano has produced numerous eruptions during the last 80 years, but little is known of the size or duration of the early events. The activity of 1957 took the form of intermittent explosive and effusive phases which gradually increased in intensity. In December major outbursts extensively damaged native gardens and all the inhabitants were moved to the mainland; 6 weeks later an eruption of unprecedented magnitude covered most of the western side of the island with a heavy deposit of cinder, and produced *nuées ardentes* which wiped out part of the empty villages and destroyed forest areas.

2 major eruptions followed this outburst. The February event increased the cinder deposits to a minimum thickness of 30 cm for much of the western slopes, and *nuées ardentes* devastated further areas of forest on the southern slopes. The March eruption devastated a narrow zone on the eastern slopes with a heavy cinder fall and poured lava down to the sea on the southern flank of the volcano. A hiatus of more than 3 months ended in June with a new phase of explosive activity which still continues. (Auth.)

14-a-64 TAYLOR, G. A., & THOMPSON, J. E., 1956 — An outline of the Mount Lamington eruption phenomena, 1951-52. *Papua-New Guinea Sci. Soc., ann. Rep. & Proc. 1956*, 14-9.

This summarizes entry 14-a-61.

14-a-65 TAYLOR, G. A., BEST, J. G., & REYNOLDS, M. A. 1957 — Eruptive activity and associated phenomena, Langila Volcano, New Britain. *Bur. Miner. Resour. Aust. Rep.* 26.

Langila crater, 11 km south of C. Gloucester, comprises 2 adjoining craters, No. 1 (southern) and No. 2 (northern). Activity in No. 1 crater is confined to a small fissure in the western half within the crater and some minor vents on the outer northwest slopes. There has been no apparent change in its activity over the last 15 years. The southern half of No. 2 crater forms the active crater from which the recent eruption has emanated.

Between June and August 1952, No. 2 crater began vigorously producing gas at a temperature of about 220°C. By October-November, anomalous tilts were recorded and analyses of fumarole condensates suggested an eruption might occur. The actual eruption began on 18 May 1954, with explosive phases lasting up to 4 hours, during which much dust and some bombs were ejected, and vapour clouds were given off. Observations indicated the volcano was of the closed conduit type and the eruption was low-grade Volcanian tending towards steam explosion. The last reported explosive phase was on 25 March 1956. The initial eruption occurred at full moon but subsequent explosive activities coincided with new moons. (Auth.)

14-a-66 WARTEGG, E. VON HESSE, 1902 — SAMOA, BISMARCKARCHIPEL UND NEU-GUINEA: DREI DEUTSCHE KOLONIEN IN DER SUDSEE (Samoa, the Bismarck Archipelago and New Guinea: three German colonies in the South Sea). *Leipzig, Weber*, viii + 329 pp.

Included in the description of New Guinea is mention of the 1902 eruption of Manam, in which a column of dense smoke was seen, and lava poured down the north flank of the cone. (W.M.)

14-a-67 WHITE, D. E., 1963 — Summary of studies of thermal waters and volcanic emanations of the Pacific Region, 1920-1961: report of Standing Committee on Geology and Solid Earth Geophysics of the Pacific Basin. *10th Pacif. Sci. Cong., Honolulu*, 161-9.

Studies of volcanic emanations and thermal waters in the Pacific region during the period 1920-1961 are listed. (W.M.)

14-a-68 WICHMANN, A., 1909 — Entdeckungsgeschichte von Neu-Guinea bis 1828 (History of exploration in New Guinea until 1828, in German). *Nova Guinea*, 1, 1-387.

The first recorded activity on Bam and Manam was in 1616; Manam and Karkar are reported to have been active in 1643; Karkar was issuing steam in 1700; Ritter appeared above sea level on 15 March 1700 with vast clouds of steam and smoke and poured out large amounts of lava; Ritter was active again in 1793, 1827 and 1850. Bam was smoking strongly in 1874. (W.M.)

14-a-69 WICHMANN, A., 1910 — Entdeckungsgeschichte von Neu-Guinea 1828 bis 1885 (History of exploration of New Guinea 1828 to 1885, in German). *Nova Guinea*, 2, 1-369.

In 1830, two centres (probably Manam and Karkar) are reported to have been active; in November 1877 Bam was smoking strongly; in 1878 two centres on C. Gloucester were emitting smoke and ash. (W.M.)

14-a-70 WICHMANN, A., 1912 — Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 (History of exploration of New Guinea 1885 to 1902, in German). *Nova Guinea*, 2, 371-1026.

The eruptive centre on C. Gloucester was showering ash and lapilli in 1900; Ritter I. was active in 1887 and explosively active in March 1888; Karkar was emitting ash and smoke in June 1895; Manam was active in 1887, 1888, 1889, and 1902. (W.M.)

14-a-71 WOODFORD, C. M., 1888 — Exploration of the Solomon Islands. *Proc. Roy. geogr. Soc.*, 10(n.s.), 351-76.

In early 1886 there was an active volcano (Bagana) near the centre of Bougainville I. (W.M.)

14-a-72 ZOLLER, H., 1891b — DEUTSCH-NEUGUINEA UND MEINE ERSTEIGUNG DES FINISTERRE-GEBIRGES (German New Guinea and my discoveries in the Finisterre Ranges, in German). *Stuttgart, Union Dtsch. Varlagsges*, xxxii + 564 pp.

During 1888 Manam was periodically erupting lava and abundant clouds of glowing ash, Bam was emitting clouds of steam and smoke, as were the active vents of Dallman and Schneider (Langila) on C. Gloucester. Karkar volcano was reported to have been emitting smoke, steam, and ash in 1885. (W.M.)

(b) SURVEILLANCE

See also entries

12-a-12 12-i-24 12-i-35 14-a-58
12-i-22

14-b-1 FISHER, N. H., 1954a — Report of the subcommittee on vulcanology 1951 —Australian National Committee on Geodesy and Geophysics. *Bull. volc. (Ser. 2)*, 15, 71-9.

The re-establishment of instrumentation at Rabaul vulcanological observatory is reported, and an outline given of volcanic activity in the several eruptive centres and fumarolic sites around Rabaul since 1937. A tabular summary of the volcanic centres of New Guinea is appended. The 1951 eruptive activity of Mt Lamington is outlined, and the following volcanoes were examined: Mt Goropu in Papua, Long I., Mt Galloseulo on the north coast of New Britain, and Mts Taroka, Balbi, and Bagana on Bougainville I. The presence of previously unknown inactive craters has been established on Rooke and Sakar Is. (W.M.)

14-b-2 FISHER, N. H., 1959 — Report of the subcommittee on vulcanology 1954-56 — Australian National Committee on Geodesy and Geophysics. *Bull. volc.* (*Ser. 2*), 21, 153-61.

An outline of volcanological field work based on the observatory at Rabaul, and a list of reports issued are presented. Volcanic and seismic activity since January 1954, at Tuluman, Bam, Manam, Long I., Langila, Lamington, and Dobu are summarized. A brief statement of research interests, some petrographic notes, and a list of publications and unpublished reports are included. (W.M.)

14-b-3 NEWSTEAD, G., 1969 — Keeping watch on volcanoes. *Hemisphere*, 13, 32-7.

The origin of the present active cones in the Rabaul crater is related to the volcanism which produced Simpson Har. and its related shallow lava chamber. Further eruptions can be expected, and this possibility is being monitored by a series of seismic stations around the caldera. (W.M.)

14-b-4 TAYLOR, G. A. M., 1966 — The surveillance of volcanoes in the Territory of Papua and New Guinea. *S. Pacif. Bull., 2nd Quart.*, 1966.

Volcanic warning phenomena are outlined, including methods of monitoring them. The siting, role, and equipment of the Volcanological Observatory at Rabaul and the surrounding regional network of observation stations are discussed. Case histories of eruptions of Langila, Manam, and Mt Lamington are described in terms of surveillance methods. (W.M.)

(c) INTERPRETATIVE

See also entry 14-a-53.

14-c-1 JOHNSON, R. W., 1970 — Volcanoes of New Britain. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

There are 3 areas of Quaternary volcanism in New Britain: (1) the Rabaul area; (2) an area along the north coast between Open Bay and Willaumez Pen.; (3) the C. Gloucester area. With the probable exception of the Rabaul volcanoes, these areas form the eastern part of the Bismarck Volcanic Arc, a chain of volcanoes that also includes the islands off the north coast of New Guinea. The rocks of the arc range from tholeiitic basalt to rhyolite, and include lavas of intermediate composition in which the ratio total iron oxides (as FeO) : MgO is variable. The Al_2O_3 content of the basalts is also variable. Compositions of the New Britain lavas may be related to the depth of the seismic zone which dips northwards at about 70° beneath the island. (Auth.)

14-c-2 KVALE, A., 1952 — En ny Vulkan av Mt Pelee-typen (On a Pelean volcano, in Norwegian). *Naturen*, 76, 357-69.

The 1951 Pelean eruption of Mt Lamington is described, and the mechanism of volcanic activity discussed. (W.M.)

14-c-3 MICHAEL, M., 1969 — Volcanic pulses in the New Guinea-Solomons region. *Trans. Papua-New Guinea Sci. Soc.*, 10, 8-13.

For the New Guinea-Solomons region a graph of the number of volcanoes in eruption each year for the period 1900-65 shows a spectacular increase in volcanic activity since 1935, and short pulses of volcanic activity with intervening quiet periods: the former may be the result of local fluctuating spreading of the mantle under this area, and the latter to variations in the rate of movement in elements of the Melanesian Shear Zone. (Auth.)

14-c-4 MICHAEL, M., 1970 — Relationship between large magnitude tectonic earthquakes and volcanic eruptions in the New Guinea-Solomons region, 1904-1962. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

Volcanic activity in the area has increased markedly since 1935. During the period 1930-62, the large-magnitude tectonic earthquakes display a periodicity, with a 1-2 year phase difference, the earthquake maxima occurring earlier than the volcanic pulses; for smaller tectonic units within the study area, comparison of graphs of 5-year running means of numbers of earthquakes per annum with those volcanic eruptions does not give such good correlation. When M6 earthquakes, with epicentres within 25 km of an active volcano, are considered for the period 1904-62, all correlation in time between earthquakes and volcanic eruptions vanishes.

Thus it appears that large-magnitude tectonic earthquakes are usually neither a direct cause nor a result of volcanic eruptions, but that both seismic and volcanic periodicity may be caused by the same process, possibly variations in the rate of movement in elements of the Melanesian Shear Zone. (Auth.)

14-c-5 PHILLIPS, C., 1899 — Volcanoes of the Pacific. *Trans. N.Z. Inst.*, 32, 188-212.

The volcanic features of the ridge of uplift extending eastward from Papua to Easter I. in the Pacific Ocean are outlined. (W.M.)

14-c-6 RENWICK, A., 1970b — Volcanoes and solfataric areas. *In* WARD, R. G., & LEA, D. A. M. (Eds) — AN ATLAS OF PAPUA AND NEW GUINEA. *Port Moresby* and *Glasgow, Univ. Papua and New Guinea* and *Collins-Longman,* 34-5.

On a map of Papua New Guinea, all volcanoes and solfataric areas currently recorded as non-extinct are plotted, and related to a tabulated key of names and activity. Included in the active volcanoes are some which probably erupted in historic time, but for which there is no established written record. (W.M.)

14-c-7 RUXTON, B. P., 1965c — Volcanoes of the Managalase Plateau and their tectonic setting. *38th ANZAAS Cong., Hobart,* Sec. C. Abs. (listed by title in *Aust. J. Sci.,* 28, 312).

The Managalase Plateau (9°S, 148°20′E) is a fault-bounded block of fractured basement meta-basalt and basic plutonic rock overlain by Pliocene to Recent terrestrial volcanic rocks and sediments. It contains over 30 centres of late Pleistocene to Recent volcanic activity grouped along criss-crossing easterly and northerly trend lines which represent basement fractures; 2 of the major north-trending fractures bound a horst block which appears to be the northern portion of a 'basalt arc' which includes the Pliocene Sesara alkali-basalt shield volcano. The most recent rhyodacite-trachybasalt activity lies near, and inside, the cusp of 2 major arcuate structures which are concave towards the northeast. Both arcs are part of the much larger Morobe arc which probably represents the result of early Tertiary thrusting of the mantle southwest over the Owen Stanley metamorphic rocks.

Strong uplift of the margins of the thrust wedge in mid-Tertiary was complemented by subsidence at the rear of the arc along the margins of the C. Vogel geosyncline. Continued differential vertical tectonism in late Tertiary, leading to the formation of the ultrabasic mountain blocks, was accompanied by strong lateral movements, probably due to sinistral mega-shearing, and the advent of volcanism along lines of least strain.

4 zones of volcanism are the result of this history: an inner zone of minor activity, mostly gaseous, along the Kumusi-Musa fault troughs; a zone of alkali basalt lava outpouring along parts of the uprising ultrabasic belt; a zone of mixed trachybasalt-rhyodacite activity on the Managalase Plateau; and an outer zone of large 'andesitic' stratovolcanoes along the major marginal faults of the C. Vogel geosyncline. (Auth.)

14-c-8 SAPPER, K., 1971a — Beitrag zur Geographie der tätigen Vulkane (Contribution to the geography of active volcanoes, in German). *Z. Vulk.*, 3, 65-197.

The world-wide distribution of active and recently active volcanoes is examined, including their petrology and distribution relative to major regions of the Earth's surface, their historic record or eruptive activity, variation and frequency of activity, magnitude of eruptions, and influence of volcanic eruption on climate. Most New Guinea volcanic centres are included. (W.M.)

14-c-9 TAYLOR, G. A., 1954 — Volcanological observations, Mount Lamington 29th May, 1952. *Bull. volc.* (Ser. 2), 15, 81-9.

The January 1951 eruption of Mt Lamington, and subsequent volcanic and seismic activity are interpreted in the light of the theoretical model of '*nuée ardente*' rhyolitic and dacitic volcanism, and it is concluded that Lamington at present represents a vent in the final stages of eruption. Regional reactivation, as suggested by the creation of 2 craters in the nearby Goropu Mts in 1943, may bring about a change in Lamington's incipient dormant condition, but this seems unlikely. (W.M.)

14-c-10 TAYLOR, G. A. M., 1965 — New Guinea Vulcanicity. *38th ANZAAS Cong., Hobart* (listed by title in *Aust. J. Sci.*, 28, 312).

This is known by title only.

14-c-11 TAYLOR, G. A. M., 1969 — Post-Miocene volcanoes in Papua New Guinea. *Geol. Soc. Aust. spec. Publ.*, 2, 205-8.

No period in post-Miocene Papua New Guinea appears to have been completely free of volcanic activity. It probably reached its highest intensity about the beginning of Pleistocene when large-scale activity took place in the highland areas. Some of the highland centres cannot be reliably clasified as extinct. Insufficient work has been done in palaeovolcanology to indicate a scheme of development in the region's volcanism. Evidence of large-scale eruptions occurring within the last 2000 years in the island region extending from New Guinea to New Zealand suggests a closer examination of the age of some Australian volcanic centres. (Auth.)

15 SEISMOLOGY

(a) Descriptive (including Tsunamis)

See also entries

01-a-13	02-c-30	12-b-96	14-a-38
01-b-56	05-b-11	14-a-3	14-a-46
02-a-10	05-c-32	14-a-12	
02-b-19	05-d-5	14-a-14	

15-a-1 Anonymous, 1888b — Die Fluthwelle des Stillen Oceans im März 1888 (The tidal wave in the Pacific Ocean in March 1888, in German). *Ann. Hydrogr.* 1888, 518-9.

This quotes entry 15-a-2.

15-a-2 Anonymous, 1888d — (Eruption of Vulcan 13 March 1888). *Nachr. Kaiser-Wilhelmsl.*, 2, 76-9; 3, 147-9.

At Finschhafen, on the morning of 13 March . . . 'the sea became violently agitated, and a reef off the harbour was exposed, the water returning in 3 or 4 minutes. The wave appears to have been caused by a volcanic outburst at Vulcan I.' . . . The captain of the *Ottilie* arriving 2 days later could not recognize the spot (Vulcan). Reefs were altered, the level country with its villages had disappeared, while towards the mountains the land was strewn with pumice and shattered trees. Volume 3 contains details of the ravages caused on the southern coast of New Britain by the tidal wave. Mention is made of the tidal disturbances registered in South Africa on 14 March, and at Sydney on 15-17 March. (C.F.)

15-a-3 Anonymous, 1902 — General report on Bismarck Archipelago and Kaiser-Wilhelmsland. *German New Guinea ann. Rep. for 1900-01,* Addendum E2, 75.

A severe earth tremor was felt in the Rabaul area at 8 a.m. on 12 September 1900. European homes were damaged, and some lightly built houses collapsed. The shock was accompanied by a tidal wave which did not cause any damage. The tremor appeared to originate near the volcanoes Father and Son. Minor tremors persisted throughout the day. (W.M.)

15-a-4 Branch, C. D., 1967d — Effect at Rabaul of seismic sea waves generated by the Great Alaskan Earthquake of 28 March 1964. *In* Branch, C. D. — Short papers from the Vulcanological Observatory, Rabaul, New Britain. *Bur. Miner. Resour. Aust. Rep.* 107 (*Rep. PNG* 2), 17-9.

A seismic sea wave generated by the great Alaskan earthquake of 28 March 1964 arrived in Rabaul at 0125 L.T. on 29 March. The initial wave height was 10 cm. A possible second seismic sea wave arrived at 0723 and a wave at 0933 had a crest to trough height of 40 cm. A maximum double amplitude of 60 cm was recorded at 1330, possibly caused by oscillations from the first and second seismic sea wave groups coming in phase. Oscillations of sea level due to this earthquake lasted 4 days. The velocity of the first seismic sea wave was calculated to be 770 km per hour, and the average ocean depth between Alaska and Rabaul as 4725 m. (Auth.)

15-a-5 Denham, D., 1969b — Recent damaging earthquakes in New Guinea. *Earthq. Engng Symp., Melbourne,* 1, iii + 13 pp.

The distribution of earthquakes in the New Guinea-Solomons region is described and areas susceptible to damage from large shallow shocks are outlined. In the past 2 years, 3 series of damaging earthquakes have occurred causing over $0.5 million worth of damage. The first series occurred in east New Britain in August 1968, the second off the coast of west New Britain in September 1968, and the third near Wewak in September/October 1968. The events are described, isoseismal maps presented, and some of the damage is illustrated. All earthquakes occurred in well defined seismic zones which have experienced many earthquakes in recent years. Most of the resulting damage would not have taken place if the earthquakes had occurred 10 years earlier because only a few of the buildings affected were in existence then. (Auth.)

15-a-6 FISHER, N. H., 1944b — The Gazelle Peninsula, New Britain, earthquake of January 14, 1941. *Bull. seism. Soc. Amer.*, 34, 1-12.

The January 1941 earthquake had an epicentre southwest of Rabaul, and a magnitude of 9 on the Rossi-Forel scale. The earthquake is described, the general effects are outlined, and some instrument data recorded. A brief history of large earthquakes in the area is included. (W.M.)

15-a-7 GROVER, J. C., 1960 — Seismic and volcanic activity in the Solomons during 1957-58. *Brit. Solomon Is. geol. Rep.* 1957-58, 95-101.

38 earthquakes on or near Bougainville I. were recorded during 1957 and 1958. The earthquake on 28-4-57 had its epicentre near Bagana and a focal depth of 60 km was calculated; a nearby quake on 7-10-57 and one on 1-10-57 east of Buka had focal depths of 150 km; a quake near Bagana on 5-1-58 had a calculated focal depth of 100 km. Data on all earthquakes in the area between 4-1-57 and 22-12-58 are listed, and notes made on minor volcanism on some of the Solomon Is. (W.M.)

15-a-8 MACLAY, N. VON MIKLUCHO, 1878 — Über vulkanische Erscheinungen an der nordöstlichen Kuste Neu-Guinea's (On volcanic phenomena on the northeast coast of New Guinea, in German). *Petermanns Mitt.*, 24, 408-10.

Earth tremors were felt on the Maclay coast southeast of Madang in 1873 and 1876. The 1876 earthquakes are attributed to eruption of Vulcan (Manam) which caused seismic disturbances in the nearby Finisterre Ra. where numerous land-slips are reported. Reference is made to an earlier report (entry 02-c-30) of earthquakes in 1871-72, and to possible earthquakes on the Maclay coast in 1856 related to eruptions of Karkar volcano. Volcanic activity of Vulcan and Lesson (Bam) Is in November 1877 produced earth tremors and large volumes of glowing ash. (W.M.)

15-a-9 PIGOT, E. F., 1923 — Brief notes regarding earthquakes in the New Guinea region. *New Guinea ann. Rep. for 1921-22*, App. E, 1-4 (also issued as *Aust. parl. Pap. 18, Sess. 1923-24*, 4, 1602-5).

Most strong seismic activity in the Territory has its focus off the north coast or is associated with volcanic craters in New Britain, though the whole Territory is subject to periodic small tremors. Only 6 of the 295 earthquakes between 1 January 1916 and 30 June 1923 exceeded force 5 on the Rossi-Forel scale. (W.M.)

15-a-10 RUSSELL, H. C., 1888 — The March storms. *Nature*, 38, 491.

A 12-m tidal wave of unaccounted cause reached New Britain on 13 March (entry 15-a-13). (W.M.)

15-a-11 SIEBERG, A., 1910 — Die Erdbebentätigkeit in Deutsch-Neuguinea-Kaiser-Wilhelms-Land u. Bismarckarchipel (Earthquake activity in German New Guinea-Kaiser-Wilhelmsland and the Bismarck Archipelago, in German). *Petermanns Mitt.*, 56, 72-4; 116-22.

All earthquakes recorded in German New Guinea and the Bismarck Arch. between 1900 and 1906 are tabulated. The most active regions were the Gazelle Pen., the peninsula near Madang, north of Astrolabe Bay, and the Maclay coast. The earthquake of 15 September 1906 in western New Britain is described and interpreted. Zones of seismic activity appear to be coincident with or related to either active volcanic centres or major crustal fractures. (W.M.)

15-a-12 STANLEY, G. A. V., CAREY, S. W., MONTGOMERY, J. H., & EVE, H. D., 1935 — Preliminary notes on a recent earthquake in New Guinea. *Aust. Geogr.*, 2(8), 8-15.

Violent earth tremors occurred near Aitape in October 1935. The falling of trees, landslides, changes in river-bank properties, and jamming of streams with debris are the main features recorded. (W.M.)

15-a-13 WHARTON, W. J. L., 1889 — Volcanic sea wave, New Guinea. *Nature*, 39, 303.

An article from the 1888 issue of the Berlin *Annalen der Hydrographie* is translated. It describes the destruction caused in the Bismarck Arch. by the tidal wave generated by the volcanic eruption on 13 March 1888 (entry 15-a-1). It is suggested that an eruption 300-600 km north of Hatzfeld Har. could produce this wave effect, as well as the wave effect registered at Arica (South Africa) on 14 March, but probably not the wave effect recorded at Sydney on 15-17 March. (W.M.)

15-a-14 WINTER, F. P., 1896 — Despatch reporting visit to various places in the northeastern and eastern portions of the possession. *Brit. N. Guinea ann. Rep. for 1894-95*, App. G, 10-4.

During a visit to Sim Sim I. in the Amphlett Group an earthquake shock was felt on 6 March 1895. The shock appears to have had a nearby epicentre; the island was hit soon after the shock by a 2-m tidal wave from the west. Much animal and coral debris was washed onto the beach. (W.M.)

(b) TECHNIQUES AND INSTRUMENTATION

See also entry 16-b-21.

15-b-1 BROOKS, J. A., 1969c — The national seismic coverage. *Earthq. Engng Symp., Melbourne,* 1, 11 pp.

Maps of seismic coverage illustrate that the present Australian network of 35 permanent stations needs supplementing, especially in parts of N.S.W., Queensland, and W.A. Only in southeast Australia can earthquakes of low magnitude be measured consistently enough to allow estimation of the average frequency of large earthquakes pertinent to engineering problems.

Many variables control the computation of areas covered, and maps provided are subject to large uncertainties. These arise partly because existing methods of estimating magnitude are unsatisfactory, but could be reduced by a more refined and co-ordinated study of Australian seismicity, which would also allow more effective use of the existing seismograph network. More accelerographs are needed in New Guinea to accumulate ground acceleration data quickly from large earthquakes. This is not possible in Australia.

By 1969, permanent seismic stations were established at Port Moresby, Popondetta, D'Entrecasteaux Is, Lae, Goroka, Mt Hagen, and Rabaul; accelerographs were situated at Lae, Goroka, Madang, Talasea, Rabaul, and Bougainville. It is proposed to extend coverage to Manus I. and Talasea, and upgrade instrumentation at Talasea and Bougainville. (Auth./W.M.)

15-b-2 TAZIEFF, H., 1966 — Volcano survey. *Earth-Sci. Rev.*, 1, 299-335.

A short review is made of the main means of investigation of eruption forecast used in the few existing well staffed volcanological observatories as well as during sporadic expeditions on active volcanoes, together with non-exhaustive data obtained during recent years.

In the case of the Rabaul observatory and the volcanological station on Mt Lamington, tilt and seismic instruments are installed. Routine measurements of temperature are conducted, and preliminary work on the study of gas compositions is in progress. Volcanic prediction is of necessity the main preoccupation of observatory staff, and some success has been achieved using unrefined seismic and tilt data together with the hypothesis that forces external to the local volcanic energy system can influence its pattern of release. (Auth./W.M.)

(c) EARTHQUAKE DATA

See also entries

12-b-60 14-a-52 15-a-9 15-a-11

15-c-1 GROVER, J. C., 1958 — Structure of the region — earthquakes in the years 1952-56. *In* GROVER, J. C., PUDSEY-DAWSON, P. A., & THOMPSON, R.B.M. — The Solomon Islands — geological exploration and research 1953-1956. *Mem. Brit. Solomon Is geol. Surv.*, 2, 22-6.

The location and effects of the large earthquake on 13 October 1955 near Malaita I. are outlined. The accompanying map indicates 29 earthquakes at 13 sites on or near Bougainville I. from 9 May 1952 to 4 July 1956. The position and origin time of major earthquake centres in the Solomon Is region from 12 February 1952 to 23 July 1956 are appended. (W.M.)

15-c-2 GUTENBERG, D., & RICHTER, C. F., 1934 — On seismic waves. *Beitr. Geophys.*, 43, 56-133.

Among seismic disturbances used to interpret wave travel characteristics in the crust and upper mantle are several unlocated earthquakes in the Solomon Is and New Guinea which apparently are recorded here for the first time. They include several in the Solomon Is between April 1931 and August 1933, one in New Guinea on 7 August 1931, and one off New Guinea on 24 December 1932. (W.M.)

15-c-3 HECK, N. H., 1947 — List of seismic waves. *Bull. seism. Soc. Amer.*, 37, 269-85.

A list of sea waves or tsunamis believed to be of seismic or volcanoseismic origin include several in the New Guinea region. Those in eastern New Guinea are: (i) 2 tsunamis associated with an eruption of Raluan (Vulcan) volcano on 4 February 1878; (ii) an unlocated earthquake and sea wave on 14 September 1906; and (iii) a local tidal wave associated with an earth tremor in Huon G. on 11 October 1911. (W.M.)

15-c-4 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967a — Catalogue of events and associated observations — January 1964. *Bull. Int. seism. Centre,* 1(1), 1-234.

During January 1964, 18 earthquakes with epicentres in the New Guinea region were recorded. Most occurred in the New Ireland-New Britain area, with several scattered in or off the New Guinea mainland and Bougainville.

This is the first of a continuing series, in which data on earthquakes are tabulated in chronologic sequence. Data include preliminary and revised estimates of the time, position, and magnitude of each earthquake, and wave travel specifications from all recording stations.

Revised and improved summaries of these data are issued in the periodic Regional Catalogue of Earthquakes issued by this Centre, in which is published the time and epicentre co-ordinates of earthquakes, and magnitude and depth where known. Data for January 1964 are summarized in Vol. 1 No. 1 of this Catalogue (entry 15-c-12). (W.M.)

15-c-5 INTERNATIONAL SEISMOLOGICAL CENTRE 1967b — Catalogue of events and associated phenomena — February 1964. *Bull. Int. seism. Centre,* 1(2), 1-221.

15 earthquakes were recorded in the New Guinea region during February 1964; most had epicentres in New Britain or Bougainville. Essential data are tabulated here, and summarized in entry 15-c-12. (W.M.)

15-c-6 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967c — Catalogue of events and associated phenomena — 1964 March 1-27. *Bull. Int. seism. Centre,* 1(3), 1-212.

Nearly all earthquakes during 1-27 March had epicentres in New Britain, with only occasional centres in Bougainville and one in New Ireland. Data are recorded here, and summarized in entry 15-c-12. (W.M.)

15-c-7 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967d — Catalogue of events and associated observations — 1964 March 28-31. *Bull. Int. seism. Centre,* 1(4), 1-272.

In the last 3 days of March 1964, a large number of earthquakes were recorded in the Earth's seismic zones, including 3 centred on Bougainville. Data are tabulated, and summarized in entry 15-c-12. (W.M.)

15-c-8 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967e — Catalogue of events and associated observations — 1964 April 1-12. *Bull. Int. seism. Centre,* 1(5), 1-241.

The 5 earthquakes in New Guinea during 1-12 April 1964 had their epicentres in the New Ireland-Bougainville area. Data are tabulated, and summarized in entry 15-c-12. (W.M.)

15-c-9 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967f — Catalogue of events and associated observations — 1964 April 13-30. *Bull. Int. seism. Centre,* 1(6), 1-244.

During 13-30 April 1964 12 earthquakes were recorded in the New Guinea region. Most occurred in the New Ireland-New Britain-Bougainville zone, with 3 epicentres on mainland New Guinea and 1 near Huon G. Data are tabulated, and summarized in entry 15-c-12. (W.M.)

15-c-10 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967g — Catalogue of events and associated observations — 1964 May. *Bull. Int. seism. Centre,* 1(7), 1-396.

In May 1964, 6 earthquakes were recorded in the New Guinea region, all with epicentres in the New Ireland-Bougainville region. (W.M.)

15-c-11 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967h — Catalogue of events and associated observations — 1964 June. *Bull. Int. seism. Centre,* 1(8), 1-347.

During June 1964, 30 earthquakes were registered with epicentres in the New Guinea region. Most were in the New Britain-Bougainville region, though several epicentres in mainland New Guinea were recorded. Data are tabulated, and summarized in entry 15-c-12. (W.M.)

15-c-12 INTERNATIONAL SEISMOLOGICAL CENTRE, 1967i — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 1 No. 1, 1964 January-June. *Edinburgh, Int. seism. Centre,* 219 pp.

This is the first of a series, bringing together brief data on earthquakes recorded throughout the world and reported to the Centre. Each volume records 6-monthly lists of agencies reporting epicentre estimates, seismological observatories providing data, seismic and geographic regions of the world, shallow focus, intermediate focus, and deep focus earthquakes, probable explosions, and a catalogue of all earthquakes by region. In the regional catalogue, earthquakes are identified by date, time of origin, latitude and longitude of epicentre, depth of focus where known, magnitude where known, and I.S.C. number. For each the number of recordings of shock wave observations and delta range in degrees are noted.

During the first half of 1964, 15 earthquakes with magnitude greater than 5.5 were recorded in the New Guinea region (except West Irian and the Solomon Is). Of these, 4 were shallow earthquakes, 10 intermediate focus, and 1 deep earthquake. In all, 105 earthquakes were recorded in the region, details of which are given in the Bulletin (entries 15-c-4 to 15-c-11). (W.M.)

15-c-13 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968a — Catalogue of events and associated observations — 1964 July. *Bull. Int. seism. Centre,* 1(9), 1-380.

During July 1964, 31 earthquakes were recorded as originating in the New Guinea region. Most epicentres are in the Bougainville-New Britain-New Ireland area, with some in the Admiralty Is area and throughout the mainland. Data are tabulated, and summarized in entry 15-c-19. (W.M.)

15-c-14 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968b — Catalogue of events and associated observations — 1964 August. *Bull. Int. seism. Centre,* 1(10), 1-294.

During August 1964, 20 earthquakes were recorded in the New Guinea region. Most activity was in the Bougainville-New Britain area, with scattered epicentres east of New Ireland and near Huon G. Data are tabulated, and summarized in entry 15-c-19. (W.M.)

15-c-15 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968c — Catalogue of events and associated observations — 1964 September. *Bull. Int. seism. Centre,* 1(11), 1-273.

30 earthquakes were recorded in the New Guinea region during September 1964, with greatest activity being in the New Britain-Solomon-New Ireland area, and with scattered epicentres throughout mainland eastern New Guinea and off the north coast. Data are tabulated in entry 15-c-19. (W.M.)

15-c-16 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968d — Catalogue of events and associated observations — 1964 October. *Bull. Int. seism. Centre,* 1(12), 1-326.

Data for 29 earthquakes in the New Guinea region during this month are tabulated in entry 15-c-19. Most activity during October was in the New Britain-Bougainville region, with scattered epicentres over mainland New Guinea and off the north coast. (W.M.)

15-c-17 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968e — Catalogue of events and associated observations — 1964 November. *Bull. Int. seism. Centre,* 1(13), 1-314.

During November 1964, 67 earthquakes were recorded in the New Guinea region, most of which had epicentres in the New Britain area. Data are tabulated in entry 15-c-19. (W.M.)

15-c-18 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968f — Catalogue of events and associated observations — 1964 December. *Bull Int. seism. Centre,* 1(14), 1-289.

During December 1964, 27 earthquakes were recorded in the New Guinea region, data being tabulated in entry 15-c-19. The earthquakes were scattered throughout the region, with greatest activity in the New Britain-Bougainville area. (W.M.)

15-c-19 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968g — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 1 No. 2, 1964 July-December. *Edinburgh, Int. seism. Centre,* 215 pp.

12 earthquakes of magnitude of 5.5 or greater were recorded in the New Guinea region during the second half of 1964. A total of 194 earthquakes were recorded. Details for each are recorded in the Bulletin issued by this Centre (entries 15-c-13 to 15-c-18). (W.M.)

15-c-20 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968h — Catalogue of events and associated observations — 1965 January. *Bull. Int. seism. Centre,* 2(1), 1-283.

During January 1965, 21 earthquakes with epicentres in the Papua New Guinea region were recorded. 16 were in or near the New Britain and Bougainville Trenches, and the others were in the Bismarck Sea west of northern New Ireland and near Long I. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-21 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968i — Catalogue of events and associated observations — 1965 February 1-10. *Bull. Int. seism. Centre,* 2(2), 1-390.

Only 5 earthquakes were recorded in the Papua New Guinea area during the early part of February 1965; 2 had epicentres near Long I., 1 in the trench west of Buka I., 1 in east New Britain near Ulawun, and 1 in west New Britain near Langila. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-22 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968j — Catalogue of events and associated observations — 1965 February 11-28. *Bull. Int. seism. Centre*, 2(3), 1-255.

During the later half of February 1965, 11 earthquakes were recorded as having epicentres in the New Guinea region; 8 were in the New Britain seismic region, mostly in east New Britain and the New Britain Trench; 1 was off the New Guinea coast near the mouth of the Sepik R.; 1 was centred west of Long I.; the other was in the Bismarck Sea north of Talasea. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-23 INTERNATIONAL SEISMOLOGICAL CENTRE, 1968k — Catalogue of events and associated observations — 1965 March. *Bull. Int. seism. Centre*, 2(4), 1-464.

During March 1966, 28 earthquakes were recorded with epicentres in the New Guinea region. Nearly all were in the New Britain area associated with active volcanoes or the New Britain Trench. Others were north of Wewak, near Long I., and west of Madang. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-24 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969a — Catalogue of events and associated observations — 1965 April. *Bull. Int. seism. Centre*, 2(5), 1-390.

In April 1965, 16 earthquakes were registered with epicentres in the New Guinea seismic region; 13 were in the New Britain-Bougainville-New Ireland region; 1 was in the Bismarck Sea north of Langila in west New Britain; 1 was immediately east of the Admiralty Is, and 1 near Lae. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-25 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969b — Catalogue of events and associated observations — 1965 May. *Bull Int. seism. Centre*, 2(6), 1-312.

9 earthquakes were recorded with epicentres in the New Guinea region. 1 was in the Gazelle Pen., 4 scattered along the New Britain Trench, 1 in the Solomons Trench west of Bougainville, 1 south of the Trobriand Is, 1 near Long I., and 1 near Vanimo. Data are tabulated, and summarized in entry 15-c-27. (W.M.)

15-c-26 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969c — Catalogue of events and associated observations — 1965 June. *Bull. Int. seism. Centre*, 2(7), 1-381.

During June 1965, 15 earthquakes were recorded in the New Guinea area; 13 were in the New Britain-Bougainville-New Ireland area, 1 in the D'Entrecasteaux Is, and 1 north of Vanimo. Data are listed, and summarized in entry 15-c-27. (W.M.)

15-c-27 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969d — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 2 No. 1, 1965 January to June. *Edinburgh, Int. seism. Centre*, 248 pp.

During the first half of 1965, 5 major earthquakes were recorded in the Papua and New Guinea regions; 4 shallow focus major earthquakes were recorded, 3 in the New Britain region immediately west of Wide Bay, and 1 in the New Britain Trench; 1 earthquake of intermediate depth was recorded near Long I.

Summary data recorded for these and all other earthquakes in the region are tabulated in sequence of initiation time within geographical and seismic regions. Data tabulated include date and time of initiation, position of epicentre, depth and magnitude of shock, number of recorded observations, I.S.C. number, and delta range. In all, 104 earthquakes in the Papua and New Guinea regions are recorded. Details for each earthquake are recorded in the Bulletins prepared by this Centre (entries 15-c-20 to 15-c-26). (W.M.)

15-c-28 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969e — Catalogue of events and associated observations — 1958 July. *Bull. Int. seism. Centre,* 2(8), 1-310.

During July 1965, 15 earthquakes with epicentres in the East New Guinea region were recorded. Most had epicentres in the New Britain-Bougainville area, 2 near Dobu in the D'Entrecasteaux Group, and 1 in the Bismarck Sea. Data are tabulated, and summarized in entry 15-c-34. (W.M.)

15-c-29 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969f — Catalogue of events and associated observations — 1965 August. *Bull. Int. seism. Centre,* 2(9), 1-406.

During August, 20 earthquakes were recorded. The New Britain area was the centre of particularly intense activity (15 quakes), 3 were recorded in the New Ireland area, and 2 in eastern Papua. Data are tabulated, and summarized in entry 15-c-34. (W.M.)

15-c-30 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969g — Catalogue of events and associated observations — 1965 September. *Bull. Int. seism. Centre,* 2(10), 1-356.

22 earthquakes, all except 1 being in the New Britain-New Ireland-Solomons area, were recorded during September. Part 2 of the 1965 Regional Catalogue (entry 15-c-34) contains tabulated summary data for each shock. (W.M.)

15-c-31 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969h — Catalogue of events and associated observations — 1965 October. *Bull. Int. seism. Centre,* 2(11), 1-298.

Seismic activity recorded during October 1965 included 18 earthquakes, mostly in the New Britain-Solomons area, with only 2 shocks centred in eastern Papua. Data are listed here, and summarized in entry 15-c-34. (W.M.)

15-c-32 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969i — Catalogue of events and associated observations — 1965 November. *Bull. Int. seism. Centre,* 2(12), 1-304.

During November, 12 earthquakes were recorded in the eastern New Guinea regions. Several were centred in New Britain and New Ireland, the others scattered through eastern Papua and off the north coast of New Guinea. Data are tabulated, and summarized in entry 15-c-34. (W.M.)

15-c-33 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969j — Catalogue of events and associated observations — 1965 December. *Bull. Int. seism. Centre,* 2(13), 1-292.

12 earthquakes were recorded during December 1965; 5 were centred in the New Britain area, 2 in New Ireland, 3 off the north coast of New Guinea, and 2 in the Solomon Sea. Data are tabulated, and summarized in entry 15-c-34. (W.M.)

15-c-34 INTERNATIONAL SEISMOLOGICAL CENTRE, 1969k — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 2 No. 2, 1965 July to December. *Edinburgh, Int. seism. Centre,* 179 pp.

6 major shallow earthquakes occurred in the Papua-New Guinea region during the second half of 1965; 2 were in New Britain near Ulawun, 2 in St Georges Channel between New Britain and New Ireland, 1 in the New Britain Trench, and 1 offshore near Wewak. 3 major earthquakes of intermediate focal depth were recorded in the region: 2 in east New Britain south of Ulawun, and 1 in the Markham Valley west of Lae. 3 major deep earthquakes were recorded: 2 offshore north of Buka I. and 1 in east New Britain offshore from Talasea.

Summary data recorded for these and all other earthquakes in the region are tabulated in sequence of initiation time within geographical and seismic regions. Data tabulated include date and time of initiation, position of epicentre, depth and magnitude of shock, number of recorded observations, I.S.C. number, and delta range. In all, 99 earthquakes in the Papua and New Guinea regions are recorded. Details for each earthquake are recorded in the Bulletins prepared by this Centre (entries 15-c-28 to 15-c-33). (W.M.)

15-c-35 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970a — Catalogue of events and associated observations — 1966 January. *Bull. Int. seism. Centre,* 3(1), 1-291.

During January, 12 earthquakes were recorded with epicentre in the Papua New Guinea region. Most were in the New Britain-Bougainville-New Ireland region, particularly in the Bismarck and Solomon Seas; 2 were in the D'Entrecasteaux Is. Details of quake characteristics and observations (entry 15-c-4) are recorded for each earthquake, and summarized in entry 15-c-41. (W.M.)

15-c-36 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970b — Catalogue of events and associated observations — 1966 February. *Bull. Int. seism. Centre,* 3(2), 1-342.

Most of the 19 earthquakes in this period were centred on New Britain, with some shocks in the Bougainville and New Ireland regions, and 2 in Huon G. Details are tabulated, and summarized in entry 15-c-41. (W.M.)

15-c-37 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970c — Catalogue of events and associated observations — 1966 March. *Bull. Int. seism. Centre,* 3(3), 1-398.

Of the 14 earthquakes in Papua New Guinea regions during March, 12 were in the New Britain-New Ireland region and the Bismarck Sea, 1 was in the Huon G., and 1 near Manam I. Details are tabulated, and summarized in entry 15-c-41. (W.M.)

15-c-38 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970d — Catalogue of events and associated observations — 1966 April. *Bull. Int. seism. Centre,* 3(4), 1-386.

13 earthquakes were recorded in the Papua New Guinea region during April; 10 were in eastern New Britain-New Ireland and adjacent Bismarck Sea, 2 in mainland New Guinea near Madang, and 1 in the Huon G. Details are listed, and are summarized in entry 15-c-41. (W.M.)

15-c-39 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970e — Catalogue of events and associated observations — 1966 May. *Bull. Int. seism. Centre,* 3(5), 1-379.

20 earthquakes were recorded in May in the Papua New Guinea region. They were rather evenly distributed throughout eastern New Britain, New Ireland, nearby Bismarck Sea, and the eastern end of the New Britain Trench; 4 were recorded in mainland New Guinea, and 2 in the Papuan islands. Details are recorded, and summarized in entry 15-c-41. (W.M.)

15-c-40 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970f — Catalogue of events and associated observations — 1966 June. *Bull. Int. seism. Centre,* 3(6), 1-451.

During June 1966, 17 earthquakes were recorded with epicentres in the Papua New Guinea region; 8 were in the Papuan islands and the Solomon Sea, the others in the New Britain-New Ireland area and adjacent Bismarck Sea. Details of magnitude, depth, location, and related observations are tabulated, and the Regional Catalogue entry 15-c-41 contains summary data for each earthquake. (W.M.)

15-c-41 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970g — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 3 No. 1, 1966 January to June. *Edinburgh, Int. seism. Centre,* 239 pp.

1 major shallow earthquake was recorded in the New Guinea region during the first half of 1966 in east New Britain south of Ulawun. No major earthquakes with intermediate depth or deep focus were recorded.

Summary data recorded for these and all other earthquakes in the region are tabulated in sequence of initiation time within geographical and seismic regions. Data tabulated include date and time of initiation, position of epicentre, depth and magnitude of shock, number of recorded observations, I.S.C. number, and delta range. In all, 95 earthquakes in the Papua New Guinea region are recorded. Details for each earthquake are recorded in the Bulletins prepared by this Centre (entries 15-c-35 to 15-c-40). (W.M.)

15-c-42 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970h — Catalogue of events and associated observations — 1966 July. *Bull. Int. seism. Centre*, 3(7), 1-352.

12 earthquakes were recorded in the Papua New Guinea region during July; 3 were near Bougainville, 3 in eastern New Britain and New Ireland, 2 in Huon G., and 4 in the Bismarck Sea off the north coast of New Guinea. Details for each are listed, and are summarized in entry 15-c-49. (W.M.)

15-c-43 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970i — Catalogue of events and associated observations — 1966 August 1-16. *Bull. Int. seism. Centre*, 3(8), 1-240.

During the first half of August 1966, 6 earthquakes were recorded in the region; 5 in the New Britain-New Ireland seismic region, the other in the Salamaua area. Details of these earthquakes are tabulated, and are summarized in entry 15-c-49. (W.M.)

15-c-44 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970j — Catalogue of events and associated observations — 1966 August 17-31. *Bull. Int. seism. Centre*, 3(9), 1-245.

Only 2 earthquakes were recorded in the Papua New Guinea region during this period, 1 in the Huon G. southeast of Lae and the other in the Pacific Ocean east of Namatanai in southern New Ireland. Data are quoted, and appear in summary in entry 15-c-49. (W.M.)

15-c-45 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970k — Catalogue of events and associated observations — 1966 September. *Bull. Int. seism. Centre*, 3(10), 1-367.

12 earthquakes with epicentres in the Papua and New Guinea region were recorded, 6 near the east New Britain Trench and New Ireland, 4 in mainland eastern Papua, and 2 in the Bismarck Sea near Long I. Details are tabulated, and summary data published in entry 15-c-49. (W.M.)

15-c-46 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970l — Catalogue of events and associated observations — 1966 October. *Bull. Int. seism. Centre*, 3(11), 1-371.

During October, 19 earthquakes with epicentres in the Papua New Guinea area were recorded. They were fairly uniformly scattered throughout the seismic regions, with over half in the Bougainville-New Britain-New Ireland region. Details are given, and summary data tabulated in entry 15-c-49. (W.M.)

15-c-47 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970m — Catalogue of events and associated observations — 1966 November. *Bull. Int. seism. Centre*, 3(12), 1-328.

20 earthquakes with epicentres in Papua New Guinea were recorded during November, 11 in New Britain and Bougainville regions, 2 in New Ireland and adjacent Bismarck Sea, 1 near Dobu I. in the D'Entrecasteaux Group, and the rest on the mainland. Details are listed, and are tabulated in entry 15-c-49. (W.M.)

15-c-48 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970n — Catalogue of events and associated observations — 1966 December. *Bull. Int. seism. Centre*, 3(13), 1-342.

During December, 19 earthquakes were recorded with epicentres in the Papua New Guinea region. They were scattered throughout the area with a slight concentration in the New Britain seismic region. Data are detailed here, and are listed in entry 15-c-49. (W.M.)

15-c-49 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970o — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 3 No. 2, 1966 July to December. *Edinburgh, Int. seism. Centre,* 249 pp.

2 major shallow earthquakes were recorded in the Papua New Guinea region during the second half of 1966, 1 southwest of Wewak and 1 in Huon G. 1 intermediate depth earthquake was recorded, in the western Schrader Ra. south of the mouth of the Sepik R. 1 deep focus earthquake was recorded northeast of Buka I.

Summary data recorded for these and all other earthquakes in the region are tabulated in sequence of initiation time within geographical and seismic regions. Data tabulated include date and time of initiation, position of epicentre, depth and magnitude of shock, number of recorded observations, I.S.C. number, and delta range. In all, 90 earthquakes in the Papua and New Guinea regions are recorded.

Details for each earthquake are recorded in the Bulletins prepared by this Centre (entries 15-c-42 to 15-c-48). (W.M.)

15-c-50 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970p — Catalogue of events and associated observations — 1967 January 1-15. *Bull. Int. seism. Centre,* 4(1), 1-247.

9 earthquakes with epicentres in the Papua New Guinea region were recorded during the first half of January 1967, 2 in the Bismarck Sea, 5 in New Britain, and 2 near Huon G. Details are listed, and are tabulated in entry 15-c-57. (W.M.)

15-c-51 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970q — Catalogue of events and associated observations — 1967 January 16-31. *Bull. Int. seism. Centre,* 4(2), 1-259.

During the second half of January, 14 earthquakes were recorded with epicentres in Papua New Guinea. Most were near New Ireland and eastern New Britain, with 4 in the Bismarck Sea and 1 off the south coast of western Papua. Details of origin and situation are listed, and are also summarized in entry 15-c-57. (W.M.)

15-c-52 INTERNATIONAL SEISMOLOGICAL CENTRE, 1970r — Catalogue of events and associated observations — 1967 February. *Bull. Int. seism. Centre,* 4(3), 1-329.

In February, 19 earthquakes were recorded with epicentres in the Papua New Guinea region. Almost all were near New Britain and New Ireland, with 2 in the western Bismarck Sea and 1 in the D'Entrecasteaux Is. For each earthquake, data presented include preliminary and revised estimates of time, position and magnitude of shock, together with wave travel specifications from all receiving stations. This data is summarized and refined in entry 15-c-57. (W.M.)

15-c-53 INTERNATIONAL SEISMOLOGICAL CENTRE, 1971a — Catalogue of events and associated observations — 1967 March. *Bull. Int. seism. Centre,* 4(4), 1-441.

During March 1967, 21 earthquakes with epicentres in the Papua New Guinea region were recorded, 16 in the east New Britain-Bougainville-New Ireland area, 4 in the Solomon Sea east of Papua, and 1 in the Bismarck Sea north from Talasea. Details are tabulated, and summary data appear in entry 15-c-57. (W.M.)

15-c-54 INTERNATIONAL SEISMOLOGICAL CENTRE, 1971b — Catalogue of events and associated observations — 1967 April. *Bull. Int. seism. Centre,* 4(5), 1-427.

36 earthquakes with epicentres in the Papua New Guinea area were recorded in April. Almost all were in the New Britain geographic region and in the vicinity of Bougainville I., with a few scattered in the Bismarck Sea around the Admiralty Is and 2 in the Solomon Sea east of Papua. Data are tabulated, and a summary appears in entry 15-c-57. (W.M.)

15-c-55 INTERNATIONAL SEISMOLOGICAL CENTRE, 1971c — Catalogue of events and associated observations — 1967 May. *Bull. Int. seism. Centre,* 4(6), 1-410.

In the Papua New Guinea region, 23 earthquakes were recorded during May 1967. Most were in the east New Guinea region, mostly in the western Solomon Sea. Some were scattered near east New Britain and Bougainville. Details are listed, and also appear in the summary in entry 15-c-57. (W.M.)

15-c-56 INTERNATIONAL SEISMOLOGICAL CENTRE, 1971d — Catalogue of events and associated observations — 1967 June. *Bull. Int. seism. Centre*, 4(7), 1-428.

The level of seismic activity in Papua New Guinea during June 1967 was particularly high, with 50 shocks being recorded. Of these, 36 were near east New Britain-New Ireland-Bougainville. The rest were scattered throughout mainland New Guinea, the western Solomon Sea and mainland eastern Papua, and in the Bismarck Sea west of northern New Ireland. Data are listed, and also appear in summary in entry 15-c-57. (W.M.)

15-c-57 INTERNATIONAL SEISMOLOGICAL CENTRE, 1971e — REGIONAL CATALOGUE OF EARTHQUAKES, Vol. 4 No. 1, 1967 January to June. *Edinburgh, Int. seism. Centre,* 269 pp.

1 shallow major earthquake was recorded in the Papua New Guinea region during the first half of 1967, in the Solomon Sea south of C. St George and west of Buka I. 1 earthquake of intermediate depth was recorded in the Finisterre Ra. southeast of Madang. 1 deep focus large earthquake was recorded off the north coast of the Gazelle Pen.

Summary data recorded for these and all other earthquakes in the region are tabulated in sequence of initiation time within geographical and seismic regions. Data tabulated include date and time of initiation, position of epicentre, depth and magnitude of shock, number of recorded observations, I.S.C. number, and delta range. In all, 172 earthquakes in the Papua and New Guinea regions are recorded. Details of each earthquake are recorded in the Bulletins prepared by this Centre (entries 15-c-50 to 15-c-56). (W.M.)

15-c-58 SMITHSONIAN INSTITUTION, CENTRE FOR SHORT-LIVED PHENOMENA, 1969 — ANNUAL PROGRESS REPORT — 1968. *Cambridge, Mass., Smithsonian Inst.,* 152 pp.

Included in the events reported were: (i) the submarine landslip in the Solomon Sea 400 km southeast of Madang, in which a sand avalanche after a submarine earthquake broke a marine telephone cable on 17 September 1968; (ii) 2 damaging earthquakes in the east Sepik region in September and October 1968, one of magnitude 6.6 and the other 6.4 on the Richter scale, associated with a focus at a depth of 29 km and situated at 3.7°S, 143.0°E; (iii) an earthquake of magnitude 7.1 near Wewak, with an epicentre at 2.5°S, 144.0°E on 23 October 1968. (W.M.)

16 SOLID EARTH GEOPHYSICS

(a) General and Interpretative

See also entry 18-a-13.

16-a-1 Anonymous, 1965a — Proposals for New Guinea Upper Mantle Project. *In* Ringwood, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRSSS REPORT 1960-65. *Canberra, Aust. Acad. Sci.*, 174-80.

Gravity studies have indicated a major trough associated with the Planet Deep, continuing up the Ramu and Markham valleys and along the Sepik valley north of the central range. On the north fall of the Owen Stanley Ra. high-density rocks crop out and occur at depth, and they are interpreted as modified derivatives of the Upper Mantle. Study of seismic records indicates that P-wave velocities range from 7.9 km/s at the top of the mantle to 7.6 km/s at a depth of 150 km with a low-velocity channel. Palaeomagnetic data indicate that New Guinea has been undergoing a strong counter-clockwise rotation since the Cretaceous. (W.M.)

16-a-2 Cummings, D., & Shiller, G. I., 1971 — Isopach map of the Earth's crust. *Earth-Sci. Rev.*, 7, 97-125.

Thickness values of the crust, based on seismic studies, have been compiled and plotted on a map of the world. The available data are insufficient to meaningfully analyse and interpret the crustal thickness. Hopefully, as new values are published, the map can be periodically updated to serve the geologic and geophysical community. Data from the east New Guinea region are taken from entry 16-b-14. (Auth./W.M.)

16-a-3 Davies, H. L., & Milsom, J. S., 1969 — Eastern Papuan geology and gravity (Abstract only). *EOS*, 50(4), 333.

A west-northwest-trending core of sialic rocks, 900 km x 60 km, is flanked by rocks of oceanic origin. The sialic rocks were derived from the Australian continent in Cretaceous (and earlier?) time; they include phyllite, schist, and gneiss intruded by granitic rocks in which alkali feldspar is a major component and mica is usually present. The oceanic rocks are derived from oceanic crust and mantle; they rarely contain any alkali feldspar or mica, and potash content is low. A section through oceanic mantle and crust is exposed in the Papuan Ultramafic Belt: basal ultramafics (dunite, harzburgite, pyroxenite) are overlain by 5-10 km of gabbro, which is in turn overlain by 5-10 km of Cretaceous basalt and minor andesite; Eocene quartz diorite intrudes at the gabbro-basalt interface. Oceanic mantle and crust moved west or southwest over the sialic core in the Eocene or Oligocene. Vigorous mid-Miocene to Recent orogeny was preceded by lower Miocene basalt volcanism. Overall Bouguer gravity values are high, anomalies large, and gradients steep; (relative) lows are associated with sial and sedimentary basins, and highs with oceanic rocks, especially ultramafics. (Auth.)

16-a-4 Furumoto, A. S., 1970 — Geophysical investigations in the southwest Pacific by the Hawaii Institute of Geophysics. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

The Hawaii Institute of Geophysics has sent 8 survey expeditions during 1965-70 to the Southwest Pacific including New Guinea, Solomon Is, and New Hebrides. These expeditions were co-ordinated and all available geophysical methods were used: gravity and magnetic surveys, seismic profiling, seismic refraction surveys, heat flow measurements, ocean bottom coring, etc. Some of the results were: discovery of a thick crust under the Ontong-Java Plateau, high positive gravity anomaly over the Solomon Sea, discontinuous crustal variations under the Solomon Sea, a thin crust under the Slot in the Solomon Islands, undulating sea floor with long wavelengths north of the Solomon Is, and a large vertical discontinuity along the Weitin Fault in New Ireland. (Auth.)

16-a-5 GIRDLER, R. W., 1968 — Statistical analyses of terrestrial heat flow and seismicity of the Pacific Ocean. *Geophys. Monogr. Amer. geophys. Un.*, 12, 35-9.

Correlations are drawn between depth of seismicity, satellite gravity data, heat flow, and various tectonic features of the Pacific Ocean. The region of shallow seismicity forms a continuous belt following the East Pacific rise, which crosses and connects 2 regions of negative free-air gravity. The deep earthquakes occur in 2 separate regions (off eastern and southeastern Asia including New Guinea, and the western part of South America) and are associated with island arcs and deep-sea trenches that occur in regions of positive free-air gravity. As the belt of shallow seismicity is a region of crustal extension and the areas of deep seismicity are regions associated with compression, it is suggested that the regions of negative free-air gravity are a consequence of uprising mantle convection and the regions of positive free-air gravity are a consequence of descending mantle convection. In support of this, the heat flow over the regions of negative gravity is found to be higher than the heat flow over regions of positive gravity. (Auth./W.M.)

16-a-6 MEINESZ, F. A. VENING, 1961 — Orogeny in the New Guinea, Palao, Halmaheira area: geophysical evidence. *Proc. Acad. Sci. Amst.*, 64, 240-44.

Mantle currents flowing out from below Asia are proposed as the main agent in fashioning the features of the island arc system bordering the east coast of Asia, as well as the Australian continent. The theory of shear which predicts over-riding is applied to an analysis of the structure of the area in which the New Guinea, Palao, and Halmaheira islands are situated. (W.M.)

16-a-7 ST JOHN, V. P., 1967b — Evidence from gravity of the state of the crust and upper mantle in the New Guinea region. *39th ANZAAS Cong., Melbourne,* Sec. C Abs., M9-10.

Anomalies based on several different methods of reduction are used in interpretation of a regional gravity survey of Papua New Guinea.

Some topographic correlation with mean free-air anomalies is evident in the central highlands, but is less pronounced in the Owen Stanleys and absent in the Finisterre-Saruwaged block. These anomalies give the strongest definition of first-order tectonic features. A positive free-air anomaly through the central highlands indicates a mass-excess which becomes greater to the west. Flanking it on the south is a small negative anomaly over the Papuan Geosyncline; and on the north a low trends through the Sepik valley and the Finisterre Ra. to link up with the southern negative through the uplifted Aure Trough.

Bouguer anomaly profiles across the area indicate a downwarp of the crust under the central cordillera, but not to the extent required by an assumption of local compensation. The mass-deficiencies to the north and south are due to deep sediments partly, and sometimes completely, compensated by a rise in the base of the crust.

Isostatic anomalies, on both hypotheses, are small over the central cordillera, thereby indicating that local compensation can largely explain the Bouguer anomalies. Consistent with the mass-excess indicated by the free-air anomalies, isostatic anomalies become positive over the Star Mts. The only seismic evidence available confirms the existence of some crustal thickening under the cordillera.

The Owen Stanley Block and Papuan Ultrabasic Belt are encompassed by a free-air anomaly and separated by the Aure Trough low from the central cordillera. On the western side of the Goropu Mts the anomaly has a pronounced sinistral offset. A transcurrent fault here would be consistent with an origin of the Papuan Ultrabasic Belt as a thrust from the northeast of subcrustal material over metamorphics. The regional Bouguer anomalies indicate that such a structure is quite possible.

The free-air and Bouguer profiles over the New Britain Trench show a crustal thinning which is probably tensional in origin. Free-air, Bouguer, and isostatic anomalies are strongly positive on the north coasts of New Guinea and New Britain, and are explained by a general thinning of the crust. This is also the case in the Solomon Is chain. (Auth./W.M.)

16-a-8 TAYLOR, G. A. M., 1967 — Vulcanology, seismology and petrology in the Territory of Papua and New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-57. *Canberra, Aust. Acad. Sci.*, 153-6.

Improved instrumentation has been made in volcano surveillance. Esa'ala Obersvatory (09°44'18.2"S, 150°48'50.7"E) is now operating continuously with data from long and short period seismic recorders and from water tube tiltmeters. Manam Observatory (04°06'S, 145°02'E) is having its temporary instruments replaced by permanent equipment of a type similar to that at Esa'ala. Temporary field stations are operating on Bagana and Ulawun volcanoes both of which erupted in 1966. It is expected that the central observatory at Rabaul will have a telemetered network in operation by June 1967. FM seismic signals from 5 seismometer stations situated near active vents within the caldera will be received at the observatory on short period visual recorders; 4 stations will be connected to the observatory by underground cable and 1 by a VHF radio link.

In October 1967, a crustal study project is to be undertaken in the Rabaul area. About 40 charges will be exploded in the sea on 2 lines orientated through the region in east-west and north-south azimuths. Recordings will be made by land-based geophone spreads and single component stations as well as by the Rabaul Observatory network. The data derived from this experiment will be of value to the volcano surveillance system at Rabaul. Petrological study of the New Guinea lavas is proceeding and a detailed examination of the geology of the Blanche Bay caldera area is being undertaken. (Auth.)

16-a-9 TAYLOR, G. A. M., et al., 1965 — Vulcanology, seismology and petrology in the Territory of Papua and New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT 1960-65. *Canberra, Aust. Acad. Sci.*, 100-1.

Serious study of volcanism in New Guinea began at Rabaul in 1937 after the eruption of Tavuvur volcano in May. An observatory was completed in 1939 and provisionally equipped with seismographs of the Hawaiian type. The institution was destroyed during the war and reconstruction began in 1950. A heavy-motion Omori type seismograph was installed initially and this was supplemented in 1953 by a 3-component, short-period Benioff seismograph. In 1962 World Wide standard instruments were installed and the current instrument program includes a 5-station telemetered array which will go into operation in 1966.

Some success has been achieved in the prediction of eruption events by recognition of a triggering action from luni-solar tidal forces. Another factor which appears to have a bearing on volcanic activity is the conditions of regional stress as manifest in the occurrence of tectonic earthquakes. The likelihood of a stress condition having some bearing on the behaviour of a volcano was first suggested by investigation of an eruption of Ambryn volcano in the New Hebrides in 1951. Subsequent examination of the available data on seismic and volcanic events in New Guinea revealed patterns suggesting an episodic character to the stress pulses which caused unusual earthquakes and closely associated volcanic instability. (Auth./W.M.)

(b) Seismic

See also entries

02-d-53	14-c-4	15-a-11	16-c-4

16-b-1 Acharya, H. K., 1971 — Variation of stress in Upper Mantle. *EOS*, 52(4), 279.

Magnitude frequency relation for earthquakes in the island arcs for the years 1961-67 have been examined. In the Solomons-New Guinea, New Hebrides, and Andes regions, below the level of minimum activity, the value of the slope is significantly small. Therefore, stress under these regions may be significantly higher than elsewhere in the upper mantle. (Auth.)

16-b-2 Australia, Bureau of Mineral Resources Geology & Geophysics, 1965 — Observatory Seismology. *In* Ringwood, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT 1960-65. *Canberra, Aust. Acad. Sci.*, 19-20.

8 seismological observatories are operated at Port Moresby, Darwin, Kalgoorlie, Mundaring, Toolangi, Macquarie Island, Mawson, and Wilkes. All observatories contribute to 2 world-wide data-collecting systems, the USCGS system of preliminary epicentre and origin time determinations, and the ISRC program of final determinations.

A study has been made of the residuals of seismic travel times in various parts of Australia based on epicentre and origin times as determined by the USCGS. A wide range in P-wave velocities in the upper mantle is indicated. The highest velocities are found in the southern part of the Western Australian shield and the lowest velocities in New Guinea. (Auth./W.M.)

16-b-3 Balakina, L. M., 1961 — The character of stresses and rupture in the earthquake foci of the Pacific seismic zone. *10th Pacif. Sci. Cong., Honolulu*, Abs. Vol., 354.

Earthquakes may be connected with orogenesis in the circum-Pacific region and may originate in geotectonic movements in the crust and mantle. If the stresses acting at the foci are part of the total field of stresses in the seismic zone, the latter can be evaluated by studying the earthquake foci. It is assumed that at the foci of both surface and deep earthquakes, a rupture takes place when an earthquake occurs, with relative translation of its faces. A study was made of 58 Pacific seismic zone earthquakes, whose depths of foci ranged from about 20 to 700 km. The results do not confirm the view that in the Pacific seismic zone transcurrent movements predominate on rupture planes inclined toward the continents. On the contrary, they indicate the absence of large horizontal strike slips. (Auth.)

16-b-4 Balakina, L. M., 1962 — General regularities in the directions of the principal stresses effective in the earthquake foci of the seismic belt of the Pacific Ocean. *Akad. Nauk. SSSR, Izv. geopizs. Ser.*, 7, 918-26.

A study was made of the orientation of the axes of the principal stresses in the foci of earthquakes of the seismic belt of the Pacific Ocean. It was found that the Earth's crust and the upper layers of the mantle in the region of the Pacific coast are being subjected to the effect of stresses in which the maximum compression is almost horizontal, and perpendicular to the structural trend. (W.M.)

16-b-5 Brooks, J. A., 1962 — Seismic wave velocities in the New Guinea-Solomon Islands region. *Geophys. Monogr. Amer. geophys. Un.* 6, 2-10.

Independent values of the velocity of P-waves have been determined to a depth of 500 km below the New Guinea-Solomon Is region from an empirical study of the arrival times at the surface from 185 earthquakes. The existence of a low-velocity channel with an axis at a depth of 150 km, where P-waves may be transmitted at a velocity of 7.6 km/s, is inferred.

The use of preliminary earthquake epicentres, origin times, and depths of the USCGS have confirmed the greater reliability of such data since these were determined by electronic computer. (Auth.)

16-b-6 BROOKS, J. A., 1965a — Earthquake activity and seismic risk in Papua and New Guinea. *Bur. Miner. Resour. Aust. Rep.* 74, 30 pp.

Seismic activity in Papua New Guinea is very high, comprising 5-10% of the world's total earthquake occurrences. Earthquakes potentially large enough to cause considerable damage occur at an average rate of about 10/year. Seismic activity during the last 50 years indicates a periodic variation and general trends of seismic activity may thus be predictable. In 1963 the whole region was apparently strained to an extent not surpassed in the last 30, possibly 50, years; the next 4-5 years may therefore be a period of relatively high seismic activity. (Auth.)

16-b-7 BROOKS, J. A., 1965b — Phase velocity project — New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — AUSTRALIAN PROGRESS REPORT 1960-65. *Canberra, Aust. Acad. Sci.* 23.

A network of 3 long-period field seismographs have been set up in New Guinea to determine phase velocity dispersion in surface waves from teleseisms. The position of the network will be changed periodically so that the depth to the upper mantle can be determined in a number of areas. The first area to be studied is part of the Owen Stanley Ra. (Auth./W.M.)

16-b-8 BROOKS, J. A., 1965c — Seismicity of New Guinea. *38th ANZAAS Cong., Hobart,* Sec. C Abs.

The seismicity of the region is described by the distribution of earthquakes according to size and focal position with time. The starting point for any description of seismicity is the epicentre map. Lack of data restricts the New Guinea map to earthquakes of magnitude 6 or over, of which about 250 have been catalogued since 1930. Consideration of actual occurrences places the average incidence per century at about 900-1000 earthquakes of magnitude 6.0 or greater, of which about 10-15% are above magnitude 7. Shallow earthquakes comprise the bulk of occurrences in the New Guinea islands and western Sepik district. Intermediate shocks are mostly characteristic of activity under the Eastern Highlands and Finisterre Ra., and deep earthquake epicentres are almost entirely restricted to a zone striking southeast and including Bougainville and New Ireland.

Return period diagrams compare New Guinea shallow (100 km) earthquake data with that for Southern California and the world as a whole. This shows that large earthquakes tend to recur within the following periods:

Magnitude	Return Period (years) World	S. California	New Guinea	Last Occurence New Guinea
7½	1	35	7 (5-10)	1955
7¾	2½	60	15 (9-40)	1953?; 1946
8	6	100	30 (17-80)	1939?; 1906

The New Guinea figures in parenthesis give the time range within which there is a 2/3 probability of occurrence of an earthquake of the indicated magnitude.

Comparison of activity on a similar basis within the Territory east and west of 148°E longitude reveals the following:

Magnitude	Return Period (years) E of 148°E	W of 148°E
7½	8	15
7¾	17	30
8	30	60

Thus the eastern sector experiences roughly twice as much activity as the western sector, if the normal frequency magnitude law applies for smaller earthquakes.

Rayleigh wave dispersion data indicate a crustal thickness about 45-50 km under the central Papuan landmass. (Auth.)

16-b-9 BROOKS, J. A., 1965d — Seismicity of the Territory of Papua and New Guinea. *3rd Wold Conf. Earthq. Engng, Sess. 3,* 111/B/10/1-0.

The distribution of large earthquakes in Papua New Guinea provides the only practicable means at present to zone the region according to probable maximum intensities. Changing probabilities with time are illustrated by three maps compiled for 25, 50, and 100 year intervals. The pattern of seismic activity during the last 50 years is analysed from the standpoint of strain fluctuations. In 1963 the relative level of accumulated regional strain appeared to be high. (Auth.)

16-b-10 BROOKS, J. A., 1967 — Phase velocity project, New Guinea. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.,* 36.

Field observations of fundamental mode Rayleigh waves have been completed for networks covering the general areas of the Owen Stanley Ra., the Eastern Highlands, and the G. of Papua. Provisional time domain analyses indicate a crustal thickening under the Owen Stanley Ra. Many recordings show a high degree of irregularity, probably owing to the interfering effects of superimposed multipath transmissions. (Auth.)

16-b-11 BROOKS, J. A., 1969a — Rayleigh waves in southern New Guinea — 1. Higher mode group velocities. *Bull. seism. Soc. Amer.,* 59, 945-58.

A shear velocity structure having features similar to the Gutenberg model for the upper 200 km of the mantle is consistent with features of higher mode Rayleigh-wave group-velocity dispersion curves in the period range 4 to 30 seconds, for paths across southern New Guinea. Pronounced discontinuities appear to be absent within the crust where shear velocities are expected to gradually increase with depth. Clearly dispersive second mode Rayleigh waves, well separated in time from the fundamental mode, are shown for path lengths less than 2000 km. Frequencies excited show some dependence on focal depth. Stationary wave groups of period 10-20 seconds, very like the Sa phase, and generated by earthquakes of focal depth 100-160 km, coincide with expected normal mode group arrivals. (Auth.)

16-b-12 BROOKS, J. A., 1969b — Rayleigh waves in southern New Guinea — 2. A shear velocity profile. *Bull. seism. Soc. Amer.,* 59, 2017-38.

A profile to 300 km beneath the southern New Guinea Shield region reveals lower average shear velocities than beneath the Canadian Shield and slightly lower than the Gutenberg model. Disparity with Brune and Dorman's CANSD profile is greatest (0.3 km/s) immediately beneath the Moho, but persists to more than 200 km depth and is interpreted to mean that upper mantle mineralogy beneath southern New Guinea differs from that beneath the Canadian Shield.

The numerical inversion technique of Dorman and Ewina was used in a combined reduction of fundamental and first higher Rayleigh mode 'single-station' phase velocities after isolating the approximate value of initial source phase using group velocities as a reference.

Average crustal thickness, from fundamental mode data alone, is 33 ± 1 km over about 1500 km of southern New Guinea path, a figure consistent with an average Poisson's Ratio for the crust of 0.23 to 0.32. (Auth.)

16-b-13 CLEARY, J. R., 1967 — P-time terms at Australian stations. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.,* 26.

Amchitka I. and the Marshall Is lie in about the same azimuth from most

Australian stations. Station time terms calculated from nuclear events on these islands should therefore be compatible with each other; i.e. no errors will be caused by the presence of azimuthal variations in the time terms.

Analysis of P times from these events with the aid of the Cleary-Hales travel time curve has provided estimates of time terms for almost all Australian stations. These show regional features similar to those observed in other parts of the world: negative terms (early arrivals) in shield areas, and positive terms (late arrivals) in areas of recent tectonic uplift. The time term calculated for Port Moresby is −0.8. (Auth./W.M.)

16-b-14 DENHAM, D., 1968a — Thickness of the earth's crust in Papua and New Guinea and the British Solomon Islands. *Aust. J. Sci.*, 30, 277.

Crustal thicknesses determined by an analysis of the P-wave spectrum from deep earthquakes recorded at 3 localities are presented. At Port Moresby a crustal thickness of the order of 31 km is indicated, with thicknesses of 14.5 km at Rabaul and 17 km at Honiara (the latter result is considered unreliable). (W.M.)

16-b-15 DENHAM, D., 1968b — Seismicity of Papua-New Guinea, 1958-1966. *40th ANZAAS Cong., Christchurch*, Sec. C Abs.

The location of earthquakes is related to the main structural units in the Papua New Guinea-Solomon Is region. A new trend (the Bismarck Sea lineament) consisting of a line of shallow earthquakes across the Bismarck Sea is thought to be either an embryonic mid-ocean ridge or a fault zone. Cross-sections both parallel and perpendicular to the strike of the New Britain Arc and the Solomon Chain show that the north New Guinea coastal region of uplift is on a different trend to the island arc structures of New Britain; and that most of the seismicity of the region is possibly associated with the spreading of the Solomon Sea. Depth, magnitude, and strain release statistics for the period 1958-66 show that the strain release has been reasonably constant for the period; that most of the events occur in the depth range 20-30 km and that currently all events with magnitude 5 and greater can be located. (Auth.)

16-b-16 DENHAM, D., 1969a — Distribution of earthquakes in the New Guinea-Solomon Islands region. *J. geophys. Res.*, 74, 4290-9.

This is similar to entry 16-b-15.

16-b-17 DENHAM, D., 1970 — Earthquakes. *In* WARD, R. G., & LEA, D. A. M. (Eds) — AN ATLAS OF PAPUA AND NEW GUINEA. *Port Moresby* and *Glasgow, Univ. Papua New Guinea* and *Collins-Longman*, 36-7.

The New Guinea-Solomon Islands region is in the zone of interaction between the westward-spreading Pacific plate and the northward-moving Australian plate. In the New Guinea region the main seismic activity is associated with the northward-moving Australian plate, which has its leading edge along the north coast of New Guinea and the northern boundary of the Solomon Sea. The map locates epicentres of earthquakes recorded between 1958 and 1968 which had a force of 5.5 or greater.

The most active seismic area is associated with the New Britain Island Arc, which is a gently curved feature with a line of volcanoes located on the northern concave side and a deep ocean trench which reaches a maximum depth of about 9140 m at the convex southern side of the island. Seismic activity associated with this arc is highest near east New Britain. Most shocks are located in the 40-60 km depth range. In general the shallow earthquakes lie at the southern side of the island and the active seismic zone dips north under the island. The deepest shocks associated with the zone occur under the Bismarck Sea at depths down to 600 km. The secondmost active area is between Bougainville and New Ireland, where the seismic zone dips northwest under the axis of the Solomon Is.

A line of shallow earthquakes stretching across the Bismarck Sea from the south-west end of New Ireland to the New Guinea coast near Wewak (Bismarck Sea Seismic Lineation) is well defined and its maximum width appears to be about

40 km. It does not correspond to any known topographic feature on the floor of the ocean.

2 important zones of minor seismicity are revealed on the map. 1 is associated with the West Melanesian Arc, which stretches from the north of New Ireland to the West Irian border with its convex side facing north. Only a few earthquakes occur in this zone, which is probably caused by the interaction of the Pacific Plate with the northern edge of the New Guinea region. The second zone stretches from the volcanic region in southeast Papua to the Solomon Is and appears to be associated with the ridge across the Solomon Sea. (W.M.)

16-b-18 DENHAM, D., 1971 — The seismicity of the south-west Pacific and new global tectonics. *12th Pacif. Sci. Cong., Canberra,* Abs. Vol., 350.

The spatial distribution of earthquakes in the Southwest Pacific is examined in relation to plate tectonics. In the Tonga-Kermadec area the westward movement of the Pacific plate is predominant and causes vigorous underthrusting of the lithosphere. West of Fiji the Indian-Australian plate exerts the major influence because of the 'shadow zone' effect of the Tonga-Kermadec feature. The leading edge of the plate extends from India, through Indonesia, New Guinea, and the Solomon Is to the New Hebrides. In general the distribution of earthquakes at this boundary consists of a series of north-dipping seismic zones correlating well with ocean trenches and indicative of underthrusting.

Several of the tectonically active areas of the Southwest Pacific result from interaction between ocean provinces. The complicated New Guinea-Solomon Is region contains both ocean/ocean and continent/ocean interactions and the seismicity of this region is examined in detail. Several well defined seismic zones are revealed most of which can be explained in terms of sea-floor spreading. (Auth.)

16-b-19 DENHAM, D., & BYRNE, W. M. J., 1969 — A storage and retrieval system of seismic data for the New Guinea and Solomon Islands region. *Earthq. Engng Symp., Melbourne,* 2, 5 pp.

As the economy of Papua New Guinea has developed, the need for a reliable system of supplying local earthquake data reports has increased considerably. Earthquake risk must now be considered in any engineering project undertaken in New Guinea.

This paper describes a computerized storage and retrieval system for seismic data that has been in use for about 2 years in Port Moresby. The data, which consist of felt reports and hypocentral details of local earthquakes, are stored on a magnetic disc of an IBM 1130 computer. The method of data processing and some of the system's uses are described. It is estimated that the disc at present in operation will store about 24 000 separate events and should be sufficient until the 1980s. (Auth.)

16-b-20 DENHAM, D., & EVERINGHAM, I. B., 1970 — Seismicity in the New Guinea-Solomon Islands region. *42nd ANZAAS Cong., Port Moresby,* Sec. 5 Pap., 1, 6 pp.

Recent studies based on results of a better seismograph network have improved the definition of seismic zones in the New Guinea-Solomon Is region. The main area of seismic activity runs along the northern part of New Guinea, New Britain, Bougainville, and the Solomon Is chain. The most active seismic regions are in central east New Britain and between Bougainville and New Ireland. (Auth.)

16-b-21 DENHAM, D., & EVERINGHAM, I. B., 1971 — Seismicity of the New Guinea-Solomon Islands region. *Civ. Engng Trans.,* April 1971, 75-8.

This is similar to entry 16-b-20.

16-b-22 DOYLE, H. A., & WEBB, J. P., 1963 — Travel times to Australian stations from Pacific nuclear explosions in 1958. *J. Geophys. Res.,* 68, 1115-20.

Travel times from the 1958 series of nuclear explosions near Bikini and Eniwetok Is to Australian seismic stations were studied. For stations at distances between 25° and 63° the mean residual for *P* from the Jeffreys-Bullen times for a surface focus was —1.6±0.7 s, agreeing with travel-time determinations to other continents. Times to Rabaul (19° and 21°) strongly suggest a sharp bend in the *P* curve near 17°, corresponding to the '20° discontinuity'. There is also a possible bend near 25° to 26°, but this would be less marked. (Auth.)

16-b-23 DUBOIS, J., 1968 — Etude de la dispersion des ondes de Rayleigh dans la région du sud-ouest Pacifique (Study of the dispersal of Rayleigh waves in the southwest Pacific region, in French). *Ann. de Geophys.*, 24, 1-10.

Rayleigh waves dispersion at seismological stations of Noumea (New Caledonia) and Port-Vila (New Hebrides) is considered for 54 earthquakes which occured in Indonesia, New Britain, Solomon Islands, New Zealand, and Macquarie Islands. Structural heterogeneities of the area between Australia and the andesite line appear. Comparison of group velocities with SAITO and TAKEUCHI models implies: a thick crust in the northwest of the Coral Sea (30 km and more), a 22-28 km crust in the Fiji-Tonga-Samoa area, on the northwest side of which 2 basins have a thin crust (15 km). The Norfolk ridge appears to be on a direction where the crust would be thicker than in the surrounding oceanic areas. An upper mantle with P and S waves low velocities would be under the Coral Sea and New Caledonia-New Hebrides area; this fact agrees fairly with late arrivals observed in body waves propagation. A shear wave low-velocity layer at a depth of 60 km would be in good agreement with data for the oceanic basins between New Hebrides and Fiji, Kermadec and New Caledonia, Australia and New Zealand. The study of Rayleigh waves first mode dispersion along the New Hebrides seismic belt gives results in fair agreement with observed S and P waves propagation anomalies. (Auth.)

16-b-24 DUBOURDIEU, G., 1969 — LA CEINTURE DU PACIFIQUE ET LES SYNCHRONISMES DE SON ACTIVITE SEISMIQUE (The Circum-Pacific Belt and the synchronism of its seismic activity, in French). *Le Neubourg, Imprimerie du Neubourg*, 47 pp.

A study of seismic activity in time in the Circum-Pacific Belt leads to 2 conclusions: (1) seismic activity in certain regions occurs in a regular time-space pattern; and (2) seismic activity is to a large degree related to geological activity. Movement of crustal plates appears at least in part to account for some seismic activity, such as in the New Guinea region. (Auth./W.M.)

16-b-25 DUDA, S. J., 1965 — Secular seismic energy released in the Circum-Pacific Belt. *Tectonophysics*, 2, 409-52.

Data on the largest earthquakes in the 68 years from 1897 to 1964 are listed. The Circum-Pacific seismic belt is divided into 8 regions showing different intensities of strain-energy release and statistically different *b*-coefficients in the recurrence diagrams, which relate number of earthquakes to magnitude. The intensities and *b*-coefficients are correlated with each other, indicating that the *b*-coefficient depends on the stress pattern. The seismic energy release per year has decreased significantly in the time interval investigated in all depth ranges in the Circum-Pacific belt and outside it. Papua and New Guinea and the Solomon Is fall within region 6, in which a total of 127 shallow and 68 intermediate earthquakes of magnitude ≥7 (Richter) are recorded. This region follows the pattern of stress release and energy diminution that characterizes most Circum-Pacific regions. (Auth./W.M.)

16-b-26 EWING, M., & PRESS, F., 1952 — Crustal structure and surface wave dispersion. 2. Solomon Islands earthquake of July 29, 1950. *Bull. seism. Soc. Amer.*, 42, 315-25.

Rayleigh waves from the Solomon Is earthquake of 29 July 1950, recorded at Honolulu, Berkeley, Tucson, and Palisades are analysed. The epicentre of the earthquake was located at 6°8'S, 155°1'E, at a depth of 75± km J.S.A. Magnitude was 7 Pas. Both the direct waves and those propagated through the Antipodes were observed for all stations except Honolulu. Application of a correction for land travel results in a dispersion curve for the oceanic portion of the path. It is found that the observed dispersion could be accounted for by propagation through a layer of water 5.57 km thick overlying simatic rocks having shear velocity 4.56 km/s and density 3.0 g/cc. Basement structure in the Pacific, Indian, South Atlantic, and North Atlantic oceans is identical within the limits of accuracy of the method. The sinusoidal nature and duration of the coda is explained by the effect of the oceans on the propagation of Rayleigh waves. The results are compatible with seismic refraction measurements in the Atlantic and Pacific oceans. (Auth./W.M.)

16-b-27 EWING, M., KUD, J., & BRUNE, J. N., 1961 — Surface wave studies of the Pacific crust and mantle. *10th Pacif. Sci. Cong., Honolulu,* Abs. Vol. 358.

Surface-wave data obtained from the long-period Press-Ewing seismographs installed during the IGY in the Pacific at Honolulu, Suva, and Mt Tsukuba are analysed to determine phase and group velocities. Both normal and inverse branches of dispersive Rayleigh waves are well developed in the intermediate period range. Group velocities for Rayleigh waves reach a maximum of 4.0 km/s at a period about 35 s. Phase velocity is nearly constant in the period range from 30 to 75 s with a velocity 4.0 km/s; most of the phase velocity curves indicate a slight maximum and minimum at about 35 and 50 s respectively. Phase velocity for longer periods increases to 4.18 km/s at 120 s.

A precise measurement of phase velocities in the period range from 20 to 40 s from records of Pacific nuclear explosions agrees with the phase velocities presented. Correlations of wave trains between the stations Honolulu and Mt Tsukuba are used to eliminate the effect of variation of initial phase as a function of period. Except across the Melanesian-New Zealand region, dispersion curves for the paths of Rayleigh waves throughout the Pacific Ocean are fairly uniform. Both phase and group velocities are comparatively lower for the paths of Rayleigh waves across the Melanesian-New Zealand region. The results support a normal oceanic crust and a low-velocity channel in the upper mantle beneath the Pacific Ocean and a tectonic complex of thicker crust in the Melanesian-New Zealand region of the southwest Pacific Ocean. (Auth.)

16-b-28 FINLAYSON, D. M., 1967 — Refraction seismology and seismic surface wave studies. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.,* 6-8.

The history of regional seismic studies by the Bureau of Mineral Resources, Canberra, is outlined, and includes the Carpentaria Region Upper Mantle Project (CRUMP) in late 1966, designed to investigate the structure of the north Queensland and Gulf of Papua region. Data were recorded on modified Willmore long-period and short-period seismometers at several mobile field stations.

It was proposed to investigate the crustal structure of Papua New Guinea by observing and analysing the phase velocity disposition characteristics of Rayleigh waves from distant earthquakes. Using 3 sets of apparatus, a system of triangular recording networks was set up, each network recording for a few months at a time. So far records have been obtained from Port Moresby, Kerema, Tapini, Popondetta, and Daru.

Associated with the phase velocity studies were studies of earthquake seismology in Papua New Guinea and Rayleigh-wave group-velocity studies for paths across Australia and across Papua New Guinea. Both these programs are now routine work at Port Moresby Observatory. (Auth./W.M.)

16-b-29 FINLAYSON, D. M., 1968 — First arrival data from the Carpentaria region upper mantle project (CRUMP). *J. geol. Soc. Aust.,* 15, 33-50.

Travel-time from explosions fired on the continental shelf around the C. York Pen. were recorded by a number of mobile seismic recording crews and seismic observatories. Least squares analysis of the results from various groups of shots indicated upper crustal velocities between 5.82 and 5.94 km/s, lower crustal velocities between 6.62 and 6.83 km/s, and upper mantle velocities between 7.84 and 8.09 km/s. Subsequent time-term analysis of the results gave depths to the intermediate refractor of 10 km at the continental margins increasing to 25 km in the Gilbert R. region of C. York. The Mohorovicic 'Discontinuity' dips at an average of 3° from depths of 25 km at the edge of the continent to 45 km in central C. York and the area northwest of Charters Towers.

During this survey, a recording station at Daru was used; distance and travel times between shot and station are tabulated. Extension of the regional contours on refractor horizons suggests that in western Papua near Daru the intermediate depth refractor in the crustal basement lies at around 15 km and that the Moho is at about 30-35 km depth, dipping steeply northward. (Auth./W.M.)

16-b-30 Furumoto, A. S., Sutton, G. H., & Rose, J. C., 1967 — Results of the seismic refraction survey in the Solomon Islands group (abstract only). *Trans. Amer. geophys. Un.*, 48, 217.

The region around the Solomon Is has several unusual features: the reverse arrangement of trenches and island arcs, a large area of very high positive gravity anomaly, and a peculiar distribution of earthquake foci. The Hawaii Institute of Geophysics carried out a seismic refraction survey in that region during November-December 1966. The results of the survey raised more geological questions instead of providing answers. (Auth.)

16-b-31 Furumoto, A. S., Wiebenga, W. A., & Webb, J. P., 1969 — The New Guinea crustal studies programme (Abstract). *EOS*, 50, 644.

An international crustal studies program in the Bismarck Arch. of Papua New Guinea involving a number of institutes has been going on for several years. Large-scale seismic refraction surveys were carried out in 1967 and 1969. Magnetic, gravity, and geological surveys were also conducted in the area. The results to date show that the Moho discontinuity under New Ireland is about 40 km deep and slopes upward very rapidly to the east. Under New Britain the Moho discontinuity has an undulating character, varying in depth from 12 km to 24 km. A fault extending downward into the mantle separates New Britain from New Ireland. Marked anisotropy in mantle seismic velocities was observed in the area. (Auth.)

16-b-32 Green, R., & Pitt, R. P. B., 1967 — Suggested rotation of New Guinea. *J. Geomag. Geoelect.*, 19, 317.

Palaeomagnetic sampling has been carried out at 8 sites in New Guinea. The magnetic stability has been verified by a.c. washing. The results give an increase in westerly declination with age, stretching back as far as the Cretaceous. The rotation of New Guinea during the Tertiary is suggested. (Auth.)

16-b-33 Grover, J. C., 1955a — Seismic activity and vulcanism. (*In* Geology, mineral deposits and prospects of mining development in the British Solomon Islands Protectorate. *Mem. B.S.I.P. intm geol. Surv.*, 1, 20-4).

There are numerous centres of seismic disturbance of tectonic origin in the Solomon Is, including one on Bougainville near Mt Bagana. Numerous volcanic centres that are active or have been active in historic time are found in these islands. Two of these — Bagana and Balbi — are on Bougainville. (W.M.)

16-b-34 Grover, J. C., 1965a — Seismological and vulcanological studies in the British Solomon Islands to 1961. *Brit. Solomon Is geol. Rec.*, 2, 183-8.

The development and early activity of the seismological and volcanological observatory in Honiara is outlined. Seismic and volcanological activity in the Solomon Is region in the period 1959-62 is recorded. During 1959, 10 seismic centres were recorded on and around Bougainville, some of them with multiple activity. Those for which depth of focus could be calculated were deeper than 100 km. During 1960 activity in 11 centres is recorded, with several multiple-activity centres. All calculated foci are deeper than 100 km. During 1961 activity in 34 centres 20-204 km deep is recorded. Distribution pattern of foci suggests a very steep west-dipping focal plane. During 1962 only 11 centres were active, with foci 25-370 km deep. (W.M.)

16-b-35 GROVER, J. C., 1967 — Forecasting of earthquakes — correlation between deep foci and shallow events in Melanesia. *Nature,* 213(5077), 686-7.

Deep-focus earthquakes in the zone beneath New Britain, New Ireland, and Bougainville are part of a major arch of seismicity beneath the Solomon Is chain. Most major earthquakes since 1963 have occurred in this area at depths of 250-600 km, rising to less than 200 km in the crest of the arch. A time-space correlation between deep-focus earthquakes and series of shallower seismic events appears to be demonstrable, and is thought to be related to transfer of thermo-energetic phenomena in tectonic zones which may be expressed as faults. (W.M.)

16-b-36 GUTENBERG, B., & RICHTER, C. F., 1954 — SEISMICITY OF THE EARTH (2nd Edn). *Princeton, Univ. Press,* 310 pp.

As many as 10% of the world's deep and shallow focus earthquakes occur in the New Guinea area, mostly at depths less than 400 km. Within the Solomons-New Guinea area, 3 structural areas are recognized: the arcuate Solomon Is group fronting the Pacific; the Bismarck Arch. arcuate island chain with structures extending into New Guinea; and the region of central New Guinea. Seismicity level in the Solomon and Bismarck area is high, with large shallow shocks being recorded frequently. Activity in mainland New Guinea is low, with only moderate to low intensity shocks recorded.

The distribution in space and depth of the earthquakes in the area is interpreted as indicating a group of crustal plates of variable size and mobility. Earthquakes frequently are closely related to volcanic centres. The date, time, depth, location, and magnitude of major shocks in the area are tabulated. (W.M.)

16-b-37 JERSEY, N. J. de, 1946 — Seismological evidence bearing on crustal thickness in the south-west Pacific. *Univ. Qld Dep. Geol. Pap.,* 3(2), 18 pp.

A study is made of evidence bearing on crustal thickness in Australia and the southwest Pacific, mainly using seismograms recorded at Brisbane. For the Australian continent evidence from surface waves indicates a crustal thickness of about 40 km down to the Mohorovicic discontinuity. For the sub-oceanic area to the east a continental structure is indicated by observations of an amplitude ratio PP/P and this is supported by data on surface waves which, in addition, indicate a total crustal thickness of the order of 25 km, comparable with that of the crustal layers under the Atlantic and Indian oceans. The origin of this difference in thickness is explained in terms of a gradual thinning of the continental material towards the Pacific margin.

Some data on the boundary between the Australasian continental mass and the Pacific basin are presented. Northeast of the New Hebrides there are few well located epicentres, so that the boundary of the active belt is not sharply demarcated, and the andesite line provides the most accurate representation of the Pacific margin in this region. General support to the validity of the andesite line has been given by preliminary study of PP reflections recorded at Apia from earthquake epicentres in the Solomons region. To the east, evidence indicates that the boundary extends to within at least 5° of Apia. It then turns towards the south between Samoa and the northern Tonga Is and follows the Tonga-Kermadec line to the north island of New Zealand. There can now be little doubt, from all the lines of evidence, that Australia, New Zealand, Fiji, New Caledonia, and the other island groups within the andesite line form parts of one homogenetic structure and the inference is that they were co-extensive in the past. (Auth./W.M.)

16-b-38 KHAN, M. A., & WOOLLARD, G. C., 1968 — Methods of analysis and comparison of geophysical data on a plane, with specific application to the Solomon Islands area. *Rep. Hawaii Inst. Geophys.,* HIG-68-17, 79 pp.

Techniques of frequency representation and of comparison of various geophysical data on a bounded plane area are outlined, and applied to the gravity field over the Solomon Is area. The general effectiveness of these techniques in the study of crustal and upper mantle structure on a regional scale, rather than on a global scale as in studies based on spherical harmonic representation, is demonstrated. The results of this analysis, in conjunction with the geophysical information provided by the recent seismic refraction work in the area, are used to examine and establish the inter-relationships among the various parameters of the crust and the mantle.

Maps of the free-air gravity anomalies in the Solomon Sea and adjacent island masses, together with Bouguer gravity anomaly, 1° x 1° and 5° x 5° free-air anomaly and bathymetric maps, accompanying the interpreted seismic refraction profile map of several sites in the area. Seismic refraction profiles were constructed in the Gazelle Pen. area (crust about 16 km thick to 7.3 km/s layer with 3 velocity horizons), and at several sites in the Solomon Sea (crust 12-13 km thick to 7.7 km/s layer, with 4 or 5 velocity horizons). (Auth./W.M.)

16-b-39 KONING, L. P. G., 1952a — Earthquakes in relation to their geographical distribution, depth and magnitude — 1. The East Indian Archipelago. *Proc. K. Ned. Akad. Wet., Sec. Sci.*, 55, 60-8.

Earthquake epicentres or foci are plotted in terms of magnitude and location on a series of earth layer maps representing 0-50 km down to 700-720 km in 50 or 100 km stages. Earthquakes in the East Indies are plotted, iso-magnitude contours constructed and commented on, and the rationale of this style of analysis of earthquake data is discussed. (W.M.)

16-b-40 KONING, L. P. G., 1952b — Earthquakes in relation to their geographical distribution, depth and magnitude — 2. *Proc. K. Ned. Akad. Wet., Sec. Sci.*, 55, 69-77.

This discusses data presented in entry 16-b-39 on the areal distribution and depth of earthquake foci and epicentres in the East Indian Arch. The complicated depth-magnitude distribution of foci in the 0-50 km layer is attributed to the structural heterogeneity of this layer. 2 belts of earthquake foci are recognized — (a) a belt of shallow to intermediate shocks along the west coast of Sumatra, the south coast of Java, and over the Lesser Sunda Is to New Guinea, and (b) a J-shaped belt in the northeastern part of the archipelago. Belt (a) is paralleled by a deeper focus belt lying closer to the Asiatic continent. Profiles across these belts show that not all earthquake foci lie on the 2 theoretical zones dipping northwards under the Asiatic continent. (W.M.)

16-b-41 KONING, L. P. G., 1952c — Earthquakes in relation to their geographical distribution, depth and magnitude — 3. The southwestern Pacific. *Proc. K. Ned. Akad. Wet., Sec. Sci.*, 55, 194-206.

Earthquakes between 1904 and 1946 are mapped in terms of their magnitude and location of epicentre. Maps are prepared for a variety of depth zones for earthquake foci, ranging from 0-50 km to 600-660 km in 50 or 100 km stages, and iso-magnitude contours drawn on each. 2 belts of seismic activity are recognized, (a) a belt of shocks with foci depths to about 400 km, extending through New Guinea-New Britain-Solomon Is-New Hebrides-New Caledonia, and (b) a belt from south of New Zealand through New Zealand-Kermadec-Tonga-Fiji-Samoa. Near Fiji and Samoa foci are deeper than observed elsewhere in the southwest Pacific. Profiles normal to these belts indicate that there is a more or less regular distribution of foci of relatively large-magnitude earthquakes in both a horizontal and vertical sense to depths of 150 k. (W.M.)

16-b-42 KONING, L. P. G., 1953 — Summarizing considerations on the distribution of earthquakes in relation to their magnitude and focal depth. *Geol. Mijnb.*, 15(7), 271.

Earthquake data relating to their geographic distribution, depth, and magnitude have been analysed using the iso-magnitude line technique; 2 large seismic zones are recognized, the Mediterranean belt and the Circum-Pacific belt, which merge into each other in southeast Asia. These belts are discussed in relation to their tectonic lines and associated volcanism, and conclusions drawn concerning depth/magnitude zoning of seismic disturbances, surface distribution of seismic zones and their aseismic gaps, and form of seismic discontinuity surfaces. (W.M.)

16-b-43 MIYAMURA, S., 1968 — Seismicity of island arcs and other arc tectonic regions of the Circum-Pacific zone. *Geophys. Monogr. Amer. geophys. Un.*, 12, 60-9.

Seismicity of the Circum-Pacific regions, including all known island arcs, has been investigated by the computer processing of PDE data for 1965 supplied by the USCGS. Magnitude-frequency relations for the different regions seem to suggest the tectonic ages of the respective regions. The relation of seismic activity to depth in each Circum-Pacific region reveals the existence of a common aseismic transient layer at a depth of 300-450 km between deep and intermediate earthquakes layers. For Japan to Kamchatka and the Marianas, this minimum seismicity layer shifts to shallower and deeper levels, respectively. Although the deep and intermediate depth earthquakes are distributed on an inclined zone dipping toward the continental side of the arc, they are generally separated by the aseismic transient layer. Only in a certain limited part of the whole length of the arc are they connected by a small irregular-shaped column with fewer foci. (Auth.)

16-b-44 MIZOUE, M., 1968 — Earthquake magnitude determination in relation to regional variations of P-wave amplitudes — Part 1. *Bull. Earthq. Res. Inst. Tokyo*, 46, 457-84.

Body wave magnitude m_{pz} in EDR (Earthquake Data Report) of USCGS for earthquakes with shallow focal depth determined at near and regional epicentral distances deviates significantly from the magnitude of the same events determined at teleseismic distances. Overestimation of magnitude by as much as 0.5 to 1.5 magnitude units in the epicentral distance ranging between 5° and 13° relative to the magnitude at teleseismic distances shows that the zone of low amplitude signals predicted by Gutenberg and Richter (1956) in that distance range does not exist as a worldwide phenomenon. Available distance range of the calibrating function provided by Gutenberg and Richter as a worldwide standard should be limited to the distance range of more than 20°.

Regional correction factor as a function of epicentral distance subtractive from the calibrating function is calculated for the 5 reference stations, College (Alaska), Tonto Forest (Arizona), Caracas (Venezuela), Port Moresby (New Guinea), and Rabaul (New Britain). The Port Moresby station data include 58 earthquake recordings during 1966-67; Rabaul data are from 52 earthquakes recorded during 1965-67. (Auth./W.M.)

16-b-45 OFFICER, C. B., 1955 — Southwest Pacific crustal structure. *Trans. Amer. geophys. Un.*, 36, 449-59.

This investigation has been concerned with the determination of the crustal thicknesses of the various features of the southwest Pacific from Love — and Rayleigh — wave dispersion characteristics. The crustal thickness of the Tasman Basin between New Zealand and Australia is the same, 5-10 km, as that for the South Pacific Basin east of New Zealand. The thickness of East Cape-Kermadec-Tonga Ridge bordering the South Pacific Basin on the west and that of the Lord Howe Rise bordering the Tasman on the northeast is 20-25 km. A crustal refraction profile over New Zealand gives a thickness of 20 km. The interior region of ridges and troughs, northeast of New Zealand, has an average thickness of 15-20 km. The results are indicative of an origin from successive orogenic belts built out over an oceanic crust. The area is not part of an extensive continent. (Auth.)

16-b-46 RIPPER, I. D., 1970a — New Guinea-Solomon Islands seismicity interpreted in terms of regional tectonics. *42nd ANZAAS Cong., Port Moresby,* Sec. 3 Abs.

The seismicity and tectonics of some regions of the Earth can be understood in terms of differential movements between lithospheric plates on a constant-sized earth. Plate formation at the mid-ocean ridges is compensated by downturn of lithosphere in ribbon-like flows through the asthenosphere, leading to trench formation and seismicity.

The New Guinea-Solomon Is region cannot be described by the plate concept for the following reasons:

a) The seismicity of the New Guinea-Solomon Island region does not define a simple boundary between the Australian and Pacific plates. Although the individual seismic trends can be recognized, the regional pattern so formed is complex.
b) The trench pattern associated with the seismicity is discontinuous. It does not appear possible to demonstrate a continuous system of trenches, transform faults, and hinge faults joining zones of advance and downturn of the Australian plate.
c) Earthquake focal mechanism studies of the New Britain-Bougainville trench system indicate 2 different trends of motion direction of the Solomon Sea section of the Australian plate.

As an alternative to the plate interpretation, the New Guinea-Solomon Is region can be better envisaged in terms of interaction between the mantle blocks of the Australian and Pacific regions, involving lateral shear and zones of local compression. In addition to being a simplification of the plate concept, this model is consistent with the hypothesis of an asymmetrically expanding earth. (Auth.)

16-b-47 RIPPER, I. D., 1970b — Global tectonics and the New Guinea-Solomon Islands region. *Search*, 1, 226-32.

The New Guinea-Solomon Islands region is one of the least understood seismic zones of the earth, and one of the most complicated. It is therefore the ultimate testing ground of tectonic theories, including the expansion and convection theories of global evolution, and the more recent 'New Global Tectonics'.

The seismic activity, and its distribution in time and space, is used in interpreting the structural complexity of the New Guinea region. It is concluded that this region is a zone of lateral interaction, including compression and shear, between the Pacific and Australian mantle blocks. The evolution of the Indian and Pacific Oceans on an expanding earth is thought to have been an important factor in the development of the New Guinea structural features. (Auth./W.M.)

16-b-48 RITSEMA, A. R., 1957 — Earthquake-generating stress systems in southeast Asia. *Bull. seism. Soc. Amer.*, 47, 267-79.

The positions of earthquake-generating stress systems on 28 fault-plane earthquakes in southeast Asia are found using initial motions of the longitudinal waves. 2 shallow earthquakes in western Papua are included in the study data; 1 on 2 December 1953 lies at 2.75°S, 141.5°E, the other on 6 June 1954 lies at 5.5°S, 142.5°E. The position of the two nodal planes in the focus of each earthquake is determined, and the causative stress system derived. (W.M.)

16-b-49 SANTO, T., 1970 — Regional study of the characteristic seismicity of the world: Part *IV*, New Britain Island region. *Bull. Earthq. Res. Inst. Tokyo*, 48(2), 127-43.

Seismicity in the New Britain region was investigated using data from the USCGS during the period January 1963 to July 1969.

There were 3 parallel east-west seismic zones. Earthquakes along the north and south zones were all shallow. Foci distributions in the central seismic zone along profiles perpendicular to the trench showed a trench-island arc system. They were expresed by the same curve except 1 along a profile crossing Bougainville, in which foci were dispersed to such an extent that no focal zone could be recognized.

In the central zone, swarms and aftershocks were quite active. Large earthquakes have historically been active only along this zone. These features are common with the seismicity along an arc from New Hebrides to New Guinea. However, foci in the New Britain region were found to penetrate deeper. (Auth.)

16-b-50 TAMRAZYAN, G. P., 1970 — Some characteristic features of seismic energy release (in time) on the southwestern margin of the Pacific Ocean. *N.Z.J. Geol. Geophys.*, 13, 400-17.

Seismic activity on the southwestern margin of the Pacific Ocean is closely connected with the position of the moon in the sky and to a lesser extent with that of the sun. The existence of such a relationship is supported by the analysis of systematic data on strong earthquakes covering the period 1900 to 1956. The distribution of earthquakes and their energy within the lunar and solar days depends largely on the orientation of the basic geological structures of the region. For intance, within the structural belt oriented in a northeasterly direction (New Zealand region) the greater part of the seismic energy (94%) was released in the first half of the lunar day. Within the structural belt oriented in a northwesterly direction (New Guinea-New Caledonia region) most of the seismic energy (90%) was released in the second half of the lunar day. (Auth.)

16-b-51 WESTWOOD, J. V. B., 1970 — Seismicity of the Solomon and Santa Cruz Islands, southwest Pacific. *J. geol. Soc. Aust.*, 17, 87-92.

Seismic data for 1965-68 from stations in the region show 2 low longitudinal (P) velocity channels at 100-130 km and 400-450 km which correlate with 2 such channels reported in the Japanese islands. Spatial distribution of hypocentres for 1963-69 suggests several recognizable surfaces but no single overall picture. (Auth.)

(c) GRAVITY

16-c-1 FALVEY, D. A., & TALWANI, M., 1969 — Gravity map and tectonic fabric of the Coral Sea (Abstract only). *Geol. Soc. Amer., 65th ann. Meet. Abs.*, 7, 62-3.

Various marine free-air gravity anomaly data, and onshore Bouguer anomaly data have been compiled from the areas of northeast Queensland, Coral Sea, Papua, and Solomon Sea. The persistence of linear gravity trends has permitted extrapolation of onshore geological features and separation of the effects of significant topographic features. A continuity of the New Guinea-New Caledonia Arc is suggested by gravity trends. In the Coral Sea, a close relationship between sediment thickness and free-air anomaly is observed and significant features of the Tasman Geosyncline are indicated. The computed model cross-section clarifies mainly near-surface features while conclusions on deeper density distributions remain ambiguous. Magnetic data are compiled for the Coral Sea Basin and some linearity of anomalies is suggested. The parallelism of physiography, gravity anomalies, and magnetic anomalies suggests a simple (though not conclusive) explanation for the formation of the Coral Sea Basin by rifting between New Guinea and the Queensland Plateau. (Auth.)

16-c-2 GROVER, J. C., 1965b — Gravity values in the Solomon Islands and plans for a gravity-magnetic-bathymetric survey of the region. *Brit. Solomon Is geol. Rec.*, 2, 199-200.

5 gravity base stations have been set up along the Solomon Is, including a station at the airstrip on Buka I. with the following specifications: latitude, 5°26′S; longitude, 154°40′E; station No. WA3072; elevation, 2.5 m a.s.l.; $g=978.3016$ cm/s^2. (W.M.)

16-c-3 GROVER, J. C., 1966b — Gravity surveys in the British Solomon Islands — a narrative. (*In* POOLE, W. H. (Ed.) — Continental margins and island arcs — Report of Symposium. *Geol. Surv. Canada Pap.*, 66(15), 257-77.)

Examination of the structure of the Solomon Is region in the light of the latest bathymetric data led to the following conclusions:

a) The South Solomons-Santa Cruz Trench 'elbow' is almost entirely analogous to that of the New Britain Trench; b) it is of interest because of its proximity and connexion with the Vitiaz Trench north and east of Santa Cruz; c) the anomalous Ulawa sea-bed feature runs into the Vitiaz Trench; d) the Vitiaz Trench is surely the shredded remnant of the Circum-Pacific Kermadec-West Melanesian-Mariana trench system; e) 3 main ridges extend from New Guinea into the area: i) the ridge New Britain-Bougainville-Choiseul-Malaita, ii) the ridge Trobriands-Woodlark-New Georgia-Guadalcanal-San Cristobal, iii) the ridge Louisiades-Rennell-New Hebrides.

These ridges cause the trenches to become less apparent in the mid-Solomons and mid-New Hebrides areas. (Auth./W.M.)

16-c-4 GROVER, J. C., 1968 — The British Solomon Islands: some geological implications of the gravity data, 1966. *Geophys. Monogr. Amer. geophys. Un.*, 12, 296-306.

During the land gravity expedition of 1963, gravity stations were established on coastlines and across the mountain ranges of the various larger islands of the Solomons. Most work was done on Guadalcanal. Some implications of the gravity maps are discussed from the point of view of the field geologist after 15 years of ground investigations. A remarkable correlation with deep-seated geological features is apparent from the maps with Bouguer isogal intervals of 10 mgal. Higher values in higher country suggest that the 'tectogenic' mountain-building process does not apply. Major shears are suggested on Choiseul, Santa Isabel, and Guadalcanal. Tension features causing disruption of islands such as Florida, western Santa Isabel, and Savo are reflected by a change of direction in the isogals. Major faults on Guadalcanal, and discrete blocks such as San Cristobal, the 2 on Choiseul, and that of southeastern Guadalcanal show up well in the isogal maps. The mantle is probably much closer to the surface than the world average.

Foci of large to medium earthquakes at depths of 300-600 km are recognized beneath New Britain-New Ireland-Bougainville, well to the west of the 'arch of seismicity' and approximately coinciding with deep, faulted trenches. (Auth./W.M.)

16-c-5 GROVER, J. C., & LAUDON, T. S., 1966 — Gravity maps cf. geology of the individual Solemn Islands and situation report on the surveys of the surrounding seas. *Proc. 11th Pacif. Sci. Cong., Tokyo*, 3.

In 1963-64 more than 2000 gravity stations were occupied in the Solomon Is and Papua New Guinea. Mean values of 2758 calculated free anomalies are 119.2 mgal, 112.9 Bouguer — all positive.

In the Solomons steep gravity gradients occur on all islands, and Guadalcanal has the greatest gravity anomalies mapped anywhere in the world to date: free-air minimum of 17 positive to maximum of 211 positive: the flanks of the Teters 'high' show gradient of 118 mgal in 10 km, believed due to concealed ultrabasic massif. Maximum Bouguer anomalies exceed 24 mgal at Buka on Bougainville in the north and San Cristobal at the southeast end of the island chain. Maximum free-air anomaly values in Guadalcanal Mts exceed 290 mgal positive, and in the mountains of San Cristobal more than 300 mgal. Minimum observed free-air and Bouguer anomaly values of 1 mgal negative occur in Florida Group and New Georgia Sound, along the axis of Solomon structure.

Apparent irregularities in mapped isogal lines fit in well with knowledge of major deep-seated geological structures from 16 years of field studies. New Georgia Group appears to be uncompensated. Geological comparisons are made with major structures on every island. (Auth./W.M.)

16-c-6 LAUDON, T. S., 1968 — Land gravity survey of the Solomon and Bismarck Islands. *Geophys. Monogr. Amer. geophys. Un.*, 12, 279-95.

Bouguer isogal maps of the Solomon and Bismarck Is are characterized by large, extremely steep, positive anomalies. Local anomalies can be related to near-surface geological features. Basement rocks and Quaternary volcanic centres are expressed as gravity highs; Upper Tertiary sedimentary basins are expressed as gravity lows. The regional gravity field of the Solomons consists of a broad low, elongated parallel to the trend of the islands, with smaller highs corresponding to individual islands superimposed on its flanks. The gravity results suggest that regional isostatic compensation of the Solomons has occurred. However, the gravity fields of the individual islands suggest significant departures from isostasy. These are attributed to: support of Quaternary volcanic piles by the strength of the Earth's crust without isostatic compensation; higher-than-normal crustal densities; and upwarping of the mantle beneath the islands. (Auth.)

16-c-7 MILSOM, J. S., 1967 — Regional gravity surveys, eastern Papua and Papuan Ultramafic Belt. *In* RINGWOOD, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.*, 48-9.

In 1966-67 about 400 gravity readings were taken in and around the Papuan Ultramafic Belt, and about 500 readings were made east of this area, both on the mainland and in the island groups. An overall density of more than one station to 130 km^2 (land area) was obtained, but coverage was not uniform, being dictated by the availability of landing grounds for the helicopter, or the existence of navigable waterways. To date only simple Bouguer anomalies have been plotted, and these only for the ultramafic area. Calculations for a few selected stations show that terrain effects of as much as 10 mgal do occur, but terrain effect for most stations will probably not exceed 1 mgal.

A very steep gravity gradient was observed associated with the Owen Stanley Fault zone, which separates the ultramafic rocks from the Owen Stanley Metamorphics of the central cordillera. A maximum gradient of 10 mgal per km was observed on the Francisco R. near Salamaua over an interval of 90 mgal. The maximum Bouguer anomaly observed was +175 mgal in the Bowutu Mts, the largest single area of outcropping ultramafic rocks. Still larger Bouguer anomalies were obtained on Kiriwina, Woodlark, and Rossel Is, at the extreme edges of the Papuan continental shelf. The lowest Bouguer anomalies, of about −100 mgal, occur in the Owen Stanley Ra. Along a line from the Bowutu Mts into the Owen Stanley Ra. crossing the fault zone at right angles, the Bouguer anomaly falls from +175 mgal to −106 mgal in a distance of 50 km. Preliminary analysis of the gravity results in this area indicates that the Owen Stanley Fault dips under the ultramafic rocks at an angle of about 60°. (Auth.)

16-c-8 ROSE, J. C., & MALAHOFF, A., 1967 — Marine gravity and magnetic studies in the Solomon Islands (abstract only). *Trans. Amer. geophys. Un., geophys. Un.*, 12, 379-410.

Marine gravity, magnetic, and bathymetric studies of the Solomon Is region were made in October-December 1965. Gravity anomalies in the region southeast of New Britain and between Bougainville and New Guinea appear to be excessively positive by more than 100 mgal. Amplitudes of magnetic anomalies are generally less than 200 gammas and in the form of elongated dipoles striking perpendicular to the observed structural trends. Depth estimations suggest a 3-layer crust, and computed susceptibility contrasts suggest that the anomalies are associated with instrusive basalts. (Auth.)

16-c-9 ROSE, J. C., WOOLLARD, G. P., & MALAHOFF, A., 1968 — Marine gravity and magnetic studies of the Solomon Islands. *Geophys. Monogr. Amer. geophys. Un.*, 12, 379-410.

This is similar to entry 16-c-8.

16-c-10 ST JOHN, V. P., 1965 — The Gravity Pattern of New Guinea. *38th ANZAAS Cong., Hobart*, Sec. C Abs. (listed by title in *Aust. J. Sci.*, 28, 312).

Bouguer anomalies over mainland Papua New Guinea define 6 broad subdivisions:

The Fly Platform. Anomalies in this region are broad and undulating, with values generally between 0 and +40 mgal. The Delta Embayment to the east has a low of −30 mgal. *The Eastern Cordillera.* The Owen Stanley Ra. has a negative anomaly of −40 to −60 mgal. *The Papuan Ultrabasic Belt.* A very steep positive gradient in the vicinity of the Owen Stanley Fault separates a broad belt of anomalies, of up to +150 mgal, from the Owen Stanley minimum. A similar positive, smaller in extent, occurs in the Milne Bay region on the opposite side of the Owen Stanley low. *The Central Cordillera and Northern Ranges.* A general negative of less than −100 mgal extends across the Ramu-Markham depression into the Finisterre-Saruwaged Ras. The anomaly becomes positive in the Adelbert Ra., and along a line close to the course of the lower Sepik. It merges into the smaller negatives of the Eastern and Western Cordillera, and is bounded on the south by the Fly Shelf. A central area, including the Kubor and Bismarck Ras, and the Wahgi, Jimi, and middle Ramu Valleys, is a relative high. This is surrounded by anomalies reaching −160 mgal in the Finisterre Ra. and Markham Trough, and −150 mgal in the western Central Cordillera. *The Western Cordillera.* The negative anomalies here are of the order of −50 mgal, and these small anomalies continue through the Star Mts into west New Guinea. *The Sepik Basin.* Except for a low of −40 mgal in the Nuku area this is a positive region. From an east-west-trending low of less than 10 mgal north of the Sepik R. the anomaly rises to the south to +40 mgal where it is bounded by the Western Cordillera low, probably at the Tahin Fault Zone. To the west the high is bounded by a pronounced negative over the upper Sepik, which may be due to an extension of the Sobger Embayment of the west New Guinea North Coast Basin. The gravity anomalies rise rapidly northwards over the Torricelli, Bewani, and Prince Alexander Mts to over 120 mgal in the Oenake Ra. *Isostatic Anomalies.* Both Pratt-Hayford and Airy-Heiskanen systems of compensation greatly reduce the anomalies over the Central Cordillera: to between −20 and +40 mgal for Airy, and −40 and +20 for Pratt. However, in other areas the Pratt anomalies are smaller and show considerably less correlation with Bouguer trends than do the Airy. This is particularly evident in the Eastern Cordilleran and Sepik Basin areas. The Papuan Ultrabasic Belt and the Finisterre-Adelbert region are uncompensated on either system, but the Pratt anomalies are the lesser.

It would seem that the Pratt system, with a depth of compensation of 100 km, is closer to reality than the Airy. This indicates that much of the isostatic compensation may occur in the upper mantle. (Auth.)

16-c-11 St John, V. P., 1967a — Gravity investigations in New Guinea. *In* Ringwood, A. E. (Ed.) — INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS UPPER MANTLE PROJECT — SECOND AUSTRALIAN PROGRESS REPORT 1965-67. *Canberra, Aust. Acad. Sci.*, 50-1.

Rayleigh wave dispersion studies indicate some crustal thickening under the central cordillera and this is borne out by interpretation of the negative Bouguer and small isostatic anomalies. The deeper sedimentary basins appear to be partly compensated by a rise in the base of the crust, which persists even where large Plio-Pleistocene uplift has occurred, as in the Finisterre-Saruwaged Mts. The crust similarly thins under the deep New Britain Trench, as evidenced by Bouguer anomalies of +450 mgal. Very steep gradients over the Owen Stanley fault are compatible with a model postulating the origin of the Papuan Ultrabasic Belt as a thrust from the northeast of subcrustal material over metamorphics.

Gravity anomalies define a fundamental problem of orogenesis. Over all the deepest parts of the Neogene Papuan Geosyncline and the Northern Geosyncline the sialic crust is thinner than usual. Where uplift of Neogene rocks has commenced in the Finisterre-Saruwaged Mts, the Kukukuku Lobe, and the mountains of the western cordillera and West Irian, the crust is often thinner than normal. Yet where there has been a long pre-Tertiary history of uplift and sedimentation, culminating in Plio-Pleistocene uplift which has exposed crystalline basement in areas such as the central cordillera and Owen Stanley Ra., a seismic and gravimetric crust of light material is considerably thicker than normal.

Since this light material is not due to a downbuckle of the original crust, it appears that in orogenic areas of this nature material of low density is added to the base of the crust from the upper mantle. If the initial uplift of an orogenic region can be attributed to an expansion of the upper mantle, it is likely that differentiation of the phase-changed mantle would provide lighter (granodioritic) material to restore isostatic stability by thickening the crust in the late stages of an orogeny. (Auth.)

16-c-12 St John, V. P., 1970 — The gravity field and structure of Papua and New Guinea. *APEA J.*, 10(2), 41-55.

Interpreted in the light of existing geological knowledge, a regional gravity survey of eastern New Guinea defines the major tectonic units of the area and clarifies its tectonic history. At least 7000 m of Mesozoic sediments are present in a basin extending from the Aure Trough to West Irian, reaching its maximum development in the Southern Highlands area. South and west of this basin the Fly platform exhibits an undulating basement resulting from northwest to west-trending faults or flexures of Lower Cretaceous age. Anomalies over the Papuan Ultrabasic Belt are consistent with the origin of this body as a thrust of subcrustal material from the northeast. Starting in the Cretaceous the thrust uplifted metamorphics overlying the ultrabasics, and the rising land provided a source of thick Tertiary sedimentation in the Aure Trough. Transcurrent faulting in the C. Vogel area separates the small rising C. Vogel Basin from the Northern Papuan Basin over the subsiding north-eastern edge of the ultrabasic belt. More than 8000 m of Miocene and younger sediments are present in a basin extending from the Markham valley to the lower Sepik, the sediments being uplifted by thrusting in the Adelbert, Finisterre, and Saruwaged Ras.

Isostatic and free-air anomalies indicate that a zone of isostatic and tectonic instability extends the length of the northern coast of eastern New Guinea. South and east of this zone, which is generally less than 150 km wide, the Owen Stanley block, the central highlands, and the southern platform are in a state of much greater stability. This present distribution of stable and unstable regions lends support to the concept of the evolution of New Guinea as a series of orogenic zones developing on, and becoming incorporated in, the northeastern margin of the Australian continent. (Auth.)

16-c-13 St John, V. P., & Green, R., 1967 — Topographic and isostatic corrections to gravity surveys in mountainous areas. *Geophys. Prospect.*, 15, 151-62.

In mountainous areas it is inadequate to reduce gravity observations by merely subtracting the effect of an infinite flat slab of material between the station and sea level, and adding a terrain correction. A program is described which directly computes the effect of masses above sea level, and mass-deficiencies below it, as well as the effect of compensating masses under the Pratt and Airy isostatic systems. The method has been applied to a regional gravity survey of Papua New Guinea where it is seen to remove the usually high correlation of the Bouguer anomaly with local topography. (Auth.)

16-c-14 St John, V. P., & Kugler, A., 1965 — The gravity of Bougainville. *38th ANZAAS Cong., Hobart*, Sec. C Abs.

A coastal gravity survey of Bougainville, Buka, Shortland, and Fauro Is defines some very large anomalies. The strongest positive is centred on the Mt Bei region of Buka, having a maximum of over 240 mgal. This decreases to the east and south to a low of about 120 mgal trending across the island from C. L'Averdy. Southwards the gravity increases to a broad high of about 150 mgal trending roughly east-west across central Bougainville, and extending from Wakunai to the Kieta

Pen. Farther south the anomalies decrease over the Crown Prince Ra. and Mt Takuan to a trough of less than +100 mgal trending northeast between Buin and Torau Bay, and paralleling Tonolei Har. This trend changes direction at the south coast to form a low of 80 mgal between the relatively high Shortland and Fauro Is. Since the gravity readings were taken at sea level, these anomalies would closely approximate to isostatic anomalies. The magnitude of these anomalies confirms the definition, from satellite data, of a high point on the geoid in this area. (Auth.)

16-c-15 TOMODA, Y., 1971 — Gravity anomalies in the Pacific Ocean. *12th Pacif. Sci. Cong., Canberra*, Abs. Vol., 348.

The general features of free-air gravity anomalies are: a) the difference between continental margin with and without trench is not clear. In some cases, the relation between bottom topography and free-air gravity anomaly is clear but in others it is not. It is suggested that this shows the stages of formation of trenches; b) seamounts, without exception, have gravimetric trenches around them. This shows that all seamounts in the central Pacific have roots. The depth of the root seems to be deeper in the western part than in the central part of the Pacific.

Seamounts have positive mass and they have their roots just beneath them, like stable continents. This is considered to be a mass dipole having a vertical axis. On the other hand, trenches and island arcs make a mass dipole of the horizontal axis, where island and trench represent positive and negative mass, respectively. In some cases the dipole axis is oblique as in the Izu-Ogasawara Is arc and the trenches on both sides. This shows that island arcs or seamounts are produced by excess mass which is transferred by downward convectional force around them. This seems to be the reason why small seamounts are isostatic. (Auth.)

16-c-16 WOOLLARD, G. P., 1963 — The Woods Hole-University of Wisconsin international network of gravimetry bases. *In* WOOLLARD, G. P., & ROSE, J. C. — INTERNATIONAL GRAVITY MEASUREMENTS. *Tulsa, Soc. expl. Geophys*, 19-124.

The worldwide network of gravity stations set up by this group since 1948 is outlined. An appendix gives location of each gravity recording station, and 'g' value at each station. Several stations in the network are in Papua New Guinea. (W.M.)

16-c-17 WOOLLARD, G. P., 1966 — Crust and mantle relations on the southeast and central Pacific area as deduced from gravity data. *Proc. 11th Pacif. Sci. Cong., Tokyo*, 3.

A study of Bouguer gravity anomalies for southeast Asia, Philippine Is, New Guinea, Solomon Is, New Caledonia, and the Society and Hawaiian Is indicates 3 distinct sets of relations. Normal continental relations in which the Bouguer anomalies bear an inverse relation to surface elevation characterize most of southeast Asia and most of New Guinea. In the Philippine Is, Solomon Is, and New Caledonia there is an apparent lack of crustal compensation, and the Bouguer anomalies bear an inverse relation to surface elevation characterize most elevation. On the oceanic islands there is apparently only regional compensation and the field is frequently dominated by the geologic effect of intrusive bodies derived from the mantle having a density of approximately 3.2 g/cc and a seismic velocity of 7.6 km/s. (Auth.)

16-c-18 WOOLLARD, G. P., & STRANGE, W. E., 1962 — Gravity anomalies in the crust of the earth in the Pacific basin. *Geophys. Monogr., Amer. geophys. Un.*, 6, 60-80.

Free-air and Bouguer gravity anomalies are related to seismic measurements of crustal thickness throughout the world. A similar study is made of the relation between depth of water in the oceans and crustal thickness established seismically. It is shown that the regional free-air anomaly values, whether in the ocean or on land, are indicative of abnormalities in crustal composition and thickness. Negative anomaly values are shown to be associated with a crust of subnormal density and thickness, and positive anomaly values with a crust of greater than normal density and thickness.

An analysis of crustal structure in the East Indies area, based on the empirical relations between the depth of the Moho discontinuity and Bouguer anomalies, shows that the marked negative isostatic belts are not related so much to a crustal downbuckle beneath the trench as crustal crumpling and thickening inshore from the trench in the transition zone from a thick continental thrust to a thin oceanic crust. On the section studied, the negative isostatic anomaly is centred over a well defined topographic rise of some 3000 m where the crust has a thickness of about 20 km. The trench, which occurs on the seaward flank of this crustal bulge, has a near normal oceanic crustal thickness of about 9.0 km. (Auth.)

(d) MAGNETIC (INCLUDING PALAEOMAGNETISM)

See also entry 16-c-1.

16-d-1 GRAY, F., 1965 — Proton magnetometer surveys in the Solomon Islands and western Pacific Ocean, 1958. *Brit. Solomon Is geol. Rec.*, 2, 201-10.

During the 1958 survey in the Solomon Is region, a continuous magnetic intensity profile was run on a traverse line from Fiji to Hong Kong via Honiara, Port Moresby, and Singapore. The results show considerable variation in shape and size of anomaly and in the relationship between magnetic profile and bathymetry. In some sections marked magnetic anomalies are detected in areas of little variation in depth; in other sections marked variations in depth are not accompanied by magnetic variations; in some there appears to be a relationship between depth and magnetic profiles. All sections lie on the continental side of the andesite line.

Sections along the southeast coast of Papua show little variation in the magnetic profile with values ranging between 43 650 and 44 000 gammas, and little relation to the bathymetric profile. The magnetic intensities fall to a minimum of 43 000 gammas off Port Moresby, rising steadily to the west to 44 800 gammas on the continental sea-floor area. There is no marked magnetic profile change across the abrupt bathymetric change from the Coral Sea basin to the Torres Str. shelf (W.M.)

16-d-2 LINDEN, J. VAN DER, 1965 — Isogonic map of Australia and New Guinea for the epoch 1965.0. *Bur. Miner. Resour. Aust. Rep.*, 98, 5 pp.

The map accompanying this report shows lines of equal magnetic declination, over Australia and Papua New Guinea, predicted in 1950 and published by BMR at intervals of 5 years. Insets on the map show: (a) The isogonic lines of an area in the Indian Ocean bounded by latitudes 8° to 16°S and longitudes 96° to 108°E; (b) the rate of change of declination (i.e. secular variation) in minutes per year; (c) the density of declination stations in Australia and Papua New Guinea. (Auth.)

16-d-3 MAEDA, R., RIKITAKE, T., & NAGATA, T., 1965 — Sudden commencements of geomagnetic storms and their irregularities. *J. Geomag. Geoelect.*, 17, 69-73.

Vertical components of geomagnetic variations at times of sudden commencements of magnetic storms apparently show an irregular distribution over the world, in contrast to the simultaneous horizontal field-change. The geomagnetic vertical field-change depends on the topographic condition at magnetic observatories, and this seems to be explained by electromagnetic induction within the Earth's outermost layer. At Port Moresby there is a positive vertical change and a negative vertical change; the opposite effects are recorded from observatory data at Djayapura. (Auth./W.M.)

16-d-4 NAGATA, T., 1966 — A review of recent studies on conductivity anomalies along continental margins. *In* POOLE, W. H. (Ed.) — Continental margins and island arcs — report of symposium. *Geol. Surv. Canada Pap.*, 66(15), 418-29.

The disturbance vector of geomagnetic variation of a duration from several minutes to several hours along some continental margins (e.g. Australia, Antarctica, and California coasts and Japanese Islands) has an anomalous behaviour referred to as the coastal effect. The coastal effect is attributed to a difference in electric conductivity of the upper mantle under the oceans and under the continents; either the thickness of the non-conductive uppermost part of the mantle is much thinner under the oceans than under the continents, or the conductivity of the upper mantle is much higher under the oceans than under the continents. Port Moresby is one of the coastal observatory stations considered, using data in entry 16-d-7. (Auth./W.M.)

16-d-5 PARKINSON, W. D., 1959 — Isogonic map of Australia and New Guinea showing predicted values for the epoch 1960.5. *Bur. Miner. Resour. Aust. Rep.* 42, 3 pp.

The accompanying map shows lines of equal magnetic declination over Australia and New Guinea predicted for the epoch 1960.5. It continues the series, started in 1950, of isogonic maps published at intervals of 5 years. The map contains an isoporic chart showing the expected annual rate of change of declination for the same epoch. (Auth.)

16-d-6 PARKINSON, W. D., 1962 — The influence of continents and oceans on geomagnetic variations. *Geophys. J.*, 6, 441-9.

During bays and similar magnetic variations the vectors representing changes in the geomagnetic field tend to lie on or close to a plane. The orientation of this plane varies from one observatory to another. At coastal observatories it almost invariably tilts upward towards the nearest deep ocean.

Results are derived defining the 'preferred plane' for 21 stations, 1 of which is Port Moresby. At the Port Moresby observatory, data indicate that the 'preferred plane' dips with moderate scatter at 35° south-southwest (116 observations during the period 1958-60).

The 'preferred plane' tilts upwards towards the nearest deep ocean, with the tilt measurably greater at stations near the edges of continents — e.g. Port Moresby. This effect is thought to be attributable to either or both of the electromagnetic induction in ocean waters or higher conductivity of the mantle below oceans. (Auth./W.M.)

16-d-7 PARKINSON, W. D., 1964 — Conductivity anomalies in Australia and the ocean effect. *J. Geomag. Geoelect.*, 15, 222-6.

The direction of tilt of the vector 'preferred plane' at coastal stations, one of which is Port Moresby, is found to be towards the nearest deep ocean. Comparisons of magnetogram records from coastal observatories with data from an experimental terrella simulation model suggest that sea water in oceans with a highly conducting core at a depth of 600 km cannot explain either the coastal effect of vector plane attitude or the very low vertical component usually found at inland stations. (W.M.)

16-d-8 PARKINSON, W. D., & CUREDALE, R. G., 1962 — Isomagnetic maps of eastern New Guinea for the epoch 1957.5. *Bur. Miner. Resour. Aust. Rep.* 63, 5 pp.

Isomagnetic maps of eastern New Guinea and the surrounding region are presented showing 5 magnetic elements reduced to the epoch 1957.5. All magnetic observations made in the region since 1917 have been used; the older observations have been corrected for secular variation by repeat observations at Port Moresby. (Auth.)

16-d-9 WOOD, F. W., & EVERINGHAM, I. B., 1953 — A provisional isogonic map of Australia and New Guinea showing predicted values for the epoch 1955.5. *Bur Miner. Resour. Aust. Rep.* 14, 6 pp.

A provisional isogonic map of Australia and New Guinea has been prepared showing predicted values of declination for the middle of 1955. An isoporic chart shows the expected annual rate of change of declination over the same area for the same epoch. This rate of change (secular variation) can be taken as applying for all practical purposes from the beginning to the end of 1957.

The main points about the present map, in comparison with that for 1950.5, are (i) the declination over Tasmania is from $\frac{2}{3}$ to $\frac{3}{4}$ of a degree greater (more easterly) than would have been expected from the 1950.5 map; (ii) the annual rate of change of declination over southeast Australia shows an increased positive (easterly) value; (iii) the annual rate of change of declination over northwest Australia now shows a small negative (westerly) value instead of the small positive value shown in previous years. (Auth./W.M.)

(e) GEOTHERMAL

16-e-1 FISHER, R. L., VON HERZEN, R. P., & RHEA, K. P., 1967 — Topographic heat flow studies in seven Micronesian and Melanesian trenches (Abstract only). *Trans. Amer. geophys. Un.*, 48, 218.

Scripps Institution's 1962 Proa expedition made precise sounding, photographic, bottom-sampling, and heat flow explorations of portions of Challenger Deep, Yap, and Palau trenches in Micronesia and the 'interior' New Britain, Solomons, and North New Hebrides trenches; 36 trench island arc measurements are reported. High heat flow was measured within or near the Palau, Yap, and Solomon trenches, which are topographically complex and cross-faulted; high heat flow, even in the sedimented Papua trench, may result from extensive volcanism. Low heat flow characterizes the topographically simpler but seismically more active Challenger Deep and New Britain and North New Hebrides trenches, which are slightly to moderately sedimented. Heat flow in moderate to deep portions of the Coral Sea south and southwest of the Solomons to northern New Hebrides is normal. Low heat flow was measured northwest of Palau and Challenger Deep and northeast of the eastern Solomons. Heat flow across South New Hebrides trench-New Hebrides ridge-North Fiji basin is consistently high. (Auth.)

16-e-2 LEE, W. H. K., & UYEDA, S., 1965 — Review of heat flow data. *Geophys. Monogr. Amer. geophys. Un.*, 8, 87-190.

All available heat flow data (about 2000 observations) are reviewed and analysed. Statistical methods are used to summarize the data, and numerical techniques are developed to find their essential features. Analysis of nearby and repeated measurements suggests that regional heat flow variations more than 0.2 μcal/cm^2/s are significant. At the 95% confidence level, the world's mean heat flow is 1.5$\pm$10% and the average over the continents does not differ significantly from that over the oceans. Heat flow results are well correlated with major geological features. On land, the average and standard deviation of heat flow values are 0.92$\pm$0.17 from Precambrian shields, 1.23$\pm$0.4 from Palaeozoic orogenic areas, 1.54$\pm$0.38 from post-Precambrian non-orogenic areas, and 1.92$\pm$0.49 from Mesozoic-Cainozoic orogenic areas. At sea, they are 0.99$\pm$0.61 from trenches, 1.28$\pm$0.53 from basins, and 1.82$\pm$1.56 from ridges. On a large scale, a negative correlation between heat flow and gravity is found.

Heat flow values of 1.1 from one measurement and 0.4 as the mean of two measurements are given for the east New Guinea mainland (145°-150°E, 5°-10°S) and for the Solomon Sea (150°-155°E, 5°-10°S) respectively. These data appear in a map showing earth-surface distribution of heat flow measurements. (Auth./W.M.)

16-e-3 LEE, W. H. K., UYEDA, S., & TAYLOR, P. T., 1966 — Geothermal studies of continental margins and island arcs. *In* POOLE, W. H. (Ed.) — Continental margins and island arcs — report of symposium. *Geol. Surv. Canada Pap.*, 66(15), 398-417.

The thermal regime in continental margins and island arcs was investigated by analysing existing heat flow results and other pertinent data. Heat flow patterns across the continental margins were found to be correlatable with geological features. Time-series analysis of ocean water temperature records indicated that annual and semidiurnal temperature variations are dominant in the oceans. These suggest that oceanic heat flow measurements can be carried out in shallow water, provided that the probe penetrates beyond a depth of about 3 m.

For 5° x 5° grids covering eastern Papua and the Solomon Sea, heat flow rates of 1.1 and 0.4μ cal/cm^2/s are quoted from previously published data (entry 16-e-2), and are thought to suggest stable continental margin conditions. (Auth./W.M.)

17 GEOCHRONOLOGY

(a) General

17-a-1 Hossfeld, P. S., 1962 — Radiocarbon sampling of the Aitape skull site. *36th ANZAAS Cong., Sydney*, Sec. C Abs. (listed by title in *Aust. J. Sci.*, 25, 385).

This is known by title only.

17-a-2 Page, R. W., 1971 — Ages of emplacement and mineralization of economic mineral deposits in the New Guinea-Solomon Islands region. *12th Pacif. Sci. Cong., Canberra*, Abs. Vol., 418.

Potassium-argon ages are reported for several mineral deposits in New Guinea and Bougainville. Mineralized rocks are genetically associated with sub-volcanic porphyries and other high-level intrusives which are all Miocene or younger. They are emplaced individually or as parts of larger plutons at a time of widespread tectonic activity in New Guinea which began in the lower Miocene and continued through the Pliocene to the present.

The significantly mineralized intrusions in the New Guinea Highlands lie in a roughly east-southeast-trending arcuate belt which includes the prospects of Ok Tedi, Frieda, Porgera, Yanderra (Bismarck Granodiorite), and the Kainantu and Morobe Goldfields. The ages of most intrusions studied in this belt of nearly 600 km fall in the narrow span from 16 to 7 m.y. (middle to upper Miocene). For the Bismarck Grandiorite a time gap of 5 m.y. is recognized between emplacement of the pluton and subsequent copper mineralization.

Preliminary dating results from the Panguna porphyry copper orebody on Bougainville indicate that this is an extremely young deposit. The earliest dioritic rocks (about 6 m.y. old) were postdated by intrusions which brought about extensive alteration, rock fracturing, and potash metasomatism some 2-3 m.y. later (middle to upper Pliocene). (Auth.)

17-a-3 Page, R. W., & McDougall, I., 1970b — Potassium-argon dating of the Tertiary f_{1-2} stage in New Guinea and its bearing on the geological time-scale. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

K-Ar ages of lavas from New Guinea interbedded with sedimentary rocks that contain faunas indicative of the East Indies Tertiary f_{1-2} letter stage range from 13 to 15 m.y. On the basis of these ages the f_{1-2} stages are considerably younger than those extrapolated from the Tertiary Geological Time-Scale, but are supported by ages obtained in marine successions from elsewhere. The New Guinea dating confirms recent stratigraphic opinion that the East Indies letter stages are younger relative to the European Tertiary stages than previously thought. An estimate of the age of 14-15 m.y. for the *Orbulina* Datum in New Guinea is concordant with that recently suggested for California. (Auth.)

(b) Absolute Ages

See also entry 06-b-2.

17-b-1 Dury, G. H., 1964 — Australian geochronology: check list 1. *Aust. J. Sci.*, **27**, 103-9.

In a list of 124 age determination results assembled from published and unpublished sources, information is given on the locality, material examined and source or radiogenic carbon, suggested age, and source of data. All ages are C^{14} determined. Results from 9 samples from Papua New Guinea are listed (W.M.)

17-b-2 DURY, G. H., 1966 — Australian geochronology: check list 2. *Aust. J. Sci.*,. 29, 158-62.

In a list of 163 age determination results collected from published and unpublished sources, information is given on the locality, material examined and source of radiogenic carbon, suggested age, and source of data. 11 results on samples from Papua New Guinea are included, mostly from archaeological material. (W.M.)

17-b-3 DURY, G. H., & SMITH, T. LANGFORD, 1968 — Australian geochronology: check list 3. *Aust. J. Sci.*, 30, 304-6.

In a list of 53 age determination results collected from published and unpublished sources, information is given on the locality, material examined and sources of radiogenic carbon, suggested age, and source of data; 6 results on material from Papua New Guinea are included. (W.M.)

17-b-4 EVERNDEN, J. F., SAVAGE, D. E., CURTIS, G. H., & JAMES, G. T., 1964 — Potassium-argon dates and the Cenozoic mammalian chronology of North America. *Amer. J. Sci.*, 262, 145-98.

A study was made of the reliability of age determination for North American strata containing described vertebrate remains and interbedded volcanics. Age determined from the faunal evidence was compared with the K-Ar age for whole-rock and mineral samples from the volcanics.

The position of the Pliocene-Pleistocene boundary is considered in the light of North American mammalian faunal evidence and K-Ar ages on volcanics interbedded with vertebrate-bearing strata throughout the world. Included in this study were samples from the Otibanda Formation near Bulolo; plagioclases from 2 tuff samples indicated ages of 6.1 and 7.6 m.y. (W.M.)

17-b-5 FERGUSSON, G. J., 1955 — New Zealand C^{14} Age measurements — II. *N.Z. J. Sci. Tech.*, 36B, 371-4.

Carbonized wood from a tree embedded in ashes deposited in the early stages of the volcanic activity in the Buna-Kokoda area south of Mt Lamington gave an age of 13 750± years. (Auth./W.M.)

17-b-6 GREEN, J. H., HARRIS, J., NEUHAUS, J. W. G., SEWELL, D. K. B., & WATSON, M., 1965 — University of New South Wales radiocarbon dates — I. *Radiocarbon*, 7, 162-5.

2 samples of material from a recently felled *Nothofagus* from the Kabanunt Forest (5°20'S, 143°30'E) gave an age of 550±85 years for the heart-wood and a modern age for the outer 2-cm layer. (W.M.)

17-b-7 HARDING, R. R., 1969 — Catalogue of age determinations on Australian rocks, 1962-65. *Bur. Miner. Resour. Aust. Rep.* 117.

Material from Papua New Guinea that has been dated includes (i) biotite granite from basement of Australian Petroleum Co. Aramia No. 1 well near L. Murray, the biotites giving a K-Ar age of 236 m.y. for intrusion or metamorphism; (ii) granodiorite from near Bundi, from which biotite and whole-rock give a minimum Rb-Sr age of 195 m.y.; (iii) basaltic lava from the C. Vogel area, with a total rock minimum K-Ar age of 28.0 m.y.; and (iv) tuffs from the Otibanda Formation near Bulolo, 2 plagioclases giving a K-Ar age of 6.1-7.6 m.y. (W.M.)

17-b-8 HOSSFELD, P. S., 1964 — The Aitape calvarium. *Aust. J. Sci.*, 27, 179.

Radiogenic age determinations on shell fragments, coconut shell, and wood debris from the site of the Aitape skull are ranged from 4400±85 years B.P. for the shells to 5070±140 years B.P. for one of the wood samples. The probable time of accumulation is 5000 years B.P. Uranium content of the skull fragments indicates a late Pleistocene to Recent age. In the light of these ages it is suggested that the coastal uplift at Aitape has been much more active than previously recognized. (W.M.)

17-b-9 HOSSFELD, P. S., 1965 — Radiocarbon dating and palaeoecology of the Aitape fossil human remains. *Proc. Roy. Soc. Vic.*, 78, 161-7.

The site near Aitape, where fossil human remains were collected in 1929, was revisited and materials for radiocarbon dating were collected. The associated fossils show that the ecology was mangrove swamp. Organic materials from the lenticle containing the human bones were C^{14} dated at about 5000 years. (Auth.)

17-b-10 KIGOSHI, K., 1967 — Gakushuin natural radiocarbon measurements — VI. *Radiocarbon*, 9, 43-62.

Plant debris samples from sediments in L. Inim near Wabag gave ages ranging from 2240±90 to 8310±170 years B.P. A similar suite from nearby L. Birip gave ages ranging from 1520±100 to 2440±490 B.P. This lake occurs in a volcanic crater, and ashes at a depth of 225 cm, thought to represent the final eruptive phase, are dated at 2140±90 years B.P. (W.M.)

17-b-11 KIGOSHI, K., & KOBAYASHI, H., 1965 — Gakashuin natural radiocarbon measurements — IV. *Radiocarbon*, 7, 10-23.

Charcoal from a fireplace exposed by wave action on Motu Paea I., Matupi (16°24′40″S, 152°12′W) gave an age of less than 220 years. Wood charcoal from the Aitape human skull horizon gave an age of 5070±140 years B.P. (W.M.)

17-b-12 KIGOSHI, K., & KOBAYASHI, H., 1966 — Gakushuin natural radiocarbon measurements — V. *Radiocarbon*, 8, 54-73.

Dating of samples from many localities is recorded. Papua New Guinea material treated was: samples of charcoal from dacitic ashes around Managalase and Mt Lamington, which give ages of 6800±250 B.P., 15 600±500 B.P., 20 100±500 B.P., and 7930±370 B.P.; clam shell fragments from a raised reef on Buka I. giving an age of more than 33 500 years, and a coral fragment from a cave in this reef giving an age of more than 33 000 years; some hearth ashes from Aibura cave near Kainantu, giving ages of 770±100 B.P. and 3800±110 B.P.; charcoal from implements in soil near Kosipe in the Goilala Subdistrict, giving dubious ages of 16 300±1200 B.P., and 19 350±600 B.P. (W.M.)

17-b-13 KIGOSHI, K., AIZAWA, H., & SUZUKI, N., 1969 — Gakushuin natural radiocarbon measurements — VII. *Radiocarbon*, 11, 295-326.

Charcoal ashes from the Managalase Plateau south of Mt Lamington range in age from 30 620 (+6400 to −3600) years to 120±100 years. Wood and charcoal from Karkar volcano near Madang range from 282±80 years to 730±90 years in age. (W.M.)

17-b-14 PAGE, R. W., & McDOUGALL, I., 1970a — Isotopic dating of the igneous and metamorphic rocks of the New Guinea highlands. *42nd ANZAAS Cong., Port Moresby*, Sec. 3 Abs.

Isotopic age determinations and geological mapping by BMR and the pattern of seismic activity in the area suggest a major structural discontinuity along the axis of the northwest-trending New Guinea Cordillera. This break separates the relatively stable southern part from a distinct structural belt of younger plutonic rocks arcuately aligned in a west-northwest fashion in the north.

K-Ar ages from 210 to 245 m.y. (supported by Rb-Sr data) indicate that the southern area contains the oldest rocks dated in New Guinea, viz. the Kubor Massif and the exposed and cored pre-Jurassic granites scattered through Papua.

The intensity of igneous and metamorphic activity in Miocene time in the west-northwest-trending belt to the north is unique in the geological history of New Guinea. K-Ar and Rb-Sr ages dating the final cooling of the intrusive and volcanic rocks in this belt indicate more or less continuous volcanism and emplacement of intrusions from 18 to 7 m.y. ago. There was a distinct peak of activity between 15 and 12 m.y. in the middle Miocene. Further early and late Miocene ages obtained from metamorphic rocks in the same belt support the hypothesis that the north New Guinea crustal development occurred in late Tertiary time. (Auth.)

17-b-15 PAGE, R. W., & MCDOUGALL, I., 1970c — Postassium-argon dating of the Tertiary f_{1-2} stage in New Guinea and its bearing on the geological time-scale. *Amer. J. Sci.*, 269, 321-42.

This is similar to entry 17-a-3.

17-b-16 POLACH, H. A., CHAPPELL, J., & LOVERING, J. F., 1969 — A.N.U. radiocarbon date list — III. *Radiocarbon*, 11, 245-62.

Terraces of elevated coralline fringing reefs on the north coast of the Huon Pen. near the mouth of the Masaweng R. range up to 770 m above sea level. A series of samples from these reef terraces range in age from 270±50 years to 43 000 (+2100, −2000) years. (W.M.)

17-b-17 POLACH, H. A., GOLSON, J., LOVERING, J. F., & STIPP, J. J., 1968 — A.N.U. radiocarbon date list — II. *Radiocarbon*, 10, 179-99.

The results of age determinations carried out between January and August 1967 are presented. New Guinea material dated includes a suite of modern vegetation debris samples from L. Birip near Wabag, a suite of anthropological and palaeontological material from Batari cave in the Eastern Highlands and from Kafiavana rock shelter, recent plantation growth material from Manton plantation east of Mt Hagen, and pottery and archaeological samples from Wotom I. near Rabaul. (W.M.)

17-b-18 POLACH, H. A., STIPP, J. J., GOLSON, J., & LOVERING, J. F., 1967 — A.N.U. radiocarbon date list — I. *Radiocarbon*, 9, 15-27.

Charcoal from the 'B' horizon of a volcanic soil from Mt Lamington, and collected at Kosipe Mission near Woitape give an age of 4050±500 years B.P. These soils overlie older volcanic soils for which ages of 16 300±1200 and 19 350±600 years B.P. are reported. (W.M.)

17-b-19 RICHARDS, J. R., & WILLMOTT, W. F., 1970 — K-Ar age of biotites from Torres Straits. *Aust. J. Sci.*, 32, 369-70.

4 samples gave ages ranging 286±3 to 302±5 m.y. for biotites from the Badu Granite. One sample which gave an age of 302±5 m.y. was from outcrops on a small island off Mabadauan in western Papua. An upper Carboniferous age is assigned to this material. (W.M.)

17-b-20 TAYLOR, T. L. G., & RAFTER, T. A., 1963 — New Zealand natural radiocarbon measurements — I to V. *Radiocarbon*, 5, 118-62.

Charcoal collected on Tunnel Hill Road from the lower part of pyroclastic deposits which form the wall of Blanche Bay caldera at Rabaul gave an age of 1190±60 years B.P. This sample is considered to date the latest catastrophic phase of active volcanism in the area. (W.M.)

18 OCEANOGRAPHY

(a) Sedimentation

See also entries

02-b-47 18-b-14

18-a-1 AUSTRALIA. COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION, 1962 — Oceanographic observations in the Pacific Ocean in 1960, HMAS *Gascoyne* cruises G 1/60 and G 2/60. *CSIRO, Oceanogr. Cruise Rep.* 5, 255 pp.

During cruise 2/60, bottom sediment samples were collected at a few of the 112 stations in the southwest Pacific. Sediment samples were collected with a 3-m core near Port Moresby, in the Jomard Passage in the Louisiade Arch., off the southwest coast of New Ireland, and near New Georgia; 2 cores near Port Moresby penetrated 95-100 cm into interbedded grey-green silt and grey mud at depths of 560 and 360 fathoms (1020 and 658 m). The Jomard Station penetrated 3 m into organic ooze at a depth of 750 fathoms (1370 m). The New Ireland core penetrated disturbed interbedded grey sand and green silt at a depth of 350 fathoms (640 m). (W.M.)

18-a-2 EWING, J. I., HOUTZ, R. E., & LUDWIG, W. J., 1970 — Sediment distribution in the Coral Sea. *J. geophys. Res.*, 75, 1963-72.

Analysis of reflection profiles and sonobuoy data from the Coral Sea show that an erosion surface was cut into the Queensland Plateau during the early Tertiary, implying that the Coral Sea basin was in existence at this time. The plateau subsided about 1500 m during late Tertiary and Pleistocene time, and a system of normal faults resulted in the formation of the graben-like trough now separating the plateau from the mainland. The edge of the plateau facing the basin probably was not faulted or seriously deformed at this time. The oldest sediments in the Coral Sea basin are acoustically transparent, antedate the erosion surface, and rest directly on basement. They are covered and partly scoured by a thick sequence of turbidites. The older turbidites may be derived from the planation of the Queensland plateau, whereas the younger turbidites are from the Fly R. in New Guinea. The Papuan plateau may represent an outer barrier ridge filled to sill depth by Fly R. turbidites. (Auth.)

18-a-3 EWING, J., EWING, M., AITKEN, T., & LUDWIG, W. J., 1968 — North Pacific sediment layers measured by seismic profiling. *Geophys. Monogr., Amer. geophys. Un.*, 12, 147-73.

A reconnaissance survey of the sediment thickness in the north Pacific Ocean has been accomplished through the use of the continuous seismic profiler. A major division in the sediment cover is recognized and corresponds approximately to the Mesozoic-Cainozoic boundary. It appears that most, if not all, pre-Cainozoic sediments are in the western part of the basin. The major accumulations, except turbidites, are found in a belt approximately following the equator and in a belt along the western and northwestern margin of the basin. Deposition in the central part of the basin appears to have been extremely slow throughout the Cainozoic. There is a marked decrease in the thickness of the equatorial sediment belt over the crest of the East Pacific rise. However, the overall agreement between the patterns of sediment accumulation and productivity indicates that deposition during much of the Cainozoic occurred under conditions closely resembling those now obtaining. It is concluded that episodic spreading of the sea floor best accounts for the sediment distribution and that the present cycle of spreading commenced about 10-12 m.y. ago, preceded by a quiescent period of at least 15 m.y. duration.

One of the profiles lies near the equator north of Bougainville. In this profile, the edge of the Solomon Is Plateau is crossed, and a thick pile of sediment at the foot of the break of slope is thought to be the product of turbidite ponding in depressions formed by faulting and possibly erosion. (Auth./W.M.)

18-a-4 Gorbunova, Z. N., 1966 — Clay minerals in the sediments of the Pacific Ocean. *Proc. 11th Pacif. Sci. Cong., Tokyo*, 2.

6 mineralogical associations are recognized in clay minerals in the sediments of the Pacific Ocean: (1) a mixture of hydromica and chlorite typifies open ocean areas north of 20°N, and occurs near the coasts of Antarctica and South America; (2) a mixture of hydromicas, chlorite, and montmorillonite occurs along the ocean boundaries, in tropical open waters, and some deep basins — e.g. near Chile and New Zealand; (3) a mixture of kaolinite and montmorillonite occurs in western margin tropic to subtropic waters, except around New Guinea; (4) a pure montmorillonite is found near California, Solomon Is, and Caroline Is; (5) a mixture of montmorillonite, hydromica, kaolinite, and some chlorite occurs near New Guinea and Mariana Is; (6) a mixture of clays whose identification is suppressed by the predominance of diatoms and iron-manganese compounds is found in Antarctic waters.

The distribution of clay minerals is associated primarily with climatic zonation of soils in source areas. Hydromica and chlorite are associated mainly with areas of colder and drier climate; kaolinites are predominant in areas with subtropical and tropical climate. The distribution of minerals of the montmorillonite group is not always determined by climate zonation, and their formation is often connected with the weathering of products of volcanogenic activity. (Auth./W.M.)

18-a-5 Houtz, R. E., Edgar, N. T., & Ludwig, W. J., 1968 — Coral Sea sediment distribution (abstract). *Trans. Amer. geophys. Un.*, 49, 218.

Detailed reflection profile data from the Coral Sea show that sediments on the eastern edge of the Queensland plateau have apparently subsided 3 km. The mechanism of the subsidence may be normal faulting down to the basin or a migrating monocline. Normal faulting towards a shallow trough separating the northern part of the plateau and the Australian mainland is apparently occurring at present. 13 sonobuoys taken in the Coral Sea yield 27 sediment velocities at various depths, 3 refraction velocities in the 5.0-5.7 km/s range, and 4 refraction velocities in the 6.1-6.6 km/s range. One shear wave was recorded. The sediment velocities are much faster than those recorded in the Atlantic and the G. of Mexico. One anomalous sonobuoy station (4 sediment layer velocities) showing low velocities typical of the Atlantic occurs behind a buried ridge filled to sill depth along the southern coast of New Guinea. (Auth.)

18-a-6 Krause, D. C., White, W. C., Piper, D. J. W., & Heezen, B. C., 1970 — Turbidity currents and cable breaks in the western New Britain Trench. *Bull. geol. Soc. Amer.*, 81, 2153-60.

The western New Britain Trench is receiving abundant sediment from the west. Evidence for earthquake-triggered turbidity currents has been detected in the New Britain Trench through breaks in a submarine telephone cable in 1966 and 1968. The average velocity of the turbidity currents is 50 and 30 km/hr, respectively, assuming that the most likely single source of the turbidity currents is the Markham R. delta. Bottom photographs and sediment samples support these conclusions. Deep-sea channels are present. (Auth.)

18-a-7 LISITZIN, A. P., 1970 — Sedimentation and geochemical consideration. *In* WOOSTER, W. S. (Ed.) — SCIENTIFIC EXPLORATION OF THE SOUTH PACIFIC. *Washington, Nat. Acad. Sci.*, 89-132.

Eastern New Guinea mainland supplies terrigenous detritus to the ocean at the rate of 100-240 tonnes per km^2 of water discharge area, while the New Guinea islands supply at the rate of 50-100 tonnes per km^2. Material is supplied to sedimentary basins in the Bismarck, Solomon, and Coral Seas. Sedimentary materials contain dominantly kaolinitic clays with subordinate montmorillonite, illite, and chlorite; a relatively small biogenic contribution is recognized.

Dominant sediments in the Bismarck Sea are medium to high-carbonate types; in the Solomon Sea pelagic red clays dominate in the north and high-carbonate sediments dominate in the south; in the Coral Sea carbonate sediments accumulate except off the Fly R. where terrigenous material is dominant; east of New Ireland-Bougainville the sediments are dominantly high-carbonate types. All sediments contain less than 1% contribution of amorphous silica. Most sediments are in the zone of humid tropic lithogenesis and are characteristic of such sediments, with contributions of volcanigenic sediments around New Britain and Bougainville. (W.M.)

18-a-8 MURRAY, J., 1895 — REPORT ON THE SCIENTIFIC RESULTS OF THE VOYAGE of HMS *Challenger* DURING THE YEARS 1872-76: A summary of the scientific results (second part). *Edinburgh, Neill,* xix and 797-1608.

Near the Schouten Is water temperature-depth and density-depth profiles were recorded, and a sample of blue mud containing 17.17% lime collected from the sea bed at a depth of 1070 fathoms (1950 m). One species of heteropod and 83 species of forams are recorded from this bottom sample.

In Nares Har. on Manus I. coral sands and muds running 86.87% lime constitute bottom sediment; the beach of the main island was composed of sand with 27.30% lime. The harbour bed deposits contain 80 named and listed species of forams; 12 species of pteropods are recorded from a sample near the entrance to Nares Har. (W.M.)

18-a-9 MURRAY, J., 1906 — On the depth, temperatures of the ocean waters, and marine deposits of the south-west Pacific Ocean. *Qld. geogr. J.*, 21, 71-134.

Data on seafloor depth, water temperature, and seafloor sediments are presented from the southwest Pacific Ocean west of 160°W and north of 50°S. Few depth soundings were taken in the area east of New Guinea and New Britain, and the seafloor topography here is still somewhat unknown.

Seafloor sediments in the very deep areas include *Globigerina* ooze as the dominant lithology, with lesser amounts of red clay, blue and green muds, volcanic and coral muds, and rare radiolarian ooze. Carbonate-rich deposits are largely restricted to shallower areas. (W.M.)

18-a-10 SHOR, G. G., 1967 — Seismic refraction profile in the Coral Sea Basin. *Science*, 158, 911-3.

A refraction profile near the south edge of Coral Sea Basin shows sediments, 'second layer,' and ocean crust all thicker than normal for an oceanic station; normal mantle lies at a depth of 9 km.

Some tentative conclusions are drawn about structure and geological history: the slope on the north side of the Queensland Plateau is partly depositional, and considerable sedimentary material has been derived from the plateau to build the rise at the foot of the slope and to help fill the Coral Sea Basin. This finding does not rule out Krause's conclusion that much of the fill comes from the northwest from the Papuan Plateau. The thickened second layer suggests additional filling of the basin by either sediments or volcanic rocks. The velocity of the very thick third layer, very close to that found under the ocean basins but well above values normally found at such depths under continental areas, suggests that the basin originated as a separated area of oceanic structure.

The zone of thickened 'oceanic layer' may demonstrate part of the process by which a piece of ocean can be converted into continent: the sedimentary section thickens by deposition at the top at the centre of the basin, and the crustal section thickens by conversion or addition from below at the edges. (Auth./W.M.)

18-a-11 SPRIGG, R. C., 1948 — Newly discovered submarine canyons of New Guinea and South Australia. *Nature,* 161 (4085), 246-7.

3 submarine canyons off the south coast of Huon G. near Morobe are attributed to erosion of the soft volcanic muds on the seafloor by silt-laden waters from the Gira, Eia, and Waria Rs. The canyons have gradients of up to 1:10 across the 15-km wide continental shelf, and extend to within 1.5 km of the modern coast. Minor coral growths are present along the canyon rims at a depth of 60-80 fathoms (110-145 m), and a relative rise of sea level of 40-50 fathoms (75-90 m) since their formation is postulated. (W.M.)

18-a-12 WHITE, W. W., 1965 — Bottom sampling in the Huon Gulf area, north and eastern Australia and New Guinea. *38th ANZAAS Cong., Hobart* (listed by title in *Aust. J. Sci.,* 28, 312).

This is known by title only.

18-a-13 WILLCOX, J. B., 1971 — Preliminary results of a marine geophysical survey in the Bismarck Sea. *43rd ANZAAS Cong., Brisbane,* Sec. 3 Abs., 54.

In 1970 BMR carried out a marine geophysical survey around Papua New Guinea, including the G. of Papua and the Bismarck Sea. Continuous gravity, magnetic, and seismic sparker profiles were recorded along tracks spaced at 10 or 20 nautical miles (18.5 or 37 km).

Preliminary interpretation of seismic reflection profiles obtained in the Bismarck Sea indicates that relatively thick sediments and possibly lava flows are present in Vitiaz Str. and in Kimbe Bay, New Guinea. No evidence has been found to support the hypothesis that the axis of deposition of the northern New Guinea basin lies offshore. A broad east-west-trending basement rise underlies the Admiralty Is. Gravity and magnetic contour maps indicate a seaward extension of several structural features mapped on land. A strong correlation is evident between magnetic lineations and earthquake epicentres. (Auth.)

18-a-14 WINTERER, E. L., 1970 — Submarine valley systems around the Coral Sea Basin (Australia). *Marine Geol.,* 8, 229-44.

Several major and many minor submarine valleys and canyons lead into the deep (4650 m) Coral Sea Basin from the surrounding land, reef, and submarine plateau areas. Moresby valley, 500 km long, and comprising Pandora Trough, Moresby Trough, and Moresby Canyon, plus all their tributary canyons, is an integrated submarine drainage system that collects sediments from nearly the entire Papuan coast and channels it onto the floor of the basin. The Bligh System, including Queensland Trough, Bligh Trough, and Bligh Canyon, drains a 900 km sweep of the Great Barrier Reef coast of Queensland, and parts of the Queensland Submarine Plateau. Reflection profiles of the valleys show that they are mainly located in structural depressions, but that the submarine relief has been further accentuated by erosional entrenchment of the valleys into older, probably pelagic, sediments to a depth of as much as 750 m. Since the time of the entrenchment, the valleys and many canyons have been backfilled by as much as 500 m of sediments (assuming a sound velocity of 2 km/s in the fill). The valleys may be thought of as graded, and their filling is assigned to adjustments in the long profiles of the valleys as the Coral Sea Basin fills with sediment. (Auth.)

18-a-15 WUST, G., 1964 — The major deep-sea expeditions and research vessels, 1873-1960. *In* STEARS, M. (Ed.) — PROGRESS IN OCEANOGRAPHY, Vol. 2, *N.Y., Pergamon,* 1-52.

The history of oceanography is outlined, relating major advances in ideas and technology to surveys and cruises; 4 eras of oceanographic research in the period 1873-1960 are recognized: exploration (1873-1914), national systematic surveys (1925-40), development of new techniques (1947-56), and international research co-operation (since 1957).

During the first era, New Guinea was visited by the HMS *Challenger,* SMS *Gazelle,* and SMS *Planet*; during the second no major surveys covered New Guinea waters. During the third era, the Danish ship *Galathea* and ships from the Scripps Institution and U.S. Navy Electronic Laboratory surveyed the Solomon Sea, and the Russian ships *Ob* and *Vitiaz* visited eastern New Guinea waters. In the latest era, the *Vitiaz* and *Mikhail Lomonosov* covered New Guinea waters as part of their contribution to the IGY survey program; visits also were made by USS *Argo,* the Russian submarine *Sereryanka,* and HMAS *Diamantina.* (W.M.)

(b) Structural

See also entries

02-b-47 18-a-3

18-b-1 ANONYMOUS, 1909b — Soundings by the *Planet* in the Western Pacific. *Geogr. J.,* 34, 91-2.

A depression below 8000 m (4375 fathoms) was located west of the Solomon Is, and is thought to be structurally generated. The floor of the sea between mainland New Guinea and New Britain reaches depths of over 2000 m (1100 fathoms) over a large area. (W.M.)

18-b-2 ANONYMOUS, 1909e — (No title — soundings by the *Planet* in the western Pacific). *Geogr. Z.,* 15, 173-4.

Immediately west of Bougainville a trench in excess of 8000 m deep has been discovered. It is thought to be structural in origin and to form part of the series of trenches in this area of the Pacific. A broad plain at depths in excess of 2000 m underlies the Bismarck Sea south of New Britain. (W.M.)

18-b-3 ANONYMOUS, 1949 — Submarine gravity expeditions in the Pacific. *Trans. Amer. geophys. Un.,* 30, 149.

In 1948 the USS *Capitaine* observed gravity stations in the Louisiade-Bougainville-New Britain area as part of a general coverage in the region. An offset duplicate run was made in late 1948 by the USS *Bergell.* Results of observations confirm the relation of earthquake epicentre belts to the negative gravity anomaly strips. (W.M.)

18-b-4 BORCH, C. C. VON DER, 1969—Submarine canyons of southeastern New Guinea: seismic and bathymetric evidence for their modes of origin. *Deep-Sea Res.,* 16, 323-8.

Several apparently 'geologically active' submarine canyons off the New Guinea northeast coast have been surveyed by sparker seismic reflection profiling. Canyon initiation in the area is discussed and a model proposed which invokes canyon growth in vertical dimensions by a combination of rim up-growth and axial down-cutting. It is suggested that these canyons may have been initiated immediately after the formation of the present morphological outline of New Guinea, and that they have been maintained as conduits during surrounding continental shelf up-growth and progradation. (Auth.)

18-b-5 BRYAN, E. H., 1963 — Geography of the Pacific. *In* GRESSITT, J. L. (Ed.) — PACIFIC BASIN BIOGEOGRAPHY. *Honolulu, Bishop Mus. Press,* 189-91.

A diagonal line from Japan to Chile divides the Pacific into a northeast half of somewhat uniform depth, rather free from islands (the main group being the Hawaiian chain), and a southwest part. A more irregular boundary, the Andesite Line of Gutenberg and the Sial Line of Stearns, separates 2 distinct areas: (1) 'younger' islands, few of those now visible being older than Pliocene (or at most

Miocene), built up as mountains of basaltic lava, with minor additions of reef limestone; and (2) 'older' islands, containing Palaeozoic and Mesozoic fossils, extending eastward from New Guinea to Fiji and Tonga, and including all Melanesia. This boundary in general follows a series of deeps and trenches.

It is believed that in the past there was more continuous land connexion across Melanesia, and also between it and southeast Asia, through Australasia and Indonesia. The recent discovery of numerous submerged seamounts, at least some of which may have reached sea level in past eras, suggests that there may have been more extensive continuous chains of stepping-stones out across the central Pacific.

Islands in Polynesia and Micronesia take the form of 'high' islands, composed of basaltic volcanic materials, and 'low' islands, of reef and sand, believed to be deposits of skeletons of marine plants and animals on sunken or eroded volcanic peaks. Most of the low islands are atolls. A reef island may be elevated by earth movements to form a raised limestone island. Within the area of sialic islands (west of the Sial Line) are both high and low volcanic and limestone islands located on anticlinal ridges, as well as islands of more ancient metamorphic rocks. (Auth./W.M.)

18-b-6 COTTON, C. A., 1961 — Growing mountains and infantile islands on the western Pacific rim. *Geogr. J.*, 127, 209-11.

The post-Pliocene uplift of several mountain ranges in the western Pacific region is attributed to tectonic compression. Several coralline islands are thought to have developed on seafloor rises formed by anticlinal upheaval. (W.M.)

18-b-7 EWING, M., HAWKINS, L. V., & LUDWIG, W. J., 1970 — Crustal structure of the Coral Sea. *J. geophys. Res.*, 75, 1953-62.

Seismic refraction measurements made on the marginal Queensland (Coral Sea) plateau indicate that it is a submerged extension of the mainland. The basement of the plateau is a 1-2-km thick layer of seismic velocity 5.1-5.7 km/s resting on a 5.9-6.3 km/s crustal layer. There is an intermediate (or transitory) layer of velocity 7.3-7.6 km/s in the lower crust beneath the outer edge of the plateau and the continental rise that may indicate that the plateau proper is related to an orogenic belt, in all likelihood the Eastern Highlands and/or its progenitor, the Tasman coastal geosyncline of Palaeozoic age. The Queensland plateau may have subsided to its present position as an accompaniment to *en bloc* elevation of the Eastern Highlands during late Tertiary time. The subsidence probably occurred along major normal faults that today are manifested by the graben-like Queensland trough separating the plateau from the continental shelf. The Coral Sea basin has velocities and thicknesses indicative of normal oceanic crust on which has been deposited about 2.5 km of sediment in a semi-closed basin type of environment to produce a somewhat shallower sea floor than that in the much larger southwest Pacific basin. (Auth.)

18-b-8 FAIRBRIDGE, R. W., 1962 — Basis for submarine nomenclature in the southwest Pacific Ocean. *Dtsch. Hydrograph. Z.*, 15, 1-15.

Focus of attention on the geophysical interpretation of the topographic features of the sea floor calls for an appraisal of the nomenclature problem. Valuable contributions have already been made by various committees, but important problems remain. Since historical priority and customary usage rank high in the normal nomenclatorial systems of science, a careful review of existing methods and names is submitted, together with recommendations. The history and synonymy of nomenclature of ocean-floor features in the southwest Pacific Ocean are reviewed, and oceanographic cruises in the area listed. Recommendations are made for approaches to be followed in naming bottom features. (Auth./W.M.)

18-b-9 FAIRBRIDGE, R. W., 1966a — Bismarck Sea. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF OCEANOGRAPHY, Encyclopedia of Earth Sciences Series, Vol. 1. *N.Y., Reinhold*, 142-4.

The Bismarck Sea lies north of New Guinea and New Britain and extends west from New Ireland to Wuvulu and the Ninigo Group west of the Admiralty Is. The northern and eastern margin is marked by the Bismarck Ridge, of mean depth about 1000 m. The interior depression has depths about 2000 m, and is split by a rise (500-1000 m) separating the New Ireland Basin in the east from the New Guinea Basin in the west. Numerous seamounts and volcanic islands mark the southern margin of the sea.

Most of the basin floors and rises are covered with *Globigerina* ooze, giving way around the Admiralty Is to carbonate reef deposits and along the southern margin to volcaniclastic and pyroclastic detrital sediments and lavas. The Bismarck Sea is one of the quasi-cratonic basins of the western Pacific, characterized by block faulting, central downwarping, and marginal uplift. (W.M.)

18-b-10 FAIRBRIDGE, R. W., 1966b — Solomon Sea. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF OCEANOGRAPHY, Encyclopedia of Earth Sciences Series, Vol. 1, *N.Y., Reinhold* 820-2.

The Solomon Sea is bounded on the west by New Guinea, on the north and east by New Britain and the Solomon Is, and on the south by the 1000-fathom (1830 m) line south of the Louisiade Reefs and a line across to Rennell I. Within it 2 basins each with deeper rifts are recognized. The New Britain Basin in the north has a mean depth of over 4000 m and has its southern limits in the rise which is expressed in Kiriwina and Woodlark Is. The New Britain-Bougainville Trench (Solomon Trench) in the north of this basin has depths in excess of 5000 m and extends 500 km along the south and southwest coasts of New Britain and Bougainville. Off Bougainville this trench sinks to 9140 m in the Planet Deep. Kiriwina Trough is a rift on the south edge of the basin with depths of as much as 5419 m, and passes to the southwest over a low sill into the San Cristobal Trench. An elongated trough between the inner and outer chains of Solomon Is is termed the Santa Isabel Trough, in which depths of as much as 4340 m are recorded.

Seafloor deposits are characterized by *Globigerina* ooze in the southeast and by terrigenous sediments near the coasts. Several active volcanoes around the north and east margins contribute pyroclastic debris. Coral reefs and derived sediments mark the southern areas, and red clay occurs in the trenches. Submarine landslides triggered by seismic disturbances produce turbidite deposits in the trenches. Several major sinistral strike-slip faults are postulated as causing or accounting for the distribution of trenches and island blocks. The Solomon basins appear to have subsided during the late Tertiary to Quaternary, and to be at present undergoing uplift and emergence. (W.M.)

18-b-11 FAIRBRIDGE, R. W., & LINDEN, W. J. M. VAN DER, 1966 — Coral Sea. *In* FAIRBRIDGE, R. W. (Ed.) — ENCYCLOPEDIA OF OCEANOGRAPHY, Encyclopedia of Earth Sciences Series, Vol. 1, *N.Y., Reinhold,* 219-24.

The Coral Sea extends south from Papua, the 1000-fathom (1830 m) line, and the Louisiade Reefs to 30°S, and east from the Queensland coast almost to 170°E and includes New Caledonia. It is bounded by distinct structural highs, and 3 of the largest barrier reefs in the world form part of its boundaries, viz.: The Great Barrier Reef, the Tagula Barrier Reef and the New Caledonia Barrier Reef. There are 3 broad rises: the Mellish Rise, the Louisiade Rise, and the Indispensible Rise. In the southwest and south are 2 extensive plateaux — the Coral Sea Plateau and the Bellona Plateau, on both of which extensive shoal areas are developed. There are 3 major basins — Coral Sea Basin, New Hebrides Basin, and Santa Cruz Basin — and several minor troughs and imperfect basins, including the Queensland, Cato, New Caledonia, and Loyalty Troughs, and Frederick Basin. Near its eastern margin lie the San Cristobal, Torres, and New Hebrides Trenches.

The physical oceanography of the sea is complex, reflecting tidal and current influences. The floor of the sea is covered with pelagic red clay and *Globigerina* ooze. On the Papua abyssal plain a thin veneer of red clay covers the terrigenous turbidites containing wood fragments. These sediments are thought to have originated from the Fly R. area. The large plateau areas are largely covered by coral sands and carbonate muds. The lagoons of great barrier reefs are filled largely by terrigenous detritus with only minor coral-derived accumulations. Extensive volcanic sediments are found around the New Hebrides. 7 tectonic unit types are recognized in the Coral Sea, and their tectonic significance noted and discussed. The area has long been one of continental fracturing, and it is thought that much of the area of the Coral Sea was a landmass during the late Palaeozoic and early Mesozoic. (W.M.)

18-b-12 FISHER, R. L., & HESS, H. H., 1963 — *In* HILL, M. N. (Ed.) — THE SEA, Vol. 3. *N.Y., Interscience Publishers,* 411-36.

The structural significance, principal morphological features, and associated geophysical phenomena of ocean trenches in the Pacific Ocean are discussed. Depth recordings in most deeps are tabulated, and bathymetric charts of many are presented. Included in the trenches studied are the North Solomons (Bougainville), New Britain, and South Solomons Trenches, for which revised depth estimates of 8940±20 m, 8245±20 m, and 8310±20 m respectively are given, and the New Britain-Bougainville-New Hebrides slot for which a topographic contour map is presented.

The linked trenches of New Britain-Solomon Islands are concave towards the Pacific Ocean, the only example of this type. The area is active seismically and volcanically, with earthquake foci of moderate depth below the concave (oceanic) side of the area and andesitic volcanism on the concave rim of the trenches. These relatively small trenches are well developed near the ends but tend to shoal off the middle of the arcs.

An origin of oceanic trenches by upwelling of sub-crustal material into large tensional fractures does not account for all observed geophysical properties of such regions. Origins involving compressional downwarping and the over-riding of oceanic plates by continental plates similarly do not account for all observed features. A mechanism is suggested, involving tensional rifting inside the concave side of arcs, with associated compressional stresses on the convex side of arcs owing to blocks each side of the arc approaching each other under the influence of sub-plate convection. (W.M.)

18-b-13 FURUMOTO, A. S., HUSSONG, D. M., CAMPBELL, J. F., SUTTON, G. H., MALAHOFF, A., ROSE, J. C., & WOOLLARD, G. P., 1970 — Crustal and upper mantle structure of the Solomon Islands as revealed by seismic refraction survey of November-December 1966. *Pacif. Sci.,* 24, 315-32.

Results of a seismic refraction survey in the waters around the Solomon Is in 1966 show that (a) on the Ontong-Java Plateau northwest of the islands the crust is about 25 km thick with subnormal crustal velocities; (b) southwest of the New Georgia Is the crust is thinner than normal and is underlain by a mantle with low velocity; (c) southwest of Bougainville the crust is generally of normal oceanic structure underlain by a mantle with low velocity; and (d) mantle material in the Slot is found at a depth of 14 km. (Auth.)

18-b-14 GARDNER, J. V., 1969 — Aspects of the submarine geology of the Coral Sea (Abstract only). *Geol. Soc. Amer., Abs. 65th ann. Mtg,* 7, 75.

A detailed bathymetric map of the western Coral Sea reveals continental margins consisting of a continental shelf, continental rise and sediment aprons, marginal plateaux, and an abyssal plain. Of the 4 marginal plateaux found in the Coral Sea, the Queensland Plateau, is dated as early Miocene and represents the initial marine to the Blake Plateau off eastern North America; 4 large submarine troughs and several smaller submarine canyons are also delineated.

The Coral Sea Basin was probably formed by late Eocene to early Oligocene rotational spreading accompanied by large-scale subsidence of the basin margins. An erosional unconformity, previously identified on seismic reflection records across the Queensland Plateau, is dated as early Miocene and represents the initial marine transgression onto the basin margin. Subsidence continued, accompanied by faulting which subdivided the margin into a series of 4 marginal plateaux, generally bounded by 1 or more of the 4 submarine troughs. Subsidence rates average 17-24 cm/1000 years since the lower Miocene. Thick terrigenous turbidite sequences derived from New Guinea were deposited in the Coral Sea Basin during the last glacial stage while predominately calcareous pelagic sediments have accumulated since. Recent pelagic sedimentation rates are 3.6 cm/1000 years while glacial rates are higher by at least a factor of 4. (Auth.)

18-b-15 HAWKINS, L. V., 1967 — Oceanographic research. *APEA J.*, 7(2), 20-3.

The 1967 project of seismic refraction mapping in the Coral Sea by a combined University of New South Wales-Lamont Geological Observatory of Columbia University is discussed. (W.M.)

18-b-16 HAWKINS, L. V., HOUTZ, R. E., EDGAR, N. T., & LUDWIG, W. J., 1968 — Crustal structure beneath the Coral Sea (Abstract). *Trans. Amer. geophys. Un.*, 49, 218.

The structure of the central basin and the Queensland plateau of the Coral Sea was studied with 20 refraction profiles. In the central basin an average oceanic crustal velocity of 6.6 km/s was recorded overlying a normal mantle velocity of 8.1 km/s. Thin sediments on the Queensland plateau overlie a 5.1-5.6 km/s layer, which overlies a 6.2 km/s crustal layer. In the southern part of the plateau an intermediate crustal layer of 7.3 km/s has been recorded. Mantle velocities were not recorded beneath the Queensland plateau, although shot distance was more than 60 km. Profiles in the northern part of the Coral Sea adjacent to the south-east coast of New Guinea recorded moderately thick sediments on a 4.2-5.0 layer (possibly also sediments) on a 6.0-6.5 km/s layer. (Auth.)

18-b-17 HESS, H. H., 1948 — Major structural features of the western north Pacific, an interpretation of H.O. 5485 bathymetric chart, Korea to New Guinea. *Bull. geol. Soc. Amer.*, 59, 417-46.

By combining wartime soundings with those already existing on Pacific charts, it was possible to construct more accurate detailed bathymetric charts of the western Pacific. The first of these charts covers the area from Korea to New Guinea. The elongate deep trenches form the most striking topographic and structural features. The deeps are more continuous than previously indicated. East of the deeps from Japan to Palau, part of the North Pacific Basin province differs markedly in topography, structure, and petrology from the island-arc provinces to the west. The so-called 'Andesite Line' separates the North Pacific Basin province from the western island-arc provinces. The concave side of the curved deeps contains 1 to 3 parallel geanticlinal swells on which volcanic islands are characteristic.

The volcanism and seismic activity of the area are discussed, and the geologic history of the region is outlined. In general the eastern and southern belt of arcs and mountains is related to late Cretaceous-early Tertiary deformation which has continued spasmodically up to Recent time, whereas a western belt including southern Japan, the Ryukyus, Formosa, and the western Philippines is probably the product of mid-Mesozoic deformation. Both deformations have associated belts of peridotite intrusions. (Auth.)

18-b-18 KRAUSE, D. C., 1965a — Submarine geology north of New Guinea. *Bull. Soc. Amer.*, 76, 27-42.

A bathymetric chart of the sea floor north of New Guinea between 129° and 140°W was based on soundings of the Recorder Expedition of August 1961 and other soundings, published and unpublished. The tectonic features of the seafloor can be correlated with features in northern New Guinea, especially: (1) a north-south deformational zone north and west of Mapia Is links tectonic features in New Guinea to those near Palau Is; (2) an east-southeast trend paralleling the north coast of New Guinea; and (3) east-west troughs, especially well developed near the equator. A major left-lateral shear zone may extend the length of New Guinea. The 3 major periods of deformation have been Cretaceous-Eocene, between Miocene and Pliocene, and Quaternary. The geologic history of northern New Guinea is similar to that of the Darwin Rise. (Auth.)

18-b-19 KRAUSE, D. C., 1967 — Bathymetry and geologic structure of the northwestern Tasman Sea-Coral Sea-south Solomon Sea area of the southwestern Pacific Ocean. *Bull. N.Z. Dep. Sci. ind. Res.*, 183, 1-50.

The area can be divided into 2 major tectonic regions (1) Tasman Sea-southern Coral Sea, and (2) northern Coral Sea-southern Solomon Sea. Tectonism in the former is relatively quiescent, but extremely active in the latter.

The Australian region is characterized by warped continental shelves on which are developed large sand islands and banks in the south, and by coral reefs in the north. Submarine canyons and channels cut the shelf and slope in several places. Turbidity-current deposits are overlain by Recent pelagic clay in the Coral Sea and Tasman Basin. A long range of submarine volcanoes on the deep-sea floor rims the continent on the east and is associated with a rift-like feature, the Cato Trough. The physiography of the region is relatively subdued.

In contrast, the New Guinea-Solomon Is region is characterized by a sea floor of great complexity and large relief. Earthquakes are frequent, and volcanoes, some of them active, abound. At least one large active fault, the Pocklington Fault, marks the southeast border of the region. The southwest border is marked by a large step in the sea floor of the Coral Sea Basin. This whole region seems to be one of east-west trending, left-lateral shear. (Auth.)

18-b-20 MAYNARD, G. L., SUTTON, G. H., & HUSSONG, D. M., 1969 — Seismic observations in the Solomon Islands and Darwin Rise regions using repetitive sources. *EOS*, 50(4), 206.

During the 1967-69 Hawaii Institute of Geophysics cruises in the Solomon Is and Darwin Rise regions, about 90 wide-angle reflection-refraction profiles, in addition to continuous vertical reflection recordings, were obtained. The reflection and refraction curves, aided by vertical reflection data, provide information on velocities and structure of the sediments and other crustal layers, in some cases extending down to Moho. Between the Marshall and Hawaiian Is the data indicate normal oceanic structure and velocities down to the mantle. Sub-Moho velocities about 8.2 km/s were determined by wide-angle reflection and refractions. An apparently simple column prevails over much of the Darwin Rise, with a thin layer of very soft, homogeneous, low-velocity sediment overlying strata of more consolidated material. North of the Solomon Is sediments of 2-3 seconds reflection time in thickness, having low velocities and many reflecting horizons, overlie a very thick crust. (Auth.)

18-b-21 MENARD, H. W., 1964 — MARINE GEOLOGY OF THE PACIFIC. *N.Y., McGraw Hill*, x + 271 pp.

Much information about the Pacific Basin and immediately adjacent continental areas is presented. The history of geological and geophysical oceanography in the Pacific is outlined; maps indicate route of surveys and sites of heat flow stations, seismic stations, core and dredge samples, photographs of sea floor, and a contoured bathymetric chart of the Pacific Ocean is printed in 14 sheets. An extensive bibliography and gazetteer of features are included. Much of the material is concerned with or relevant to the ocean-floor features near and east of Papua New Guinea. (W.M.)

18-b-22 MILSOM, J. S., 1970 — Woodlark Basin, a minor centre of seafloor spreading in Melanesia. *J. geophys. Res.*, 75, 7335-9.

Woodlark Basin extends from the eastern tip of New Guinea to New Georgia in the Solomon Is. It is characterized by rugged bathymetry, with most lineations paralleling its long axis. The bathymetric pattern, seismicity, upper mantle P-wave velocity, and the petrology of rocks exposed on the surrounding islands, suggest that sea-floor spreading is taking place within the basin. This spreading may account for the marked discontinuity in the Solomon Is marginal trench and for the lack of deep earthquakes near New Georgia. (Auth.)

18-b-23 MURRAY, J., & HJORT, J., 1912 — THE DEPTHS OF THE OCEANS. *London, Macmillan*, xx + 821 pp.

Oceanography up to 1910 is described, including the main observations, results, and techniques of cruises and surveys. Mention is made of the 4998-fathom (9140 m) deep discovered off the west coast of Bougainville by the German survey ship *Planet* in 1910. It is noted that this is only one of several deeps close to land masses on the Pacific coastline. The western Pacific Ocean is generally shallower than the eastern Pacific. (W.M.)

18-b-24 PETERMANN, A., 1877 — Die Bodengestallung des grossen Ozeans (The bottom features of the major oceans, in German). *Petermanns Mitt.*, 23, 125-32.

Results of cruises by the German ship *Gazelle* in 1875-76, the English ship *Challenger* in 1874-76, and the American ship *Tuscarora* in 1873-76 are integrated to produce a new map of the main structures of the floors of the major oceans. Most named structures are deeps.

The New Guinea region was visited by the *Challenger* and by the *Gazelle*. The *Challenger* called at Schouten Is and Manus I. (entries 02-d-58 and 02-d-55); the *Gazelle* called at Ninigo Is, New Hanover, west coast of New Ireland, Blanche Bay at Rabaul, and west coast of Bougainville before sailing to Solomon Is and Australia. An unnamed deep was mapped off the west coast of Bougainville, and Carpenter Deep in the Coral Sea was recorded. (W.M.)

18-b-25 PHIPPS, C. V. G., 1967 — The character and evolution of the Australian continental shelf. *APEA J.*, 7(2), 44-9.

The evolution and character of the Australian continental shelf is related to the geology of the hinterland, the character of the continental slope and the rise, and features of the ocean basins, and involves that part of the continent which is most susceptible to tectonic modification where there is a transition from thick sialic crust to a thinner oceanic crust. The width of the Australian shelf, and the depth of its outer margin vary considerably. The bathymetry of the shelf is discussed, comments are made on the shelf rises, several small areas of the shelf are compared, and the origin of the Carpentaria Graben is discussed. (W.M.)

18-b-26 SOLOMON, S., & BIEHLER, S., 1969 — Crustal structure from gravity anomalies in the southwest Pacific. *EOS*, 50(4), 205.

During the 1967 Nova Expedition in the southwest Pacific, gravity was measured along some 5800 km of the track of the *Argo*. The North Fiji Basin is characterized by a broad free-air anomaly of +25 to +35 mgal, while over the Coral Sea Basin the free-air anomaly averages near zero. Free-air anomalies are roughly −10 to −30 mgal for the New Hebrides Basin and +20 to +30 mgal for the South Fiji Basin, though these figures are less reliable owing to incomplete data. 2-dimensional models of crustal sections, consistent with reproducible seismic refraction profiles, are presented for the Lord Howe Rise, the New Caledonia Basin-Norfolk Ridge, the New Hebrides Basin-New Hebrides arc-North Fiji Basin, and the Coral Sea Basin. (Auth.)

18-b-27 SUPAN, A., 1899 — Die Bodenformen des Weltmeers (The bottom features of the seas of the world, in German.) *Petermanns Mitt.*, 45, 177-88.

Included in the major named structures of the world's seas is the Korallen-Becker (Coral Sea), the only named feature in the New Guinea region. (W.M.)

18-b-28 SUPAN, A., 1930 — GRUNDZUGE DER PHYSISCHEN ERDKUNDE (3rd Edn). (Major features of physical geography, in German). *Leipzig, Walter de Gruyter*, 3 Vols. (495, 551 and 269 pp.).

The deep trench to the west of Bougainville is 7570 m deep, and is thought to be fault-bounded. It is probably connected through the trench along the south New Britain coast to Huon G. (W.M.)

18-b-29 THOMSON, J. P., 1893 — The 'Melanesian Plateau': Notes on Mr C. Hedley's paper. *Proc. Roy. geogr. Soc. Australas., Qld Br.*, 8, 18-25.

The areal extent and significance of the Melanesian Plateau defined by Hedley are discussed, and some palaeogeographic reconstructions of the Pacific Basin thrown into doubt. In the discussion, Maitland outlines the bathymetry of the New Guinea-Coral Sea-Bismarck Sea-Solomon Sea area and the Pacific Ocean immediately southeast of the Solomon Sea. A large 2000-fathom (3650 m) plateau includes New Guinea, New Britain, Solomon Is and New Hebrides-Fiji, and is separated by a trough heading in the Gulf of Papua from a similar plateau embracing Norfolk and Lord Howe Is, New Zealand, and Chatham Rise. (W.M.)

18-b-30 UDINTZEV, G. B., 1958 — Discovery of a deep-sea trough in the western part of the Pacific Ocean, in Russian. *Priroda*, 47, 85-8.

During 1957-58 the Russian oceanographic survey ship *Vitiaz* traversed several trenches in the chain on the western border of the Pacific Ocean. The Fiji Rise and the North Fiji Basin were re-surveyed in greater detail than previously. A narrow, steep-sided, V-shaped trench 10 m across and 6140 m deep was recognized near the Marshall Is and named the Vitiaz Trench. It is thought to be tectonically related to the Bougainville Trench as part of a slightly ruptured continuous ocean-rim fracture system. (W.M.)

18-b-31 UDINTZEV, G. B., 1959 — Relief of abyssal trenches in the Pacific Ocean. *Int. oceanogr. Cong., New York, Preprints*, 54-5.

Abyssal oceanic trenches are steep-sided, long, extended, and narrow depressions on the bottom of the ocean. There is a characteristic relationship between abyssal trenches and the base of the continental slope, indicated by a combination of marginal sea depressions and island arcs. Study of these abyssal trenches is difficult, owing to their great depth and narrow width. The studies by the Institute of Oceanology of the USSR Academy of Science have, on the *Vitiaz* cruises, virtually covered the trenches along the western rim of the Pacific. They have provided much new information on the configuration and sizes of abyssal trenches, and material for a comparison on the morphology of the individual trenches.

The shapes of the Yap, Palau, New Britain and Bougainville Trenches are established with greater precision. The New Britain and Bougainville Trenches are independent units, separated by a sill; the former is recorded as having a depth of 8320 m. The presence of narrow deep trenches was established all along Melanesia. Other trenches are deeper, yet they occupy an analogous position morphologically to the transition zone of the western margin of the Pacific Ocean. These are narrow elongate trenches at the base of the slopes of island arcs. Their depths are about 5000-6000 m, but as compared with the bottom of the oceanic depressions adjoining them, they are incised to a depth of 1500-2000 m. These trenches extend along the western part of New Guinea, along the islands Western and Admiralty, along the islands Anuda, Mitre, and Duff (north of Fiji). The chain of trenches discovered by the *Vitiaz* closes the gap in the chain of trenches extending from the coasts of Alaska to New Zealand. (Auth./W.M.)

18-b-32 WICHMANN, H., 1911a — Tiefseelotsungen S.M. Schiff *Planet* 1910 im südlichen Stillen Ozean (Investigations of the ocean depths by SMS *Planet* in the southern Pacific during 1910, in German). *Petermanns Mitt*, 57, 139.

Results of a survey by the *Planet* are noted, in which it was found that the deep trench south of New Britain extends to the east and is continuous with a trench west of Bougainville. (C.F.)

18-b-33 WISEMANN, J. D. H., & OVEY, C. D., 1954 — Proposed names for features on the deep-sea floor. 1. The Pacific Ocean. *Deep-Sea Res.*, 2, 93-106.

The British National Committee on Ocean Bottom Features recommended to the International Nomenclature Committee that geographical names should be given wherever possible to all major features, and that personal or ship names should only be given to secondary features where no suitable geographical name is available. In 1952 the International Committee endorsed these proposals. The British Committee has prepared a list of names for the Pacific Ocean, extending to 50°S but excluding the East Indies. Few isolated elevations have been given provisional names because the Committee is considering the general principles which should govern the allocation of names to these features. Features in the Papua New Guinea region to which names are assigned include Eauripik-New Guinea Rise, Solomon Is Ridge, Woodlark Ridge, Coral Sea Basin, New Britain Basin, and New Britain Trench. (Auth./W.M.)

18-b-34 Wust, G., 1936 — Die Gliederung des Weltmeeres (The divisions of the oceans, in English.) *Int. hydrogr. Rev.*, 13, 46-59.

The philosophy and semantics of naming major ocean-floor features, particularly basins, is reviewed and the history of the nomenclature of deep-sea basins outlined. The distinction between trough and basin is drawn and a new system of names for major features introduced. Included in the names introduced are the Salomonen (Solomon) Basin and Korallen (Coral) Basin in the New Guinea region. (W.M.)

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05-a-39 —Archbold, R. & Rand, A. L., 1940
05-b-28 —Beaver, W. N., 1914b
05-b-30 —Bevan, T. F., 1887
05-f-1 —Bik, M. J., 1964
05-a-57 — 1967
05-e-9 —Blake, D. H. & Loffler, E., 1970
05-e-10 — 1971
05-a-69 —Champion, I. F., 1938
05-d-17 —Chance, S. H., 1928
05-d-27 —Herbert, C. E., 1911
05-d-28 —Hides, J. G. & O'Malley, J., 1936
05-d-29 —Jennings, J. N. & Bik, M. J., 1962
05-f-3 —Loffler, E., 1970b
02-c-28 —Perry, R. A., 1965a
05-a-124—Perry, R. A. et al., 1965
05-a-125— 1965
05-d-45 —Williams, P. W., 1971

Sediments and soils

07-b-23 —Rutherford, G. K., 1962
07-b-24 — 1964
07-b-25 — 1968
07-a-18 —Rutherford, G. K. & Haantjens, H. A., 1965

Sedimentary rocks

08-a-1 —Hosking, J. S., 1967

Igneous rocks

09-c-10 —Jakes, P. & Gill, J., 1970
09-c-12 —Jakes, P. & White, A. J. R., 1969
09-c-13 — 1970
09-b-21 —Mackenzie, D. E., 1970
09-c-17 —Mackenzie, D. E. & Smith, I. E., 1971

Economic geology

12-i-72 —Kaufmann, G. F., 1961

14—AWORRA RIVER—SB/54-16

Discovery and exploration

01-b-21 —Bevan, T. F., 1888
01-a-10 — 1889
01-b-30 —Champion, I. F., 1940

Areal geology

02-b-30 —Murray, J. H. P., 1938
02-b-140—Rand, A. L. & Brass, L. J., 1940
02-b-145—Ryan, H. J., 1914

Palaeontology

04-f-1 —Cookson, I. C. & Dettmann, M. E., 1958a
04-f-2 — 1958b
04-d-1 —Cookson, I. C. & Eisenack, A., 1958
04-i-3 —Cookson, I. C. & Manum, S., 1960

Geomorphology

05-b-30 —Bevan, T. F., 1887
05-a-69 —Champion, I. F., 1938
05-b-46 —Middleton, S. G., 1929

Economic geology

12-i-7 —Anonymous, 1961a
12-i-32 —Australia, Territories, 1952c
12-i-33 — 1955
12-i-35 — 1962b
12-a-12 — 1966b
12-i-42 —Barnwell, G. F., 1951
12-i-43 — 1952
12-i-44 — 1953
12-i-45 — 1954
12-i-67 —Kaufmann, G. F., 1956
12-i-68 — 1957
12-i-69 — 1958
12-i-70 — 1959
12-i-83 —Mott, W. D., 1957
12-e-29 —Townsend, F. I. & Konecki, M. C., 1965

15—KIWAI—SC/54-4

Discovery and exploration

01-b-10 —Anonymous, 1890e
01-b-17 —Albertis, L. M. d', 1882
01-b-21 —Bevan, T., 1888
01-b-30 —Champion, I. F., 1940

15—KIWAI—SC/54-4—*Contd*
Discovery and exploration—*Contd*
01-a-18 —Everill, H. C., 1886
01-a-19 — 1888
Areal geology
02-a-2 —Anglo-Persian Oil Co., 1930
02-b-50 —Gray, W. M., 1930b
02-b-104—Macgregor, W., 1897f
02-b-133—Oldham, E. R., 1929
02-b-140—Rand, A. L. & Brass, L. J., 1940
Stratigraphy and historical geology
03-e-2 —Albertis, L. M. d', 1879a
03-d-5 —Chapman, F., 1930b
Palaeontology
04-b-4 —Chapman, F., 1930g
Geomorphology
05-b-2 —Anonymous, 1878c
05-b-3 — 1878d
05-b-7 —Albertis, L. M. d', 1879b
05-b-42 —Hennessy, J. M., 1890
05-c-46 —Jukes, J. B., 1847b
05-b-45 —Macfarlane, S., 1876
05-a-118—Paijmans, K., 1970
Quaternary geology
06-d-4 —Macgregor, W., 1890l
Sedimentary rocks
08-b-18 —Wilkinson, C. S., 1890
Economic geology
12-a-12 —Australia, Territories, 1966b
Geochronology
17-b-19 —Richards, J. R. & Willmott, W. F., 1970

16—DARU—SC/54-8
Discovery and exploration
01-a-4 —Anonymous, 1873b
01-a-31 —Moresby, J., 1874a
01-a-33 — 1875a
Areal geology
02-b-22 —Beaver, W. N., 1920
02-b-62 —Haddon, A. C., 1935
Geomorphology
05-c-41 —Douglas, J., 1886
05-c-43 —Hunte, G. R. le, 1901c
05-a-116—Moresby, J., 1876

17—NINIGO—SA/55-5
Areal geology
02-d-4 —Anonymous, 1901
02-d-50 —Schleinitz, G. E. G. von, 1877
02-d-60 —Thilenius, G., 1900
Geomorphology
05-d-5 —Allied Forces etc. 1942ad
05-c-25 — 1943af

18—SEPIK—SA/55-13
Discovery and exploration
01-a-9 —Belcher, E., 1843
01-b-23 —Bonaparte, (Prince) R., 1887
01-a-34 —Moresby, J., 1875b
01-a-35 — 1875c
Areal geology
02-d-1 —Anonymous, 1894a
02-a-2 —Anglo-Persian Oil Co., 1930
02-c-32 —Marchant, S., 1969a
02-c-34 —Papp, S., 1930a
02-c-36 — 1930c
02-d-43 —Reiber, J., 1907
02-d-45 —Sapper, K., 1910a
Stratigraphy and historical geology
03-d-8 —Chapman, F., 1930e
03-a-9 —Marchant, S., 1969b
Geomorphology
05-b-5 —Anonymous, 1909c
05-b-14 —Allied Forces etc., 1943p
05-a-32 — 1943as
05-a-50 —Behrmann, W., 1917
05-a-54 — 1924b
05-a-86 —Haantjens, H. A. (Ed.), 1968
05-a-90 —Haantjens, H. A. et al., 1968
05-a-116—Moresby, J., 1876
05-a-130—Reiner, E. & Mabbutt, J. A., 1968
05-a-141—Schleinitz, G. E. G. von, 1887
05-b-51 —Schrader, C., 1888
05-a-162—Tappenbeck, E., 1901
Sediments and soils
07-a-9 —Haantjens, H. A., 1968
Igneous rocks
09-b-25 —Morgan, W. R., 1966
Volcanology
14-a-26 —Finsch, O., 1888
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-a-34 —Holtker, G., 1942
14-a-68 —Wichmann, A.. 1909
Seismology
15-c-22 —International Seismological Centre, 1968j
15-a-11 —Sieberg, A., 1910
Oceanography
18-a-8 —Murray, J., 1895

19—BOGIA—SB/55-1
Discovery and exploration
01-b-23 —Bonaparte, (Prince) R., 1887
01-b-43 —Jena, L. Schultze, 1914
Areal geology
02-a-2 —Anglo-Persian Oil Co., 1930
02-c-8 —Behrmann, W., 1913a
02-c-28 —Lauterbach, C., 1896b
02-c-34 —Papp, S., 1930a
02-c-40 —Poch, R., 1907a
02-d-43 —Reiber, J., 1907
02-d-45 —Sapper, K., 1910a
Palaeontology
04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-5 — 1967b
Geomorphology
05-b-5 —Anonymous, 1909c
05-a-13 — 1914
05-b-14 —Allied Forces etc., 1943p
05-c-18 — 1943r
05-b-18 — 1943ab
05-a-32 — 1943as
05-b-20 — 1943at
05-c-32 — 1943aw
05-c-34 — 1944b
05-a-50 —Behrmann, W., 1917
05-a-52 — 1922
05-a-54 — 1924b
05-a-55 — 1927
05-a-86 —Haantjens, H. A. (Ed.), 1968

19—BOGIA—SB/55-1—*Contd*

Geomorphology—*Contd*

05-a-90 —Haantjens, H. A. et al., 1968
05-a-99 —Lauterbach, C., 1897a
05-e-15 —Poch, R., 1908b
05-a-130—Reiner, E. & Mabbutt, J. A., 1968
05-a-141—Schleinitz, G. E. G. von, 1887
05-d-40 —Schneider, C., 1886
05-b-51 —Schrader, C., 1888
05-b-56 —Tappenbeck, E., 1897
05-a-162— 1901

Sediments and soils

07-a-9 —Haantjens, H. A., 1968

Igneous rocks

09-b-11 —Glaessner, R., 1923
09-b-25 —Morgan, W. R., 1966
09-b-26 — 1967a
09-b-27 — 1967b

Economic geology

12-b-31 —Australia, Parliament, 1932
12-c-7 — 1959
12-a-6 — 1961

Volcanology

14-a-7 —Australia, Parliament, 1964
14-a-8 — 1965
14-a-9 — 1966
14-a-10 — 1967
14-a-11 — 1968
14-a-12 — 1969a
12-c-8 — 1969b
14-a-17 —Best, J. G., 1956
14-a-19 —Branch, C. D., 1967a
14-a-23 — 1967f
14-a-24 —Carder, D. S., 1959
14-a-26 —Finsch, O., 1888
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-a-31 —Grabowski, F., 1895
14-a-34 —Holtker, G., 1942
14-a-39 —Marr, C. C., 1937
05-e-14 —Ollier, C. D., 1969
14-a-41 —Pfluger, A., 1901b
14-a-58 —Taylor, G. A., 1956b
14-a-62 — 1958b
14-b-4 — 1966
14-a-66 —Warteg, E. von Hesse, 1902
14-a-68 —Wichmann, A., 1909
14-a-69 — 1910
14-a-70 — 1912
14-a-72 —Zoller, H., 1891b

Seismology

15-a-8 —Maclay, N. von Miklouho, 1878
15-a-11 —Sieberg, A., 1910

Solid earth geophysics

16-a-8 —Taylor, G. A., 1967
16-a-9 —Taylor, G. A. et al., 1965
16-c-16 —Woollard, G. P., 1963

Geochronology

17-b-15 —Page, R. W. & McDougall, I., 1970c

20—RAMU—SB/55-5

Discovery and exploration

01-b-33 —Chinnery, E. W. P., 1934
01-b-46 —Lauterbach, C., 1896c
01-b-67 —Zoller, H., 1889

Areal geology

02-c-2 —Anonymous, 1898e
02-c-5 —Australia, Parliament, 1940
02-c-7 — 1960
02-c-11 —Brass, L. J., 1964
02-c-15 —Dow, D. B. & Dekker, F. E., 1964
02-c-17 —Edwards, A. B. & Glaessner, M. F., 1953
02-c-22 —Haantjens, H. A., 1970a
02-c-31 —McMillan, N. J. & Malone, E. J., 1960
02-c-38 —Perry, R. A., 1965b
02-c-45 —Rickwood, F. K., 1955
02-c-47 —Taylor, J. L., 1935

Stratigraphy and historical geology

04-a-4 —Crespin, I., 1960

Palaeontology

04-b-2 —Adams, C. G., 1970
04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-11 —Crespin, I., 1938a
04-d-3 —Erni, A., 1944
04-d-4 — 1945
04-d-5 —Glaessner, M. F., 1945
04-c-1 —Glaessner, M. F. et al., 1950
04-d-11 —Skwarko, S. K., 1963
04-d-13 — 1967b

Geomorphology

05-a-6 —Anonymous, 1897b
05-a-7 — 1897e
05-b-18 —Allied Forces etc., 1943ab
05-b-20 — 1943at
05-a-36 —Anas, M., 1960
05-a-48 —Bearup, A. J., 1936
05-a-52 —Behrmann, W., 1922
05-a-54 — 1924b
05-a-55 — 1927
05-f-1 —Bik, M. J., 1964
05-a-57 — 1967
05-a-87 —Haantjens, H. A. (Ed.), 1970
05-a-91 —Haantjens, H. A. et al., 1970
05-a-99 —Lauterbach, C., 1897a
05-a-100— 1897b
05-f-3 —Loffler, E., 1970b
05-b-47 —Montgomery, D. E., 1960
05-a-123—Perry, R. A., 1965a
05-a-124—Perry, R. A. et al., 1965
05-a-125— 1965
05-f-5 —Peterson, J. A., 1970
05-f-6 —Reiner, E., 1960
05-a-151—Spinks, K. L., 1936
05-a-155—Stanley, G. A. V., 1949

Sediments and soils

07-b-7 —Guilcher, A., 1966
07-b-10 —Haantjens, H. A., 1970b
07-b-13 —Hosking, J. S., 1939a
07-a-18 —Rutherford, G. K. & Haantjens, H. A., 1965

Sedimentary rocks

08-c-2 —Crook, K. A. W., 1961
08-a-1 —Hosking, J. S., 1967

Igneous rocks

09-b-11 —Glaessner, R., 1923

Economic geology

12-c-4 —Anonymous, 1968b
12-a-2 —Australia, Parliament, 1928
12-c-13 —Barnes, C. E., 1967
12-c-21 —Boldt, J. R. Jnr & Queneau, P., 1967

20—RAMU—SB/55-5—*Contd*
Economic geology—*Contd*
12-a-17 —Davies, H. L., 1971c
12-b-56 —Fisher, N. H., 1940
12-a-19 — 1965
12-h-3 —Howard, E. J., 1964
12-b-97 —Schmeisser, C., 1906
Seismology
15-c-23 —International Seismological Centre, 1968k
Geochronology
17-b-7 —Harding, R. R., 1969
17-b-14 —Page, R. W. & McDougall, I., 1970a

21—KARIMUI—SB/55-9
Discovery and exploration
01-a-10 —Bevan, T. F., 1889
01-b-33 —Chinnery, E. W. P., 1934
01-b-53 —Leahy, M., 1936
Areal geology
02-c-2 —Anonymous, 1898e
02-b-18 —Australasian Petroleum Co., 1961a
02-c-5 —Australia, Parliament, 1940
02-b-24 —Bell, L. L., 1911
02-c-11 —Brass, L. J., 1964
02-b-28 —Cawley, F. R., 1925a
02-b-31 —Chance, S. H., 1927
02-c-16 —Dow, D. B. & Plane, M. D., 1965
02-b-43 —Ethell, A. L., 1946
02-c-22 —Haantjens, H. A., 1970a
02-c-31 —McMillan, N. J. & Malone, E. J., 1960
02-b-131—Murray, J. H. P., 1939
02-c-38 —Perry, R. A., 1965b
02-c-45 —Rickwood, F. K., 1955
02-b-146—Saunders, H. M., 1924
12-a-32 —Smith, M. Staniforth C., 1911b
02-b-170—Stanley, E. R., 1921a
Stratigraphy and historical geology
03-a-2 —Australasian Petroleum Co., 1961b
03-c-3 —Carey, S. W., 1945
03-a-8 —Gillespie, J., 1967
Palaeontology
04-b-2 —Adams, C. G., 1970
04-g-7 —Belford, D. J., 1962
04-g-3 — 1966
04-d-5 —Glaessner, M. F., 1945
04-d-8 — 1958
04-c-1 —Glaessner, M. F. et al., 1950
Geomorphology
05-a-36 —Anas, M., 1960
05-a-48 —Bearup, A. J., 1936
05-d-13 —Beaver, W. N., 1911
05-a-54 —Behrmann. W., 1924b
05-b-30 —Bevan, T. F., 1887
05-a-69 —Champion, I. F., 1938
05-d-17 —Chance, S. H., 1928
05-a-87 —Haantjens, H. A. (Ed.), 1970
05-a-91 —Haantjens, H. A. et al., 1970
05-d-27 —Herbert, C. E., 1911
05-d-28 —Hides, J. C. & O'Malley, J., 1936
05-d-29 —Jennings, J. N. & Bik, M. J., 1962
05-f-3 —Loffler, E., 1970b
05-a-112—Macgregor, W., 1894e
05-a-123—Perry, R. A., 1965a
05-a-124—Perry, R. A. et al., 1965
05-a-125— 1965
05-a-150—Spinks, K. L., 1934
05-a-151— 1936
05-a-155—Stanley, G. A. V., 1949
Quaternary geology
06-d-8 —Stuiver, M., 1969
Sediments and soils
07-b-7 —Guilcher, A., 1966
07-a-10 —Haantjens, H. A., 1970b
07-a-18 —Rutherford, G. K. & Haantjens, H. A., 1965
Sedimentary rocks
08-b-1 —Chappell, B. W., 1968
08-b-2 —Edwards, A. B., 1950a
08-b-3 — 1950b
08-a-1 —Hosking, J. S., 1967
08-b-6 —Jack, R. L. & Rands, W. H., 1894
Igneous rocks
09-c-12 —Jakes, P. & White, A. J. R., 1969
09-b-21 —Mackenzie, D. E., 1970
09-c-17 —Mackenzie, D. E. & Smith, I. E., 1971
Economic geology
12-c-20 —Barrie, J., 1965g
12-d-3 —Corbett, D. W. P., 1965
02-i-17 —Edwards, A. B. & Glaessner, M. F., 1953
12-a-19 —Fisher, N. H., 1965
12-i-69 —Kaufmann, G. F., 1958
12-d-4 —Little, W. J., 1911
12-b-76 —McLeod, I. et al., 1965
12-h-7 —Papuan Apinaipi Petroleum Co., 1961
Volcanology
14-a-7 —Australia, Parliament, 1964
Solid earth geophysics
16-c-16 —Woollard, G. P., 1963
Geochronology
17-b-2 —Dury, G. H., 1966
17-b-15 —Page, R. W. & McDougall, I., 1970c
17-b-17 —Polach, H. A. et al., 1968
17-b-18 — 1967

22—KIKORI—SB/55-13
Discovery and exploration
01-a-8 —Anonymous, 1887a
14-a-1 — 1887d
01-b-4 — 1887e
01-b-21 —Bevan, T. F., 1888
01-a-10 — 1889
01-b-28 —Chalmers, J., 1884
01-b-29 —Chalmers, J. & Gill, W. W., 1885
01-b-30 —Champion, I. F., 1940
01-a-24 —Macgregor, W., 1899d
01-a-25 — 1899e
01-b-55 —Mackay, D. & Little, W. S., 1911
12-i-87 —Murray, J. H. P., 1928
02-b-155—Smith, M. Staniforth C., 1912c
01-a-43 —Thomson, J. P., 1888b
Areal geology
02-b-10 —Anonymous, 1938a
02-b-11 — 1939
02-a-2 —Anglo-Persian Oil Co., 1930

22—KIKORI—SB/55-13—*Contd*
Economic geology—*Contd*
12-e-30 —Wade, A., 1914a
12-e-31 — 1914b
12-i-116— 1917a
12-e-32 — 1917b

23—MAER—SC/55-5

24—ADMIRALTY ISLANDS WEST—SA/55-10
Discovery and exploration
01-a-7 —Anonymous, 1876c
Areal geology
02-d-4 —Anonymous, 1901
02-d-19 —Cohn, L., 1913
02-d-33 —Kicinski, F. M. & Belford, D. J., 1965
02-d-55 —Spry, W. J. J., 1876
02-d-58 —Swire, H., 1938
02-d-60 —Thilenius, G., 1900
Geomorphology
05-d-3 —Allied Forces etc., 1942j
05-d-5 — 1942ad
05-c-25 — 1943af
05-d-10 — 1943au
05-a-141—Schleinitz, G. E. G. von, 1887
Sediments and soils
06-d-5 —Quinn, W. H., 1971
Sedimentary rocks
08-a-1 —Hosking, J. S., 1967
08-c-3 —White, W. C., 1964
Igneous rocks
09-b-10 —Glaessner, R., 1915
Economic geology
12-c-18 —Barrie, J., 1965e
12-c-23 —British Sulphur Corporation, 1964
12-c-26 —Dimmick, T. D. & Ludbrook, N. H., 1947
12-c-39 —Hollrung, M., 1888a
12-c-40 —Hutchinson, G. E., 1950
12-c-41 —Hutchinson, R. C., 1941
12-c-44 —McLeod, I. R., 1965b
12-c-51 —Meise, W., 1938
12-c-55 —Owen, H. B., 1954
12-c-56 —Owen, L., 1923
12-i-98 —Seidel, H., 1891
12-c-62 —Theime, P., 1970
12-c-64 —Warin, O. N., 1964
Volcanology
14-a-17 —Best, J. G., 1956
14-a-30 —Fisher, N. H., 1957
14-a-70 —Wichmann, A., 1912
Oceanography
18-a-8 —Murray, J., 1895

25—ADMIRALTY ISLANDS EAST—SA/55-11
Areal geology
02-d-4 —Anonymous, 1901
02-d-19 —Cohn, L., 1913
02-d-33 —Kicinski, F. M. & Belford, D. J., 1956
02-d-57 —Stutzer, O., 1910
02-d-60 —Thilenius, G., 1900
Geomorphology
05-d-3 —Allied Forces etc., 1942j
05-d-5 — 1942ad
05-c-25 — 1943af
05-d-10 — 1943au

Igneous rocks
09-b-10 —Glaessner, R., 1915
09-b-13 —Key, C. A., 1968

Economic geology
12-c-18 —Barrie, J., 1965e
12-c-44 —McLeod, I. R., 1965b
12-c-51 —Meise, W., 1938
12-c-55 —Owen, H. B., 1954
12-c-62 —Theime, P., 1970
12-c-64 —Warin, O. N., 1964

Volcanology
14-a-6 —Australia, Parliament, 1963
14-a-17 —Best, J. G., 1956
14-a-18 — 1957
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-a-38 —Maclay, N. von Miklouho, 1884
14-a-42 —Reynolds, M. A., 1957a
14-a-43 — 1957b
14-a-44 —Reynolds, M. A. & Best, J. G., 1957
14-a-58 —Taylor, G. A., 1956b
14-a-68 —Wichmann, A., 1909

Seismology
15-c-24 —International Seismological Centre, 1969a

Solid earth geophysics
16-c-16 —Woollard, G. P., 1963

Oceanography
18-a-8 —Murray, J., 1895

26—KARKAR—SB/55-2
Discovery and exploration
01-a-9 —Belcher, E., 1843

Palaeontology
04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-5 — 1967b

Geomorphology
05-c-6 —Allied Forces etc., 1942l
05-e-4 — 1943q
05-c-18 — 1943r
05-c-27 — 1943ai
05-d-11 — 1944c
05-a-146—Schleinitz, G. E. G. von, 1887
05-d-40 —Schneider, C., 1886

Igneous rocks
09-b-25 —Morgan, W. R., 1966
09-b-27 — 1967b

Economic geology
12-i-26 —Australia, Parliament, 1953

Volcanology
14-a-30 —Fisher, N. H., 1957
14-a-34 —Holtker, G., 1942
14-a-68 —Wichmann, A., 1909
14-a-69 — 1910
14-a-70 — 1912
14-a-72 —Zoller, H., 1891b

Seismology
15-a-8 —Maclay, N. von Miklucho, 1878

28—MARKHAM—SB/55-10—*Contd*

Geomorphology—*Contd*
05-a-99 —Lauterbach, C., 1897a
05-f-3 —Loffler, E., 1970b
05-f-4 — 1971
05-a-141—Schleinitz, G. E. G. von, 1887
05-a-150—Spinks, K. L., 1934
05-d-44 —Vial, L. G., 1938
05-b-57 —Wilson, H. M., 1968

Sediments and soils
07-b-7 —Guilcher, A., 1966
07-a-10 —Haantjens, H. A., 1970b
07-b-12 —Hosking, J. S., 1938b
07-c-2 —Rudiger, H., 1897

Sedimentary rocks
08-c-1 —Banner, F. T. & Wood, G. V., 1964
08-b-1 —Chappell, B. W., 1968
08-b-2 —Edwards, A. B., 1950a

Igneous rocks
09-b-27 —Morgan, W. R., 1967b

Economic geology
12-b-5 —Anonymous, 1928a
12-b-6 — 1928d
12-a-2 —Australia, Parliament, 1928
12-b-31 — 1932
12-b-32 — 1934
12-i-26 — 1953
12-i-27 — 1954
12-a-6 — 1961
12-f-1 —Australia, Works Dept, 1968b
12-c-19 —Barrie, J., 1965f
12-b-39 —Braithwaite, J. B., 1938
12-a-19 —Fisher, N. H., 1965
12-f-3 —Gardner, D. E. & Carter, E. K., 1968
12-c-35 —Gourlay, A. J. C., 1965b
12-b-76 —McLeod, I. R. et al., 1965

Structural geology
13-b-27 —Davies, H. L., 1968

Volcanology
14-a-19 —Branch, C. D., 1967a

Seismology
15-c-24 —International Seismological Centre, 1969a

Solid earth geophysics
16-c-16 —Woollard, G. P., 1963

Geochronology
17-b-12 —Kigoshi, K. & Kobayashi, A., 1966
17-b-16 —Polach, H. A. et al., 1969

Oceanography
18-b-4 —Borch, C. C. von der, 1969

29—WAU—SB/55-14

Discovery and exploration
01-b-32 —Chinnery, E. W. P., 1920
01-b-33 — 1934

Areal geology
02-b-10 —Anonymous, 1938a
02-a-2 —Anglo-Persian Oil Co., 1930
02-c-7 —Australia, Parliament, 1960
02-c-9 —Blackwood, B., 1939
02-b-32 —Chinnery, E. W. P., 1918
02-b-36 —Davies, H. L., 1965a
09-c-4 — 1970b
02-b-42 —English, A. C., 1907
02-c-18 —Fisher, N. H., 1944a
02-c-19 — 1970
02-b-48 —Gillespie, A., 1921a
02-b-51 —Gray, W. & Bourchier, J. R., 1921
02-b-54 — 1930c
02-b-55 — 1930d
02-b-73 —Kugler, A., 1965
02-b-98 —Macgregor, W., 1894b
02-b-128—Murray, J. H. P., 1933
02-b-132—Newcombe, A. B., 1913
02-c-39 —Plane, M. D., 1967b
02-a-15 —Range, P., 1937
02-b-144—Ruxton, B. P., 1969b
02-b-147—Seligmann, C. G., 1908
02-b-159—Stanley, E. R., 1912a
02-b-165— 1918b
02-b-172—Strong, W. M., 1908
02-b-182—Wade, A., 1918
02-c-50 —Woods, J. T., 1962

Stratigraphy and historical geology
03-d-1 —Chapman, F., 1918
03-d-2 — 1923
03-d-18 —Plane, M. D., 1965
03-d-19 — 1966
03-e-23 —Takai, F., 1953

Palaeontology
04-h-1 —Anderson, C., 1937a
04-h-2 — 1937b
04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-5 — 1967b
04-g-9 —Chapman, F., 1930f
04-h-6 —Plane, M. D., 1967a
04-h-7 —Ride, W. D. L., 1964
04-d-14 —Skwarko, S. K., 1967c
04-h-9 —Stirton, R. A., 1963
04-b-16 —Stirton, R. A. et al., 1967
04-h-10 —Stirton, R. A. et al., 1967

Geomorphology
05-c-3 —Allied Forces etc., 1942c
05-c-6 — 1942l
05-b-11 — 1942w
05-c-10 — 1942y
05-c-13 — 1942ac
05-b-19 — 1943aj
05-a-46 —Australia, Parliament, 1926b
05-a-51 —Behrmann, W., 1919
05-c-40 —Brown, L. N., 1925a
05-a-72 —Detzner, H., 1920
05-a-73 — 1928
05-a-74 — 1935
05-c-47 —Moresby, J., 1874b
05-a-116— 1876
05-b-48 —Paijmans, K., 1970
05-a-136—Ruxton, B. P., 1969a
05-a-138—Ruxton, B. P. et al., 1969
05-a-139— 1969

Quaternary geology
06-a-15 —Ruxton, B. P., 1969c

Sediments and soils
07-a-2 —Bleeker, P., 1969

Sedimentary rocks
08-c-1 —Banner, F. T. & Wood, G. V., 1964
08-b-1 —Chappell, B. W., 1968
08-b-2 —Edwards, A. B., 1950a

29—WAU—SB/55-14—*Contd*

Sedimentary rocks—*Contd*

08-a-1 —Hosking, J. S., 1967
08-b-6 —Jack, R. L. & Rands, W. H., 1894

Igneous rocks

09-a-1 —Davies, H. L., 1967b
09-b-21 —Mackenzie, D. E., 1970

Metamorphic rocks

10-b-2 —Fisher, N. H., 1939d
10-b-3 — 1939e

Mineralogy-crystallography

11-b-2 —Heming, R. F., 1969
11-a-6 —Liversidge, A., 1907

Economic geology

12-b-2 —Anonymous, 1917
12-b-3 — 1927b
12-b-4 — 1927c
12-b-5 — 1928a
12-b-6 — 1928b
12-b-7 — 1928c
12-b-8 — 1928d
12-b-9 — 1928e
12-b-10 — 1929a
12-b-11 — 1929b
12-b-12 — 1930a
12-b-13 — 1930b
12-b-15 — 1932a
12-b-16 — 1932b
12-b-17 — 1932c
12-b-18 — 1933b
12-b-19 — 1937b
12-e-1 — 1938b
12-b-21 — 1944b
12-b-22 — 1946
12-b-23 — 1952
12-i-7 — 1961a
12-e-3 —Anglo-Persian Oil Co., 1921a
12-e-4 — 1921b
12-b-24 —Armit, L. P. B., 1912
12-b-27 —Australia, Parliament, 1924
12-i-17 — 1925
12-i-18 — 1926a
12-b-28 — 1927
12-a-2 — 1928
12-b-29 — 1929
12-b-30 — 1931
12-b-31 — 1932
12-i-19 — 1933
12-b-32 — 1934
12-b-33 — 1935
12-i-20 — 1936
12-b-34 — 1937
12-i-21 — 1939
12-i-22 — 1941
12-i-27 — 1954
12-c-7 — 1959
12-c-9 — 1970
12-b-35 —Banks, C. A., 1932a
12-b-36 — 1932b
12-c-19 —Barrie, J., 1965f
12-b-38 —Blanchard, R., 1933
12-b-39 —Braithwaite, J. B., 1938
12-e-9 —Carne, J. E., 1912a
12-c-25 —Casey, J. N., 1956
12-a-16 —Cumberland, R. B., 1960
12-b-36 —Decoto, L. A., 1930
12-b-47 —Dickinson, A., 1933
12-b-49 —Dunkin, H. H., 1950a
12-b-50 — 1950b
12-b-51 —Emmons, W. H., 1937
12-b-53 —Fisher, M. S., 1935a
12-b-54 — 1935b
12-b-55 —Fisher, N. H., 1939c
12-b-56 — 1940
12-b-57 — 1945
12-a-19 — 1965
12-c-31 —Fisher, N. H. et al., 1959
12-c-32 —Gardner, D. E. & Ludbrook, N. H., 1945
12-c-33 —Geary, J. K. et al., 1956
12-e-13 —Gillespie, A., 1921b
12-e-16 — 1921e
12-e-17 — 1921f
12-c-34 —Gourlay, A. J. C., 1965a
12-c-35 — 1965b
12-j-11 —Healey, H. M., 1967
12-b-61 —Hennelly, J. P., 1911
12-e-18 — 1912
12-b-62 —Higginson, C. B., 1908
12-b-64 —Hooper, R. Pitman & Black, A. B., 1953
12-b-66 —Humphries, W., 1918
12-e-19 —Humphries, W. R., 1926
12-j-12 —Idriess, I. L., 1933
12-j-13 — 1935
12-b-67 —Jensen, E. B., 1951
12-a-25 —Lyons, A. P., 1911a
12-b-69 — 1911b
12-c-49 —McLeod, I. R., 1965g
12-b-76 —McLeod, I. R. et al., 1965
12-b-84 —Morley, I. W., 1931
12-b-85 —Murray, J. H. P., 1930
12-b-88 — 1936
12-b-89 —Muscutt, C. R., 1920
12-i-90 — 1921
12-b-91 —Oldham, E. R., 1913
12-b-92 — 1914
12-i-95 — 1917
12-h-8 —Phillips Australian Oil Co. et al., 1969
12-b-95 —Range, P., 1938
12-b-96 —Rhys, L., 1942
12-b-98 —Schumaker, F., 1939
12-e-27 —Smith, M. Staniforth C., 1929
12-b-103—Struben, R., 1961
12-b-107—Taylour, H. & Morley, L. W., 1933a
12-b-108— 1933b
12-b-109— 1933c
12-b-110— 1933d
12-b-111— 1933e
12-b-112— 1934
12-e-30 —Wade, A., 1914a
12-c-63 —Ward, J. & Barrie, J., 1962

Structural geology

13-b-25 —Davies, H. L., 1965b
13-b-26 — 1967a
13-b-27 — 1968

Geochronology

17-b-4 —Evernden, J. F. et al., 1964
17-b-7 —Harding, R. R., 1969

30—YULE—SC/55-2

Discovery and exploration

01-a-5 —Anonymous, 1873c

30—YULE—SC/55-2—*Contd*

Discovery and exploration—*Contd*

01-b-26 —Chalmers, J., 1881a
01-b-27 — 1881b
01-a-16 — 1887a
01-b-29 —Chalmers, J. & Gill, W. W., 1885
01-b-47 —Lawes, W. G., 1882
01-a-26 —MacLeay, W., 1875
01-a-31 —Moresby, J., 1874a
01-a-36 —Morton, A., 1885

Areal geology
02-b-10 —Anonymous, 1938a
02-a-2 —Anglo-Persian Oil Co., 1930
02-b-12 —Archbold, R. & Rand, A. L., 1935
02-b-32 —Chinnery, E. W. P., 1918
02-b-40 —Edelfelt, E. G., 1886
02-b-55 —Gray, W. & Bourchier, J. R., 1930d
02-b-58 —Greffrath, H., 1876
02-b-61 —Haddon, A. C., 1900
02-b-76 —Lawes, W. G., 1875
02-b-77 —Mabbutt, J. A., 1965a
02-b-94 —Macgregor, W., 1892e
02-b-98 — 1894b
02-b-108—Maitland, A. G., 1890
02-b-109— 1891
12-e-21 —Mayo, H. T., 1921a
02-b-114— 1921b
02-b-115— 1930
02-b-116—Mayo, H. T. & Verteuil, J. P. de, 1930a
02-b-117— 1930b
02-b-118— 1930c
02-b-119—Mayo, H. T. et al., 1930a
02-b-120— 1930b
02-b-139—Power, P. E., 1960
02-b-144—Ruxton, B. P., 1969b
02-b-148—Seligmann, C. G. & Strong, W. M., 1906
02-b-156—Speight, J. G., 1965c
02-b-157—Stanley, E. R., 1911a
02-b-165— 1918b
02-b-168— 1920a
02-b-172—Strong, W. M., 1908
02-b-176—Thomson, J. P., 1891a
02-b-181—Verteuil, J. P. de, 1930
02-b-182—Wade, A., 1918

Stratigraphy and historical geology
03-e-2 —Albertis, L. M. d', 1879a
03-d-1 —Chapman, F., 1918
03-d-2 — 1923
03-d-13 —Etheridge, R. Jnr, 1876
03-d-17 —Papuan Apinaipi Petroleum Co., 1960
03-e-27 —Wilkinson, C. S., 1876a
03-e-28 — 1876b
03-e-29 — 1876c

Palaeontology
04-g-1 —Belford, D. J., 1960
04-g-2 — 1962
04-g-3 — 1966
04-g-5 — 1967b
04-a-6 —Etheridge, R. Jnr, 1889
04-g-16 — 1892
04-b-15 —McTavish, R. A., 1966
04-g-26 —Tate, R., 1894
04-g-29 —Wilkinson, C. S., 1877
03-d-24 —Woods, J. E. T., 1878a
04-g-30 — 1878b

Geomorphology
05-b-7 —Albertis, L. M. d', 1879b
05-a-22 —Allied Forces etc., 1942u
05-d-20 —Davis, W. M., 1928
05-b-37 —Edelfelt, E. G., 1889
05-a-103—Mabbutt, J. A., 1965b
05-a-105—Mabbutt, J. A. et al., 1965
05-a-106— 1965
05-a-107—Macfarlane, S., 1877
05-c-47 —Moresby, J., 1874b
05-a-116— 1876
05-a-136—Ruxton, B. P., 1969a
05-a-138—Ruxton, B. P. et al., 1969
05-a-139— 1969
05-b-53 —Speight, J. G., 1965a
05-b-54 — 1965b
05-a-163—Thompson, J. E., 1954

Quaternary geology
06-a-15 —Ruxton, B. P., 1969c

Sediments and soils
07-a-2 —Bleeker, P., 1969
07-d-2 —McMahon, T. J., 1918
07-a-19 —Scott, R. M., 1965

Sedimentary rocks
08-d-1 —Crook, K. A. W., 1970
08-b-6 —Jack, R. L. & Rands, W. H., 1894
08-b-11 —Liversidge, A., 1886

Igneous rocks
09-b-22 —Maitland, A. G., 1892a

Economic geology
12-e-1 —Anonymous, 1938b
12-i-13 — 1968f
12-e-4 —Anglo-Persian Oil Co., 1921b
12-c-11 —Australia, Territories, 1953
12-i-41 —Barnwell, G. F., 1950
12-c-22 —Bowden, N. H. M., 1908
12-j-10 —Dalton, H. W., 1969
12-e-14 —Gillespie, A., 1921c
12-e-15 — 1921d
12-i-69 —Kaufmann, G. F., 1958
12-i-70 — 1959
12-a-23 —Kowald, C., 1897
12-h-8 —Phillips Australian Oil Co. et al., 1969
12-b-113—Thomson, J. P., 1887
12-j-30 —Wade, A., 1940
12-e-34 —Wyllie, B. K. N., 1930a

Geochronology
17-b-12 —Kigoshi, K. & Kobayashi, H., 1966

31—AROA—SC/55-6

Discovery and exploration
01-a-3 —Anonymous, 1873a
01-a-4 — 1873b
01-b-26 —Chalmers, J., 1881a
01-b-27 — 1881b
01-a-16 — 1887a
01-b-29 —Chalmers, J. & Gill, W. W., 1885
01-b-34 —Gill, W. W., 1873
01-b-35 — 1875
01-a-30 —Moresby, J., 1873
01-a-31 — 1874a
01-a-33 — 1875a

Areal geology
02-b-7 —Anonymous, 1897c

31—AROA—SC/55-6—*Contd*

Areal geology—*Contd*

92-b-8 —Anonymous, 1897d
02-a-2 —Anglo-Persian Oil Co., 1930
02-b-61 —Haddon, A. C., 1900
02-b-77 —Mabbutt, J. A., 1965a
02-b-79 —MacGillivray, J., 1852
02-b-105—Macgregor, W., 1898b
02-b-139—Power, P. E., 1960
02-b-156—Speight, J. G., 1965c
02-b-168—Stanley, E. R., 1920a
02-b-172—Strong, W. M., 1908

Stratigraphy and historical geology

03-d-17 —Papuan Apinaipi Petroleum Co., 1960

Palaeontology

04-g-1 —Belford, D. J., 1960
04-g-9 —Chapman, F., 1930f
04-b-4 — 1930g
04-g-10 —Chapman, F. & Crespin, I., 1932

Geomorphology

05-d-20 —Davis, W. M., 1928
05-a-103—Mabbutt, J. A., 1965b
05-a-105—Mabbutt, J. A. et al., 1965
05-a-106— 1965
05-c-47 —Moresby, J., 1874b
05-a-116— 1876
05-a-163—Thompson, J. E., 1954

Sediments and soils

07-a-19 —Scott, R. M., 1965

Sedimentary rocks

08-b-18 —Wilkinson, C. S., 1890

32—SAG-SAG—SB/55-7

Discovery and exploration

01-a-39 —Rossel, — (Ed.), 1808

Areal geology

02-d-51 —Schleinitz, G. E. G. von, 1896

Palaeontology

04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-5 — 1967b

Geomorphology

05-e-3 —Allied Forces etc., 1943k
05-e-5 — 1943y
05-e-7 — 1943aa
05-c-23 — 1943ad
05-c-29 — 1943am
05-d-9 — 1943aq
05-a-55 —Behrmann, W., 1927
05-c-51 —Schleinitz, G. E. G. von, 1889
05-d-40 —Schneider, R. W., 1886

Quaternary geology

06-a-3 —Chappell, J., 1970a

Igneous rocks

09-b-17 —Lovering, J. K., 1957
09-b-25 —Morgan, W. R., 1966

Mineralogy-crystallography

11-b-2 —Heming, R. F., 1969

Economic geology

12-i-26 —Australia, Parliament, 1953
12-c-7 — 1959
12-c-28 —Fisher, N. H., 1942a

Volcanology

14-a-4 —Allied Forces etc., 1943ag
14-a-5 —Australia, Parliament, 1962
14-a-6 —Australia, Parliament, 1963
14-a-8 — 1965
14-a-9 — 1966
14-a-10 — 1967
14-a-11 — 1968
14-a-12 — 1969a
14-a-17 —Best, J. G., 1956
14-a-25 —Chalmers, J., 1887b
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-c-2 —Johnson, R. W., 1970
14-a-58 —Taylor, G. A., 1956b
14-b-4 — 1966
14-a-65 —Taylor, G. A. et al., 1957
14-a-72 —Zoller, H., 1891b

Seismology

15-a-5 —Denham, D., 1969b
15-c-20 —International Seismological Centre, 1968h
15-c-21 — 1968i
15-c-27 — 1969d

Geochronology

17-b-1 —Dury, G. H., 1964
17-b-16 —Polach, H. A. et al., 1969

33—HUON—SB/55-11

Discovery and exploration

01-a-12 —Bonaparte, (Prince) R., 1888

Areal geology

02-c-33 —Marr, J. C., 1938
02-c-40 —Poch, R., 1907a
02-c-41 — 1907b

Palaeontology

04-g-2 —Belford, D. J., 1962
04-g-3 — 1966
04-g-5 — 1967b

Geomorphology

05-c-3 —Allied Forces etc., 1942c
05-c-6 — 1942l
05-d-4 — 1942ab
05-c-14 — 1943a
05-c-15 — 1943f
05-a-26 — 1943h
05-d-6 — 1943m
05-c-19 — 1943u
05-b-17 — 1943v
05-c-23 — 1943ad
05-b-35 —Chappell, J., 1970b
05-a-72 —Detzner, H., 1920
05-a-74 — 1935
05-a-98 —Keysser, C., 1913
05-f-3 —Loffler, E., 1970b
05-f-4 — 1971
05-d-39 —Pilhofer, G., 1911a
05-a-126— 1911b
05-c-50 —Schleinitz, G. E. G. von, 1888
05-c-51 — 1889
05-d-40 —Schneider, C., 1886

Quaternary geology

06-a-3 —Chappell, J., 1970a
06-a-12 —Manser, W., 1970
06-d-9 —Veeh, H. H. & Chappell, J., 1970

Sediments and soils

07-c-1 —Anonymous, 1897f
07-c-2 —Rudiger, H., 1897

Sedimentary rocks

08-d-1 —Crook, K. A. W., 1970

33—HUON—SB/55-11—*Contd*

Sedimentary rocks—*Contd*

08-d-2 —Haupt, O., 1906
08-d-4 —Tan Sin Hok, 1926

Volcanology

14-a-1 —Anonymous, 1887d
14-a-2 — 1887g
14-a-25 —Chalmers, J., 1887b
14-a-51 —Schrader, C., 1876

Seismology

15-a-2 —Anonymous, 1888d
15-c-3 —Heck, N. H., 1947
15-c-44 —International Seismological Centre, 1970j
15-a-11 —Sieberg, A., 1910

Geochronology

17-b-16 —Polach, H. A. et al., 1969

Oceanography

18-b-4 —Borch, C. C. von der, 1969
18-a-6 —Krause, D. C. et al., 1970
18-a-12 —White, W. W., 1965

34—SALAMAUA—SB/55-15

Discovery and exploration

01-b-12 —Anonymous, 1891b
01-a-12 —Bonaparte, (Prince) R., 1888

Areal geology

02-b-7 —Anonymous, 1897c
02-c-7 —Australia, Parliament, 1960
02-b-29 —Cawley, F. R., 1925b
02-b-36 —Davies, H. L., 1965a
09-c-4 — 1970b
02-c-14 —Dow, D. B. & Davies, H. L., 1964
02-b-93 —Macgregor, W., 1892c
02-b-100— 1894f
02-b-105— 1898b
02-b-108—Maitland, A. G., 1890
02-b-137—Paterson, S. J. & Kicinski, F. M., 1956
02-a-15 —Range, P., 1937
02-b-147—Seligmann, C. G., 1908
02-b-177—Thomson, J. P., 1891b

Geomorphology

05-c-4 —Allied Forces etc., 1942d
05-c-6 — 1942l
05-c-8 — 1942q
05-a-22 — 1942u
05-c-10 — 1942y
05-c-13 — 1942ac
05-c-19 — 1943u
05-a-46 —Australia, Parliament, 1926b
05-a-72 —Detzner, H., 1920
05-a-74 — 1935
05-a-141—Schleinitz, G. E. G. von, 1887

Quaternary geology

06-d-7 —Sprigg, R. C., 1947

Igneous rocks

09-a-1 —Davies, H. L. 1967b
09-b-15 —Klautzsch, A., 1909

Economic geology

12-b-13 —Anonymous, 1930b
12-b-27 —Australia, Parliament, 1924
12-i-26 — 1953
12-c-7 — 1959
12-c-15 —Barrie, J., 1965b
12-c-17 — 1965d
12-c-19 — 1965f
12-c-21 —Boldt, J. R. Jnr & Queneau, P., 1967
13-b-27 —Davies, H. L., 1968
12-a-17 — 1971c
12-b-51 —Emmons, W. H., 1937
12-c-33 —Geary, J. K. et al., 1956
12-b-75 —Maclaren, J. N., 1908
12-c-45 —McLeod, I. R., 1965c
12-c-46 — 1965d
12-b-97 —Schmeisser, C., 1906
12-i-113—Turner, C. O., 1905
12-c-63 —Ward, J. & Barrie, J., 1962

Structural geology

13-b-25 —Davies, H. L., 1965b
13-b-26 — 1967a

Volcanology

14-a-25 —Chalmers, J., 1887b

Solid earth geophysics

16-c-7 —Milsom, J. S., 1967

Oceanography

18-b-4 —Borch, C. C. von der, 1969
18-a-11 —Sprigg, R. C., 1948

35—BUNA—SC/55-3

Discovery and exploration

01-b-12 —Anonymous, 1891b
01-b-32 —Chinnery, E. W. P., 1920
01-b-54 —Macgregor, W., 1899b
01-b-65 —Thomson, J. P. & Forbes, H. O., 1887

Areal geology

02-b-7 —Anonymous, 1897c
02-b-8 — 1897d
02-b-9 — 1898a
02-b-12 —Archbold, R. & Rand, A. L., 1935
02-b-14 —Armit, W. E., 1901c
02-b-29 —Cawley, F. R., 1925b
02-b-33 —Clunas, A., 1899a
02-b-34 — 1899b
02-b-36 —Davies, H. L., 1965a
09-c-6 — 1970b
02-c-14 —Dow, D. B. & Davies, H. L., 1964
02-b-68 —Hunte, G. R. le, 1901b
02-b-77 —Mabbutt, J. A., 1965a
02-b-93 —Macgregor, W., 1892c
02-b-100— 1894f
02-b-105— 1898b
02-b-106— 1898d
02-b-121—Monkton, C. A. W., 1907a
02-b-122— 1907b
02-b-136—Paterson, S. J., 1964a
02-b-137—Paterson, S. J. & Kicinski, F. M., 1956
02-b-141—Rands, W. H., 1890
07-d-5 —Ruxton, B. P., 1967d
02-b-156—Speight, J. G., 1965c
02-b-167—Stanley, E. R., 1919b
02-b-177—Thomson, J. P., 1891b

Geomorphology

05-a-3 —Anonymous, 1890d
05-a-8 — 1898b
05-a-9 — 1898c
05-a-10 — 1898d
05-c-2 —Allied Forces etc., 1942b
05-b-9 — 1942g
05-a-18 — 1942k

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Geomorphology—*Contd*
05-a-20 — 1942o
05-a-22 — 1942u
05-a-23 — 1942v
05-a-76 —Forbes, H. O., 1897
05-a-82 —Haantjens, H. A., 1964a
05-a-85 —Haantjens, H. A. (Ed.), 1964a
05-a-92 —Haantjens, H. A. et al., 1964
05-e-12 —Ingelby, I., 1966
05-a-102—Lawes, W. G., 1889
05-f-2 —Loffler, E., 1970a
05-f-3 — 1970b
05-a-103—Mabbutt, J. A., 1965b
05-a-105—Mabbutt, J. A. et al., 1965
05-a-106—Mabbutt, J. A. et al., 1965
05-a-108—Macgregor, W., 1890k
05-a-111— 1890p
05-a-121—Paterson, S. J., 1964b
05-b-53 —Speight, J. G., 1965a
05-b-54 — 1965b
05-a-163—Thompson, J. E., 1954
05-a-165—Thomson, J. P., 1890a
01-b-64 — 1896
05-a-169—Vernon, G. H., 1946
05-a-170—Walker, A. L., 1902b

Quaternary geology
06-b-1 —Ruxton, B. P., 1970a
06-b-2 —Ruxton, B. P. & McDougall, I., 1967

Sediments and soils
07-b-6 —Greenland, D. J. et al., 1969
07-a-5 —Haantjens, H. A., 1964b
05-e-14 —Ollier, C. D., 1969
07-b-21 —Pain, C. F., 1970
07-b-22 — 1971
07-d-4 —Ruxton, B. P., 1966c
07-d-6 — 1968
07-d-7 — 1969d
07-a-19 —Scott, R. M., 1965

Sedimentary rocks
08-b-6 —Jack, R. L. & Rands, W. H., 1894
08-e-2 —Ruxton, B. P., 1965b
08-e-3 — 1966b

Igneous rocks
09-b-1 —Alexander, K. M. & Vivian, H. E., 1953
09-b-6 —Clarke, A. W., 1892
09-a-1 —Davies, H. L., 1967b
09-c-12 —Jakes, P. & White, A. J. R., 1969
09-b-18 —Lovering, J. K., 1958
09-b-25 —Morgan, W. R., 1966
09-b-27 — 1967b
09-b-29 —Paterson, S. J. & Green, D., 1964
09-b-30 —Ruxton, B. P., 1965a
09-b-31 — 1966a

Mineralogy-crystallography
11-a-9 —Rands, W. H., 1901b

Economic geology
12-i-5 —Anonymous, 1941
12-i-16 —Armit, L. P. B., 1919
12-b-25 —Armit, W. E., 1900
12-b-26 — 1901a
12-i-33 —Australia, Territories, 1955
12-i-34 — 1962a
12-c-17 —Barrie, J., 1965d
12-c-19 — 1965f
12-i-49 —Beaver, W., 1907
12-i-49 — 1909
12-i-50 —Beaver, W. N., 1914a
12-i-51 — 1917
12-b-37 —Bell, L. L., 1908
12-i-52 —Blyth, A. L., 1920
12-c-21 —Boldt, J. R. Jnr & Queneau, P., 1967
12-d-3 —Corbett, D. W. P., 1965
12-i-60 —Dowdney, G., 1908
12-c-33 —Geary, J. K. et al., 1956
12-b-60 —Green, J., 1897
12-i-64 —Henderson, W., 1911
12-b-63 —Higginson, J. B., 1905
12-i-74 —Lyons, A. P., 1908
12-i-75 — 1909
12-b-71 —Macgregor, W., 1897d
12-b-74 — 1898c
12-c-45 —McLeod, I. R., 1965c
12-c-46 — 1965d
12-b-67 —McLeod, I. R. et al., 1965
12-b-77 —Maguire, H. R., 1902
12-i-77 —Miller, T., 1918
12-b-58 —Monkton, C. A. W., 1904a
12-i-78 — 1905a
12-b-80 — 1905b
12-b-81 — 1905c
12-j-18 —Moreton, M. H., 1897
12-b-87 —Murray, J. H. P., 1935
12-i-89 — 1940
12-i-91 —Naylor, E. H., 1908
12-i-92 —Newman, A., 1919
12-b-90 —Nicholls, G. H., 1911
12-i-96 —Oldham, E. R., 1920
12-b-97 —Schmeisser, C., 1906
12-b-99 —Shanahan, M. W., 1899a
12-b-100— 1899b
12-a-44 —Stanley, E. R., 1918a
12-i-177—Walker, A. L., 1902a
12-c-63 —Ward, J. & Barrie, J., 1962
12-c-118—Winter, F. P., 1903
12-i-119—Wuth, C. T., 1917
12-i-120— 1921
12-i-121— 1922
12-i-122— 1923

Structural geology
13-b-25 —Davies, H. L., 1965b
13-b-26 — 1967a
13-b-27 — 1968

Volcanology
14-a-5 —Australia, Parliament, 1962
14-a-13 —Australia, Territories, 1952b
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-c-2 —Kvale, A., 1952
14-c-7 —Ruxton, B. P., 1965c
14-c-9 —Taylor, G. A., 1954
14-a-57 — 1956a
14-a-58 — 1956b
14-a-59 — 1956c
14-a-61 — 1958a
14-a-63 — 1963
14-a-64 —Taylor, G. A. & Thompson, J. E., 1956
14-b-4 —Taylor, G. A. M., 1966
15-b-2 —Tazieff, H., 1966

35—BUNA—SC/55-3—*Contd*

Solid earth geophysics
16-c-7 —Milsom, J. S., 1967
16-a-9 —Taylor, G. A. M. et al., 1965

Geochronology
17-b-1 —Dury, G. H., 1964
17-b-2 — 1966
17-b-3 —Dury, G. H. & Smith, T. Langford, 1968
17-b-12 —Kigoshi, K. & Kobayashi, H., 1966

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Discovery and exploration
01-a-4 —Anonymous, 1873b
01-b-1 — 1877
01-b-3 — 1887c
01-b-18 —Armit, W. E., 1884
01-b-24 —Chalmers, J., 1880a
01-b-25 — 1880b
01-a-16 — 1887a
01-b-29 —Chalmers, J. & Gill, W. W., 1885
01-b-32 —Chinnery, E. W. P., 1920
01-b-36 —Giulianetti, A., 1898
01-b-37 —Goldie, A., 1878
01-b-40 —Hartmann, C. H., 1887
01-b-42 —Hunter, G., 1887
05-a-101—Lawes, W. G., 1880
01-b-48 — 1883a
01-b-49 — 1883b
01-b-51 — 1887
01-b-54 —Macgregor, W., 1899b
01-a-30 —Moresby. J., 1873
01-a-31 — 1874a
01-a-33 — 1875a
01-a-34 — 1875b
01-a-35 — 1875c
01-a-36 —Morton, A., 1885
02-b-155—Smith, M. Staniforth C., 1912c
01-b-61 —Stone, O. C., 1875b
01-b-62 —Thomson, J. P., 1889b

Areal geology
02-b-2 —Anonymous, 1889c
02-b-3 — 1890b
02-b-6 — 1892d
02-b-7 — 1897c
02-b-8 — 1897d
02-a-2 —Anglo-Persian Oil Co., 1930
02-b-13 —Armit, W. E., 1901b
02-b-19 —Australia, Territories, 1956
02-b-21 —Barton, F. R., 1902a
02-b-35 —Cuthbertson, W. R., 1887
02-b-36 —Davies, H. L., 1965a
09-c-4 — 1970b
02-b-41 —English, A. C., 1898
02-b-45 —Forbes, H. O., 1888a
02-b-46 — 1888b
02-b-49 —Glaessner, M. F., 1952a
02-b-61 —Haddon, A. C., 1900
02-b-66 —Hennessy, J. M., 1886
02-b-77 —Mabbutt, J. A., 1965a
02-b-79 —Macgillivray, J., 1852
02-b-88 —Macgregor, W., 1890i
02-b-93 — 1892c
02-b-105— 1898b
02-b-107— 1899a
02-b-137—Paterson, S. J. & Kicinski, F. M., 1956
02-b-138—Powell, C. McA., 1965a
02-b-141 —Rands, W. H., 1890
02-b-143—Ruxton, B. P., 1967b
02-b-150—Smith, J. W. & Green, D. H., 1961
02-b-152—Smith, M. Staniforth C., 1908c
02-b-156—Speight, J. G., 1965c
02-b-158—Stanley, E. R., 1911b
02-b-166— 1919a
02-b-167— 1919b
02-b-168— 1920a
02-b-170— 1921a
02-b-172—Strong, W. M., 1908
02-b-187—Yates, K. R. & de Ferranti, R. Z., 1967

Stratigraphy and historical geology
03-d-2 —Chapman, F., 1923

Palaeontology
04-g-8 —Chapman, F., 1914
04-g-9 — 1930f
04-g-10 —Chapman, F. & Crespin, I., 1932
04-g-11 —Crespin, I., 1938a
04-a-4 — 1960
04-g-16 —Etheridge, R. Jnr, 1892
04-d-9 —Glaessner, M. F., 1960
04-b-15 —McTavish, R. A., 1966
04-g-21 —Palmeri, V., 1970
04-i-8 —Shirley, J., 1899a
04-i-9 — 1899b

Geomorphology
05-a-3 —Anonymous, 1890d
05-a-22 —Allied Forces etc., 1942u
05-b-29 —Beswick, T., 1880
05-a-61 —Blayney, J. P., 1902
05-b-34 —Brown, M. J. F., 1970b
05-a-70 —Chester, H. N., 1899
05-d-20 —Davis, W. M., 1928
05-b-36 —Dowsett, T. J. L., 1925
05-a-75 —Forbes, H. O., 1890
05-a-76 — 1897
05-b-38 —Fraser, J. B., 1968
05-a-77 —Frey, G., 1916
05-a-89 —Haantjens, H. A. et al., 1967
05-c-45 —Jennings, J. N., 1965
05-a-101—Lawes, W. G., 1880
05-a-102— 1889
05-a-103—Mabbutt, J. A., 1965b
05-a-105—Mabbutt, J. A. et al., 1965
05-a-106— 1965
05-a-107—Macfarlane, S., 1877
05-a-108—Macgregor, W., 1890k
05-a-11 — 1890p
05-c-47 —Moresby, J., 1874b
05-a-116— 1876
05-e-14 —Ollier, C. D., 1969
05-a-132—Rochfort, F. A., 1899a
05-a-133— 1899b
05-a-134—Ruxton, B. P., 1967a
05-a-135— 1967c
05-a-137—Ruxton, B. P. et al., 1967
05-a-157—Stone, O. C., 1875c
05-a-158— 1876a
05-a-161—Strong, W. M., 1916
05-a-163—Thompson, J. E., 1954
05-a-164—Thomson, J. P., 1888a
05-a-165— 1890a
01-a-64 — 1896
05-a-169—Vernon, G. H., 1946

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Quaternary geology
06-b-1 —Ruxton, B. P., 1970a

Sediments and soils
07-a-1 —Anonymous, 1887b
07-b-6 —Greenland, D. J. et al., 1969
07-a-8 —Haantjens, H. A., 1967
07-b-20 —Leask, M. F., 1943
07-a-16 —Mabbutt, J. A. & Scott, R. M., 1966
07-a-17 —Macgregor, W., 1899c
07-d-4 —Ruxton, B. P., 1966c
07-d-5 — 1967d
07-d-7 — 1969d
07-a-19 —Scott, R. M., 1965

Sedimentary rocks
08-a-1 —Hosking, J. S., 1967
08-b-6 —Jack, R. L. & Rands, W. H., 1894
08-d-3 —Ludbrook, N. H., 1961
08-b-16 —Rands, W. H., 1892
08-e-2 —Ruxton, B. P., 1965b
08-e-3 — 1966b
08-b-17 — 1970b
08-b-18 —Wilkinson, C. S., 1890

Igneous rocks
09-a-1 —Davies, H. L., 1967b
09-c-7 —Green, D. H., 1961
09-b-18 —Lovering, J. K., 1958
14-c-7 —Ruxton, B. P., 1965a
09-b-13 — 1966a

Metamorphic rocks
10-a-1 —Ryburn, R. J., 1970

Mineralogy and crystallography
11-b-2 —Heming, R. F., 1969
11-a-4 —Jack, R. L. & Dunstan, B., 1899
11-a-7 —Pontifex, I. R., 1967
11-a-9 —Rands, W. H., 1901b

Economic geology
12-b-1 —Anonymous, 1878a
12-i-1 1920
12-i-29 —Australia, Territories, 1941
05-a-47 — 1949
12-i-31 — 1952c
12-a-7 — 1954
12-i-34 — 1962a
12-i-35 — 1962b
12-a-10 — 1964a
12-i-36 — 1964b
12-c-15 —Barrie, J., 1965b
12-c-17 — 1965d
12-i-48 —Beaver, W., 1908
12-i-54 —Bramell, B. W., 1905b
12-i-55 — 1909
12-b-40 —Buchanan, W. E., 1898
12-c-24 —Carne, J. E., 1913d
12-c-25 —Casey, J. N., 1956
12-c-27 —Dimmick, T. D. & Ludbrook, N. H., 1948
12-b-52 —English, A. C., 1905
12-c-30 —Fisher, N. H., 1958
12-a-19 — 1965
12-c-31 —Fisher, N. H. et al., 1959
12-a-21 —Fort, G. S., 1886
12-c-33 —Geary, J. K. et al., 1956
12-c-37 —Gourlay, A. J. C. & McLeod, I. R., 1965
12-g-1 —Hamilton, L. H., 1965
12-c-42 —Jiear, A. H., 1908
12-c-43 —Knight, C. L. & Ludbrook, N. H., 1947
12-b-68 —Lock, A. G., 1882
12-b-70 —Macfarlane, S., 1879
12-b-71 —Macgregor, W., 1897d
12-c-45 —McLeod, I. R., 1965c
12-c-46 — 1965d
12-c-48 — 1965f
12-c-49 — 1965g
12-b-76 —McLeod, I. R. et al., 1965
12-a-27 —Murray, J. H. P., 1908
12-i-87 — 1928
12-b-85 — 1930
12-i-89 — 1940
12-c-54 —Nye, P. B. & Mead, G. F., 1952
12-c-57 —Pye, A. N., 1910
12-c-58 —Skewes, H. P. et al., 1952
12-c-59 —Smith, M. Staniforth C., 1908a
12-a-31 — 1909a
12-a-33 — 1912a
12-c-60 — 1914b
12-a-38 — 1923
12-i-99 — 1925
12-i-100—Smith, W. R., 1920
12-a-44 —Stanley, E. R., 1918a
12-c-62 —Theime, P., 1970
12-b-113—Thomson, J. P., 1887
12-c-63 —Ward, J. & Barrie, J., 1962

Structural geology
13-b-25 —Davies, H. L., 1965b
13-b-26 — 1967a
13-b-27 — 1968
13-c-1 —Powell, C. McA., 1965b

Volcanology
15-a-1 —Anonymous, 1888b
14-a-25 —Chalmers, J., 1887b
14-c-7 —Ruxton, B. P., 1965c
14-a-61 —Taylor, G. A., 1958a
14-a-64 —Taylor, G. A. & Thompson, J. E., 1956

Solid earth geophysics
16-b-13 —Cleary, J. R., 1967
16-c-7 —Milsom, J. S., 1967
16-c-16 —Woollard, G. P., 1963

Geochronology
17-b-5 —Fergusson, G. J., 1955
17-b-13 —Kigoshi, K. et al., 1969

Oceanography
18-a-1 —Australia, CSIRO, 1962

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Discovery and exploration
01-a-4 —Anonymous, 1873b
01-a-30 —Moresby, J., 1873
01-a-31 — 1874a
01-a-33 — 1875a

Areal geology
02-b-172—Strong, W. M., 1908

Geomorphology
05-a-61 —Blayney, J. A., 1902
05-d-20 —Davis, W. M., 1928
05-a-107—MacFarlane, S., 1877
05-a-116—Moresby, J., 1876

Structural geology
13-b-27 —Davies, H. L., 1968

37—KALO—SC/55-11—*Contd*

Oceanography
18-a-9 —Murray, J., 1906

38—CAPE NELSON—SC/55-4

Discovery and exploration
01-b-12 —Anonymous, 1891b
01-a-34 —Moresby, J., 1875b
01-a-35 — 1875c

Areal geology
02-b-93 —Macgregor, W., 1892c
02-b-100— 1894f
02-b-177—Thomson, J. P., 1891b

Geomorphology
05-d-20 —Davis, W. M., 1928

Structural geology
13-b-27 —Davies, H. L., 1968

39—TUFI—SC/55-8

Discovery and exploration
01-b-2 —Anonymous, 1886
01-b-12 — 1891b
01-b-57 —Monkton, C. A. W., 1902
01-a-34 —Moresby, J., 1875b
01-a-35 —Moresby, J., 1875c

Areal geology
02-a-2 —Anglo-Persian Oil Co., 1930
02-b-15 —Atkinson, O. J., 1928
02-b-25 —Brass, L. J., 1956
02-b-26 — 1959
02-b-36 —Davies, H. L., 1965a
09-c-6 — 1970b
02-a-21 —Forbes, H. O., 1886
02-b-59 —Haantjens, H. A., 1964d
02-b-60 —Haantjens, H. A. (Ed.), 1964b
02-b-67 —Hunte, G. R. le, 1901a
02-b-93 —Macgregor, W., 1892c
02-b-100— 1894f
02-b-124—Montgomery, J. N., 1930b
02-b-135—Papp, S. & Jones, J. Nason, 1930
02-b-137—Paterson, S. J. & Kicinski, F. M., 1956
02-c-40 —Poch, R., 1907a
02-b-143—Ruxton, B. P., 1967b
02-b-150—Smith, J. W. & Green, D. H., 1961
02-b-168—Stanley, E. R., 1920a
02-b-177—Thomson, J. P., 1891b

Palaeontology
04-g-4 —Belford, D. J., 1967a

Geomorphology
05-c-2 —Allied Forces etc., 1942b
05-a-20 — 1942o
05-a-33 — 1942v
05-a-40 —Atkinson, O. J., 1926
05-d-12 — 1927
05-b-27 —Barton, F. R., 1902b
05-a-61 —Blayney, J. A., 1902
05-d-20 —Davis, W. M., 1928
05-a-77 —Frey, G., 1916
05-a-79 —Guise, R. E., 1894
05-a-83 —Haantjens, H. A., 1964c
05-a-88 —Haantjens, H. A. & Taylor, B. W., 1964
05-a-89 —Haantjens, H. A. et al., 1967
05-a-114—Macgregor, W., 1897c
05-a-117—Morton, M. H., 1893
05-a-134—Ruxton, B. P., 1967a
05-a-135— 1967c
05-a-137—Ruxton, B. P. et al., 1967
05-a-161—Strong, W. M., 1916
05-b-58 —Winter, F. P., 1901

Quaternary geology
06-a-10 —Hohnen, P. D. & Pieters, P. E., 1970
08-b-17 —Ruxton, B. P., 1970b
06-a-16 —Smith, I. E., 1970b

Sediments and soils
07-b-1 —Anonymous, 1964
07-b-3 —Bleeker, P. & Austin, M. P., 1970
07-a-6 —Haantjens, H. A., 1964e
07-a-8 — 1967
05-e-14 —Ollier, C. D., 1969
07-d-6 —Ruxton, B. P., 1968

Sedimentary rocks
08-b-6 —Jack, R. L. & Rands, W. H., 1894
08-d-3 —Ludbrook, N. H., 1961

Igneous rocks
09-c-1 —Dallwitz, W. B., 1968
09-b-9 —Dallwitz, W. B. et al., 1966
09-c-2 — 1965
09-a-1 —Davies, H. L., 1967b
09-c-7 —Green, D. H., 1961
09-c-10 —Jakes, P. & Gill, J., 1970
09-c-11 —Jakes, P. & Smith, I. E., 1970
09-c-12 —Jakes, P. & White, A. J. R., 1969
09-c-17 —Mackenzie, D. E. & Smith, I. E., 1971
09-b-25 —Morgan, W. R., 1966
09-b-27 — 1967b
09-b-33 —Tilley, C. E. et al., 1964

Metamorphic rocks
10-a-1 —Ryburn, R. J., 1970

Mineralogy and crystallography
11-b-2 —Heming, R. F., 1969

Economic geology
12-c-1 —Anonymous, 1933a
12-j-5 — 1958b
12-a-8 —Australia. Territories, 1958
12-a-9 — 1960
12-a-10 — 1964a
12-c-17 —Barrie, J., 1965d
12-c-19 — 1965f
12-i-48 —Beaver, W. N., 1908
12-a-19 —Fisher, N. H., 1965
12-c-33 —Geary, J. K. et al., 1956
12-c-45 —McLeod, I. R., 1965c
12-c-46 — 1965d
12-b-77 —Maguire, H. R., 1902
12-b-79 —Monkton, C. A. W., 1904b
12-e-27 —Smith, M. Staniforth C., 1929
12-a-43 —Stanley, E. R., 1917b
12-a-44 — 1918a
12-c-63 —Ward, J. & Barrie, J., 1962
12-i-118—Winter, F. P., 1903

Structural geology
13-b-25 —Davies, H. L., 1965b
13-b-26 — 1967a
13-b-27 — 1968

Volcanology
12-i-34 —Australia, Territories, 1962a
12-i-35 — 1962b
12-i-36 — 1964b
14-a-16 —Baker, G., 1946
14-a-30 —Fisher, N. H., 1957

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Economic geology
12-h-1 —Anonymous, 1965b
12-c-10 —Australia, Territories, 1952a
12-a-9 — 1960
12-i-34 — 1962a
12-i-35 — 1962b
12-c-36 —Gourlay, A. J. C., 1965c
12-c-37 —Gourlay, A. J. C. & McLeod, I. R., 1965
12-i-76 —Macalpine, A., 1909
12-c-54 —Nye, P. B. & Mead, G. F., 1952
Volcanology
14-a-14 —Australia, Territories, 1957
14-a-15 — 1959
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-a-48 —Sapper, K., 1921
Seismology
15-c-26 —International Seismological Centre, 1969c
15-c-28 — 1969e
15-c-35 — 1970a
15-c-47 — 1970m
15-c-52 — 1970r
15-a-14 —Winter, F. P., 1896
Solid earth geophysics
16-a-8 —Taylor, G. A. M., 1967
16-a-9 —Taylor, G. A. M. et al., 1965

43—SAMARAI—SC/56-9
Discovery and exploration
01-a-2 —Anonymous, 1850b
01-a-4 — 1873b
01-a-5 — 1873c
01-b-9 — 1890c
01-a-30 —Moresby, J., 1873
01-a-31 — 1874a
01-a-33 — 1875a
01-a-34 — 1875b
01-a-35 — 1875c
Areal geology
02-b-1 —Anonymous, 1889b
02-b-5 — 1892b
02-b-26 —Brass, L. J., 1959
02-b-39 —Douglas, J., 1888
02-b-44 —Forbes, H. O., 1886
02-b-70 —Jack, R. L. & Clarke, A. W., 1889
02-b-78 —Macgillivray, J., 1851
02-b-79 — 1852
02-b-84 —Macgregor, W., 1890e
02-b-89 — 1890j
02-b-95 — 1892f
02-b-108—Maitland, A. G., 1890
02-b-137—Paterson, S. J. & Kicinski, F. M., 1956
02-b-148—Seligmann, C. G. & Strong, W. M., 1906
02-b-174—Thomson, J. P., 1889a
Geomorphology
05-c-1 —Allied Forces etc., 1942a
05-c-2 — 1942b
05-a-20 — 1942o
05-c-11 — 1942z
05-d-20 —Davis, W. M., 1928
05-a-107—Macfarlane, S., 1877
05-a-116—Moresby, J., 1876

Quaternary geology
06-a-8 —Fairbridge, R. W., 1970
06-a-16 —Smith, I. E., 1970b
Sedimentary rocks
08-b-6 —Jack, R. L. & Rands, W. H., 1894
Mineralogy and crystallography
11-a-3 —Baker, G., 1953
11-b-2 —Heming, R. F., 1969
Economic geology
12-i-31 —Australia, Territories, 1950
12-i-35 — 1962b
12-b-42 —Campbell, A. M., 1904
12-b-43 — 1905
12-a-21 —Fort, G. S., 1886
12-i-76 —Macalpine, A., 1909
12-b-76 —McLeod, I. R. et al., 1965
12-b-77 —Maguire, H. R., 1902
12-b-82 —Moreton, M. H., 1900
12-i-79 — 1901
12-i-80 — 1902
12-b-8 —Murray, J. H. P., 1934
12-i-89 — 1940
12-a-44 —Stanley, E. R., 1918a
12-i-114—Turner, C. O., 1907
12-i-115— 1908
Structural geology
13-b-45 —Jongsma, D., 1970
Volcanology
15-a-1 —Anonymous, 1888b
14-a-25 —Chalmers, J., 1887b

44—WOODLARK ISLAND—SC/56-6
Discovery and exploration
01-b-12 —Anonymous, 1891b
Areal geology
02-b-67 —Hunte, G. R. le, 1901a
02-b-69 — 1902
02-b-79 —Macgillivray, J., 1852
02-b-92 —Macgregor, W., 1892b
02-b-99 — 1894d
02-b-101— 1894g
12-b-73 — 1898a
02-b-148—Seligmann, C. G. & Strong, W. M., 1906
02-b-160—Stanley, E. R., 1912b
02-b-161— 1912c
02-b-177—Thomson, J. P., 1891b
02-b-180—Trail, D. S., 1967
02-b-184—Whitton, W., 1889
Palaeontology
04-h-11 —Vis, C. W. de, 1904
Geomorphology
05-c-12 —Allied Forces etc., 1942aa
05-d-20 —Davis, W. M., 1928
05-d-32 —Macgregor, W., 1893b
Mineralogy and crystallography
11-a-8 —Rands, W. H., 1901a
Economic geology
12-i-32 —Australia, Territories, 1952c
12-a-7 — 1954
12-i-34 — 1962a
12-i-35 — 1962b
12-a-10 — 1964a
12-c-16 —Barrie, J., 1965c
12-i-53 —Bramell, B. W., 1905a
12-i-56 —Campbell, A. M., 1898
12-b-41 — 1899

51—TALASEA—SB/56-5—*Contd*

Sediments and soils
07-b-10 —Hartley, A. C. et al., 1967
07-b-11 —Hosking, J. S., 1938a
07-b-12 — 1938b

Sedimentary rocks
08-e-1 —Blake, D. H., 1970
08-a-1 —Hosking, J. S., 1967

Igneous rocks
09-c-10 —Jakes, P. & Gill, J., 1970
09-c-13 —Jakes, P. & White, A. J. R., 1970
09-b-13 —Key, C. A., 1968
09-b-14 — 1969
09-b-16 —Lehmann, E., 1908
09-c-15 —Lowder, G. G., 1969
09-b-19 — 1970
09-c-16 —Lowder, G. G. & Carmichael, I. S. E., 1968
09-b-20 — 1970
09-c-20 —Peterman, Z. E. et al., 1970

Mineralogy and crystallography
11-b-2 —Heming, R. F., 1969

Economic geology
12-a-2 —Australia, Parliament, 1928
12-c-15 —Barrie, J., 1965b
12-d-3 —Corbett, D. W. P., 1965
12-c-27 —Dimmick, T. D. & Ludbrook, N. H., 1948
12-c-28 —Fisher, N. H., 1942a
12-c-37 —Gourlay, A. J. C. & McLeod, I. R., 1965
12-c-54 —Nye, P. B. & Mead, G. F., 1952

Volcanology
14-a-5 —Australia, Parliament, 1962
14-a-7 — 1964
14-a-10 — 1967
14-a-12 — 1969a
14-a-22 —Branch, C. D., 1967e
14-a-30 —Fisher, N. H., 1957
14-c-1 —Johnson, R. W., 1970
14-a-52 —Smithsonian Institution etc., 1971
15-b-2 —Tazieff, H., 1966

Seismology
15-a-1 —Anonymous, 1888b
15-c-21 —International Seismological Centre, 1968i

52—GASMATA—SB/56-9

Areal geology
02-d-11 —Allied Forces etc., 1943ak
02-d-52 —Schleinitz, G. E. G. von, 1897

Geomorphology
05-a-17 —Allied Forces etc., 1942i
05-e-1 — 1942m
05-a-25 — 1943c
05-b-12 — 1943d
05-c-21 — 1943x
05-c-25 — 1943ah
05-d-7 — 1943ao
05-c-50 —Schleinitz, G. E. G. von, 1888

Sedimentary rocks
08-d-1 —Crook, K. A. W., 1970

Structural geology
13-b-50 —Krebs, C. I., 1961

53—GAZELLE PENINSULA—SB/56-2

Discovery and exploration
01-a-15 —Bridge, C., 1886
01-b-60 —Powell, W., 1880

Areal geology
02-d-4 —Anonymous, 1901
02-d-5 — 1907
02-d-8 — 1908d
02-d-17 —Brown, G., 1877
02-d-24 —Fisher, N. H., 1939a
02-d-25 — 1942c
02-d-31 —Heming, R. F., 1970
02-d-35 —Langhans, P., 1898
02-d-36 —Macnab, R. P., 1970
02-d-38 —Noakes, L. C., 1942
02-d-40 —Pfluger, R., 1901a
02-d-42 —Rannie, D., 1889
02-d-45 —Sapper, K., 1910a
02-d-50 —Schleinitz, G. E. G. von, 1877
02-d-52 — 1897
02-d-57 —Stutzer, O., 1910
02-d-60 —Thilenius, G., 1900

Palaeontology
04-b-14 —Lloyd, A. R., 1968
04-g-24 —Schubert, R. J., 1911
04-g-28 —Vavra, W., 1901

Geomorphology
05-a-17 —Allied Forces etc., 1942i
05-e-1 — 1942m
05-e-2 — 1942s
05-c-35 — 1944f
05-c-37 — 1944i
05-a-52 —Behrmann, W., 1922
05-e-13 —Massey, C. H., 1923
05-e-14 —Ollier, C. D., 1969
05-a-127—Powell, W., 1881
05-a-128— 1883
05-a-129— 1884
05-e-16 —Romilly, H. H., 1887
05-c-50 —Schleinitz, G. E. G. von, 1888

Quaternary geology
06-a-14 —Panzer, W., 1933

Sediments and soils
07-b-4 —Dwyer, R. E. P., 1939
07-b-5 —Graham, G. K. & Baseden, S. C., 1956
07-b-7 —Guilcher, A., 1966
07-b-11 —Hosking, J. S., 1938a
07-b-13 — 1939a
07-b-16 — 1939d
07-b-17 — 1940
07-b-18 — 1948a
07-b-19 — 1948b
07-d-3 —Ollier, C. D. & Brown, M. J. F., 1971

Sedimentary rocks
08-a-1 —Hosking, J. S., 1967

Igneous rocks
09-b-10 —Glaessner, R., 1915
09-b-16 —Lehmann, E., 1908
09-b-23 —Miyake, Y. & Sugiura, Y., 1949
09-b-28 —Offerman, J., 1916
09-b-34 —Washington, H. S., 1917

Metamorphic rocks
09-b-24 —Miyake, Y. & Sugiura, Y., 1953

57—MABUA—SA/56-10

Palaeontology
04-g-24 —Schubert, R. J., 1911

Geomorphology
05-a-17 —Allied Forces etc., 1942i
05-a-19 — 1942n
05-c-28 — 1943al
05-d-8 — 1943ap

Igneous rocks
09-b-10 —Glaessner, R., 1915

Economic geology
12-b-33 —Australia, Parliament, 1935
12-b-56 —Fisher, N. H., 1940

58—NAMATANAI—SA/56-14

Areal geology
02-d-2 —Anonymous, 1894c
02-d-9 — 1908e
02-d-17 —Brown, G., 1877
02-d-18 — 1881
02-d-32 —Hohnen, P. D., & Manser, W., 1970
02-d-40 —Pfluger, A., 1910a
02-c-40 —Poch, R., 1907a
02-d-41 — 1908a
02-d-44 —Sapper, K., 1909
02-d-47 — 1910c

Palaeontology
04-g-6 —Brady, H. B., 1877
04-g-22 —Schubert, R. J., 1910a
04-g-23 — 1910b
04-g-24 — 1911

Geomorphology
05-c-3 —Allied Forces etc., 1942c
05-a-19 — 1942n
05-c-28 — 1943al

Quaternary geology
06-a-4 —Christiansen, S., 1963
06-a-11 —Jennings, J. N., 1966
06-a-14 —Panzer, W., 1933

Sediments and soils
07-b-2 —Baseden, C. S. & Southern, P. J., 1959
07-a-22 —Wijk, C. L. van, 1959

Sedimentary rocks
07-b-14 —Hosking, J. S., 1967
08-b-8 —Liversidge, A., 1877a
08-b-9 — 1877b
08-b-14 — 1888c
08-d-4 —Tan Sin Hok, 1926

Igneous rocks
09-b-10 —Glaessner, R., 1915

Economic geology
12-a-2 —Australia, Parliament, 1928
12-c-18 —Barrie, J., 1965e
12-c-23 —British Sulphur Corp., 1964
12-d-3 —Corbett, D. W. P., 1965
12-c-26 —Dimmick, T. D. & Ludbrook, N. H., 1947
12-c-40 —Hutchinson, G. E., 1950
12-c-41 —Hutchinson, R. C., 1941
12-c-62 —Theime, P., 1970

Seismology
15-a-11 —Sieberg, A., 1910

59—SAMO—SA/56-15

Areal geology
02-d-2 —Anonymous, 1894c
02-d-40 —Pfluger, A., 1901a
02-d-41 —Poch, R., 1908a
02-d-44 —Sapper, K., 1909
02-d-47 — 1910c
02-d-49 —Schlagenhaufen, O., 1909

Palaeontology
04-g-24 —Schubert, R. J., 1911

Geomorphology
05-a-17 —Allied Forces etc., 1942i
05-a-19 — 1942n
05-c-28 — 1943al
05-d-8 — 1943ap
05-e-18 —Schlagenhaufen, O., 1908a

Quaternary geology
06-a-5 —Christiansen, S., 1964
06-a-11 —Jennings, J. N., 1966

Sediments and soils
07-b-2 —Baseden, C. S. & Southern, P. J., 1959
07-b-4 —Dwyer, R. E. P., 1939
07-b-14 —Hosking, J. S., 1939b
07-a-22 —Wijk, C. L. van, 1959

Igneous rocks
09-b-10 —Glaessner, R., 1915

Mineralogy and crystallography
11-b-2 —Heming, R. F., 1969

Volcanology
14-a-30 —Fisher, N. H., 1957

Geochronology
17-b-7 —Harding, R. R., 1969

60—CAPE ST GEORGE—SB/56-3

Discovery and exploration
01-a-14 —Bougainville, L. A. de, 1772
05-a-128—Powell, W., 1883b
05-a-129— 1884

Areal geology
02-d-2 —Anonymous, 1894c
02-d-17 —Brown, G., 1877
02-d-36 —Macnab, R. P., 1970
02-d-40 —Pfluger, A., 1901a
02-d-42 —Rannie, D., 1889
02-d-44 —Sapper, K., 1909
02-d-47 — 1910c
02-d-48 —Schlagenhaufen, O., 1908b
02-d-49 — 1909
02-d-50 —Schleinitz, G. E. G. von, 1877
02-d-56 —Stephan, E. & Graebner, F., 1907

Palaeontology
04-g-24 —Schubert, R. J., 1911

Geomorphology
05-a-17 —Allied Forces etc., 1942i
05-a-19 — 1942n
05-c-28 — 1943al
05-e-16 —Romilly, H. H., 1887

Igneous rocks
09-b-10 —Glaessner, R., 1915

Structural geology
13-b-71 —Wiebenga, W. A. et al., 1971
13-b-72 — 1971

Seismology
01-a-13 —Bougainville, L. A. de, 1771

60—CAPE ST GEORGE—SB/56-3—*Contd*

Solid earth geophysics
16-a-4 —Furumoto, A. S., 1970

61—BOUGAINVILLE ISLAND NORTH—SB/56-8

Discovery and exploration
01-a-20 —[Fleurieu, C. P. C. de], 1790
01-a-21 — 1791
01-b-59 —Parkinson, R. H. R., 1907

Areal geology
02-d-5 —Anonymous, 1907
02-d-9 — 1908e
02-d-13 —Blake, D. H., 1967
02-d-14 — 1968
02-d-15 —Blake, D. H. & Miezitis, Y., 1967a
02-d-16 — 1967b
02-d-23 —Deland, C. C., 1936
02-d-26 —Friederici, G. & Sapper, K., 1910
02-d-27 —Great Britain Naval Staff etc., 1945b
02-d-46 —Sapper, K., 1910b
02-d-53 —Speight, J. G., 1965d
02-d-54 — 1967a

Stratigraphy and historical geology
03-d-15 —Kicinski, F. M., 1956

Geomorphology
05-c-7 —Allied Forces etc.. 1942p
05-c-33 — 1944a
05-a-38 —Blackwood, B., 1931
05-d-24 —Guppy, H. B., 1886
05-d-25 — 1887a
02-d-28 — 1887b
05-e-17 —Sapper, K., 1914
05-a-144—Scott, R. M. et al., 1967a
05-a-145— 1967b
05-e-19 —Speight, J. G., 1967b
05-a-147— 1967c
05-a-148— 1967d
05-a-149—Speight, J. G. & Scott, R. M., 1967
05-a-162—Tappenbeck, E., 1901
05-a-173—Zoller, H., 1891a

Quaternary geology
06-a-17 —Tester, A. C., 1950

Sediments and soils
07-a-20 —Scott, R. M., 1967
07-a-23 —Wijk, C. L. van, 1963

Sedimentary rocks
08-d-1 —Crook, K. A. W., 1970

Igneous rocks
09-b-10 —Glaessner, R., 1915
09-c-10 —Jakes, P. & Gill, J., 1970
09-c-13 —Jakes, P. & White, A. J. R., 1970
09-b-32 —Taylor, S. R. et al., 1969

Mineralogy and crystallography
11-b-2 —Heming, R. F., 1969

Economic geology
02-c-5 —Australia, Parliament, 1940
12-a-4 — 1952
12-i-26 — 1953
12-a-6 — 1961
12-c-15 —Barrie, J., 1965b
12-c-54 —Nye, P. B. & Mead, G. F., 1952

Structural geology
13-b-36 —Grover, J. C., 1955b

Volcanology
14-a-19 —Branch, C. D., 1967a
14-a-20 — 1967b
14-a-30 —Fisher, N. H., 1957
14-a-45 —Ribbe, C., 1903
14-a-72 —Zoller, H., 1891b

Seismology
15-c-1 —Grover, J. C., 1958
15-a-1 — 1960
15-c-7 —International Seismological Centre, 1967d

Solid earth geophysics
16-b-33 —Grover, J. C., 1955a
16-b-34 — 1965a
16-c-2 — 1965b
16-c-5 —Grover, J. C. & Laudon, T. S., 1966
16-b-38 —Khan, M. A. & Woollard, G. P., 1968
16-c-14 —St John, V. P. & Kugler, A., 1965
16-a-8 —Taylor, G. A. M., 1967
16-c-16 —Woollard, G. P., 1963

Geochronology
17-b-3 —Dury, G. H. & Smith, T. Langford, 1968
17-b-12 —Kigoshi, K. & Kobayashi, H., 1966

Oceanography
18-b-2 —Anonymous, 1909e
18-b-23 —Murray, J. & Hjort, J., 1912

62—BOUGAINVILLE ISLAND SOUTH—SB/56-12

Discovery and exploration
01-a-20 —(Fleurieu, C. P. C. de), 1790
01-a-21 — 1791

Areal geology
02-d-5 —Anonymous, 1907
02-d-9 — 1908e
02-d-13 —Blake, D. H., 1967
02-d-14 — 1968
02-d-15 —Blake, D. H. & Miezitis, Y., 1967a
02-d-16 — 1967b
02-d-23 —Deland, C. C., 1936
02-d-27 —Great Britain Naval Staff etc., 1945b
02-d-30 —Hamlin, H., 1929
02-d-34 —Knight, C. L. et al., 1971
02-d-37 —Macnamara, P. M., 1968
02-d-46 —Sapper, K., 1910b
02-d-53 —Speight, J. G., 1965d
02-d-54 — 1967a

Stratigraphy and historical geology
18-b-2 —Anonymous, 1909e
03-d-15 —Kicinski, F. M., 1956
03-d-16 —Mawson, D. & Chapman, F., 1935

Geomorphology
05-c-7 —Allied Forces etc., 1942p
05-c-32 — 1944a
05-e-11 —Cole, J. W., 1968
05-d-23 —Guppy, H. B., 1884
05-d-24 — 1886
05-d-25 — 1887a
05-d-28 — 1887b

62—BOUGAINVILLE I. SOUTH—*Contd*

Geomorphology—*Contd*

05-c-44 —Jennings, J. N., 1955
05-e-17 —Sapper, K., 1914
05-a-144—Scott, R. M. et al., 1967a
05-a-145— 1967b
05-e-19 —Speight, J. G., 1967b
05-a-147— 1967c
05-a-148— 1967d
05-a-149—Speight, J. G. & Scott, R. M., 1967
05-a-173—Zoller, H., 1891a

Quaternary geology

06-a-7 —Tester, A. C., 1950

Sediments and soils

07-a-20 —Scott, R. M., 1967
07-a-23 —Wijk, C. L. van, 1963

Sedimentary rocks

08-d-1 —Crook, K. A. W., 1970

Igneous rocks

09-b-2 —Baker, G., 1949
09-b-10 —Glaessner, R., 1915
09-c-10 —Jakes, P. & Gill, J., 1970
09-c-13 —Jakes, P. & White, A. J. R., 1970
09-b-32 —Taylor, S. R. et al., 1969

Mineralogy and crystallography

11-b-2 —Heming, R. F., 1969

Economic geology

12-c-2 —Anonymous, 1966
12-c-3 — 1968a
12-i-17 —Australia, Parliament, 1925
12-b-30 — 1931
12-b-32 — 1934
12-c-6 — 1938
02-c-5 — 1940
12-i-26 — 1953
12-a-6 — 1961
12-c-12 —Balberyszki, T., 1970
12-c-13 —Barnes, C. E., 1967
12-c-15 —Barrie, J., 1965b
12-f-2 —Baumer, A., 1970
12-b-56 —Fisher, N. H., 1940
12-a-19 — 1965
12-b-76 —McLeod, I. R. et al., 1965
12-f-4 —Moffit, R. B. & Kay, R. L., 1970
12-f-5 —Read, J. R. L., 1970
12-j-27 —Schiller, E. A. & Berven, R. J., 1971

Structural geology

13-b-36 —Grover, J. C., 1955b

Volcanology

14-a-5 —Australia, Parliament, 1962
14-a-8 — 1965
14-a-10 — 1967
14-a-11 — 1968
14-a-12 — 1969a
14-a-19 —Branch, C. D., 1967a
14-a-21 — 1967c
14-a-30 —Fisher, N. H., 1957
14-b-2 — 1959
14-a-45 —Ribbe, C., 1903
14-a-50 —Schleinitz, G. E. G. von, 1876
14-a-58 —Taylor, G. A., 1956b

Seismology

15-c-1 —Grover, J. G., 1958
15-a-7 — 1960
15-c-7 —International Seismological Centre, 1967d

Solid earth geophysics

16-b-26 —Ewing, M. & Press, F., 1952
16-b-33 —Grover, J. C., 1955a
16-b-34 — 1965a
16-b-38 —Khan, M. A. & Woollard, G. P., 1968
16-c-14 —St John, V. P. & Kugler, A., 1965
16-a-8 —Taylor, G. A. M., 1967
14-a-17 —Woodford, C. M., 1888

Geochronology

17-a-2 —Page, R. W., 1971

Oceanography

18-b-23 —Murray, J. & Hjort, J., 1912

63—SABLE—SC/56-13

Discovery and exploration

01-a-2 —Anonymous, 1850b

Areal geology

02-b-78 —Macgillivray, J., 1851

Geomorphology

05-c-11 —Allied Forces etc., 1942z
05-d-20 —Davis, W. M., 1928

64—TINGWON—ST/55-12

Geomorphology

05-d-8 —Allied Forces etc., 1943ap

65—TENCH—SA/56-5

Areal geology

02-d-22 —Danneil, C., 1902

66—NUGURIA—SA/56-16

Areal geology

02-d-4 —Anonymous, 1901
02-d-60 —Thilenius, G., 1900

Geomorphology

05-d-8 —Allied Forces etc., 1943ap

67—KILINAILAU—SB/56-4

Areal geology

02-d-4 —Anonymous, 1901
05-c-7 —Allied Forces etc., 1942p
02-d-27 —Great Britain Naval Staff etc., 1945b
02-d-49 —Schlagenhaufen, O., 1909
02-d-60 —Thilenius, G., 1900

Seismology

15-c-44 —International Seismological Centre, 1970j

68—TAUU—SB/57-1

Areal geology

02-d-4 —Anonymous, 1901
05-c-7 —Allied Forces etc., 1942p
02-d-27 —Great Britain Naval Staff etc., 1945b
02-d-60 —Thilenius, G., 1900

69—NUKUMANU—SB/57-3

Areal geology

02-d-4 —Anonymous, 1901
02-d-27 —Great Britain Naval Staff etc., 1945b
02-d-60 —Thilenius, G., 1900

70—GULF—SC/55-1

Economic geology

12-i-10 —Anonymous, 1968c
12-i-11 — 1968d
12-i-13 — 1968f
12-i-15 — 1968i

PAPUA AND NEW GUINEA—REGIONAL AND GENERAL

Discovery and exploration

01-b-22 —Blackie, W. G., 1885
01-a-17 —D'Urville, J. S. C. Dumont, 1844
01-a-20 —(Fleurieu, C. P. C. de), 1790
01-a-21 — 1791
01-b-38 —Griffiths, G. S., 1885
01-a-22 —Howard, D., 1933
01-a-23 —Krusenstern, A. S. de, 1824
01-b-52 —Lawson, J. A., 1875
01-a-27 —Markham, C. R., 1886
01-a-18 —Meslee, E. M. la, 1885
01-a-44 —Thomson, J. P., 1895

Areal geology

02-a-1 —Anonymous, 1945
02-a-3 —Avias, J., 1971
02-a-4 —Bain, J. H. C. et al., 1971
02-a-6 —David, T. W. E., 1914
02-a-7 —Dow, D. B. & Bain, J. H. C., 1970
02-a-8 —Dwyer, R. E. P., 1941
02-a-9 —Fisher, N. H., 1969
02-a-10 —Great Britain Naval Staff etc., 1945a
02-a-11 — 1945c
02-b-61 —Haddon, A. C., 1900
02-a-12 —Horne, R. G., 1967
02-a-13 —Hovig, P., 1937
02-a-14 —Jaeger, J. C. & Thyer, R. F., 1963
02-a-16 —Reed, F. R. C., 1949
02-a-17 —Renwick, A., 1970a
02-a-19 —Smith, T. Langford, 1951b
02-b-160—Stanley, E. R., 1921b
02-a-21 —Stanley, G. A. V., 1958
02-a-22 —Termier, H. & Termier, G., 1956
02-a-23 —Thompson, J. E., 1956
02-a-24 — 1967a
02-a-27 —Trotter, C., 1884a
02-a-30 —Wallace, A. R., 1883a

Stratigraphy and historical geology

03-e-3 —Andrews, E. C., 1924
03-c-1 —Arkell, W. J., 1956
03-e-4 —Belford, D. J. & Scheibner, V., 1971
03-a-4 —Bemmelen, R. W. van, 1949
03-e-5 —Benson, W. N., 1923
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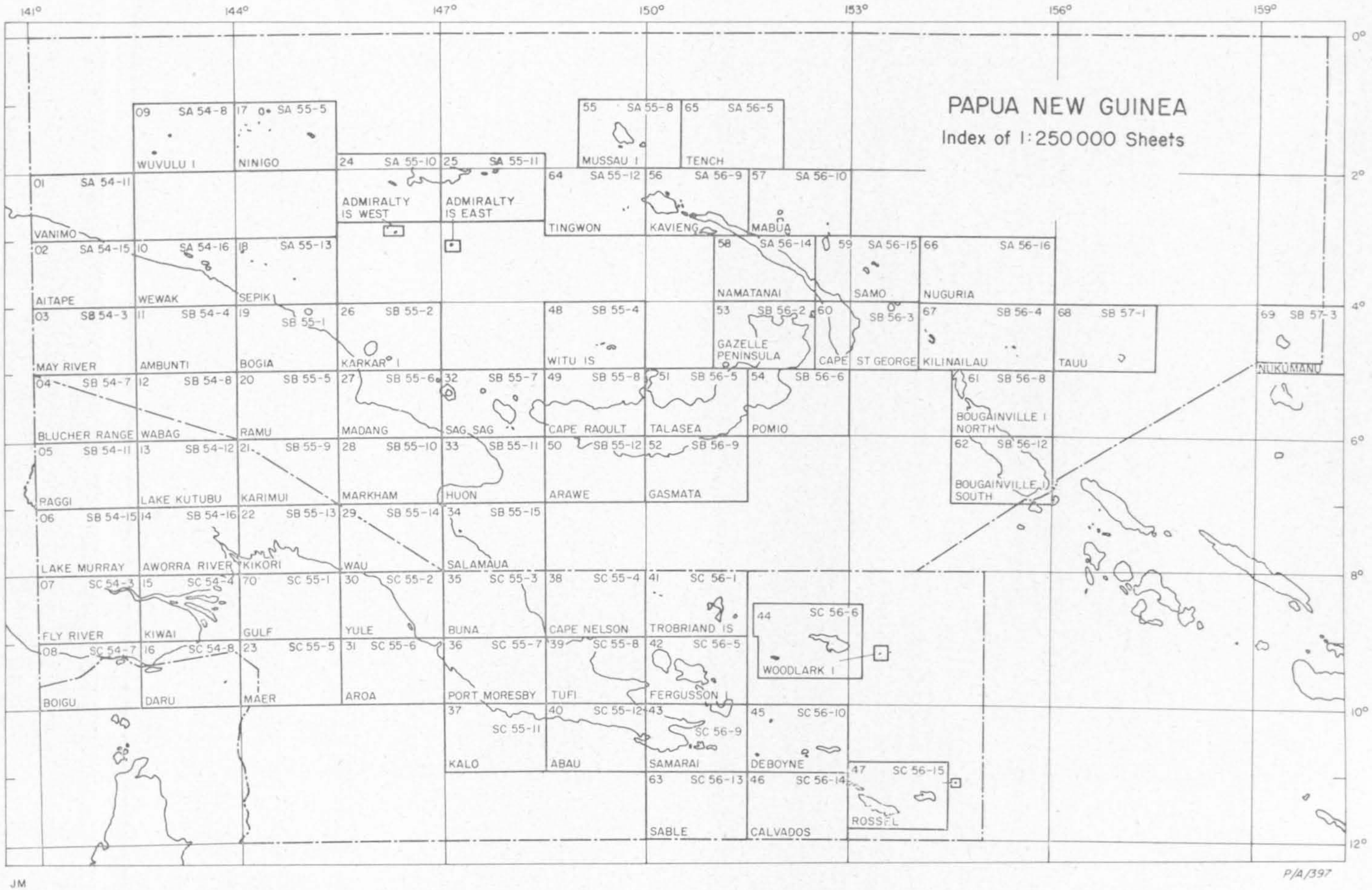
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