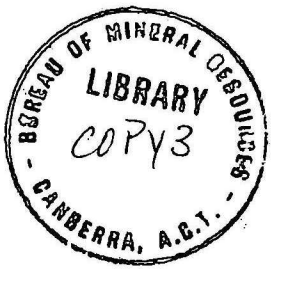
COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

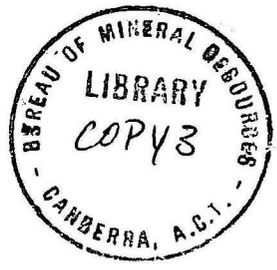
Record No. 1971/103



Geological Branch

Summary of Activities 1971

Record No. 1971/103



Geological Branch

Summary of Activities 1971

ANNUAL SUMMARY OF ACTIVITIES

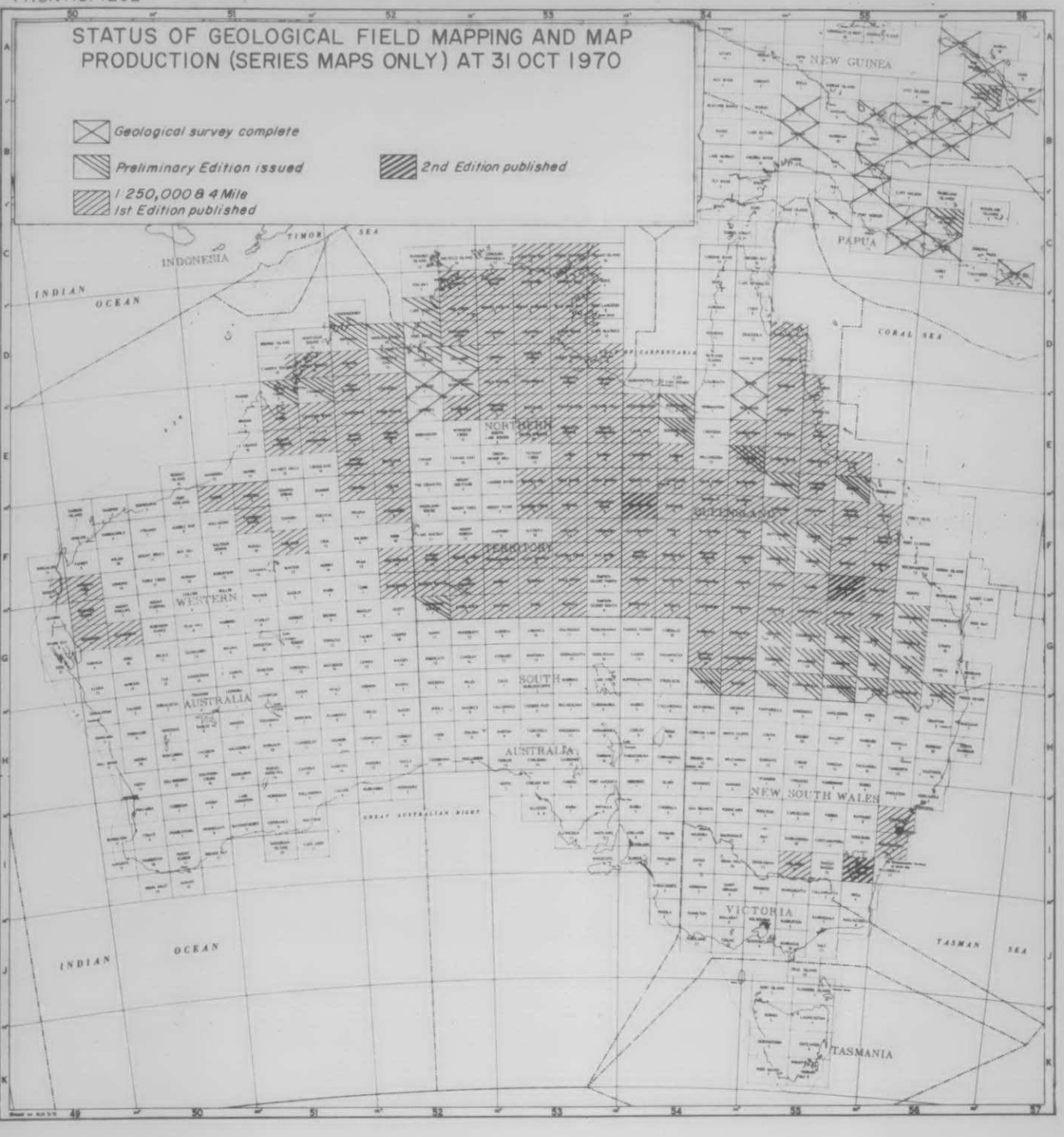
GEOLOGICAL BRANCH, 1971

RECORD 1971/103

Detailed contents (including illustrations) in Section Reports are listed at the start of each Section Report.

Frontispiece - Status of mapping and map production at 31st October, 1970, and progress in year ended 31st October, 1971.

FRONTISPIECE



1:250 000 B 56-8 BOUGAINVILLE-BUKA, TPNG, ALSO PUBLISHED

PUBLISHED 1 MILE SERIES MAPS

ALMADEN	BAN BAN	BATCELOR	BLACK CAP	BURNSIDE	BURRUNDIE
CHILLAGOE	DALY RIVER	DILGIN HOMESTEAD	GOODPARLA NORTH	GOODPARLA SOUTH	HERBERTON
HUMPTY DOO	KATHERINE	LEWIN SPRINGS	MARRAKAI	MOUNT BUNDEY	MOUNT GARNET
MOUNT HAYWARD	MOUNT STOW	MOUNT TODD	MOUNT TOLMER	MULDIVA CREEK	MUNDOGIE HOMESTEAD
MUNGANA	RANFORD HOMESTEAD	REYNOLDS RIVER	RUM JUNGLE (SPECIAL)	SOUTHPORT	TENNANT CREEK
TIPPERARY	TUMBLING WATERS	WATERHOUSE	WOOLWONGA		

1:100 000 GEOLOGICAL SURVEY COMPLETE

CLONCURRY MARY KATHLEEN MARRABA

1:100 000 PRELIMINARY EDITION ISSUED

YAMPI LEOPOLD DOWNS

ANTARCTICA 1:100 000

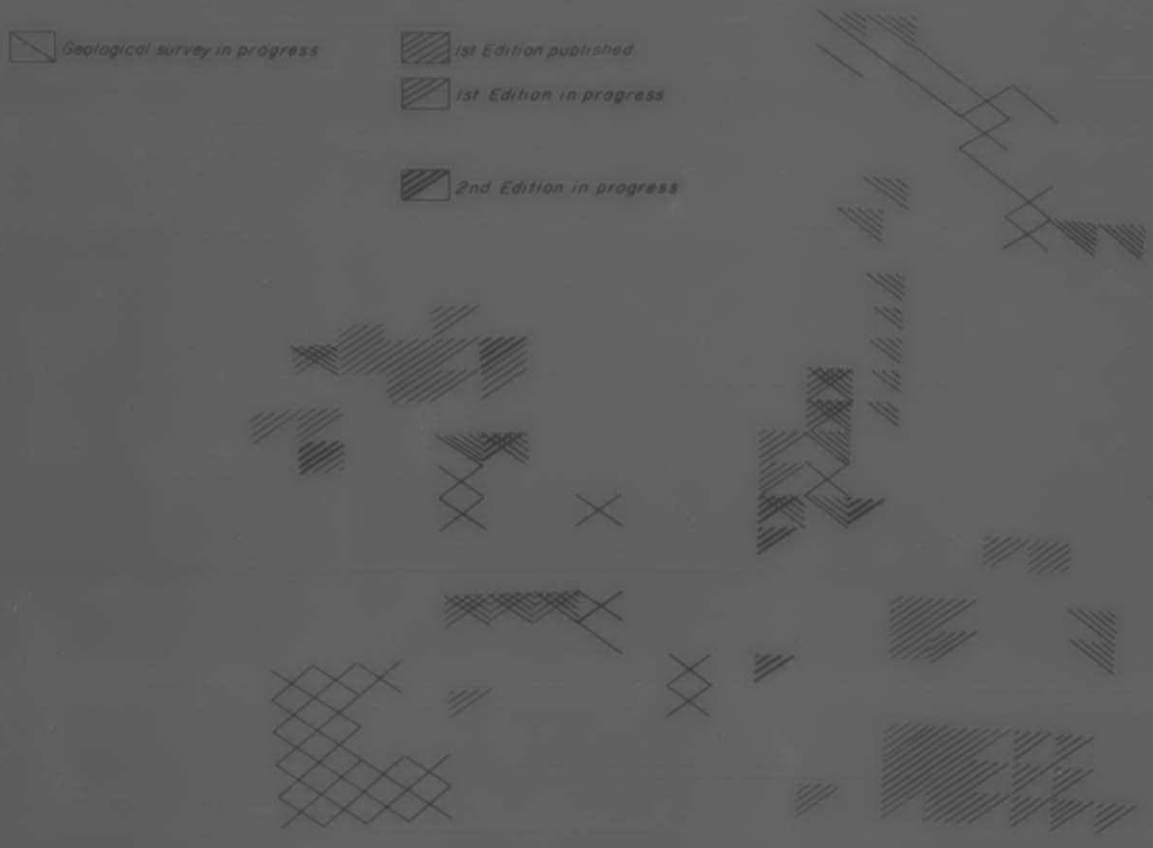
FIELD WORK IN PROGRESS SR41-42/3,6,10,11,14, and 15; SQ41-42/15

FIELD WORK COMPLETE SR41-42/16; SR43-44/2,3,5,6, and 9

PRELIMINARY EDITION ISSUED

MAWSON & MOUNT HENDERSON; OYGARDEN & LOWER PROMONTORY

AUS/2/180



Progress in geological field mapping and series map production in the year ended 31 Oct 1971

MT ISA

1:100 000 GEOLOGICAL SURVEY IN PROGRESS AS AT 31 OCT 1971

AILERON
EAST ALLIGATOR
CAHILL
REYNOLDS RANGE
TEA TREE
LAUGHLEN
RIDDOCH
FERGUSSON RANGE

SR41-42/6, 10, 11, 14 and 15

To accompany Record 1971/103

AUS/2/181

FOREWORD

by

J.N. Casey

It is appropriate in this, the Silver Jubilee of the Bureau's existence, to note that one of the major tasks of geological surveys - that is, systematic geological mapping of the continent, in the first place at 1:250,000 scale - is largely completed; the Bureau's role in this, with the co-operation of the State Geological Surveys, has been of utmost importance, not only in maintaining high mapping standards (using air photography at various scales and types as a base) but in standardising map presentation throughout Australia and Papua New Guinea, and in publishing and disseminating this information. Of the 540 Sheets at 1:250,000 scale covering Australia, B.M.R., alone and in co-operation with State Surveys, has mapped and published in colour 160, another 60 have been mapped and issued as preliminary editions, and field mapping has been completed on a further 30 sheets which will be available first as preliminaries, then as coloured editions. A substantial part of the rest of Australia has been completed by the State Geological Surveys.

A lot of effort has been put into systematic mapping in Papua New Guinea, and although only a few maps have been published in colour, and seven as preliminaries, 1972 should see a further twelve 1:250,000 Sheets issued as preliminaries, and 8 as colour editions; in fact, of the 52 Sheets (or parts thereof) at 1:250,000 scale covering Papua New Guinea, field work has been completed on 34 (i.e. 63% of the area has now been systematically covered, although reports and maps are not yet readily available). The first complete geological map of New Guinea at 1:1,000,000 scale is already in draft form, and will be published in colour in 1972.

It is estimated that by 1979 the whole of Australia and Papua New Guinea will be covered by systematic 1:250,000 scale geological maps.

Mapping at this scale merely sets the stage for the next phase of geological study, which was begun recently: that is, the detailed mapping, at 1:100,000 scale, of economically important or geologically complex areas in metalliferous provinces, or the re-mapping at 1:250,000 scale of areas that are now of economic interest, or about which there has been a great deal of additional information, particularly sub-surface information, since the first map was printed. The detailed mapping at 1:100,000 scale is evident in the 1971 programme when 8 parties, consisting of 17 geologists, were engaged in regional mapping, and 5 parties with 10 geologists concentrated on detail work. The use of colour aerial photography for detail mapping in complex areas is most successful; the accuracy, confidence and speed of mapping (twice that with black and white) justifies the additional expense which averages about $3.60 per square mile at 1:25,000 scale.

As well as the mapping of grid sheets, a considerable effort was devoted to project type work in areas that had previously been systematically mapped; such investigations involved 14 geologists in 1971 working on 9 separate projects, which ranged from the environment of deposition of coal to the petrological and geochemical characteristics of volcanic rocks in New Guinea, and the distribution of metals and sediments in modern estuaries.

Over 30% of the staff were involved in writing up investigations, or providing specialized services such as palaeontology or geochronology to various laboratory or field projects. Although manuscripts have been slower in reaching publication standard, owing in some degree to the loss of experienced staff over the last few years, effort is now directed into completing some major outstanding writing commitments, and to speeding up the writing of field reports. During the year, the publication and issue of 7 Bulletins, 6 Reports, 9 Explanatory Notes to geological maps, 26 Records, and 47 various articles for outside publication, attests to the productive and scientific attainment of the branch; as well as this, 47 Bulletins and Reports, 60 Explanatory Notes, and 38 articles for outside publication are either in press, with the editor, or in preparation, and 93 Records are being prepared.

It is unfortunate that it now takes nearly twice as long to process and print coloured maps as it did a few years ago; it takes nearly 2 years from the time the preliminary edition of a 1:250,000 map is edited, to when the coloured printed map is received - one year of this is taken up in preparing and awarding contracts for both fair drawing and printing. Strangely, the cost per map has remained about the same, viz: $2,600 for printing the coloured map, $1,500 for drafting, and $140 for printing the two-plate preliminary. In 1971, 19 coloured maps at 1:250,000 scale were printed, plus 6 for the Western Australia Geological Survey, and 4 at other than 1:250,000 scale; this does not include 10 maps re-printed. Twenty-two preliminaries were issued.

The staff situation seems to be stabilizing after the rather severe loss of experienced staff that has occurred in the last few years. If we remain at full strength, which we will reach by the end of 1971, we can be confident in achieving our 1972 and forward programmes, and should complete the major projects and writing commitments that inevitably remain when senior staff resign or are otherwise over-committed. For the twelve months to 1st December 1970, the branch had a net loss of 150 man-years of experience (29 officers with 186 man-years of experience resigned, and 18 officers with 36 man-years of experience joined). For the twelve months to 1st December 1971, there was no overall loss of experience, but a gain of 10 geologists (9 resigned with 54 man-years of experience, and 19 joined with 54 man-years of experience).

The summary of technical results achieved is given under the various section reports, but it is noticeable that more emphasis is being given to the application of the results of specific and specialized field work to broader and more regional problems. The use of

shallow drilling to provide fresh rock or determine sequences in non-outcropping areas continues to be applied successfully in different geological terrains; many of these holes are logged with gamma-ray devices, at least. Helicopters provide invaluable cover in difficult terrains and over 750 hours were flown in New Guinea, the Officer Basin, and the Tanami area. The expansion in engineering-hydrology requirements in Papua New Guinea and the demand for urban development and construction materials in developing Canberra has proved a challenge to the resources of the engineering geologists.

With 123 geologists, 40 draftsmen and 28 technical officers and assistants, the production of scientific work should be maintained at or above the level of 1971, with the objectives of completing the regional mapping and extending it into the offshore continental shelf; the systematic marine geological survey around the shelf is proceeding and 1:1 million scale maps are being produced.

SEDIMENTARY SECTION

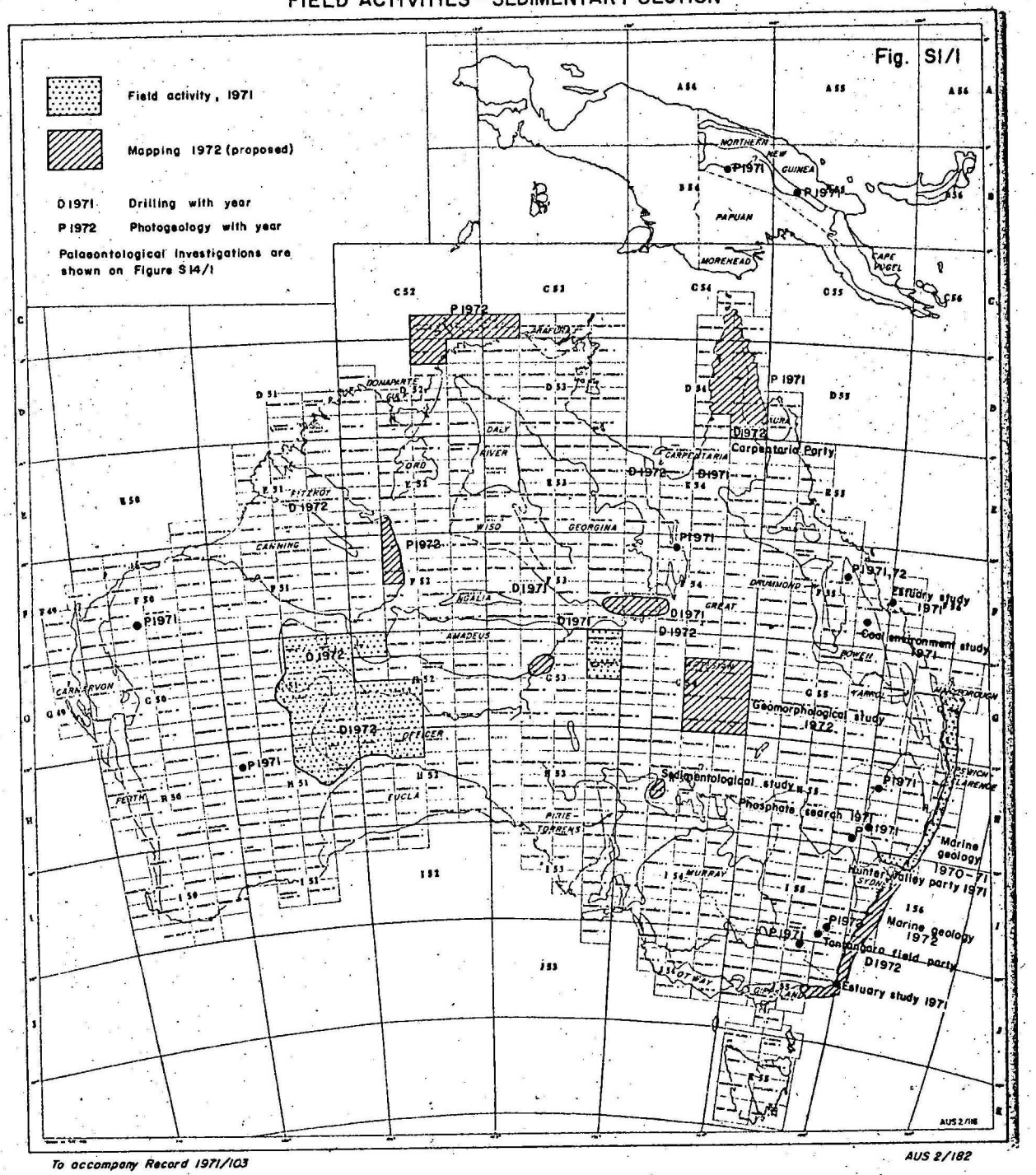
SEDIMENTARY SECTION

Contents

Contents

(ii)

AUSTRALIA
AND NEW GUINEA
FIELD ACTIVITIES - SEDIMENTARY SECTION



To accompany Record 1971/103

AUS 2/182

S1 SUMMARY (Fig S1/1)

Eighteen 1:250,000 Sheet areas were mapped in the Western Australian part of the Officer Basin and two in the Northern Territory part of the Western Eromanga Basin during the year. Shallow stratigraphic drilling in support of the regional mapping was undertaken in the Western Eromanga and Carpentaria Basins and is planned for the Officer Basin in 1972 as meagre surface outcrops there give little definite evidence of the stratigraphy or structure of the basin. A re-assessment of the age of basalt within the Officer Basin sequence as probably Ordovician rather than late Proterozoic indicates that Palaeozoic rocks could be more plentiful than previously thought.

Six regional geological maps and explanatory notes covering part of the Southern Carpentaria Basin and five from the Surat and Eromanga Basins were prepared and sent to the editors during the year. A three-colour preliminary map of the Central Eromanga Basin at 1:1,000,000 scale was issued and a Bulletin describing the geology will be written by early 1972. Geological and geophysical maps of the Ngalia Basin at 1:500,000 scale were well advanced at the end of the year. A Bulletin to accompany the maps, written as a joint project with the Geophysical Branch, is planned to be completed by mid-1972. A Bulletin on the stratigraphy and structure of the Bowen Basin was completed and accompanying geological and geophysical maps at 1:1,000,000 scale fair drawn. Writing of the final accounts of the Bowen Basin Triassic project and the Hunter Valley Carboniferous project started during the year; both should be completed in 1972.

Although no specialist contract had been engaged by the end of the year to assist with the Great Artesian Basin hydrogeological project a start was made assembling data on interconnection of aquifers within the basin, and a visit was made to intake areas in Queensland and New South Wales. The programme of water-bore logging continued in the Surat Basin.

Shallow drilling at Eyre Creek (western Springvale Sheet) in Western Queensland showed that anomalously high gamma ray log indications are almost certainly due to unusual mineral concentrations in the weathering profile developed over labile Mesozoic sediments. Minerals identified so far include alunite, svanbergite and goyazite in which substantial percentages of potash, phosphate, strontium and barium are present. Further drilling at this locality is planned for 1972.

In the Northern Territory drilling on Alcoota Sheet area proved the presence of at least 200 m of Tertiary deposits in the Waite Basin.

The detailed mapping of well-exposed coal measures in one of the Bowen Basin opencuts gave evidence of splitting of units, small-scale faulting due to compaction, and the presence of kaolinite beds. An analysis of these features in relation to the formation and burial of the coal swamps will aid prospecting and mining in the area.

Palaeontological investigations continued on material from Australia, Antarctica, Papua-New Guinea and offshore areas despite some loss of staff. Field visits were made to the Perth and Carnarvon Basins to collect from the type sections of the Jurassic, Cretaceous, and Tertiary, and to South Victoria Land, Antarctica to collect Devonian vertebrates, the latter in co-operation with the Victoria University of Wellington, N.Z.

Field studies of the modern estuaries at Broad Sound, Queensland and Mallacoota Inlet, Victoria, continued during the year. At Broad Sound beach ridge sampling and drilling on land was combined with offshore drilling and seismic profiling to establish the Quaternary stratigraphy of the area. Hydrological and sedimentological studies were made at Mallacoota Inlet and soil sampling of the catchment area completed.

Phosphate investigations were continued in the New England part of the Tasman Geosyncline and, in the laboratory, the scanning electron microscope was used to assist with the study of the petrology and chemistry of the Georgina Basin phosphorites.

The marine geological reconnaissance of the eastern Australian Continental Shelf was extended south from Brisbane to Port Macquarie in November and December 1970 and resulted in the location of Miocene? phosphatic limestone outcrops on the upper continental slope. A Bulletin on the marine geology of the Arafura Sea was well advanced by the end of the year.

The study of Australian evaporites was assisted by the engagement of a specialist consultant who visited petroleum and mineral exploration companies and State geological surveys prior to making recommendations for further exploration. Chemical and petrological work continued on cored evaporite sequences from the late Precambrian carbonate and evaporite rocks of the Amadeus Basin.

The photogeological group continued routine interpretations for field parties in Australia and New Guinea . Radar imagery of part of New Guinea was interpreted and checked in the field. Thermal infrared imagery was flown over an area of Upper Permian Coal Measures in the Bowen Basin to see whether shallow sub-cropping coal seams and associated strata could be detected by this method. Results were awaited at the end of the year.

Information was collected and proposed projects co-ordinated for Australia's contribution to the Earth Resources Technology and Science programme due to start in 1972.

Five Bulletins, two Reports, six Explanatory Notes and 14 external papers were published, and seven Records issued during the year. Eighty publications are in preparation, with the editors, or in press - including 38 Explanatory Notes, 15 Bulletins and 16 Records.

S2 - HYDROGEOLOGY OF THE GREAT ARTESIAN BASIN

by

N.O. Jones

PERSONNEL: R.R. Vine (part-time to April 1971), N.O. Jones, M.A. Habermehl (from March 1971).

The hydrogeological study of the Great Artesian Basin started with a review of previous studies of the basin and examination of literature of other comparable groundwater basins and modelling studies. A panel diagram, horizontal scale 1:1,000,000, is being prepared to illustrate the overall range of thickness and permeability of the sedimentary section throughout the basin and to give a generalized picture of aquifer interconnection. Tenders, closing 23rd June 1971, were called for the provision of contract assistance in certain aspects of the study but the contract had not been let at 31st October, 1971.

A field examination of the southeastern intake areas, between Tambo (Qld) and Dubbo (NSW) was made 19th September - 17th October, 1971, jointly with officers from the Geological Survey of Queensland and the New South Wales Geological Survey. As well as permitting study and sampling of the outcropping aquifers the examination helped in assessment of the influence of weathering, alluvial deposits and vegetation on recharge rates.

Supervision of the contracts for water-bore logging continued. Logging under the 1970 contract continued in November-December 1970 and April - July 1971. All logging was in the Surat Basin. Details of the logs obtained are given in Table S2/1. Logging under the next contract will be in the Northern Territory part of the Western Eromanga Basin and the northeastern Eromanga Basin in Queensland.

TABLE S2/1 WATER-BORE LOGGING, 1970-1971

Month	Logs obtained		
	Gamma-ray	Temperature	Flowmeter/caliper
1970			
November	20	20	2
December	3	3	-
1971			
April	7	7	2
May	19	17	1
June	16	16	-
July	4	4	-
Totals	69	67	5

N.O. Jones was Secretary of the Technical Committee on Underground Water of the Australian Water Resources Council until this position was transferred to the Water, Power and Geographic Branch of the Department in March 1971. He also attended meetings of the AWRC advisory panels on Hydrology of Smooth Plains, Effect of Rural Land Management on Runoff, and Water Resources Technical Information Services; the TCUW sub-committee on the Groundwater Maps of Australia; and the reference panel for research into artificial recharge in the Burdekin Delta. He supervised the preparation, under contract, of a bibliography of groundwater recharge studies in Australia.

S3 - CARPENTARIA BASIN PARTY

by

H.F. Doutch

PERSONNEL: BMR: H.F.Doutch (party leader), J. Smart, S.Needham, (transferred to Darwin in May): GSQ: K.G. Grimes.

In 1971 the party spent more time on reporting than on field work, which consisted for the most part of shallow stratigraphic drilling by BMR rigs.

FIELD WORK

Table S3/1 summarizes the drilling carried out. An attempt to get wireline logs from Midwood Normanton Scouts Nos. 1 and 2 failed because the holes were blocked not far from the surface. Artesian flows were encountered in BMR Rutland Plains 1 and Walsh 2 coming from the late Cretaceous? - early Tertiary Bulimba Formation. The Gamma ray log of BMR Red River 1 shows an anomaly of three to four times background. Subsequent examination of cuttings with a scintillometer revealed no measurable radioactivity.

Figure S3/1 shows the localities of the holes drilled, and also where field work was carried out. This was confined to -

(1) remapping Mesozoic and Cainozoic rocks in the west of the Atherton 1:250,000 Sheet area: where the First Edition of the Atherton Sheet shows Mesozoic rocks there is much less of them, there being also basement outcrops and Cainozoic basalt and sandstone:

(2) sampling the oldest beach ridge between Normanton and Karumba for material for radiocarbon dating:

(3) checking on the distribution of the Precambrian Esmeralda Granite and Mesozoic Gilbert River Formation in a large soil-covered area in the south-west of the Georgetown 1:250,000 Sheet area:

AMDL advised during the year that the Esmeralda Granite and Croydon ignimbrite, previously thought to be of Permian age, gave Rb/Sr dates of approximately 1400 million years.

REPORT WRITING

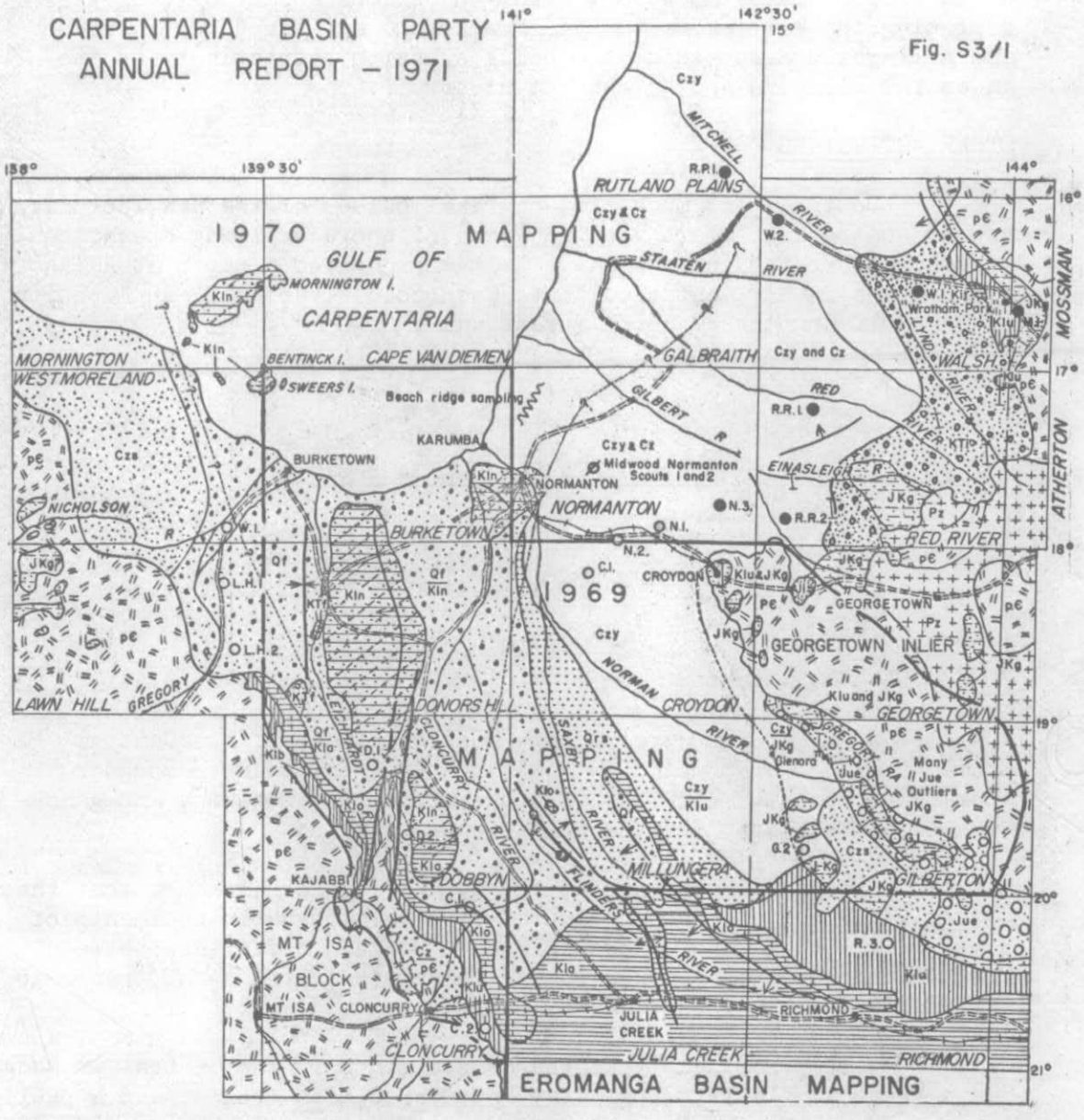
The status of Record, Paper and Explanatory Note writing by the party is given on p. . Explanatory Notes and 1:250,000 geological maps in the Editors' hands are Rutland Plains, Galbraith, Burketown, Donors Hill, Millungera and Gilberton. Those for Normanton are near completion. A Record on the Mesozoic of the Georgetown Sheet area is in press; Records on drilling in 1970 and 1971, and field work in 1969 and 1970 are all nearly finished.

TABLE 83/1. DRILLING RESULTS, CARPENTARIA BASIN, 1971

Hole Name Location Rig	Elevation and Total Depth	Coring and Recovery %	Wireline Logs	Section Penetrated (Formation Tops)	Objectives	Results	Remarks
Mossman 1 G.R. 169895 5 km SSE of Wrotham Pk Hs. Mayhew 1000	160 m 180 m (591'4")	46 cores 126 m (413'7") Rec.122 m (410') 97%	Gamma-Log to 133 m Resistivity -log to 133 m SP log to 67 m then U.S.	0m. Alluvium 25 m Wallumbilla Fm. 74 m Gilbert R. Fm. (Coffin Hill Member) 111 m Yappar Member 180 m T.D.	(1) To core the basal Wallumbilla Fm. and both members of the Gilbert R. Fm. for lithologic investigations. (2) To obtain structural data on the dip of a sandstone marker bed within the Wallumbilla Formation. (3) To determine depth to basement and thickness of the Gilbert R.Fm. (4) To test artesian water from the Gilbert R. Fm.	(1) Showed lithologies of the Gilbert R. Fm. to be different to outcrop. (2) showed sedimentary section to be thicker than expected. Basement not reached. (3) Dip of Wallumbilla Beds is 1° to WNW. (4) Artesian water flowed at 136 litres/hour from 130 m.	(1) Basement not reached due to slow drilling in conglomerate. Estimated basement depth is 185-200 m. (2) Hole completed as observation bore for Qld I.W.S.C.
Rutland Plains 1 G.R. 553985 13 km NW of Dunbar Mayhew 1000	50 m 173.5 m (570')	4 cores 11.5 m (38') Rec. 9.3 m (30'6") = 81%	Resistivity-Log to 17 m	0 m Alluvium 13.5 m Wyaaba Beds 57.5 Bulimba Fm. 173.5 T.D.	(1) To sample the Cainozoic. (2) to find the depth and nature of the laterite on the Bulimba Fm. (3) To identify and sample the top of the Mesozoic.	(1) Information on the Cainozoic lithologies was obtained. (2) Laterite was identified at 57.5 m but the top of the sequence appeared to be missing. (3) Artesian water flowing at 110,000 litres/hour was unexpectedly encountered at 174 m in the Bulimba Fm. (4) The Mesozoic was not reached.	Drilling could not continue after the unexpected artesian flow. The flow was eventually controlled and the hole plugged and abandoned.
Walsh 1 G.R. 689913 By Dunbar Rd, 21 km west of Gamboola. Mayhew 1000	122 m ± 2 m 183 m (600')	5 cores 13 m (43') Rec. 10.3 m (33'5") = 78%	Gamma-Log to T.D. (183 m) Resistivity-Log to T.D. (183 m)	0 m Alluvium 145 m Bulimba Fm. 32 m ?Allaru Mudstone 118 m ?Toolebuc Limestone equivalent. 120.5 m. Wallumbilla Fm. (Upper) 183 m T.D.	(1) To obtain stratigraphic information on the Mesozoic rocks beneath the Cainozoic. (2) To core the Toolebuc Limestone, if present, (3) To sample the laterite horizon on the Bulimba Fm, if present.	(1) The Toolebuc Limestone was not present although a slight anomaly in the Gamma-ray log could be interpreted as Toolebuc equivalent. (3) A core was obtained of the laterite horizon.	As Mesozoic does not outcrop this was basically a "wildcat" hole to determine the pre-Cainozoic stratigraphy.
Walsh 2 G.R. 602967 at Marlborough Yds. 37 km east of Dunbar. Mayhew 1000	68 m± 2 m 155 m (510')	No cores	Gamma-Log to 111 m Resistivity-Log to 111 m	0 m Alluvium 24 m Wyaaba Beds. 52 m Bulimba Fm. 155 m T.D.	(1) To test the extent of the Tertiary artesian aquifer discovered in BMR Rutland Plains 1. (2) To obtain structural and lithological information on the Cainozoic. (3) To attempt to sample the Mesozoic.	(1) An artesian flow of 33,000 litres/hour was obtained from the Bulimba Beds at 107 m. (2) The laterite horizon was identified at 52 m. The Bulimba Fm. was less sandy than in Rutland Plains 1. (3) The Mesozoic section was not reached.	Drilling below 155 m was not possible as gravel was caving into the hole and threatened to jam the drill pips. The hole was plugged with cement before abandoning.
Red River 1 G.R. 608 815 2 km south of Retreat Waterhole Mayhew 1000	120 m 210 m (690')	4 cores 5 m (16.5') rec. 2 m (7') 42%	Gamma to 210 m Then logger U.S.	0-45 m Wyaaba Beds 45-104 m Bulimba Fm. 104-210 m Wallumbilla Fm.	(1) To determine the depth and nature of the laterite horizon. (2) To determine the depth and thickness of the Gilbert R. Fm. (3) To determine depth of basement. (4) To determine thickness and nature of the Cainozoic.	(1) Showed laterite horizon at 45 m. Laterite is partly eroded in this area. (2) Showed Wyaaba Beds to be much thicker than expected. (3) Showed thick Wallumbilla Fm. to be present. (4) Obtained cores of Wyaaba, Bulimba and Wallumbilla.	(1) Depth to Gilbert R. is probably about 220-250 m, and to basement about 270-300 m.
Red River 2 G.R. 592 759 Left bank Jam Tin Ck, east of Strathmore Mayhew 1000	125 m 82 m (270')	No cores	Logger U.S.	0-18 m Wyaaba Beds 18-82 m Bulimba Fm.	(1) To determine depth and nature of the main laterite horizon. (Hole spudded near base of hill of lateritised Wyaaba Beds). (2) To determine thickness and nature of the Cainozoic. (3) To determine depth and nature of the uppermost Mesozoic.	(1) Showed laterite horizon at 18 m. (2) Showed thickness of Wyaaba Beds. (3) Showed Bulimba to be fairly thick in this area. 64 m+.	Planned as a quick, shallow hole as unable to drill deeper.
Normanton 3 G.R. 539 763 6 km west of Fords Mill, Mayhew 1000	107 m 145 m (457')	1 core 3 m (10') rec. 1.8 m (6') 60%	Logger U.S.	0-40 m Wyaaba Beds 40-67 m Bulimba Fm. 67-137 Wallumbilla Fm. 137-145 m ?Gilbert R.Fm.	(1) To determine depth and nature of the laterite horizon. (2) To determine thickness and nature of the Cainozoic. (3) To determine depth, thickness and nature of the Toolebuc Limestone.	(1) Showed laterite horizon at 40 m. The laterite is partly eroded in this area. (2) Showed thickness and nature of Cainozoic. (3) Showed Toolebuc to be absent. (4) Showed possible presence of Gilbert R. Fm. at less than 140 m.	Planned as a shallow hole, as unable to drill deeper.

CARPENTARIA BASIN PARTY
ANNUAL REPORT – 1971

Fig. S3/1



CAINOZOIC

QUATERNARY
- Cz — Undifferentiated
- Qrs — Sand, partly aeolian
- Qf — 'Black soil' - clay and sand
- Czy — Wyaaba Beds, clayey quartzose sandstone, minor sandy claystone
- Czs — Sand on ferricrete
- 'Duricrust'

TERTIARY
- KTl — Bulimba Formation, quartzose clayey sandstone and claystone
- KTf — Floraville Formation, quartzose sandstone and conglomerate

MESOZOIC

LOWER CRETACEOUS
- Kln — Normanton Formation - sandstone and mudstone
- Klo — Allaru Mudstone
- Klt — Trimble Formation - sandstone, calcilutite
- Klo — Toolebuc Limestone - Limestone, calcareous, bituminous shale
- Klu — Wallumbilla Formation - mudstone, basal sandstone

UPPER JURASSIC - LOWER CRET
- JKg — Gilbert River Formation - sandstone, siltstone
- Jue — Eulo Queen Group - conglomerate, sandstone

TRIASSIC (OR JURASSIC ?)
- Jl — Inoruni Sandstone

PALAEOZOIC
- Pz — Undifferentiated

PRECAMBRIAN
- pε — Undifferentiated

} basement to Carpentaria Basin

- Inferred, concealed boundary
- Regional dip
- Detailed section
- N.2. — Scout hole, 1969, 1970
- W.2. — Scout hole, 1971 Named by 1:250,000 sheet areas
- Abandoned petroleum exploration bore.
- Fault
- Road
- Railway
- "Glenora" — Homestead

0 100 km
0 100M

To Accompany Record 1971/103

Q/A/344

While preparing both preliminary and first edition maps the usefulness of a formal Cainozoic stratigraphy became evident; units proposed are the Wyaaba Beds and Bulimba Formation (together replacing the earlier named Lynd Formation) and the Wondoola Beds and Armraynald Beds, these two being deposits respectively of the ancestral Flinders and Leichhardt Rivers.

OTHER ACTIVITIES

Doutch spent much time on final phases of the new Tectonic Map of Australia. Smart visited Weipa offshore drilling operations as an observer for three weeks. Grimes presented a paper at ANZAAS in Brisbane in May, entitled "Late Cainozoic Riverine Plain Deposits in the Gulf Country of North Queensland".

S4 - CENTRAL EROMANGA BASIN

by

B.R. Senior

PERSONNEL: B.R. Senior

A 1:1,000,000 preliminary geological map of the Central Eromanga Basin was printed in three colours, including a Bouguer Anomaly overprint. Work on structure contours, isopachs, and gamma-ray log correlations for the Bulletin was started.

Structural contours at the top of the Permian show that the Cooper Basin sequence is continuous with Galilee Basin sediments of similar age across the Canaway Ridge. The main difference between the two basins is the marked change in regional structural trends to the east and west of the Canaway Ridge.

Widespread deeply weathered sediments in the Central Eromanga Basin are divisible lithologically into three main groups, and a publication discussing the morphology and geochemistry of these sediments is being prepared.

Progress with publication of the twenty 1:250,000 Geological Series maps and Explanatory Notes which comprise the Central Eromanga Basin is given on page

S5 - EYRE CREEK ALLUVIUM AND RADIOACTIVE MINERAL DRILLING PROJECT

by

B.R. Senior

PERSONNEL: B.R. Senior

Shallow stratigraphic drilling with a BMR Mayhew 1,000 rig was used from 1st to 22nd June, 1971, in the Eyre Creek area on western Springvale 1:250,000 Sheet (Fig. S5/1) to investigate a minor occurrence of svanbergite (a mineral composed of alumina, phosphate, strontium and barium with minor silica, iron and lead). A hole was also drilled alongside a gamma-ray logged water bore to investigate a high gamma-ray anomaly at the contact between the Cretaceous and overlying Cainozoic riverine deposits. Secondary objectives were to obtain core from the radioactive Toolebuc Limestone and to determine the thickness of Cainozoic alluvial deposits. Drilling results are summarized in Table S5/1.

Drilling at the svanbergite mineral locality (Springvale Nos. 3-6) showed that the deposit has little lateral extent. A related mineral goyazite occurs in the interval 0-3 m in Springvale 3.

All of the holes except Springvale 2 were gamma-ray logged, and zones of relatively high radioactivity up to 6 m thick were found. Core or cuttings from these zones were analysed by X-ray diffraction and X-ray fluorescence techniques, and some were forwarded for heavy element determination.

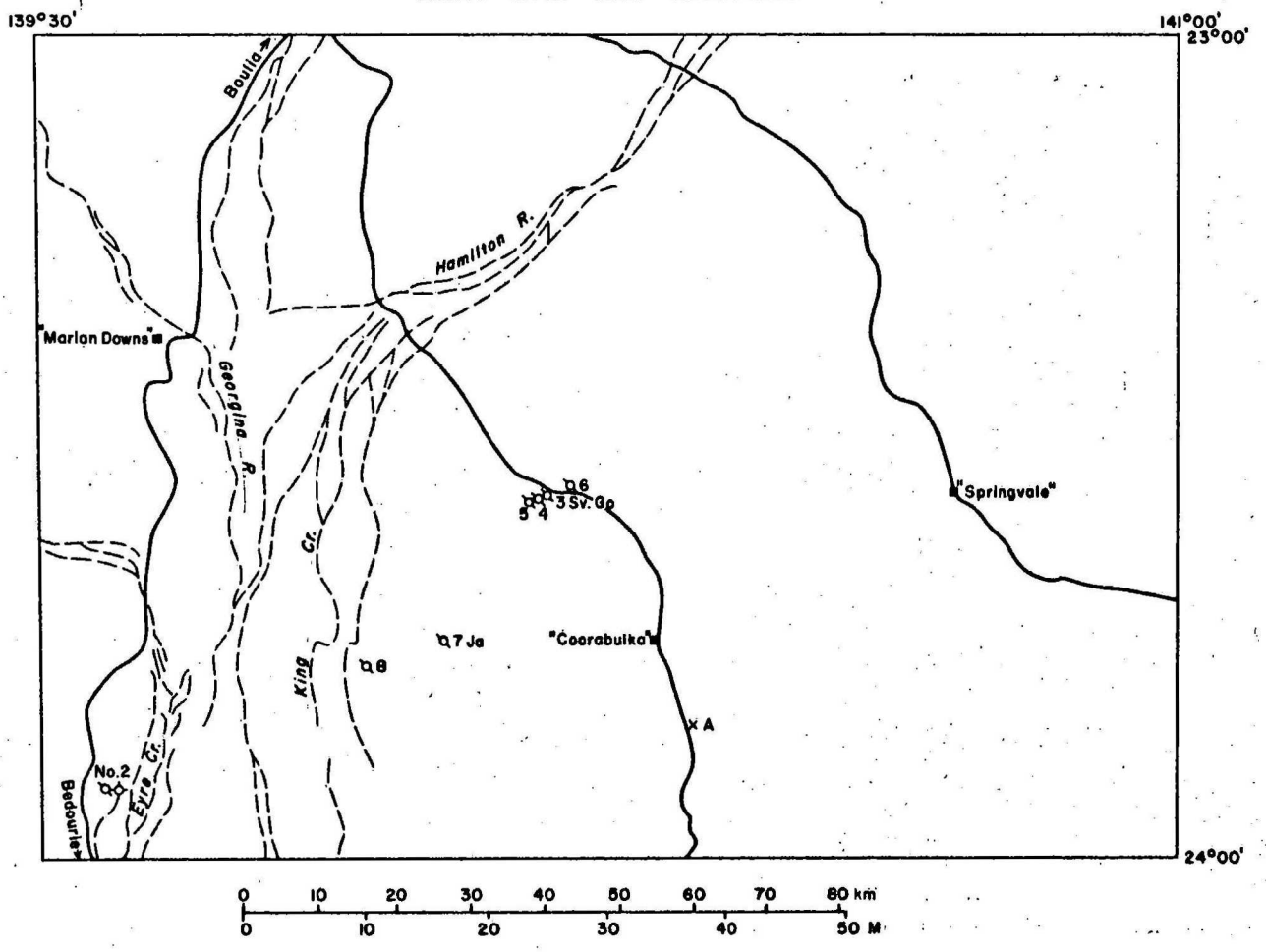
X-ray diffraction results indicated the presence of jarosite, goyazite and svanbergite. Of special interest is a sample collected in a road gravel quarry near Coorabulka station, where about 5 m of deeply weathered Mackunda Formation is exposed. Alunite and quartz were identified and the general composition of the rock is 29% SiO_2, 46% Al_2O_3 and 12% K_2O. Locations of all mineral occurrences are shown in Fig. S5/1.

Heavy element analysis of the samples proved negative and the radioactive zones in the bores are apparently due to the presence of small amounts of potassium, phosphate, strontium and barium. All anomalous zones of radioactivity in the holes are within the late Cretaceous or early Tertiary deep weathering profile or are derived from this profile. Unfortunately all the holes were positioned where this profile is thin, as it was thought when planning the drilling programme that the gamma-ray anomalies were due to uranium or related minerals concentrated in the alluvial deposits of Eyre Creek. The results show that the mineral potential of the deep weathering profile along the western edge of the Eromanga Basin requires further investigation.

Fig S5/1

EYRE CREEK ALLUVIUM AND RADIOACTIVE MINERAL DRILLING PROJECT
SPRINGVALE SHEET AREA

BMR Drill site locations



7	BMR Stratigraphic hole with number		Road
Sv	Svanbergite		River channels
Go	Goyazite	X ray diffraction determination from drill samples or outcrop	Homestead
Ja	Jarosite		Breadalbine No.9 water bore
A	Alunite		

TABLE S5/1. DRILLING RESULTS EYRE CREEK ALLUVIUM AND RADIOACTIVE MINERAL DRILLING PROJECT

Hole/Grid Ref.	Total depth	Cored	Core Recovery	Section Penetrated	Results
Springvale 2 241022	76 m	3 cores Total 7 m	3.6 m	0-17 Cainozoic 17-59 Allaru Mudstone 59-69 Toolebuc Limestone 69-76 TD Wallumbilla Formation	Drilled adjacent to gamma-ray logged Breadalbine 9 water bore. Obtained core from radioactive anomaly near base of Cainozoic. Tests for heavy elements proved negative. Flow of saline water encountered from top of Wallumbilla Formation. Logger inoperative.
Springvale 3 307066	24 m	Nil	Nil	0-1 Cainozoic 1-24 TD Allaru Mudstone	Drilled at minor mineral occurrence to determine its thickness. The mineral svanbergite occurs at the surface and a similar mineral goyazite in the interval 1.5-3 m. Gamma-ray logged.
Springvale 4 306066	32 m	Nil	Nil	0-1 Cainozoic 1-32 TD Allaru Mudstone	Springvale Nos. 4-6 were drilled as step outs from No. 3 to determine the extent of the svanbergite mineral locality. No zones of interest were encountered. Gamma-ray logs run in all holes.
Springvale 5 305065	32 m	Nil	Nil	0-1 Cainozoic 1-32 TD Allaru Mudstone	
Springvale 6 308067	23 m	Nil	Nil	0-1 Cainozoic 1-23 TD Allaru Mudstone	
Springvale 7 287045	90 m	1 core 3 m	2.8 m	0-19 Cainozoic 19-46 Allaru Mudstone 46-59 Toolebuc Limestone 59-90 TD Wallumbilla Formation	Drilled near old mound springs near the eastern edge of the Eyre Creek alluvial belt. Pressure aquifers occurred in the Cainozoic (4-19 m) and in the top of the Wallumbilla Formation (59-61 m). Core of Toolebuc Limestone taken.
Springvale 8 281044	35 m	1 core 2.1 m	1.9 m	0-14 Cainozoic 14-24 Allaru Mudstone (weathered) 24-35 TD Allaru Mudstone	Drilled to determine thickness of alluvium. Gamma-ray log shows high radioactive peak towards base of Cainozoic (7-14 m). A sample from this interval indicated the presence of jarosite. Core of Allaru Mudstone taken. Hole gamma-ray logged. A late Pleistocene diprotodon fauna collected at drill site.

S6 - MACHATTIE 1:250,000 GEOLOGICAL MAP SECOND EDITION

by

B.R. Senior

PERSONNEL: B.R. Senior

Concurrently with the Eyre Creek project (S5) surface mapping was carried out on the Machattie Sheet area. The field results, combined with interpretations of geophysics and recent drilling were used to prepare a Second Edition map and Explanatory Notes which are now with the editors.

S7 - BOWEN BASIN TRIASSIC STUDY

by

A.R. Jensen

PERSONNEL: A.R.Jensen, S.L. Roddick (until May 1971), W.A. Burgis, (until Jan. 1971).

The Triassic Mimosa Group of the Bowen Basin consists of three units: the Rewan Formation at the base, the Clematis Sandstone, and the Moolayember Formation. The Rewan Formation is a red-bed sequence consisting of labile sandstone and mudstone, whereas the dominant rock type of the Clematis Sandstone is quartz-rich sandstone. The Moolayember Formation is composed of labile sandstone and grey mudstone. The areal extent of these units was established during the regional mapping of the basin by joint BMR-GSQ geological parties between 1960 and 1967. The aim of this project is environmental interpretation of the Mimosa Group and the determination of the controls of sedimentation.

Stratigraphic analysis based on measured sections and the results of petrographic analysis have shown that the Rewan Formation comprises two widespread units. The basal unit corresponds to the Sagitarius Sandstone Member of the Blackwater area, and the upper is as yet unnamed. Thick sequences of red mudstone are found only in the upper unit. The Clematis Sandstone also comprises two basic units but their characteristics vary from one part of the basin to another. Furthermore, the upper unit can be divided into a lower fine subunit and an upper coarse subunit in some areas. It is now possible to elevate Rewan and Clematis to group rank, and to define constituent formations in order to clarify the lithostratigraphic relationships. The proposal for the changes of stratigraphic nomenclature has been included in the section on stratigraphy in the final report.

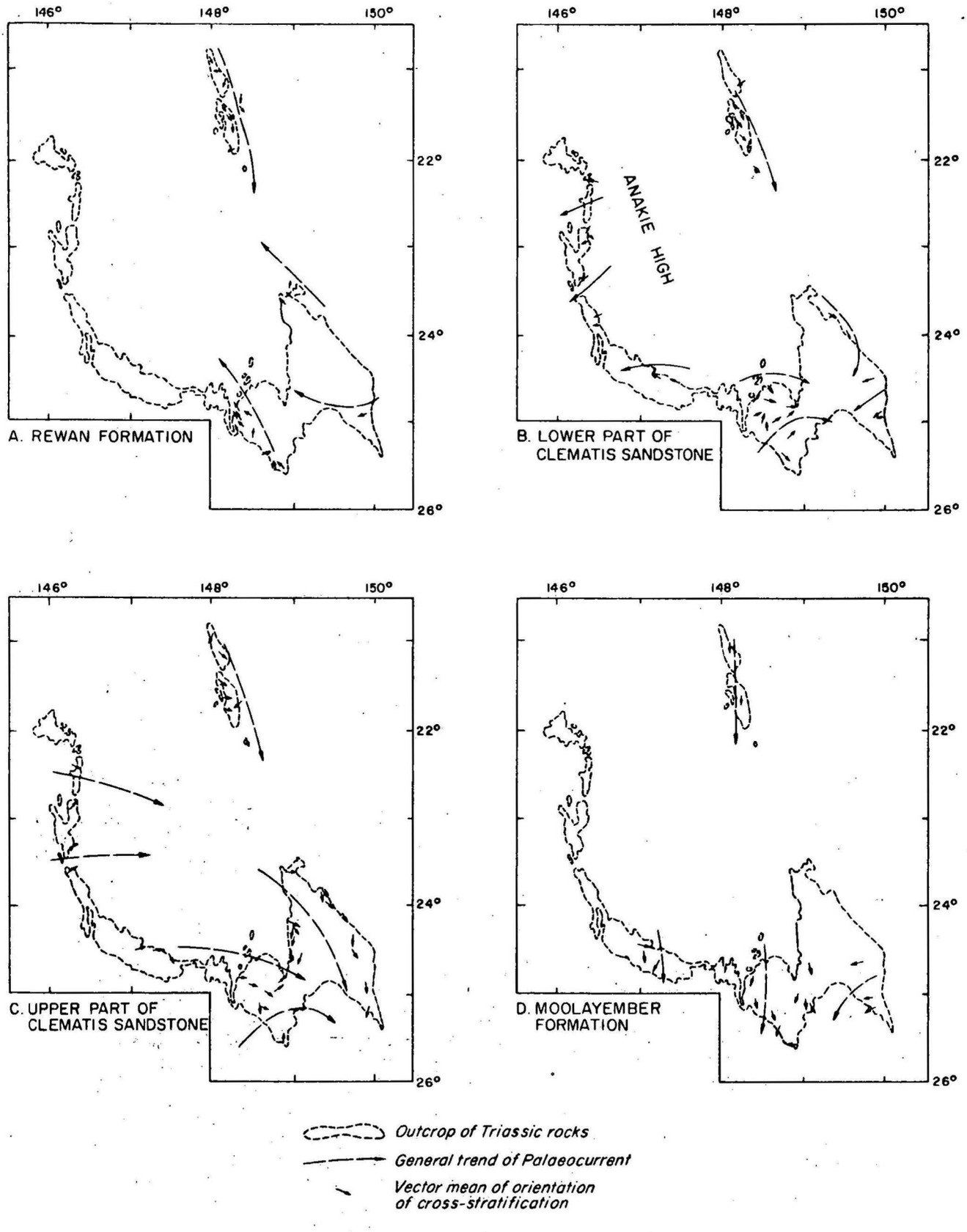


Fig S7/1 Summary of Triassic Palaeocurrents, Bowen Basin, Queensland.

Marine fossils are entirely lacking in the Triassic sequence, and fossils of continental origin are rare in both the Rewan Formation and the Clematis Sandstone. The investigation of the environment of deposition hinges mainly on the study of sedimentary structures, and for the most part this involves the analysis of stratification and grain-size variations from a number of sections measured in detail. After stratification types were classified by cluster analysis, statistical tests were applied to bedding transitions within the detailed sections, and distinctive patterns of sedimentation were identified within both the Rewan Formation and the Clematis Sandstone. The patterns recognized are similar to models developed from studies of modern fluvial sediments. The main pattern in the Rewan Formation has the characteristics of mixed-load meandering streams. A second pattern found at the top of the Rewan in the northern part of the basin is probably that of an anastomising suspended-load stream. The lower part of the Clematis Sandstone in the southwestern part of the basin was deposited mainly as bed-load flood-plain sediment, but much of the Clematis was deposited in meandering bed-load streams dominated by deposition on the upper part of the point bar. The uppermost parts of the Clematis Sandstone, especially in the northern part of the basin, were deposited in braided streams.

During the course of the study of the Mimosa Group over 4,000 measurements of the orientation of cross-stratification were made from about 200 localities. These have now been analysed and a summary of palaeocurrent directions is presented in Fig. S7/1. The palaeocurrents operative during the deposition of the Rewan Formation were much the same as those of the underlying Permian coal measures. During the deposition of the lower part of the Clematis Sandstone, the Bowen Basin appears to have been separated from the Galilee Basin to the west along the line of the Anakie High (Fig. S7/1B), but this was no barrier to sediment transport during the subsequent deposition of the upper part of the Clematis Sandstone (Fig. S7/1C).

Petrographic studies have also been directed toward the determination of the significance of red-beds in the Mimosa Group, but these are as yet incomplete. Palaeosol profiles were recognized in red mudstone of the lower part of the Clematis in the northern part of the basin during the examination of core and cuttings from shallow stratigraphic holes. Individual red mudstone samples from the Rewan Formation in some cases have characteristics associated with modern soils, but the red coloration has not been caused by pedogenesis.

As part of the investigation of the significance of stratification some research has been conducted into the application of grain elongation analysis based on a method devised by A.J.Moss, of C.S.I.R.O. The method of measurement, recording of data, and computation of statistical parameters, have been changed however, so that the time taken for one analysis has been considerably reduced. By applying the technique to laminated sandstone bearing parting lineation it has been found that this structure is formed in the upper flow stage, and in the case of the Rewan Formation this probably corresponds to flood periods.

Two Records were written in previous years on the atudy of the Moolayember Formation, and these have now been combined for inclusion in the final bulletin.

S8 - BOWEN BASIN COAL PARTY

by

W.A. Burgis

PERSONNEL: W.A. Burgis, P.E. Thomas, W. Koppe (GSQ)

DURATION OF FIELD SEASON: 24th May to 28th June.

PURPOSE OF INVESTIGATION:

To make an environmental analysis of a well exposed section of the Upper Permian Rangal Coal Measures in the Utah Development Company open-cut mine at Blackwater, Queensland, with a view to applying the results to aid exploration by defining the coal body geometry expected in different environments, and thus permitting development of exploration programmes for specific environments. Environmental data should also assist in mine development and operations by helping to predict floor, roof, and wall characteristics and local variations in coal quality. Results will be reported in a Bureau Record.

METHODS:

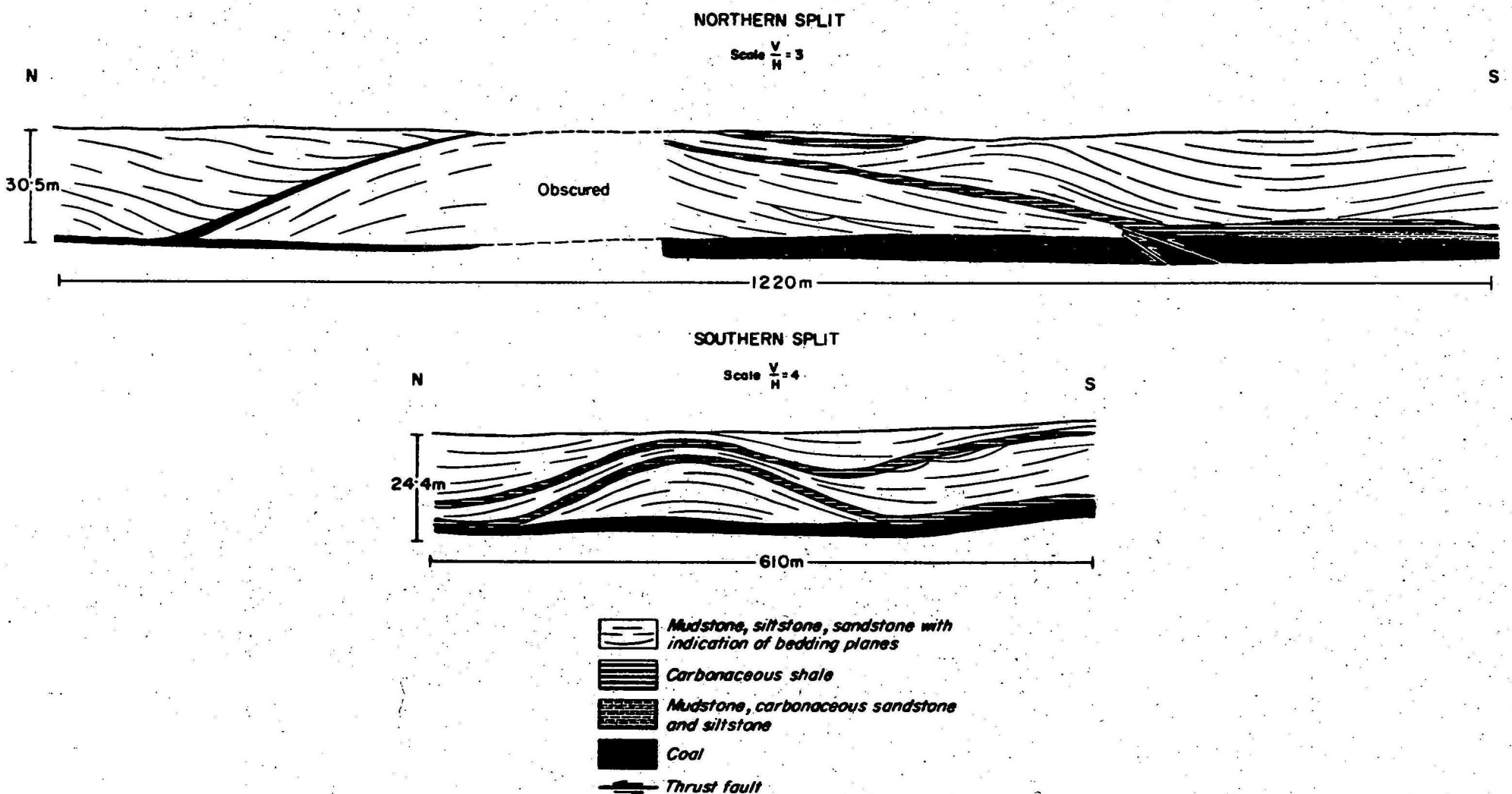
Detailed maps of 6 km of the high wall were drawn on overlapping photographs in the field. Direct access to the high wall was difficult except in two places where it was possible to measure and describe complete sections. Consequently, vertical sequences of stratification types have been analysed for only a few localities. Logs of 320 company drill holes were collected. Future analysis of this subsurface data may delineate the lateral lithologic changes which could only be tentatively identified in the field while examining the high wall from some distance. Field maps have been reduced and combined with some drill hole information to produce a simplified picture of the exposure studied.

GEOLOGY:

The lowest unit exposed in the Rangal Coal Measures at Blackwater is fine to medium-grained sandstone characterized by large-scale trough cross-bedding. This fluvial sand was deposited by currents which flowed to the northwest. It is overlain by 1.5 m of grey shale which contains Glossopterid roots (*Vertebraria*), and the presence of this root-bearing horizon directly below the main seam indicates that at least some of the coal was produced from *in situ* growth and accumulation of vegetation. However, logs with a northwest-southeast preferred orientation occur in the coal in two areas, showing that plant material was transported through some distance at least occasionally during peat accumulation.

Fig S 8/1

SKETCHES OF EXCAVATION FACE, UTAH DEVELOPMENT COMPANY BLACKWATER MINE, QUEENSLAND, SHOWING SPLITS OF COAL AND CARBONACEOUS SHALE



A 1 cm-thick horizon of brown kaolinite (tonstein) containing pellets of siderite granules is a persistent marker in the lower part of the seam throughout the mine. Another tonstein, a 1 to 2m-thick horizon of calcareous, sandy, pinkish-tan kaolinite, occurs near the top of the seam at the northern end of the mine, but southward it lies either within the unit above the coal or between that unit and the seam. The origin of these marker beds is as yet unknown.

Approximately 3 m of black carbonaceous shale overlies the coal in most of the mine. This carbonaceous shale is, however, split from the seam in two places by 7 to 29 m-thick antiform bodies of laminated siltstone, mudstone, and some fine-grained, ripple-laminated sandstone (Fig. S8/1). The same fine clastic sedimentary rocks also overlie the carbonaceous shale and occur in adjacent synforms and antiforms which are discordant with underlying structures (Fig. S8/1). The rocks which split the carbonaceous shale from the coal were deposited horizontally in basins or channels. The fine clastic beds which dip down onto the northern flank of the northern split are not large foresets but were also deposited horizontally in a subsiding area. This subsidence was probably caused by differential compaction during deposition of these beds; the peat underlying the fine clastic beds compacted more than the adjacent section composed of peat and clastic sediments. Compaction is responsible for altering the sedimentary bodies within the splits to their present antiform shape. Numerous small thrust faults affect the coal and carbonaceous shale and record movement between these units during compaction (Fig. S8/1).

The vertical succession of bedding types in one complete measured high wall section was examined, and the presence of a simple alternation of fine and laminated siltstone was detected in the fine clastic sediments above the coal. This rules out the possibility that they constitute the deposit of a point bar.

At the top of the high wall cross-stratified, fine-grained sandstone lies on an erosional surface which cuts the underlying fine clastic sedimentary rocks. This fluvial sand was deposited by currents which flowed to the northwest.

Palaeographic studies and the low boron content of Blackwater coal indicate that a continental regime existed in the study area during deposition of the Rangal Coal Measures. Four environmental models are thus being considered to account for the characteristics of the sedimentary rocks between the coal and upper fluvial sandstone: (1) floodplain; (2) lake; (3) lacustrine delta; (4) marine delta. In a deltaic environment the fine clastic sedimentary rocks within the splits would have filled distributary channels which cut across the peat-forming environment. Future attempts to discriminate among the possible environmental models centre upon determination, from subsurface data, of the 3-dimensional geometry of the split sediments and sand bodies.

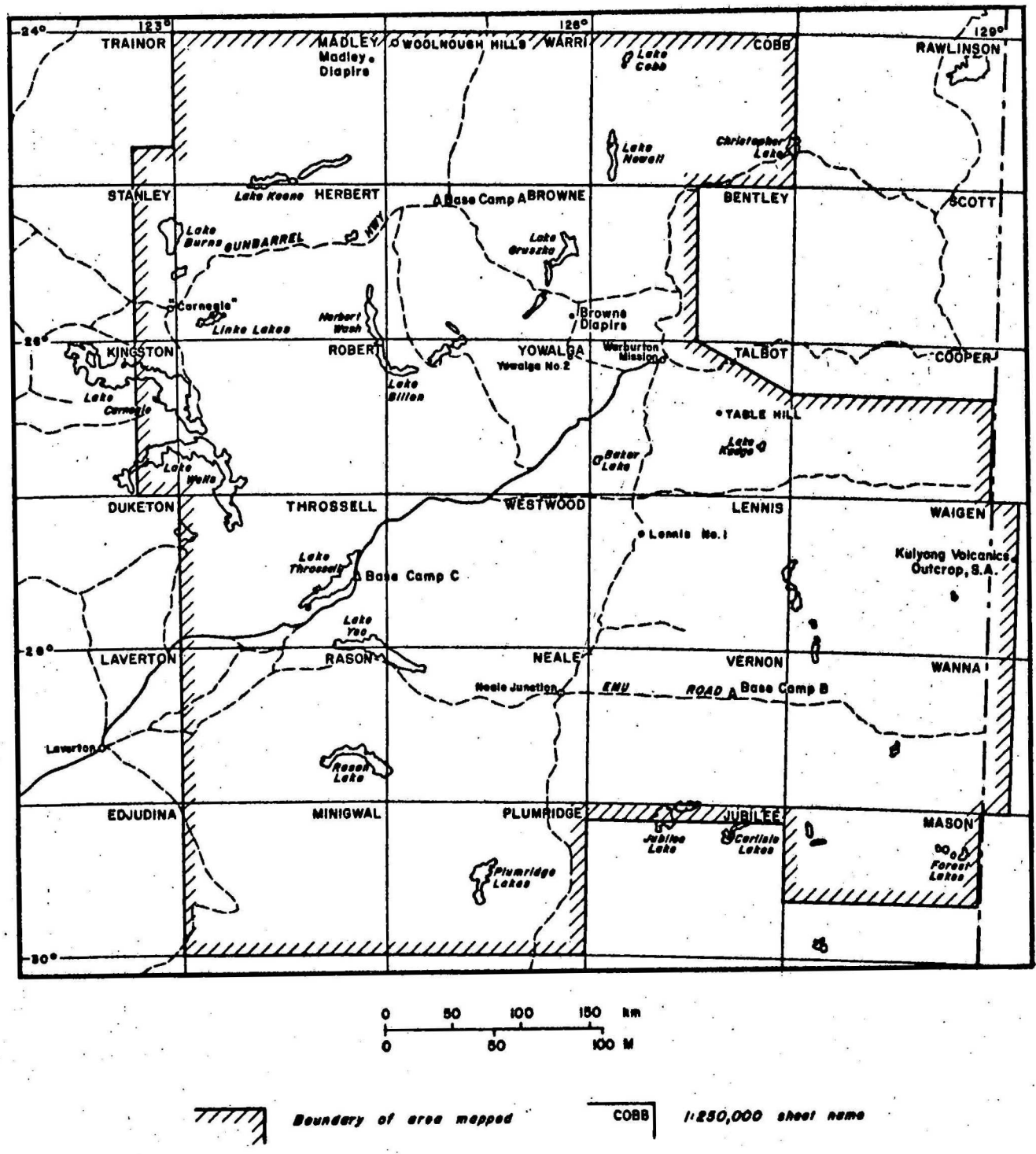


Fig S9/1 : Area mapped in Officer Basin 1971

S9 - OFFICER BASIN PARTY

by

M.J. Jackson

PERSONNEL: BMR: M.J.Jackson, P.J.Kennewell (from June 1971), I.Lamberts (draftsman, from September, 1971).

GSWA: D.C.Lowry (until Oct. 1971), W.J.G. van de Graaff (from May 1971), J.C. Boegli (from September, 1971).

OFFICE WORK

Jackson and Lowry prepared Records on the 1970 reconnaissance survey. Air photographs covering the whole area were examined prior to the start of the 1971 field season and a programme of helicopter traverses prepared.

FIELD WORK: (8/6/71 - 7/10/71)

A Hillier 1100 helicopter was used for 255 hours to complete the systematic mapping. Forty traverses, with an average circuit distance of 500 km were done. About 300 localities were visited on twenty-one 1:250,000 Sheet areas (Fig. S9/1). Six ground traverses were also carried out.

VISITORS:

R. Cope (GSWA) 28/7 - 3/8; G.E.Wilford, A.T.Wells (BMR) 14/9 - 19/9.

RESULTS:

The programme of systematic mapping was completed and a tentative assessment of the geological results made. The most important points are outlined below:

1. Small, isolated tholeiitic basalt outcrops occur in a belt from Table Hill (Talbot Sheet) southeasterly to the eastern part of Waigen Sheet and extend into South Australia. These are correlated with the Kulyong Volcanics, (Birksgate Sheet, S.A.), which have been radiometrically dated by the K/A method as Lower Ordovician. Petrographically similar basalts crop out in the northeast of the Robert Sheet area and have been intersected in Hunt Oil's Lennis No.1 and Yowalga No.2 explanatory wells. Extrapolation of seismic information indicates that basalt may be present at depths of 1500 m in parts of the Basin. If this basalt proves to be also Ordovician in age, a thickness of at least 1500 m of Phanerozoic rocks is indicated in the Officer Basin. Earlier workers considered the basalts to be late Proterozoic in age.

2. Flat-lying, red, fine-grained, micaceous sandstones were mapped in the Lennis and Waigen Sheet areas, where they are confined to a southeasterly-trending belt, generally basinward of the basalt. The sandstones disconformably overlie the basalt and are correlated with similar sandstones intersected in Lennis No.1 and Yowalga No.2. They appear to have been deposited in a high energy shallow water marine environment.

3. Flat-lying, white-weathering, fine to very fine-grained, well sorted sandstones were mapped in the Waigen and Wanna Sheet areas mostly south of the outcrop belt of basalt and overlying red sandstone described above. The regional distribution of the unit suggests it overlies the red sandstone and underlies Permian fluvioglacial sediments. Claystone intraclasts are common and large scale (several metres) cross-stratification was observed at many outcrops. A shallow marine environment of deposition is inferred for the unit.

4. The Permian Paterson Formation of the Canning Basin was traced southwards into the Officer Basin, and mesas containing the wide range of lithologies typical of this unit are present on all Sheet areas. In most outcrops only a few metres of flat-lying beds are exposed, but over 300 m were penetrated in Yowalga No.2. Along the western margin of the basin the following sequence in stratigraphic order was recorded at several widely separated localities.

Lithology	Probable environment
Cross-bedded, coarse-grained, angular, poorly sorted sandstone and conglomerate	Fluvial
(erosional contact)	
Tillite, micro-tillite and claystone	Glacial/lacustrine
(gradational contact)	
Laminated to varved claystone and siltstone, minor fine sandstone. Erratic pebbles and cobbles	Mostly lacustrine

Tillites are present throughout the basin, indicating that glacial conditions were widespread during the deposition of the Paterson Formation in this area of Western Australia.

5. Fine-grained clastics of Lower Cretaceous age are mostly confined to the area north of latitude 26°S; they are continuous with similar deposits in the Canning Basin.

6. A widespread post-Lower Cretaceous unit of terrestrial origin forms a hard capping to many mesas. It grades from a coarse-grained, poorly sorted, unbedded to indistinctly thick-bedded sandstone to a consolidated boulder bed. It is generally strongly silicified and was deposited on an irregular eroded surface.

7. In Madley, Warri and Browne Sheet areas sediments have been diapirically intruded by an underlying Proterozoic evaporite sequence.

At Woolnough Hills a circular core of gypsum, dolomite and sandstone is in faulted contact with a 350 m thick sequence of glacial, fluvioglacial and fluvial sediments. Gradually decreasing dips away from the core and little lithologic variation indicate that there are no major depositional breaks in the sequence, which is probably Permian.

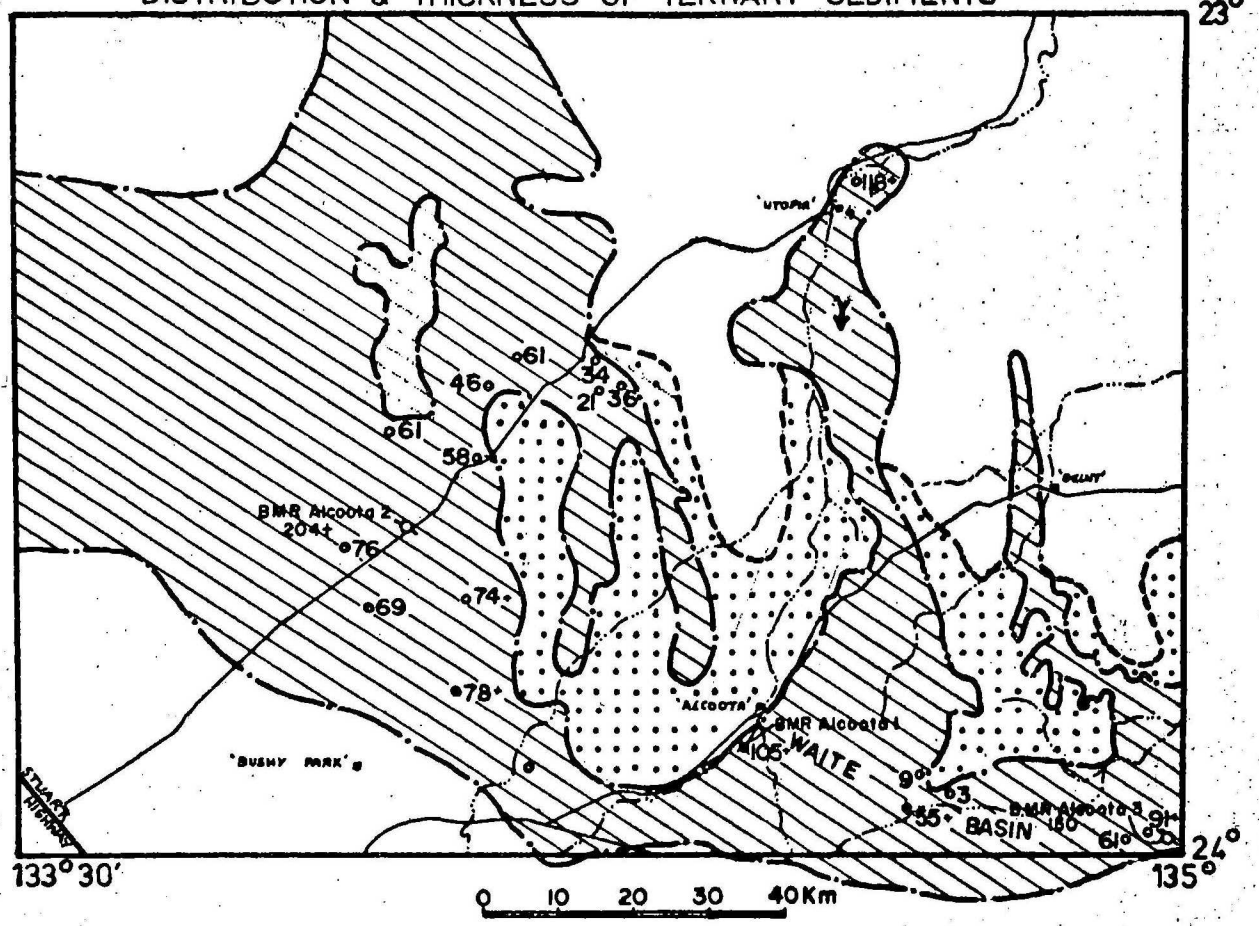
The Madley Diapirs comprise six diapiric structures aligned along a fault zone. The Proterozoic core has breached the surface in only three of the structures; in the remainder it is overlain by domed Permian sediments.

Surface mapping at the Browne Diapirs revealed that evaporites penetrated in Browne Nos.1 and 2 have not breached the surface, but have strongly folded and faulted Permian and Cretaceous sediments.

Present drainage is diffuse and generally ill-defined, but an extensive, ancient, dendritic drainage pattern has been recognized on air photographs. Laterite, silcrete and calcrete deposits appear to be closely related to this drainage system so a study of these features is being made to elucidate the Cainozoic history of the area.

Fig S 10/1

ALCOOTA
DISTRIBUTION & THICKNESS OF TERTIARY SEDIMENTS



Generalized distribution of Tertiary sediments

Areas of laterite developed in Archaean rocks which probably were covered in late Miocene time by Tertiary sediments

Pre-Cambrian & Palaeozoic rocks

Direction of transport of Tertiary fluviatile sediment

Water bore

BMR scout hole } with thickness in metres of Tertiary sediments
+ indicates Full thickness of sediments not penetrated

To accompany Record 1971/103

F53/A10/15

S10 - ALCOOTA STRATIGRAPHIC DRILLING PROJECT

by

B.R. Senior

PERSONNEL: B.R. Senior, A.N. Yeates.

Two stratigraphic holes were drilled using a BMR Mayhew 1,000 rig in the Alcoota 1:250,000 Sheet area to determine the thickness of sediments in the Waite Basin (late Miocene to Pliocene) and to examine possible Tertiary sediments below extensive sand cover in eastern Alcoota Sheet.

Figure S10/1 shows the distribution and thickness of Tertiary sediments as determined from water bore data and outcrop in Alcoota Sheet, and gives the locations of the drill sites. The drilling results are summarized in Table S10/1.

BMR Alcoota 2 was unsuccessful in reaching basement and was terminated in blue-green pyritic mudstone of unknown age at a depth of 204 m. It is likely that the full section of sediment overlying Archaean basement may exceed 300 m at this locality.

BMR Alcoota 3, located near the axis of the Waite Basin, encountered weathered sandstone, siltstone and mudstone before reaching basement at 150 m.

Age determination from core and cuttings from these holes has been unsuccessful as the material is barren of spores or pollen.

S11 - WESTERN EROMANGA BASIN PARTY

by

A. Mond

PERSONNEL: A. Mond, A.N. Yeates

DURATION OF FIELD WORK: June to October 15th.

OBJECTIVES:

(1) To map the 1:250,000 Sheet areas Simpson Desert South and Simpson Desert North.

(2) To establish correlation of the Permian and younger units in the Northern Territory part of the Eromanga Basin.

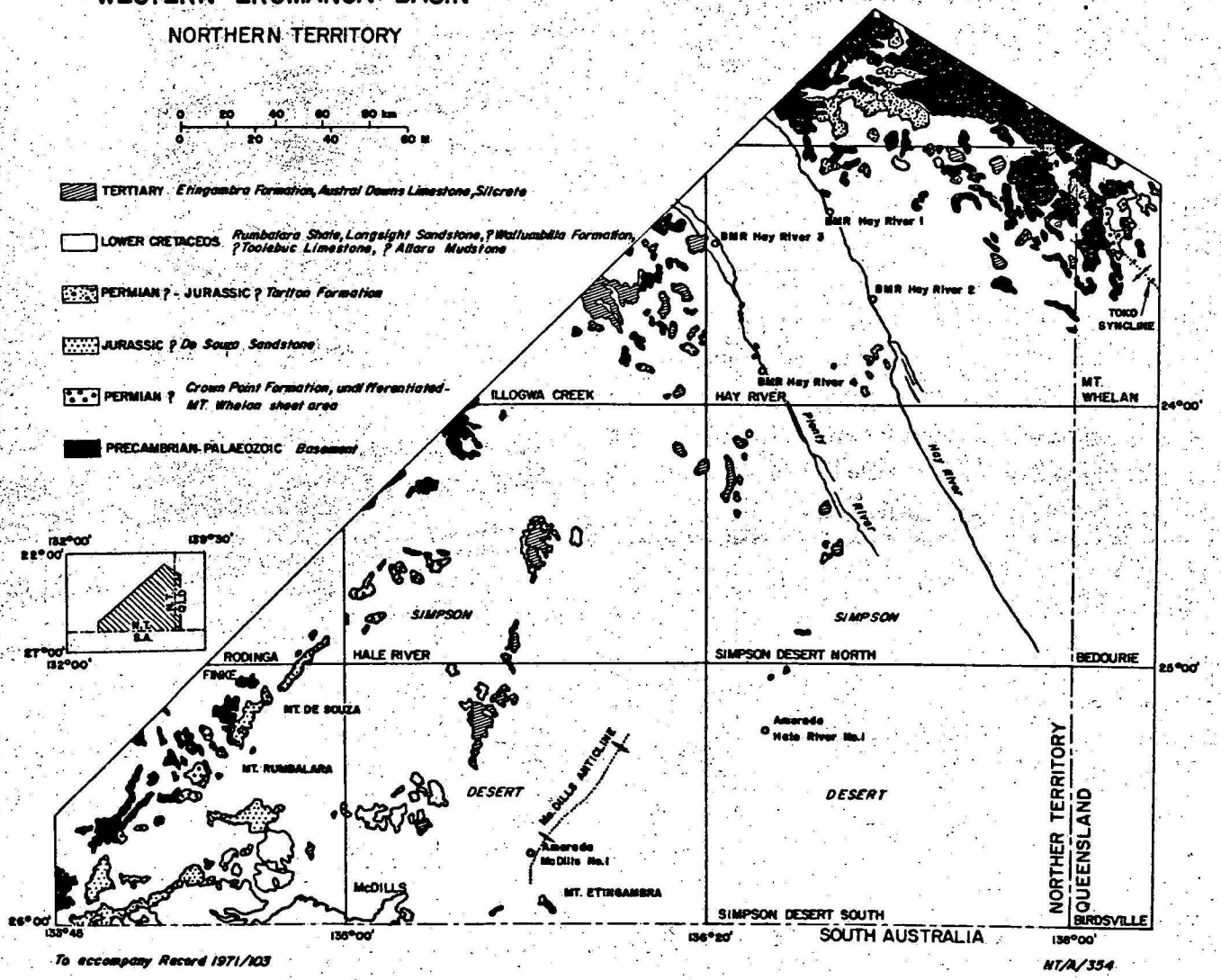
TABLE S10/1. DRILLING RESULTS ALCOOTA SHEET AREA

Hole/Grid Ref.	Total depth	Cored	Core Recovery	Section Penetrated	Results
Alcoota 2 165170	204.2 m	2 cores Total 4.5 m	3.9 m	0-2 Red sandy soil 2-25 Sand, conglomerate, chert, pisolites, ironstone 25-101 Red sandstone, siltstone, conglomerate 101-140 White to grey siltstone 140-204 Blue-green pyritic mudstone	Drilled to determine nature and thickness of sediments below an extensive mantle of Quaternary cover in eastern Alcoota Sheet. Age and affinity of section penetrated unknown. Samples barren of spores or pollens. Electric and gamma-ray logs run to 106 m.
Alcoota 3 285137	154.2 m	1 core Total 3 m	3 m	0-5 Cainozoic 5-150 Waite Formation 150-154 Archaean	Drilled to determine nature and thickness of Cainozoic sediment near the axis of the Waite Basin. Bottom hole core of garnet-gneiss. Wireline logs unsuccessful.

TABLE S11/1. SHALLOW STRATIGRAPHIC DRILLING, 1971 HAY RIVER 1:250,000 SHEET AREA, N.T.

Name & Number Grid reference	Total depth	Coring		Results	Remarks
		Cored	Recovery		
BMR Hay River 1 513101	140.5 m	1 core 1.22 m	1.09 m	0-49.6 m Cainozoic 49.6-128.0 m Cretaceous mudstone 128.0-140.5 m Proterozoic quartzite	Gamma-ray log down to 83 m Resistivity log down to 137 m SP inoperative
BMR Hay River 2 531060	196.3 m	1 core 0.91 m	0.8 m	0-31.4 m Cainozoic 31.4-194.7 m Cretaceous 194.7-196.29 m Precambrian amphibolite	Intersected thick aquifers with water between 21.3 m and 42.7 m. Two thin beds of lignite at 108.8 m and 114 m. Logged down to 131.7 m. Gamma-ray, resistivity, SP
BMR Hay River 3 459087	199.0 m	2 cores 4.57 m	2.74 m	0-15.2 m Cainozoic 15.2-36.3 m Cainozoic silcrete 36.3-185.0 m Mesozoic sediments 185.0-199.0 m Precambrian greenschist	Intersected coaly layers between 143-146.3 m. Logger inoperative
BMR Hay River 4 481028	241.1 m	3 cores 6.71 m	4.00 m	0-18.9 m Cainozoic 18.9-235.6 m Mesozoic sediments 235.6-241.1 m Precambrian gneiss	Intersected sub-artesian aquifer near base of Mesozoic. Two thin coal seams at 190.8 m. Logger inoperative

FIG. SII/1
WESTERN EROMANGA BASIN
NORTHERN TERRITORY



To accompany Record 1971/103

NT/A/354

DRILLING:

Shallow stratigraphic drilling was carried out in the Hay River Sheet area from June 18th to August 12th using a BMR Mayhew rig. The purposes were to determine the thickness and extent of the Permian, Mesozoic and Cainozoic rocks and to collect fresh material for palynological and lithological study. The results are summarized in Table S11/1.

HELICOPTER:

A Jet Ranger was used for 50 hours flying for geological reconnaissance. The survey covered all or parts of the 1:250,000 Sheet areas: Simpson Desert South and Simpson Desert North, Hay River, Mount Whelan, Tobermory, McDills, Hale River, Finke and Rodinga.

GEOLOGY

BASEMENT: The basement of the western part of the area mapped consists of Precambrian crystalline rocks, and Adelaidean, Cambrian, Ordovician, Devonian, and Carboniferous(?) sedimentary rocks of the Amadeus Basin. In the northern part the basement consists of Precambrian crystalline rocks and glacigene sediments, Cambrian and Ordovician carbonates and clastics, and Silurian? to Devonian sandstone and conglomerate of the Cravens Peak Beds.

PERMIAN: The Crown Point Formation is best exposed along the western edge of the Eromanga Basin. It lies unconformably between the Devono-Carboniferous basement and the Mesozoic De Souza Sandstone and consists of poorly sorted sandstone, boulder beds, tillite, and interbedded siltstone and claystone. Faceted erratics are common but striated ones are rare. It can be correlated with the lower part of the Tarlton Formation which crops out on the Tobermory and Hay River Sheet areas and consists of boulder, cobble and pebble conglomerate with faceted, polished and striated erratics. Undifferentiated, mostly unconsolidated, pebble deposits on the western part of the Mount Whelan Sheet area are probably equivalents of the Crown Point Formation.

JURASSIC: The De Souza Sandstone consists of sandstone, coarsely cross-bedded, pebbly sandstone, and bands and lenses of claystone and siltstone. The Jurassic age of this unit is based on a correlation with a lithologically similar sequence containing plant fossils at Mount Anna in South Australia.

The upper part of the Tarlton Formation consists of cross-bedded, coarse-grained silty sandstone and siltstone, with thin beds of pebble conglomerate. Plant fossils collected from a siltstone at the top of the sequence indicate a Triassic age. However, as in the case of the Mount Anna section, the plant material is not well preserved. The upper part of the Tarlton Formation is lithologically similar to the De Souza Sandstone and is possibly its equivalent.

LOWER CRETACEOUS: The Rumbalara Shale is disconformable on the De Souza Sandstone. It is best exposed at the type section, Mount Rumbalara and northeast of Mount Rumbalara where the base of the formation was mined for ochre. It consists of shale, siltstone, and some porcellanite. Its relationship with the overlying units is obscured. However, the outcrops mapped in the McDills Sheet area as Rumbalara Shale belong to a lithologically different sequence. Shale and siltstone grade into fine and medium-grained sandstone which are possibly tuffaceous in places. This is overlain by a glauconitic sandstone which appears to be a good marker bed over a large area and is accompanied by limestone. The youngest unit is a silicified mudstone and/or siltstone. This lithological sequence suggests correlation with the Wallumbilla Formation and Allaru Mudstone of the Central Eromanga Basin in Queensland. The same sequence was observed throughout the Simpson Desert North Sheet area and the southern part of the Hay River Sheet area near Lake Caroline and the Plenty River. The Longsight Sandstone which crops out at the western part of the Mount Whelan Sheet area is obscured by laterite and Quaternary deposits further west. On the basis of lithology and wire-line logs it can be correlated with the Cadna-owie Formation and possibly the upper part of the Algebuckina Sandstone in South Australia.

TERTIARY: Tertiary rocks are present over much of the area. In the west coarse-grained unsorted sandstone, pebbly sandstone, and lenses of granule conglomerate of the Etingambra Formation crop out. Eastwards it becomes finer grained and consists of sandstone, silty sandstone, siltstone, conglomerate, and chalcedony. In the Illogwa Creek Sheet area particularly, there are numerous outcrops of chalcedony and silicified limestone. A search for fossil shark teeth and lung fish reported to occur in the northwestern part of the Simpson Desert area was unsuccessful.

Deep weathering products are widespread over the whole area. Silcrete caps most of the Etingambra Formation and nodular laterites are typically developed on the Longsight Sandstone.

QUATERNARY: Sand and alluvium cover most of the area. Sand is widespread but alluvium is present only along the banks and in the flood-outs of the main drainage channels, marginal to areas of outcrop and in minor interdune areas.

S12 - NGALIA BASIN

by

A.T. Wells

Compilations of geological and structure maps of the Ngalia Basin at 1:500,000 scale were completed and fair drawing is in progress. The accompanying bulletin will be written in 1972. The explanatory notes of the Lake Mackay, Mount Doreen and Napperby Sheet areas are in press and the 1:250,000 scale geological map sheets to accompany them are being fair drawn.

S13 - HUNTER VALLEY PARTY

by

B.S.Oversby and J. Roberts*
(*University of New South Wales)

The party is studying the geology of Lower Carboniferous rocks in the Scone - Rouchel district of the upper Hunter Valley, New South Wales, and has mapped an area of about 640 sq km. The principal aims of the investigation are elucidation of the local stratigraphy, and determination of the succession of Lower Carboniferous faunal zone (mainly based on brachiopods) in the area. Map coverage is provided by the Wingen, Macqueen, Scone, Woolooma, Muswellbrook, and Camberwell 1:64,360 sheets; more recent 1:31,680 sheets provide only partial coverage. All aspects of the work have benefited from close co-operation with various people from the University of New South Wales, Sydney University, New England University, Newcastle University, and the New South Wales Geological Survey.

During the year 6 weeks were spent in the field, most of the time being taken up with work in Canberra. It is proposed to publish the results of the investigation as a Bulletin in 1972. Some important results and conclusions include -

1. Refinement and modification of Lower Carboniferous brachiopod zones, resulting in more precise knowledge of the zones as developed in eastern Australia as a whole. A new zone, characterized by Pustula gracilis, has been found to occur between the Schellwienella cf burlingtonensis and Orthotetes australis zones.

2. "Kuttung" and "Burindi" have been abandoned as stratigraphic names and replaced by a nomenclature based on the guidelines laid down in current stratigraphic codes. Most of the names used come from areas mapped to the north of the party's study area; a few are new.

3. In the area mapped there are no low-angle faults with large horizontal displacements. The Hunter "Thrust" is not a single fault, but rather a series of high-angle faults trending in several directions within a zone of variable width. No single fault has produced any very great stratigraphic displacement. These faults occupy a belt along the Hunter Valley which separates relatively undeformed Upper Palaeozoic rocks in the west from more intensely deformed ones in the east; the belt might appropriately be called the Hunter "Line" or the Hunter "Structural Front".

4. The area mapped lies east of the Hunter "Line" and contains two sets of intersecting folds (trending NNW - SSE and NNE - SSW) cut by a large number of high-angle faults. Structural relationships suggest that folds and faults might have developed together under the influence of a constrictive stress field.

5. Generally nonmarine units occur in the western part of the map area, grading laterally into marine units in the east. Ignimbrites are characteristic of the nonmarine assemblages, and tend to be thicker and more completely welded in the west than in the east; they are represented by shard-rich horizons in the marine rocks. Compositionally all the ignimbrites analysed are extremely acid (65% to 79% SiO_2); textures are remarkably clear, considering their age.

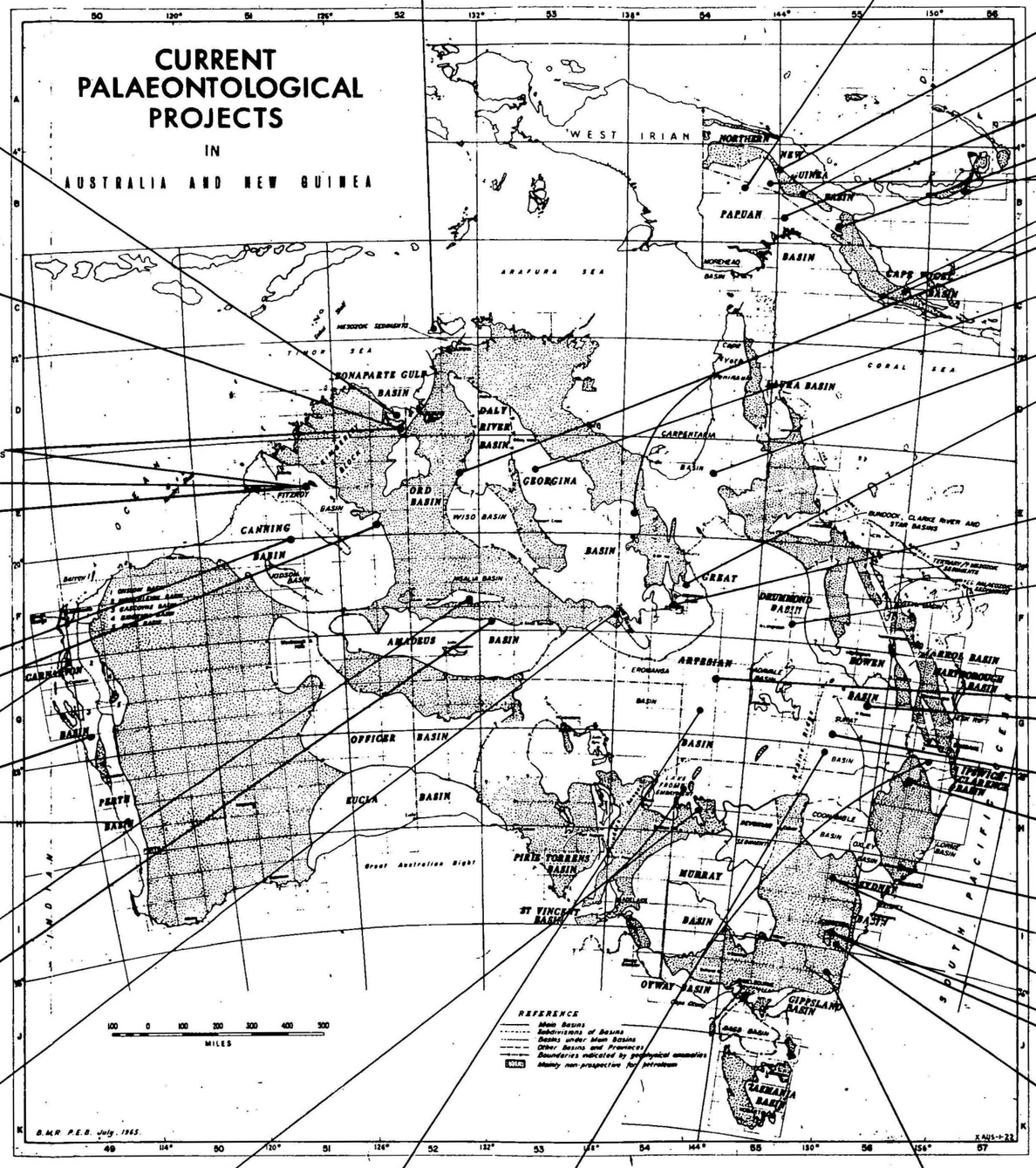
6. K/Ar ages on hornblende from ignimbrites have been determined as 319 $\pm$ 9 million yr., 308 $\pm$ 6 million yr. (the last two ages from the same rock). The ages are inconsistent with the stratigraphic positions of the samples in that the older age is from the stratigraphically higher rock.

7. Economically the area holds little promise. Some of the ignimbrites would be suitable for roadmetal and railway ballast if local demand existed. Limestones are of restricted and usually localised occurrence. Sandstones rich in heavy minerals and with up to 55% Fe and 8% Ti occur sporadically, the only one which might warrant investigation occurs just south of Glenbawn Dam.

8. Gectectonically the area appears to have been within an island arc complex during the early Carboniferous; the associated trench complex would lie to the east.

An aspect of the party's work was outlined in a talk by Oversby at the ANZAAS Congress in Brisbane entitled - Lateral and vertical variation in Carboniferous ignimbrites of the Rouchel district, Hunter Valley, N.S.W.

CURRENT PALAEONTOLOGICAL PROJECTS IN AUSTRALIA AND NEW GUINEA



Late Cambrian trilobites

Lower Carboniferous ostracods from the Bonaparte Gulf Basin

Devonian micro floras of the Bonaparte Gulf and Canning Basins

Lower Carboniferous and Upper Devonian ostracods, Canning Basin

Upper Devonian conodonts from the Canning Basin

Ordovician faunas from Canning Basin

Lower Ordovician Dikelokephalinidae from northern Australia

Upper Cretaceous foraminifera, Western Australia

Tertiary pollen grains, Napperby area

Lower Ordovician trilobites from the Amadeus Basin, N.T.

Ordovician trilobites (Rusophycus)

Late Cambrian and early Ordovician trilobites (Bancannia Trough)

Palynology of the Cretaceous Rolling Downs Group, Eromanga Basin (Qld, N.S.W.)

Neocomian–Aptian–Albian palynological zonations in the Surat Basin (Qld)

Silurian cheiruroid trilobite Onycopyge

Devonion fishes from Eastern Australia and Antarctica

Silurian brachiopods of the Canberra region

Silurian encrinurid trilobites of south-eastern Australia

Lower Devonian brachiopods, south eastern Australia

Carboniferous brachiopods of the Hunter Valley area

Lower Devonian lichid trilobites from Wellington

Carboniferous and Permian faunas from Warwick, Drake and Texas

Palaeozoic and Mesozoic plants

Jurassic and Cretaceous polynomorphs from the Great Artesian Basin

Cretaceous ammonites from Australia

Permian spores and pollen, Galilee Basin

Late Cambrian and early Ordovician trilobites (S. Burke River Structural Belt)

Late Cambrian trilobites (Chatsworth)

Lower Cretaceous pollen and spores in Carpentaria Basin

Agnostid trilobites from N.T. and N.S.W. Middle Cambrian trilobites of Northern Australia

Tertiary mammals from N.T. and Qld.

Foraminifera from eastern Papua

Upper Cretaceous foraminifera, Papua – New Guinea

Tertiary larger Foraminifera, Papua & New Guinea

New Guinea Tertiary rodents

Jurassic, Cretaceous and Tertiary palynomorphs from Papua

Tertiary larger foraminifera, Papua & New Guinea

Lower Jurassic marine fauna

Tertiary Land mammals

Cenomanian spores, pollen and microplankton, Bathurst Island

To accompany Record 1971/103

M(P)213

S14 - PALAEONTOLOGY (Fig. S14/1)

J. Roberts resigned at the end of January to take up a position as lecturer at the University of New South Wales and J. G. Binnekamp left to join Carpentaria Exploration Co. During March S.K. Skwarko transferred to the resident staff at Port Moresby and Mrs Judy A. Owen took up a scholarship at the Australian National University in August.

J. H. Shergold left Canberra on 1 September for a year at the Smithsonian Institute, Washington on exchange with the United States Geological Survey.

Specialist work under contract has been continued by Dr Irene Crespin (catalogue of Australian type specimens), Dr A. A. Opik (Cambrian trilobites and stratigraphy) and Mrs Mary E. White (fossil plants).

Annual Report

by

J. M. Dickins

Work on the Bulletin on the geology of the Bowen Basin was continued. In May he was guide for an ANZAAS excursion in the Bowen Basin and attended the Sydney Basin Symposium in Newcastle.

He examined fossils from the Kuta Limestone, New Guinea. These are of late Permian or early Triassic age and more material is needed before adequate description can be undertaken. Permian fossils were examined from the Canning Basin and Malaya and probable Lower Carboniferous gastropods from Malaya were identified.

The correlation chart, notes and bibliography for the Permian System in Australia have been brought up to date and a review of the late Permian and early Triassic sequence in Australia was prepared for presentation at the International Symposium on the Permian-Triassic boundary held in Calgary, Canada in August.

Annual Report

by

M. Plane

Work continued during 1971 on the Tertiary mammal faunas from Bullock Creek and Riversleigh. The most notable result is the series of skulls of the diprotodontid genus Neohelos which are now prepared and this material was the basis for a paper given to the ANZAAS meeting in Brisbane. The University of California party which worked in the Tirari Desert of South Australia this year collected more material referable to this genus and these fossils will be incorporated in Plane's review of the genus. Further work was done on the family Thylacoleonidae (marsupial lion) which is represented in the Bullock Creek fauna and which is also now known from the Tirari Desert. From Riversleigh, a lower jaw of the rare diprotodontid genus Bematherium is being developed and will add considerably to our knowledge of this unusual form.

A search for early marsupials in the Paleocene/ Eocene Titringo Siltstone near Nerriga, New South Wales has so far proved unsuccessful but this locality which is dated relative to a radiogenically dated basalt and from its included microflora, will be investigated further.

Fossils from a mound spring on the Springvale 1:250,000 Sheet area were identified as belonging to the late Pleistocene genus Diprotodon.

Discussions were held with colleagues from the University of California, Columbia University, New York, and the American Museum of Natural History, on the planning of the future search for late Mesozoic and Tertiary fossil mammals, co-operative field work, exchange of material, and work on fossil birds.

The paleontological exhibit for the BMR Open Day was designed, planned and constructed with the aid of other members of the group.

A paper on the occurrence of the Pliocene kangaroo Protemnodon otibandus and its widespread distribution during the late Tertiary was published.

Annual Report

by

J.H. Shergold

The main project during the year was continuation of the description of late Cambrian and early Ordovician trilobites from the Burke River structural Belt, Western Queensland. The work is well advanced and is to be published as Bulletin 136.

A joint paper with R.A. Henderson of the James Cook University of North Queensland on the echinoderm Cyclocystoides from the Middle Cambrian of the Mount Isa District, Queensland was completed and a paper with P.J. Jones and E.C. Druce on the late Cambrian and early Ordovician biostratigraphy in Western Queensland was published in the Journal of the Geological Society of Australia. A review of this work prepared jointly with P.J. Jones, was given at the Brisbane ANZAAS in May.

Shergold participated in preparing the Palaeontological exhibit for the Bureau's open day. He left for the Smithsonian Institute, Washington on 1 September for a year on exchange with the United States Geological Survey.

Annual Report

by

D.L. Strusz

D.L. Strusz spent several months working as convenor of a working group on the correlation of the early Devonian deposits of Australia and New Zealand. The results of this work were presented by him at a Symposium on the Devonian System in Australia, at the ANZAAS Congress in Brisbane, May 1971. Following discussions held at the symposium, and the subsequent receipt of written comments, the correlation chart and accompanying text were extensively revised for publication by the Geological Society of Australia late in 1971.

Brief explanatory notes were prepared for a new geological map of the Canberra area at 1:50,000 scale; this work was done in conjunction with G.A.M. Henderson of the

Engineering Geology section. The map and notes were published in time to be made available to participants in the Pan-Pacific Science Congress. Strusz also helped organize two local excursions for the Congress.

Work on a revision of the Australian species of the Silurian trilobite Encrinurus continued but was not finished before co-worker J.H. Shergold left for America. The types of Foerste's species E. bowningi and E. mitchelli were traced to the British Museum of Natural History, and latex casts were obtained. It is hoped that the remaining work (mainly the gathering of comparative information on extra-Australian species) will be completed in time for writing-up immediately on Shergold's return.

The annual field camp for students employed during the long vacation was held in the Kiandra-Long Plain area during January and February 1971, an area where 1:100,000 Scale mapping has started (see Section S22).

Annual Report

by

G.C. Young

Field Work

Three months (November, 1970 - February, 1971) were spent collecting Middle and Upper Devonian vertebrates in South Victoria Land, Antarctica as a member of the Victoria University of Wellington Antarctic Expedition No. 15.

Most of the field work was carried out in the Skelton Neve region, about 100 miles west of Scott Base. Extensive collections were made from five localities discovered in 1968/69 (Mt Crean, Portal Mountain, Mt Metschel, Boomerang Range, Mt Warren) and four new localities in the southern Warren Range and southern Lashly Range. Visits to several other localities (Boomerang Range, Escalade Peak and Mt Feather) were prevented by excessive motor toboggan break-downs and poor surface conditions. Another locality (Mt Fleming) was visited, but collecting was prevented by bad weather. All vertebrate material came from the Aztec Siltstone Formation, a silty unit at the top of the predominantly arenitic Taylor Group (?Silurian to Upper Devonian). Every outcrop of Aztec Siltstone examined contained vertebrate

fossils, which were in general well preserved but tended to be fragmentary. The fauna includes all major Palaeozoic groups of fishes. Antiarch (Bothriolepis) and arthrodire remains consist of abundant isolated plates and a number of articulated specimens. Isolated crossopterygian scales and teeth were common and several jaws, opercular plates and an almost complete fish were collected. Dipnoi are represented by two tooth-plates. Acanthodians and palaeoniscids are represented by isolated scales and spines and several partially complete specimens.

The Taylor Group is overlain by a sequence of tillite, sandstone, conglomerate and coal measures (the Victoria Group) which ranges from ?Carboniferous to Triassic in age. Small collections of Glossopteris, Gangamopteris and Dicroidium were made from these strata.

The last three weeks in the field were spent in a previously unexplored region of the Darwin Mountains, about 200 miles south of Scott Base. In this area the Maya Erosion Surface, which separates the Taylor and Victoria Groups, extends down into the underlying strata, and the equivalent of the Aztec Siltstone has been eroded. Consequently, no vertebrate remains were recovered from this area.

This expedition was most successful and over 2000lbs of fossil material was collected. The whole collection arrived in Sydney in June, and is now being studied in the BMR and the Australian Museum.

Preparatory Work and Preliminary Investigation of the Antarctic Fauna

Preparatory work has commenced on the antiarch component of the fauna. This consists predominantly of a single species of Bothriolepis, which differs from all previously described species in the posterior position of the orbital fenestra and the low breadth/length ratio of the premedian plate. In other features the Antarctic species resembles B. cellulosa (Pander) from Eastern Europe, but shows no close similarity to B. gippslandensis Hills, the only described Australian species.

Antiarchs from N.S.W.

An antiarchan fauna from south of Braidwood is being studied in conjunction with the Antarctic material. Another species of Bothriolepis occurs, together with the related genus Remigolepis.

Lower Devonian Arthrodires from Taemas/Wee Jasper, N.S.W.

Preparatory work on this fauna has been continued throughout the year. Specimens etched from limestone include previously unknown suborbital and posterior lateral plates and numerous scales of the brachythoracid Buchanosteus, a brachythoracid paranuchal plate of uncertain affinities, and the skull of a new petalychthyd genus.

A paper on these fauna was presented at the ANZAAS Congress at Brisbane in May.

Annual Report

by

Joyce Gilbert-Tomlinson

Current projects, well advanced, include studies of the Lower Ordovician dikelokephalinid trilobites of northern Australia, and Australian Ordovician representatives of the trilobite ichnogenus Rusophycns.

The dikelokephalinid trilobites mostly represent new taxa. Material from the Mt Datson area in western Queensland, first assigned to the nominate genus - the Norwegian Dikelokephalina - now proves to be new. The only extra-Australian genus identified in the collections from northern Australia is Dactylocephalus, previously known only from central China. By contrast, the Tasmanian representatives of the family are all assignable to the cosmopolitan Asaphopsoides, which is not represented in the collections from northern Australia.

Study of Ordovician trilobite trace fossils was deferred for some years because of the difficulty of photographing them. This problem has now been overcome, and, moreover, the study of similar fossils from other parts of the world has suddenly become rather popular, so that much taxonomic information and a number of stimulating theories on mode of life of these and other extinct arthropods are now available for consideration.

Studies have been started on the late Upper Cambrian and early Ordovician riberioids of northern Australian and on the Ordovician trilobites of the suborders Asaphina and Cheirurina of northern Australia.

A brief resume of the early Ordovician faunal succession of the Boulia area, Western Queensland was written for publication in the current volume of palaeontological papers.

Annual Report

by

S.K. Skwarko

S.K. Skwarko continued description of the Ordovician graptolites from the Canning Basin and studied material from the Jurassic Newmarracarra Limestone of the Perth Basin. He examined Lower Cretaceous faunas from the Great Artesian Basin and completed papers on the Lower Jurassic faunas of the Wiso Basin, Northern Territory and a Jurassic fauna from New Guinea. He joined the resident staff in Port Moresby in March.

Annual Report

by

D.J. Belford

D.J. Belford has been mainly concerned with palaeontological work connected with the regional mapping programme in Papua and New Guinea. A compilation of all palaeontological work carried out on samples from Eastern Papua has been completed, and a manuscript and illustrations prepared for inclusion in a Bulletin on this area. A draft manuscript describing Lower Miocene planktonic Foraminifera from the Nassau Range, West Irian, has also been completed. This fauna is of interest in connection with the stratigraphical range of some species of planktonic Foraminifera, and it seems that the range of these species must be extended from the upper Oligocene into the lower Miocene. A section on the Asaro River has also been examined, and may give some data on the relationship between the planktonic and larger Foraminiferal stratigraphical schemes. Unfortunately at least part of the larger Foraminifera fauna is derived, as the genus Spiroclypeus (not known to occur above Te) is associated with a planktonic Foraminifera fauna including Orbulina (not known before lower Tf). In samples from the Wabag area some species of Globorotalia (Turborotalia) apparently occur at a stratigraphical level somewhat below their first occurrence elsewhere. This fauna requires a careful comparative systematic study in order to identify accurately the species present; it may be possible to distinguish them from very similar species occurring at a higher stratigraphical level.

A field trip was made during June and July to the Perth and Carnarvon Basins, together with M. Owen, and with J. Backhouse of the Western Australian Geological Survey. Type sections and other outcrops of Jurassic, Cretaceous and Tertiary Formations were sampled at Gingin, Geraldton, Murchison River, Hamelin Pool, Giralia-Cardabia and at Cape Range. Palaeontological study of the material collected will be carried out in the future.

Annual Report

by

P.J. Jones

A chart with accompanying notes were prepared with J. Roberts, and K.S.W. Campbell ANU on the correlation of Upper Devonian rocks of Australia, which was presented at the ANZAAS Symposium on the 'Devonian System of Australia'; this will be published in the next issue of J. geol. Soc. Aust. A similar chart and the first draft of accompanying notes were prepared (with J. Roberts and K.S.W. Campbell) on the correlation of Carboniferous rocks of Australia; for eventual publication in the BMR Bulletin Series.

A paper was prepared (jointly with J.H. Shergold) on 'Late Upper Cambrian and Early Ordovician Biostratigraphy in the Burke River Structural Belt, western Queensland', which was read by Shergold at the ANZAAS Symposium on 'Cambrian and Ordovician faunas of Australia and New Zealand! Illustrations of Upper Cambrian conodonts were prepared for the Queensland Palaeontographical Society publication - 'Cambrian fossils of Queensland'.

Descriptions of Lower Carboniferous Ostracoda from the Bonaparte Gulf Basin, northwestern Australia, were continued; the Bairdiacea, the best represented superfamily - in terms of numbers of species - is being described first.

A tentative intercontinental correlation chart of the Phanerozoic scale was completed for reference within BMR; explanatory notes are in preparation.

Routine investigations included the reporting of Upper Devonian ostracods from Lennard Oil Napier No. 4 and 5 Wells in the Canning Basin, W.A., and the search for conodonts in samples (10 kg) from the Kuta Limestone (earliest Triassic?) of New Guinea, with negative results.

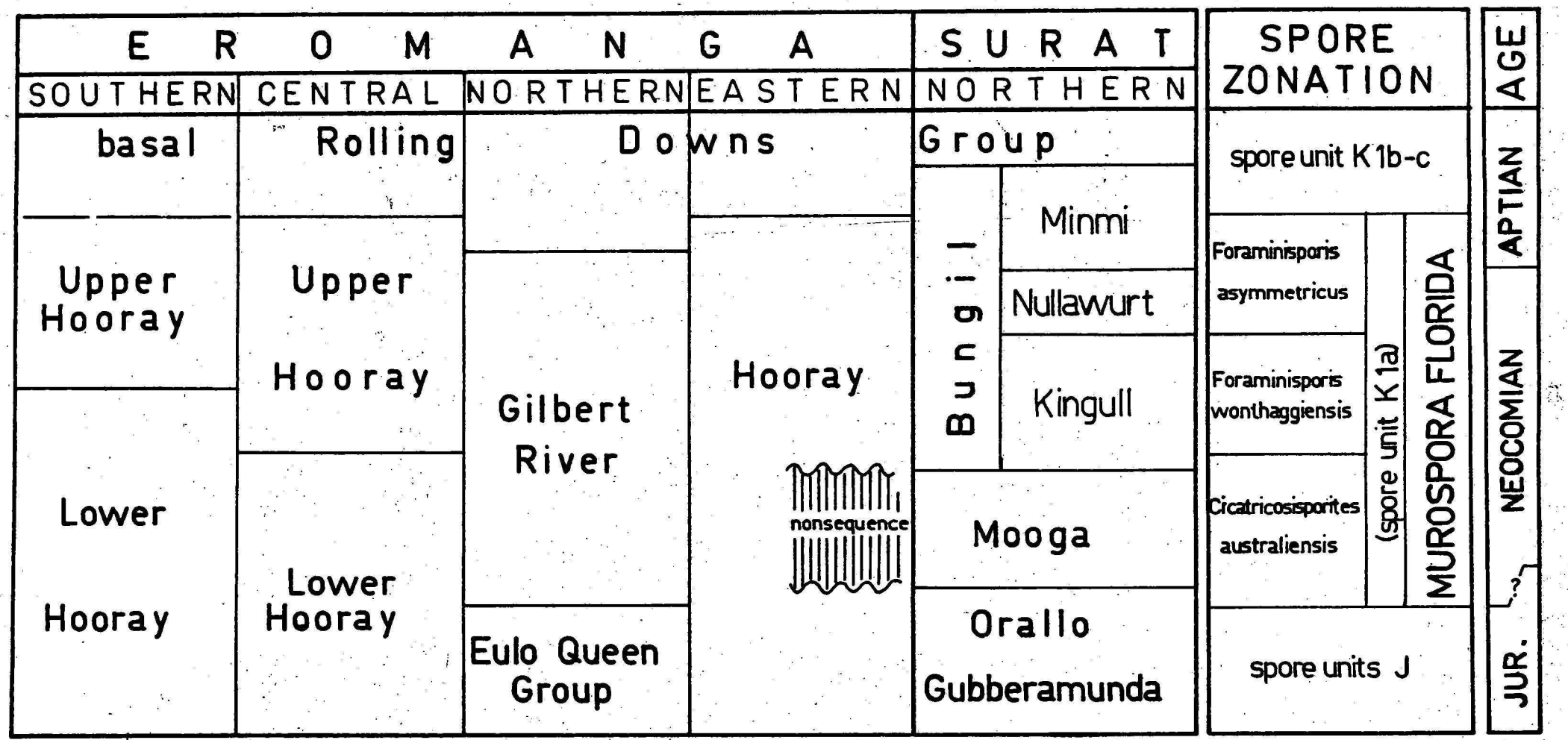
Annual Report

by

D. Burger

The palynological understanding of the Cretaceous in the Great Artesian Basin was advanced by the completion

Table S 14/2 Cretaceous stratigraphy and palynology of the Surat and Eromanga Basins



of a study on stratigraphic palynology of the Neocomian to Lower Aptian, i.e. the sequence underneath the Aptian-Albian Rolling Downs Group in the Surat and Eromanga Basins. This study was based on analysis of samples from the following oil exploration wells:

U.K.A. Cabawin No. 1
F.D. Alice River No. 1
Exoil Brookwood No. 1
P.S. Cothalow No. 1
Alliance Chandos No. 1
F.D.S. Innamincka No. 1
L.O.L. Marchmont No. 1
A.A.P. Mayneside No. 1
A.P.C. Newlands No. 1
Conorada Ooroonoo No. 1
Smart Oil Orient No. 1
A.A.O. Penrith No. 1
A.A.O. No. 1 (Roma)
L.O.L. Saltern Creek No. 1
W.O.L. Nos 1,3 (Warbreccan)
N.A.I. Whyenbirra No. 1
Alliance Yongala No. 1

Other samples were studied from BMR shallow stratigraphic holes drilled in the Roma, Mitchell, Augathella, Tambo, Jericho, Longreach, Hughenden and Gilberton 1:250,000 Sheet areas. The results of the study are shown in Table S14/2.

Study of the Carpentaria Basin is still in progress, but stratigraphic problems in the southern part of the basin have been partially clarified and the time relationship of the Cretaceous sequence with that in the Eromanga Basin has been established. This study was based on samples from the following deep wells:

D.S. Mornington Island No. 1
M.E. Burketown No. 1
A.A.O. No. 8 (Karumba)
F.B.H. No. 1 (Wyaaba)

A taxonomic and systematic study of spores and pollen grains from the Cenomanian in Bathurst Island (B. Island Nos 1, 2 wells), Northern Territory, is near completion.

Study was continued on autofluorescence of Recent pollen and spores from collections of plants kept in New Guinea (Goroka), Melbourne, and the ANU (Canberra).

Routine examinations for age determination were carried out on samples from BMR stratigraphic holes in the northern Eromanga Basin and southern Carpentaria Basin. Analyses for age determination were also carried out on samples from offshore in the Carpentaria Basin, near Weipa (drilling by Canadian Superior Oil Pty Ltd).

Mrs L. Kracuik was appointed as technical assistant in the palynological laboratory in December 1970. In this period a total of 160 rock samples was chemically processed.

Annual Report

by

M.S. Norvick

A study of Cenomanian microplankton from Bathurst Island was written up.

Stratigraphic palynology of the Permian in a number of wells in the Galilee and Bowen Basins, Queensland, was continued and a Record on Amerada Thunderbolt No. 1 Well (Muttaburra 1:250,000 Sheet area) was written.

Norvick was with the BMR West Sepik Party, T.P.N.G., from 23 August 1971 to 31 October 1971.

A lecture was given on morphological and stratigraphic aspects of fossil microplankton in August 1971, at the request of the Baas Becking Group (BMR).

Annual Report

by

M. Owen

M. Owen continued his work on Upper Cretaceous Foraminifera from Western Australia and Papua-New Guinea. The main emphasis was on the faunas from Papua-New Guinea, with a detailed examination of free specimens of planktonic Foraminifera from samples collected by Bureau field parties. Many of these samples yielded a rich, well preserved fauna, and detailed correlation with a planktonic foraminiferal zonation from the Upper Cretaceous of the Gulf Coast, U.S.A. was possible. The samples ranged in age from Turonian to upper Maestrichtian, with the majority being of upper Campanian and lower Maestrichtian age. A paper - 'Upper Cretaceous Planktonic Foraminifera from Papua-New Guinea' was prepared.

During June and July, 1971 a field trip was undertaken with D.J. Belford, and J. Backhouse from the Western Australia Geological Survey, in which extensive collections were made from the Cretaceous and Tertiary of the Perth and Carnarvon Basins. Examination of offshore well material continued, and considerable time was spent in photography of Foraminifera using the scanning electron microscope.

Annual Report

by

J.A. Owen

During the year, Devonian microfloras were examined from three wells in the Canning Basin, Western Australia. The most diverse and numerous spore assemblages were found in samples from BMR's Laurel Downs well and less diverse but still numerous assemblages in Frome Rocks No. 2 well. A poor microflora, with abundant acritarchs, was found in samples from Babrongan No. 2 well. The presence of Hymenozonotriletes lepidophytus Kedo in most samples is taken as indicating a Famennian age for the sequence. A short paper on the spore assemblages in these three wells is in preparation.

Mrs Owen left to take up a scholarship at the Australian National University in August.

Annual Report

by

J.G. Binnekamp

J.G. Binnekamp worked on samples from New Britain, the Markham 1:250,000 Sheet area, and from the Asaro River section and the Chimbu Limestone, Central Highlands, New Guinea. Papers were written on the larger Foraminifera from New Britain, and the larger Foraminifera of the Chimbu Limestone (Eocene-Oligocene).

He resigned from the Bureau in May, 1971.

S15 - SEDIMENTOLOGY

by

A.R. Jensen

PERSONNEL: A.R. Jensen, W.A. Burgis, S.L. Roddick, T.K. Zapasnik

Studies of various aspects of sedimentation in the Bowen Basin occupied members of the Sedimentology Group during the year (see S7 and S8), but Miss Burgis has also been involved with the Estuary Study (Broad Sound). As part of the studies in the Bowen Basin, Zapasnik has prepared oriented clay samples from Triassic sandstone and mudstone for x-ray diffractometer analysis, made grain elongation measurements, and carried out heavy mineral separations. As well as this he has examined seismic cuttings from the Fly River delta for heavy mineral content, and has examined two other heavy mineral concentrates for other sections of BMR.

A computer programme for the analysis of directional data such as cross-stratification was issued as a Record during the year, and modifications have now been made to the calculation of azimuthal variance.

S16 - ESTUARY STUDY PROJECTS

BROAD SOUND

by

P.J. Cook

PERSONNEL: P.J. Cook, W. Mayo (full-time), P.M. Angus, W.A. Burgis, S.E. Smith, T.G. Powell (part-time)

The 1971 field season was primarily concerned with establishing the Quaternary stratigraphy of the Broad Sound area. A brief diamond drilling programme was undertaken in the Torilla Plains area but was only a limited success owing to the inaccessibility of most potential drill sites as the result of exceptionally heavy rains. However information from the seven diamond drill holes and that from 38 auger holes has enabled a detailed picture of the onshore stratigraphy to be built up. The sequence is basically regressional with intertidal deposits at the base followed by mangrove, and then by supratidal deposits. Twenty auger holes were also drilled on some problematical circular structures in the Torilla Plains area. These structures, which are similar in appearance to the Carolina Bays of the southeast United States, are believed to have formed as a result of groundwater activity during lateritic weathering. Extensive sampling of beach ridges was carried out as part of a dating programme being undertaken in conjunction with Dr Polach of ANU.

An offshore drilling and seismic programme was undertaken by a contractor; 480 km of survey lines and 130 m of shallow drilling were completed (Fig. S16/1). Results indicated that a strongly indurated layer (possibly an old soil profile) underlies Broad Sound. Offshore work included current measurements and detailed examinations of mega-ripples. All the sand ridges in Broad Sound are believed to be of tidal origin and not, as has been previously suggested, ancient aeolian dunes.

In Canberra, geochemical analysis of samples from the Broad Sound area continued throughout the year. Trace element analyses of the Styx River catchment area were completed (see annual report of laboratories sub-section). Major and minor element analyses of some estuarine sediments were undertaken under the supervision of S.E. Smith. It is anticipated this work will be completed early in 1972. T.G. Powell carried out preliminary hydrocarbon analysis of 30 samples from various environments, but as the maximum hydrocarbon content obtained was 1 ppm, this work was suspended until total carbon contents are determined. Some free sulphur was found to be present in the supra-tidal zone sediments.

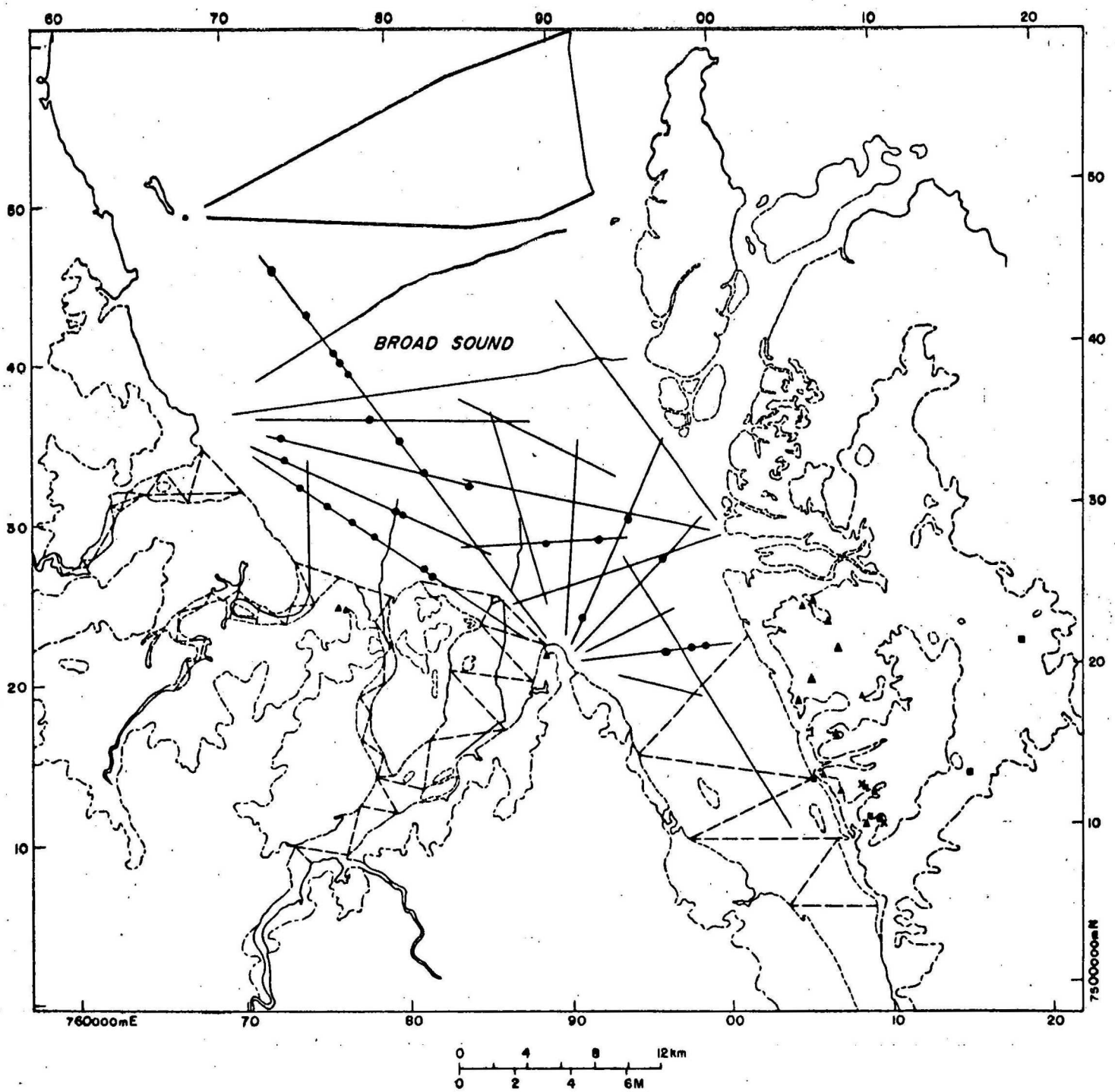


Fig S16/1 BROAD SOUND WORK-1971

The main concentration of phosphate in sediments (up to 3 times average) appears to occur in the nodular sediments present in the central portion of Broad Sound. High P_2O_5 values were recorded in the water of some of the mangrove inlets at low water. This appears to be related to acid conditions developing in this environment.

MALLACOOTA INLET

by

G.A. Reinson (ANU)

Approximately 300 sediment samples have been collected in the estuary and in its immediate environs on a 400m grid. A detailed hydrological study of the estuary was also done to determine the freshwater-seawater relationships. This involved detailed recording and sampling to obtain measurements of the three-dimensional distribution of salinity, temperature, suspended solids, and current velocity over a complete tidal cycle. Findings from this hydrological study show that the estuarine waters have definite circulation patterns throughout the year. Fresh and salt water interact to form a two-layer flow system with entrainment of salt water into the upper fresh water layer, during periods of high river discharge, and vertical mixing across the two layers during lower river discharge. The hydrological changes occurring during the largest flood of the Genoa River ever recorded were documented in some detail.

Two hundred samples of soils from different rock types were collected on a grid of approximately 3 km throughout the 2250 sq km catchment. No analyses have been done on these samples to date.

S17 - PHOSPHATE SEARCH

by

P.J. Cook

Bulletin 138 on the Georgina Basin Phosphorites was completed early in the year and handed to the editors. A paper by F. de Keyser on the stratigraphy of the Georgina Basin was modified for inclusion in the 1971 Bulletin of Geological Papers. P.J. Cook continued work on the chemistry and petrology of the Georgina Basin phosphorites. Many cell dimension determinations were carried out and close similarities with material from the Phosphoria Formation were observed. The scanning electron microscope was of great assistance in the petrological work. A short field investigation was carried out by A. Yeates to assess the phosphate potential of an area of the Tasman Geosyncline in New England but no significant deposits were discovered.

S18 - MARINE GEOLOGY

by

H.A. Jones

PERSONNEL: H.A. Jones, D. Jongsma, J. Marshall

The 1970 geological reconnaissance on the eastern Australian Continental Shelf was completed in mid-December (Fig. S18/1). Two hundred and ninety bottom samples and 3,500 km of sparker profiles were obtained in the area between Swain Reefs and Port Macquarie. The wide Continental Shelf and gently inclined upper slope of the northern part of this area is mantled by reef-derived organic carbonates. Quartz sand dominates on the narrow shelf and steep slope to the south. The seismic profiles indicate an undisturbed conformable sequence 300 to 400m thick in the Capricorn Channel, thinning landwards. Farther south, off Fraser Island, the prism of superficial sediments thins seawards and phosphatic limestone bedrock possibly of Miocene age crops out on the upper continental slope. Nodules and slabs of phosphatic limestone, probably derived from the same horizon, were dredged from a number of localities from the upper continental slope south of Cape Moreton. Some of this material analysed at 26 percent P_2O_5 but most was of much lower grade.

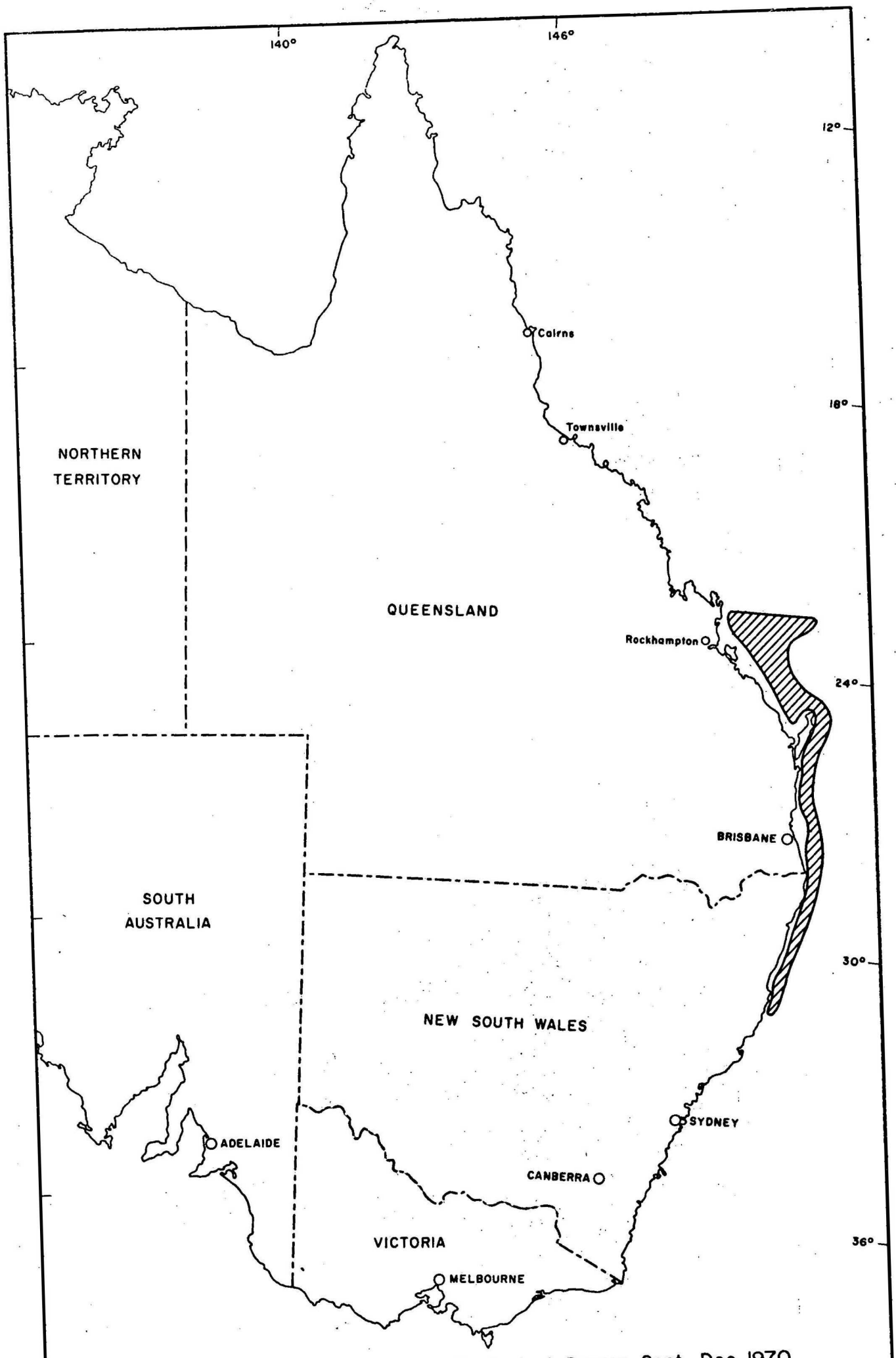


Fig S 18/1 Area covered by Marine Geological Survey Sept - Dec 1970

AUS/2/182

To accompany Record 1971/103

Throughout the year work continued on sediments and seismic profiles collected in 1970 and during earlier surveys off northern and northwest Australia. The first draft of a bulletin on the marine geology on the Arafura Sea by D. Jongsma was completed during the year. The bulletin on the northwest shelf by H.A. Jones was well advanced at the end of the year.

S19 - EVAPORITE STUDY PROJECTS

by

A.T. Wells, A.J. Stewart

PERSONNEL: A.T. Wells, P.J. Kennewell and A.J. Stewart

The programme of evaporite study involved the completion of the evaporite drilling in the Amadeus Basin, the reporting of this investigation, and the appointment of a specialist consultant, Dr G. Richter-Bernburg, Director of the Federal Geological Survey of the West German Republic, to advise on the future exploration of Australian evaporite deposits. As a result of Richter-Bernburg's visit two review reports were written on evaporite occurrences in Australia with recommendations for further investigation. Detailed geochemical and petrographic work was also carried out on evaporite cores from the Ringwood Dome east of Alice Springs.

The original programme of three continuously cored drill holes to about 300m in the late Precambrian evaporites of the Bitter Springs Formation in the Amadeus Basin was completed late in 1970. Three additional shallow test holes were also drilled, one at Goyder Pass and two in the Lake Amadeus area. The last drill hole to be completed was Lake Amadeus No. 3B which was terminated at a total depth of 306m. The first 40m of section in the hole is composed of siltstone of probable Tertiary age and the remaining 260m consisted of mixed evaporite rocks composed chiefly of gypsum, anhydrite, dolomite and calcite. The whole evaporite sequence is highly folded and in part brecciated and cut by acicular gypsum veins. The drill was still in evaporites at total depth.

The text of the Record 'Evaporite drilling in the Amadeus Basin-Goyder Pass, Gardiner Range and Lake Amadeus, Northern Territory' has been completed in first draft.

Dr G. Richter-Bernburg, Director of the West German Geological Survey visited the Bureau in the role of consulting specialist for one month in April and May. Discussions were held with geologists of numerous petroleum and mineral exploration companies and state geological surveys and a study was also made of the relevant literature. Two draft reports have been prepared which review the Australian continental evaporite deposits and give general recommendations for further exploration.

Major evaporite basins have been discovered in Australia over the past decade chiefly as a result of the increased impetus of drilling in the search for petroleum (Fig. S19/1). About twenty five petroleum exploration wells have intersected evaporites and about eight holes have been drilled to test evaporite deposits. Major deposits of evaporites have been discovered in the Adavale, Amadeus, Canning and Officer Basins. The thickest evaporite deposits penetrated so far are about 600m in the Frome Rocks Diapir on the Broome Swell and a similar thickness in the McLarty No. 1 well in the Canning Basin. To date potash has been discovered only in the Adavale Basin but the known deposits are uneconomic. Native sulphur has been found only in recent playa lake deposits.

Further exploration of basin evaporite deposits, with the aim of locating economic minerals, can be divided into the following broad categories:

(1) Mapping and core hole drilling of selected surface occurrences;

(2) Local detailed geophysical surveys to determine the physical dimensions and attitude of surface and near surface deposits;

(3) Lithofacies and palaeogeographic studies of evaporite formations in certain basins.

Obvious drilling targets that have already been mapped are the Woolnough Hills, Broome and Madley Diapirs in the Officer Basin and the Mount Toondina structure in the Arckaringa Sub-basin in South Australia. Possible diapiric structures in the offshore Bonaparte Gulf Basin and in the northern part of the Canning Basin are to be drilled by the lease-holding Companies.

PETROGRAPHIC AND GEOCHEMICAL STUDY OF THE EVAPORITE ROCKS OF THE RINGWOOD DOME, AMADEUS BASIN (Progress Report By A.J. Stewart

The Ringwood Dome, 100 km east of Alice Springs is an anticline in carbonate and evaporite rocks of the Bitter Springs Formation. In 1968, the evaporite core of the dome was air-drilled to a total depth of 260m; a thickness of 205m was continuously cored, and 190m recovered. Based on field examination, the upper 133m was initially described as consisting of gypsum with abundant fragments of 'anhydrite', plus interbeds of grey 'calcareous claystone';

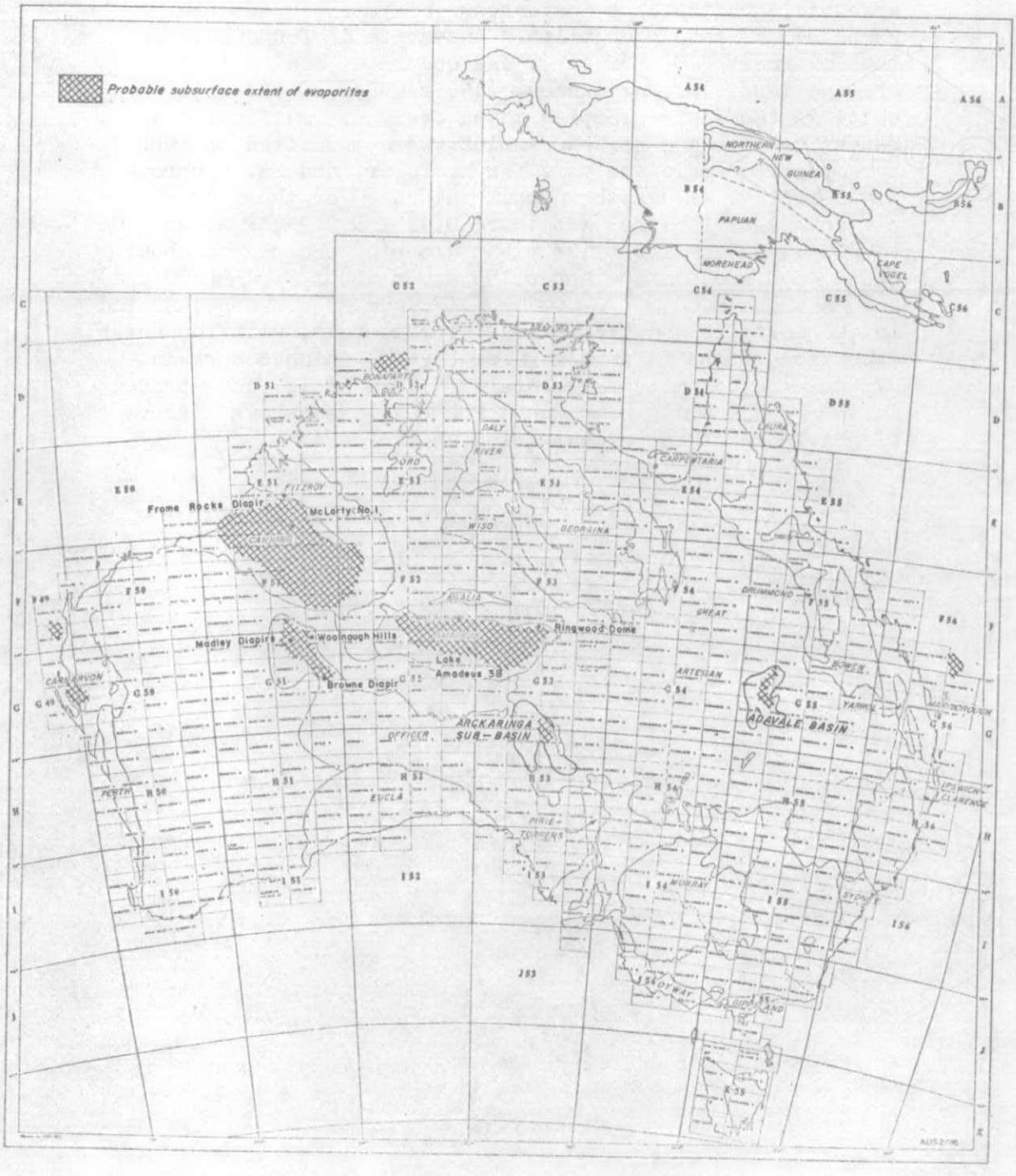


Fig S19/1 : Distribution of Evaporites in Sedimentary Basins of Australia.

the lower 127 m consisted of dark, brecciated, 'dolomitic siltstone' plus lesser amounts of the three rock-types found in the upper part of the core. Subsequent petrographic and X-ray diffraction examination has shown that the 'anhydrite' fragments and the 'dolomitic siltstone' are composed of dolomite, and that the 'calcareous claystone' beds are composed of friable dolutite. Anhydrite is found only in the lowermost 110 m of core, and occurs as medium to coarse-grained lenticles and masses. 198 samples of the drill cuttings (composite samples taken every 1.5 m), including repeat samples and spiked samples, were submitted to AMDL for spectrographic analysis for K, F, Sr, and Mn. Approximate average values throughout the core for the four elements analysed are: K between 0.1% and 0.2%, F about 0.06% (600 ppm) in the lower 127 m but dropping sharply to about 0.03% (300 ppm) in the upper 133 m, Sr about 0.04% (400 ppm), and Mn about 0.005% (50 ppm). K, F, and Mn are concentrated in the dolutite and brecciated dolomite beds, with the notable exception of the maximum K value (0.62%) which occurs in gypsum with dolomite fragments at 87 m. Sr is concentrated in the gypsum and gypsum-anhydrite beds, and shows a very slight increase in concentration up the core.

S20 - PHOTOGEOLOGY AND REMOTE SENSING

by

C.E. Maffi

PERSONNEL: C. Maffi, C.J. Simpson

PHOTOINTERPRETATION

Papua and New Guinea

Huon Peninsula: Photointerpretation was completed and information compiled onto 1:100,000 scale maps prepared from 1:250,000 bases.

Madang and Huon Sheets: Selected areas were photointerpreted to assist the TPNG Party in the preparation of the 1:1,000,000 geological map.

Ramu Sheet: A detailed study to differentiate between certain Tertiary limestones was carried out over part of the Sheet.

May River, Ambunti, Blucher Range and Wabag Sheets: Selected areas were photointerpreted to assist the West Sepik Party in the planning and execution of field work. The photointerpretation was used also to check radar interpretation.

Northern Territory

Amadeus Basin: Spot heights were measured by parallax bar to provide data for the construction of the Amadeus Basin model.

Queensland

Weipa, Aurukun and Holroyd Sheets were photo-interpreted and the information compiled onto 1:50,000 scale photomosaics.

Cape Weymouth, Coen and Ebagoola Sheets: The areas covered by Tertiary and Quaternary rocks were photointer-preted.

Normanton Sheet: Assistance was given to the Carpentaria Basin Party in the compilation of the 1:250,000 scale preliminary geological sheet.

Western Australia

Upper Robe River Area: Photointerpretation was carried out to assess the potential of iron ore reserves.

New South Wales

Inverell and Gilgandra Sheets: Selected photos were interpreted to assist the Hydrological Study Party in the planning and execution of a field trip to the eastern intake areas of the Great Artesian Basin.

Australian Capital Territory

Tuggeranong-Weston Creek Area: A detailed structural examination of airphotos covering the route of the proposed sewer tunnel was carried out for the Engineering Geology Group.

Victoria

Murray-Goulburn Valley Area: Ancient river channels were outlined on airphotos to assist the Engineering Geophysics Group in investigating underground water.

REMOTE SENSING

W.A. Remote Sensing Project

Interpretation was commenced of colour, colour IR and multispectral photos over areas of the Laverton and Leonora Sheets, in collaboration with the BMR Airborne Geophysics Section.

Cloncurry Remote Sensing Project

A remote sensing research team from Bedford College (London University) spent six months in the Cloncurry area. The team carried out investigations into the value of using airborne photographic and line scan techniques for detecting geobotanical anomalies associated with mineralization.

Under the supervision of the photogeology group the BMR provided some logistic support to the project.

Canberra area Infrared Linescan Project

Linescan imagery ranging through the 1.55 micron band was flown, as a complimentary demonstration, by Canadian Aeroservice Co. over Lake George, Captain's Flat, Googong Damsite and Orroral Valley areas. A study of the imagery, followed by a field check, did not reveal any significant features which could not be detected on conventional air photos. However the quality of the imagery was poor, and the experiment did not eliminate thermal IR as a potentially useful technique. A report on the experiment was written and will be issued as a Record.

Bowen Basin Thermal IR Project

Upper Permian Coal Measures, which outcrop in the Hail Creek Syncline near Nebo, were chosen for a further experiment with thermal IR imagery. Three runs of 11 km each were flown three times (at 4 a.m., 11 a.m., and 8 p.m.) with a scanner sensitive to the 8 to 14 microns band. During the 11 a.m. run, vertical air photographs were taken also.

The study of the imagery was commenced.

New Guinea Radar Imagery

Radar imagery of the West and South Sepik Region was interpreted. The information was checked on air photographs and in the field.

The study proved that radar imagery is a valuable exploration tool because:

(a) it displays a synoptic picture of the terrain;

(b) it emphasizes morphological features;

(c) it is independent of weather conditions except for very heavy rain.

The main limiting factors are:

(a) image deformations along the edges of the strips (particularly 'layover' in the near range;

(b) radar shadows along back slopes and at the bottom of narrow valleys;

(c) dependence of information content on look direction.

The mosaics of the original radar strips contain considerable errors due to scale variations along the joins. Also, as strips with opposite look directions were joined together, the mosaics are difficult to read. Though more costly, mosaics should be prepared from strips with a single look direction.

Where two strips with the same look direction overlap each other, stereo vision is possible and the information content is greatly increased.

ERTS "A" Project

Information was collected to assist the Australian Committee for Earth Resources Technology and Science (ACERTS) in the preparation of its proposals to NASA for participation in the ERTS "A" satellite programme.

S21 - TANTANGARA PROJECT

PERSONNEL: M. Owen, D.E. Gardner

Field mapping of the 1:100,000 Tantangara Sheet area southwest of Canberra, started on 12 October. The 1:100,000 scale Sheets to the east are currently being mapped by the New South Wales Geological Survey.

S22 - OVERSEAS VISITS

OVERSEAS VISIT 30.4.71 - 29.5.71 W.J. PERRY

Mr W.J. Perry attended the first International Workshop on Earth Resources Survey Systems, a conference sponsored by seven U.S. Government Agencies held in Ann Arbor, Michigan from 3 to 14 May, as a representative of the Australian Committee for Earth Resources Technology and Science (ACERTS). Subsequently he attended the Seventh Symposium on Remote Sensing of the Environment from 71 to 21 May in the same place. The workshop was designed to assist administrators who would be responsible for authorizing and organizing earth resources programmes as well as scientific and technical personnel who will eventually process and apply in their own countries, data from aircraft and spacecraft. The Workshop was attended by 385 people from 38 countries, of whom 120 stayed for the whole conference. During the first week there were thirty-one addresses concerned mainly with a broad coverage of remote sensing from aircraft and spacecraft, and directed principally toward administrators. For the second week the participants were divided into groups of about fifteen and each group attended the presentation of twenty-seven technical papers on the application of remote sensing in the fields of Agriculture (5), Forestry (2), Cartography (1), Geography (4), Environmental quality (3), Geology (3), Hydrology (4), and Oceanography (4). The Seventh Symposium on Remote Sensing was attended by 791 people; eighteen nations were represented and more than 160 papers were presented, necessitating four concurrent sessions on each of three afternoons. Several of the papers given at the Workshop were presented again at the Symposium.

An internal report to ACERTS was prepared in collaboration with Dr K.G. McCracken of C.S.I.R.O.

OVERSEAS VISIT - C.E. MAFFI

C.E. Maffi returned from leave of absence on 7.12.70, after a ten-months UNESCO assignment in Brazil. During this period he organized under- and post-graduate courses in photogeology at the Federal University of Bahia.

OVERSEAS VISIT - N.O. JONES

N.O. Jones was seconded to the Thai-Australian Land Development Project as a groundwater specialist under the Colombo Plan from 14 April to 4 June 1971. Field surveys were made in Nan, Lampang and Kampengpet Provinces of northern Thailand and a drilling programme recommended.

S23 - PACIFIC SCIENCE CONGRESS TOURS

by

G.E. Wilford

Assistance with arranging four post-congress tours was given to the organizing committee of the Twelfth Pacific Science Congress held in Canberra from 18 August to 3 September. The itineraries were:

Tour 10 : Mt Isa-Groote Eylandt-Gove-Darwin (inc. Rum Jungle, Frances Creek)

Tour 11 : Broken Hill-Whyalla-Perth-Kalgoorlie Kambalda-Dampier-Tom Price-Port Hedland

Tour 12 : Alice Springs-Ross River-Palm Valley Gasfield, Gosses Bluff-Glen Helen-Ayers Rock-Alice Springs

Tour 13 : Port Moresby-Madang-Rabaul-Kieta-Port Moresby.

Unfortunately, as with most of the other Congress tours, numbers were insufficient (20 to 25 for each tour being required) for the four tours to be operated.

METALLIFEROUS SECTION

METALLIFEROUS SECTION

Contents

ILLUSTRATIONS

Figures

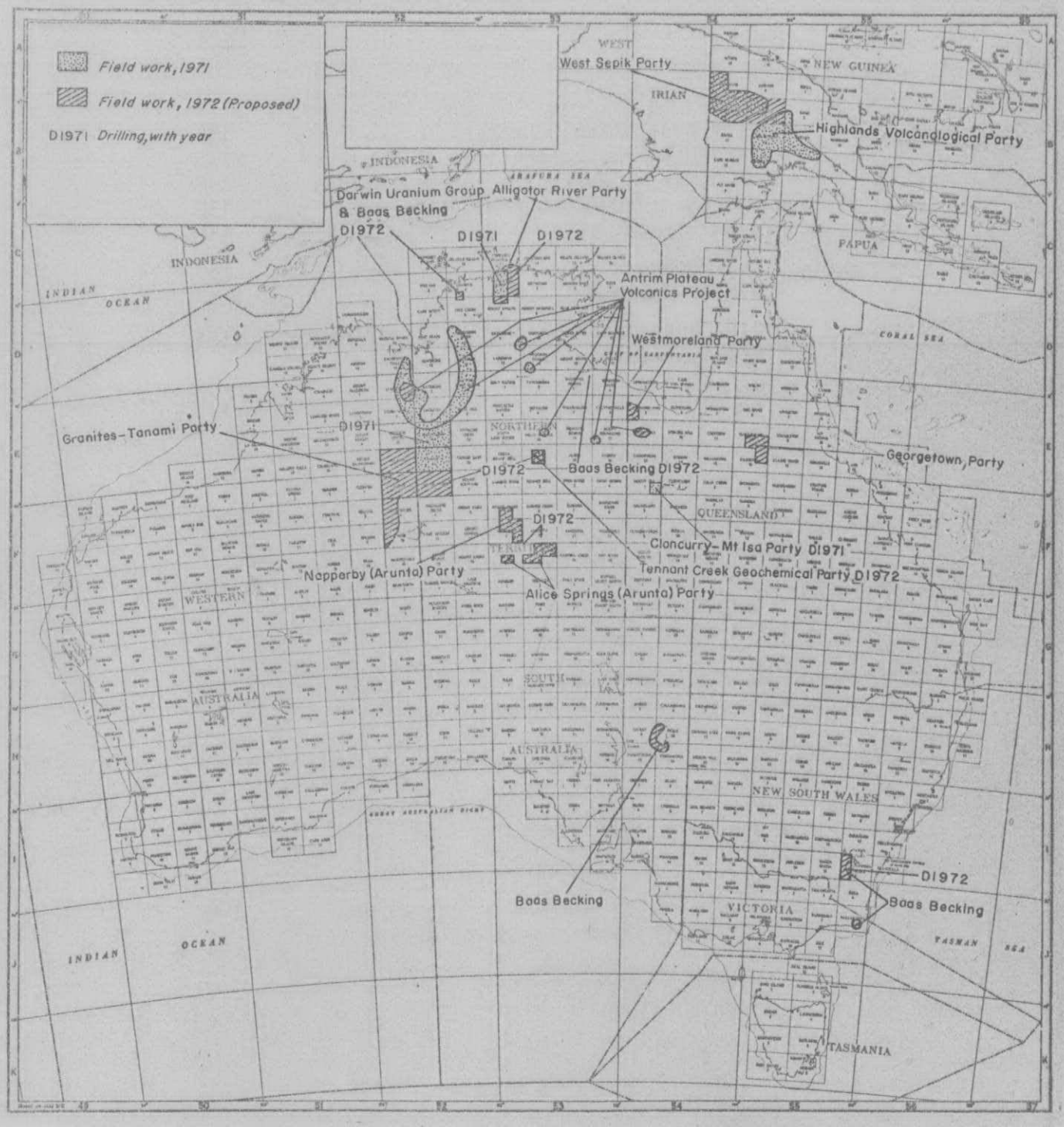


Fig MI Field activities, Metalliferous Deposits Section, Australia and Papua New Guinea

SUMMARY

The report that follows summarizes the work of the Metalliferous Section from November, 1970, to October, 1971.

Figure M1 shows the areas where mapping was carried out in 1971, and areas where field work is planned for 1972. Regional mapping was carried out in the Arunta Complex, the Granites-Tanami and Tennant Creek areas, the western part of Papua New Guinea, and Antarctica. Detailed or semi-detailed mapping took place in the Mount Isa and Alligator River areas, and in parts of the Arunta Complex. Field work for a special study of Antrim Plateau Volcanics and their stratigraphic correlatives in various parts of Western Australia, Northern Territory, and Queensland was almost completed during the year.

Field work for the Papua New Guinea volcanological project was carried out in parts of the highland area north of the Gulf of Papua, and work on volcano surveillance continued. Petrographic and geochemical studies on volcanic rocks from New Britain and islands to the west, from islands northeast of the Papuan mainland and northeast of New Ireland, and from the New Guinea Highlands proceeded for the greater part of the year.

Laboratory staff provided support services for a variety of field operations, and in addition engaged in project work in petrology, geochemistry, isotope geology, and geobiology; a joint geochemical project was started in the Tennant Creek area in co-operation with two mining companies and the Mines Branch of the Northern Territory Administration.

Publications and Records issued and in preparation are listed in a separate section of the Branch Summary of Activities headed "Publications and Records".

Totals for the period under review are as follows:

Bulletins:	Issued 2, in press 5, with editor 4, in preparation 11.
Reports:	Issued 4, in press 3, with editor 2, in preparation 7.
Explanatory Notes:	Issued 3, in press 4, with editor 5, in preparation 13.
Records:	Issued 17, in preparation 54.
Outside Publications:	Published 33, in press 15, submitted 12.

In addition, 15 special maps at scales ranging from 1:50,000 to 1:5,000,000 are in various stages of preparation, and two have been printed in readiness for inclusion in a Bulletin.

REGIONAL PROJECTS

FIELD WORK

ARUNTA PARTY, N.T.

by Various Authors

Personnel

BMR - R.D. Shaw and A.J. Stewart (Party Leaders)
R.G. Warren, A.Y. Glikson, and A.N. Yeates (part-time)

A.N.U. - M.J. Rickard, J.L. Funk, M. Yar Khan, R.W. Marjoribanks

University of Queensland - A. Allan, P. Woodford, S. Iyer

Fieldwork in the Arunta Complex extended from 13 May to 30 October; the areas mapped are shown in Fig. M2. Regional mapping of the Alcoota 1:250,000 Sheet area was completed, and semi-detailed mapping of the Riddoch,* Fergusson Range, Laughlen, and Burt 1:100,000 Sheet areas begun. Three post-graduate students from the University of Queensland and a staff member from the Australian National University contributed to this work. Two post-graduate students from A.N.U. continued detailed mapping of the Arltunga Nappe Complex, and mapping of that structure is now almost complete. A third post-graduate student from A.N.U. began detailed mapping of the Ormiston Nappe Complex, in the Hermannsburg 1:100,000 Sheet area. Work also commenced in the Reynolds Range 1:100,000 Sheet area, and broad-scale reconnaissance of the Mount Peake and Mount Theo Sheet areas was carried out in preparation for later mapping at 1:250,000 scale.

The various sections of the report were written by the field workers listed in brackets, unless otherwise stated.

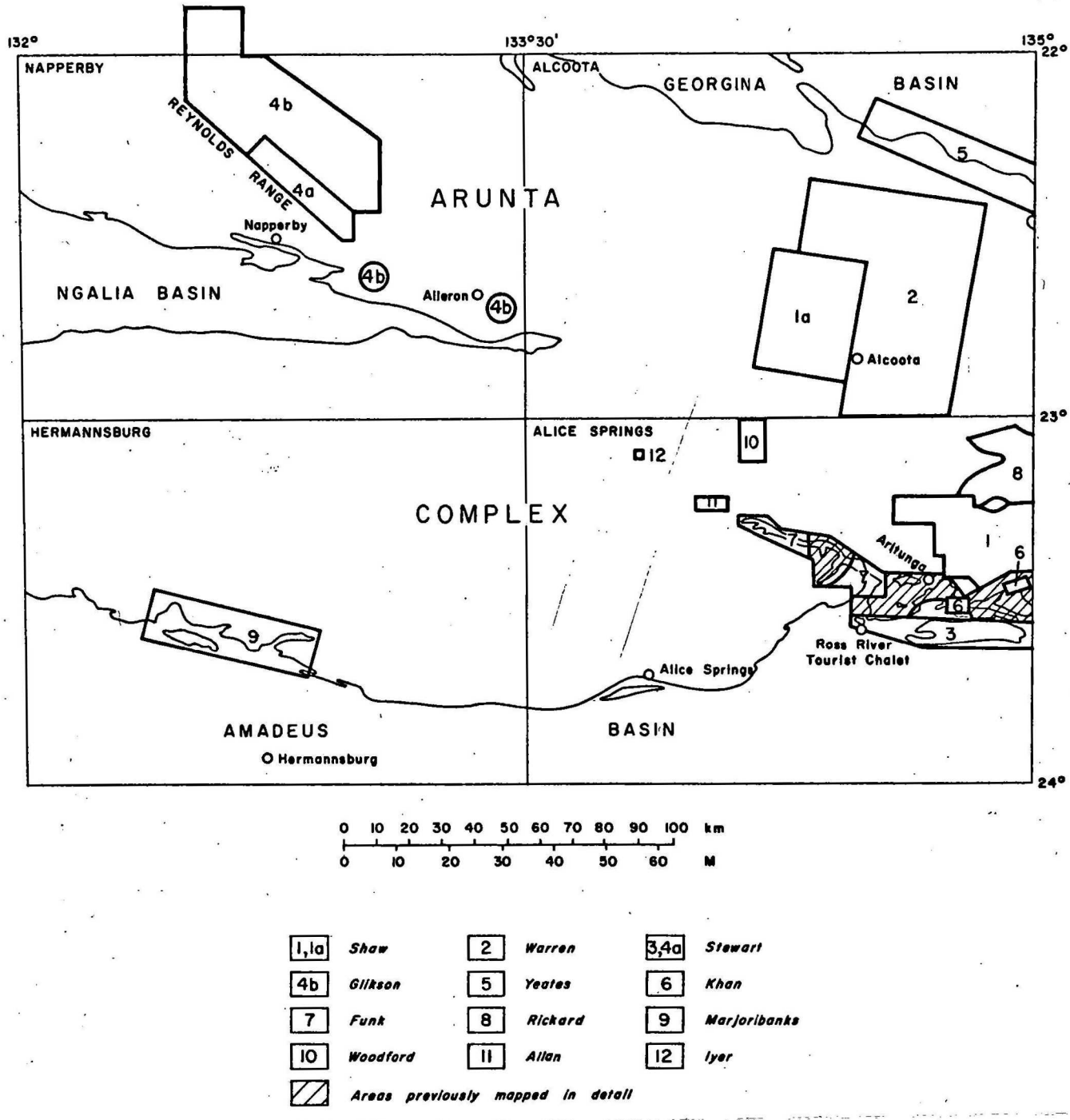
Regional Projects

Regional Mapping of the Alcoota 1:250,000 Sheet Area - (R.G. Warren, R.D. Shaw)

Further investigation of the rock units recognized during the 1970 field season continued. The unit pG_5 appears to grade into pG_{11} without any distinct boundary. pG_5 contains minor calc-silicate rocks not located during the 1970 field season. The unit consists of acid gneisses

* Alice Springs 1:250,000 Sheet area.

Fig M2



Locality map of Arunta Complex, showing areas mapped May — October 1971

showing evidence of local partial melting, basic to intermediate granulites and amphibolites, and minor calc-silicates. Multiple deformation has taken place within the unit. $p\mathcal{G}_{11}$ is made up of biotitic and quartzo-feldspathic gneiss and minor amphibolites. Outcrop is poor throughout most of the area mapped as $p\mathcal{G}_{11}$. The unit grades into $p\mathcal{G}_{13}$ through a zone about 1km wide; the division is based on the presence of muscovite, which is at present in $p\mathcal{G}_{13}$, but absent from $p\mathcal{G}_{11}$.

$p\mathcal{G}_{12}$ is now considered to be an orthogneiss which intrudes $p\mathcal{G}_{13}$, and is intruded by the Mount Ida Granite. Deformation of $p\mathcal{G}_{12}$ occurred before intrusion of the Mount Ida Granite.

The area mapped as $p\mathcal{G}_3$ has now been examined in more detail, and the rocks are correlated with units of the Harts Range Group on the basis of lithology and stratigraphic relationships. However, not all the rocks within $p\mathcal{G}_3$ have correlatives in the Harts Range Group, so the unit has been subdivided on lithology. The porphyritic gneiss in the vicinity of Queenie Flat Dam is considered to be an orthogneiss intruding fine-grained leucogneiss, whereas the equivalents of these two rock-types in the Harts Range Group, namely, the Entia Gneiss and Bruna Gneiss, were considered by Joklik in 1955 to be stratigraphically separate units.

Material for age determination has been collected from the Mount Ida Granite, the Ledan Peak Schists, and from pegmatites which intrude both units.

Stratigraphic Reconnaissance in the Northeastern Part of the Alcoota 1:250,000 Sheet area - (A.N. Yeates)

A reconnaissance was made to determine the relationships between the Central Mount Stuart Beds and beds informally referred to (in 1970) the Mount Michael Beds in the Alcoota 1:250,000 Sheet area, and the Mount Michael Beds and the Grant Bluff Formation on the Huckitta 1:250,000 Sheet area. The Mount Michael Beds are in fact Grant Bluff Formation; it is suggested that the name Mount Michael Beds should be abandoned. At Prince Henry Gap, in the Alcoota Sheet area, the Central Mount Stuart Beds unconformably overlie the Grant Bluff Formation, and appear to have been deposited against an old fault scarp.

Metallogenetic Studies - (R.G. Warren)

Collection of data continued for a mineral deposits map and later a metallogenetic map of the basement rocks in central Australia. Mines and mining regions within the

Arunta Complex were visited, and information gathered from mining companies and from geologists of the Mines Branch of the Northern Territory Administration. It is now possible to divide the Arunta Complex into several metalliferous regions:

1. The Bonyar-Jervois Range Metalliferous Region The rocks in this area are within the andalusite grade of regional metamorphism; they appear to contain simple mappable, stratigraphic sequences. Metallic deposits include copper, lead, zinc, bismuth, and tungsten. Localization of deposits is controlled by stratigraphy and by later small granitic intrusions.

2. The Harts Range-Strangways Range Metalliferous Region Small copper and base metal deposits occur within the Harts and Strangways Ranges, and several companies are exploring these at the present time.

3. The Arltunga Nappe Complex Metalliferous Region Small deposits of gold, copper, and base metals occur in the immediate vicinity of the Arltunga Nappe Complex. These were introduced during the Alice Springs Orogeny in the Carboniferous, and so are not Arunta Complex deposits in the strict sense, but belong to a later metallogenetic epoch.

4. The Patmungala Metalliferous Region The Patmungala Beds on the northern margin of the Ngalia Basin contain small occurrences of copper, lead, and arsenic, and also some banded iron formation.

5. The Mount Doreen Metalliferous Region Tungsten, copper, tin, and tantalum occur in a broad zone from Delmore Downs homestead in the Alcoota 1:250,000 Sheet area, to Mount Singleton in the Highland Rocks 1:250,000 Sheet area. The tantalum occurs as tantalite in pegmatites in this region. The tungsten, tin, and copper deposits occur in or close to granites. The granites should be mapped and their chemical characteristics established to determine which types are associated with the various metalliferous deposits.

6. The Mount Hardy Metalliferous Region The copper deposits in the Mount Hardy and Red Rock districts are far removed from any visible igneous source. However, these deposits post-date the schistosity of their enclosing rocks, and are considered to be epithermal.

7. The Georgina Basin Metalliferous Region Sediments in the southern part of the Georgina Basin contain minor bedded deposits of copper and lead.

Metamorphic Map of Central Australia - (D.J. Forman, R.D. Shaw)

Drafting of the metamorphic map of central Australia at a scale of 1:1,000,000 is in progress.

Semi-Detailed Mapping

Riddoch 1:100,000 Sheet Area

(a) Claraville-Lizzie Creek Area - (R.D. Shaw) Mapping in this area has been completed. Shallow-water metasediments consisting of calc-silicate rocks, schist, and amphibolite underlie most of the area, and have been intruded by mafic igneous rocks (also metamorphosed). The rocks have undergone at least three generations of folding, these being best displayed northwest of Muller Bore. Thrusting took place before the final folding was complete. Metamorphism to the upper amphibolite and lower granulite facies accompanied the folding. Rocks of similar composition and grade, which crop out to the south of a group of east-trending high-angle faults, have been folded about axes that plunge gently northeast; the existence of earlier fold generations is not established. Farther south the effect of a later metamorphism of a dynamic type is confined to a zone of intense deformation localized near infolded and inthrust cover rocks (Heavitree Quartzite). Auriferous quartz veins were introduced into this zone during the final stages of deformation. North of the deformed zone, the high-grade rocks have been retrogressed to the upper greenschist facies, but the retrogression is patchy, and high-grade relics are common.

(b) Mount Brassey Area - (M.J. Rickard) The work this year extended the mapping coverage into the Harts Range, in the northeast corner of the Alice Springs 1:250,000 Sheet area.

An area of gneiss, calc-silicate rocks, quartzite, marble, and amphibolite has been mapped, and a stratigraphic sequence is emerging. Similar lithologies have been identified to the southwest and in the intervening ground by Shaw, Stewart, and Funk, and it is confidently expected that stratigraphic subdivision and lithological correlation will be achieved. All the rocks are of the amphibolite facies, with garnet and biotite the most common minerals in the gneiss; sillimanite is of restricted occurrence. Feldspar porphyroblasts are common, and growth to large crystals is to some extent stratigraphically controlled.

Three phases of folding have been established. The first is isoclinal, but details of its geometry are not clear. The second phase is tight, and has a strongly variable plunge to its axial planes, which trend east-west. Strong schistosity is commonly developed. The second-phase folds control the map pattern of the lithological units. The third-phase folds are open, upright folds with an east-west trend.

A copper-zinc prospect (Oonagalarbi Prospect) occurs several kilometres west of Mount Brassey, and is being investigated by Russgar Minerals, N.L. The mineralization is associated with a sequence of calc-silicate rocks, para-amphibolite, and marble.

(c) Laughlen and Burt 1:100,000 Sheet Areas - written by R.D. Shaw Three post-graduate students from the University of Queensland were assisted by the BMR in their work in the Strangways Range.

(i) Woollanga Bore Area (P. Woodford) This area contains calcareous metasediments, garnet-quartz-feldspar gneiss, (sillimanite-) spinel-hypersthene granulites, and granulites derived from basic igneous rocks; the rocks have been metamorphosed to the high granulite facies. Several of the spinel-hypersthene granulites contain sapphirine. Petrographic, geochemical, and O-isotope studies are in progress.

(ii) Harry Bore Area (A. Allan) A meta-igneous complex including leucocratic pyroxene granulite and leucocratic norite, together with small amounts of pyroxene anorthosite, appears to be unconformably overlain by metasediments. A major shear-zone cuts the rocks in the southern part of the area.

(iii) Yambah Homestead Area (S. Iyer) In this area, kyanite-bearing schist is associated with granulite from which it appears to have formed by retrogression. Both the kyanite schist and the granulite are cut by a shear-zone in which retrogression to the greenschist facies has taken place. Further work in this area will be concentrated on K-Ar, Rb-Sr, and O-isotope studies.

Planet Metals N.L. are investigating several copper and lead prospects in the Strangways Range.

Detailed Mapping in the Arltunga Nappe Complex

Northwestern Part of the Arltunga Nappe Complex - (J.L. Funk)

Detailed mapping of the cover rocks (Heavitree Quartzite and Bitter Springs Formation) of the White Range Nappe in the area extending from Bald Hill in the west to near Hillsoak Bore in the east was completed.

Five generations of folds are now recognized, the first three of which represent superposed, co-planar deformations which all have an east-west trend. The schistosity and north-plunging lineation in the cover rocks are related to the second generation of folds (reclined). Evidence for an earlier inclined to recumbent phase with an east-west trend was found where the reclined folds were seen to refold a pre-existing lineation. The first generation folds appear to have formed during the early episode of north to south thrust faulting and basement-cover inversion. The reclined folds are well exposed at the western end of Bald Hill, where a stack of five tight folds abruptly terminates the cover rocks, and forms the end of the nappe.

Faulted overturned folds along the southern margin of the nappe form a major dislocation that separates undeformed autochthonous Heavitree Quartzite from the intensely deformed allochthonous cover rocks. This dislocation may be the remnants of the basal sole fault of the thrust nappe.

In the area north of Hillsoak Bore, a major thrust nappe of basement rocks gliding on Bitter Springs Formation has overridden an inverted slice of Heavitree Quartzite for about 2 km. The inverted Heavitree Quartzite moved along a glide horizon about 100 metres above the base of the Bitter Springs Formation in the autochthonous cover sequence.

The basement rocks comprise monotonously uniform rock-types with a paucity of minor structures. To date, it has not been possible to separate refoliation of the basement rocks associated with the cover deformation from any earlier structures. The structures in the allochthonous basement rocks exhibit great similarity to the structures preserved in the cover rocks in terms of style, orientation, and sequence of fold generations. Refoliation of the basement is obvious only in the narrow zone of mylonite that represents the basement-cover contact. In only a few places is it possible to observe relict basement structures cut by the new schistosity.

At Winnecke Gap and at many other places along the north and south flanks of the nappe, a well exposed layer of Bitter Springs Formation is sandwiched between the basement and the Heavitree Quartzite; the origin of these layers is not fully understood.

Atnarpa Area of the Arltunga Nappe Complex - (M.Yar Khan)

Parts of the northeastern sector of the Atnarpa Range (informal name) were again studied in order to establish the relationship of the quartz-elongation lineation to the folding, and more structural measurements were recorded from this area. The lineation is associated with isoclinal folds, and has been folded by later open folds that in some places plunge west-northwest, elsewhere southwest.

The area west of Atnarpa homestead was mapped in order to elucidate its relationship to the Atnarpa Range. In this area the stratigraphic order in the thrust sheets, as in the Atnarpa Range, was found to be right way up.

Some mapping and sampling were done in the basement rocks north of the area mapped last year.

Southern Part of the Arltunga Nappe Complex - (A.J. Stewart)

(a) Giles Creek Synform The Giles Creek Synform is the southernmost outlier of the Arltunga Nappe Complex. The synform consists of basement rocks of the Arunta Complex underlain by inverted Heavitree Quartzite, except along the northern margin of the synform, where the Quartzite is faulted out. The whole synform 'floats' on a sea of contorted dolomite and shale of the Bitter Springs Formation. The basement rocks of the synform are dominantly hornblendic types. Amphibolite, epidiorite, and hornblende gneiss are the main rock-types in the eastern part of the area, and an assemblage of interlayered amphibolite and quartzite and lesser amounts of feldspathic gneiss and metavolcanic rock form the bulk of the central part of the area. Two small outcrops of weakly metamorphosed basalt and one of norite occur in this central area. The western part of the synform consists mainly of igneous rocks, including coarse-grained leucogranite and weakly foliated granodiorite with numerous xenoliths. Cross-cutting dykes of pegmatite, aplite, and microgranite are abundant throughout the entire area. All the basement rocks are epidotized. At the southwestern end of the synform, a very heterogeneous assemblage of diorite, amphibolite, talc-chorite rock, quartz-hematite rock, and epidote-actinolite-hematite marble crops out; a small massive deposit of the red hydrogarnet hibschite occurs at the contact of marble and talc-tremolite-chlorite rock.

(b) Area North of Ross River The southwesternmost corner of the White Range Nappe, in the area 7 km north of Ross River Tourist Chalet, was also mapped. This area was previously interpreted as a synform of basement rocks underlain by inverted Heavitree Quartzite, but the mapping has shown that the northern limb of Quartzite dips and faces

south, and is therefore right way up; traversing southwards across this 'limb', one encounters pebble sandstone and conglomerate at the base, then cleaner blocky sandstone, followed by contorted platy quartzite at the top. This sequence is characteristic of the lower, middle, and upper members (respectively) of the Heavitree Quartzite. The platy upper beds are in contact with basement rocks on the southern side of the ridge, and so the junction between the two formations must be a fault. The overturning of the southern ridge of Quartzite is probably due to rotation during the overall southward translation of the nappe.

Detailed Mapping in the Ormiston Nappe Complex
(R.W. Marjoribanks)

Detailed mapping was carried out on the Arunta Complex and overlying Upper Proterozoic rocks in the region of Ormiston Pound. Mapping was also extended westwards along the basement-cover contact as far as Mount Razorback.

Arunta basement rocks in the area mapped are at the amphibolite facies of regional metamorphism. The basement includes an extensive quartzite unit, the Chewings Quartzite, which unconformably underlies, and is very different in appearance from, the Heavitree Quartzite. The existence and relationships of the two quartzites are quite unambiguous in this area.

The central part of Ormiston Pound is occupied by a large granite mass which appears to have been emplaced after the development of the main metamorphic foliation in the surrounding Arunta rocks. The granite is unconformably overlain by the basal grits and conglomerates of the Heavitree Quartzite.

At least three phases of folding, all earlier than the Alice Springs Orogeny, can be seen in the Arunta rocks. The first two phases are associated with recrystallization and the development of strong penetrative axial-plane foliation.

The structure of the cover-rocks which form the northern boundary of Ormiston Pound is interpreted as two large recumbent folds with lower limbs partly replaced by thrusts. No large-scale inversion has taken place. These folds will be called the Ormiston Fold Complex. The northern boundary of the complex is formed by the uppermost (northernmost) thrust sheet, which brings Arunta rocks southwards over upper Heavitree Quartzite.

Westwards from Ormiston Pound, the basement and cover are affected by recumbent folding and thrusting similar to those of the Ormiston Fold Complex. The southward movement of the rocks in these structures has not been great. Displacement along the basal thrust of the upper fold at Ormiston Gorge is about 1 km.

South of Davenport Creek, a large outcrop of Arunta rocks surrounded by Heavitree Quartzite has been confirmed as a synformal structure. Abundant well preserved cross bedding indicates that the Heavitree Quartzite youngs downwards. This is the nose of the Razorback Nappe as described by Forman and Milligan (BMR Report 103, 1967).

Between Mount Sonder and Mount Razorback, the northernmost thrust, which brings Arunta rocks southwards on to the back of right-way-up Heavitree Quartzite, is interpreted as being the thrust-out lower limb of the Razorback Nappe. Southward movement of the nose of the Razorback Nappe is at least 6 km. The nappe overlies the folds and thrusts seen between Mount Razorback and the Ormiston Pound, and is structurally comparable to the White Range Nappe of the Arltunga Nappe Complex.

The effects of the Alice Springs Orogeny on the Arunta rocks are slight, and are readily identified only in rocks near the basement-cover contact. Here, overturned folding and crenulation cleavage in the Arunta rocks can be correlated with folds seen in the cover. Narrow zones of retrogression are present in the vicinity of the large thrusts, but are of restricted occurrence. The Heavitree Quartzite, except where adjacent to the thrust faults, is undeformed and unmetamorphosed. No north-south folds or lineation are present in the cover.

Detailed Mapping in the Reynolds Range 1:100,000 Sheet Area - (A.J. Stewart)

The Reynolds Range in this area consists of a sequence of weakly metamorphosed sedimentary rocks of unknown but probable Precambrian age. The range is flanked on each side by large bodies of intrusive gneissic granite. The sedimentary sequence begins with massive pebble arkose which crops out along the northeastern side of the range; sandstone beds in the arkose have been contact metamorphosed to andalusite-biotite hornfels. Xenoliths of arkose are present in the granite. The arkose is overlain by a steeply south-west-dipping sequence of interbedded shale, sandstone, and quartzite, intruded by sills of granodiorite; minor amounts

of silvery-blue hematitic sandstone, boulder conglomerate and low-grade calc-silicate rocks are present in the central part of the range. Primary sedimentary structures are common in the sediments, and all indicate a consistently southwestward and therefore right-way-up sense of facing. Much of the shale has been metamorphosed to sericite slate, and andalusite porphyroblasts are abundant in the slate where it adjoins the sills of granodiorite. Most of the granodiorite is phyllonitic, but in places the phyllonite grades into lenses of nearly massive rock; xenoliths and rafts of slate and quartzite are common in the granodiorite. Boudins and lenses of vein quartz, and shear-folded aplite and quartz veins, indicate that the phyllonite formed by a combination of shearing and flattening. Small quartz-hematite lodes have formed where the hematitic sandstone is brecciated and intruded by the granodiorite.

Several sets of folds are present in the sedimentary rocks of the Reynolds Range. The earliest folds are tight to isoclinal with steep axial planes parallel to the northwest trend of the range, and axes whose plunges range from subhorizontal to subvertical (in different folds). In the southeastern part of the range, later folds are southwest-verging open drag folds with subhorizontal axes, and these are accompanied by an axial plane cleavage that cross-cuts the earlier folds. In the central part of the range the later (open) folds have vertical axes, and their axial planes trend obliquely across the range. Also in this area are steeply dipping kink bands in the foliated rocks (slate and phyllonite), and the range is cut by large, east-west trending wrench faults. Thus, the later stages of deformation in the two parts of the range appear to have been very different, viz., upthrusting and drag folding towards the southwest in the southeastern area, and west-northwest/east-southeast compression in the central area.

Results of detailed mapping by A.Y. Glikson in the northeastern part of the Reynolds Range 1:100,000 Sheet area are presented in the report for the Petrological, Geochemical, and Geochronological Laboratories, in this Record.

Reporting of Results

The results of work done by the Arunta Party to date will be reported as follows:

Progress reports (Records) will be issued on the Arltunga Nappe Complex (Rec. 1971/66), on mapping in the Reynolds Range, Tea Tree, and Aileron 1:100,000 Sheet areas, and on mineral deposits of the Arunta Complex.

A Record (preliminary text for Report) and Explanatory Notes on the Alcoota 1:250,000 Sheet area will be issued.

A Record (preliminary text for Report or Bulletin) on the Arltunga Nappe Complex will be issued.

GRANITES-TANAMI PARTY, N.T.

by

D.H. Blake

PERSONNEL: D.H. Blake, I.M. Hodgson, and P.A. Smith

Introduction

Field work in the Granites-Tanami area of the Northern Territory was carried out between mid-June and early October. During this period a reconnaissance survey was made of the area covered by the Birrindudu and Tanami 1:250,000 Sheets (Fig. M3). This is a semi-desert area of low relief, consisting of hills and strike ridges, generally less than 70 m high, separated by smooth to gently undulating plains. The annual rainfall ranges from about 25 cm in the south to 40 cm in the north. There are no permanent water courses and very few permanent water holes.

A base camp was set up at Tanami, an abandoned gold mining settlement on the road connecting Alice Springs, 640 km to the southeast, and Halls Creek, 320 km to the northwest.

The geological mapping involved both Land Rover and helicopter traverses. Additional information was obtained from vertical drill holes, up to 80 m deep, put down by a BMR drilling crew under E. Lodwick. Photogeological maps of the area prepared by C.J. Simpson in 1969 proved invaluable in the field.

GEOLOGY OF THE BIRRINDUDU AND TANAMI 1:250,000 SHEET AREAS

Precambrian, Cambrian, (?)Mesozoic, and Cainozoic rocks crop out in the Birrindudu and Tanami Sheet areas. The Precambrian rocks comprise very steeply dipping and weakly metamorphosed sedimentary and volcanic rocks, which are assigned to the Lower Proterozoic; generally gently dipping sedimentary and volcanic rocks, which are assigned to the Upper Proterozoic; and various intrusive granitic rocks. The ages of these rocks are mostly uncertain, and will remain so until isotopic age determinations are available. The Cambrian consists predominantly of basaltic volcanics, but also

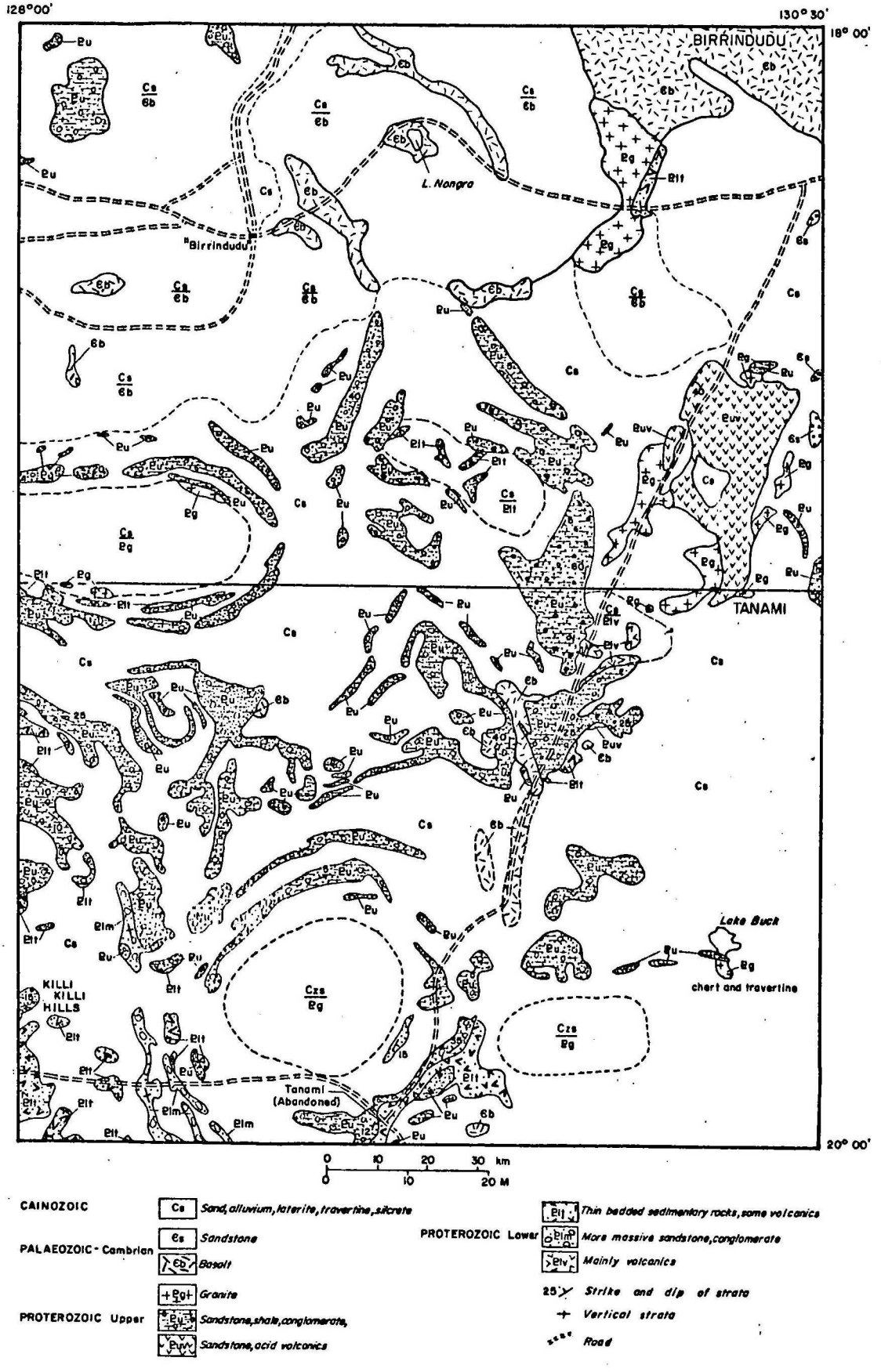


Fig M3 Geological sketch map of the Birrindudu and Tanami 1:250,000 sheet areas.

To accompany Record 1971/103

E52/A2/13

includes some sandstone outcrops in the extreme east. Scattered outcrops of possibly Mesozoic sedimentary rocks occur mainly in the south. Over half the area is covered by a veneer of Cainozoic alluvium, wind blown sand, soil, laterite, travertine, and silcrete. The main rock units are shown on the accompanying geological sketch map (Fig. M3).

The Lower Proterozoic rocks consists of thinly interbedded and commonly cherty shale, mudstone, siltstone, and 'dirty' sandstone; more massive cross-bedded 'clean' sandstone and conglomerate; and basaltic to rhyolitic lava and tuff. The thinly bedded sedimentary rocks, many of which appear to be highly tuffaceous, and the volcanic rocks are commonly closely associated. The more massive 'clean' sandstone and conglomerate are largely confined to a northerly striking belt west of Tanami. Iron-rich gossans are locally common, as near Tanami. The Lower Proterozoic rocks are tentatively correlated with the Halls Creek Group of the East Kimberley area. They are typically very steeply dipping, and commonly show minor contortions; cleavage is generally present. They have been affected by low-grade regional metamorphism, and are recrystallised and sheared adjacent to granite southwest of Birrindudu.

The Upper Proterozoic rocks form most of the hills and ridges in the area, except in the northeast, and they underlie much of the area covered by Cainozoic superficial deposits. They include the Mount Winnecke Sandstone and rocks mapped as Gardiner beds on the adjoining sheets in Western Australia. The dominant rock types exposed are sandstone and conglomerate, but thick sequences of shale, mudstone, and siltstone are also present, generally forming depressions covered by a veneer of sand between sandstone ridges. In addition stromatolitic chert crops out at several localities, and acid volcanics and tuffaceous rocks are associated with sandstone in the eastern part of the area. No glacial deposits have been recognised. The sandstone beds generally show cross-bedding, and ripple marks and mud cracks are locally common. Bedding planes are typically undulating. Glauconitic sandstone occurs at several levels, and is often a useful marker horizon. The presence of glauconite indicates that most of the sedimentary rocks are probably marine. Shale, mudstone, and siltstone are best developed near the base of the succession, in contrast to chert, which is confined to the uppermost part, and is commonly the youngest Upper Proterozoic rock exposed. In the east, acid volcanics interfinger with sandstone throughout the succession, and much of the sandstone appears to be highly tuffaceous. The volcanics here consist of lava flows, tuff, minor agglomerate, and possibly some high-level laccolithic intrusions. These rocks are much altered (propylitised) and generally strongly weathered. The intimate association of lava flows and water-laid sediments, and the abundance of associated tuffaceous rocks but lack of ignimbritic deposits, indicates that the volcanic rocks were probably erupted under water.

There is a marked angular unconformity between the Upper and Lower Proterozoic successions, and the Upper Proterozoic appears to be younger than granite northwest of Tanami and southwest of Birrindudu. However, the Upper Proterozoic succession is intruded by granite in the east.

Granite of Proterozoic age crops out in several parts of the area. In the east the Winnecke Granophyre, a high-level intrusive complex of biotite granite, granophyre, and quartz-feldspar porphyry intrudes Lower and Upper Proterozoic rocks, and is overlain by Cambrian basalt. Southwest of Birrindudu muscovite granite intrudes Lower Proterozoic rocks. Granite also occurs northeast and northwest of Tanami.

Most of the Cambrian rocks in the area are correlated with the Antrim Plateau Volcanics. They consist of basalt lava and minor associated tuff and chert. The basalt is generally deeply weathered, ranging in colour from black to reddish-brown and white, and most outcrops are capped by laterite. The present outcrops are remnants of a much more widespread cover which extended south at least as far as Tanami. Also thought to be Cambrian are scattered low outcrops of ferruginous sandstone along the eastern edge of the area; these have been mapped as Merrina beds. The Cambrian rocks appear to be sub-horizontal, and are unconformable on the underlying Proterozoic rocks.

Rocks of possible Mesozoic age form scattered small outcrops (not shown on Fig. M3) mainly in the Tanami Sheet area. They consist of flat-lying, bedded, white, calcareous and silicified sandstone and minor conglomerate, and are generally less than 3 m thick. Cross-bedding is apparent in places. The beds cap flat-topped hills, especially those of basalt. They are probably fluvial deposits, but their distribution cannot be related to the present drainage pattern, indicating that they are probably at least as old as early Tertiary, and may be as old as Mesozoic.

The extensive Cainozoic deposits comprise Recent alluvial sand, silt, and clay associated with the main drainage lines in the area; older soil and alluvium, mostly forming well-grassed black soil plains (largely on basalt); wind blown sand, which in the southeast and southwest forms low longitudinal dunes with east-west trends; laterite; travertine, mainly along former river courses; and silcrete, which is patchily developed on most rock types, commonly as hill cappings. Lateritic weathering profiles up to 10 m thick are developed on most broad ridge and hill crests and plateau surfaces. These profiles are thickest on basalt and granite, and are thin or absent on sandstone.

The structure of the Precambrian rocks is complex. The Lower Proterozoic rocks are tightly folded, probably isoclinally, along mainly northerly-trending axes. This folding occurred during an early period of orogenesis, before the deposition of the Upper Proterozoic sediments. The Upper Proterozoic rocks have been more gently folded, and the Lower Proterozoic rocks refolded in a later orogenic period. During this period broad domes and basins were formed, separated by zones of irregular folds with very variable dips. The broad domes have cores of granite or Lower Proterozoic sedimentary rocks, and they appear to have acted as stable blocks that were surrounded by mobile zones. Many faults occur in the area, but no major trends have been identified as yet. Most of the faulting probably took place during the later orogeny, and few of the faults affect the flay-lying Cambrian and younger rocks.

The only known mineral deposits of possible economic significance at present are gold at Tanami, which occurs in quartz veins cutting Lower Proterozoic thinly bedded rocks, and uranium at the Killi Killi Hills, which occurs in a conglomerate at the base of the Upper Proterozoic.

Reporting of Results

The results of the work reported here will be presented as a Record (preliminary text for a Report) and as Explanatory Notes on the two 1:250,000 Sheet areas.

ANTRIM PLATEAU VOLCANICS PROJECT, N.T., W.A., AND QLD

by

R.J. Bultitude

Personnel: R.J. Bultitude

The inter-field season was spent examining in detail core and chip samples obtained from nine stratigraphic holes drilled in the Antrim Plateau Volcanics during the 1969 and 1970 field seasons. Forty five flows and one band of agglomerate were penetrated during the course of the drilling. Flow thicknesses range from a minimum of 4 m to a maximum of 114 m. The average flow thickness is 36 m.

The lavas are dominantly basalts. Labradorite, clinopyroxene, opaque oxide, and devitrified glass or a quartzo-feldspathic residuum account for a high proportion of the total volume of the rocks. Accessory components include olivine (replaced by chlorite or "iddingsite"), quartz, hornblende, mica, sanidine, and apatite. The majority of flows show a central, compact or nearly non-vesicular zone in the upper and generally also the basal parts. Basalt from the more massive parts of virtually every flow contain phenocrysts of plagioclase. However, feldspar phenocrysts are nowhere abundant.

Normally, chips from the central part to within 3 m or so of the base of a flow are characterised by relatively coarse grainsize; the grainsize becomes noticeably finer towards the top and the base of the flow. Devitrified glass decreases in abundance from the chilled upper and basal vesicular portions towards the massive, highly crystalline interior. Devitrified glass may account for an estimated 80-90% of the total volume of basalt from a chilled contact, whereas in the centre of a flow interstitial "glass" generally accounts for only 5-10% of the rock.

The occurrence of minor amounts of interstitial primary quartz in the lavas is a characteristic of the formation. In most flows the quartz is either very sparse or absent in the upper parts, and becomes more abundant with depth. Maximum concentrations occur in the central and lower parts. Usually there is a noticeable decline in the abundance of quartz in the chilled basal 1.5-3 m of a flow. This decrease is accompanied by an increase in the amount of devitrified glass, a diminution in grainsize, and sometimes the appearance of olivine pseudomorphs.

Augite and/or sub-calcic augite ($2V=73^{o}$) is the most common pyroxene. However pigeonite ($2V=0-15^{o}$) has been identified in a number of flows. It is generally associated with a more calcic clinopyroxene. The pigeonite occurs most commonly (and apparently abundantly) in the more quartz-rich rocks as small groundmass grains. Large phenocrysts of pigeonite were found in two flows.

Accessory amounts of alkali feldspar (sanidine) and primary amphibole and mica also occur in massive relatively quartz-rich basalts from the central and lower parts of some flows.

Vesicles are frequently filled with a variety of secondary minerals, the most common being chlorite, quartz, calcite, chalcedony, agate, prehnite, and pumpellyite. South of Wave Hill homestead prehnite-lined geodes up to 1 metre long occur in massive basalt. In other areas geodes filled with amethystine quartz have been weathered out of the basalt.

Almost invariably the vesicular parts of flows are more extensively altered than the massive parts. Most flows are characterised by moderately to heavily altered upper contacts and less altered basal contacts; the centres of flows are massive and fresh to moderately altered. Typically, the thicker the flow, the fresher the basalt from the central and lower parts. Locally, former glass and ferromagnesian minerals in basalt from the uppermost parts of flows are very extensively chloritised or replaced by pumpellyite.

On a modal mineralogical classification the basalts of the Antrim Plateau Volcanics range from olivine tholeiites through tholeiites to quartz tholeiites. Some of the more quartz-rich variants are probably best described as andesites. Often several rock types are represented in single flows, suggesting that some fractionation occurred in the lavas during consolidation. Alternatively, the variations in modal composition may be entirely due to differences in degrees of crystallinity.

Specimens selected for chemical analysis display a variation in silica contents ranging from around 50% to around 56%, the majority having SiO_2 contents in the range 52-54%. Geochemical analyses were carried out on about 300 specimens from the stratigraphic holes. The results have yet to be interpreted.

During the 1971 field season, selected areas of the main body of the Volcanics in the Northern Territory and Western Australia were examined in detail, and specimens were systematically collected for petrological, chemical, and geochronological investigation. Several small isolated outcrops of basic volcanics in the eastern part of the Northern Territory were examined - viz., the Helen Springs Volcanics, Nutwood Downs Volcanics, and the Peaker Piker Volcanics (Fig. M1); it was impossible to collect any fresh rock from the Peaker Piker Volcanics. The Colless Volcanics in western Queensland could not be reached because of unfavourable weather. These minor occurrences of volcanics are all of probable Lower Cambrian age, and have been correlated by Dunn and Brown with the Antrim Plateau Volcanics.

Outliers of the Volcanics were found by the Granites-Tanami Party (see Fig. M3) as far south as the southern margin of the Tanami 1:250,000 Sheet area, and additional outcrops could be found even farther south. Near Blackfellow Rockhole, in the Limbunya 1:250,000 Sheet area, the uppermost part of the Volcanics over quite an extensive area consists of coarse agglomerate which is commonly between 30 and 35 m thick.

Economic aspects of the Volcanics were briefly dealt with in last year's Annual Summary.

Reporting of Results

The results of this special study of the Antrim Plateau Volcanics will be presented in a Bulletin; this will be preceded by a comprehensive Record containing all available information. A Record (1971/69) on the results of stratigraphic drilling in the Volcanics is almost ready for issue.

TENNANT CREEK PARTY, N.T.

by

R.G. Dodson

Personnel: J.R. Mendum, P.C. Tonkin (both resigned August)

During a short field season Mendum mapped the area southwest of the Black Angel trigometrical station to complete the regional mapping of the Tennant Creek 1:250,000 Sheet area. Near the Black Angel a greywacke/shale sequence (Warramunga Group) is overlain by greywacke which contains pods of breccia, possibly of volcanic origin.

Tonkin further investigated the astrobleme structure west of Kelly West bore, and collected additional specimens of shatter cones. The astrobleme is about 1.5 km across, and was formed in rocks of the Hatches Creek Group; remnants of flat-lying post-impact Gum Ridge Formation (Cambrian) are preserved in the central part of the structure.

Reporting of Results

A Record describing the geology of the Tennant Creek 1:250,000 Sheet area is nearing completion, and will form the basis for a Bulletin. Explanatory Notes are also being prepared.

WEST SEPIK PARTY, T.P.N.G.

by

H.L. Davies

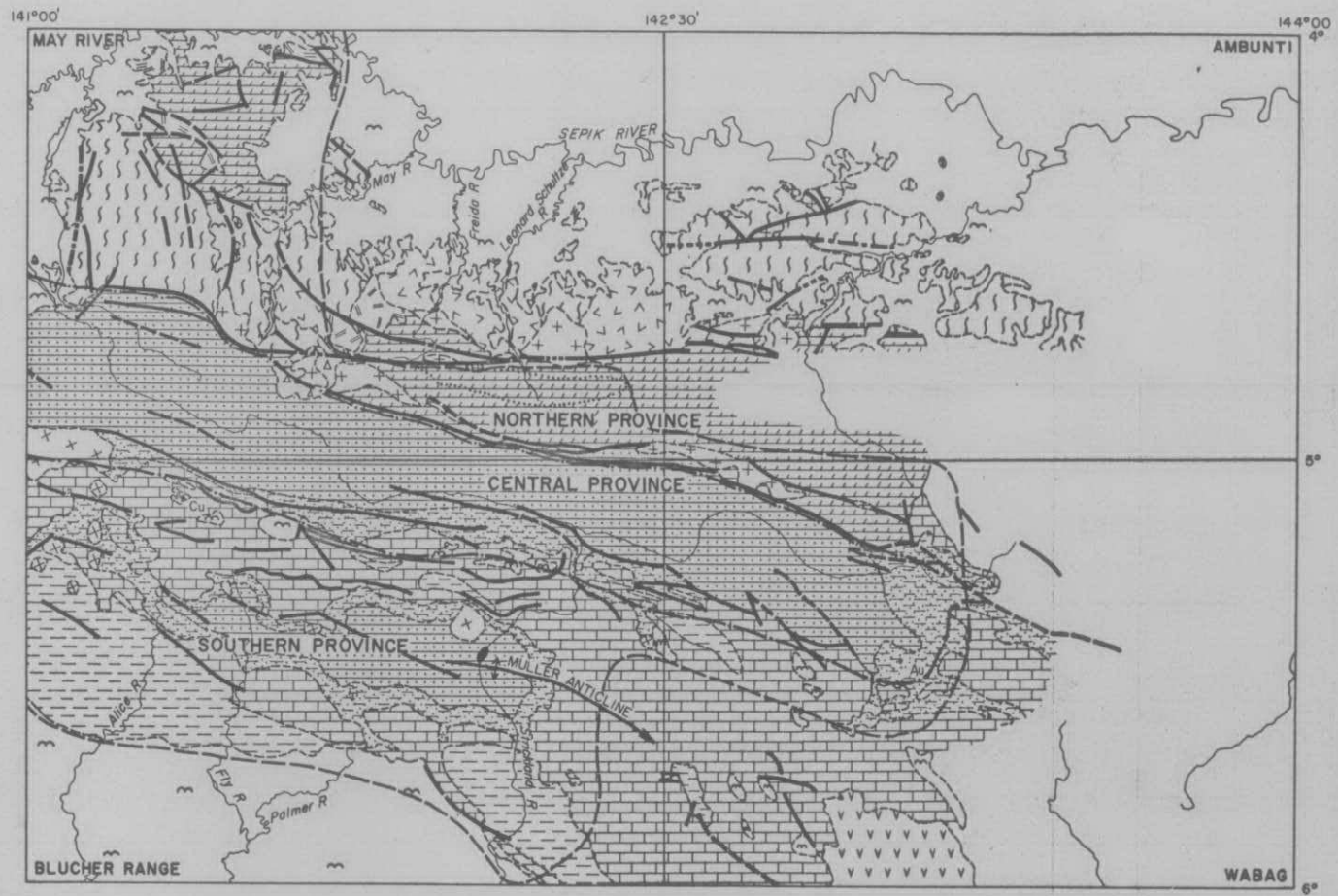
Personnel: H.L. Davies, R.J. Ryburn, D.S. Hutchison, M. Norvick, I.P. Sweet; draftsman P. White, and camp manager A.C. Russell. Others who participated for periods of up to five weeks were C.E. Maffi (photogeologist), P.E. Pieters (Geological Survey of Papua New Guinea), D.E. Coutts (BMR gravity survey), and Professor D.S. Simonett (University of Sydney, remote sensing specialist).

Introduction

The object of the survey is to map the geology of an area in the central ranges of Papua New Guinea between Porgera and the West Irian border. The area overlaps previous BMR mapping in the northeast (South Sepik) and east (Wabag area), and previous oil company mapping in the southeast and south (BP and APC).

The survey area consists of part of the May River, Ambunti, and Wabag 1:250,000 Sheet areas and almost the entire Blucher Range 1:250,000 Sheet area (Fig. M4). In addition a little information has been obtained on the southern Aitape and northern Lake Kutubu and Raggi Sheet areas.

The area is of interest for both its copper and petroleum potential. Kennecott Pacific are investigating porphyry copper mineralization on a tributary of the Ok Tedi (Alice) River (5°30'S, 141°15'E) and at Tifalmin (5°05'S, 141°28'E), and Carpentaria Exploration Company Pty Ltd is investigating similar mineralization on the Frieda River (4°12'S, 141°50'E) found in 1967 by the BMR South Sepik Party. Texaco has recently drilled a 3500 m oil exploration well on the Cecilia anticline southeast of the Strickland River (6°03'S, 142°20'E), and Australasian Petroleum Company is currently drilling an exploration well near Komo-Mananda, farther to the southeast (at 6°10'S, 142°55'E). Most of the stratigraphic information for these wells was obtained from oil company geological mapping in the Strickland River area.



NORTHERN PROVINCE

QUATERNARY	Alluvium
	Ultramafic breccia
MIOCENE	Diorite, gabbro, andesite porphyry
MIDDLE MIOCENE	Agglomerate, tuff, siltstone
OLIGOCENE?	Ultramafics
CRETACEOUS–EOCENE	Slate, schist, marble, metavolcanics (including blueschists)
JURASSIC–OLIGOCENE	High-grade regional metamorphics

CENTRAL AND SOUTHERN PROVINCES

QUATERNARY	Alluvium, Volcanics
PLIOCENE	Diorite, andesite porphyry
UPPER MIOCENE–PLIOCENE	Siltstone
UPPER OLIGOCENE–MIDDLE MIOCENE	Limestone
UPPER CRETACEOUS	Siltstone, sandstone
JURASSIC	Shale, sandstone, some slate and phyllite
PRE JURASSIC	Granite
.....	Approximate limit of glaucophane-epidote metamorphic rocks

0 20 40 60 80 km
0 10 20 30 40 50 M

LOCALITY MAP

- Geological boundary, position approximate
- Anticline, showing direction of plunge
- Fault, position accurate
- Fault, position approximate
- Inferred fault
- Concealed fault
- Province boundary
- Limit of 1971 mapping

Fig. M4 Geological sketch map, West Sepik Region, P.N.G.

To accompany Record 1971/103

B 54/A/14

The survey lasted from June to December with a short break in August. A helicopter was used throughout: a Bell 4763B1 for three months, and a Jetranger for about six weeks; the contractor was Helicopter Transport Pty Ltd of Cairns, Queensland. A permanent base was established at Telefomin, and temporary bases were occupied at Frieda River, Lake Kopiago, and Porgera. Field-work was carried out by helicopter reconnaissance, day traverses, and traverses of up to four days. Field observations were plotted on vertical aerial photographs where these were available, but where these werenot available, observations were plotted on side-looking radar imagery which had been obtained by the Department of Army from Westinghouse-Raytheon in 1970. The geologists took polaroid photographs from the helicopter in areas where the radar imagery did not provide sufficient detail.

Geology

The area may be divided into three broad geological provinces (Fig. M4). These provinces are bounded by changes in Mesozoic and Tertiary sedimentation, and by changes in structural style, degree of metamorphism, and igneous activity.

The southern province consists of broadly folded unmetamorphosed Mesozoic and Cainozoic sediments; the central province is a transition zone characterized by tight folding, faulting, and slight metamorphism; the northern province is predominantly igneous and metamorphic with major faults bringing disparate rock types into juxtaposition. The boundary of the southern and central provinces coincides with the northern limit of cliff-forming Miocene limestone. The boundary of the central and northern provinces is the approximate line of the Lagaip Fault Zone (Dow et al.).

Simplified stratigraphic columns for these provinces are as follows:

Southern Province

TERTIARY	Pliocene :	(a) Acid intrusives and extrusives (e.g., Ok Tedi intrusive)
		(b) Clastic sediments derived from Middle Miocene and older rocks
	Upper Miocene:	Clastic marine sediments
	Lower to Middle Miocene:	Cliff-forming bioclastic limestone, thickness about 1000 m
	Oligocene:	Some limestone found only as float (as of Oct., '71)
	Eocene-Palaeocene:	Present at a few localities; siltstone and marl
MESOZOIC	Upper Cretaceous:	Blue-green siltstone and silty sandstone
	Cretaceous) Jurassic):	Arkosic quartz sandstone (especially in southwest), siltstone, and shale
	Permo-Triassic:	Basement granite (exposed in Strickland River)

Central Province

TERTIARY	Miocene or Pliocene:	Intermediate dyke rocks; Porgera diorite
	Oligocene:	Not recorded
	Palaeocene and Eocene:	(a) Thinly developed clastic sediments immediately adjacent to Middle Miocene; limestone in south
		(b) Lithic sandstone and conglomerate (probably derived from Mesozoic rocks) in north
MESOZOIC	Cretaceous and Jurassic:	Predominantly siltstone and carbonaceous siltstone, some fine-grained quartz sandstone interbeds, some coarser quartz sandstone beds in south. Unmetamorphosed in south, but metamorphosed to low greenschist in north; typical metamorphic rock is graphitic phyllite, slate, or schist

NOTES:

(1) Porgera diorite could be older than Miocene or Pliocene, e.g., Eocene.

(2) The Mesozoic sediment pattern suggests shoreline to south, and shallow to moderately deep water to north.

(3) The Central Province is a transition zone from thick Middle Miocene limestone in the south to thick Middle Miocene volcanic and clastic sequences in the north.

Northern Province

TERTIARY	Middle Miocene:	(a) Volcanics and clastic sediments with a large volcanic component (e.g., Wogamush Beds, Burger Formation, West Sepik basin)
		(b) Intrusives presumably related to the volcanics (e.g., Frieda porphyry, Whitescarp diorite, Maramuni Diorite)
	Oligocene:	Not recorded
	Eocene:	(a) Lithic sandstone and conglomerate probably derived from Mesozoic sediments
		(b) Limestone, submarine basalt breccias and lava, (a and b intruded by gabbro and peridotite)
	Palaeocene and Upper Cretaceous:	Some submarine basalt and sediments
	Mesozoic? and lower Tertiary	Mafic and salic high-grade (amphibolite facies) metamorphics, possibly metamorphosed in Oligocene. Includes eclogite and lawsonite-bearing rocks

Structure

In the southern province, the Mesozoic and Cainozoic rocks form a conformable sequence characterized by broad folding and normal and low-angle reverse faulting. The low-angle reverse faulting appears to be a gravitational effect: the thick Miocene limestone sheet was tilted in Plio-Pliostocene time, and slumped southward, producing asymmetric folds which ruptured in places on low-angle fault planes. (Alternatively the phenomenon might be explained by north-south compression). Mesozoic sediments were involved in both the normal and reverse faulting.

There is probably a major normal fault ("Digiam Fault") along the boundary between the southern and central provinces.

The central province consists of Mesozoic sediments which are folded and faulted. Broad folds can be recognized along the southern margin and in the Porgera area, but farther northwards the fold structures are obscured by stronger development of cleavage, and are probably disrupted by faulting.

The boundary between the central and northern provinces is the southern margin of the Lagaip-Frieda fault-zone. The term Lagaip-Frieda fault-zone is here used to include the Lagaip and Frieda faults and the generally imbricated area between them; the zone is up to 25 km wide, and is characterized by fault-bounded slices of ultramafic rocks, greenschist, lawsonite-glaucophane schists, glaucophane-epidote schists, eclogite, and Eocene limestone and metasediments.

The northern province is characterized by strong faulting. Trends are generally west and west-northwest in the south (Lagaip-Frieda fault-zone) and northeast (Hunstein Ranges), but strong northerly trends (north-northwest, north-northeast) are evident farther north and in the extreme west. Curvature and bifurcation of the Lagaip-Frieda fault-zone suggest left-lateral movement, and possible left-lateral movement of about 30 km might have displaced the Mount Kasa ultramafic body from a position immediately north of the Mount Stolle ultramafics.

Economic Geology

Copper: Pliocene granodiorite intrusives in the Ok Tedi-Tifalmin area are host to porphyry-copper type and some skarn mineralization. Diamond drilling has established promising mineralization at Ok Tedi, but the results are still confidential. Preliminary drilling at Tifalmin had halted at the time of writing.

Middle Miocene granodiorite intrusives in the Frieda River area are similarly host to porphyry copper type mineralization. The deposit has been extensively diamond drilled, and an airstrip has been constructed, but grades so far are low for such a remote locality. Other Middle Miocene intrusives are known to have some associated copper mineralization, e.g., the Maramuni Diorite, north of Porgera, and the Whitescarp diorite in the west.

Pliocene? intrusives also occur north of Tifalmin, east of Ok Tedi in the Din River-Nong River area, and in the Bolivip, Strickland, and Carrington River areas. The zone is presumably continuous with the zone of Pliocene-Pleistocene volcanoes which lies to the east and southeast (Doma Peaks, Sisa, Bosavi, etc.).

Gold: Free gold is associated with minor silver-lead-zinc mineralization in metasomatized diorite at Porgera. Underground development is going ahead, and associated alluvial-eluvial deposits are being worked.

Nickel: The many bodies of ultramafic rock in the Lagaip-Frieda fault-zone and northward have lateritic and possibly sulphide nickel potential. However, no nickel sulphide mineralization has been found to date.

Petroleum: Numerous gas shows are known, most of them along the boundary between the southern and central provinces. These indicate a source of petroleum in the Mesozoic, and possible reservoir rocks in the form of the quartz sandstone which characterize the southern Mesozoic rocks. It is understood that the two wells drilled in 1971 were aimed at possible structural traps in Upper Mesozoic reservoir rocks. It may be possible to define likely stratigraphic traps in the general area of the boundary between the southern and central provinces, where the quartz sandstones presumably lens out. However, the task is complicated by faulting.

Reporting of Results

A progress report (Record) on the results of 1971 field work will be prepared; after a field check in 1972 a final Record, which will form a basis for a Bulletin, will be prepared on the geology of the Ambunti, May River, Blucher Range, and Wabag 1:250,000 Sheet areas. Explanatory Notes on these areas will also be produced.

NEW GUINEA PORPHYRY COPPER DEPOSITS

by

J.H.C. Bain

Bain visited porphyry copper prospects at Frieda River, Ok Tedi, and Yanderra, and examined specimens from Bougainville and several minor mineralised porphyries. Published and unpublished data relating to porphyry copper type mineralisation in the Papua New Guinea-Solomons region were assembled, and literature on world-wide porphyry copper deposits was read. Preparation of a paper on porphyry copper type mineralisation in Papua New Guinea was started.

PRINCE CHARLES MOUNTAINS, ANTARCTICA

by

R.G. Dodson

Personnel: R.G. Dodson, R.J. Tingey, R.M. Hill, J. Smart

Regional geological mapping at 1:250,000 scale of the Prince Charles Mountains continued during the 1970/71 summer field season. Field operations commenced from the Moore Pyramid base camp on 12th January, and ended on 12th February when the field party returned to Mawson Base. Following recommendations made after the 1970 field season, the field parties working from Moore Pyramid were made up of a geologist and a field assistant with Antarctic winter experience. Surveyors operated separately. Three geological parties were landed by helicopter at localities remote from Moore Pyramid, and were moved on request after completion of mapping. Dodson worked from Moore Pyramid, and made day excursions by helicopter to outcrops within a fifteen mile radius of the base. When field parties were moved he assisted in the mapping of more distant rock exposures. Owing to several factors such as favourable weather conditions and the greater mobility achieved by the formation of separate geological parties, regional mapping of the Prince Charles Mountains north of latitude 72°S was completed.

In addition to geological mapping, geologists made gravity measurements wherever circumstances permitted use of the LaCoste and Romberg geodetic gravity meter supplied by the Regional Gravity Group of BMR. As in previous years, rocks were collected for isotopic dating. In late February, helicopters used in the Prince Charles Mountain survey were taken from Mawson for use in a rescue operation at Heard Island, thereby precluding programmed work in the Church Mountain-Scullin Monolith area from Mawson base. The party returned to Melbourne on 16th March.

After returning from Antarctica, each member of the field party completed petrographic study of rocks collected during the year. Contributions to a Record on the season's work were completed by Dodson, Smart, and Hill, and are being collated by Tingey. Tingey assisted R.J.S. Cooke, geophysicist, with the preparation of a Record on the gravity results obtained in the Northern Prince Charles Mountains area.

Geology

The regional geological mapping in 1971 has generally confirmed the findings of previous work, although some details have been modified. The rocks exposed in the northern Prince Charles Mountains consist of high-grade granulite to amphibolite facies metamorphics with a predominance of silica-rich types. The metamorphic rocks are extensively intruded by minor granites, aplites, and pegmatites, and locally by dolerite. Petrographic work on the metamorphic rocks has confirmed their generally high grade of metamorphism, but has also revealed evidence of at least two episodes of retrograde metamorphism, indicated by mylonitization and cataclasis in certain zones.

Reporting of Results

A Record on the results of the 1971 fieldwork is being prepared. Explanatory Notes on five 1:250,000 Sheet areas in the Prince Charles Mountains are scheduled for completion in 1972, and when the mapping of the Prince Charles Mountains is finished, a Bulletin on the whole area will be prepared.

REPORT WRITING

KIMBERLEY PROJECT, W.A.

East Kimberley and Kimberley Basin, by K.A. Plumb

Personnel: D.C. Gellatly, K.A. Plumb, H.G. Roberts, G.M. Derrick, I. Gemuts, D.B. Dow, R.A. Halligan, V.M. Bofinger

Bulletin 107, "Metamorphism and igneous activity in the Lamboo Complex, East Kimberley area, Western Australia", by Gemuts, was published and released during the year. The Bulletin, "Geochronology of the East Kimberley region, W.A.", by Bofinger, is still with the editor; the text will need modification to incorporate the results of later work. Report 150, "Adelaidean and Cambrian stratigraphy of the Mount Ramsay 1:250,000 Sheet area, Western Australia", by Roberts, Gemuts, and Halligan, has gone to press, and Report 140, "Palaeozoic rocks of the Hardman, Rosewood and Argyle Basins, East Kimberley Region, Western Australia" by Dow, is with the editor.

A paper, "Proterozoic palaeocurrent directions in the Kimberley Region, northwestern Australia", by Gellatly, Derrick, and Plumb, was published in Geological Magazine v.107 (1970), pp. 249-257.

The following 1:250,000 maps and Explanatory Notes were published during the year: Cambridge Gulf, Drysdale-Londonderry, and Prince Regent-Camden Sound. The Medusa Banks and Montague Sound maps have been printed, and both are awaiting Explanatory Notes which are with the printer.

Compilation of a 1:500,000 scale map of the Kimberley Basin is in progress.

West Kimberley, by R.G. Dodson and K.A. Plumb

Personnel: D.C. Gellatly, J. Sofoulis, G.M. Derrick

Gellatly started writing a Bulletin on the geology of the West Kimberley region before resigning in May. Derrick will continue preparation as time permits. Compilation of the West Kimberley 1:500,000 map to accompany the Bulletin is well advanced. Charnley and Lennard River, 1:250,000 maps are in press, and their Explanatory Notes are with the editor. Editorial modifications to the Yampi 1:250,000 map and Explanatory Notes are in hand.

Two geological papers to be included in Bulletin 125, one by Derrick and Gellatly describing leucite lamproites from the West Kimberley, the other by Gellatly on the Yampi Iron ores, are in press.

Records 1971/2 by Gellatly, and 1971/61 by Derrick and Gellatly, were issued. Records 1970/117 by Gellatly, and 1971/1 by Sofoulis et al., are in preparation, as are other Records describing the Lennard Sheet area by Gellatly and Derrick, and the chromite-bearing ultrabasic rocks on the Mount Ramsay 1:250,000 Sheet area, by Gellatly.

VICTORIA RIVER PARTY, N.T.

by

I.P. Sweet

Personnel: I.P. Sweet, J.R. Mendum (resigned August), R.J. Bultitude

Apart from the continuation of the Antrim Plateau Volcanics investigation, no further fieldwork was done in the Victoria River area. Study of data collected during the 1969 and 1970 field seasons has, however, indicated certain geological features not recognized in the field:

1. Theoldest of the Proterozoic groups mapped, the Limbunya Group, thickens eastward and westward of its type area in the Limbunya 1:250,000 Sheet area.

2. The palaeogeography of both the Wattie and Auvergne Groups indicates a marine encroachment from the north; the main sediment source areas were to the south.

3. The Bullita Group, particularly the Timber Creek and Skull Creek Formations, exhibits cyclic deposition, with alternating shallow marine and lagoonal paralic environments. The Supplejack Dolomite Member is believed to be a transgressive deposit.

Glauconite samples from the Wandoan Hill Formation were submitted for isotopic dating; it is hoped that this work will give an indication of the ages of the Auvergne and Bullita Groups.

Reporting of Results

The results of the Victoria River Region survey (1967-70) are being written up in a series of Records, Reports, and Explanatory Notes, and a synthesis of the geology of the whole area will appear as a Bulletin. Records on the Auvergne 1:250,000 Sheet area (1968/117) and the Cape Scott, Port Keats, Fergusson River, and Delamere Sheet areas (1970/3) have been issued; Record 1971/71, dealing with the Victoria River Downs, Wave Hill, Waterloo, and Limbunya Sheet areas, is in an advanced stage of preparation, as are Explanatory Notes for most of the Sheet areas.

CARPENTARIA PROJECT, N.T.

by

K.A. Plumb

A brief paper on revisions to the stratigraphy of the McArthur Group, by Plumb and M.C. Brown, had gone to press as part of Bulletin 125, but was withdrawn for revision following modifications to the geology of the H.Y.C. ore-deposit as a result of recent drilling by the Carpentaria Exploration Company Pty Ltd. The paper has been revised, and is about to go to press again in Bulletin 139.

CENTRAL HIGHLANDS OF NEW GUINEA

by

J.H.C. Bain

Personnel: J.H.C. Bain, D.E. Mackenzie, R.J. Ryburn

Record 70/79 "Geology of the Kubor Anticline", a detailed account of the results of field work undertaken in 1968-1970 to determine the Mesozoic and Tertiary stratigraphy of the central highland region, was produced and distributed, and has been accepted as a draft manuscript for a Bulletin. The Ramu and Karimui 1:250,000 Sheets are being drafted, and the Explanatory Notes are in preparation. A Record on the results of 1970 field work in the Baiyer and Jimi valleys is also in preparation.

Both Bain and Mackenzie presented papers to the 12th Pacific Science Congress in Canberra, and prepared several papers for outside publication and for publication in BMR Bulletin 139.

NEW BRITAIN, T.P.N.G.

by

R.J. Ryburn

Personnel: R.J. Ryburn and D.E. Mackenzie

Ryburn continued compilation of results obtained during the 1969 field work. Mackenzie prepared the Record 1971/70 "Intrusive rocks of New Britain" which was issued during the year.

Compilation of Pomio, Talasea-Gasmata, and Arawe-Cape Raoult 1:250,000 Sheet areas continued.

EASTERN PAPUA

by

H.L. Davies

Personnel: H.L. Davies, I.E. Smith, D.J. Belford

Compilation of the geological results obtained during the preceding years continued. Bulletin 128 "Peridotite-gabbro-basalt complex in eastern Papua: an overthrust plate of oceanic mantle and crust" by Davies, was issued during the year, and work continued on a Record entitled "Geology of southeastern Papua" by Smith, Davies, and Belford, which it is intended to produce as a Bulletin. The results of various smaller investigations were produced during the year as Records, contributions to Bulletins 125 and 139, and outside publications.

Preliminary Editions and Explanatory notes were completed for the following 1:250,000 Sheet areas - Abau and Samarai (Smith) and Fergusson Island (Davies). Work continued on Tufi (Davies and Smith), and Buna and Salamaua (Davies) (see list of Publications).

DETAILED PROJECTS

FIELD WORK

CLONCURRY-MOUNT ISA PROJECT, QLD.

Personnel: G.M. Derrick, R.M. Hill, A.Y. Glikson, J.E. Mitchell, S. Henley and R.W. Page (part-time) (BMR); I.H. Wilson (G.S.Q.); Miss D.M. Pillinger and M. Little (drafting).

During 1971 the mapping of the Mount Isa 1:100,000 Sheet area using colour aerial photographs at a scale of 1:25,000 was completed, and parts of the Marraba and Mary Kathleen Sheet areas were re-examined. Sample collections of most igneous rocks in the area were made for age determination, and some stratigraphic drilling was carried out. The data have been compiled on bases enlarged from 1:100,000 maps produced by the Division of National Mapping in 1969.

Precambrian Geology of the Mount Isa 1:100,000 Sheet Area

Most of the Sheet area (Fig. M5) is occupied by a large north-plunging anticlinorium; the core of this structure contains the complex Sybella Granite, which is flanked mainly by older basic volcanics and sandstones. Some younger conglomerate, siltstone, and shale are present. To the east of the anticlinorium is a belt of steeply dipping shales, the Mount Isa Group, in which the Mount Isa silver-lead-zinc and copper deposits are located. The sedimentary rocks in the Sheet area form part of the Western Succession. A summary of the stratigraphy is given below.

Stratigraphic Table, Mount Isa 1:100,000 Sheet Area (excluding Cambrian units)

Formation	Thickness (metres)	Lithology
Pilpah Sandstone (Bui)	330	F. to m.g. sandstone, pale brown to white; finer-grained near base.
Paradise Creek Formation (Blx)	Incomplete sequence	Siltstone, sandstone, and dolomitic shale with stromatolites.

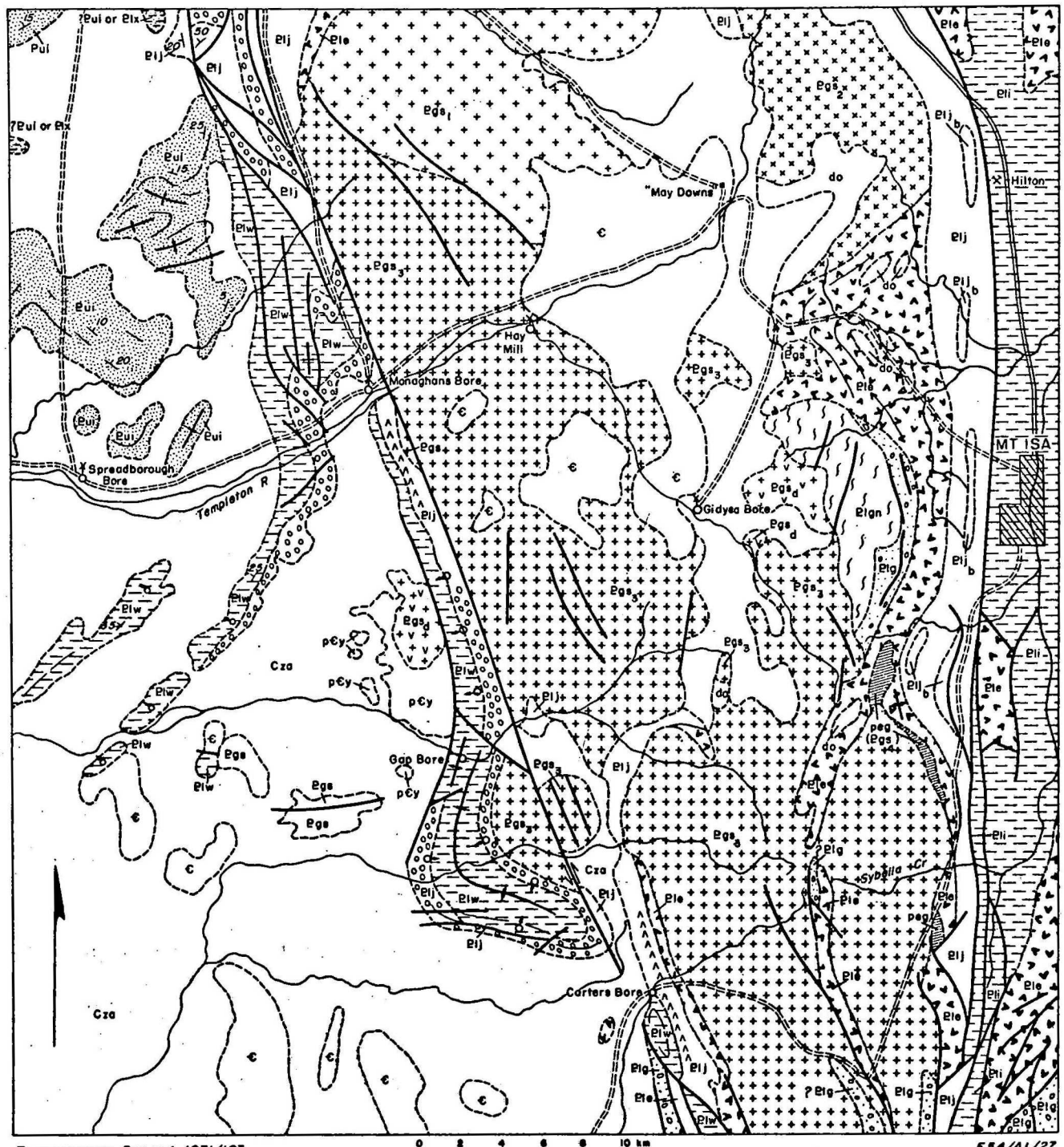


Fig M5 Geology, Mt Isa 1:100,000 Sheet Area No. 6756

Formation Top	Thickness (metres)	Lithology
Mingera Beds (Elw)	?1660	Boulder conglomerate at base, feldspathic quartzite, siltstone, shale at top; minor acid volcanics.
Mount Isa Group	4660	Thin-bedded shale and siltstone, dolomitic and pyritic in part.
Judenan Beds (Elj)	?2000	1. quartz-sericite schist; chlorite schist and amygdaloidal metabasalt throughout the sequence; 2. red-brown micaceous shale; 3. clean, white, m. to c.g. quartzite.
Eastern Creek Volcanics (Ele)	?5000	1. metabasalt with minor metasediment; 2. quartzite and pelitic schist, minor metabasalt; 3. metabasalt with minor metasediment.
May Downs Gneiss (Elgg)	?300	C.g. quartz-sillimanite and quartz-muscovite gneisses.
Mount Guide Quartzite (Elg)	200-500	Feldspathic quartzite, pebbly quartzite, arkose, conglomerate.
Yaringa Metamorphics (pGy)	?	Gneiss, quartz-mica schist, (?)sillimanite schist.

Bottom

Igneous Rocks

Sybella Granite (Egs)	1. Coarse-grained porphyritic granite with blue quartz phenocrysts. 2. F. to m.g. pink even-grained granite. 3. Very coarse-grained, foliated porphyritic biotite granite. 4. Pegmatite, with muscovite, beryl, and monazite.

All the granite masses contain accessory fluorite, and allanite less commonly. Dolerite dykes and gabbro intrude all formations except the Mingera Beds and the Pilpah Sandstone. Intrusion of dolerite into the Mount Isa Group and Sybella Granite is rare.

Hybrid diorite and tonalitic rocks with rapakivi textures occur as large roof pendants in Sybella Granite 10 km west of Mount Isa. They represent granitized blocks of Eastern Creek Volcanics and/or contaminated Sybella Granite.

Structure

The Sybella Granite is a major element controlling structure in the Sheet area. It has intruded a north-plunging anticlinorium of quartzite and volcanics, up to the Judenan Beds; accompanying or post-dating the intrusion of granite, major faults (Mount Isa and May Downs Faults) developed; vertical movement along these resulted in a horst structure of Sybella Granite. The graben forming to the west of the May Downs Fault could have controlled sedimentation in the Pilpah Sandstone and Paradise Creek Formation.

Along the May Downs Fault the Judenan-Mingera Beds sequence forms a series of elongate basin-and-dome structures. South of Gap Bore a nappe-like structure is present, with the May Downs Fault representing the basal thrust fault. Major shear-zones also occur within the Sybella Granite, obscuring contacts between the various granite types.

Economic Geology

Silver, Lead, Zinc: Deposits are confined to the Urquhart Shale in the Mount Isa Group, and are being mined at Mount Isa, and developed at Hilton.

Copper: This is the major metal at present mined at Mount Isa; several gouger shows occur elsewhere in the Mount Isa Group; these are generally controlled by faulting. Small shows in the Eastern Creek volcanics are related to dolerite.

Gold: "Double Event" is a small working gold mine located in a shear-zone in shale adjacent to the May Downs Fault.

Uranium: A large number of anomalies have been found in the Eastern Creek Volcanics, but none of these has contained sufficient ore to warrant development.

Silica: Quartz-filled faults near Mount Isa are mined for silica flux for Mount Isa Mines. The potential value of large cupriferous silica deposits could increase in the future because of their use in the extraction of SO_2 from smelter fumes at Mount Isa.

Beryl, columbite, and muscovite have all been mined from the Mica Creek pegmatites. Monazite is also present.

Sand, gravel, etc.: Many of the creeks draining the Sybella Granite contain abundant sand and gravel deposits.

Major findings:

1. Mapping of four distinct phases in the Sybella Granite (see stratigraphic table).

2. Recognition and mapping of three units in the Judenan Beds.

3. Mapping of the May Downs Gneiss, first recognized by C.L.J. Wilson (ANU); it is the basal part of the Mount Guide Quartzite metamorphosed by the Sybella Granite.

4. Depth zones in the Sybella Granite can be postulated using -
   (a) distribution of xenoliths and their state of recrystallization;
   (b) distribution of hybrid and contaminated rocks;
   (c) presence of contact aureoles;
   (d) distribution of pegmatite.

   The roof zone of the Sybella Granite probably lies in the area between Gidyea Bore and Mica Creek to the east.

5. An acid volcanic sequence of quartz-feldspar porphyry occurs in the Mingera-Judenan Beds in the southwest of the Sheet area. This is one of the youngest igneous units known in the area, and could have been a source for much of the fine-grained tuffaceous material recorded from the penecontemporaneous Mount Isa Group.

6. The coarse-grained arenites of the Mingera Beds are equivalent to the Judenan Beds; the shale and siltstone of the Mingera Beds are equivalent to the Mount Isa Group.

7. Granite boulders occur in conglomerate of the Mingera-Judenan Beds north of Monaghan's Bore. This indicates that the Sybella Granite in the north is older than the Judenan-Mingera sequence. In the southeast the Sybella Granite is considered younger than the Judenan Beds, which suggests there are at least two distinct ages of granite intrusion. Alternatively, the conglomerate could represent a major unconformity between the Judenan and Mingera Beds, previously thought to be conformable.

8. The weathered core of the Sybella Granite, considered by Carter et al. to be a result of hydrothermal alteration and granitization, is in fact a part of the Cambrian weathering profile, in which kaolinization and silicification of the older granite have been extensive.

9. Two new stromatolite occurrences in the northwest of the Sheet area overlie the Mingera Beds, and could be part of either the Paradise Creek Formation or Pilpah Sandstone.

Other Activities

Age Determination

Collections were made of nearly all acid intrusive rocks in the area, including the Sybella, Kalkadoon, Wonga, Burstall, and Naraku Granites, and acid volcanics from the Argylla Formation and Leichhardt Metamorphics. Hybrid dioritic rocks from the Eastern Creek Volcanics, and some dolerite dykes, were also sampled. R.W. Page is undertaking Rb/Sr analyses of most of the samples collected, and Dr D.C. Green, of Queensland University, will assist with some K-Ar determinations on mineral separates.

Preliminary K-Ar dates by Green are in the range 1350 to 1450 my for samples ranging from old amphibolites to young granites, which suggests that K-Ar results are probably metamorphic ages, and of limited value in determining abolute ages and relationships.

Stratigraphic Drilling

A BMR Foxmobile drilling rig was used in a stratigraphic drilling programme of continuous coring in the Cloncurry 1:250,000 Sheet area. The first hole (Cloncurry No. 3) was located 2 km west of Dolomite Siding, in alluvium. It was sited to evaluate an intense magnetic anomaly, and the nature of the contact between the Overhang Jaspilite and overlying Corella Formation. The hole was drilled to about 30 metres; about 10 metres of core were recovered, mainly chlorite schist and amphibotite laced with calcite and quartz veins. A major fault-zone in dolerite has been inferred, trending northeast along Chinaman Creek. Mount Leviathan, an iron ore deposit near Cloncurry, probably lies within the same fault-zone. The magnetic anomaly is related to the dolerite, or to massive hematite-magnetite bodies located at depth along the fault-zone.

A second hole (Cloncurry No. 4) was sited near the Duchess railway line, 6 km south-southwest of Marimo siding, to evaluate relationships between members of the Marimo Slate. About 60 metres were drilled, and only 15 metres of a highly weathered micaceous siltstone were recovered. This is probably a part of member Plm_2 in the Marimo Slate.

The third hole (Cloncurry No. 5) was drilled in the Corella Formation, 16 km northwest of Mary Kathleen, in pyrrhotitic black shale and limestone immediately underlying the Deighton Quartzite. Abundant banded gossan indicates the presence of massive layered sulphide bands at depth. This unit is considered to be equivalent to the Dugald River lead-zinc deposits.

Reassessment of Marraba, Mary Kathleen, and Cloncurry Sheet Areas

Certain areas in the above three Sheet areas were re-examined to correct some stratigraphic discrepancies.

1. In the Rifle Creek area conglomeratic greywacke with clasts of granite forms part of the lower Mount Guide Quartzite; it is associated with Argylla Formation acid volcanics, and probably overlies them unconformably.

2. In the same area it was established that the Surprise Creek Beds are younger than the Kalkadoon Granite.

3. Near Mary Kathleen an unconformity previously inferred between the Corella Formation and the underlying Argylla Formation has been established; checking of the contact has shown the presence of a thin quartzite bed and schistose cobble conglomerate immediately overlying the Argylla Formation.

4. The area covered by the Burstall Granite in the Godkin Ranges has been significantly extended.

5. Stromatolites were found in the Marimo Slate near Marimo Siding. They underlie black slate, and were not recorded by Carter et al. (1961). In the same area up to 60° of overturning occurs in overlying calcareous sediments; an arcuate, south-dipping thrust plane up to 16 km long is postulated, along which the Marimo Slate has been thrust northwards.

6. Jaspilite in the Soldiers Cap Formation is thought to be older than the Overhang Jaspilite; it had been suggested that the two units might be equivalent.

7. Examination of copper mines outside the Sheet areas showed that -

(a) Mount Oxide and possibly Mammoth mines belong to the "black slate" type, in which copper ore is located in structural traps in slate, and for which an obvious igneous source of the ore is lacking.

(b) Mightly Atom, Little Wonder, Mussclini, Orphan, and Crusader all occur near the Ballara Quartzite - Argylla Formation unconformity, in association with metadolerite dykes. This partly stratigraphic control was noted in the 1970 Annual Summary, and is considered a target for future prospecting.

(c) At the Lady Annie mine a jaspilite unit with barite is associated with the ore body. This lithological association suggests a correlation with the barite-bearing Overhang Jaspilite, and could provide a means of correlation between the Eastern and Western successions of the Precambrian block.

Geochemistry

Further whole rock geochemistry continued during 1971. Limestones and impure calc-silicate rocks in the Corella Formation contain high trace values of copper (85 ppm average);

slate and metabasalt also show high trace copper contents of 45 and 160 ppm, respectively. Acid volcanics on the other hand are relatively low in copper (average 18 ppm), but only a few samples have been studied so far.

A continuation of whole rock geochemistry is planned. Gossans, granitic and volcanic rocks, slate, limestone, and dolerite will be treated in detail to provide background to problems of ore genesis and exploration in the area.

Reporting of Results

Records on the Marraba, Mary Kathleen, and Mount Isa 1:100,000 Sheet areas will be completed, and these Records, together with that on the Cloncurry 1:100,000 Sheet area, will be modified for publication as Reports. A brief Bulletin on all four Sheet areas, with a map at 1:250,000 scale, is also planned.

REPORT WRITING

McARTHUR RIVER PROJECT, N.T.

by

K.A. Plumb

New information from drilling by the Carpentaria Exploration Company Pty Ltd has necessitated changes to some of the stratigraphic interpretations in the area, and consequently Record 1969/145, "The Proterozoic Barney Creek Formation and H.Y.C. Lead-Zinc deposit and some associated units, McArthur Group, McArthur River area, N.T.", by M.C. Brown, has had to be revised. This revision is well advanced. The geochemical analysis of about 400 samples collected by Brown, and analysed by C.W. Claxton, is now complete (see also report of Geochemical Laboratory under "Petrological, Geochemical, and Geochronological Laboratories"). Writing of the final Report on the project, incorporating both the chemical data and data from Record 1969/145, will commence when the Record has been revised.

DARWIN URANIUM GROUP, N.T.

Personnel: C.E. Prichard, G.C. Lau (to February), J.S. Morlock (to February), R.S. Needham (from May), P.G. Smart (from May)

OFFICE AND GENERAL

by

C.E. Prichard

Professional geological staff was reduced to one by transfer of J.S. Morlock and G.C. Lau to Mines Branch, N.T.A., early in the year. Following arrival of R.S. Needham and P.G. Smart during May the establishment was again filled.

The Senior Geologist continues to hold and exercise Departmental delegations, and to provide some Departmental services, including pay, to wages staff of regional field parties and to staff of the three Branches of the Bureau represented in the Darwin Uranium Group.

The new store, workshop, and core store (Maranga Store) were completed by the Department of Works, and handed over in January. The new facilities are a big improvement on the old Winnellie Store which has since been demolished. Liaison has been maintained with the Department of Works and the P.MG. on the construction of the new Seismic Observatory near Manton Dam. Construction is well advanced, and operation will probably commence early in 1972. The Senior Geologist was Departmental representative on several Promotions Appeal Committee hearings and interviews for employment during the year.

Members of the staff represented the professions of geology and geophysics at the High School Careers Night, and the office was opened to students for Visits to Industry arranged by the Department of Labour and National Service. Senior students from two secondary schools were taken on short geological excursions around Darwin at the request of their Science Masters.

The discovery of the Alligator Rivers Uranium Field last year has increased interest and activity in that area and in the N.T. generally. Consequently there was a marked increase in the number of company visitors calling to discuss uranium occurrences during the year. Two visits were made to company prospects, and two to the BMR party engaged in detailed mapping of the Field.

Activities of the geophysical staff in the group are reported in the Geophysical Branch's summary of activities.

CRATER DRILLING (Rum Jungle District)

by

C.E. Prichard

Two rotary percussion holes were drilled to test the No. 1 Conglomerate of the Crater Formation, and to obtain core from it.

The drilling has confirmed the sequence established by French (1970). It has shown that higher radioactivity is associated with zones of conglomerate which occur within a stratigraphic interval of over 300 feet extending from the No. 1 Conglomerate zone through the "Crater Grits" to the base of the formation. The main conglomerate bed in the No. 1 Conglomerate zone is the thickest and most radioactive unit. This bed has a true thickness ranging from 4 feet to 7 feet in the two holes.

Gamma spectrometer analysis of samples from the No. 1 Conglomerate indicate that the radioactivity is caused by thorium which does not exceed 0.12% ThO_2; the radioactive mineral is a partly acid soluble calcium thorium phosphate of uncertain identity.

In conjunction with previous testing it must be concluded that the anomalous radioactivity of conglomerates in the Crater Formation is essentially due to thorium, and that this mineralization is well below possible ore grade.

Two Records (1970/65 and 1971/65) dealing with recent work on the Crater Formation have been issued.

ALLIGATOR RIVER PARTY

by

R.S. Needham

Personnel: R.S. Needham, P.G. Smart

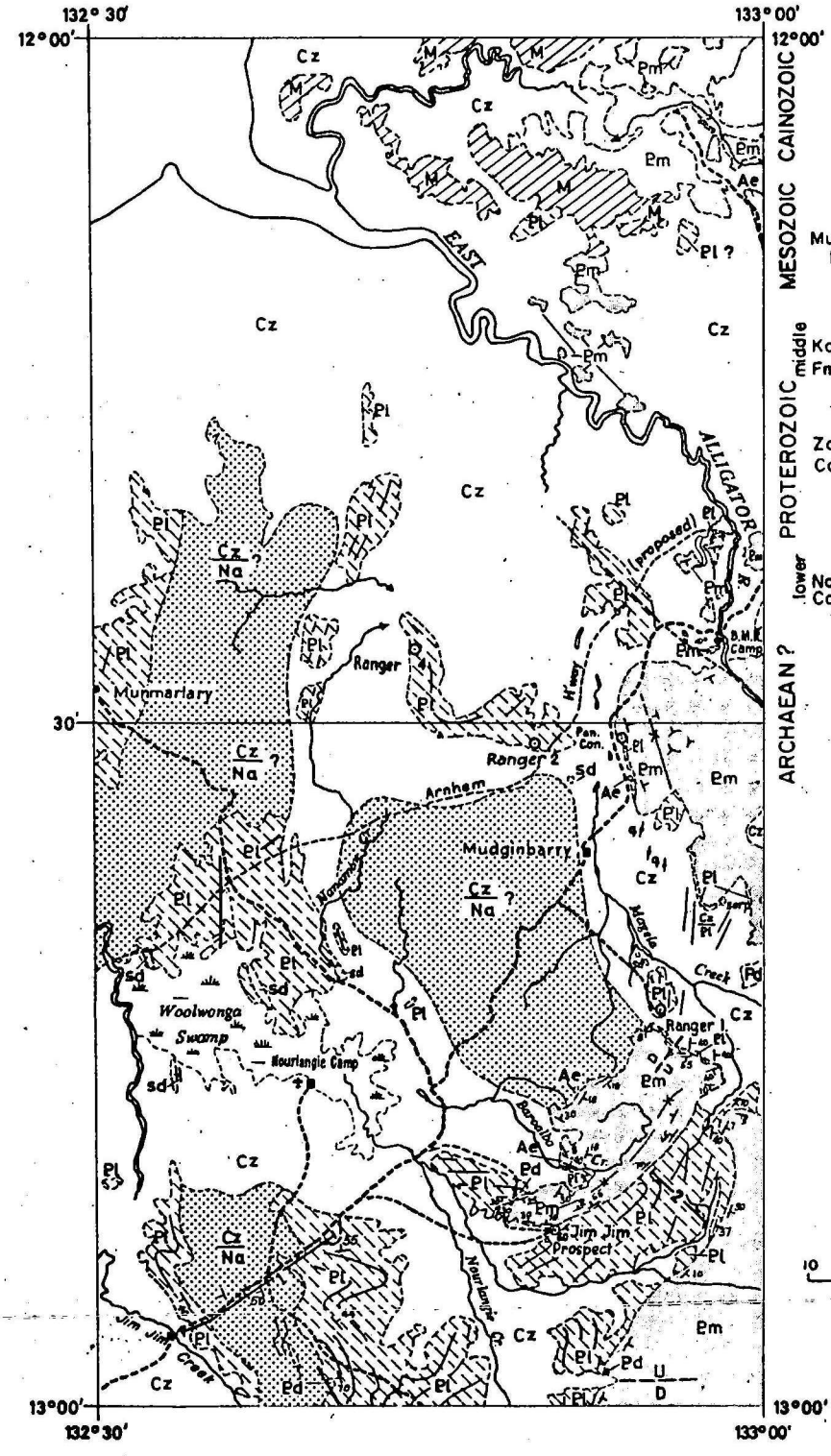
Introduction

Mapping of the Cahill and East Alligator 1:100,000 Sheet areas (Alligator River 1:250,000 Sheet area) was virtually completed, and compilation is being carried out at 1:50,000 scales. RC9 photography at 1:86,000 scale was used for mapping until late in the season, when 1:16,000 photography became available.

The mapping of Dunn, Walpole, and others has provided a useful framework for the more detailed work. Outcrop of "basement" rocks in the area is generally extrememly sparse, and auger

Fig M6

GEOLOGICAL SKETCH MAP OF THE CAHILL & EAST ALLIGATOR 1 : 100000 SHEET AREAS



REFERENCE

MESOZOIC CAINOZOIC

Cz — Alluvium, residual colluvial and outwash sand, talus material

Mullaman Beds — M — Siltstone with cherty bands, fossiliferous

PROTEROZOIC middle

Kombolgie Fm — Pm — Ill-sorted clayey sandstone, pebble beds, cross bedding and ripple marks common

Zamu Complex — Pd — Dolerite

PROTEROZOIC lower

Nanambu Complex — Pl — Muscovite, chlorite, quartz, biotite schist, quartzite, silicified dolomite

Na — Leucocratic gneiss and schist, interbedded biotite and chlorite schists

sd - silicified dolomite

serp - serpentinite

ARCHAEAN ?

Ae — Foliated biotite granite

Geological boundary

Fault

Dip and strike

Trend lines

Quartz veins

Syncline axis

Road

Auger traverse

Uranium prospect

Scale

10 0 10 M

10 0 10Km

To accompany Record 1971/103

D53/A1/3

drilling was carried out in the latter part of the field season to provide additional information in selected areas.

Geology (Fig. M6)

Foliated biotite granite, found in a few widely scattered places, appears to be the oldest rock in the area, and is possibly of Archaean age.

The Cahill and East Alligator areas consist mostly of folded low-grade metamorphic rocks, which are apparently continuous with the Lower Proterozoic Mount Partridge Formation, and "undifferentiated sediments" of the same age. These have been previously mapped in the Mount Evelyn 1:250,000 Sheet area to the south as occupying the eastern trough of the Pine Creek Geosyncline.

The lower part of the Lower Proterozoic sequence is invaded by lit-par-lit pegmatites, and granitic or augen gneisses have been formed in places. It is not possible to map out the intrusive rocks owing to their generally thin interlayered nature and sparse discontinuous outcrop. The Lower Proterozoic sequence with lit-par-lit injection is, however, recognizable as a mapping unit, for which the name Nanambu Complex has been retained.

Lower Proterozoic rocks within the Nanambu Complex are biotite and chlorite schists (the latter probably formed by retrograde metamorphism), sheared metaquartzite, and muscovite-quartz-feldspar schists which appear to grade into quartz feldspar gneisses with progressive decrease in muscovite.

Lower Proterozoic rocks above the Nanambu Complex generally display more planar bedding and more continuous modes of outcrop. Usually feldspathic quartzite, arkose, hematitic metaquartzite, and silicified dolomite occur adjacent to areas occupied by rocks of the Nanambu Complex. These are succeeded by a thick succession of chlorite muscovite schist, quartz muscovite schist, and (?)amphibole-muscovite schists.

The Nanambu Complex, Lower Proterozoic metamorphics, and the (?)Archaean foliated granite are all intruded by quartz dolerite which is commonly uralitized and albitized. An aegirine-augiteanorthoclase porphyry, with or without aegirine and nepheline, also intrudes the Nanambu Complex.

The Middle Proterozoic Kombolgie Formation lies unconformably above the rocks described above. The unconformity is generally well exposed at the base of the Arnhem Escarpment, and it is also here where the best exposures of the underlying rocks occur. The formation consists of ill-sorted clayey (weathered feldspar matrix?) quartz sandstone with occasional pebble beds up to 30 m thick. Where a basal pebble bed is developed, subangular pebbles of schist are common. Cross bedding and ripple marks are common throughout the formation.

The Mesozoic Mullaman Beds lie unconformably over the lateritized surface of the Kombolgie Formation in the Mount Borradaile region. They consist of white and yellow chalky siltstone with cherty bands, and contain indeterminate pelecypods and (?)belemnites, and numerous bores and trails.

Cainozoic deposits consist of widespread colluvial and outwash sands in areas adjacent to the Arnhem Escarpment, and over the Northern Plains. Talus slopes are common at the base of the escarpment. Black soil is present in swampy areas in higher country, and in areas within the wide alluvial flood plains adjacent to the main rivers and creeks in the Northern Plains.

Structure: The Nanambu Complex occupies the cores of generally northerly elongated domes within the Lower Proterozoic metamorphics. Strikes and dips of the two units are similar overall; dips are usually about 40° - 60°, but vertically dipping Lower Proterozoic schists occur near Cannon Hill. Very tightly folded ("M"-folded) biotite schists are well exposed at Nourlangie Rock, where recumbent and overthrust folds on a small scale were also noted.

The Kombolgie Formation is folded into a basin-like structure in the Mount Brockman Range, and a partly closed basin in the range east of Mudginbarry Homestead. Dips in the Arnhem scarp of 30° decrease to an overall southeasterly dip of 5 to 10° away from the scarp. The latter are possibly depositional, whereas the former are of tectonic origin, slickensiding and brecciation being occasionally apparent. Vertical jointing is widespread; the main trends of the jointing are northeast, northwest, and easterly. Vertical displacement of up to 70m has been noted along faults in the Kombolgie Formation.

The Mullaman Beds lie almost horizontally over Upper and Lower Proterozoic strata.

Economic Geology

The Jim Jim, Ranger 1, and Pan Continental prospects all lie adjacent to the Kombolgie scarp, whereas the Ranger 2 and 4 prospects lie between 10 and 15 km away from it. All prospects appear to lie in a similar stratigraphic position within the Lower Proterozoic metamorphics (near the base of the chlorite-mica schists), so an original stratigraphic control of uranium mineralization is envisaged.

Reporting of Results

A progress report (Record) on the work carried out in 1971 is in preparation. It will not be possible to prepare a final report until the relationships of the Lower Proterozoic schistose

rocks with the less metamorphosed rocks of the Pine Creek Geosyncline to the west have been established. It is expected that isotopic dating will play an important part in elucidating the geology of the area, especially that of the Nanambu Complex.

RUM JUNGLE PROJECT

A draft Record on a geobotanical survey at the Woodcutters L5 prospect has been completed by W.F. Ridley, of the Geological Survey of Queensland. A Record on magnesite occurrences in the Rum Jungle district is being prepared by C.E. Prichard.

VOLCANOLOGICAL STUDIES

PERSONNEL: G.A.M. Taylor, R.W. Johnson, D.E. Mackenzie, I.E. Smith (L.W.O.P.)

Systematic study of late Cainozoic to Recent volcanoes in Papua New Guinea by Canberra-based geologists (sometimes working in cooperation with geologists of the P.N.G. Geological Survey) was begun about three years ago, and most of the volcanic areas have now been covered on a reconnaissance scale.

G.A.M. Taylor acted as Chief Government Geologist, P.N.G. Geological Survey, for three months from April to June, and on two occasions, totalling more than four months, as Supervising Geologist (Metalliferous). He also wrote a precis of information available on the volcanic areas of the Gazelle Peninsula, New Britain, for inclusion in the explanatory notes to accompany the Gazelle Peninsula 1:250,000 map sheet.

VOLCANO SURVEILLANCE AND PETROLOGICAL STUDIES

by G.A.M. Taylor

VOLCANO SURVEILLANCE IN NEW ZEALAND

A visit was made to New Zealand in November, 1970, in connection with volcanological surveillance studies being undertaken in that country by the Geological Survey and the University of Victoria, Wellington.

Periodic surveillance checks are made of White Island volcano by helicopter. The parameters studied include changes of level of the crater floor, temperatures, gas composition, and magnetic changes. During a visit on 5 November clear weather provided good visibility, and all measurement surveys were completed. Noisy high-pressure vents on the floor of the crater emitted dense vapour clouds containing an unpleasantly high proportion of sulphur dioxide. Temperatures ranged above 300°C, level measurements indicated bulging of the crater floor, and magnetic measurements indicated an increase in negative anomaly. Assessment of these trends by Professor R.H. Clark led to predictions which were confirmed by the activity of 1971. Further eruptions are expected from this volcano on the basis of current surveillance measurements.

At Taupo an address on volcanic surveillance was given to the members of the annual Geological Survey Conference, and later to a public meeting.

Geological studies of the volcanic areas of the North Island have revealed a long history of disastrous eruptions in the immediate past. This information, in combination with the intermittent eruptions of White Island and Ruapehu, has developed a strong

awareness of the need for the establishment of a comprehensive surveillance system to cover the most vulnerable points in the region.

The Department of Industrial and Scientific Research is forming a group of earth scientists and electronic specialists based at Wairakei, to study the phenomena of active volcanism.

VOLCANO SURVEILLANCE - T.P.N.G.

Recommendations were made to the P.N.G. Administration on the need for investigation of activity at Karkar volcano, following examination of photographs which indicated a change in exhalation pattern. A severe tectonic earthquake occurred in this region in November, 1970. A further recommendation was made on the need for surveillance checks on the volcano following results of the investigation by P.N.G. Geological Survey staff in May, 1971. Changes in the activity of the volcano seem to be continuing.

Advice on the significance of a report on sulphur gas activity at Doma Peaks (Western Highlands) was provided to the Administration, and recommendations made on the checking of the phenomenon.

A submission was made for air photography of the island volcanoes off the northern coast of New Guinea. The islands include Umboi, Tolekiwa, Long Island, Crown Island, Bagabag, Karkar, Bam, Kardovar, Blup Blup, Vokeo, Koil, and Kairiru.

PETROLOGICAL STUDIES

Study of the rocks of the volcanic islands east of New Ireland was continued, and a progress report prepared as part of a joint paper on New Guinea volcanic petrology submitted to the Pacific Science Congress.

The New Ireland volcanic rocks consist predominantly of under-saturated basalts which have shoshonitic affinities. The lavas are strongly porphyritic: plagioclase and olinopyroxene are the most common phenocrysts, and may be accompanied by one or more of olivine, hornblende, biotite, leucite, hauyne, analcite, zeolites, magnetite, apatite, and anhydrite. In rare specimens either clinopyroxene or plagioclase may be absent. The composition of the plagioclase generally ranges from oligoclase to bytownite, and is most commonly labradorite: some specimens contain anorthoclase phenocrysts.

Chemical analyses of 11 specimens reveal compositions resembling basic members of Joplin's shoshonitic association. The New Ireland rocks differ from normal shoshonitic rocks in a predominance of Na_2O over K_2O; the relatively high Na_2O content makes them all nepheline normative. The term "undersaturated shoshonites" has been suggested for them.

REPORTING OF RESULTS

A Bulletin on the eruptions of Manam volcano over an extended period is being prepared: Records on Karkar volcano and Doma Peaks are in an advanced stage of preparation, and an account of the petrology of volcanic islands off the east coast of New Ireland is being prepared.

VOLCANOES OF NEW BRITAIN, THE BISMARCK SEA AREA, AND THE PAPUA NEW GUINEA HIGHLANDS

by R.W. Johnson

Throughout the year, reports have been written on the geology and petrology of Quaternary volcanoes in New Britain, which were surveyed during field seasons in 1969 and early 1970. Record 1971/14 gave descriptions of the geology and petrology of volcanoes in the Cape Gloucester area, together with an account of the eruptive history of Langila Craters by R.A. Davies and W.D. Palfreyman, (both members of the Geological Survey of Papua New Guinea). "Short papers on Quaternary volcanic areas in Papua-New Guinea" were presented in Record 1970/72 (co-authors: D.E. Mackenzie and I.E. Smith). In addition, the draft of Record 1971/55 was completed; this describes the geology and petrology of Bamus volcano, the Lake Hargy area, and the Sulu Range, in New Britain.

A paper entitled "Seismicity and Late Cenozoic volcanism in parts of Papua-New Guinea" (co-authors: D.E. Mackenzie and I.E. Smith) was accepted for publication in "Tectonophysics". A second paper, "Distribution and chemistry of Late Cenozoic volcanoes in Papua-New Guinea" (co-authors: D.E. Mackenzie, I.E. Smith, and G.A. M. Taylor), was read at a Symposium of the Pacific Science Congress, held in Canberra in August. The drafts of two papers on Ulawun volcano were completed; these are: "Ulawun volcano, Papua New Guinea; Part I: Geology and eruptive history between 1915 and 1967"; "Ulawun volcano, Papua New Guinea; Part III: Petrology" (co-authors: A.J.R. White and R.A. Davies).

Between August and October, 1970, a geological survey was made of the Witu Islands, and of islands west of New Britain, off the north coast of New Guinea (excluding Manam and Karkar Islands). Petrographic examinations of samples collected during this field season were made at the Central Volcanological Observatory, Rabaul, between July and September, 1971, in conjunction with R.A. Davies. Preliminary reports on the geology and petrology of the islands were prepared.

In July, five days were spent on islands adjacent to St. Andrew Strait, Bismarck Sea. An account of the volcanic geology was completed (co-author: R.A. Davies), and submitted for presentation as a "Note of Investigation". These islands are made up largely of alkali-rich, acidic volcanic rocks.

During the year it was established that there are marked differences in chemical and mineralogical composition between Quaternary lavas in central New Britain, and those from the Cape Gloucester area and islands to the west. The seismic regimes of both areas are also different (see Record 1970/35). The petrological differences are as follows:

(1) Whereas the central New Britain lavas range from tholeiitic basalt to andesite, dacite, and rhyolite, the rocks from volcanoes farther west appear to be only basalts and andesites and, at the time of writing, no dacites or rhyolites had been identified.

(2) Many basalts and andesites from volcanoes west of New Britain contain more than 10 percent augite phenocrysts. In contrast, most of those from central New Britain contain less than 10 percent augite phenocrysts, and olivine phenocrysts also appear to be less common.

(3) For a given silica value, most of the lavas from central New Britain are lower in total alkalies than lavas from islands west of New Britain.

During the coming year it is planned to produce the following accounts:-

Records

(1) "Geology and petrology of Quaternary volcanic islands off the north coast of New Guinea" (co-author: R.A. Davies).

(2) "Volcanic geology and petrology of Witu Islands, Papua New Guinea".

(3) "Volcanic geology and petrology of St. Andrew Strait islands, Papua New Guinea".

(4) "Volcanic geology and petrology of Willaumez Peninsula, and Cape Hoskins and Cape Reilnitz areas" (co-author: D.H. Blake).

Bulletin

"Late Cainozoic volcanoes of the southern Bismarck Sea" (co-authors: G.A.M. Taylor?, R.A. Davies?)

On October 1st Johnson left Rabaul on a 6-week field trip to examine, in cooperation with D.E. Mackenzie, late Cainozoic to Recent volcanoes in highland areas in the western part of Papua New Guinea (Fig. M1). The results of this work will be written up initially as Records, and Mackenzie will work on some of the material for a Ph.D. project at the University of Melbourne.

CENTRAL HIGHLANDS VOLCANOES

by D.E. Mackenzie

Mackenzie left Canberra on 13/10/71 to commence detailed mapping of the Quaternary volcanoes of the New Guinea Highlands. At the time of writing work had been concentrated on the Mount Hagen volcanic complex which is composed of at least five separate volcanic vents, the youngest being the northernmost. It was also established that the intrusive core of the southernmost cone is a biotite-amphibole dacite/andesite associated with andesite dykes, and that andesitic flows are intercalated with the youngest shoshonite flows in the summit area of the range. Field work was expected to finish before the end of November.

Analyses of 14 specimens from the middle Miocene Daulo Volcanic Member, in the Eastern Highlands, have been received. The rocks range from highly undersaturated and K-rich shoshonite to oversaturated amphibole-bearing andesite and dacite. A paper for external publication will be written in late 1971.

EASTERN PAPUA VOLCANIC PROJECT

by I.E. Smith

Smith has been on leave without pay since April. He is at the Australian National University working on volcanic rocks collected in eastern Papua, as a Ph.D. project.

Rocks collected on Goodenough, Fergusson, Dobu, and Sanaroa Islands, and the Amphlett Islands in the D'Entrecasteaux Group, and from Egum Atoll and the Lusancay Islands, have been examined in thin section. The volcanics of Goodenough Island are mainly basaltic, although there are minor quantities of andesite, including rare hornblende andesite. On Fergusson Island the volcanics range from basalt to high-silica obsidian with peralkaline affinities; basaltic rocks predominate in the western part of the island and high-silica rocks predominate in the east. Dobu and Sanaroa Islands are made up of high-silica lavas, some of which contain inclusions of olivine-bearing basalt. The Amphlett Islands consist entirely of volcanic rocks ranging in composition from basalt to dacite, and including a moderate proportion of hornblende andesite. The volcanics collected from Egum Atoll are all andesites, many of them containing hornblende. The Lusancay Islands consist of fine-grained rhyolite and minor quantities of dacite.

Preliminary analytical results indicate that at least some of the volcanic rocks in the D'Entrecasteaux Islands belong to the alkali basalt-trachyte-comendite association. This is an interesting development, as such rocks have not been noted from the New Guinea area previously, and their presence in eastern Papua may mean that the tectonic setting of the area will have to be re-evaluated.

A preliminary draft of a report on the distribution and chemistry of the volcanic rocks in the islands northeast of the Papuan mainland is in an advanced stage of preparation.

PETROLOGICAL, GEOCHEMICAL, AND GEOCHRONOLOGICAL LABORATORIES

PROFESSIONAL STAFF: K.R. Walker, A.D. Haldane, D.C. Gellatly (resigned May), J.A. Cooper (resigned March), A.Y. Glikson, R.W. Page, L.P. Black (commenced September), S.E. Smith, R.N. England, J.W. Sheraton, S. Henley (commenced December, 1970), C.W. Claxton, and Misses B. Labonne, R.Bennett (commenced December, 1970), and D.J. Pritchard (commenced September). Mrs P.M. Angus (nee Rew) transferred to the Publications and Information Section in May.

TECHNICAL STAFF: G.H. Berryman, M. Mahon, T.I. Slezak, R.B. Hawkins (Baas Becking), J. Weekes, A. Maenner, W.C. Whitwell, and Miss A. Ahern.

TRAINEE TECHNICAL OFFICERS: R.W. Powell, I.M. Donald, and Miss R.J. Gibbs (all commenced March).

INTRODUCTION

by

K.R. Walker

The year has been one of good progress in most projects in the laboratory. Difficulties experienced in previous years with the X-ray fluorescence equipment have been almost completely overcome, and most other equipment operated at a satisfactory level of output during the year. The end of the year saw greater staff stability than in previous years.

Work in exploration geochemistry was initiated with a co-operative study (with mining companies and the N.T. Mines Dept) of the Tennant Creek mineral field, and will be extended in 1972 with supporting investigations into laboratory methods, in particular, the determination of mercury. In addition, in the Georgetown area, Queensland, some exploration geochemical investigations will be conducted in conjunction with the detailed mapping programme in 1972.

At the year's end there were 2 Bulletins in press, one with the editor, and 3 others in an advanced stage of preparation; a Report is with the editor; 6 Records were issued, another 14 are near completion, and 8 are in an early stage of preparation. Twenty-two manuscripts were accepted for publication in outside scientific journals, and another 7 are in preparation for external publication. In addition, 176 Laboratory Reports presenting the results of minor investigations were completed; these are collated into a single Record of miscellaneous investigations, which is issued annually. B. Labonne did various French translations for B.M.R. officers.

Various staff members attended symposia and training courses; four papers were presented to these, and there were six contributions from laboratory staff to the B.M.R. weekly lecture series. R.W. Page participated in a symposium on Sea Floor Spreading held at the A.N.U. in November, and presented a paper on the ages of mineralization in T.P.N.G. to the Pacific Science Congress in August. In March, S. Henley attended a symposium in Adelaide on statistics in mining and exploration, and contributed a paper. A.D. Haldane attend a joint AIMM/AMIE seminar in Melbourne in April on the effects of mining on the environment, and effective pollution control. K.R. Walker attended the symposium "Platinum Metals: Economic Geology and Geochemistry", held at the Melbourne University in October.

In early December Mr G. Birk, of Ernst Leitz, Wetzlar, conducted a three-day course in photomicrography, which was attended by 15 Bureau officers. R.W. Page and M. Mahon participated in a course of 8 Fortran lectures related to the use of the Hewlett-Packard computer installed on-line with the mass spectrometers at the Australian National University. R.N. England has been undergoing instruction preliminary to his joining the Antarctic summer expedition in December.

Three of the technical staff (G.H. Berryman, M. Mahon, and A. Maenner), together with three technical officer trainees in the laboratory, have commenced the B.M.R. course in basic geology conducted by M.E. Nancarrow. These trainees are also doing a four-year course at the Canberra Technical College while at the same time gaining practical experience through "in-service" training in several sections of the Bureau's laboratory.

The laboratory contributed to world co-operative projects in the earth sciences, such as analytical data on standards. The laboratory liaised with the I.U.G.S. Working Group on "Metallization Associated with Acid Magnetism", providing information on Australian work relating to this topic. A.D. Haldane represented the Bureau on the Standards Association of Australia Subcommittee MT/12, Analysis of Aluminium Ores.

Again laboratory staff visited field areas where this was necessary to obtain background information for their projects. Six officers made field visits: A.D. Haldane and S.E. Smith spent nine weeks between them gathering data and samples at Tennant Creek for their geochemical investigation of the area; A.Y. Glikson joined the Arunta Party for nine weeks, carrying out regional mapping, and gathering material for laboratory investigations. Brief visits were made by R.W. Page and S. Henley to the Cloncurry detailed mapping project, to familiarize themselves with the geology of the area preparatory to doing geochronology and geochemical work. J.W. Sheraton accompanied W.G.B. Phillips, of the Mineral Resources Branch, on a brief survey of tin deposits in north Queensland.

Continuing interest in the work of the laboratories was shown by the numerous visitors and enquiries received from Government agencies, industry, and educational organizations, as well as from overseas. The results of project activity from the three laboratory groups (i) petrology and mineralogy; (ii) geochemistry, and (iii) geochronology, are presented.

PETROLOGY AND MINERALOGY GROUP

by

K.R. Walker

PERSONNEL: D.C. Gellatly, A.Y. Glikson, R.N. England, J.W.Sheraton, B. Labonne.

Major projects in progress are: petrological and geochemical studies associated with (i) the Cloncurry-Mount Isa detailed mapping project; (ii) the Arunta mapping project, and (iii) acid volcanics and granites of northeastern Queensland. In addition, A.Y. Glikson has been carrying out research on Archaean rocks of continental shield areas, and R.N. England investigated mineralogical changes brought about during progressive metamorphism of amphibolites in the Soldiers Cap Formation, northwest Queensland, and the Petermann Ranges, N.T., using the electron probe microanalyser.

D.C. Gellatly resigned in May, before he was able to report the results of all his projects. However, much of his time in the laboratory was spent on the West Kimberley project, the current status of which is reported elsewhere. Since his departure the laboratory has augmented the mineralogical and chemical data he obtained earlier, so that, with laboratory measurements now complete, Gellatly hopes to write up his investigations into (i) Chromite-bearing ultrabasic rocks near Egans Bore, Mount Ramsay 1:250,000 Sheet area, W.A.; (ii) Strangways Range carbonatite, N.T., and (iii) Narlarla Pb/Zn ores, Kimberley Region, W.A. He completed a study of the Currambeen Dolerite from Wollongong, N.S.W., and the results are presented in Record 1971/51.

Dr G.A. Joplin (A.N.U.) was assisted in obtaining information needed for the compilation of chemical analyses of Australian Rocks covering the period 1962-1969; these will be presented in a Bulletin.

Petrological and Geochemical studies associated with the detailed mapping of the Cloncurry-Mount Isa area

by

A.Y. Glikson

The results of detailed mapping of a part of the Mount Isa trough (east and north of Mount Isa), which was carried out in 1970, were written up; this report will be incorporated in a Record on the Mary Kathleen 1:100,000 Sheet area. The mapping was accompanied by systematic sampling of lithological units and type sections. Petrographic descriptions were made of 76 rocks, and 41 were analysed for

major elements by XRF (AMDL), and for minor elements (Ba, Cr, Cu, Ni, Sc, Sr, V, Y, Zr) by T.I. Slezak. Pb and Zn were determined by atomic absorption (AMDL). Using the geochemical data, S. Henley calculated various norms and petrochemical indices and ratios by computer. The results will be reported along with earlier results from the Soldiers Cap Group in a Bulletin entitled 'Basic volcanic sequences of the Proterozoic in the Cloncurry-Mount Isa region, northwest Queensland'. Some of the main observations follow:

(1) Petrological and geochemical work on rocks from the Eastern Creek Volcanics indicate a transition in time from tholeiitic basalts to alkali basalts, and back to tholeiites. The trend involves a progressive increase in FeO, Fe_2O_3, TiO_2, Na_2O, and Fe/Mg, and a decrease in SiO_2 and CaO, during the first stage. These variations are interesting, as the increase in iron-magnesium ratio is inconsistent with an alkaline trend. Similar geochemical trends were reported by Baragar in Proterozoic volcanics of the Coppermine River area, Canada. The strong depletion in calcium may have resulted from synmetamorphic outward diffusion. The basic dykes in the area are not the feeders of the basalt flows, but were emplaced after the main deformation.

(2) Important differences exist between the metabasalts of the Soldiers Cap Group Volcanics (Cloncurry) and the Eastern Creek Volcanics (Mount Isa). The metabasalts of the Soldiers Cap area are mainly amphibolites metamorphosed under relatively dry conditions; they include mainly tholeiites with relatively low K_2O content, lack vesicular and flow-brecciated structures, and have abundant intercalations of water-laid sediments. The metabasalts of the Eastern Creek Volcanics abound in epidote, chlorite, and carbonate, include both tholeiitic and alkaline varieties, contain amygdaloidal and brecciated flow-tops, and are mainly intercalated with sandstones derived from both granitic basement rocks and basic rocks. These variations indicate the development of an increasingly thicker continental crust from east to west, assuming both volcanic sequences are of similar age. The early fault pattern of the Mount Isa trough may have controlled the distribution of mineralization of the Mount Isa type; this possibility should be investigated by further detailed mapping along the Mount Isa trough.

Petrological studies associated with the mapping of the Arunta Complex, N.T.

by

A.Y. Glikson

Nine weeks were spent on field traverses in the Reynolds Range 1:100,000 Sheet area and adjacent parts of the Aileron, Tea Tree, and Mount Peak 1:100,000 Sheet areas. The work followed on from a reconnaissance survey carried out in 1968. Colour aerial photographs at 1:30,000 scale were used in parts of these areas.

Extensive sampling of a range of rock types was carried out to supplement the petrographic work done previously. Some of the principal observations made this year are:

(1) A basic stratified sill complex was found in the Mount Stafford area, about 16 km northeast of Coniston homestead. The complex extends over about 150 sq. km; it overlies metasandstones, has metasandstones intercalated with it, and is intruded by coarse-grained porphyritic granite. In the western part of the complex the layering dips about 25° northeast. The western segment of the complex consists of numerous sills, 10 to 15 metres thick, intruded into sandstone and quartzite. Individual sills display fine-scale layering of gabbro and dolerite. The sediments intercalated with the basic sills show effects of contact metamorphism, and include andalusite-bearing metasandstones and hornfels. Although the formation as a whole is little deformed, fine-scale folding and faulting of the rocks is common. The igneous sheets are mostly heavily altered, except for occasional retention of pyroxene in the coarser-grained rocks. The eastern part of the complex consists of vertical sheets of intermediate porphyry and gabbro intruded into sandstone.

(2) Detailed observations on granulites, paragneiss, and metamorphosed granites northeast of the Reynolds Range were conducted. The granulites include interbanded basic and acid types including hypersthene granulites; acid granulite and paragneiss have been migmatitically mobilized, and intrude the basic granulite bands. Large bodies of calc-silicate granulites interbanded with quartzo-feldspathic paragneiss are present, and include lenses of basic granulite. The acid granulites contain perthite, sillimanite, cordierite, garnet, spinel, and relict lower-grade components such as biotite and andalusite. The basic granulites contain hypersthene, diopside, brown hornblende, and calcic plagioclase. Slight retrograde metamorphic effects are present. Pods of basic granulite occur within the metamorphosed granites, and represent metamorphosed intrusions. Complex folding and faulting occur in the belt of high-grade rocks; elucidation of the structure will require further work.

(3) Gradual transitions from unmetamorphosed sediments into low-grade schists, high-grade schists, paragneiss, and granulite were observed both across and along the regional strike. Study of this sequence will establish the mineralogical changes which took place with rising metamorphic grade.

(4) Thick sills of sheared and unsheared granite and quartz porphyry were found along the central and northwestern parts of the Reynolds Range. The sheared sills consist of sericite schist with numerous small sheared quartz phenocrysts, and were previously mistaken for quartz gritstones. In several localities the granite appears to preferentially intrude calc-silicate rocks, which probably yielded more readily to deformation and intrusive forces owing to their plasticity.

(5) An earlier assumption which suggested that the low-grade belt of the Reynolds Range includes retrograded equivalents of the northern high-grade belt had to be abandoned, mainly in view of the discovery of widespread primary sedimentary structures in these rocks. However, an isolated pod of high-grade rocks in the low-grade belt was found, and remains unexplained pending petrographic study.

(6) Thick units of sedimentary quartzite which overlie granite unconformably were found in the Mount Peak Sheet area east of the Lander River. These rocks include conglomerates at basal levels, and may represent equivalents of the Vaughan Springs Quartzite of the Ngalia Basin.

The results of the work in the Reynolds Range and adjacent Sheet areas will be written up as a progress report (Record) with A.J. Stewart as co-author.

Geochemistry of Australian Granites: North Queensland Volcanic and Granitic Rocks (J.W. Sheraton and B. Labonne)

by

J.W. Sheraton

The Australian Granites Project was started about two years ago, but repeated breakdowns in the XRF equipment have resulted in considerable delays from time to time. The main current aims of the project are the investigation of regional geochemical variations in north Queensland granites, with particular reference to associated economic mineralization. It is hoped that it will be possible to relate major and minor element geochemistry to type of mineralization, as well as to other variables such as rock-type, tectonic setting, and age.

A total of 579 samples of granitic and acid volcanic rocks from the Georgetown Inlier and adjacent areas of north Queensland have been selected for an initial geochemical study. A further 280 samples from areas of eastern Queensland, as far south as Rockhampton, are available for the second phase of the project. Crushing and grinding of both batches of samples are almost complete.

Petrographic descriptions for the majority of these samples have been completed, and summaries of the petrographic data are being prepared.

Three hundred and forty nine samples have been analysed for major elements (Na, Mg, Al, Si, P, K, Ca, Ti, Mn, and Fe) by X-ray fluorescence, and it is hoped that analysis of the remaining 230 samples will be completed early in 1972. Determinations of FeO, H_2O, and Na_2O have been carried out on about 300 of these samples by AMDL, and a small number have also been analysed for CO_2 and F.

A start has been made on trace element determinations. To date, 332 samples have been analysed for Rb, Sr, Pb, and Th. Trace elements still to be determined include Ba, Ce, Co, Cr, Cu, Ga, La, Ni, Sn, U, V, Y, Zn, Zr, and possibly S and Sc. It is estimated that this work will require up to twelve months of continuous X-ray spectrometer time.

Ten samples each of the Esmeralda Granite and the Croydon Volcanics were sent to AMDL for Rb/Sr dating; an age of about 1400 m.y. has been established for both the granite and the volcanics.

Synthesis and evaluation of the analytical data will commence as soon as all the major element results are available. This will include calculation of norms and critical element ratios. Graphical and statistical techniques will be used to compare the chemistry of the various rock units. A progress report (Record) on the project is planned for mid-1972.

Studies of Archaean rocks

by

A.Y. Glikson

Reading and correspondence regarding correlations between Archaean systems in Western Australia, South Africa, Rhodesia, and the Canadian Shield have led to the construction of a proposed geochemical and geotectonic model of early Precambrian evolution. A paper presenting this model has been submitted to the Geological Society of America Bulletin, and a letter summarizing the principal concepts was prepared for Earth and Planetary Science Letters. A summary of the main points of the model follows:

The primordial crust consisted of an oceanic ultrabasic-basic assemblage, segments of which are retained at the base of Archaean sequences in South Africa and Western Australia. Metabasalts of these assemblages compare with oceanic tholeiites, but have higher Mn, Ni, Cr, Co, Fe/Fe+Mg, and Rb, and lower Al, Ti, Sr, Zr, Y, K/Rb, and Fe^{+3}/Fe^{+2} than recent oceanic tholeiites. Compared to the oceanic tholeiites averaged by Engel et al., Archaean metabasalts are characterized by element abundance ratios closer to those of carbonaceous chondrites. Metabasalts from Archaean calc-alkaline volcanic sequences which overlie the ultrabasic-basic oceanic assemblages are more differentiated, and have K, Ba, Sr, Zr, and Fe+Mg values higher than those of metabasalts of Archaean oceanic assemblages and recent oceanic tholeiites. The chemical evidence suggests derivation of the basalts through partial melting at depths shallower than 15 km. Possibly the Archaean mantle had higher levels of siderophile and certain transition elements than the present mantle; this may have been related to a lesser degree of development of the core. The earliest Archaean granites have high Na/K, Ni, and Cr levels, and were probably derived from partial

melting of the oceanic crust. Granitic cyles showing a progressive decrease of the Na/K and K/Rb ratios reflect an increase in the degree of differentiation and a thickening crust. The pattern and evolution of Archaean volcanic-sedimentary troughs were controlled by early nuclei of sodic granite and granodiorite emplaced in the oceanic crust; these greenstone belts are therefore not analogous to Alpine or island-arc systems. The stabiliztion of these belts through deformation and metamorphism resulted in the aggregation of the early granitic nuclei into shields; subsequently high-grade metamorphic belts developed along shield-ocean boundaries.

Mineralogical changes in amphibolites during progressive metamorphism

by

R.N. England

A mineralogical study has been concluded on the progressive metamorphism of amphibolites from the Petermann Ranges, N.T., and the Soldiers Cap Formation in the Cloncurry area, Qld. During the year, 319 mineral analyses were performed by electron probe microanalyser for this project. The information gained was used in an attempt to elucidate the reactions by which amphiboles of different compositions are formed during prograde metamorphism. In the samples from the Soldiers Cap Formation a marked increase in iron content during the transition from actinolite to hornblende, both in zoned hornblendes and in different rocks, together with other evidence, strongly suggests that iron oxide minerals have played an important role in reactions leading to the formation of aluminous amphibole. In general the reactions are complex, and vary from rock to rock, so that it would be difficult to use hornblende as an indicator of metamorphic grade. It has been established that hornblende compositions in the vicinity of edenite do not occur in the upper greenschist and lower amphibolite facies. There does not appear to be a solid solution gap between actinolite and hornblende in the Soldiers Cap area, but rather a scarcity of compositions with 6.9 to 7.2 Si atoms per unit cell. A Record on the results of this work is being prepared.

In the Thin Section Laboratory (A. Maenner) 1190 thin sections, 116 polished sections, and 58 polished thin sections were prepared. Numerous specimens were cut for the X-ray laboratory, for chemical analysis, and for display and study purposes. Over one hundred mineral grain mounts were prepared, and a large number of slides were cleaned and labelled.

Major Instrument Laboratories

by

S.E. Smith

Work in the Major Instrument Laboratories provided analytical services required for major projects and minor investigations throughout the year, including projects being undertaken by other Sections and Branches.

In the Electron Probe Microanalyser and Electron Scanning Microscope Laboratories (R.N. England and R.B. Hawkins) a number of smaller projects were undertaken in addition to the study of mineralogical changes in amphibolites. These included:

(i) the identification of the source of radioactivity in the pebble beds of the Crater Formation, Rum Jungle area, N.T., as a partly acid-soluble calcium thorium phosphate of uncertain identity;

(ii) the determination of feldspars and feldspathoids in volcanic rocks from New Ireland;

(iii) the analysis of pyroxenes from the Cape Ward Hunt and the Amgen River areas, T.P.N.G.

R.B. Hawkins was involved in operation of the scanning electron microscope, and maintained both the microscope and electron probe as well as other laboratory equipment for the Baas-Becking Group. He was also occupied with the design and construction of specialized electronic equipment.

In the Direct Reading Optical Spectrograph Laboratory (T.I. Slezak) 1040 samples were quantitatively analysed for various projects. This amounted to 16,000 element determinations for the year, and contributed to the investigation of specimens from the Antrim Plateau Volcanics (N.T.), Broad Sound (Qld), the Strangways Range (N.T.), Tennant Creek (N.T.), Talasea (T.P.N.G.), and the Cloncurry-Mount Isa (Qld) areas. The results of this analytical work are recorded in Laboratory Reports 1970-93, 102, and 103, and 1971-59, 70, 71, 72, 73, and 90. In addition, about 250 samples were analysed semi-quantitatively, mainly to assist in the interpretation of X-ray diffraction patterns.

In the X-ray Diffraction Laboratory (G.H. Berryman) 1460 mineral identifications were made; some of these were for the Estuary Study Project and the Phosphate Cell Dimension Project of the Phosphate Group, and the Clay Mineralogy Project of the Sedimentological Laboratory; minerals were identified in 126 samples from the Suckling-Dayman Mountain Block, eastern Papua, in addition, the Royal Australian Mint was given some assistance with the

identification of forged sovereigns. The results of these investigations and of other ad hoc determinations are recorded in Laboratory Reports 1970-64, 92, 94 and 98, and 1971-4, 6, 19, 26, 27, 30 to 41 inclusive, 43, 44, 46 to 53 inclusive, 57, 58, 60, 61, 62, 79, 86 to 89 inclusive, and 91. In October, 1971, the diffractometer was modified so that 2 samples can be run simultaneously.

In the X-ray Fluorescence Laboratory (J.W. Sheraton) 654 samples were analysed for major elements (Na, Mg, Si, Al, P, K, Ca, Ti, Mn, and Fe). Of these, 350 were for the project Geochemistry of Australian Granites. The remaining analyses assisted in investigations in the Cloncurry-Mount Isa, Gosses Bluff, Kalgoorlie, Alcoota, and Alice Springs areas of Australia, as well as several localities in T.P.N.G., and included some ad hoc determinations. The results of this analytical work are given in Laboratory Reports 1970-64, 94, 96, 97, 98, 99, 100, and 107, and 1971-1, 2, 3, 63, 65, 66, 67, 75, 76, 77, and 78. The spectrometer was also set up and calibrated for trace element analyses. Three hundred and thirty two samples were analysed for Rb, Sr, Pb, and Th, as part of the granite project. In addition, 11 determinations of Hf in zircons, and 3 of Y in xenotime concentrates were made as part of a survey of the composition of Australian zirconium minerals for the A.A.E.C.

Total element determinations by X-ray fluorescence for the year amounted to 7870. There was considerable loss of analytical time as continual equipment breakdowns continued into early 1971. However, since a major overhaul in February, the reliability of the spectrometer has greatly improved.

The Sample Preparation Laboratory (W.C. Whitwell) prepared samples for analysis by direct reading optical spectrograph and X-ray fluorescence spectrometer. In all 562 samples were crushed and ground, and 726 fusion discs and 704 powder pellets were made.

GEOCHEMISTRY GROUP

by

A.D. Haldane

Personnel: A.D. Haldane, S.E. Smith, C.W. Claxton, P.M. Angus, D.J. Pritchard.

The year's work has been concerned mainly with 3 projects: (i) Geochemistry of carbonate rocks of the McArthur River, area, N.T.; (ii) Geochemistry of the Styx River catchment, Broad Sound, Qld; and (iii) The Tennant Creek Mineral Field Geochemical Project.

Geochemistry of the carbonate rocks, McArthur River

by

C.W. Claxton

All analytical work for this project was completed early in the year, and comprised the determination of Ca, Mg, insolubile residue, Fe, Mn, Ni, Co, Cu, Pb, Zn, and phosphate on a total of 363 samples from 14 measured sections. The analytical data were analysed statistically by Gestat and factor analysis programmes. The results showed that the geochemical anomaly associated with the H.Y.C. mineralization is only very local, and that there is no regional stratigraphic geochemical anomaly associated with the Barney Creek Formation. There is also no mineralized halo around the H.Y.C. "orebody" in any beds other than the H.Y.C. Member of the Barney Creek Formation. Compilation of a joint geological-geochemical report with M.C. Brown is in progress.

Geochemistry of the Styx River Catchment

by

P.M. Angus

This project was undertaken in collaboration with the Phosphate Group as part of their Estuary Study Project. Its objective was to evaluate the geochemical character of the Styx River catchment, which forms one of the sources of dissolved and clastic material entering Broad Sound estuary, and, if possible, to relate this to the geochemistry of the estuary sediments and water. About 900 stream sediment, soil, and rock samples were collected from an area of 1800 sq. kilometres. Samples were analysed for Cu, Pb, Zn, Co, Ni, Sn, Mo, V, Ag, Be, and phosphate by stectrographic, atomic absorption, and colorimetric techniques, as appropriate. Compilation of the results and preparation of a Record are in progress.

Tennant Creek Mineral Field Geochemical Project

by

S.E. Smith and A.D. Haldane

Preliminary discussions between Geopeko, Australian Development, the Mines Branch of the Northern Territory, and the Bureau to formulate a programme of study of the fundamental geochemistry of the Tennant Creek field began in November, 1970. The first sampling of core from surface drilling by Geopeko was completed in May. Further sampling of core from Geopeko and Australian Development in August brought the collection to 299 samples of Warramunga sediments, porphyry, dolomite "lodes", mineralized sediments, including (?)talc-chlorite rocks, lamprophyres, and basic rocks. In addition, 30 samples were collected from granite outcrops.

Chemical analyses by spectrographic and atomic absorption techniques have been completed for Na, K, Ca, Mg, Fe, Ti, Zr, Sr, Ba, Pb, Zn, Cu, Co, Ni, Cr, Mn, V, Be, Sc, Y, Ag, Bi, and Cd on one third of the collection. Trace elements showing significant variation so far include Ba, Pb, Zn, Cu, Co, Ni, Cr, Mn, Be, Sc, Ag, Bi, and Cd. The distribution of some of these elements, especially Pb, Zn, Cu, Co, Ni, Ag. Bi, and Cd, suggests an association between (?)talc-chlorite rocks, lamprophyres, and mineralization, though there is also a close spatial relationship between granite, porphyry, and mineralization. Major element analyses by X-ray fluorescence will complete the analytical programme by adding Si, Al, and P, and checking Fe, Ca, Mg, and K. A progress report on the trace element analyses is expected to be available by March, 1972.

MINOR INVESTIGATIONS: Monitoring of the zinc level in the Molonglo River/Lake Burley Griffin system continued. About 2300 samples collected by the Departments of the Interior and Works were analysed for pH, specific conductance, Zn, and in some cases Fe. A report on zinc pollution in the Molonglo River was prepared for the N.C.D.C. Zinc Pollution Sub-Committee.

Some time was spent examining analytical methods, in particular the atomic absorption method for chromium (which has been troublesome because of extreme sensitivity to flame conditions), spectrographic methods for the analysis of ironstones for trace elements, and a suitable method for the determination of mercury in the parts per billion range.

Miscellaneous partial analyses of rock samples numbered 127, and water analyses, 37.

GEOCHRONOLOGY GROUP

by

R.W. Page

Personnel: R.W. Page, L.P. Black, R. Bennett, J.A. Cooper; M. Mahon, T.O. 2.

The Group continued working on dating problems in Queensland, the Northern Territory, and Papua New Guinea. Over 260 solid source and 50 gas source mass spectrometer runs, and 200 X-ray fluorescence analyses (in duplicate) were carried out during the year. In addition, much time and effort were devoted to improving chemical techniques and making various standard and tracer calibrations. Providing assistance with the construction and assembly of A.N.U.'s new MS-10 mass spectrometer was another facet of the Group's activities during the year. The new Hewlett-Packard computer was installed early in 1971, and is now in full use for the reduction of some mass spectrometer data.

Considerable progress was made during the year on two major projects and a number of smaller studies, and two major new projects were started towards the end of the year. Following is a brief summary of the major topics and areas covered during the year.

CAPE YORK (QLD): Rb-Sr dating of granitic and metamorphic rocks by R. Bennett and M. Mahon is complete, and has indicated widespread tectonic activity in the Silurian and early Devonian. The question of the eastern limit of Precambrian granites is unresolved, although some possible Precambrian ages have been found. The data are currently being interpreted and written up by J.A. Cooper at the University of Adelaide.

GEORGETOWN INLIER (QLD): Before his departure Cooper did some further dating on the rocks of this area, and L.P. Black will continue with the work in 1972. Rb-Sr isotopic studies are currently being performed on rocks from the Georgetown Inlier area of North Queensland. Earlier regional mapping of the area led to several interesting hypotheses of ore and rock genesis which should be amenable to testing by isotopic dating techniques. Initial work is being focused on the extensive areas of volcanic rocks, in particular the Featherbed and the Newcastle Range Volcanics. This will be followed by a detailed chronological study of the approximately contemporaneous granitic rocks in order to determine both the overall duration and the sequence of igneous activity. Rb-Sr measurements on another volcanic suite, the Glen Gordon Volcanics, were completed earlier in the year, and gave an age close to 300 m.y.

The results of studies in the Georgetown Inlier area will be presented in a Record.

NABARLEK URANIUM DEPOSIT: A single sample of pitchblende from this deposit was analysed by the U-Pb method by J.A. Cooper. An interpretation of the data tentatively suggests that uranium mineralization took place at around 700 to 800 m.y. ago. A Record is being prepared on the results.

NEW GUINEA HIGHLANDS (R.W. Page): This K-Ar and Rb-Sr study of the Mesozoic and Tertiary granitic, volcanic, and metamorphic rocks was completed and written up in late 1970. Emplacement of Miocene granodiorite/diorite stocks and batholiths in a magmatic belt several hundred kilometres long was demonstrated. The youthfulness of the area is also exhibited by the Kaindi and Ambunti Metamorphics and possibly the Bena Bena Metamorphics, all of which exhibit mid-Tertiary metamorphic imprints.

The K-Ar age studies of igneous bodies related to porphyry copper mineralization has been a continuing aspect of the work; ages as young as Pleistocene have been recorded from one of these bodies. Results from some areas have been written up, and are to be submitted for outside publication. Areas of mineralization in the Antares Pluton in West Irian are currently under investigation, and the ages of a number of smaller mineralized bodies in north-western Papua are also being determined in co-operation with Kennecott Explorations.

NORTH NEW GUINEA RANGES (R.W. Page): A reconnaissance age study of granites in the Torricelli Mountains is under way in co-operation with the Continental Oil Company of Australia Ltd. Initial results indicate a complex intrusive history from Jurassic to mid-Tertiary time.

NEW BRITAIN (R.W. Page): Several granodiorite suites from the core of this island have been dated by the K-Ar method. A remarkably close grouping of ages at around 26 m.y. is indicated. The work is almost complete. Results will be incorporated in a Bulletin on the area.

ISOTOPIC COMPOSITION OF STRONTIUM IN NEW GUINEA ISLAND ARCS (R.W. Page): Measurements of Sr^{87}/Sr^{86} variations in the Quaternary volcanic rocks of New Guinea were undertaken as an extra petrological tool in this complex series of volcanic arcs. Rocks from the New Britain Arc and extinct volcanoes northeast of New Ireland have been examined. The most striking feature is the uniformity of the Sr^{87}/Sr^{86} ratios (0.704), irrespective of rock type. The results of this work will be incorporated in various reports (Records) currently being prepared by field geologists.

TENNANT CREEK (N.T.) (R. Bennett): Rb-Sr biotite analyses from two contrasting granite types were made. The foliated "Rapakivi" type granite and an even-grained adamellitic type have identical ages close to 1800 m.y. This is some 200-300 m.y. greater than K-Ar ages previously obtained on other granites in the same region; the consistency of the two Rb-Sr ages of 1800 m.y. provides a much more reliable minimum value for the age of emplacement of the Tennant Creek granites. Results of this and any further studies will be incorporated in reports on the regional geology which are still in preparation.

VICTORIA RIVER REGION, N.T. (R. Bennett and M. Mahon): Several glauconitic sandstones were examined, and will be dated initially by the Rb-Sr method. The aim of this study is to determine a possible maximum age for the overlying (?)Proterozoic Angalarri Siltstone. Results will be incorported in a Bulletin now in preparation.

MOUNT ISA-CLONCURRY (QLD) (R.W. Page): Rb-Sr dating will be the main tool in delineating the ages of several intrusive and volcanic suites which were sampled in September. It is also hoped that it will be possible to determine ages of the widespread copper and uranium mineralization in the region. Results will be incorporated in Reports and a Bulletin currently being written.

ISOTOPIC AND ELEMENTAL GEOCHEMISTRY OF BLACK SEA SEDIMENTS: J.A.Cooper completed his laboratory work for the project before he left the Bureau. A paper interpreting the results, and prepared jointly with E.J. Dasch and M. Kaye, has since been submitted to the Woods Hole Oceanographic Institute.

Rb/Sr and K/Ar dating of rocks from the Arunta Complex will be carried out by L.P. Black and AMDL, respectively. Work has started and the project will continue over several years; results will be presented in various Reports and Bulletins projected for the future.

MATHEMATICAL GEOLOGY AND GEOSTATISTICAL STUDIES

by

S. Henley

A survey of computer programmes available in the Geological Branch has shown that there are 61 programmes, of which substantial development of 17 has taken place during the last year. A summary of the more important of these is given below (the remainder are mainly small data-manipulation programmes, or have very restricted applications).

During the year, detailed statistical computations were performed on geochemical data from the McArthur River area, N.T., and various types of norm and other petrochemical calculations were carried out for various field parties.

Name	Purpose	Amount of Development in 1970/71	State of Completion
BLOCK	Plotting of stacked sections as a block diagram	50%	50%
CIPWNORM	Computation of CIPW norms; plotting of triangular and tetrahedral diagrams	40%	100%
ANYNORM	Computation of norms based on any given assemblage of normative minerals	100%	100%
NIGGBART	Computation of Niggli values, Barth standard cell, QLM and and QKpNe triangles	100%	100%
ZAVSKY	Computation and plotting of Savaritsky numbers	100%	100%
NONLIN	Nonlinear least squares approximation	20%	100%
TRICONT	Plotting of contour maps from irregularly spaced data by linear interpretation	20%	100%
DISCONT	Identification of discontinuities in irregularly spaced data	100%	100%
X12	Processing of XRF trace element data	95%	95%
GCDATA	Geochemical data storage/ retrieval	30%	30%
WULFF	Scatter plotting (lineprinter) of orientation data on a Wulff net	100%	100%
TRIGDIG	Lineprinter plotting of triangular diagrams	100%	100%
TRIGPLOT	Incremental plotter: triangular diagrams	100%	100%
TETRPLOT	Incremental plotter: tetrahedral diagrams	100%	100%
McARTHUR	Plotting of chemical data vs height in measured sections	100%	100%

A new sample submission form was designed in collaboration with F.W. Brown, and after consultation and discussions with members of the Geological Branch, is now in use for a trial period. This form has been designed for greatly improved efficiency in transferring data to a computer-based storage/retrieval system.

A large amount of time has been spent on the problems of identifying discontinuities in 3-dimensional data, with particular relevance to topographic and geological data from the Carpentaria Basin, and a programme TRICONT (listed above), written by R. Whitworth, has been modified, and a second programme, DISCONT, has been written to partly overcome this problem.

BAAS BECKING GEOBIOLOGICAL RESEARCH LABORATORY

BIOLOGICAL GROUP

by

P.A. Trudinger

PERSONNEL: P.A. Trudinger, B. Bubela, G.W. Skyring, H.E. Jones, A.D. Agate, Miss L.A. Chambers.

The biological research programme for 1971 continued to revolve around the following main projects:

1. Physiology and biochemistry of sulphate-reducing bacteria.
2. Concentration of metals by bacteria.
3. The response of microorganisms to metals.
4. The taxonomy and evolutionary status of sulphur-metabolising organisms.

Two new projects were commenced: namely, the fractionation of stable sulphur isotopes by bacteria, and the oxidation and concentration of manganese by microorganisms.

Dr A.D. Agate joined the Staff as a Research Fellow for a period of two years.

SULPHATE REDUCTION BY DESULPHOTOMACULUM NIGRIFICANS. (P.A. Trudinger, L.A. Chambers).

Studies on the sulphite reductase, the catalyst responsible for hydrogen sulphide production by D. nigrificans, were temporarily held up pending the arrival of an electrophoretic apparatus to be used in its preparation. The apparatus is now installed, and the optimum conditions for the separation of the pigment are being determined.

EXTRACTION OF METALS BY BACTERIA. (P.A. Trudinger, L.A. Chambers, H.E. Jones).

The studies on the ability of sulphate-reducing bacteria to concentrate metals, which were described in the 1970 summary, have been extended to include a wider range of metals. Results for Mn, Pb, Ni, and Ag confirm earlier findings that the extraction is partly selective. In particular, no extraction of Ni was obtained. Qualitative examinations of a number of sulphate-reducing bacteria suggest that not all species concentrate metals to the same extent. This aspect is to be examined further. If confirmed, it will lend support to previous findings that the concentration of metals is not due simply to their chemical fixation as sulphides.

Preliminary studies have been made on the mechanism by which the metals are fixed in the bacteria. The results suggest that lipids, or fatty material, located in the outer structure of the bacteria, may be involved in the metal binding.

BACTERIAL OXIDATION OF MANGANESE. (A.D. Agate).

The ability of bacteria to oxidise manganous salts, and to bring about large-scale concentration and precipitation of manganese from dilute solutions, is being studied. A number of soil bacteria, as well as organisms isolated from manganiferous deposits in the Bendora pipeline, are being used. Initial results indicate at least two types of manganous oxidation, one leading to the formation of MnO_2, and the second involving the formation of what is probably Mn_3O_4.

CHEMISTRY OF SULPHATE-REDUCING BACTERIA. (H.E. Jones, A.D. Agate).

Earlier work on the characterization of porphyrinic pigments from sulphate-reducing bacteria has continued. The main project has been a survey of pigment composition of representatives of all species of sulphate-reducing bacteria. The results should help in the more precise classification of these organisms.

Studies are also in progress on the characterization of the fatty acids and hydrocarbons present in sulphate-reducing bacteria.

SULPHUR ISOTOPE FRACTIONATION BY SULPHATE-REDUCING BACTERIA.
(L.A. Chambers, P.A. Trudinger)

It is proposed:

1. To examine the conditions governing the fractionation of stable sulphur isotopes by Desulphovibrio and Desulphotomaculum.
2. To determine whether fractionation is dependent or independent of bacterial species, and
3. To obtain information on the mechanism of sulphur fractionation.

As a prerequisite to this work, a continuous culture system, which will enable the growth of the organisms to be precisely controlled, has been constructed, and is being tested.

RESPONSES OF MICROORGANISMS TO METALS. (B. Bubela)

Effect of copper on bacterial cell walls. Studies reported in the 1970 summary have been extended. The ability of copper to induce chemical changes in the cell walls of organisms appears to be specific, as neither Ni, Fe, Co, Mg, or Zn caused similar changes. It is possible that one effect of copper is to compete with Mn, which is essential to a number of biochemical reactions, as Mn, but no other metal tested, reversed the effects of copper.

The interrelationship between copper and oxygen with respect to bacterial growth. It has previously been demonstrated that copper is more toxic to bacteria under anaerobic than aerobic conditions. In an attempt to gain some insight into the relationship between copper and oxygen, studies have begun in the electron transport systems of Bacillus stearothermophilus when it is grown under various concentrations of copper and oxygen.

RELATIONSHIPS AMONGST DISSIMILATORY SULPHATE-REDUCING BACTERIA.

(G.W. Skyring)

Studies are in progress to determine the extent of natural relationships between sulphate-reducing bacteria. The results will aid in:

1. the taxonomic classification of the organisms,
2. attempts to determine the evolutionary status of the bacteria, and,
3. circumscribing the environmental conditions under which the sulphate-reducing bacteria might contribute to sulphide ore genesis.

MINERALOGICAL GROUP

PERSONNEL: W.M.B. Roberts, C.J. Downes, J. Ferguson, I.B. Lambert.

WOODCUTTERS DEPOSIT. by W.M.B. Roberts

Following the return of Roberts from Heidelberg in May, the investigation of the Woodcutters lead-zinc deposit has been completed, and a manuscript giving the results has been prepared for publication. The conclusions reached on the events leading to the emplacement of the ore in its present location are -

1) In the dolomitic restricted basin environment, lead and zinc were removed from solution by co-precipitation with dolomite precursors.
2) Dolomitization during early diagenesis allowed the release of the metals to the pore fluids.
3) During diagenesis the metals remained in solution by forming organo-metallic complexes with material derived from the degradation of algal protein.
4) A flexure developed in the sediments after lithification caused pressure gradients which moved the ore fluids into tension fractures developed in the anticline, where decomposition of the complexes allowed precipitation of the sulphides.

On the basis of this hypothesis two lines of research are being investigated -

C.J. Downes is studying the chemistry of carbonate precipitation and the co-precipitation of base metals with dolomite precursors.

J. Ferguson is investigating the formation of organo-metallic complexes with algal decomposition products.

GEOCHEMICAL AND MINERALOGICAL STUDY OF WATERS AND SEDIMENTS FROM THE TALASEA HARBOUR EXHALATIVE SEDIMENTARY ENVIRONMENT.
by I.B. Lambert.

Personnel: I.B. Lambert, J. Ferguson.

These studies are almost completed. The thermal waters are of the acid-sulphate type. Their metal contents are, with a few exceptions, fairly low. The harbour sediments are locally enriched in Zn, Cu, Pb, V, and Sr in the vicinities of thermal areas. The volume of thermal waters entering Talasea Harbour is smaller than at Matupi Harbour, and this is the basic reason for the lower metal enrichments in the former.

EXPERIMENTAL DIAGENESIS AND METAMORPHISMS. by I.B. Lambert.

Work has continued on the breakdown of pyrite in the presence of organic matter. Low and medium-rank coals cause partial conversion of pyrite to pyrrhotite at the lowest temperatures - as low as 350°C. The influence of pressure and water content on the breakdown has been investigated.

Release of sulphur as pyrite is metamorphosed to pyrrhotite could cause replacement textures in sedimentary ores.

Work has continued on the formation of metal sulphides from sulphur released from organic matter during diagenesis. Greigite can be formed from organic sulphur over a wide range of temperatures (at least 150°to 300°C) provided the runs are quenched rapidly. This conflicts with previous reports that it forms only at temperatures very close to 190°C.

It has now been established that some replacement textures in sedimentary ores could be the result of the formation of later generations of sulphides consequent upon the diagenetic release of organic sulphur.

GEOCHEMICAL AND BACTERIOLOGICAL STUDY OF IRON SULPHIDE FORMATION IN INTERTIDAL GEOTHERMAL AREAS AT TALASEA, NEW BRITAIN. by J. Ferguson and I.B. Lambert.

A manuscript has been prepared for publication, and is currently undergoing revision.

PHYSICAL CHEMISTRY OF BRINES. by C.J. Downes

Isopiestic experiments on brines containing cobalt and nickel have continued. A modified apparatus has been designed and constructed (using platinum dishes) so that brines containing copper salts can be investigated (copper salts corrode the gold-plated dishes used for other systems). Experiments on solutions containing copper salts have started.

NON-BACTERIAL SULPHATE REDUCTION. by C.J. Downes.

Of the several systems tried, none that is likely to operate in the natural environment has been satisfactory. However, several further systems are being investigated.

INTERACTION OF ALGAE AND METALS. by J. Ferguson and B. Bubela.

A culture of the alga, Chlorella vulgaris, has been obtained, and preliminary biological studies are in progress. This species has been selected as some data on its response to metals are available in the literature. An attempt is being made to obtain a species of alga closely resembling algal material found in the Paradise Creek Formation, as the isotopic age of this Formation is equivalent to the model age of syngenetic Mount Isa lead. Meanwhile the complexing properties of a green alga isolated from Corin dam, A.C.T. are being investigated; this species can accumulate up to 0.5% of its freeze-dried weight of Ag, and at least 0.04% Cu.

SCAPOLITE SYNTHESIS. by I.B. Lambert.

Experiments conducted with mixtures of sodium chloride, calcium carbonate, and albite showed that scapolite may be synthesized from these minerals, but further work was abandoned because reaction times were so slow that insufficient data could be accumulated in a reasonable time.

MELTING IN SULPHIDE-WATER SYSTEMS. by I.B. Lambert.

This project was abandoned when it was found impossible to obtain reaction vessels which were inert to the action of sulphide at the temperatures and pressures involved.

MISCELLANEOUS

STUDY OF AUSTRALIAN BAUXITES

by

K.A. Plumb

During April, 1971, Plumb accompanied two Russian scientists, Professor A.D. Shcheglov, Deputy Minister of Geology, and Dr V.A. Tenyakov, Specialist Geologist (Bauxite) on an inspection of Australian bauxite deposits in association with Dr V. Gostin, Department of Geology, University of Adelaide, who acted as interpreter. Deposits at Weipa - Queensland, Gove - Northern Territory, and Mitchell Plateau - Kimberley Region, W.A., were visited. The rest of the party visited the Darling Ranges, Western Australia, before Plumb joined them.

Many significant observations contributing to further understanding of the Australian bauxites were made in the field, and considerable benefits resulted from discussions with the visitors. On his return to Canberra, Plumb continued his research into the origin of bauxites by a review of literature and by limited laboratory studies utilizing the optical microscope, electron probe microanalyser, and electron scanning microscope.

Briefly it has been concluded that most, if not all, of the bauxites in Australia are sediments, derived from physical and chemical reworking of primary residual in situ bauxite. Little, if any, in situ bauxite is preserved.

The results of this study are being written up as a Record. A paper on the origin of Australian bauxite deposits was presented at the Pacific Science Congress in August.

STRANGWAYS RANGE CARBONATITE PROJECT, N.T.

by

R.G. Dodson

PERSONNEL: D.C. Gellatly, P.W. Crohn

Petrographic, mineralogical, and geochemical work is nearly complete for a Bulletin describing the Strangways Range carbonatite. However, both authors have resigned from BMR; completion of the Bulletin is dependent on their continued work from outside.

TECTONIC MAP OF AUSTRALIA AND NEW GUINEA

See Report under Geological Services Section : Map Compilation.

NEW GUINEA 1:1,000,000 GEOLOGICAL MAP

See under Geological Services Section : Map Compilation.

OVERSEAS VISITS

R.G. DODSON

R.G. Dodson attended a NATO-sponsored Advanced Study Institute on "Methods of Prospecting for Uranium Minerals", held in London 21-28 September, and presented a paper entitled "Some Environments of Formation of Uranium Deposits". En route to London, Dodson visited uranium deposits in South Africa and France, and on the return journey, deposits in Canada and the United States of America. The deposits visited were selected as examples of conglomerate, vein, and sandstone type uranium deposits.

Four days spent in South Africa were devoted mainly to discussion with staff from Rio Tinto Ltd and Anglo American Corp. Ltd. Uranium in the Witwatersrand System, South Africa, is contained in conglomerates in the upper, arenaceous part of the Witwatersrand System. The uranium occurs as fine grains of pitchblende and thucolite, and tends to be distributed in sympathetic relationship with gold. Although a visit to the newly discovered uranium deposit at Rossing, South West Africa, was not possible, staff from Rio Tinto Ltd provided an account of the deposit. Rossing was discovered by a prospector, and later tested by airborne and surface radiometric surveys. The ore, mainly finely divided pitchblende, is contained in arenite of Lower Proterozoic age, and also in a leucocratic granitic rock, alaskite, which has invaded the arenite.

In France the uranium-producing district at Limoges was visited. The visit included discussion with resident staff of the Commissariat A L'Energie Atomique (C.E.A.), field excursions and inspection of uraniferous veins in the underground mine Margnac, and in the opencut mine Brugeaud.

Dodson spent four days in Canada in the Lake Athabasca district, Saskatchewan. Uranium deposits in this region consist mainly of vein deposits, presently mined at the Eldorado Mine, and

formerly mined at numerous smaller mines. South of Lake Athabasca, uraniferous deposits in glacial till were examined; the uranium in the till takes the form of pitchblende whose grainsize ranges from 1 mm or less to boulders measuring over 20 cm across; it is hoped that the boulders will enable the uranium mineralization to be traced to its source.

In the United States of America roll-type uranium deposits in the Casper district, Wyoming, and stratiform uranium deposits in the "Urovan" province, Colorado, were visited.

W.M.B. ROBERTS

W.M.B. Roberts spent from April, 1970, to May, 1971, based on the Mineralogical Institute of the University of Heidelberg, on a Commonwealth Public Service Board Post-Graduate Scholarship.

The scholarship was granted for the study of the genesis of the Woodcutters L.5 lead-zinc deposit, Northern Territory.

Selected lead-zinc mines in Sweden, Norway, Austria, Jugoslavia, Germany, Italy, and Sardinia were visited to obtain additional information on the formation of lead-zinc orebodies in sedimentary rocks.

Of particular interest was the occurrence of lead and zinc in the Triassic dolomites and limestones which form a belt through northern Italy and northern Jugoslavia. Here the ores are confined almost exclusively to the dolomitic rocks; where a dolomite bed containing lead and zinc gives way to limestone the ore disappears, and reappears in either overlying or underlying dolomite layers. This preference of lead and zinc for dolomite is world-wide, and forms the basis of a paper prepared at Heidelberg on the Woodcutters deposit.

I.U.G.S. SUBCOMMISSION ON THE NOMENCLATURE AND SYSTEMATICS OF IGNEOUS ROCKS

W.B. Dallwitz prepared notes, comments, and suggestions on the nomenclature and classification of igneous rocks. A report on the findings of working groups, and of members of the Subcommission, will be submitted to the International Geological Congress at Montreal in 1972.

GEOLOGICAL SERVICES SECTION

(PNG Geological Survey Report appears separately)

GEOLOGICAL SERVICES SECTION

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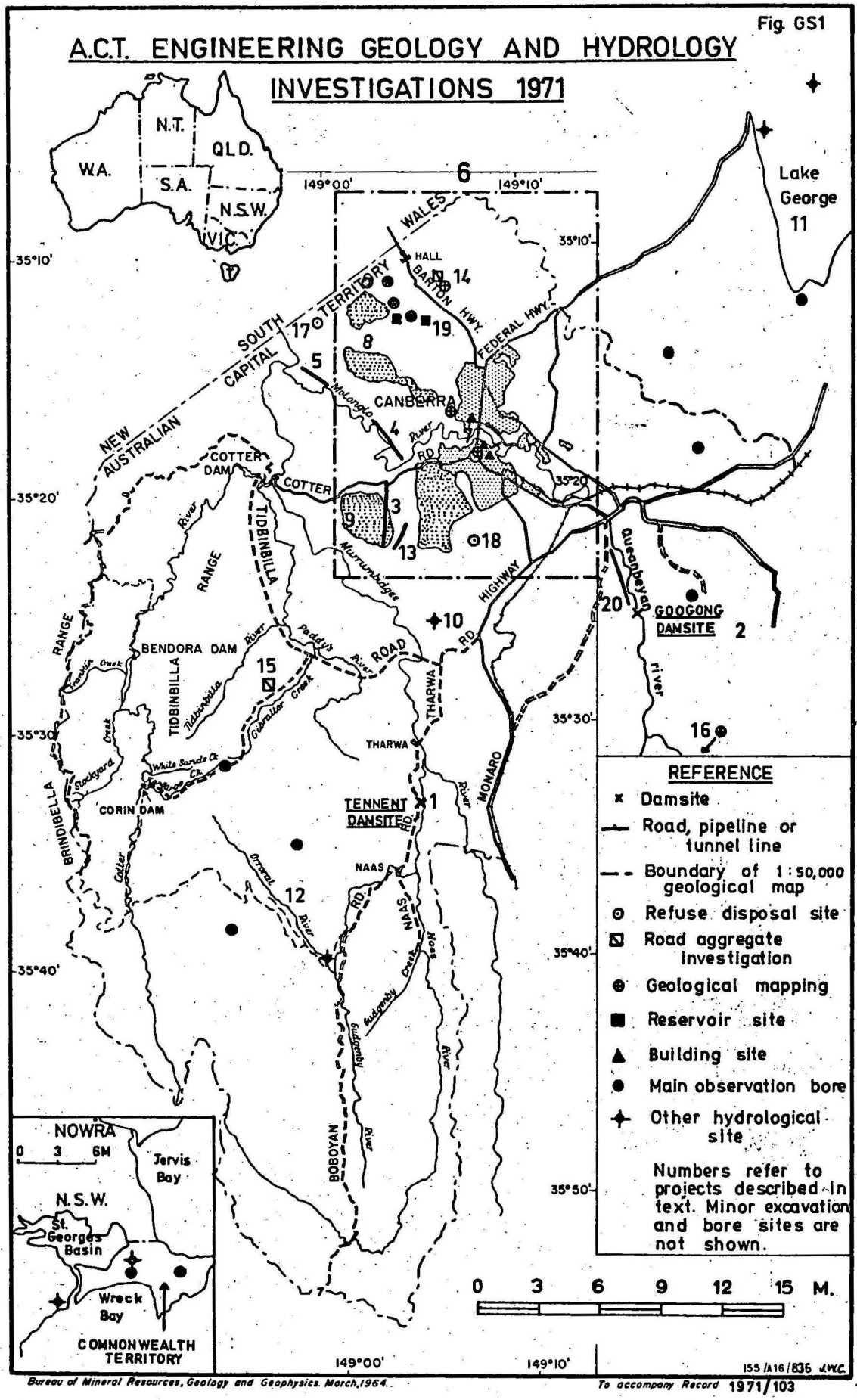
Fig. GS1

A.C.T. ENGINEERING GEOLOGY AND HYDROLOGY INVESTIGATIONS 1971



Bureau of Mineral Resources, Geology and Geophysics. March, 1964.

To accompany Record 1971/103

155/A16/836 JMC

GEOLOGICAL SERVICES SECTION

INTRODUCTION

The period under review has been one of considerable achievement and a certain amount of change. As a result of staff changes and vacancies, the Engineering Geology and Mineral Reports Groups had inadequate experienced senior staff for a large part of the period. The turnover of professional staff was comparable with that for the previous period; technical staff turnover was low. Pressures in the Engineering Geology area, and the availability of suitable applicants have called for flexibility in the use of positions.

The activities of the P.N.G. Geological Survey are reported separately because the Survey forms a discrete organizational and geographical entity. Under the existing organization the professional staff of the Survey constitute the P.N.G. Resident, Geological Sub-Section staff of the Geological Services Section.

Highlights of the year include:

The Bureau's Silver Jubilee Open Days and King's Hall Exhibition.

Completion by the Engineering Geology and Hydrology Group of important investigations for two major engineering projects in, or near, the A.C.T., and the start of detailed mapping of the Tuggeranong urban development area.

A substantial effort, in conjunction with geologists of other sections of the Bureau and other organizations, was made on the compilation of special-purpose and small scale geological maps of Australia and Papua - New Guinea. Progress ranged from start of compilation to publication on ten such maps. In addition; a major contribution was made to the production and publication, in time for the 12th Pacific Science Congress, of a geological map of the Canberra area, scale 1:50,000, together with explanatory notes. The Map Editing and Compilation Group also edited twenty standard and special maps.

The Drawing Office's work during the year contributed greatly to 29 colour maps being published, 10 others being reprinted and 20 still in press. At the end of the period 13 colour maps were ready for the printer, 8 were being fair-drawn and 6 had been or were being compiled. In addition, 22 preliminary editions of maps were issued and 20 were being compiled at the end of the period; more than one thousand miscellaneous drawings were completed for publications and Records.

Two Records were issued, or had numbers allocated, and the writing of 20 Records was completed; advance copies of 5 of the Records which have still to be issued were sent to the client Department. Three other Records are being written.

The Assistant Chief Geologist (Geological Services) (E.K. Carter), in addition to his administrative and supervisory tasks as Section Leader, provided technical supervision of major engineering geology investigations in P.N.G. The work involved liaison between Department of Works' Head Office (Melbourne), engineers, BMR geophysicists and Port Moresby geologists; the main activities were the preparation of geological material for the tender documents for the Ramu 1 hydro-electric scheme (construction of which will start in February, 1972) and the checking of the first reports on systematic investigation of the Musa hydro-electric scheme. The Musa scheme was visited at the end of October, 1970. Several visits were made to C.D.W. Melbourne, during the year.

A visit was made to Port Moresby from 27th - 30th September 1971 to participate in the programme conference of the P.N.G. Geological Survey. In May, Carter attended a P.S.B. Senior Management Course for two weeks. As a result of the restriction of funds in the past nine months, and the expected restriction for some time yet, it proved necessary to implement a closer control of expenditure than in the past. Those items for the control of which Geological Branch was made responsible were largely handled by the Assistant Chief Geologist (Geological Services), who also acted for the Assistant Director (Geology) for a total of seven weeks during the year.

A.C.T. ENGINEERING GEOLOGY AND HYDROLOGY

By G.A.M. Henderson, A.T. Laws and G.M. Burton

ORGANIZATION

The Sub-section, under the supervision of G.M. Burton, operated as two co-operating groups. The No. 1 (or Hydrogeological) Group assumed responsibility for major hydraulic structures (dams, sewer tunnels, etc.) and hydrogeological investigations. A.T. Laws became senior geologist in charge of this group in May. D.E. Gardner was senior geologist in charge of the No. 2 (or Urban Engineering Geological) Group until the end of July when he transferred to other duties. The Urban Engineering Geological Group was responsible for urban engineering geological mapping, soils mechanics investigations, and investigations for foundations of buildings and roads. The division of staff between the two groups is flexible and was particularly so during 1971. For simplicity, the work of the two groups is described together in the 1971 report.

P. Vanden Broek joined the Sub-section during the year as Geologist, Class 1.

G.M. Burton spent a major part of the year supervising major projects, arranging changes in the work of the Groups and attending to duties connected with the Australian Water Resources Council - groundwater maps, representative basins and the Advisory Panel on research into extraction of water from unconsolidated sediments. He also answered technical enquiries in connection with farm water supplies and engineering materials, and supervised the investigations at Lake George.

GENERAL

The work completed in November and December of 1970 is covered as part of the general report on work in 1971 because most 1970 projects ran on into 1971.

The notable feature of the year was the completion of important phases of two major projects -

(1) the detailed feasibility study of the Googong dam site was completed and the recommendations forwarded through the Department of Works to the National Capital Development Commission, and

(2) the design investigation for the Tuggeranong-Weston Creek sewer tunnel was carried through all stages and the documentation for tenders for construction completed to final draft stage.

Miscellaneous investigations increased in importance with the increased rate of works in the A.C.T. The soils mechanics facilities planned and developed by D.E. Gardner, with the assistance of J.R. Kellett, came into general use during the year and proved a valuable asset to the Sub-section's work.

Considerable attention had to be paid to staff training during the year because of the increasing importance of tunnelling and soils mechanics and the recruitment of several new officers to the Sub-section. Engineering Geology is covered reasonably adequately in only one Australian university and staff training must continue on the job in this Sub-section. To assist in this, the compilation of an Engineering Geology Manual was commenced during the year and is expected to be issued in initial form in December, 1971.

DAMSITES AND SEWER LINES

Tennent Damsite, Gudgenby River (G.A.M. Henderson - Fig. GS1, Locality 1*)

The investigations, which were carried out during 1970, were completed with some additional plane-table mapping of outcrops on the upper part of the west abutment. The drafting of plans was completed, and a report written on the investigations. Conditions are generally favourable, should it be decided to construct a dam at this site. More investigations will be needed, however, particularly on the east abutment where there is a major fault.

* The numbered localities in the report on engineering geology and hydrology refer to Fig. GS1.

Googong Damsite (J.A. Saltet, G.B. Simpson; Locality 2)

Saltet completed the mapping of the damsite and environs, and co-operated with Simpson in the mapping of the storage area. He supervised drilling and water pressure testing, completed core logging and core photography, and carried out a study of joint orientation. The feasibility report was finished in April, 1971 and an 'advance copy' supplied to the Department of Works.

An investigation of the micro-seismicity of the dam storage area was planned, in conjunction with the Geophysical Branch and recordings commenced in September; recordings are expected to be maintained for at least three months.

A short electrical resistivity survey was carried out successfully in October in an attempt to locate fracture zones which were not detected during seismic refraction traversing.

Saltet prepared samples from the site for sulphide content tests, compression tests and sonic velocity tests.

Routine water level measurements were taken weekly in some of the exploratory drillholes.

The reservoir area was mapped by Simpson, with assistance from Saltet, on a 1:2400 scale and compiled on a 1:12,500 scale, to locate and study areas of possible leakage from the reservoir, stability of slopes, sources of construction materials and water contamination.

An observation bore is to be drilled within the catchment area to study the effects of the filling of the reservoir on the groundwater base level.

The surface geology, diamond drill hole and seismic data were plotted on a 1 inch to 40 feet scale model of the damsite. The model was used in the display during the BMR Silver Jubilee Open Days.

Tuggeranong-Weston Creek Sewer Tunnel (D.C. Purcell, G.B. Simpson; Locality 3)

The Tuggeranong-Weston Creek area was geologically mapped by Simpson on a scale 1:9600 to supplement the previous work of D.E. Gardner, and vacation students C. Wilson, P. Newstead and A. Rossiter (No. 1 Group). The mapping provided detailed structural data for the sewer tunnel design report. Simpson logged in detail an inspection shaft constructed at the northern end of the

tunnel route. The design report for the project was completed and officers of the Department of Works were assisted in the preparation of the final technical tender document.

Molonglo Valley Outfall Sewer - Ryan Tunnel and Pine Ridge Tunnel (G.B. Simpson)

Airphoto interpretation and reconnaissance mapping was carried out in preparation for the drilling of three diamond drill holes by the Snowy Mountains Engineering Corporation at the proposed Ryan (Locality 4) and Pine Ridge Tunnels (Locality 5). The holes were completed in late August and the core logged. Detailed mapping of the tunnel lines is in progress.

URBAN GEOLOGY

General

The geological map of the northern part of the A.C.T. covering the Canberra urban area (Locality 6), which was compiled during 1970, was amended and published in 1971. The map is at scale 1:50,000. A contribution to the geology of the Black Mountain area by Dr K.A.W. Crook, of the Australian National University, was incorporated in the map. Notes on the geology of the area were compiled by G.A.M. Henderson for issue as a Record; the comprehensive explanatory notes published with the map were compiled by D.L. Strusz and G.A.M. Henderson.

Canberra City (D.E. Gardner, G.A.M. Henderson, P.H. Vanden Broek - Locality 7)

Geological mapping of excavations was continued during the year. Mapping of excavations for roadworks included sketching of the detailed geology, by vacation student I. Williams, in the cutting in State Circle between Capital Hill and Camp Hill, and the cuttings in Barry Drive on the eastern side of Black Mountain. Excavations for building sites mapped included those for the Conference Hotel in London Circuit, the Department of Trade building in Kings Avenue and the extensions to Parliament House.

Geological information from drill holes for the Acton Saddle Road was assessed, and some outcrop on the Acton Peninsula was mapped to help interpret results. A drill hole was begun on the Black Mountain Peninsula to

help prove the stratigraphic position of the State Circle Shale; the hole reached 110 feet and will be drilled deeper at a later stage. Holes drilled to investigate foundation conditions at the site of the National Gallery, in the northeast corner of the Parliamentary Triangle, were logged.

Gardner compiled notes on the engineering geology of excavations in Lyneham, Braddon, Civic, Forrest and Phillip. The excavations were for building or other construction projects that have been inspected or investigated during the last few years.

Belconnen (G.A.M. Henderson - Locality 8)

A manuscript on an area covering six 1 inch: 200 feet scale A.C.T. Detail Sheets in the north of Belconnen was amended to conform with recent mapping in surrounding areas. A report on a further six sheets in the eastern part of Belconnen, mapped several years ago, was written. One sheet, north of the Barton Highway, was mapped by vacation student I. Williams. A report on eight sheets in the southern part of Belconnen was written. Time was not available to inspect all excavations in the Belconnen area, but some excavations were mapped during the year.

Woden-Weston Creek (D.E. Gardner, D.C. Purcell, G.A.M. Henderson - Locality 9)

Additional mapping was carried out by Purcell in connection with the Tuggeranong-Weston Creek sewer tunnel project. Gardner interpreted the geology of an area north-west of Lyons that had been mapped in the preceding years. Henderson began compiling all previous mapping for a report on the geology of the area.

Tuggeranong area (J.A. Saltet, P.H. Vanden Broek, J.R. Kellett)

Saltet commenced an investigation into the hard rock geology of the Tuggeranong Urban Development area (Locality 10). A photogeological interpretation has been completed. Vanden Broek and Kellett started to investigate in detail the thick soil profiles of the area.

HYDROGEOLOGY (A.T. Laws, J.A. Saltet, A. Schuett)

The network of observation bores in the A.C.T. continued to operate under the care of the technical staff. Water levels in October were, in general, lower than in the corresponding period in 1970.

Observation bores B5, B6, B7, and B8 are due to be backfilled because of the Belconnen urban development; two new bores were drilled to replace them. B15 was drilled to replace B5, and B16 to replace B6, B7, and B8; however B15 was unsuccessful, in spite of attempts to develop it with explosives, and a further replacement is to be drilled.

Laws selected five bore sites during late 1971. These included the two observation bores B15 and B16 and also a second observation bore for the Lower Yass Representative Basin (on behalf of C.S.I.R.O.), and water supply bores for two rural properties.

Saltet sited two water supply bores for farms in the northern A.C.T. and sited four observation bores for Forestry Branch in the Uriarra area.

A pumping test was carried out on B16 to assess the capacity and efficiency of the bore and the characteristics of the aquifer. The test also served to train a field hand from the Bureau and a technical assistant from Forestry Branch.

Lake George (Locality 11)

Routine monthly gaugings, and measurements of salinity and pH were continued. Schuett carried out a detailed chemical sampling of the southern half of the lake in December, 1970, and January, 1971. The lake has continued to show the effects of drought; the winter months of 1971 had low rainfall and there has been no appreciable reversal in the decline of the lake that started at the beginning of 1965. Schuett has maintained and calibrated the equipment for the Kenny's Point gauging station and has prepared it for installation. He assisted with the planning of flight-lines and ground-control for the aerial thermal scanning that was carried out during March. Schuett planned the drilling of a stratigraphic hole at Lake George; this has been partially drilled and is to be completed by the end of the year.

Drainage Problems

Saltet investigated a drainage problem at Burgmann College (ANU) and prepared a technical report recommending methods of resolving the problem. He continued supervision of the major drainage study near the Canberra Grammar School, Red Hill. Laws commenced investigations of a major drainage problem in Ainslie.

Jervis Bay (See inset map, Fig. GS1)

Schuett visited Jervis Bay on three occasions during the year to carry out routine maintenance of observation bores, measure water levels, and photograph several features. A new device for obtaining water samples from small diameter piezometers was tested successfully and routine water samples were subsequently taken by this method.

The second visit followed a period of heavy rain and extensive flooding on the south coast; detailed checking of the installations and water sampling were carried out.

On the third visit two of the piezometers (JB2 and JB3) were deepened.

Groundwater along the Tuggeranong-Weston Creek Sewer Tunnel Route

Routine measurements of water levels in diamond drill holes along the tunnel route began during the second half of 1971. A pumping test and recovery test were carried out on the inspection shaft of the tunnel to assist in evaluation of the water inflow rates during tunnel construction.

Orroral Valley (Locality 12)

K. Palmer, a vacation student, undertook mapping of the Orroral Valley to define the hydrogeology of the representative basin. A preliminary report was compiled and edited by Simpson. The report was discussed at the May meeting of the Australian Water Resources Council's Advisory Panel on the Operation of Representative Basins in Perth which was attended by G.M. Burton.

Thermal scanning of the Orroral Valley was carried out in March; the area was flown by Canadian Aero Services Ltd.

MAJOR ROADS INVESTIGATIONS (P.H. Vanden Broek, J.R. Kellett)

Two major road investigations have been partly carried out: Tuggeranong Freeway, Stage 2 (Locality 13), and the Isabella Plains Arterial Road (Locality 10). Associated drainage designs were also investigated. Work is continuing on these projects.

MATERIALS

Rural Road Gravel (P.H. Vanden Broek, J.R. Kellett)

An alternative source to the Barton Highway quarry was investigated for rural road gravel. A suitable deposit (Locality 14) adjacent to the Gold Creek road was tested and a Record was written; the Record recommended that land be resumed for a quarry site. The resumed land would allow at least 133,000 cubic yards of gravel to be extracted.

Investigations were undertaken to locate a source of road gravel in the Tidbinbilla and Corin Dam Roads area (Locality 15). The site recommended in a report by Miss E. Rosenberg was ultimately rejected by the Department of the Interior because of the proximity of an experimental pine plantation.

Proposed Building Stone Quarry (G.B. Simpson)

Simpson investigated and prepared a brief technical note on a proposed building stone quarry in the Urialla Foliated Granite, near Urialla Homestead, N.S.W. (Locality 16).

GARBAGE DISPOSAL AREAS (P.H. Vanden Broek)

Two sites for garbage disposal areas were investigated. One, located south of the Department of Works' quarry at Mugga (Locality 17) was found to be unsuitable because of insufficient soil cover and groundwater problems in the area; the other, (Locality 18) located at Belconnen, west of the suburb of Holt, was found to be suitable. Records were written for each of these investigations.

MISCELLANEOUS

Reservoir Sites (J.A. Saltet)

Two reservoir sites in Belconnen (Locality 19) were investigated. Augering was carried out to determine the nature of the soil cover and the weathering profile. A photo-geological study was carried out and the sites mapped in detail. A report has been completed.

Pipeline Route (J.A. Saltet, Locality 20)

A proposed pipeline route from the Googong damsite to North Canberra was briefly investigated and a technical report completed.

Crustal Movement in the Dalton-Gunning Area (G.B. Simpson)

In conjunction with the Division of National Mapping, following a suggestion from the Department of Geophysics and Geochemistry, ANU, geological reconnaissance mapping is being carried out in the Dalton-Gunning area to determine the geological structure of the area and to select sites for laser beam geodimeter stations. The area has a record of minor seismicity, and the purpose of the study is to record any crustal movements on faults in the area.

Open Day Exhibition

An exhibition of the work of the Engineering Geology Sub-section was included in the exhibition during the Bureau's Silver Jubilee Open Days, in May. The display formed one of the major items of the exhibition and involved the Sub-section in considerable preparation time.

Parliament House Exhibition

Some of the material used in the Open Days exhibition was included in the Bureau's 25th Anniversary Display in Parliament House, during August.

TRAINING

During the year J.A. Saltet and D.C. Purcell attended the Department's Basic Supervisors' Course to prepare them for increasing supervisory duties.

To meet difficulties in report writing and editing, the Sub-section arranged an internal discussion group course. The course, of eight sessions, was led by G.B. Simpson and covered the major aspects of report writing and processing.

J.A. Saltet and G.B. Simpson paid a three-day technical visit to the Tumut 3 Project of the Snowy Mountains Authority and the Little Scotland (Rosslynn) Dam of the Victorian State Rivers and Water Supply Commission in order to study geological work on dam sites in the construction phase, and to examine the methods of other organisations for possible later use by the Bureau.

G.M. Burton visited the testing laboratories of the N.S.W. Department of Main Roads, the Eastern Suburbs Railway (Sydney), and the Western Australian Geological Survey's Engineering Group while in Sydney and Perth for meetings of committees of AWRC.

A.T. Laws and D.C. Purcell attended the 1st Australian and New Zealand Geomechanics Conference in Melbourne in August, and afterwards visited several major engineering works of the Melbourne and Metropolitan Board of Works and the State Electricity Commission of Victoria.

In February, G.A.M. Henderson attended the Rock Bolting Symposium conducted by the Australasian Institute of Mining and Metallurgy in Wollongong.

G.M. Burton and A.W. Schuett attended a symposium on salinity conducted by the Agricultural Council in Mildura in May. Burton delivered a paper on the salinity of Lake George at the symposium and chaired one of the sessions.

J.R. Kellett, A.W. Schuett and L. Pain attended the intra-Branch geological training course for technical staff.

MAP EDITING AND COMPILATION

by

G.W. D'Addario

STAFF: Dr G.W. D'Addario, Miss R.G. Warren (part-time), Miss R.L. Cameron, Miss P.E. Thomas (from 23rd August), J.M. Fetherston, Miss J.M. Wedgebrow (from 14th September to 17th October), A.J. Kantsler (Student, during 1970-71 vacation).

GENERAL

Map Committee meetings were held in November 1970 and May 1971. A map sub-committee to discuss priorities in map production was formed in May and meetings were called every month.

A number of additional or amended geological symbols were approved for use on field compilations and preliminary maps. The symbols will be submitted for consideration at the next Chief Government Geologist's Conference in May 1972 and, they are now being used on final edition maps of the Papua - New Guinea region.

EDITING

Six special maps and fourteen final-edition maps of the 1:250,000 Geological Series were edited and checked against the draft Explanatory Notes during the year.

COMPILATION

Northern Territory Geological Map, Scale 1:2,500,000 (G.W. D'Addario)

The draft of the solid geology map was checked, new information added and a draft colour guide prepared. The draft of the structural geology plate was also completed. A draft colour guide for the Cainozoic deposits overlay was prepared by Miss R.L. Cameron. Age data and the final legend have still to be compiled; line work for the final compilation of the body of the map is 75% complete.

Groundwater Maps of Australia, Scale 1:5,000,000 (G.M. Burton)

After amendments and additions, the compilation of the four sheets (9 plates) was completed and edited. Colour guides were prepared and all material, ready for fair drawing by a contractor, was delivered to the Water Power and Geographic Branch of the Department.

Mineral Deposits Map of Papua-New Guinea, Scale 1:2,500,000 (R.L. Cameron, D.J. Grainger, I.H. Crick)

Work on the compilation of the map began towards the end of July. The work was carried out in the Port Moresby office until the middle of September. Extensive use was made of a bibliography, compiled by I.H. Crick, of reports on mineral occurrences; the reports are held in the archives of

the P.N.G. Geological Survey. Since then natural oil and gas seeps have been plotted. Technical files in Canberra and BMR Records remain to be searched.

A commentary on the mineral deposits of P.N.G., in booklet form, will accompany the 1:2,500,000 scale maps.

It is also proposed to show the locations of mineral occurrences on the 1:1,000,000 scale geological map of P.N.G.

Lithological Map of Australia, Scale 1:10,000,000 (Miss P.E. Thomas)

At the request of Mr K.H. Northcote, Head of the Pedology Section, Division of Soils, C.S.I.R.O., Adelaide, the Bureau undertook in May to compile a lithological map of Australia. The map is required as part of the text and illustrations to accompany a Soil Map of Australia, at scale 1:5,000,000, which has been compiled under the leadership of Mr Northcote, as part of a Soil Map of the World being published jointly by F.A.O. and U.N.E.S.C.O. The Bureau will also produce a chapter for the explanatory volume.

The lithological map is being compiled at 1:10,000,000 scale and is expected to show about twelve categories of consolidated and unconsolidated material. The data will probably be presented in several black and white text figures, at scale 1:20,000,000. The preliminary compilation of the data is about half complete.

Papua-New Guinea Geological Map, Scale 1:1,000,000 (J.H.C. Bain and others) (See also Metalliferous Section Report).

Scribing of the map is complete except for the results of this year's field work by the West Sepik Party, which was recently submitted by H.L. Davies, and the mineral deposits data, which is being compiled by Miss R.L. Cameron in co-operation with Mr Bain. Type-set also still has to be stuck on the map.

The map received a preliminary edit before preparation of a hand-coloured and lettered copy for display at the 12th Pacific Science Congress in August. It is considered to be 70% complete and should shortly be ready for final edit. Editing and co-ordination of aspects of the map compilation were carried out by G.W. D'Addario.

Tectonic Map of Australia, Scale 1:5,000,000 (Written by K.A. Plumb)
(H.F. Doutch, K.A. Plumb, Miss R.G. Warren, M.J. Rickard-A.N.U.)

The new tectonic map of Australia and New Guinea, which is being published by the Geological Society of Australia, has gone to press. The Commonwealth Territories Divisional Sub-Committee of the Tectonic Map Committee (listed above) has been responsible for compilation of the Northern Territory, the Kimberley district of Western Australia, Papua-New Guinea and West Irian, and most of Queensland; it has also been responsible for co-ordinating all the other State Sub-Committees' drafts and compiling the final map of the whole continent. It has been mainly responsible for determining the basic concepts of the map and designing the legend and colour schemes. Close liaison has been maintained with the compilers of the metallogenic map of Australia.

During the past year all editing and corrections were completed, the design of the legend, map layout and the colour scheme finalised, and a hand coloured copy of the completed, final draft compilation was exhibited at the Pacific Science Congress at Canberra in August.

Fair drawing of the map is now almost complete. The first stages of the map have gone to the printer for colour masking; the complete map will be forwarded to the printer before the end of the year, and the published map is expected early in 1972. Explanatory Notes will be produced later.

Metallogenic Map of Australia (Written by R.G. Warren)
(Miss R.G. Warren, G.E. Wilford, R.A. Swoboda)

Compilation of the Metallogenic Map of Australia at 1:5,000,000 scale has been completed and fair drawing is in hand. The map will be published as a single sheet. Notes to accompany the map have been compiled - these take the form of a brief commentary on each of the tectonic units, with a set of principal references for each unit.

Close co-operation with the compilers of the tectonic map of Australia was maintained at all times.

INDEXES AND MINERAL REPORTS

by

B. Hall

STAFF: Miss E. Rosenberg (resigned in September), Miss P.E. Thomas (from January to August), Mrs B. Hall (from February) and F. Perussich (from May), P. Smith (January to May), University student P. Kelo, during the 1970/71 vacation.

STRATIGRAPHIC INDEX (E. Rosenberg, P.E. Thomas, B. Hall, and F.Perussich)

Literature coming into the Bureau library was searched for stratigraphic names. New names were added to the Central Register and all references to previously published names were noted in the card index.

Variation lists, giving additions to the Central Register, were compiled periodically and sent to State Geological Surveys, Universities and interested companies.

Proposed new names were checked against the Register and, where appropriate, were reserved for the enquirer's use.

Bibliographic references to publications were filed by 1:250,000 sheet areas. The index should prove a useful source of information on the geological literature recorded by sheet areas. The references were also cross-indexed under broad subject headings. The subject index is kept in the Bureau library.

INTERNATIONAL STRATIGRAPHIC LEXICON (P. Smith, P.E. Thomas, B. Hall, F. Perussich).

Work was resumed on Volume 5h - Australia General, - of the International Stratigraphic Lexicon, which is published by Centre National de la Recherch Scientifique in Paris. Volume 5h is designed to provide an index to already published volumes for each State and to bring up to date the list of published Australian stratigraphic names. The Volume was started several years ago but work had to be suspended because of lack of staff. The lexicon is complete to letter "H" and substantial work has been done on the remainder of the lexicon. However, considerable checking remains to be done. Lack of staff again resulted in suspension of work on the lexicon in mid-September. If the work cannot soon be resumed and carried to completion a great deal of extra work will be required to bring the volume up to date.

TECHNICAL FILES (B. Hall, part-time)

Filing of unpublished data and newspaper clippings under 1:250,000 Sheet areas continued.

The card indexes of Bureau Records, P.S.S.A. applications and P.S.S.A. reports recorded by 1:250,000 Sheet areas, were maintained.

A.M.D.L. reports were filed as they were received. Great difficulty was experienced in identifying old AMDL reports; consequently it was decided to cross-index AMDL Reports onto the Technical Files. This involves extra work but it is hoped it will make the files more useful. It has not proved possible in recent weeks to maintain the extraction of information from all available sources for placement on the appropriate technical file, owing to lack of staff.

MINERAL INDEX (B. Hall)

A mineral index, supplementary to Bulletin 72, was maintained, listing published articles and some unpublished data under state and commodity.

A card index of mineral reserves, listed under commodity and locality name was maintained. The information on this index was mostly obtained from newspaper reports.

MINERAL REPORTS (I. McLeod, (part-time), Mrs. S. Roddick (part-time), P. Thieme (November only).

Work continued on geological reports on deposits of individual minerals, or groups of minerals, in Australia. The reports take the form of revised versions of the various chapters of Bulletin 72 "Australian Mineral Industry: The Mineral Deposits" by I.R. McLeod, 1965. The revisions are prepared in conjunction with the State Mines Departments and mining companies.

Reports No. 1	Bauxite deposits,	by P. Thieme
No. 2	Nickel deposits,	by P. Thieme
No. 3	Phosphate deposits	by P. Thieme

were printed during the first half of 1971.

Reports No. 4	Iron deposits,	by P. Thieme
No. 5	Lead-zinc deposits	by S. Roddick

are almost ready to go to the printer.

MUSEUM AND TRANSIT ROOM

by

G.C. Young

MUSEUM

Staff: G.C. Young (part-time), P.C. Tonkin (part-time, resigned in August), P.A. Lang (on leave March-June), A. Haupt (from August, part-time).

Registration of rocks and minerals

About two and a half thousand specimens of rocks collected by Bureau field parties were registered and placed in storage in 80 boxes in the Fyshwick rock store during the year. A further 250 specimens of rocks and minerals were added to the museum collections.

Commonwealth Palaeontological Collection

Type fossil numbers CPC 11397 to CPC 12906 were allocated to various authors during the year.

Reorganization of the type collection in the strongroom was continued; 4,000 specimens have now been placed in numerical order in the cabinets.

Museum collections and displays

Building stone samples in the museum were brought together and registered. New collections of rock and mineral specimens were acquired from A.G.L. Paine and P.R. Dunn and a set of rocks was received from the Geological Survey of Fiji.

Several mineral displays were arranged during the year. Sixty specimens were set up for the Canberra Gem Club display in October; seven display cabinets were filled for the Bureau's Open Days in May; and three cabinets were filled for the display in King's Hall, Parliament House, in August.

The Minister's mineral display was changed in March.

BMR - Silver Jubilee Open Days

Considerable time was spent during March, April and May selecting and arranging rock and mineral specimens for the Open Days display. Eight placards and 300 labels were prepared for the seven cabinets of rocks and minerals which went on display.

Since the Open Days the mineral collections have remained on display in the lift foyers of the building.

Exchange and loan of specimens

Six cases of stromatolite specimens were returned by M.R. Walker in January. A number of Tertiary gastropods from the Wade Collection of Papua/New Guinea fossils were dispatched on loan to research workers in the Netherlands. Polyzoan type fossils were dispatched on loan to the Smithsonian Institution and University of Illinois.

A number of calcite crystals were sent to the Israel Institute of Technology for research into polishing of marble.

Teaching sets and school collections

Twenty specimens were brought together for use in training programmes at Tasman House. Teaching sets of igneous, sedimentary, and metamorphic rocks were prepared for use in the geology training course for technical staff at the Bureau. Forty-three rocks and minerals were given to Higgins High School and 12 Australian ore samples were sent to Queanbeyan West Junior School.

Field Work

P. Tonkin attended the vacation student mapping camp in January, spent several days collecting samples for the teaching sets in March, and visited Broken Hill for four days in April to examine pegmatites with geologists of the Geological Survey of N.S.W. He carried out two weeks mapping for the Tennant Creek project in June.

From November to February G. Young was a member of the Victoria University of Wellington Antarctic Expedition, which carried out geological mapping and fossil collection in South Victoria Land, Antarctica.

Visitors to the Museum

On average, there were about three visitors per week to the museum during the year. Many of them brought in rock, mineral or fossil specimens for identification.

On several occasions the museum collections were made available to official visitors for examination.

TRANSIT ROOM

The officer-in-charge of the transit room (D.W. Lea) sends on to the appropriate contractor or section in the Bureau, all samples submitted for thin-sectioning or detailed laboratory work. Appropriate financial documentation is arranged where necessary. An average of about 800 samples are handled each month.

He also stores, catalogues, and maintains a loans register of all petrological thin sections.

Plans were made some years ago to store sample information on punch cards, but were only partly implemented. As time allowed, work was continued in preparation for the card-punching of data on all samples submitted.

GEOLOGICAL DRAWING OFFICE

Set out below is a statement of the work completed in the twelve months preceding 31st October, 1971, and of work in progress at that date.

The position with regard to Standard Series Maps is presented pictorially in the frontispiece to the Record.

SHEET MAPS

1:250,000 Series

21 sheets published (including 4 sheets compiled by the Geological Survey of Western Australia)

9 sheets reprinted (including 2 sheets compiled by G.S.W.A.)

19 sheets in press (including 6 sheets compiled by G.S.W.A.)

7 sheets ready to go to press

1 sheet fair drawing in progress

Special Maps

1:30,000	:	1 sheet ready to go to press (Yass Basin)
1:50,000	:	1 sheet published (Canberra)
"		2 sheets compiled (Herberton, Mount Garnet mineral maps)
"		1 sheet fairdrawing in progress (Rouchel district)
1:63,360	:	2 sheets published (Herberton, Mount Garnet geological maps)
1:250,000	:	1 sheet reprinted (Bougainville - Buka Island)
"		1 sheet ready to go to press (South Sepik Region)
1:500,000		4 sheets published (Amadeus Basin East and West, Drummond Basin, Papuan Ultramafic Belt)
"		1 sheet in press (Cape York Peninsula and Torres Strait)
"		3 sheets compilation in progress (West Kimberley, Kimberley Basin, Ngalia Basin)
1:1,000,000	:	3 sheets fairdrawing completed (Bowen Basin)
"		4 sheets fairdrawing in progress (Papua and New Guinea)
"		1 sheet compilation in progress (Tectonic map of Central Australia)
1:5,000,000	:	1 sheet ready to go to press (Sheet No. 1, Australia and Oceania)
"		2 sheets fairdrawing in progress (Metallogenic map of Australia, Tectonic map of Australia)
1:12,000,000	:	1 sheet published (Geological map of Australia)

PRELIMINARY EDITION MAPS

1:30,000 : 1 sheet published (Yass Basin)

1:250,000 : 17 sheets published

" 20 compilations in progress

1:500,000 : 2 sheets published (Burdekin River Region, Cape York Peninsula and Torres Strait)

1:1,000,000 : 2 sheets published (Central and Western Eromanga Basin)

PHOTOGEOLOGICAL MAPS

7 - 1:250,000 areas at scale 1:63,360 (i.e. 84 maps) completed.

TEXT FIGURES FOR BULLETINS, REPORTS AND EXPLANATORY NOTES

367 completed

16 in progress

MISCELLANEOUS

18 plates) completed (Ramu Hydroelectric and

12 textfigures) Tuggeranong Tunnel Projects

3 sheets compiled (Marraba 1:50,000, Cloncurry 1:100,000, Kubor Anticline 1:500,000)

649 drawings completed for Records, etc.

GEOLOGICAL SURVEY OF PAPUA NEW GUINEA

GEOLOGICAL SURVEY OF PAPUA NEW GUINEA

Contents

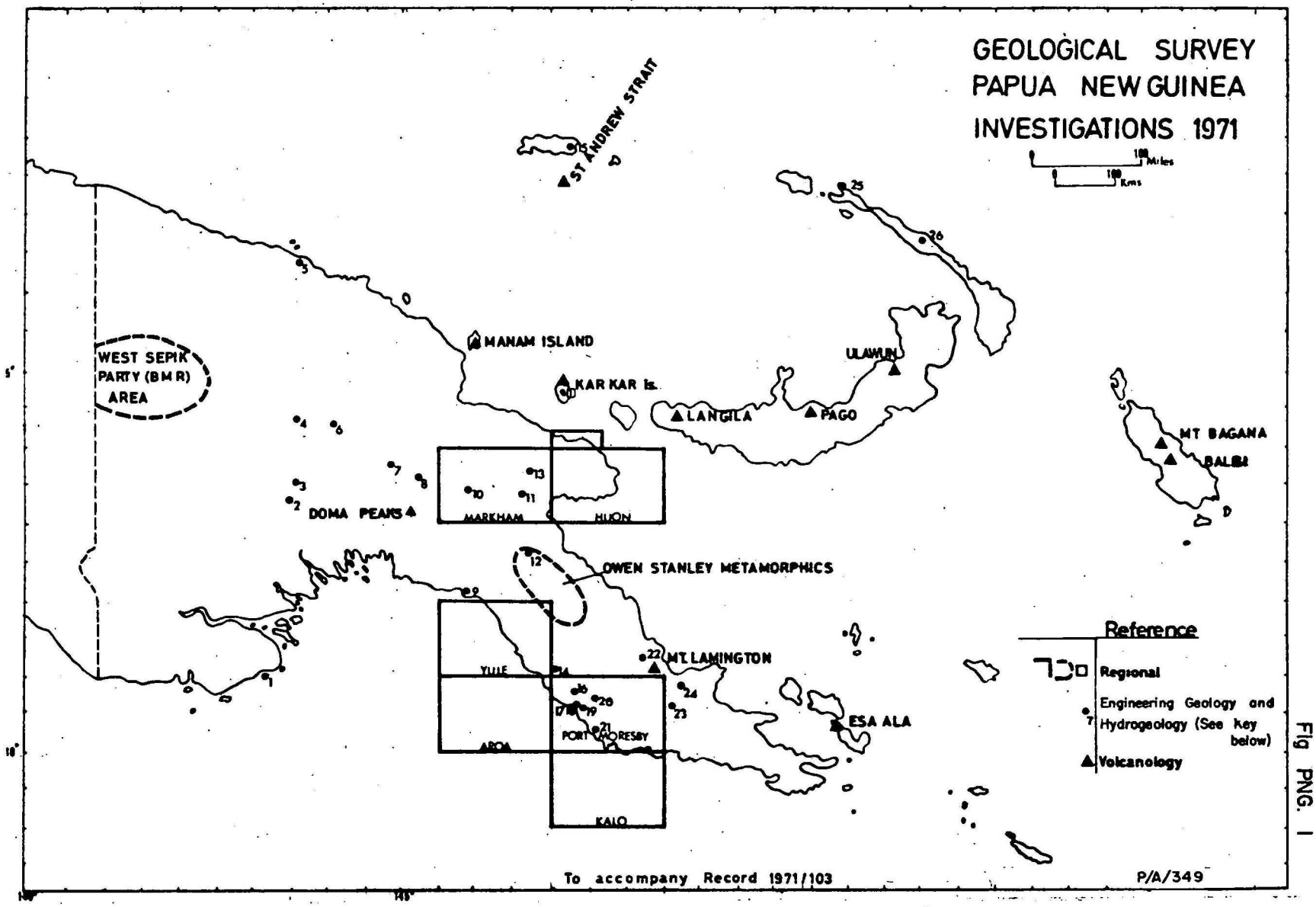

GEOLOGICAL SURVEY
PAPUA NEW GUINEA
INVESTIGATIONS 1971
100 Miles
100 Kms
ST ANDREW STRAIT
MANAM ISLAND
KAR KAR Is.
ULAWUN
LANGILA
PAGO
MT BAGANA
BALBI
WEST SEPIK
PARTY (BMR)
AREA
DOMA PEAKS
MARKHAM
HUON
OWEN STANLEY METAMORPHICS
MT LAMINGTON
YULE
PORT MORESBY
AROA
KALO
ESA ALA
5°
10°
Reference
Regional
Engineering Geology and Hydrogeology (See key below)
Volcanology
To accompany Record 1971/103
P/A/349

Fig PNG. 1

160°

KEY FOR ENGINEERING GEOLOGY AND HYDROGEOLOGY INVESTIGATIONS AS SHOWN ABOVE

1. DARU GROUNDWATER
2. SOUTHERN HIGHLANDS VILLAGE WATER SUPPLY SURVEY
3. HUMGAP ROAD
4. TOGOBA-WAPENAMANDA ROAD
5. WEWAK, GROUNDWATER FOR TOWN SUPPLY
6. MT. HAGEN GROUNDWATER
7. EASTERN HIGHLANDS/CHIMBU DISTRICT CONSTRUCTION MATERIALS
8. ASARO GEMBOGI ROAD
9. KEREMA GROUNDWATER AND CONSTRUCTION MATERIALS
10. RAMU HYDRO-ELECTRIC PROJECT
11. MARKHAM VALLEY GROUNDWATER RESOURCES
12. WAU MT. KAINDI ROAD STABILITY PROBLEMS
13. WANTOAT-LERON ROAD
14. AGGREGATE FOR RUBBERLANDS ROAD
15. LORENGAU GROUNDWATER
16. LALOKI HOSPITAL WATER SUPPLY
17. (ENGINEERING-GEOLOGICAL MAP, PORT MORESBY
18. (QUARRY SITE INVESTIGATIONS, PORT MORESBY
19. PAVEMENT FAILURES, PORT MORESBY
20. LALOKI RIVER HYDRO-ELECTRIC PROJECT
21. CENTRAL DISTRICT VILLAGE WATER SUPPLY DRILLING PROGRAMME
22. NORTHERN DISTRICT VILLAGE WATER SUPPLY SURVEY
23. MUSA RIVER HYDRO-ELECTRIC SCHEME
24. MUSA ACCESS ROAD
25. KAVIENG GROUNDWATER
26. NEW IRELAND VILLAGE WATER SUPPLY SURVEY

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INTRODUCTION

by

A. Renwick

The Geological Survey Division of the Papua New Guinea Department of Lands, Surveys and Mines was created by determination of the Minister for External Territories on 22 October 1970. It is the successor to the former Geological and Volcanological Branch of the Department, and the still earlier Geological Section.

The professional cadre of the survey is provided by the BMR, and consists of both geologists and geophysicists. The supporting staff belong to the Papua New Guinea Public Service.

HEADQUARTERS

by

A. Renwick

OFFICE OF THE CHIEF GOVERNMENT GEOLOGIST

G.A.M. Taylor, (BMR) acted as Chief Government Geologist during A. Renwick's leave from March to June.

In addition to the routine professional, administrative and financial functions, Renwick continued to serve on the Petroleum and Mining Advisory Boards, and to be chairman of the Advisory Committee on Seismology and Earthquake Engineering and of the Scientific Advisory Committee to the National Parks Board.

In July he attended meetings in Manila sponsored by ECAFE on co-ordination of offshore prospecting activities, and in October he visited Canberra for a number of discussions.

DRAWING OFFICE

The establishment in March of a drawing office with an experienced Drafting Officer in Charge (G. Millist from the BMR) has already resulted in a considerable increase in the quality of cartographic and other drafting work. Three trainee Drafting Assistants are now working in the office, and a Technical Assistant operates equipment in the production room.

LIBRARY, ARCHIVES AND CLERICAL SERVICES

The number of books in the library is gradually increasing, and the cataloguing and indexing of archive material has been maintained throughout the year.

Clerical services systems have been constantly under review to provide the necessary support for the expanding Survey.

REGIONAL MAPPING AND MINERAL INVESTIGATIONS

by S.K. Skwarko

STAFF

S.K. Skwarko - Took up duties from BMR Canberra on 29 March as Head of the Section.

D.J. Grainger - Was overseas on leave from the end of March to 20 July when he resumed duties in the Mineral Investigation Sub-section.

G.P. Robinson - Was transferred in May from the Engineering Geology and Hydrogeology Section to the Regional Mapping Sub-section.

P.E. Pieters - Resumed duties in the Regional Mapping Sub-section on 26 July, following his return from seven months' leave.

I.H. Crick - Continued his duties in the Section, until his transfer to the Volcanological Section on 30 September.

C. Brown - A new appointee from the United Kingdom, due to assume duty in mid-November.

Miss R.L. Cameron - Worked in the Mineral Investigation Sub-section on 26 July, for a period of two months. She returned to the BMR on 22 September.

REGIONAL MAPPING

INTRODUCTION

In the twelve months' period, field activity was virtually limited to the Huon and Port Moresby 1:250,000 Sheet areas, though some specialist assistance was provided by two members of the Survey to the West Sepik (BMR) geological party. Field work on the Port Moresby Sheet area will be completed during the year, but an additional two months' work in the field by one geologist will be required at the beginning of 1972 to finish the regional mapping of the Huon Peninsula. Compilation of results from the

Markham Sheet area was completed after D.J. Grainger's return from leave. The Yule Sheet received little attention but, on his arrival, C. Brown will become engaged in its completion.

PROJECTS AND INVESTIGATIONS

Huon 1:250,000 (Field mapping: S.K. Skwarko, G.P. Robinson, I.H. Crick; compilation and further field work G.P. Robinson).

The Huon Peninsula is situated northeast of Lae, and covers an area of about 7,000 sq. km. It is geologically and geomorphologically young, and consequently of strong relief, with a maximum elevation of 4,121 metres. The rivers draining the peninsula, particularly to the south, are overloaded with sediment, which currently - as in the past - is accumulating in alluvial flats and fans. The continuous, though irregular uplifting process, which affected in the past and still affects today the whole area, exposes even the fairly young fluvatiles to continuous processes of dissection and erosion.

The following mappable rock-units, ranging in age from Oligocene to Recent and representing a total stratigraphical thickness of about 6,000 metres, are recognised.

(i) In the southwest the Oligocene basaltic agglomerate, tuff, and lava. The lava became brecciated as it moved downslope in a northeasterly direction, giving rise to paraconglomerates and associated turbidites.

(ii) A massive algal biomicrite, which represents Miocene reef complex probably developed on edges of submarine step blocks formed of the Oligocene volcanics.

(iii) The fine-grained fore-reef equivalents of this limestone, which occur in the east, where well-bedded calcarenites and calcilutites formed in deep water shielded by reefs from terrigenous detritus.

(iv) The volcanically derived siltstone and sandstone, which are lateral equivalents of the fore-reef calcarenites, occur in the east-central part of the peninsula.

(v) The extensive Miocene Gowop Limestone which forms a sheet covering a large northerly-tilted fault block, but has later been partially dissected by large rivers.

(vi) A complex of Pleistocene fringing reefs in the northeastern part, which has been intermittently uplifted and terraced by marine erosion forming raised coral beach deposits.

Fundamentally, the Huon Peninsula consists of a series of northerly-tilted fault blocks. There are many high-angled normal faults of small displacement probably resulting from strong uplift in Pliocene and Pleistocene times.

Markham 1:250,000 (Field work: D.J. Grainger, P.E. Pieters, R.J. Tingey, P.D. Hohnen, J.A.J. Smit, J.C. Braybrooke, M.D. Barsdell, P.G. Flood (BMR 1968 Kubor Range Party; compilation D.J. Grainger).

The Sheet area covers 18,500 sq. km of the Morobe and Eastern Highlands district, New Guinea. Three main physiographic units are recognized, viz. the Central Mountains, the Saruwaged Range, and the Markham Valley, the last being a part of long and structurally important depression stretching from the West Irian border to the Huon Gulf. The stratigraphy of the Sheet is described under three main headings; the Markham Valley geology is not well known.

The Central Mountains together with the Owen Stanley Range (in this area called the Hertzog Mountains) constitute the central highlands which form part of the backbone of New Guinea. Nineteen names - some probably synonymous - have been applied in the past to rock units recognized in the Central Mountains. The oldest are the Mesozoic Bena Bena Formation (schists, gneiss and quartzite), in part possibly as old as Lower Triassic, and the upper Mesozoic (?) - Eocene Goroka Formation (low grade metamorphics and sediments). Overlying the Mesozoic strata is the upper Oligocene to lower Miocene Omaura Greywacke (greywacke, siltstone, limestone and conglomerate) with the locally occurring basal Nasananka Conglomerate. The Miocene is also represented by the Movi Beds (greywacke, siltstone and conglomerate), a greywacke, sandstone and siltstone sequence near Kurawabi, and the late geosynclinal sediments variously known as Asaro Conglomerate, Lamari Conglomerate, and other names. The sedimentation in the Aure Trough was accompanied during the

Miocene by emplacements of intrusive rocks, which are described under the names of Akuna Dolerite, Bismarck Intrusive Complex, Elandora Porphyry. The last unit laid down in the geosyncline is the Miocene Babwaf Conglomerate. There is no evidence of Pliocene sedimentation. Quaternary tuffaceous lacustrine sediments of the Marawaka area were contemporaneous with the andesite lava flows and associated pyroclastics of the Mount Yelia volcano and possibly with the Pleistocene (?) to Recent Kainantu Beds.

Hertzog Mountains contain only Owen Stanley Metamorphics of Mesozoic age, and the intrusive mid-Miocene Morobe Granodiorite. The Owen Stanley Metamorphics in the area have been divided into Kaindi Metamorphics (slate, schist, phyllite, greywacke) and the fossiliferous marginal metamorphics (greywacke, argillite, phyllite, slate and conglomerate), of Cretaceous age.

Saruwaged Range is separated from the geologically dissimilar Central Mountains and the Owen Stanley Range by the Ramu-Markham Fault Zone depression. The oldest rocks are the Oligocene Finisterre Group (a thick sequence of basaltic and andesitic extrusives deposited under marine, some shallow water, and subaerial conditions). These are followed by the geosynclinal Oligocene-Miocene Mebu "Series"(Formation)(greywacke, argillite, volcanic conglomerate with limestone lenses) derived in part from the Finisterre volcanics, the lithologically similar Mena Group of Lower to Middle Miocene age, and the peak-forming Gowop Limestone. The uplifted Saruwaged-Finisterre geanticline gave rise to coarse detritus, included in the Ouba Formation of upper Miocene and Pliocene age. Fluvio-glacial deposits formed on and near the uplifted ranges, while rivers choked with abundant detritus deposited alluvial fans and piedmont deposits at lower levels. The dominant structural lineation, expressed both in fold and fault patterns is in a northwest to north-northwest direction except in the southeastern part of the Sheet area where the Aure Trough sediments have a northeast strike. This can be explained in the context of plate tectonics involving an interaction between the north-moving Australian block and the westward moving Pacific plate.

Port Moresby, Aroa and Kalo 1:250,000 (Current field work by P.E. Pieters; compilation and writing up by Pieters).

After his return from leave, during part of which he undertook a course of photogeology at the International Training Centre for Aerial Survey at Delft, Holland, Pieters substantially completed the regional mapping of the Port Moresby Sheet area.

Aided by a helicopter, which he used for two weeks, he was able to tie up quickly the previously individually mapped areas, and to collect rapidly samples for dating and geochemical analysis. In addition, he made critical traverses along Ofi Creek-Goldie River, Brown River, Lako River-Mori River (aided by Grainger).

It is expected that the Explanatory Notes on the area will be written and map compilation completed by early June, 1972.

Buna 1:250,000 (H.L. Davies (BMR); P.E. Pieters).

Fieldwork on the Buna Sheet is nearly completed. Pieters spent four helicopter hours mapping along the Mount Albert Edward-Mount Scratchley watershed. Davies will compile the Sheet.

Yule 1:250,000 (Available information compiled by I.H. Crick).

No field work was attempted in the Sheet area, but Crick completed in draft form and at 1:250,000 scale the compilation of the available geological data on the Sheet. He also wrote a precis of the stratigraphy of the area.

West Sepik (BMR) Geological Mapping Party

S.K. Skwarko spent 12 days in August with the party, based at Telefomin, assisting with the mapping of the widespread and richly fossiliferous Mesozoic sediments, by making thorough collections of fossils and, where possible, dating them.

P.E. Pieters joined the party for a month on 15 October in order to assist in the geological photo interpretation of the area by working on the side-looking radar imagery.

MINERAL INVESTIGATIONS

INTRODUCTION

The need for an assessment of the mineral resources of Papua New Guinea has been felt for some time, and was particularly stressed in the 1970 Summary of Activities.

Several programmes were initiated and some completed. I.H. Crick prepared a general check list on archival reports on mineral occurrences in Papua New Guinea. S.K. Skwarko initiated a comprehensive card index system which provides at a glance answers to queries connected with exploration company activities. The work on the mineral resources map of Papua New Guinea was commenced and advanced by Grainger, and Miss R.L. Cameron who visited the Geological Survey specifically for this purpose.

The goals which have already been attained, and others which will be pursued in the future, will ensure a better knowledge of the local mineral resources, and consequently a more competent service to the mineral industry in Papua New Guinea.

PROJECTS AND INVESTIGATIONS

Mineral and Copper Occurrences in Papua New Guinea (I.H. Crick)

I.H. Crick prepared a check list for mineral occurrences recorded in the Geological Survey archives. From this list a compilation of 'Copper deposits found in P.N.G.' was produced, together with a map showing the localities of the deposits. The compilation includes archive reference number and where possible, the locality, type of mineralization and associated rocks, and the extent of the copper mineralization.

Exploration Companies' Activities Card Cross-Index System (Initiated by S.K. Skwarko; now maintained by D.J. Grainger and S.K. Skwarko)

Every Prospecting Authority held in Papua and New Guinea is represented by a master card and arranged in alpha-numeric order under company name - P.A. number. Each master card contains condensed information relating to the particular P.A., the data being acquired from the application for the P.A., quarterly reports, annual

reports, completion reports, and notices of renewal and relinquishment. Cross-indexing is effected by additional card systems grouped together under the following headings: area or project name; P.A. numbers; mineral discovered (in 'interesting' quantities). The time taken in keeping the system up to date is negligible compared with time saved in obtaining required information.

Mineral Occurrences Map of Papua New Guinea (Miss R. L. Cameron (BMR Canberra); local supervisor D.J. Grainger)

The map at the scale of 1:2,500,000 to be accompanied by appropriate notes, is designed to record as fully as practicable, the distribution of the known mineral occurrences in Papua New Guinea. Construction materials, fluxing materials, and ground water are not included.

Miss Cameron worked full time in Port Moresby from 26 July to 22 September compiling data for the mineral occurrences map. D.J. Grainger supervised the project, and worked part time abstracting data.

Information condensed from the data files in Port Moresby, from BMR reports and supplemented by BMR technical file data as well as outside publications, was entered on a card system indexed by 1:250,000 Sheet areas and cross-referenced according to bibliography, commodity, locality. The system is so designed that it can be easily kept up-to-date in the Port Moresby office as more information becomes available.

It is proposed that the importance of each deposit be indicated by a simple five-part system. Each category will have a distinctive map symbol. Commodities present or won from a deposit are to be indicated by an appropriate mineral symbol.

The accompanying notes are intended to provide factual information to supplement the map rather than being a synthesis of metallogenesis. Eight chapter headings refer to major mineral groupings such as Fuel Minerals, Major Base Metals, Steel Industry Metals. Sections will deal with each commodity within the group. An overprint showing the locations of the mineral deposits will be made on the 1:1,000,000 geological map which is nearing completion.

ENGINEERING GEOLOGY AND HYDROGEOLOGY

by G. Jacobson

STAFF

G. Jacobson, L.T. Macias, and J. Harris (Geologists) and M. Pounder (Technical Officer) were with the Section throughout the year.

R. Hansen (vacation student) assisted during January.

G.P. Robinson (Geologist) was with the section until May when he transferred to Regional Mapping.

B. Weber (Geologist) joined the section on 6 April.

INTRODUCTION

The Engineering Geology and Hydrogeology Section became fully staffed in 1971 with 4 geologists and a technical officer. The Section was involved in many aspects of the applications of geology to civil engineering development in Papua New Guinea. As in the past, geological services were provided in connection with the investigation and design of major hydro-electric schemes by the Commonwealth Department of Works. Village water supply surveys were completed in three districts and implementation of recommended improvements is under way in two others. Compilation and assessment of the country's groundwater resources continued and investigations of possible groundwater sources for the supply of several towns and hospitals were undertaken for the Department of Public Works. Several investigations of proposed road alignments were completed with particular reference to slope stability in mountainous terrain. New projects which were initiated included a systematic review of construction materials in Papua New Guinea, and the compilation of an engineering-geological map of Port Moresby for use in development planning. It is hoped to extend the engineering-geological mapping to the New Guinea towns, with particular reference to seismic zoning for building foundations.

Officers of the Section were engaged on 40 investigations during the year. A total of 15 Notes on Investigation were issued and another 6 are in an advanced state of preparation.

ENGINEERING GEOLOGY FOR HYDRO-ELECTRIC SCHEMES

Ramu 1 Hydro-Electric Project (Jacobson)

Tenders were called in July, 1971, for the main civil engineering contract for the Ramu 1 Hydro-Electric Project in the Eastern Highlands of New Guinea. The project will supply power to Lae, Madang and the main Highlands towns. Some additional mapping was done late in 1970 along the access road to the tailwater tunnel portal, and in the proposed diurnal pondage. Additional sources of construction materials were inspected. In 1971 Jacobson was engaged in the review of geological aspects of the tender documents, and later spent two weeks on site inspections with prospective tenderers.

Musa Gorge Hydro-Electric Project (Robinson and Macias)

Field work in the Musa Gorge area, Eastern Papua, was completed late in 1970. Robinson compiled a geological map of the reservoir area and prepared a report on the geology of the reservoir including engineering-geological aspects. The reservoir will cover an area of 620 sq km, mainly of Quaternary alluvium, and is bounded to the north by a major fault which is possibly still active. An important problem is the evaluation of additional seismicity likely to be induced by filling of the reservoir. Macias prepared a detailed geological map of the possible damsite areas and a report on the geological factors involved in selecting the most suitable damsite. The damsite area is mainly of partly serpentinized ultramafic rocks, fresh at river level, but weathered to considerable depths higher on the slopes. Choice of a damsite is restricted by a large landslide in the gorge. Recommendations for further investigation were prepared for submission to the Commonwealth Department of Works.

Rouna No. 3 Hydro-Electric Project (Jacobson)

Investigations for the Rouna No. 3 Hydro-Electric Project continued throughout the year and tenders for construction of the pipeline were called late in 1971. The Rouna No. 3 Project consists of a diversion weir, low pressure pipeline and penstock to a surface power station on the Laloki River. It will duplicate the existing Rouna No. 1 power station and provide an extra 12 megawatts for the Port Moresby power supply. The pipeline will traverse colluvium containing large agglomerate boulders. Unstable

foundation conditions were noted at some of the anchor block sites and recommendations made for improving stability. The power station will probably be founded on agglomerate boulders beside the existing Rouna No. 1 station.

Rouna No. 4 Hydro-Electric Project (Jacobson)

A Note on Investigation on the preliminary investigation of the geology of the Rouna No. 4 Hydro-Electric Project was completed. This project will include construction of a pipeline or flume, penstock and surface power station on the Laloki River downstream of the Rouna No. 1 and No. 3 power stations, utilising the tailwater from both. Most of the proposed works will be sited on colluvium containing large agglomerate boulders. Foundations for structures will be partly on rock and partly on soil, and some slope stability problems are expected.

Sirinumu Dam Stage 2 Construction (Robinson)

Construction of the Sirinumu Dam Stage 2 was completed in April, 1971 and a report on the geology of the dam construction was prepared. The dam is situated near the axis of a shallow syncline in a sheet of crudely bedded Astrolabe Agglomerate which forms the Sogeri Plateau. The agglomerate at the damsite consists of poorly sorted subangular to subrounded clasts of basalt and andesite in a tuffaceous matrix which commonly constitutes 50 percent or more of the rock. Joints have played an important part in excavations and in connection with leakage problems at Sirinumu. A common problem was the isolation of dangerous unstable thin wedges of agglomerate formed by the intersection of the excavation faces with sets of joints. Valuable information regarding the relationship between geological structure and engineering excavations at Sirinumu was obtained by low-altitude vertical aerial photographs taken at several intervals during Stage 2 construction.

Purari River Hydro-Electric Scheme (Jacobson)

A site investigation of the Wabo Damsite on the Purari River, Gulf District, is being undertaken by Japanese consulting engineers. The investigation is directed towards proving foundation conditions for a concrete gravity dam 110m high, which would be founded on sandstone and shale dipping 40^{o} upstream.

HYDROGEOLOGY

Groundwater for Wewak Town Supply (Harris)

Exploratory drilling for the Wewak town supply by the Department of Public Works continued during the first half of the year. Five exploratory bores were completed in coastal plain alluvium consisting of interbedded clay, silt and sand. Several sand aquifers were intersected but have not yet been evaluated by pumping tests. The demand for town supply is about 500,000 gallons per day.

Central District Drilling Programme (Jacobson, Harris, Pounder)

Drilling of water bores for villages and schools in the Central District continued throughout the year, using two percussion rigs belonging to the Mines Division of the Papua New Guinea Department of Lands, Surveys and Mines.

In the Kwikila-Rigo area southeast of Port Moresby, bores were sited and successfully completed at Kemaia, Gunugau, and Munaguro villages and near the 34-mile peg, Rigo Road. Several other bores were sited in this area but owing to poor access roads to some villages, the drilling programme could not be completed. Dug wells were sited and successfully completed for schools in the coastal villages of Tupuseleia, Barakau, and Gaile. Drilling for the Settlement Scheme at Tavai Teak had to be abandoned as adequate supplies of groundwater could not be obtained.

Two bores were sited at the Laloki Psychiatric Hospital, 10 miles north of Port Moresby. Pump tests proved that a supply of about 500 gallons per hour could be obtained from an alluvial sand and gravel aquifer at a depth of 60 to 80 feet.

A bore was sited and successfully completed at Boira School, 27 km northwest of Port Moresby, where a flow of 700 gallons per hour was achieved in calcareous mudstone.

Several bores were sited for the Kuriva Settlement Scheme about 55 km north of Port Moresby. Three bores have so far been successfully completed in volcanic rocks and alluvial gravel.

Bores were sited for several schools and villages on the Sogeri Plateau, east of Port Moresby. A drilling programme is in progress there.

Several other bores and wells were sited in the Port Moresby area for government departments and for private owners.

Markham Valley Groundwater Resources Appraisal
(Jacobson, Pounder)

A preliminary appraisal was made of the groundwater resources of the Markham valley, New Guinea. The geomorphology of the valley was mapped using a helicopter for field checks of the photo interpretation. The valley is infilled with redistributed alluvial fan deposits, derived from the rising Finisterre-Saruwaged Ranges to the north. The aquifers are lenticular gravel beds deposited in stream channels on the fans.

A data census was carried out to establish the locations and levels of all bores in the valley. Excluding the Lae town area, there are 80 operating bores which have been constructed to depths of up to 250 feet. Water quality is generally good, the content of total dissolved solids being generally from 300 to 500 ppm. As the depth of alluvium is probably very great, the full groundwater potential of the valley has not been realised. Additional investigation is recommended and should consist of a geophysical survey to determine the depth of alluvium at three valley cross-sections, followed by some deep stratigraphic and observation bores.

Kavieng Groundwater Investigation (Harris)

A hydrogeological study of the Kavieng area, New Ireland, was made in order to assess the likelihood of a groundwater supply being available for the proposed hospital and, possibly, also the town. The only aquifer in the area is raised coral limestone, which contains a freshwater lens up to 40 feet thick. Adequate supplies of groundwater are available but care will be necessary to avoid penetrating the freshwater lens.

Kerema Hospital Water Supply (Weber, Pounder)

An investigation was made of possible sources of groundwater to supply the hospital at Kerema in the Gulf District. A dug well has been sited on the sandy coastal plain southwest of the town. Because of the possibility of saltwater intrusion, the height of the water table above mean sea level was determined. The thickness of the freshwater lens should, with careful pumping, be sufficient to supply the hospital.

Groundwater Investigations at Mount Hagen (Jacobson, Macias)

The town of Mount Hagen in the Western Highlands District is founded on a plateau of volcanic rocks, and several dry holes have been drilled in the past. Drilling for the hospital supply was not recommended. A dug well on an alluvial terrace to augment the hospital supply was sited and successfully constructed. An aquifer test is in progress.

A well for the town emergency supply was sited in alluvium at Kala Creek, 2 km east of the town.

At Baisu Corrective Institute, about 20 km east of Mount Hagen, a dry hole was drilled by the Department of Public Works to 100 feet on an alluvial fan. A second bore was sited on flood plain alluvium, and successfully constructed.

Mendi Hospital and High School Water Supply (Jacobson, Macias)

Two bores at Mendi Hospital in the Southern Highlands District intersected a fractured basalt aquifer at 119 feet. Testing of the aquifer is in progress.

The High School site was inspected but drilling for groundwater was not recommended. The water supply will have to come by pumping from the Mendi River.

Groundwater Investigation, Cape Rodney (Jacobson, Weber)

Potential groundwater sources for the Bamguina Settlement Scheme near Cape Rodney, Central District, Papua, were investigated. Most of the area of the settlement scheme is alluvium which contains sand aquifers. A drilling programme was recommended.

Dug wells were sited for three schools near Marshall Lagoon and bores were sited for two schools on the Kupiano-Bamguina road.

Lorengau Groundwater Investigation (Weber)

The possibility of supplying Lorengau town, on Manus Island, with groundwater was investigated as the surface sources of water supply are polluted. The town is on a narrow coastal plain of clayey and silty alluvium backed by foothills of mudstone and basalt. The prospects of obtaining sufficient groundwater are poor, and surface sources will have to be redeveloped.

Groundwater Investigation for Daru Town Supply (Pounder)

At the request of the Department of Public Health a data census was made of shallow wells at Daru in the Western District. The town (population 5,000) uses water from these wells, many of which are saline, and most of which are polluted. Several deeper bores in the town produce groundwater of unacceptable salinity. Recommendations were made for the investigation of a possible groundwater supply from shallow wells south of the town.

New Ireland Village Water Supply Survey (Harris)

A survey of village water supplies in the New Ireland District was completed in March by a team including a local government engineer and a public health technician. A total of 95 villages and mission posts was visited. Problems of water supply are generally not acute in the New Ireland area except on some coral islands. Sanitary dug wells were recommended in 26 places, rainwater catchments in 20 places, spring development in 12 places, and reticulation of creek water in 3 places. Adequate tank storage was evident in 34 of the places visited, but generally greater catchment areas are required. A Note on Investigation was prepared.

Northern District Village Water Supply Survey (Macias)

A village water supply survey of the Northern District was completed in June. The team visited 37 villages and settlement schemes. In the coastal areas near Tufi and Popondetta dug wells and rainwater catchments were recommended. Inland, in the Kokoda and Sila areas, recommended water supplies are mainly by gravity reticulation from springs and creeks.

Southern Highlands Village Water Supply Survey (Harris)

A village water supply survey of the Southern Highlands District was completed in September. A large number of missions, villages, schools, hospitals and aid posts were visited. The installation of sanitary dug wells was recommended in alluvial valleys and on river banks. Where feasible, spring development was recommended. Serious shortages of water were encountered in villages on limestone, and at these sites the construction of rainwater catchments and tank storage was recommended. The use of a helicopter for the first time in a water supply survey proved successful.

East Sepik District Village Water Supply Survey (Harris)

Three bores were sited for the Yangoru Local Government Council at the Yangoru Station in the East Sepik District. Dug wells were also sited for two villages near Dreikikir.

ROAD INVESTIGATIONS

Slope Stability Problems, Highlands Highway, Kundiawa (Jacobson, Harris)

An investigation was made of slope stability problems on the Highlands Highway, near Kundiawa, in the Chimbu District. A landslide at Chuave blocked the highway, which is New Guinea's main artery, for two weeks in October, 1971. The slide occurred in weathered shale in an old landslide area, and contributing factors were an earthquake of felt intensity MM VI and heavy rainfall. Re-alignment of the highway was necessary at this locality to ensure stability of the road.

There is an "area problem" of slope stability near Kundiawa associated with weathered shale. Unstable cuts and fills in the shale and subsidence of the road in old landslide areas are common. Improved drainage is the key remedial measure in most cases.

Wantoat-Leron Road (Macias)

An investigation was made of the proposed new alignment of the Wantoat-Leron road in Morobe District, New Guinea. Much of the terrain is unstable and subject to landslides. Parts of the road have already been constructed but are not trafficable. Recommendations were made for improving the stability of cuts and fills and for improved drainage and anti-erosion measures.

Asaro-Gembogl Road (Jacobson)

The proposed road route from Asaro, in the Eastern Highlands District, to Gembogl or the Iwam Pass was inspected with consulting engineers commissioned to design the road for the Public Works Department. The route traverses mountainous country including a crossing of the Bismark Range at 3,000m. The road will be constructed mainly in weathered granodiorite and stability problems associated with the steep terrain are expected to be severe.

Hum Gap Road (Harris)

An investigation was made of the geology of the Hum Gap Road between Mendi and Nipa in the Southern Highlands District. The road is cut into a steep slope of limestone, which is stable, and siltstone and mudstone which tend to slump. It is not economically feasible to regrade or widen the road to a higher standard. However, with minor improvements and regular maintenance, it could be used as a low standard access road.

Wau-Mount Kaindi-Edie Creek Road (Jacobson)

Fundamental instability of slopes in the Edie Creek Gorge has led to a series of landslides at Blue Point. The latest slide, which closed the Wau-Mount Kaindi-Edie Creek road early in 1971, was an earthflow in clayey silt (completely weathered porphyry) involving about 75,000 cubic metres of material. A permanent solution to the stability problem is unlikely to be achieved, and construction of a by-pass route has been recommended. A proposed by-pass route from Wau to Mount Kaindi is not expected to encounter serious stability problems.

Usino-Madang Road (Harris)

An interpretation of the results of a geophysical survey of bridge sites was made at the request of the Commonwealth Department of Works. Recommendations were made for drilling at each site before foundation design is completed.

Pavement Failures in the Port Moresby area (Weber, Pounder)

An investigation of possible geological factors in road pavement failures in the Port Moresby area was begun in conjunction with the Materials Laboratory of the Commonwealth Department of Works. The different types of failure were surveyed and categorized. Some augering was done in the failed sections and samples are undergoing soil mechanics tests at the Laboratory. Causes of the failures are probably complex and the investigation will be a long-term one.

Togoba-Wapenamanda Road (Harris)

An investigation was made of the geology of the Togoba-Wapenamanda road in the Western Highlands, which is to be upgraded by the Department of Public Works. Slope

stability problems are expected in the Minamp valley where mudstone of the Chim Group crops out. Elsewhere weathered tuff and agglomerate may cause construction difficulties. Recommendations were made for stable batters in the various rock types likely to be encountered.

Musa Gorge Access Road (Macias)

An investigation was made of the geology of the proposed access road from Pongani to the Musa Gorge damsite area (Musa hydro-electric scheme) in the Northern District. The road will be constructed mainly through low-lying swamp country except for the crossing of the Didana Range. No serious problems are anticipated.

CONSTRUCTION MATERIALS

Concrete Failures (Harris, Jacobson)

A petrographic study was made of aggregate, used in concrete which failed at the Army Barracks in Wewak. The aggregate contained an appreciable proportion (5 percent) of volcanic glass, and the failure was possibly due to reaction with the alkalis in the cement.

A petrographic study was also made of concrete from a failure at Rabaul. In this case, the aggregate was found to contain 20-30 percent of volcanic glass, and some reaction rims were observed in thin section. Reactive aggregate may be more widely used in Papua New Guinea than has previously been realised.

Kerema Construction Materials (Weber, Pounder)

An investigation was made of possible sources of material for construction of the Kerema airstrip and the Kerema-Malalaua road. Two deposits of coronus (coral limestone) at Epo Plantation were inspected but found to be unsuitable. A more suitable limestone deposit was located near the coast about 27 km from Kerema; the deposit could supply material for all constructional uses in the area for some time to come.

Quarry Sites in the Port Moresby area (Jacobson, Harris Weber, Hansen)

Throughout the year mapping and evaluation of possible quarry sites in the Port Moresby area continued. Considerable quantities of concrete and sealing aggregate are required in the area for major works, including extensions to Jackson's Airport.

There are at present two operating quarries in limestone, about 10 km north of Port Moresby. The lithology of the limestone is variable and strict quality control is necessary for concrete aggregate. Some of the limestone fails the standard specifications for aggregate.

The geology of Mount Lawes, 20 km north of Port Moresby, was mapped on a scale of 1:25,000. Mount Lawes is formed of gabbro, limestone and calc-silicate hornfels. A possible quarry site in hornfels on the south ridge of Mount Lawes was mapped in detail and is expected to yield at least 700,000 cubic metres of material. The quality of the material is being tested.

The geology of Mount Eriama, 15 km northeast of Port Moresby, was mapped in detail. At this locality gabbro is capped by limestone and calc-silicate hornfels. A quarry site in calc-silicate hornfels could yield 65,000 cubic metres of material. Diamond drilling proved that the quality of the material is variable, and possibly 20 percent of it will be unsuitable for aggregate.

Roadmaking Materials in the Port Moresby area (Weber, Jacobson)

Several possible sources of roadmaking materials in the Port Moresby area were inspected at various times with officers of the Commonwealth Department of Works. In general, two types of material are used in the Port Moresby area, locally known as "Red Ridge Gravel" and "Diorite". Weber compiled a report summarizing the geotechnical properties of the "Red Ridge Gravel", which consists of hillwash and weathered bedrock and is developed on sedimentary rocks of the Port Moresby Beds. The "Diorite" is weathered gabbro.

Aggregate for the Brown River-Rubberlands Road (Jacobson, Weber)

Several possible sources of aggregate for the Brown River-Rubberlands Road were inspected with officers of the Commonwealth Department of Works. This road, in the

Central District, forms part of the Port Moresby-Bereina road which will eventually be linked with Lae. Alluvial gravel deposits from the Vanapa River should provide sufficient material for re-surfacing the road as far as the Veimauri River. The road between the Veimauri River and Rubberlands is still under construction. It passes through an area of volcanic rocks and it may be necessary to crush basalt or agglomerate for surfacing materials.

Construction Materials, Eastern Highlands and Chimbu Districts (Weber)

A comprehensive survey was made of existing and potential sources of roadmaking materials and concrete and sealing aggregate in the Eastern Highlands and Chimbu Districts. The problem of providing and maintaining all-weather surfaced roads is of primary importance for development. The investigation was concerned with pavement aggregate for the main trunk roads, sealing aggregate for the Highlands Highway, and pavement and concrete aggregate for the developing towns of Kainantu and Goroka. At present the main sources of materials with a good performance as aggregate are gabbro of the Akuna intrusive complex and porphyry of the Daulo Volcanics. River gravel is widely used but its performance is not satisfactory.

Inventory of Quarry Sites, Papua New Guinea (Weber)

Compilation has been started of the technical details of all known quarry sites and gravel pits in Papua New Guinea.

ENGINEERING - GEOLOGICAL MAPPING

Engineering - geological map of Port Moresby (Harris, Jacobson, Pounder)

Compilation began of an engineering - geological map of Port Moresby. A good deal of geological and site investigation data has accumulated but is not yet synthesised. Recent excavations were recorded, and additional hand auger holes were drilled in the alluvial valleys to obtain sections. All water bore data were compiled.

VOLCANOLOGY

by W.D. Palfreyman

STAFF

W.D. Palfreyman	- Was Head of the Section throughout the year, apart from a short period of leave in October.
R.A. Davies and Mrs J.C. Davies	- Were with the Section as volcanologists, for the whole year except for a period of leave in November-December.
R.J.S. Cooke	- Commenced duty on 9 June as the senior Seismologist and continued with the Section for the remainder of the year.
D.A. Wallace	- Commenced duty at the Observatory in October.

VOLCANIC ACTIVITY

Manam Volcano

The main vent showed little variation in its pattern of activity throughout the year, ejecting moderate quantities of white or light brown vapour at short intervals. These ejections were on occasions accompanied by rumbling explosions. Only one light fall of ash was reported during the year. Summit glows were seen during March, May and June.

A new phase of activity commenced during early October, 1970, when vapour emission commenced from a small crater located in the southern vent area. The pattern of activity established at this time, that of regular ejections of white or grey vapour at intervals of from 1 to 5 seconds, continued with little variation for the remainder of the year and during 1971.

Seismic activity, as measured by the daily count and average daily amplitude of the volcanic tremor, declined steadily during the last part of 1970 and during early 1971; by mid-February it had reached an extremely low level. A moderate resurgence then occurred and this was later

followed by a rapid rise in the level of activity at the end of April. A decline then ensued and by the beginning of June activity had again reached a low level. The period June-October was marked by rapid and large fluctuations in the level of activity. Peaks were recorded on 12 June, 5 July, 21 August and 1 September, at which times activity was at a generally higher level than had been recorded for at least seven years.

Tiltmeter readings from the instruments at Tabele and Waris in general showed little meaningful variation during the period.

Bagana Volcano

Intermittent ash-laden vapour ejections, occasionally accompanied by rumbling explosions, occurred during the latter half of 1970 and punctuated the continual emission of white vapour from the crater rim and lava dome. Blocky andesite lava flows, initiated in July and October, 1970, made their way down the southwestern and eastern flanks of the cone during this period; the larger of the two eventually measured 2.25 km x 200m x 10m.

Explosive activity commenced in March, 1971, a climax being reached later in the month. The frequency and magnitude of the explosive events slowly diminished during April and had ceased by the 24th.

Lava movement was again seen on the southern flanks of the cone during July and August.

Langila Volcano

A number of small explosions occurred in the No. 2 crater early in October, 1970. All activity at this crater had ceased by the end of the month.

Activity was renewed on 23 February and continued intermittently until the date of reporting. It consists of weak to moderate ejections of dark ash-laden vapour from the No. 2 crater. Accompanying audible explosions were absent until late in June after which time muffled rumblings were sometimes heard. During August incandescent boulders could on occasions be seen from the airstrip.

Ulawun Volcano

Mild activity recommenced during mid-December, 1970, when dark ash emissions were seen over a period of six days. A summit flow was also observed on several evenings at this time. Further ash emissions were recorded on 10 January and vigorous white vapour emissions continued for a further two weeks after that date. Weak emissions of light brown vapour were reported on 10 February.

Balbi Volcano

Brief aerial inspections were made on 11 October, 1970, and 23 March, 1971. Activity at these times showed little change from that seen previously.

Karkar Volcano

An aerial inspection made on 2 November, 1970, showed that activity was confined to the central cone complex (Bagiai). A detailed ground inspection was made of the two cones in June. Ulumam, the small scoria cone, was found to be inactive. Thermal areas on Bagiai are confined to the central and southeastern cones, where overall activity appears to have increased somewhat since 1963 although no temperatures over 90^{o} were found.

Lamington Volcano

Ground inspections were made of the dome area in October and May when particular attention was given to high temperature fumaroles checked previously. At one site a maximum temperature of 357^{o}C was recorded. There have not been any significant changes in the pattern of activity on the dome during the past year.

Doma Peaks

Strong sulphurous odours were reported by the pilots of passing aircraft during November, 1970.

St Andrew Strait

An extensive survey of the volcanic islands in St Andrew Strait was made in July. All known areas of thermal activity on Lou and Baluan Islands were inspected. An examination of Tuluman Island failed to reveal any thermal activity.

Pago Volcano

A brief examination was made of Pago Volcano in July. Temperatures of 98°C and 99°C were recorded at the main thermal area. There is no evidence of any significant change in activity since 1938.

SPECIAL PROJECTS AND INVESTIGATIONS

Analysis of Tabele Seismic Records

A plot of the daily count and average daily amplitude was extended to take in the period January, 1968-May, 1969. Work on this project is continuing.

Bismarck Sea Island Survey

Work continues on the preparation of a Note on the geology and volcanology of the volcanic islands of the Bismarck Sea.

Eruptive History of Mount Langila Volcano (71501)

A summary of the eruptive history of Mount Langila volcano, up to 1970, was prepared and issued as a Note on Investigation (No. 71-020).

Karkar Island Crater Investigation (71502)

An account of the investigation of the thermal activity in Karkar Island crater was prepared and is to be issued as a Note on Investigation.

St Andrew Strait Investigation (71503)

An account of the geology and volcanology of the volcanic islands in St Andrew Strait was prepared and is to be issued as a Note on Investigation.

Portable Seismic Telemetry Equipment Investigation (69501A)

A Note on Investigation (No. 71-021) was issued, giving a description of low cost telemetry equipment developed for use in volcano surveillance.

The July, 1971, Rabaul Earthquakes Investigation (71504)

Data are being gathered together for inclusion in a Note on Investigation on the nature and effects of the July, 1971, earthquakes.

Eruption Summaries of Mounts Langila and Bagana

Brief reports were prepared on the recent eruptions at Langila and Bagana volcanoes for inclusion in the Bulletin of Volcanic Eruptions.

ROUTINE ACTIVITIES

VOLCANOLOGICAL

Rabaul

Weekly temperature readings were continued at the thermal areas at Sulphur Creek, Rapindik, Sulphur Springs, Rabalanakaia, Tavurvur and Vulcan throughout the year. No significant temperature changes were recorded.

Manam Island

Routine daily observations of volcanic activity were continued from Tabele and Waris.

D'entracasteaux Islands

Weekly temperature recordings at the thermal areas on Fergusson and Dobu Islands were maintained. The surveillance of the temperatures of the more remote thermal areas on Fergusson and Goodenough Islands was initiated. Some changes in the configuration of thermal points at Deidei became evident in June.

SEISMOLOGICAL

A total of 25 seismic records per day (excluding records from temporary field stations) were obtained from local and regional stations. The production of a Preliminary Earthquake Analysis continued on a regular basis. Telegrams containing data relating to significant earthquakes were forwarded to the American Embassy, Canberra, for transmittal to the U.S. Department of Commerce. Data for the International Seismic Centre, Edinburgh, were forwarded on request.

Seismic Activity

A total of 7173 earthquakes were recorded at Rabaul between 1 September, 1970 and 31 August, 1971. Over 250 earthquakes were felt, with Intensity II-VII (MM), in Rabaul during this period; most followed the large shocks in July, 1971.

At 1753 hours G.M.T. on 31 October, 1970, much of mainland New Guinea was shaken by a large earthquake the epicentre of which was located to the northwest of Madang. The following data have been determined for this event:-

Focal depth - about 40 km
Epicentre - 4.95°S, 145.70°E
Magnitude - M 7.0

A maximum intensity of MM VIII or greater was experienced within 20 km of the epicentre and intensities of MM VII and greater were felt over an area of approximately 10,000 square kilometres. An estimated cost of 1.7 million dollars damage resulted and 13 people were killed.

Aftershocks continued for several months after the event.

At 0717 hours G.M.T. on 10 January, 1971, a large earthquake was widely felt throughout western Papua New Guinea; intensities ranged up to MM VII.

N.O.S. (U.S. National Ocean Survey) give the following data for this event.

Epicentre - 3.1°S, 139.7°E
Normal depth i.e. not greater than 70 km
Magnitude - Mb 7.3, Ms 8.1

Aftershocks continued for several months.

A major earthquake occurred at 0612 hours G.M.T. on 14 July and was located in the Solomon Sea off the west coast of Bougainville. Locally severe damage was reported from the Gazelle Peninsula. It was felt at intensity MM VII in Rabaul. A small seismic seawave inundated lowlying foreshore areas around Rabaul harbour.

N.O.S. give the following data for this event.

Epicentre - 5.5°S, 153.9°E
Depth - 47 km
Magnitude - Ms 7.9

At 0123 hours G.M.T. on 26 July a further major earthquake occurred, the epicentre of which was located off the southern tip of New Ireland. Damage was minor in Rabaul (intensity MM VI) but was locally severe on the Gazelle Peninsula (to MM VIII). A series of seismic seawaves inundated the foreshore areas of Rabaul harbour; a maximum rise of seven feet above mean sea level was calculated.

N.O.S. give the following data for this event.

Epicentre - 4.9°S, 153.2°E
Depth - 48 km
Magnitude - Ms 7.9

Stations and Equipment

W.W.S.S. Equipment

The World-Wide Standard Seismograph equipment was operational throughout the period apart from a few hours lost in February (due to a faulty lamp), and in July, immediately following the large earthquakes.

Rabaul Harbour Network

Cable faults resulted in loss of records from TAV during January and from SUL, RAL and TAV during April and May. A power failure caused loss of records from VUL for some days during January and an intermittent transmitter fault caused further loss during May and June. All networks records were lost on 1 February due to a power failure in the equipment room.

Tanaka Station

A seismograph incorporating the newly developed Pony telemetry equipment was installed at Tanaka, approximately 18 km south of Rabaul, during October, 1970. Modifications were made to the equipment in November and new batteries and aerials installed in April. The station was closed during May, the equipment being taken to Popondetta. It was re-established on 19 July.

Kerevat Station

The station operated satisfactory until February when a drive belt broke. It was closed down on 5 May and the equipment returned to Rabaul.

Agenahambo Station

The station was operational except for a period between February and May. Routine inspections were made in November, May and August.

Mount Lamington Station

A seismograph station incorporating Pony telemetry equipment was re-established on the flanks of Mount Lamington on 9 November, 1970. Modified equipment was installed in December. The station was operational except for a period from February to May. Routine inspections were made in May and August.

Tabele Station

The station operated satisfactorily through the year.

Waris Station

Tiltmeter readings were received for most of the year.

Esa'Ala Station

The station operated satisfactorily throughout the year. A routine inspection was made in August.

Ulamona Station

Tiltmeter readings were received throughout the year.

Piva Station

Tiltmeter readings were received throughout the year.

Technical Developments

During April preparatory work was commenced in anticipation of the arrival of the new stations' equipment. By October wiring of the control racks had been completed and testing was underway.

PUBLICATIONS AND RECORDS

PUBLICATIONS AND RECORDS

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PUBLICATIONS AND RECORDS

Set out below are lists of publications and unpublished reports prepared in the Geological Branch which were either issued or worked on in the period under review. The right hand column gives the status of the publication or unpublished report at 31st October, 1971.

The reports of the Branch are listed in the following categories:

(1) Bulletins
(2) Reports
(3) Explanatory Notes and maps
(4) Other Bureau publications
(5) Articles and papers published in outside (i.e. non-Bureau) publications.
(6) Unclassified Bureau Records (unpublished)
(7) P.N.G. Geological Survey Notes on Investigations (unpublished)

The status of standard series maps (which are not issued without explanatory notes) is also shown pictorially in the Frontispiece; other, special purpose or small-scale, coloured maps are referred to under "Map Compilation (p) or "Geological Drawing Office" (p.), or both.

Numbers against authors' names indicate that the author -

1. was formerly a Bureau Officer
2. is, or was, an officer of a State Geological Survey
3. is a member of the staff of the Baas Becking Geobiological Research Laboratory and is not a Bureau officer.
4. is a member of staff of a University or other institution
5. is not a Bureau officer and does not fall into categories 1 to 4, e.g. performs work for B.M.R. under contract.

BULLETINS

PUBLISHED OR IN PRESS

56	[1]THOMAS, G.A.	Carboniferous and early Permian brachiopods from Western and Northern Australia	Published
95	COOK, P.J.	The Stairway Sandstone; a sedimentological study	In press
100	WELLS, A.T.	The geology of the Amadeus Basin, Central Australia	Publ.
107	[2]GEMUTS, I.	Metamorphism and igneous activity in the Lamboo Complex, East Kimberley area, W.A.	"
110	DRUCE, E.C. JONES, P.J.	Cambro-Ordovician conodonts from Burke River Structural Belt, Queensland	"
112	SHERGOLD, J.H.	Late Cambrian trilobite fauna from the Gola Beds	In press
115	[4]PLAYFORD, G.	Carboniferous spores from the Bonaparte Gulf Basin	"
116	PALAEONTOLOGICAL PAPERS, 1968		Publ.
	BURGER, D.	Early Cretaceous angiospermous pollen grains from Queensland	
	DICKINS, J.M.	Correlation and subdivision of the Permian of Western and Eastern Australia	
	DRUCE, E.C.	Conodonts from the Garra Formation (Lower Devonian), New South Wales	
	[1]EVANS, P.R.	Revision of the miospore genera Perotrilites Erdtm. ex Couper, 1953, and Diaphanospora Balme & Hassell, 1962	
	[4]RUNNEGAR, B.	Eurydesma and Glendella gen. nov. (Bivalvia) in the Permian of Eastern Australia	
	[4]STRUSZ, D. JELL, J.S.	Cyathophyllum (Radiophyllum) from the Devonian of eastern Australia	
	TOWNLEY, K.A.	Bibliography of Australian Permian invertebrates	
	[1]VEEVERS, J.J.	Upper Devonian and Lower Carboniferous calcareous algae and stromatolites from the Bonaparte Gulf Basin, northwestern Australia	

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117	JONES, P.J.	Lower Ordovician conodonts from the Bonaparte Gulf Basin and the Daly River Basin, northwestern Australia	Publ.
124	BLAKE, D.H.	Geology and mineral resources of the Herberton-Mount Garnet area, Herberton Tinfield, North Queensland	In press
125	GEOLOGICAL PAPERS, 1969:		
	[1]de KEYSER, F.	Proterozoic tillite at Duchess, Northwestern Queensland	In press
	COOK, P.J. ARMSTRONG, K.A.	Clay mineralogy of the Middle Cambrian Beetle Creek Formation, Georgina Basin, Northwest Queensland	
	[1]SENIOR, B.R., [1]SENIOR, Daniele	Silcrete in Southwest Queensland.	
	WATTS, M.D.	Geological interpretation of a gravity survey over basement inliers near Millungera, North Queensland	
	SMITH, I.E. SIMPSON, C.J.	Late Cainozoic uplift in the Milne Bay area, eastern Papua	
	JONGSMA, D.	Marine geology of Milne Bay, New Guinea	
	[1]MANWARING, E.A.	Palaeomagnetism of some Recent basalts from New Guinea	
	ENGLAND, R.N.	Lamellar intergrowth of pyrophyllite and muscovite in kyanite-bearing quartzite from the Petermann Ranges, Northern Territory	
	[1]DICKINS, J.M. [1]ROBERTS, J. [1]VEEVERS, J.J.	Permian and Mesozoic geology of the Bonaparte Gulf Basin	
	DERRICK, G.M.	New leucite lamproites from the West Kimberley, Western Australia	
	GLIKSON, A.Y.	Petrology and geochemistry of Archaean ophiolites near Kalgoorlie, Western Australia	

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127	[4]von der BORCH, C.C.	Marine geology of the Huon Gulf region, New Guinea.	In press
128	DAVIES, H.L.	Peridotite-gabbro-basalt complex in eastern Papua; an overthrust plate of oceanic mantle and crust	Publ.
131	SMITH, S.E. WALKER, K.R.	Primary element dispersions associated with mineralization at Mount Isa, Queensland.	In press
134	[4]LINK, A.G. DRUCE, E.C.	Ludlovian and Gedinnian conodont stratigraphy of the Yass Basin, N.S.W.	In press
136	SHERGOLD, J.H.	Late Cambrian trilobites from the Burke River Structural Belt	In press

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130	[1]DICKINS, J.M. [1]MALONE, E.J.	Geology of the Bowen Basin, Queensland	With editor
133	[1]DOW, D.B. [1]SMIT, J.A.J. BAIN, J.H.C. RYBURN, R.J.	Geology of the South Sepik Region, T.P.N.G.	Editing complete
137	[4]CHATTERTON, B.	Some aspects of palaeontology, palaeoecology and biostratigraphy of the limestones of the Murrumbidgee Group at Taemas, near Yass, N.S.W.	With editor
138	[1]de KEYSER, F. COOK, P.J.	The geology of the Middle Cambrian phosphorites and associated sediments of northwest Queensland.	With editor
139	GEOLOGICAL PAPERS, 1970		With editor
	[1]BAIN, J.H.C. [1]BINNEKAMP, J.G.	The foraminifera and stratigraphy of the Chimbu Limestone, New Guinea	
	[1]de KEYSER, F.	A review of the Middle Cambrian stratigraphy in the Queensland portion of the Georgina Basin	
	[1]ROBERTS, J. [1]VEEVERS, J.J.	Summary of BMR studies of the onshore Bonaparte Gulf Basin, 1963-71	
	SMITH, I.E.	The geology of the Calvados Chain, Southeastern Papua	

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139	GEOLOGICAL PAPERS, 1970 (Cont.)		With editor
	SMITH, I.E.	An uplifted wave-cut terrace on Sudest Island, Southeastern Papua	
	SMITH, I.E., PIETERS, P.E.	The geology of the Deboyne Island Group, Southeastern Papua	
	SMITH, I.E., PIETERS, P.E.	Notes to accompany a geological map of Rossel Island, Southeastern Papua	
	[1]VEEVERS, J.	Stratigraphy and structure of the continental margin between North-West Cape and Seringapatam Reef, Northwest Australia	
	[1]PLUMB, K.A., [1]BROWN, M.C.	Revised correlations and stratigraphic nomenclature in the Proterozoic carbonate complex of the McArthur Group, Northern Territory	
	BAIN, J.H.C., MACKENZIE, D.E., RYBURN, R.J.	Geology of the Kubor Anticline, New Guinea	With editor
	[1]BOFINGER, V.M.	Geochronology of the East Kimberley region, W.A.	In prep.
	BURGER, D.	Cenomanian spores and pollen grains from Bathurst Island, N.T.	"
	[1]DUNN, P.R., [1]ROBERTS, H.G., [1]SMITH, J.W., PLUMB, K.A.	Geology of the Carpentaria Proterozoic Province, N.T.: Roper River to the Queensland border	"
	[1]GELLATLY, D.C., [2]SOFOULIS, J., DERRICK, G.M.	Precambrian geology of the Kimberley Region, W.A.: The West Kimberley	"
	GLIKSON, A.Y.	Basic volcanic sequences of the Proterozoic, Cloncurry-Mount Isa region, Queensland	"
	JONGSMA, D.	Marine geology of the Arafura Sea	"
	JONES, H.A.	Marine geology of the northwest Australian continental shelf	"
	[4]JOPLIN, G.A.	Chemical analyses of Australian rocks: Part II, Igneous and metamorphic, 1962-1969	With editor

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NORVICK, M.S.	Microplankton from the Cenomanian of Bathurst Island, N.T.	In prep.
[4]PAGE, R.W., [4]MACDOUGALL, Ian	The geochronology of igneous rocks in the New Guinea region	With editor

PALAEONTOLOGICAL PAPERS, 1970-71 — In prep.

BURGER, D.	Palynological observations in the Carpentaria Basin, Queensland
NORVICK, M.S.	The microplankton genus Disphaeria. Cookson & Eisenack emended
[1]BINNEKAMP, J.G.	Tertiary larger Foraminifera from New Britain, T.P.N.G.
SKWARKO, S.K.	Cretaceous stratigraphy of part of the Wiso Basin, N.T.
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OWEN, M.	Upper Cretaceous planktonic Foraminifera from Papua-New Guinea
SHERGOLD, J.H.	Index and bibliography of Australian Cambrian trilobites

PLUMB, K.A.	Precambrian geology of the Kimberley Region, W.A.	In prep.
[1]ROBERTS, H.G., [1]PLUMB, K.A., [1]DUNN, P.R.	Geology of the Carpentaria Proterozoic Province: Arnhem Land, N.T.	"
[1]ROBERTS, J., OVERSBY, B.S.	The Lower Carboniferous geology of the Rouchel district, Upper Hunter Valley, N.S.W.	"
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SENIOR, B.R.	Geology of the Central Eromanga Basin	"
SMITH, I.E., DAVIES, H.L., BELFORD, D.J.	Geology of southeastern Papua	"

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TAYLOR, G.A.M.	Eruptions of Manam volcano, New Guinea	"
TINGEY, R.J.	Geology of the Prince Charles Mountains, Antarctica	"
[1]WILLMOTT, W.F., [2]PALFREYMAN, W.D., [2]WHITAKER, W.G., [1]TRAIL, D.S.	Metamorphic and igneous rocks of Cape York Peninsula and Torres Strait Islands	With editor

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126	[1]PAINE, A.G.L., [1]HARDING, R.R., [2]CLARKE, D.E.	The geology of the northeastern part of Hughenden 1:250,000 Sheet area, Queensland	In press
127	[2]WYATT, L.H., [1]PAINE, A.G.L., [2]CLARKE, D.E.	The geology of the Townsville 1:250,000 Sheet area, Queensland	Published
128	[1]PAINE, A.G.L., [1]GREGORY, C.M., [2]CLARKE, D.E.	The geology of the Ayr 1:250,000 Sheet area, Queensland	"
135	[1]TRAIL, D.S.	ANARE 1961 geological traverses on the MacRobertson Land and Kemp Land coast	"
137	[2]WYATT, D.H., [1]PAINE, A.G.L., [2]CLARKE, D.E., [1]GREGORY, C.M., [1]HARDING, R.R.	The geology of the Charters Towers 1:250,000 Sheet area, Queensland	"
140	DOW, D.B.	Palaeozoic rocks of the Hardman, Rosewood, and Argyle Basins, West Kimberley Region, W.A.	With editor
144	[2]CLARKE, D.E., [1]PAINE, A.G.L., JENSEN, A.R.	The geology of the Proserpine 1:250,000 Sheet area, Queensland	In press
145	[1]PAINE, A.G.L., [2]CLARKE, D.E., [1]GREGORY, C.M.	The geology of the northern half of the Bowen 1:250,000 Sheet area, Queensland	In prep.
147	[4]PHILLIP, G.M.	Catalogue of type and figured specimens in the Palaeontological Collection of the Department of Geology, Univ.New England, N.S.W.	Published

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148	[1]CRESPIN, Irene	Catalogue of additional type and figured specimens of Protista (Foraminifera, Radiolaria, and Tintinnina) in the Commonwealth Palaeontological Collection, Canberra	Published
149	[4]FOLDVARY, G.Z. [4]SANDERSON, J.L.	Catalogue of palaeontological collections, University of Sydney	In press
150	[1]ROBERTS, H.G., [2]GEMUTS, I. [2]HALLIGAN, R.	Adelaidean and Cambrian stratigraphy of the Mount Ramsay 1:250,000 Sheet area, W.A.	Editing complete
	BAIN, J.H.C., McLEOD, I.R. GRAINGER, D.J.	Geology of the eastern side of Prydz Bay, Antarctica	In prep.
	BENNETT, Rosalind PAGE, R.W.	Catalogue of age determinations on Australian rocks, 1966-70	With editor
	BENNETT, Rosalind PAGE, R.W.	Catalogue of isotopic age determinations carried out on Australian rocks, 1966-70	In prep.
	[1]MACNAB, R.P.	The geology of the Gazelle Peninsula, New Britain	"
	[1]MIEZITIS, Y.	Compilation of geological and geochemical information from the Hundred of Goyder, Rum Jungle district, N.T.	"
	[1]MORGAN, C.M. [1]SWEET, I.P. [1]PONTIFEX, I.R.	The geology of the northern part of the Victoria River Basin, N.T.	"
	[1]OLGERS, F. [1]FLOOD, P.G.	Palaeozoic geology of the Warwick and Goondiwindi 1:250,000 Sheet areas	With editor
	PLUMB, K.A.	Petrography of the igneous and metamorphic rocks of Arnhem Land, N.T.	In prep.
	[1]PONTIFEX, I.R., [1]MORGAN, C.M. SWEET, I.P.	The geology of the Auvergne 1:250,000 Sheet area, N.T.	"
	[1]SWEET, I.P. [1]MENDUM, J.R. [1]BULTITUDE, R.J. [1]MORGAN, C.M.	The geology of the southern part of the Victoria River Basin, N.T.	In prep.

EXPLANATORY NOTES AND MAPS

(1971 progress indicated by underlining)

1:250,000 MAPS AND NOTES

SHEET No.	NAME	FIELD WORK	PRELIM. ED.ISSUED	COLOURED ED.PUBL. DATE/STATUS	AUTHORS (Explanatory Notes)	STATUS
A56/9,14,15, B56/3	New Ireland (Special)	1970	1971 (dyeline only)			
B54/3	May River	1966 & 1971	1969	In prep.	DOW, D.B. HUTCHISON, D.S.	In prep.
B54/4	Ambunti	1966 & 1971	1969	In prep.	DOW, D.B. HUTCHISON, D.S.	In prep.
B54/7	Blucher Range	1971	In prep.		DAVIES, H.L. HUTCHISON, D.S.	In prep.
B54/8	Wabag	1966 & 1971	1969	In prep.	DAVIES, H.L. HUTCHISON, D.S.	In prep.
B55/5	Ramu	1971	In prep.		BAIN, J.H.C. MACKENZIE, D.F.	In prep.
B55/8-12	Cape Raoult-Arawe	1969	In prep.		RYBURN, R.J.	In prep.
B55/9	Karamui	1970	In prep.		BAIN, J.H.C. MACKENZIE, D.E.	In prep.
B55/14	Wau	1968	In prep.		SMIT, J.A.J. DOW, D.B.	In prep.
B55/15	Salamaua	1970	In prep.		DAVIES, H.L.	In prep.
B56/2	Gazelle Peninsula	1968	1971	In prep.	DAVIES, H.L.	With editor

B56/5-9	Talasea-Gasmata	1969	In prep.		RYBURN, R.J.	In prep.
B56/6	Pomio	1969	In prep.		RYBURN, R.J.	In prep.
C54/8- C55/5	Daru-Maer Island	1968	1970	In press	WILLMOTT, W.F. WHITAKER, W.G.	In press.
C55/3	Buna	1970	In prep.		DAVIES, H.L.	In prep.
C55/8	Tufi	1969	In prep.		DAVIES, H.L. SMITH, I.E.	In prep.
C55/12	Abau	1969	1971		SMITH, I.E.	With editor
C56/5	Fergusson Island	1969	1971	In prep.	DAVIES, H.L.	With editor
C56/9	Samarai	1969	1971		SMITH, I.E.	With editor
D51/12	Montague Sound	1965	1967	1971	ALLEN, A.D.	In press
D51/16-15	Prince Regent - Camden Sound	1965	1967	1971	WILLIAMS, I.	Published
D52/7	Cape Scott	1968	1970	In prep.	MENDUM, J.R.	In press
D52/9-5	Drysdale - Londonderry	1965	1966	1971	GELLATLY, D.C. SOFOULIS, J.	Published
D52/10	Medusa Banks	1965	1969	1971	PLUMB, K.A. PERRY, W.J.	In press
D52/11	Port Keats	1967/8	1970	In prep.	MORGAN, C.M.	In press.
D52/12	Fergusson River (2nd Ed.)	1967 1968	1970	Ready for printer	PONTIFEX, I.R. MENDUM, J.R.	In press.

D52/14	Cambridge Gulf	1963	1966	1971	PLUMB, K.A. VEEVERS, J.J.	Published
D52/15	Auvergne	1967	1970	In press	PONTIFEX, I.R. SWEET, I.P.	In press
D52/16	Delamere	1966 - 1968	1970	In prep.	SWEET, I.P.	In press.
D54/4	Cape Weymouth (part)	1967	1969)	To be completed by Sedimentary Section	WILLMOTT, W.F.)	Awaiting contributions from Sedimentary Section.
D54/8	Coen (part)	1967	1969)		WHITAKER, W.G.)	
D54/12	Torres Strait (part)	1968	1970)		WILLMOTT, W.F.)	
D54/15	Rutland Plains	1970	Aug.'71	With editor	NEEDHAM, S. DOUTCH, H.F.	With editor
E51/3	Yampi	1966 - 1967	1970	With authors for modifications	GELLATLY, D.C. SOFOULIS, J.	With authors for modifications
E51/4	Charnley	1965 - 1967	1969	In press	GELLATLY, D.C. HALLIGAN, R.A.	With editor
E51/8	Lennard River	1965 - 1967	1969	2nd Ed. In press	DERRICK, G.M. PLAYFORD, P.E.	With editor
E52/3	Waterloo	1969	In press	In prep.	SWEET, I.P.	In prep.
E52/4	Victoria River Downs	1966 - 1969	In prep.		SWEET, I.P.	In prep.
E52/7	Limbunya	1969	1971	In prep.	MENDUM, J.R.	With editor
E52/8	Wave Hill	1966 - 1969	1971	In prep.	BULTITUDE, R.J.	With editor
E52/11	Birrindudu	1971	In prep.		(BLAKE, D.H.	In prep.
E52/15	Tanami	1971	In prep.		(HODGSON, I.M. (SMITH, P.A.	In prep.

E53/14	Tennant Creek	1970-71	In prep		MENDUM, J.R.	In prep.
E54/1-2	Mornington - Cape Van Dieman	1970	Ready for printer	In prep.	GRIMES, K.	In prep.
E54/3	Galbraith	1970	Aug. '71.	With editor	NEEDHAM, S. DOUTCH, H.F.	With editor
E54/4- E55/1	Walsh - Mossman	1970-71	In prep.	In prep.	GRIMES, K.	In prep.
E54/5	Westmoreland	1970	2nd.Ed. In prep.	Awaiting Metalliferous Section contribution.		
E54/6	Burketown	1969	Nov. '70	With editor	INGRAM, J.A.	With editor
E54/7	Normanton	1969-70	April '71.	In prep.	SIMPSON, C.	In prep.
E54/8 - E55/5	Red River - Atherton	1970-71	In prep.	In prep.	SMART, J. GRIMES, K.	In prep.
E54/9	Lawn Hill	1970	2nd Ed. In prep.	In prep.	GRIMES, K.	In prep.
E54/10	Donors Hill	1969	Nov. '70	With editor	INGRAM, J.A.	With editor
E54/11	Croydon	1969	Ready for printer.	In prep.	DOUTCH, H.F.	In prep.
E54/12	Georgetown	1969-70	Ready for printer. (2nd. Ed.)	Awaiting Metalliferous Section contributions.		
E54/14	Dobbyn	1969	April '71.	2nd.Ed. In prep.	SMART, J.	In prep.
E54/15	Millungera	1969	April '71.	With editor	GRIMES, K.	With editor
E54/16	Gilberton	1969	Nov. '70	With editor	SMART, J.	With editor

F52/11	Lake Mackay	1968	1969	In press	NICHOLAS, T.	In press
F52/12	Mount Doreen	1967-68	1st.1968 2nd.1969	In press	WELLS, A.T.	In press
F53/9	Napperby	1968	1969	In press	EVANS, T.G.	In press
F55/1	Hughenden	1963	1964	Awaiting contribution from R.R. Vine	PAINE, A.G.L. VINE, R.R.	Await. contrib. from R.R.Vine
F55/3	Bowen	1961-64/5.	1967	In press.	PAINE, A.G.L.	With editor
F55/4	Proserpine	1962-'65.	1968	1971	PAINE, A.G.L.	With editor
F55/9	Muttaburra	1963	1964	Issued	VINE, R.R.	Issued
F55/13	Longreach	1964		Issued	VINE, R.R.	Issued
F55/14	Jericho		1967	In prep.	SENIOR, Daniele	In prep.
G53/4	Simpson Desert North	1971	In prep.		MOND, A.	In prep.
G53/8	Simpson Desert South	1971	In prep.		YEATES, A.N.	In prep.
G54/2	Machattie	1969		2nd.Ed.with editors	SENIOR, B.R.	With editors
G54/7	Canterbury	1966	1967	Issued	GREGORY, C.M. VINE, R.R.	Issued
G54/11	Barrolka	1967	1968	Issued	SENIOR, B.R.	Issued
G54/12	Eromanga	1968	1969	Issued	INGRAM, J.A.	In press
G54/16	Thargomindah	1968	1969	Issued	SENIOR, Daniele	Issued

G55/1	Blackall	1965	1966	Issued	CASEY, D.J. GALLOWAY, M.C.	Issued
G55/5	Adavale	1966	1967	Issued	GALLOWAY, M.C.	Issued
G55/6	Augathella	1965	1966	Issued	GALLOWAY, M.C.	Issued
G55/9	Quilpie	1968	1969	Issued	SENIOR, B.R.	Issued
G55/10	Charleville	1968	1969	Issued	SENIOR, Daniele	Issued
G55/13	Toompine	1968	1969	Issued	INGRAM, J.A.	In press
G55/14	Wyandra	1968	1969	Issued	THOMAS, B.M.	In press
G55/15	Homeboin	1969	1970	In press	SENIOR, B.R.	In press
G56/13	Dalby	1968	1969	In prep.	MOND, A.	In prep.
H54/3	Tickalara	1967	1968	Issued	GALLOWAY, M.C. SENIOR, Daniele	In press.
H54/4	Bulloo	1968	1969	Issued	INGRAM, J.A.	Issued
H55/1	Eulo	1968	1969	In press	SENIOR, B.R.	In press
H55/2	Cunnamulla	1968	1969	Issued	THOMAS, B.M.	In press
H55/3	Dirranbandi	1969	1970	Ready for printer	GRAHAM, Barbara K.	In press
H55/4	St. George	1969	1970	In press	SENIOR, Daniele	In press
H56/1	Goondiwindi	1968	1969	In prep.	SENIOR, Daniele	In prep.
I55/16	Canberra			Issued	STRUSZ, D.L.	Issued

ANTARCTICA

Stinear Nunataks	To 1971	In prep.	TINGEY, R.H.	In prep.
Crohn Massif	To 1971	In prep.	TINGEY, R.J.	In prep.
Beaver Lake	To 1971	In prep.	TINGEY, R.J.	In prep.
Mount Hicks	To 1971	In prep.	TINGEY, R.J.	In prep.
Fisher Massif	To 1971	In prep.	TINGEY, R.J.	In prep.

OTHER MAPS	Scale and Name	Authors	Position as at 31st October, 1971.
	1:30,000		
	Yass Basin, N.S.W.	LINK, A.G.	Preliminary edition issued
	1:50,000		
	Canberra (8727 III & IV)	STRUSZ, D.L. HENDERSON, G.A.M.	Published, with notes
	Herberton and Mount Garnet mineral locality maps, Qld	BLAKE, D.H.	Fair drawing contract ready to be let.
	1:63,360		
	Herberton, Qld	BLAKE, D.H.	Printed (to be included in Bulletin 124).
	Mount Garnet, Qld	BLAKE, D.H.	" " "
	1:100,000		
	Yampi, W.A.	DERRICK, G.M.	Preliminary printed 26/7/71
	Tennant Creek (Special) N.T.	MENDUM, J.R. TONKIN, P.C.	In preparation.
	Cloncurry) Mary Kathleen) Qld Marraba)	DERRICK, G.M. et al	Being drawn for preliminary edition.
	Mount Isa, Qld	DERRICK, G.M. et al.	Being compiled

OTHER MAPS (Cont.)	1:500,000		
	Cape York area, Qld	WILLMOTT, W.F. et al.	Preliminary edition issued; to printer 21/9/71 for 1st edition.
	West Kimberley, W.A.	GELLATLY, D.C. et al.	Compilation in progress.
	Burdekin River region, Qld	PAINE, A.G.L. CAMERON, R.L.	Preliminary edition issued 26/7/71.
	Kimberley Basin	PLUMB, K.A.	Base compiled; awaiting compilation of geology.
	Victoria River	SWEET, I.P.	Base to be prepared in readiness for geology.
	1:1,000,000		
	Geological map of Papua New Guinea.	BAIN, J.H.C. CAMERON, R.L. et al.	Fair drawing in progress; mineral deposits being compiled.
	Central Eromanga Basin	SENIOR, B.R.	Preliminary edition issued
	Bowen Basin geological	DICKINS, J.M. MALONE, E.J.	Preliminary edition in prep.
	Bowen Basin geophysical	DICKINS, J.M. MALONE, E.J.	Preliminary edition in prep.
	Arafura Sea	JONGSMA, D.	Preliminary edition in prep.
	Rowley Shoals, W.A.	JONES, H.A.	Preliminary edition in prep.
	Scott Reef, W.A.	JONES, H.A.	Preliminary edition in prep.
	Metamorphic map of central Australia	FORMAN, D.J. SHAW, R.D.	Compilation in progress; notes to be written.
	1:2,500,000		
	Mineral deposits of Papua New Guinea	CAMERON, R.L. GRAINGER, D.J.	Being compiled; notes to be written.

OTHER MAPS (Cont.)	1:5,000,000		
	Metallogenic map of Australia	WARREN, R.G.	Fair drawing almost complete; notes to be written.
	Tectonic Map of Australia	DOUTCH, H.F. et al	Fair drawing almost complete; notes to be written.
	1:20,000,000		
	Lithological map of Australia	THOMAS, P.E.	To accompany 1:5,000,000 Soil Map of Australia (compiled by others). Being compiled, notes to be written.

OTHER BUREAU PUBLICATIONS

Contributions were made by Geological Branch staff to four of the pamphlets prepared for the Bureau's Silver Jubilee Open Days and for subsequent use:

Engineering geology and geophysics, by D.E. Gardner
Marine geology and geophysics, by H.A. Jones
Phosphate in Australia, by P.J. Cook
The Amadeus Basin, Central Australia, by A.T. Wells

OUTSIDE PUBLICATIONS

BAIN, J.H.C., 4 OLLIER, C.D.	Geology of Papua New Guinea.	Encyclop. P.-N.G., in press.
BELFORD, D.J., 2 SCHEIBNER, V.	Turonian Foraminifera from Western Australia and their palaeogeographical significance.	Micropalaeontology, in press.
BLAKE, D.H.	Geology of the Alftafjordur volcano, a Tertiary volcanic centre in southeastern Iceland.	Scientia Islandica, 2, pp. 43-63, 1970.
BLAKE, D.H.	Geology and mineral deposits of the Herberton Tinfield, north Queensland.	Qld Govt Min. J. 71., 1970.
BLAKE, D.H.	Geology and geomorphology of the Morehead-Kianga area.	C.S.I.R.O. Aust. Land Res. Ser. 29, 1971. pp. 56-68.
BLAKE, D.H., 4 BLEEKER, P.	Volcanoes of the Cape Hoskins area, New Britain, Territory of Papua and New Guinea.	Bull. volc. 34, pp. 385-405, 1970.
BLAKE, D.H., 4 LOFFLER, E.	Volcanic and glacial-landforms on Mount Giluwe, Territory of Papua and New Guinea.	Geol. Soc. Amer. Bull. 82, pp. 1605-14, 1971.
BLAKE, D.H., 4 OLLIER, C.D.	Geomorphological evidence of Quaternary tectonics in southwestern Papua.	Rev. Geomorph. dynam. 19. pp. 28-32, 1970.
BLAKE, D.H., 4 OLLIER, C.D.	Alluvial plains of the Fly River, Papua.	Zeitschr. Geomorph. (in press)

Outside Publications (Cont'd)

	BLAKE, D.H.,	Mineralogical zoning in the	Econ. Geol.
1	SMITH, J.W.	Herberton Tinfield, North Queensland, Australia. Discussion.	65, pp. 993-7, 1970. Econ. Geol. 66, p. 815, 1971.
	BURGER, D.	Palynology and stratigraphy of the Neocomian to lower Aptian in the Great Artesian Basin, Queensland.	J. geol. Soc. Aust. Spec. Publ. 1972.
3	CHAMBERS, L.A.,	Cysteine and S-sulphocysteine	Arch.
3	TRUDINGER, P.A.	biosynthesis in bacteria.	Mikrobiol. 77, 165-184.
	COOK, P.J.	The Illamurta diapiric complex and its position on an important Central Australian structural trend.	A.A.P.G.
	COOK, P.J.	Discussion on the Illamurta diapiric complex.	A.A.P.G.
1	COOPER, J.A.	Lead isotope classiciation of the A.B.H. Consols and Browne's Shaft veins at Broken Hill, N.S.W.	A.I.M.M. Proc. 234, 67-69, 1970.
1	COOPER, J.A.,	Lead isotopes in island	Bulletin
4	ARMSTRONG, R.L.	arcs.	Vulcanologique In press.
1	COOPER, J.A.,	Rb-Sr dating within the	J. Geol. Soc.
4	COMPSTON, W.	Houghton Inlier, South Australia	Aust. 17, Pt 2 213-219, 1971.
1	COOPER, J.A.,	Isotopic and elemental	Contributions
4	DASCH, E.J.,	geochemistry of Black Sea	to Woods Hole
4	KAYE, Maureen	sediments	Oceanographic Inst. Spec. Publ. In press.
1	COOPER, J.A.,	Dating of glauconite from	J. Geol. Soc.
	WELLS, A.T.	the Ngalia Basin, Northern	Aust. 18(2),
1	NICHOLAS, T.	Territory, Australia.	pp. 97-106 1971.

Outside Publications (Cont'd)

DAVIES, H.L., SMITH, I.E.	Geology of eastern Papua.	Geol. Soc. Amer. Bull. In press.
1 DICKINS, J.M., ROBERTS, J.	Progress in Gondwana stratigraphy and palaeontology in Australia since 1967.	Proc. 2nd Gondwana Symp. S. Africa, 1970.
DOW, D.B., BAIN, J.H.C.	A Miocene volcanic arc in New Guinea.	Aust. N.Z. Assoc. Adv. Sci. 42nd Congr. Abstr. Section 3.
DRUCE, E.C.	Upper Palaeozoic and Triassic conodont distribution and biofacies.	Geol. Soc. Amer. Spec. Publ. In press.
1 GELLATLY, D.C.	Possible Archaean rocks of the Kimberley region, W.A.	Geol. Soc. Aust. Spec. Publ. In Press.
1 GELLATLY, D.C., DERRICK, G.M., PLUMB, K.A.	Proterozoic palaeocurrent directions in the Kimberley region, north-western Australia.	Geol. Mag. 107, 1970 p. 249-257.
GLIKSON, A.Y.	Geosynclinal evolution and geochemical affinities of Early Precambrian systems	Tectono-physics 9, 397-433, 1970.
GLIKSON, A.Y.	Archaean geosynclinal sedimentation near Kalgoorlie, W.A.	Geol. Soc. Aust. Spec. Publ. 3. In press.

Outside Publications (Cont'd)

GLIKSON, A.Y.	Structure and metamorphism of the Kalgoorlie System south-west of Kalgoorlie, W.A.	Geol. Soc. Aust. Spec. Publ. 3. In press.
GLIKSON, A.Y.	Cross folding and the origin of megabreccias in a Proterozoic belt near Cloncurry, N.W. Queensland.	Submitted to J. geol. Soc. Aust.
GLIKSON, A.Y.	Early Precambrian geochemical patterns: evidence on the primitive mantle, a primary oceanic crust, and the nucleation of granitic shields.	Submitted to Geol. Soc. Amer. Bulletin.
GLIKSON, A.Y.	Primitive Archaean element distribution patterns: Chemical evidence and geo-tectonic significance.	Submitted to Earth Planet Sci. Letters
HALDANE, A.D., CARTER, E.K., BURTON, G.M.	The relationship of pyrite oxidation in rock fill to acid water at Corin Dam, A.C.T., Australia.	1st Internat. Congr. Internat. Assoc. of Eng. Geology, Paris, 1970.
HENLEY, S.	Petrogenesis of quartz porphyry dykes in South-west England.	Nature In press.
HENLEY, S.	An application of statistical methods to the geochemistry of an area around Perranporth, Cornwall.	Proc. Ussher Soc. 2, Pt 3 210-216, 1970.
HENLEY, S.	Hedenbergite and sphalerite from the Perran Iron Lode, Cornwall.	Proc. Ussher Soc. 2, Pt 4 In press.
HENLEY, S.	Chemical analysis of a spilitic dyke in mid-Cornwall, England.	Trans. Royal Geol. Soc. Cornwall, 1971. In press.

Outside Publications (Cont'd)

	HENLEY, S.	Rediscovery of a granite dyke at Perranporth, Cornwall.	Trans. Royal Geol. Soc. Cornwall, 1971. In press.
	HENLEY, S.	The geology and geochemistry of an area around Perranporth, Cornwall.	Trans. I.M.M. 80, B75-6, 1971 (Thesis Abstract)
	HENLEY, S.	Computer simulation in geology, by Harbaugh and Bonham-Carter.	Aust. I.M.M. Bull. 342, 1971. (Book Review)
	HENLEY, S.	Trend-surface analysis of lithogeochemical data as a guide to ore-bearing districts. (Paper presented to a Conference on "Statistics in Mining and Exploration", Adelaide, 1971.)	Conference proceedings. In press.
	JENSEN, A.R.	Regional aspects of the Upper Permian regression in the northern part of the Bowen Basin.	in Geol. Surv. Qld Rep. 62
	JOHNSON, R.W., MACKENZIE, D.E., SMITH, I.E.	Late Cainozoic volcanism and seismicity in Papua-New Guinea.	Tectono-physics. In press.
	JONES, H.A.	Late Cenozoic sedimentary forms on the northwest Australian continental shelf.	Marine Geology.
3	JONES, H.E.	A re-examination of Desulfovibrio africanus.	Arch. Mikrobiol Submitted
	JONES, P.J., SHERGOLD, J.H., DRUCE, E.C.	Late Cambrian and Early Ordovician stages in western Queensland.	J. geol. Soc. Aust. 18, (1), 1-32.
3	LAMBERT, I.B.	The composition and evolution of the deep continental crust.	Geol. Soc. Aust. Spec. Publ. 3. In press.

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3	LAMBERT, I.B.	Granulites - a comment.	Neues Jahrbuch für Mineralogie, - 3, 1971 pp. 103-4.
3 4 3	LAMBERT, I.B., MCANDREW, J.A., JONES, H.E.	Geochemical and bacteriological studies of the cupriferous environment at Pernatty Lagoon, South Australia.	Proc. Aust. Inst. Min. Met. Submitted.
3 4	LAMBERT, I.B., WYLLIE, P.J.	Low velocity zone in the Earth's mantle: incipient melting caused by water.	Science 169, 764-766, 1970.
4	MACKENZIE, D.E., WHITE, A.J.R.	Phonolite globules in basanite from Kiandra, New South Wales.	Lithos. Oct. issue, 1970.
	MAFFI, C.	Photogeological interpretation. Textbook for the Course in Photogeology. (In Portuguese)	Federal Univ. Bahia Press, Brazil.
	MOND, A.	The Permian sediments of the Beaver Lake area, Prince Charles Mountains, Antarctica. (SCAR/IUGS Symposium on Antarctic Geology and Solid Earth Geophysics, Oslo, 1971.)	Symposium proceedings.
4	PAGE, R.W., MCDOUGALL, Ian	K-Ar dating of the Tertiary f_{1-2} stage in New Guinea and its bearing on the geological time scale.	American J. Sci. 269, 321-342, 1970.
	PLANE, M.	A New Guinea fossil macropodid (Marsupialia) from the marine Pliocene.	Mem. Nat. Mus. Vict. In press.
4	RHODES, F.H.T., DRUCE, E.C.	The evolution of conodont assemblages and its implication for conodont taxonomy. (Paper presented at International Symposium on conodont taxonomy, Marburg/Lahn, Sept. 1971.)	In press.

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4 RHODES, F.H.T., DRUCE, E.C., 4 AUSTIN, R.L.	Recognition, evolution and taxonomy of Lower Carboniferous conodont assemblages. (Paper presented at International Symposium on conodont taxonomy, Marburg/Lahn, Sept. 1971.)	In press.
ROBERTS, W.M.B., 4 BUCHANAN, A.S.	The effects of temperature, pressure, and oxygen on copper and iron sulphides synthesised in aqueous solution.	Mineral. Deposita, 6, 1971, 23-33.
4 ROY, A.B., 3 TRUDINGER, P.A.	The biochemistry of inorganic compounds of sulphur.	C.U.P., 1970
SENIOR, B.R.	Structural interpretation of the southern Nebine Ridge area, Queensland.	A.O.G. Review Feb. 1971.
SHAW, R.D. FORMAN, D.J.	Relationship between regional metamorphism, structure and Bouguer gravity anomalies in Central Australia.	Aust. N.Z. Assoc. Adv. Sci., 43rd Congr. Brisbane, Austr., 3, 36, 1971.
SHERATON, J.W.	The origin of the Lewisian gneisses of N.W. Scotland, with special reference to the Drumberg area, Sutherland.	Earth & Planet Sci. Letters 18, No. 4, 301-310, 1970.
SHERGOLD, J.H., 4 HENDERSON, R.A.	Occurrence of the echinoderm Cyclocystoides from the Middle Cambrian of the Mount Isa District.	
3 SKYRING, G.W., 3 JONES, H.E.	The gwarine-cytosine contents of deoxyribonucleic acids of some sulphate-reducing bacteria - a reassessment.	J. Bacteriol. Submitted
3 SKYRING, G.W., 3 TRUDINGER, P.A.	Electro phoretic characterization of ATP - adenylyltransferase (ATP-sulfurylase) using acrylamide gels.	Analytical Biochem. Submitted.

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SMART, J., INGRAM, J.A., DOUTCH, H.F., 2 GRIMES, K.G.	Recent mapping in the Carpentaria Basin; new stratigraphic names.	Q. Govt. Min. J. 72, 227-233.
SMITH, I.E.	Late Cainozoic uplift and geomorphology in south-eastern Papua.	Search 1, 5, 222-225.
SMITH, I.E.	High-potassium intrusives from southeastern Papua.	Contrib. Miner. & Petrol. Submitted.
STEWART, A.J.	Potassium-argon dates from the Arltunga Nappe Complex, Northern Territory.	J. geol. Soc. Aust., 18, 205-211, 1971.
STRUSZ, D.L., 4 CHATTERTON, B.D.E., 1 FLOOD, P.G.	Revision of the New South Wales Devonian brachiopod "Spirifer yassensis".	Proc. Linn. Soc. NSW 95(2); 170-190 VII-IX
STRUSZ, D.L.	Correlation of the Lower Devonian In CAMPBELL, K.S.W. (Ed.) - Symposium on the Devonian System in Australia.	J. geol. Soc. Aust.
TAYLOR, G.A.M.	Contribution to World Map of Post-Miocene volcanoes.	I.A.V.C.E.I. In press.
TAYLOR, G.A.M. et al.	Handbook for excursions, ANZAAS 42nd Congress.	Published.
3 TRUDINGER, P.A.	Microbes, metals, and minerals.	Minerals Science and Engineering. Submitted
3 TRUDINGER, P.A.	On the absorbancy of reduced methyl viologen.	Anal. Biochem., Submitted
WALKER, K.R., 4 WARE, N.G., 4 LOVERING, J.F.	Compositional variations in the pyroxenes of the differentiated Palisades Sill, New Jersey.	Submitted to Geol. Soc. America Bull.

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	WELLS, A.T., PERRY, W.J.	A comparison of panchromatic and colour 70 mm aerial photography of the Patmungala Syncline, Northern Territory.	Photointer-pretation. 71-1, pp. 1-4 Jan-Feb. 1971.
2	WILSON, I.H., DERRICK, G.M., HILL, R.M.	Origin of copper mineral-ization in the Precambrian of Northwest Queensland.	Int. Geol. Congr. Montreal. 1972. Submitted

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1970/3	1	MORGAN, C.M. SWEET, I.P. 1 MENDUM, J.R. 1 PONTIFEX, I.R.	Geology of Cape Scott, Port Keats, Fergusson River, and Delamere 1:250,000 Sheet areas, Northern Territory.
1970/38	2	GRIMES, K.G. SMART, J.	Shallow stratigraphic drilling, Southern Carpentaria Basin, 1969.
1970/49	1	HOHNEN, P.D.	The geology of New Ireland, T.P.N.G.
1970/63	1	MACNAB, R.P.	Geology of the Gazelle Peninsula, T.P.N.G.
1970/65	1	FRENCH, D.J.	Crater Formation investigation, Rum Jungle district, N.T.
1970/66		ENGLAND, R.N. DAVIES, H.L.	Mineralogy of cumulus and non-cumulus ultramafic rocks from eastern Papua.
1970/67	1	B.G. JONES	A computer programme for analysing directional data designed for use on a CDC 3600.
1970/72		JOHNSON, R.W. MACKENZIE, D.E. SMITH, I.E.	Short papers on Quaternary volcanic areas in Papua New Guinea.
1970/74		DAVIES, H.L. 1 IVES, D.J. HALDANE, A.D.	Results of 1961 stream sediment geochemical survey of Fergusson and Goodenough Islands, Papua.
1970/75		HALDANE, A.D. CARTER, E.K. BURTON, G.M.	The relationship of pyrite oxidation in rock fill to acid water at Corin Dam, A.C.T., Australia.
1970/79		BAIN, J.H.C. MACKENZIE, D.E. RYBURN, R.J.	Geology of the Kubor Range, New Guinea.
1970/112		PERRY, W.J. HILLMAN, P.J.	Visit to United States, July 18 to August 26, 1970.
1970/116		DAVIES, H.L. SMITH, I.E.	Geology of eastern Papua: a synthesis.
1971/2	1	GELLATLY, D.C.	Bibliography of recent geological work on the Precambrian of the Kimberley Region, W.A.
1971/5		JACKSON, M.J.	Notes on a geological reconnaissance of the Officer Basin, W.A. 1970.

1971/11	1 ROSSITER, A.G.	Preliminary notes on the geology of the Village Creek area, A.C.T.
1971/14	JOHNSON, R.W. DAVIES, R.A. PALFREYMAN, W.D.	Cape Gloucester area, New Britain: Volcanic geology, petrology, and eruptive history of Langila Craters up to 1970.
1971/17	D. JONGSMA J.F. MARSHALL	BMR marine geology cruise in the southern Barrier Reef and northern Tasman Sea 12/9/70 to 14/12/70.
1971/37	Compiled by REW, P.M.	Miscellaneous chemical, petrographic, and mineragraphic investigations carried out in the Geological Laboratory. Part 1: January to September; Part 2: October to December, 1970.
1971/51	OZIMIC, S.	Well completion report, Wollongong (BMR) Nos.1,2, and 2a Wells, Sydney Basin, N.S.W. Appendix 1: Petrology of the Currambeen Dolerite, by D.C. Gellatly.
1971/53	M.S. NORVICK	Palynological observations in Amerada Thunderbolt No. 1 Well, Galilee Basin, Queensland.
1971/61	DERRICK, G.M. 1 GELLATLY, D.C.	The Precambrian geology of the Oscar Range Inlier, Lennard River Sheet area, SE51/8, W.A.
1971/62	C.J. SIMPSON	Report on photo interpretation of the Birrindudu and Tanami 1:250,000 scale Sheets, Northern Territory.
1971/65	1 MORLOCK, J.S. ENGLAND, R.N.	Results of drilling of the Crater Formation, Rum Jungle, N.T.
1971/70	MACKENZIE, D.E.	Intrusive rocks of New Britain.

IN PREPARATION

* Indicates that advance copies(of engineering geology reports) have been supplied to the client department or authority.

1969/145	[4]BROWN, M.C.	The Proterozoic Barney Creek Formation and H.Y.C. lead-zinc deposit and some associated carbonate units, McArthur Group, McArthur River area, N.T.	With editor
1970/11	[1]BEEVERS, J.R. (Compiled by S.E.Smith)	Studies in the cold extraction of copper lead, and zinc from geological materials.	"
1970/39	DOUTCH, H.F. [1]INGRAM, J.A. SMART, J. [2]GRIMES, K.G.	Progress report on the geology of the Southern Carpentaria Basin	Being written
1970/54	[1]PAINE, A.G.L.	Summary report on overseas study tour, March to May, 1969.	With editor.
1970/100	NEEDHAM, R.S.	Mesozoic stratigraphy and structure of the Georgetown area, Queensland.	"
1970/115	SHAW, R.D.	Geology and copper deposits of the Pinnacles Bore area, Strangways Range, N.T.	"
1970/117	[1]GELLATLY, D.C.	Textures and genesis of the Narlarla lead-zinc ores, Kimberley region, W.A.	"
1971/1	[2]SOFOULIS, J. [1]GELLATLY, D.C. DERRICK, G.M. [1]MORGAN, C.M. [2]FARBRIDGE, R.A.	The geology of the Yampi 1:250,000 Sheet area,SE51/3, W.A.	Being reproduced
1971/39	PURCELL, D.C.	Seismic investigations of engineering projects in the A.C.T. from August 1969 to January, 1970.	"
1971/47	YEATES, A.N.	An appraisal of the New England Geosyncline for phosphate.	"
1971/55	JOHNSON, R.W.	Geology and petrology of Bamus volcano, the Lake Hargy area, and the Sulu Range, New Britain.	With editor

1971/56	DERRICK, G.M. [2]WILSON, I.H. HILL, R.M. MITCHELL, J.E.	Detailed geology of the Marraba 1:100,000 Sheet area, N.W. Queensland.	With editor
1971/57	MARSHALL, J.F.	Phosphatic sediments on the upper continental slope of eastern Australia.	Being reproduced
1971/63	[1]BINNEKAMP, J.G. DAVIES, H.L.	Subdivision of the Cainozoic: East Indian letter classification stages.	"
1971/66	SHAW, R.D. STEWART, A.J. [4]KHAN, M.Yar [4]FUNK, J.L.	Progress report on detailed mapping of the Arltunga Nappe Complex, N.T.	Being written
1971/69	BULTITUDE, R.J.	Stratigraphic drilling in the Antrim Plateau Volcanics, Victoria River district, N.T.	With editor
1971/71	SWEET, I.P. [1]MENDUM, J.R. BULTITUDE, R.J. [1]MORGAN, C.M.	Geology of the Victoria River Downs, Wave Hill, Waterloo, and Limbunya 1:250,000 Sheet areas, N.T.	Being reproduced
1971/81	RODDICK, S.L.	Petrographic examination of samples from 5 holes in the Lower Triassic, Bowen Basin, Queensland.	"
1971/94	[1]WILLMOTT, W.F. [2]WHITAKER, W.G. [1]PALFREYMAN, W.D. [1]TRAIL, D.S.	Igneous and metamorphic rocks of Cape York Peninsula and Torres Strait	"
1971/98	[1][2]LAU, G.C.	Geochemical survey of the Stapleton area, Rum Jungle, N.T.	"
1971/99	DODSON, R.G.	Some environments of formation of uranium deposits	"
1971/101	SIMPSON, C.J.	Geological potential of imagery from Bendix TM/LN-2 thermal infrared line scanner	"
1971/104	[5]WHITE, Mary E.	Report on 1969 collection of plant fossils from the Moolayember Formation and Clematis Sandstone.	"

1971/108	WALKER, K.R. MOND, A.	Mica lamprophyre (alnoite)from Radok Lake, Prince Charles Mountains, Antarctica.(Propose to submit for outside publication).	With editor
1971/109	ENGLAND, R.N.	Progressive metamorphism of amphibolites from the Soldiers Cap area, N.W. Queensland, and the Petermann Ranges, N.T. (Submitted Nov. 1971, as M.Sc thesis, A.N.U.)	"
1971/110	HALDANE, A.D.	Zinc pollution in the Molonglo River System.	"

ANGUS, Patricia M.	Geochemistry of the Styx River catchment, Broad Sound, Queensland.	Being written
BAIN, J.H.C. MACKENZIE, D.E.	Baiyer - Jimi Geological Reconnaissance, New Guinea.	"
BAIN, J.H.C. McLEOD, I.R. GRAINGER, D.J.	Geology of the eastern side of Prydz Bay, Antarctica.	"
BROOKS, J.A. TAYLOR, G.A.M. RYBURN, R.J. et al.	Investigations of crustal structure in the New Britain - New Ireland region, 1969: Part 1 - Geophysical and geological data.	With editor
BURGIS, Wendy	Cainozoic geology of Torilla Plains, Broad Sound.	Being written
CLAXTON, C.W. [4]BROWN, M.C.	Geochemistry of carbonate sequences of the McArthur River area, N.T.	"
COOK, P.J.	Preliminary report on the Broad Sound offshore seismic and drilling programme 1971.	"
[1]COOPER, J.A.	Geochronology of igneous and metamorphic rocks in the Cape York region, Queensland.	"
[1]COOPER, J.A.	On the age of uranium mineralization at Narbarlek, Northern Territory.	With editor
[1]COOPER, J.A. BLACK, L.P.	Rb/Sr dating of the late Palaeozoic volcanism in the Herberton - Mount Garnet area, Queensland.	Being written

DAVIES, H.L. HALDANE, A.D.	The Papuan Ultramafic Belt - Stream sediment geochemical reconnaissance.	Being written
DAVIES, H.L. SMITH, I.E.	Geology of southeastern Papua	"
DERRICK, G.M. [2]WILSON, I.H. GLIKSON, A.Y. HILL, R.M. MITCHELL, J.E.	Detailed geology of the Mary Kathleen 1:100,000 Sheet area, N.W. Queensland.	"
DOUTCH, H.F. SMART, J. [2]GRIMES, K.G. NEEDHAM, R.S.	Progress report on the geology of the Carpentaria Basin.	"
GARDNER, D.E.	Geological observations at several construction sites, Canberra, A.C.T. 1967-68.	With editor
[1]GELLATLY, D.C.	Chromite-bearing ultranasic rocks near Egan's Bore, Mount Ramsay 1:250,000 Sheet area, W.A.	Being written
[1]GELLATLY, D.C. DERRICK, G.M.	Notes on the younger Precambrian geology of the Lennard River and Lansdowne 1:250,000 Sheet areas, W.A.	"
GLIKSON, A.Y.	Structure and volcanism in a part of the Mount Isa trough, in Geology of the Mary Kathleen 1:100,000 Sheet area.	With editor
GLIKSON, A.Y. STEWART, A.J.	Progress report on the geology and petrology of the Reynolds Range region, N.T.	Being written
HALDANE, A.D. [1]LORD, Helen R.	Investigation into water seepages at Corin Dam, A.C.T.	"
HALDANE, A.D.	Report on 2nd Seminar on Geochemical Prospecting methods and techniques, Ceylon, 1970.	With editor
HENDERSON, G.A.M.	Geological investigations along the Bendora water main, A.C.T., 1967.	"
HENDERSON, G.A.M.	Geological investigations, Belconnen Sheets H4B, H4D, H5B, J4A, J4C, and J5A, Australian Capital Territory, 1968.	Being repro-duced.

HENDERSON, G.A.M.	Geological investigations,Belconnen Sheets G6B, G6D, H5C, H5D, H6A, H6B, H6C, and H6D, Australian Capital Territory, 1966-1970.	Being reproduced.
HENDERSON, G.A.M.	Geological investigations in the Capital Hill area, 1969-1971.	"
HENDERSON, G.A.M.	Geological investigations, Belconnen Sheets G3C, G3D, G4A, G4B, H3C, and H4A, A.C.T., 1966-1969.	With editor
HENDERSON, G.A.M.	Geological investigations Belconnen Sheets F4B and F4D, A.C.T., 1968.	"
HENDERSON, G.A.M.,	Stratigraphy and structure, Canberra 1:50,000 geological map,	"
HENDERSON, G.A.M.	Tennant Damsite, Gudgenby River, A.C.T. Geological report on detailed investigations, 1970.	"
HENLEY, S.	Computer programmes for calculation of norms and other petrochemical parameters from silicate analyses.	Being written
JOHNSON, R.W.	Ulawun volcano T.P.N.G. Part I: Geology and eruptive history between 1915 and 1967.	With editor
[2]DAVIES, R.A. JOHNSON, R.W. [4]WHITE, A.J.R. DAVIES, R.A.	Part II: The 1970 eruption Part III: Petrology.	
JOHNSON, R.W.	Volcanic geology and petrology of St.Andrew Strait islands,P.N.G.	"
JOHNSON, R.W. DAVIES, R.A.	Geology and petrology of Quaternary volcanic islands off the north coast of New Guinea.	Being written
[1]MENDUM, J.R. [1]TONKIN, P.C.	Geology of the Tennant Creek 1:250,000 Sheet area, N.T.	"
MOND, A.	Shallow stratigraphic drilling in the Gason and Pandie Pandie 1:250,000 Sheet areas, South Australia.	"
NEEDHAM, R.S. [2]GRIMES, K.G. SMART, J. DOUTCH, H.F.	Shallow stratigraphic drilling Southern Carpentaria Basin, 1970.	"

PAGE, R.W. JOHNSON, R.W.	Variations of Sr^{87}/Sr^{86} ratios in Quaternary volcanic rocks from the New Guinea - Solomons region.	Being written
[4]PAGE, R.W. McDOUGALL, I.	Towards a physical time-scale from the Neogene. Data for the Australian region (Paper for the International Geological Congress, 1972)	"
PAGE, R.W. RYBURN, R.J.	K-Ar dating of New Britain intrusive rocks.	"
PLUMB, K.A.	Bauxite deposits of northern Australia.	"
PRICHARD, C.E.	Magnesite occurrences, Rum Jungle district, N.T.	"
PURCELL, D.C.	*Tuggeranong - Weston Creek sewer tunnel, A.C.T. Geological report on detailed investigations, 1971.	With editor
[2]RIDLEY, W.F.	Woodcutters geobotanical survey, Rum Jungle area, N.T.	"
[1]ROSENBERG, Elizabeth	*Investigation for sources of road aggregate, Corin Dam and Tidbinbilla roads area, A.C.T. 1970.	"
SALTET, J.A.	*Googong Damsite - Queanbeyan River, N.S.W. Report on investigations, feasibility, 1970-1971.	"
SALTET, J.A.	General geology along the proposed pipe-line route from the Googong treatment plant to North Canberra,	With editor
SALTET, J.A.	Groundwater drainage, Burgmann College, Acton, 1971.	Being written
SALTET, J.A.	Geological investigation of proposed sites for reservoirs 6A, 6B, Belconnen, A.C.T.	With editor
SALTET, J.A.	Visit to the Hydroelectric Commission of Tasmania, May, 1970.	"
SALTET, J.A. SIMPSON, G.B.	Visit to Tumut 3 Project, Snowy Mountains, and Little Scotland Dam, Victoria, May, 1970.	"
SCHUETT, A.	Groundwater investigations, Jervis Bay, A.C.T., 1971.	"
SHAW, R.D. WARREN, R.Gladys	Geology of the Alcoota 1:250,000 Sheet area, N.T.	Being written.

SHERATON, J.W. LABONNE, Beatrice	Petrological and geochemical study of the acid volcanics and granitic rocks of the Georgetown Inlier and Cairns hinterland, Queensland: Progress Report.	Being written
SIMONIS, F.	Groundwater levels and observation bores in A.C.T. and environs. 1971.	With editor
SIMPSON, G.B.	Geology of the Googong reservoir, Queanbeyan River, N.S.W.	"
[2]SMART, J., GRIMES, K.G.	Shallow stratigraphic drilling, Central Carpentaria Basin, 1971.	Being written
SMITH, I.E.	Distribution and petrography of late Cainozoic volcanic rocks in the D'Entrecasteaux Islands, Egum Atoll, and the Lusancay.	"
TAYLOR, G.A.M.	An investigation of Karkar Volcano, T.P.N.G.	"
TAYLOR, G.A.M.	Doma Peaks Volcano, T.P.N.G.	"
TAYLOR, G.A.M.	Petrology of the New Ireland volcanoes, T.P.N.G.	"
TINGEY, R.J. DODSON, R.G. HILL, R.M. SMART, J.	Geological results of 1971 Antarctic Survey.	"
VANDEN BROEK, P.H.	*Geological evaluation of the proposed Mugga refuse disposal area, Weston district, A.C.T.	With editor
VANDEN BROEK, P.H.	*Report on the proposed gravel pit, Block 12, Hall district, A.C.T.	"
VANDEN BROEK, P.H.	Geological evaluation of the proposed Belconnen refuse disposal area, Canberra district, A.C.T.	"
WALKER, K.R.	Report on overseas visit April-June, 1970.	Being written
WELLS, A.T. KENNEWELL, P.J.	Evaporite drilling in the Amadeus Basin - Goyder Pass, Gardiner Range and Lake Amadeus, Northern Territory.	"
[4]WELLS, A.T. RICHTER-BERNBURG, G.	Evaporite deposits in Australia - sedimentary basin and surface occurrences.	"
YEATES, A.N.	Shallow stratigraphic drilling in the Hay River 1:250,000 Sheet area, N.T.	"

PAPUA NEW GUINEA NOTES ON INVESTIGATION

The numbering system was changed at the beginning of the year to a sequential one, replacing the previous system of according the Notes the same number as the Investigation.

The following Notes were issued by the P.N.G. Geological Survey in the period under review.

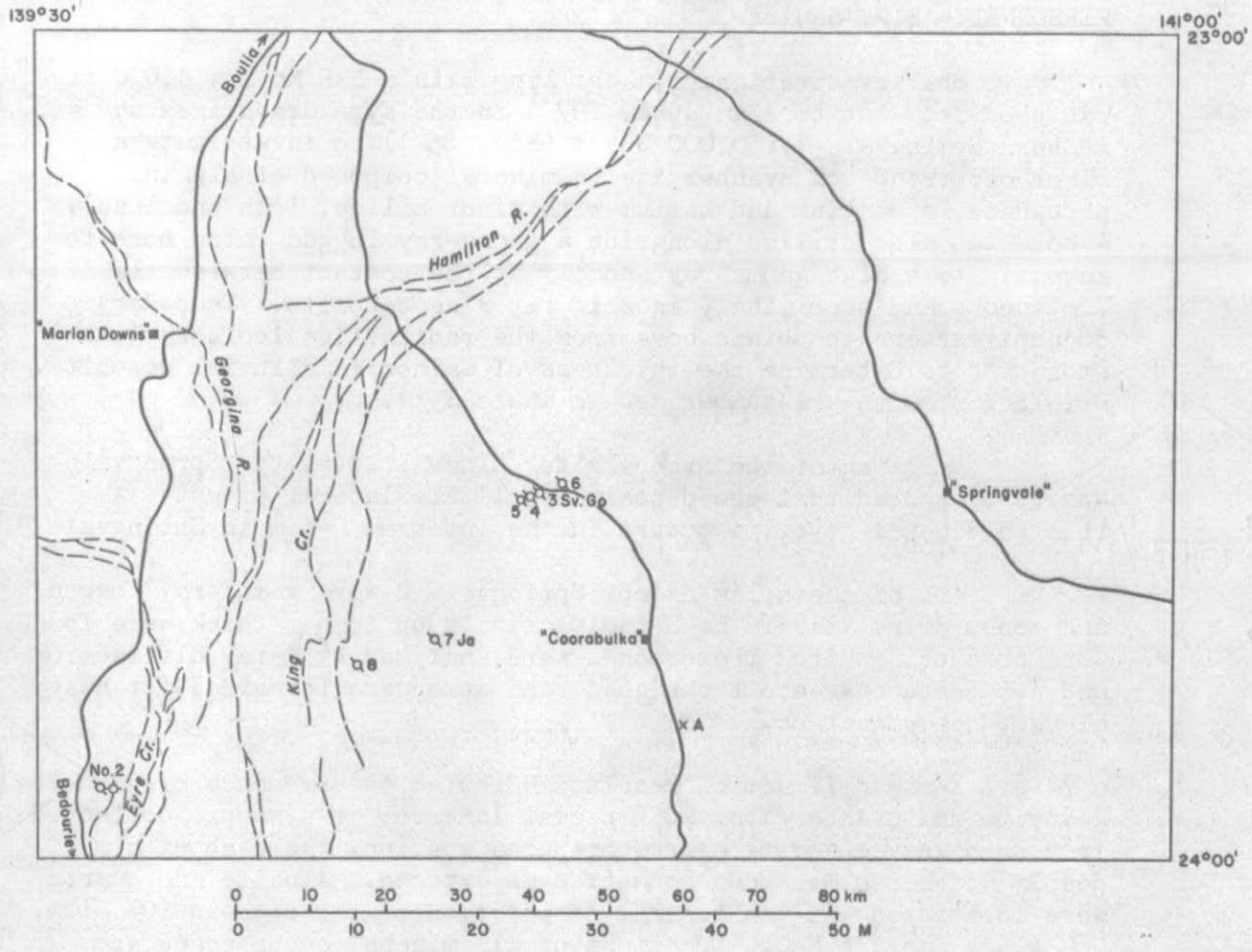
70207	I.H. Crick	Iara River Traverse
70403	G. Jacobson	Preliminary Investigation of the Geology of the Proposed Rouna No.4 Hydro-Electric Scheme, Port Moresby.
70404	G. Jacobson J. Harris	Slope Stability Problems on the Highlands near Kundiawa.
71-001	D. Grainger	The Oceanological Cruise of the Soviet Research Vessel "Vitiaz", December, 1970.
71-002	R.J. Hansen	The Geology of Mount Lawes, Central District, Papua.
71-003	L.F. Macias	Geological Investigations of the Wantoat-Leron Road, Morobe District, New Guinea.
71-004	J. Harris	Groundwater for Wewak Water Supply.
71-005	G. Jacobson	Preliminary Appraisal of Groundwater Resources, Markham Valley, New Guinea.
71-006	J. Harris	Village Water Supply Survey, New Ireland District, 1971 - Part I and Part II.
71-007	G. Robinson	The Geology of the Proposed Musa River Hydro-Electric Project Area, Eastern Papua.
71-008	L.F. Macias	Geology of the Musa Gorge Damsite Area, Eastern Papua.
71-011	G.P. Robinson	The Geology of Sirinumu Dam Stage 2.
71-012	J. Harris	Groundwater Supplies for Kavieng Hospital and Town, New Ireland District.
71-013	G. Jacobson	Groundwater Supply for Laloki Psychiatric Hospital, Central District, Papua.
71-014	G. Jacobson	Geological Investigation of the Wau-Mount Kaindi-Edie Creek Road, Morobe District, New Guinea.

No.	Author	Title
71-015	J. Harris	Geological Investigation of the Hum Gap Road, Mendi, Southern Highlands District.
71-016	B. Weber	Investigation of Construction Materials for the Kerema-Malalaua Road and the Kerema Airstrip, Gulf District, Papua.
71-017	B. Weber	Groundwater Investigation for Hospital Supply, Kerema, Gulf District, Papua.
71-018	J. Harris	A possible quarry site at Mount Eriama, Central District, Papua.
71-020	A. Davies W.D. Palfreyman	Eruptive History of Mount Langila Volcano, New Britain, up to 1970, with notes on Instrumental Operations.
71-021	N.O. Meyers	Portable Seismic Telemetry Equipment for Volcanic Surveillance.
71-022	J. Harris	Geological Investigation of the Togoba to Wapenamanda Road, Western Highlands District.
71-024	G. Jacobson B. Weber	Groundwater for the Bamguina Settlement Scheme, Cape Rodney, Central District, Papua.
71-025	B. Weber	"Red Ridge Gravel" as a Construction Material in Port Moresby.
71-027	B. Weber	Groundwater Investigations for Lorengau Town Supply, Manus District, New Guinea.
71-028	D. Grainger	Results of Geological Mapping of Markham 1:250,000 Sheet, New Guinea.
71-029	I.H. Crick R.J. Tingey	Mineral Beach Sand Deposit of Karkar Is.
71-030	D. Grainger	Sugarloaf Limestone, Morobe District.
71-031	B. Weber	Sources of Roadmaking and Concrete Aggregate in the Eastern Highlands District, New Guinea.
71-032	M. Pounder	Groundwater Investigation at Daru, Western District, Papua.
71-033	J. Harris	Village Water Supply Survey, Southern Highlands District, Papua, 1971 - Part I and Part II.

Fig S5/1

EYRE CREEK ALLUVIUM AND RADIOACTIVE MINERAL DRILLING PROJECT
SPRINGVALE SHEET AREA

BMR Drill site locations



7	BMR Stratigraphic hole with number		Road
Sv	Svanbergite		River channels
Go	Goyazite	X ray diffraction determination from drill samples or outcrop	Homestead
Ja	Jarosite		Breadalbine No.9 water bore
A	Alunite		