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DEPARTMENT OF
NATIONAL DEVELOPMENT

BUREAU OF MINERAL
RESOURCES, GEOLOGY
AND GEOPHYSICS

Record 1972/103

GEOLOGICAL BRANCH

SUMMARY OF ACTIVITIES

1972

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Record 1972/103

GEOLOGICAL BRANCH

SUMMARY OF ACTIVITIES

1972

ANNUAL SUMMARY OF ACTIVITIES
GEOLOGICAL BRANCH, 1972

RECORD 1972/103

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, 1971, and progress in year ended 31st October, 1972.

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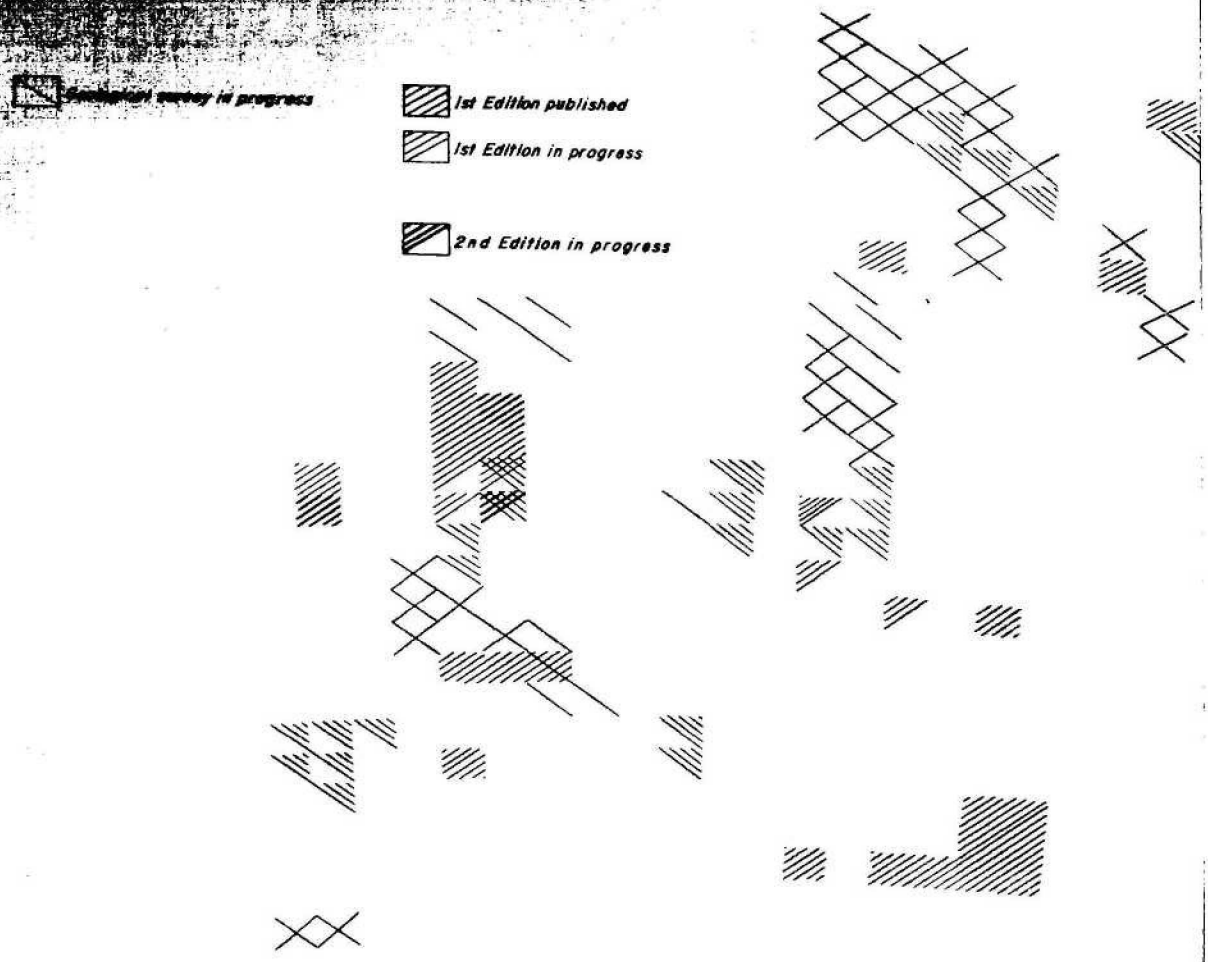


Progress in geological field mapping and series map production in the year ended 31 Oct 1972

CLONCURRY MARRABA MARY KATHLEEN

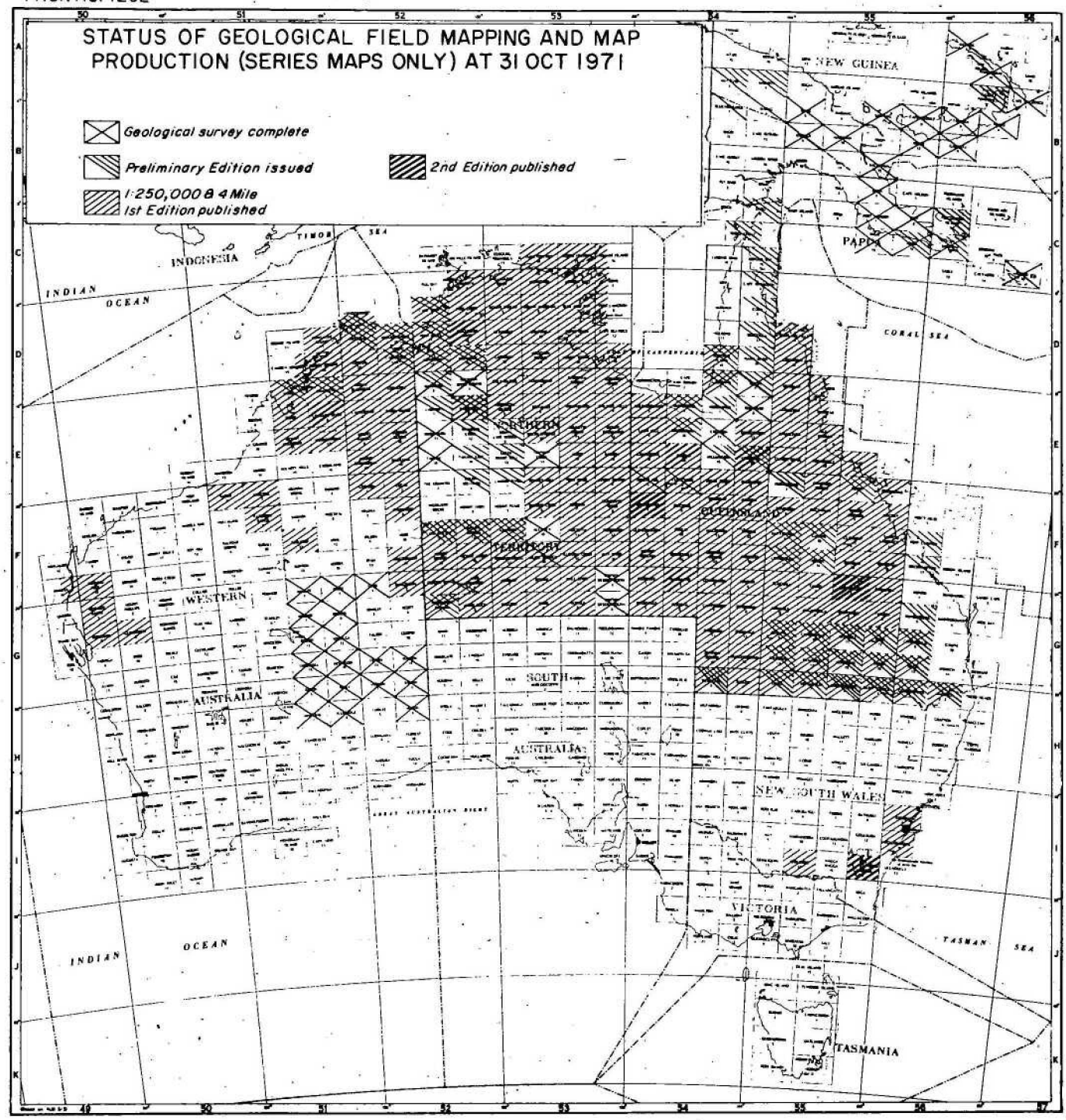
REYNOLDS RANGE MT PEAKE HEDLEYS CREEK NAPPERBY TEA TREE AILERON

1:100,000 GEOLOGICAL SURVEY IN PROGRESS AS AT 31 OCTOBER 1972

NORTH HEAD FORSAYTH SEIGAL TANTANGARA

SS 40-42/2,3,4,6,7,8,11,12

FRONTISPIECE



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

PUBLISHED 1 MILE SERIES MAPS

ALMADEN	BAN BAN	BATCHELOR	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 MT. ISA MARY KATHLEEN MARRABA

1:100 000 PRELIMINARY EDITION ISSUED

YAMPI LEOPOLD DOWNS

ANTARCTICA 1:250000

FIELD WORK IN PROGRESS SR41-42/3, SQ41-42/15

FIELD WORK COMPLETE SR41-42/6,10,11,14,15,16, SR43-44/2,3,5,6 and 9

PRELIMINARY EDITION ISSUED
MAWSON & MOUNT HENDERSON; OYGARDEN & LOWER PROMONTORY

AUS 2/218

FOREWORD

by

J.N. Casey

1972 has seen an expansion of effort in field mapping throughout Australia, Papua New Guinea, and Antarctica, made possible by the stabilized staff position with nearly full establishment, following several years' nett loss of experienced staff to the mining industry and universities.

Twenty-two field parties involving 51 geologists covered regional, detailed, and project-type investigations, and these included joint parties with geologists of the Western Australia and Queensland Geological Surveys. A comparison with the 1971 deployment of staff (in brackets) showed: regional mapping was undertaken by 8 parties with 20 geologists (8 with 17); detail mapping had six parties with 16 geologists (5 with 10); project-type studies had 8 projects with 15 geologists (9 with 14); about 20 per cent of the field staff were involved in reporting previous work.

Even though accounts of ten major projects and eleven explanatory notes were published, 66 Records were issued, and 74 articles appeared or will appear in journals outside the Bureau's series, many manuscripts are still in press or in preparation (in press or with editors - reports on 34 major projects and 28 explanatory notes; in preparation - 24 manuscripts, 28 explanatory notes and 110 Records). However, many of the manuscripts for publication have been issued as open file Records, and about 25 percent of the Records still in preparation will be issued by early 1973.

The 1:25,000 scale colour aerial photographs continue to prove their worth in our detailed mapping. The cost, about $3.50 per square mile, is considered economically justified by the benefits inherent in their use; moreover industry and institutions have purchased copies of the photographs over areas of interest. To date thirty-six 1:100,000 Sheet areas have been flown in colour in the Alice Springs/Napperby, Westmoreland/Mount Isa/Duchess, and Georgetown areas for a cost of $125,000. Side-looking radar (SLAR) has been used in Papua New Guinea and experimental SLAR was flown in the Mount Isa area to provide stereoscopic radar imagery. The Earth Resources Technology Satellite (ERTS) is providing imagery over N-S belts across Australia which will involve us, and other accredited researchers, in comparing the results with known geology and generally providing ground truth.

The provision of planimetric or topographic base maps for plotting geology at the detailed 1:100,000 scale has been a problem, as these are not always available when needed. The base-mapping authority, Division of National Mapping, has alleviated the situation by providing orthophotomaps (OPMs); these are properly controlled mosaics of airphotos, on which the information from conventional or colour photos can be plotted, stereoscopically if required, to produce an accurate map which will fit any later line compilation of the 1:100,000 map series when they become available.

A start was made on the re-examination of the outcrops in the Canning Basin, W.A., in conjunction with a subsurface basin review; this will up-date existing 1:250,000 Sheets and enable previously unpublished sheets to be brought out; the 27 sheets involved will take five years to complete. It is of interest to note that the last (Hughenden) of sixty sheets covering the Eromanga Basin was completed for printing in colour - a project that was started over ten years ago.

A major project was begun on the hydrology of the Great Artesian Basin. The designed A.D.P. system will have computerized geological and hydrological data; the object is to understand the hydrodynamic behaviour of the Basin by preparing a digital mathematical model of the multi-layered aquifer system, and so to assess the water resources and help in water management. Not only has the geological mapping of the Queensland part of the Basin been completed, but a program to log important water bores in that state will finish in 1974; nearly 900 bores have been logged with gamma-ray, half also with temperature, caliper, and flowmeter, and some with resistivity and neutron techniques - the total cost of the bore logging program approaches $1 million over twelve years.

Field geochemistry was expanded in association with detailed mapping in the Tennant Creek, Westmoreland, and Georgetown areas; stream sediments were sampled in the last two areas to determine the regional distribution of trace elements in the various formations to ascertain the backgrounnd or normal response of the rock units; anomalous zones can then be identified. As these detailed projects develop, airborne and ground geophysics will be included to integrate the various disciplines in arriving at the geological truth.

Our field operations continued to be supported by specialists (2 geochronologists, 3 petrologists, 12 palaeontologists); by shallow stratigraphic drilling in soil-covered areas, or in weathered areas to get fresh samples - a total of 5800 metres was drilled; by helicopter charter - 660 hours were flown; and by ship - 130 days at a cost of $110,000 were provided by a variety of ships. An acid laboratory was again taken into the field, to allow micropalaeontologists to provide on-the-spot solutions to stratigraphic problems, and avoid transporting large volumes of rocks back to headquarters.

Geochronology work, using K/A, Rb/Sr, and lead isotopes has been extended by radiocarbon dating by contract of samples from our marine continental shelf, estuary, and Quaternary studies. The studies of modern sediments and sedimentary processes are being extended into the near-shore environment, with an emphasis on heavy mineral deposits.

The application of computers to manipulate geological and geochemical results for contouring, and for solving geological problems has been emphasized; over twenty major operating programs have been written.

A closer interest has been taken in Precambrian fossils; the study of and, hopefully, the stratigraphic application of micro and macro fossils in the excellent sections of unmetamorphosed and undeformed Proterozoic sediments will be emphasized in future. The role of these organisms in any association within syngenetic mineralization is also programmed for study.

Training of our own geologists, both in-house, and by visits overseas, and by introducing visiting specialists, has continued. Courses have been provided for various Colombo Plan students, for university students, and for our geologists in photointerpretation; a course of twenty lectures and practical classes in geology was run for non-professional staff. An excellent practical manual on standards and methods was prepared for our Engineering Geology work as a training and induction guide for our staff.

The effort in Papua New Guinea (PNG) was maintained, with 19 percent of our scientific manpower directed there, including 7 percent from Canberra based staff. Apart from some scattered smaller islands, and the systematic standard series maps of the Papuan Basin, all 1:250,000 Sheet areas will have been mapped in 1973. The 1:1 million map of PNG was issued as a preliminary edition and will appear in colour in mid 1973. A 1:2½ million map showing the distribution of mineral deposits, with accompanying explanatory notes on deposits under commodity groups, is well under way. For the first time, the Rabaul Vulcanological Observatory was staffed with two seismologists, as well as three volcanologists.

An important organizational change came into effect on 1st. September when the professional component of the PNG Geological Survey ceased to form a Section of the Bureau. The Survey is now a division of the PNG Department of Lands, Surveys and Mines. It is, none-the-less, expected that Bureau officers, on secondment to the PNG Public Service, will provide all, or practically all, professional staff of the Survey for some years, and that close co-operation and liaison between the Survey and the Bureau will be maintained.

The rapid urban development of Canberra has resulted in a heavy demand on our engineering geology and hydrology group, which provides consulting services to the Departments of Works and Interior, and to N.C.D.C. It is hoped that a terrain evaluation survey being carried out in conjunction with C.S.I.R.O., over the likely area of Canberra's urban expansion, will provide a basis on which to assess the geology, soils, hydrology, slope stability, formation characteristics, resources, disposal sites, and groundwater conditions ahead of the development. Effort put into Canberra's development involves 7 percent of the total professional staff of the Branch.

The professional attainments for the year have been dampened by the untimely and tragic deaths of three of our colleagues: Tony Taylor, G.C., Gerry Burton, and Charlie Claxton. It will take many years, if ever, for replacements to reach the same standard of competence, integrity, and experience, and the immediate effect of shock and sadness on the rest of the staff will be felt for a long time. Our sympathy and thoughts have been with their families in the loss they have suffered.

SEDIMENTARY SECTION

SEDIMENTARY SECTION

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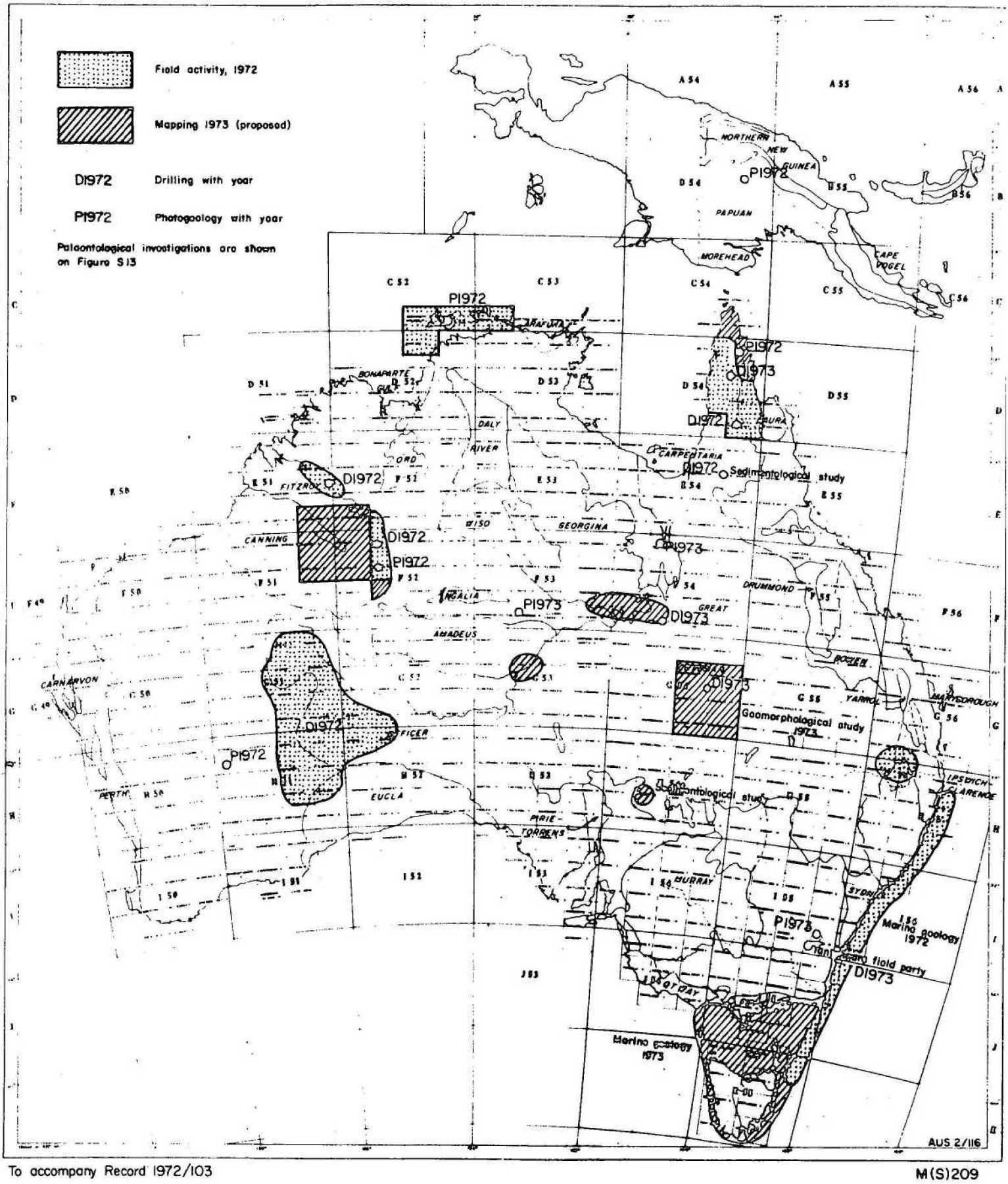

To accompany Record 1972/103

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FIG SO AUSTRALIA AND NEW GUINEA FIELD ACTIVITIES - SEDIMENTARY SECTION

SUMMARY

Fifteen geologists, including four from State Surveys, were engaged full time on regional mapping projects. Field investigations were made in the Carpentaria, Officer, and Canning Basins and were supplemented by shallow stratigraphic drilling in areas of poor outcrop. The project in the Canning Basin, in co-operation with the Petroleum Exploration Branch, is designed to complete the First Edition coverage of the basin and to produce Second Edition maps of those areas where geological knowledge has substantially increased since the previous mapping. Four outstanding 1:250 000 Sheet areas near Darwin, comprising mainly islands and peninsulas, were mapped. Explanatory notes and maps were prepared on two Simpson Desert Sheet areas in the southeast of Northern Territory. The Hughenden Sheet explanatory notes and map were sent to the editor - the last of the Queensland Eromanga Basin sheets to be completed since mapping of the basin began about 15 years ago. Progress was made with synthesizing the regional mapping in the Surat, Central Eromanga, and Ngalia Basins; a three-colour line map of the Surat Basin at 1:1 000 000 scale was issued.

Geological mapping of the Tantangara area, near Canberra continued and that of part of the Hunter Valley, NSW, was completed. Detailed stratigraphic and palaeontological investigations, including drilling, were made in the Lennard Shelf area of the Canning Basin to resolve local problems. Conodonts were found to be very useful in determining age relationships, particularly of the various Devonian reef facies; this work will aid interpretation of the buried reef features revealed in seismic sections. As sulphide mineralization is commonly associated with the reef limestones and nearby rocks, a geochemical and sedimentological study of the various reef facies is planned for 1973.

The team working on the hydrogeology of the Great Artesian Basin, including contract specialists and ancillary staff provided by B.R.G.M., designed an ADP system to manipulate the geological and hydrological data and a start was made transcribing the data from State water authorities. A mathematical model of the basin as a multi-layered aquifer system was designed and tested. The programme of water-bore logging continued; 76, mainly shallow, bores were successfully logged in the Northern Territory part of the Western Eromanga Basin and in the northeastern part of the Eromanga Basin in Queensland.

The reporting of the Bowen Basin Triassic Project and the Blackwater Coal Project was well advanced by the end of the period and both manuscripts should be with the editors by the end of 1972. A detailed examination of the late Cretaceous or early Tertiary Bulimba Formation west of Chillagoe, Queensland, showed it to be a fluvial deposit, in places in-filling valleys cut in older rocks, and that it has been lateritized at least once. The same unit near Weipa contains an important aquifer and is capped by bauxite.

The first two of several planned feasibility studies into possible sedimentological projects were carried out during the year. The first, into heavy mineral sands, indicated the need for more research directed towards the possibility of offshore accumulation. An analysis of eustatic changes and shelf morphology together with offshore drilling in the east coast area are provisionally planned for 1974. The second feasibility study showed that Lake Frome in South Australia would be a suitable internal drainage basin with an arid environment in which to determine if the movement of fluids and sediments could concentrate metals such as zinc, copper, lead and uranium through evaporation or the action of bacteria. A study of the area will be made in 1973 by a combined team from BMR, the Baas Becking Laboratory, and ANU.

Work on the modern estuary studies (Broad Sound, Qld, and Mallacoota Inlet, Victoria) consisted mainly of laboratory work, processing data and reporting, although the Geophysical Branch undertook shallow seismic work and coloured air photography at Mallacoota Inlet. Radiocarbon dating of beach ridges at Broad Sound indicates that a regression due to depositional progradation has occurred there during the last 5000 years but that sea-level has remained stationary during that period.

The marine geological reconnaissance of the eastern Australian continental shelf was extended south from Port Macquarie to the eastern part of Bass Strait from February to mid-May. Bulletins on similar earlier reconnaissances on the northwest shelf and Arafura Sea areas were with the editors by the end of the year.

Studies of Australian evaporites included a detailed petrographic and geochemical investigation of core from the Ringwood area, Alice Springs Sheet area. Field investigations were confined to the Western Australian part of the Officer Basin where the Woolnough Hills diapir was drilled.

The photogeological and remote sensing group was heavily involved in administrative work connected with the Australian Committee for Earth Resources Technology Satellites (ACERTS). Delays have occurred in receipt of imagery from the first satellite ERTS 1, launched in July. Routine photogeological interpretations were carried out of Sheet areas to be regionally mapped in Papua New Guinea, the Northern Territory, and Queensland. Completion of the evaluation of multispectral photography of the Laverton and Leonora areas in Western Australia showed that combined geophysical (aeromagnetic) and photogeological interpretation provided considerably more information than could be interpreted from either technique singly.

More than half the work of the palaeontological group is directed towards assisting current mapping projects. Field visits were made to the two Canning Basin parties and to Bathurst Island, cores from shallow stratigraphic drill holes in the Eromanga and Carpentaria Basins were examined, and many samples from Papua New Guinea were successfully dated.

REGIONAL MAPPING PROJECTS

CARPENTARIA BASIN PROJECT

by

H.F. Doutch

PERSONNEL: H.F. Doutch, J. Smart, S. Powell, D.L. Gibson, (BMR), K. Grimes (GSQ)

The party completed the regional mapping of the Mesozoic and Cainozoic rocks of the Hann River, Ebagoola, Holroyd, Aurukun, Weipa and Cape Weymouth 1:250 000 Sheet areas in Cape York Peninsula, Queensland. Most of Coen Sheet area was also mapped (Fig. S1). A BMR drilling rig put down three holes in the Westmoreland-Lawn Hill area on the western margin of the Carpentaria Basin, and three in the Hann River Sheet area.

The oldest Mesozoic rocks in the peninsula are the Jurassic and early Cretaceous clayey quartzose sandstones and conglomerates (JK1). The sequence is up to 600 m thick, and dips gently west off the Great Dividing Range towards the centre of the basin, beneath the Gulf of Carpentaria. For the most part the beds are continental, but the youngest are probably shallow marine.

In Hann River Sheet area the top at least of the quartzose sandstone sequence is represented by the Gilbert River Formation of the Carpentaria Basin and the approximately equivalent Battle Camp Formation of the Laura Basin; the two formations are one and the same body where the basins meet.

Overlying the quartzose clastics in the Carpentaria Basin are marine mudstones, siltstones and labile sandstones of the Rolling Downs Group (Klr). The Group is about 580 m thick in Z.C.L. Weipa No. 1; it may lie disconformably on the quartzose sandstone sequence. The formations that make up the group in the southern part of the basin cannot be mapped out in the north because of poor outcrop, the apparent absence of the Toolebuc Limestone, and almost total lack of drill holes; however, wireline and lithological logs of Weipa No. 1 suggest that equivalents of the Normanton Formation, Allaru Mudstone and Wallumbilla Formation were laid down in the north. All the formations are marine except possibly the youngest beds of the Normanton Formation, which may be continental.

In eastern Ebagoola Sheet area the Wolena Claystone is the Laura Basin equivalent of the Wallumbilla Formation; it does not crop out but occurs in Cabot-Blueberry Marina No. 1, Crusader Breeza Plains No. 1, and Crusader Lakefield No. 1.

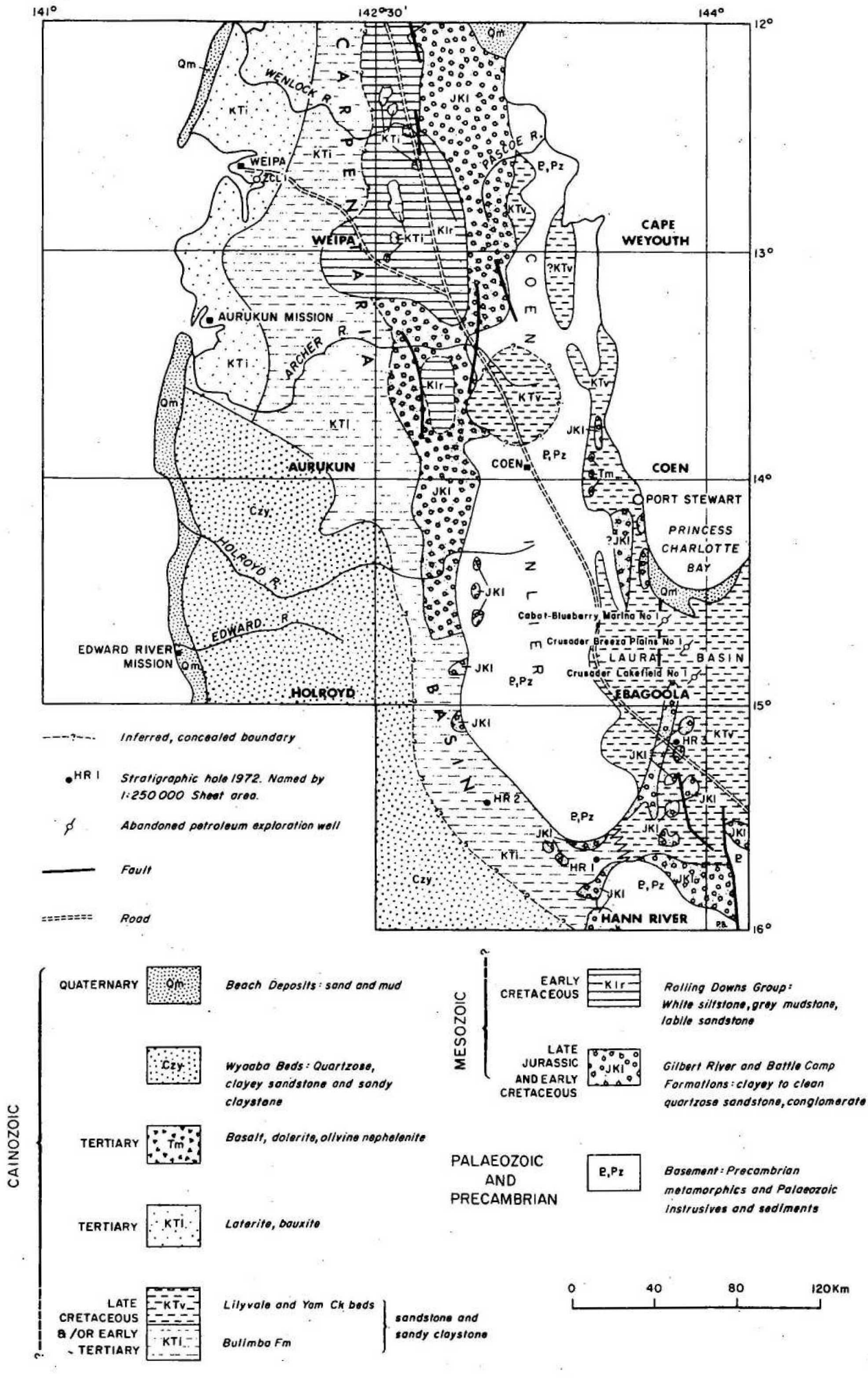


FIG. S1 GEOLOGICAL MAP OF PART OF CAPE YORK PENINSULA

To accompany Record 1972/103

D54/A/6

STRATIGRAPHIC DRILLING RESULTS, WESTERN CARPENTARIA BASIN, 1972.

TABLE S1.

Hole/ Location/ Rig	Elevation and Total Depth	Wireline Logs	Section Penetrated (Formation Tops)	Coring and Recovery %	Objectives	Results	Comments
WESTMORELAND No. 2 G.R. 140769 yd Mayhew 1000	52 m 207.6 m	Gammalog to 207.6m	0 Soil and ferricrete 1.8 Floraville Fmn. 39.6 Allaru Mudstone 70.1 Toolebuc Limestone 91.4 Wallumbilla Fmn. 202.7 Basement (Shale) 207.6 T.D.	8 cores 21.6m cored 14.7m recovered 68% recovery	To find whether the Toolebuc Limestone or Gilbert River Fmn equivalents are present at this locality and to find the depth to and the nature of the basement	Both the Toolebuc Limestone and basement were intersected, and cores were taken of each. No Gilbert River Fmn. equivalents are present.	The thickness of the Mesozoic section was far greater than expected.
WESTMORELAND No. 3 G.R. 119808 yd (Jam Tin Yards) Mayhew 1000	44 m 196.3 m	Gammalog to 196.3m	0 Soil and ferricrete 1.5 Floraville Fmn. 18.3 Allaru Mudstone 52.4 Toolebuc Limestone 71.0 Wallumbilla Fmn. 182.9 Basement (?volcanics) 196.3 T.D.	2 cores 4.6m cored 2.5m recovered 53% recovery	To find whether the Toolebuc Limestone or Gilvert River Fmn equivalents are present at this locality and to find the depth to and the nature of the basement	Both the Toolebuc Limestone and basement were intersected and a core was taken of the basement. No Gilbert River Fmn. equivalents are present.	The thickness of the Mesozoic section was far greater than expected as basement outcrops several km from the drillsite
LAWN HILL No. 3 G.R. 164685 yd Mayhew 1000	48.7 m	No logs	0 Alluvium 21.3 Wallumbilla Fmn. 44.7 Basement (?Shale) 48.7 T.D.	6 cores 13.9m cored 13.5m recovered 97% recovery	To find whether the Toolebuc Limestone or Gilbert River Fmn equivalents are present at this locality and to test for groundwater	Neither formation is present, nor is there any groundwater. The nature of the contact between the mudstone and basement was found	Drilling proved a coastal embayment during Wallumbilla Fmn. times

In late Cretaceous and/or early Tertiary times erosion of Mesozoic and older rocks after moderate uplift resulted in an ancestral Great Dividing Range with a topography much like it is at present. The valley fill and piedmont plain deposits of the Bulimba Formation and equivalent Lilyvale and Yam Creek Beds reduced relief by Pliocene times. These formations are clayey and quartzose, in places arkosic, and are up to 100 m thick. Their tops are commonly ferruginized or silicified; in the Weipa and Aurukun Sheet areas bauxite overlies ferruginized Bulimba Formation (Fig. S1).

The Bulimba Formation, its equivalents, and older rocks were eroded in late Cainozoic times, and the clayey quartzose sediments produced were deposited as the continental Wyaaba Beds west of the Great Dividing Range, in the Holroyd and Hann River Sheet areas, where the unit may be up to 100 m thick. To the east of the range no equivalents of the Wyaaba Beds have been recognized, but they may be present east of the coast.

At present the Great Dividing Range and the country west of it shown in Fig. S1 is being eroded, although colluvial sand is widespread. East of the range river distributaries are depositing wide thin spreads of clayey and silty alluvia.

Below the eastern scarp along the Great Dividing Range, between Coen and Port Stewart, a north-south line of low hills of basalt, dolerite and olivine nephelenite may mark a fault or faults. Due south of these hills hot water springs in a tributary of the Annie River appear to be part of the same complex, which probably reflects Cainozoic activity of the Palmerville family of faults.

A BMR Mayhew 1000 rig was used to drill Westmoreland 2 and 3 and Lawn Hill 3 on the western margin of the Carpentaria Basin. They demónstrated existence of the Toolebuc Limestone well north of the most northerly outcrop in the area, and absence of the Gilbert River Formation between the Wallumbilla Formation and basement, similar to relationships further south. On the eastern margin of the basin Hann River 2 penetrated Bulimba Formation and Cretaceous mudstone. Hann River 1 demonstrated continuity of the Gilbert River Formation of the Carpentaria Basin with the Battle Camp Sandstone of the Laura Basin. Hann River 3 penetrated Lilyvale Beds and Battle Camp Sandstone on the eastern margin of the Laura Basin. Results of drilling in the eastern area are summarized in Table S1; positions of the Hann River holes are shown on Fig. S1.

CENTRAL EROMANGA BASIN PROJECT

by

B.R. Senior

PERSONNEL: B.R. Senior

A synthesis of the geology of the Central Eromanga Basin was started and 10 plates and 15 figures were completed. The area comprises twenty 1:250 000 Sheet areas in southwest Queensland; the remainder of the geological maps and explanatory notes on these areas were published during the year (see 'Publications and Records' section). A plate of eleven geological sections is being prepared using an experimental computer programme designed to arrange the sections in two point perspective.

WESTERN EROMANGA BASIN

by

A. Mond

PERSONNEL: A. Mond, A.N. Yeates (to May)

The results of the 1970 shallow stratigraphic drilling in the southwestern part of the Eromanga Basin in South Australia were issued as a Record (1972/27). The drilling was done in conjunction with a joint BMR-South Australian Department of Mines regional mapping project aimed at producing geological maps of the Gason and Pandie Pandie 1:250 000 Sheet areas. The maps and the explanatory notes are being published by the South Australian Department of Mines.

The fifteen shallow stratigraphic holes drilled in the Gason and Pandie Pandie Sheet areas showed that Winton Formation underlies most of the Gason and the southeastern part of the Pandie Pandie Sheet areas, and that it consists of a freshwater sequence of lithic sandstone, siltstone, mudstone and minor coal, and that Tertiary quartz sandstone up to 35 m thick is present in both Sheet areas.

The results of the 1971 reconnaissance geological mapping of the Northern Territory part of the Eromanga Basin were used to compile the Simpson Desert North and Simpson Desert South 1:250 000 Geological maps and Explanatory Notes. The units penetrated in four shallow stratigraphic holes in the Hay River 1:250 000 Sheet area were described (Record 1971/120).

The Simpson Desert North and Simpson Desert South Sheet areas are sand-covered except for a few outcrops of Cretaceous and younger units. An interpretation of the geology based on petroleum exploration wells, geophysical data, and the geology of adjacent areas (Fig. S2) is given below.

Precambrian rocks, mostly gneiss and schist, and similar to those of the Arunta and Musgrave Complexes, are inferred to be present beneath much of the area. A sequence of volcanic rocks intersected in Amerada Hale River 1 (Fig. S2) includes volcanic conglomerate, tuffaceous agglomerate, interbedded basalt with feldspathic dykes and possible andesite sills. The southeastern part of the Simpson Desert South Sheet area is characterized by low intensity circular aeromagnetic anomalies that could indicate a basement of low grade metamorphic rocks of low magnetic contrast and possibly of Lower Palaeozoic to Proterozoic age.

Devonian to Carboniferous sediments (Finke Group) in Amerada Hale River 1 were probably deposited towards the edge of the stable southern margin of the Amadeus Basin.

Permian rocks form a northern extension of the Pedirka Basin and wedge out against Precambrian basement. The thickest successions coincide with depressions in the Precambrian basement and the thinnest with Precambrian highs. In the southwestern part of the Simpson Desert South Sheet area about 500 to 600 m of Permian is present. In Amerada Hale River 1 it consists of fine to coarse-grained sandstone interbedded with coal, siltstone and conglomerate. Some coal seams in the upper part of the unit are prominent seismic reflectors.

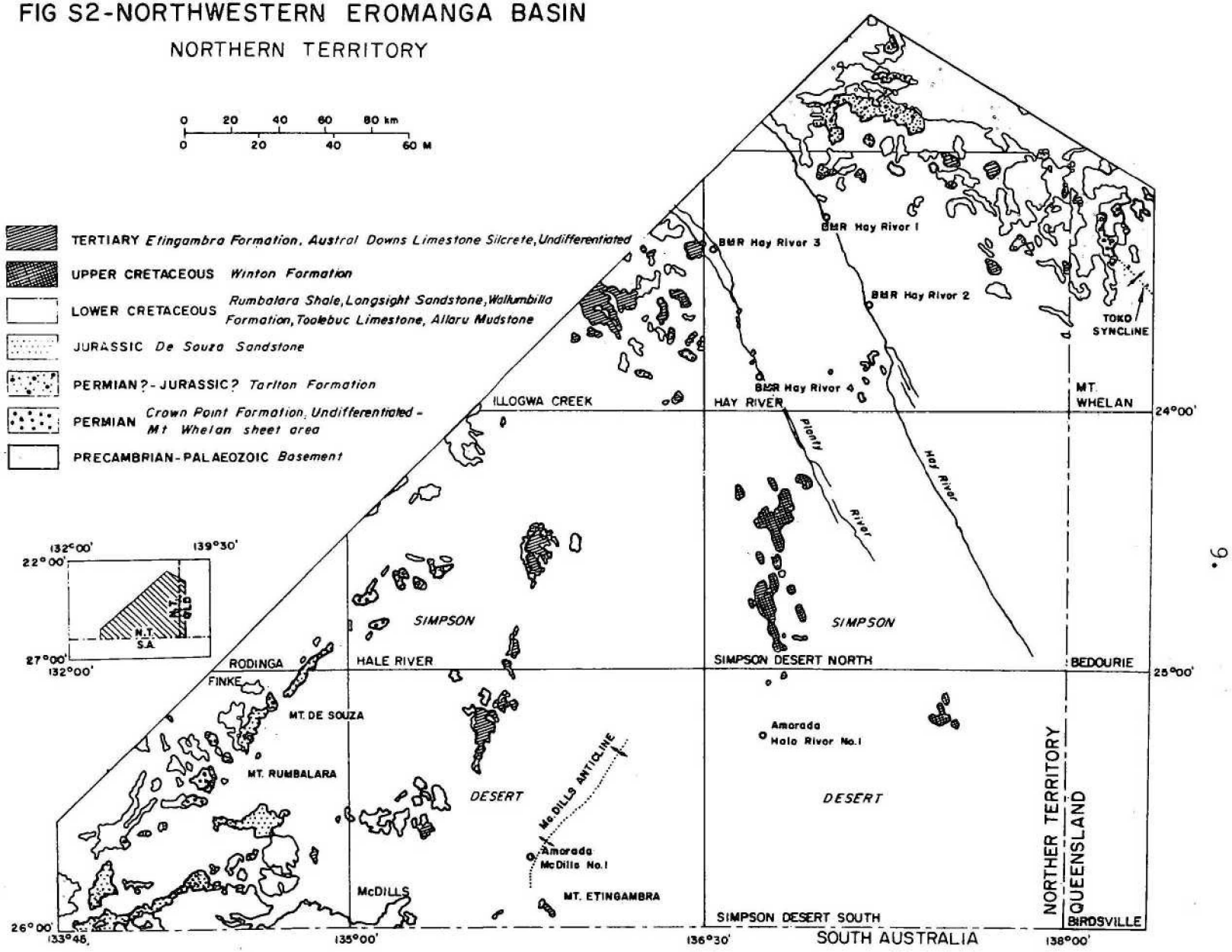
The Jurassic to Lower Cretaceous sequence can be subdivided in the south into a lower part consisting mostly of porous, white and pale brown, fine to coarse-grained, poorly sorted sandstone, in part pebbly, and rare thin beds of grey carbonaceous shale and coal and an upper part of light greyish white, fine to coarse-grained, calcareous sandstone, interbedded with light grey shale. The lower part of the sequence can be correlated with the Algebuckina and De Souza Sandstones, the main aquifers in the western part of the Eromanga Basin, and the upper part with the Cadna-owie Formation. This division is less apparent towards the north, closer to the basin margin, and in BMR Hay River 2, 3 and 4 where the sequence more closely resembles the Longsight Sandstone.

The Lower Cretaceous Wallumbilla Formation in the area consists mostly of glauconitic and calcareous shale, siltstone and fine-grained sandstone. It thins towards the northern margin of the basin and pinches out north of the Simpson Desert North Sheet area.

The Toolebuc Limestone forms a useful widespread marker horizon, between the Wallumbilla Formation and the overlying Allara Mudstone. In thesubsurface it can be recognized in most places by high radioactivity on gamma-ray logs. In Amerada Hale River 1 the gamma-ray anomaly is not as well developed as in the wells and bores to the east (e.g. FPC The Brothers 1) and south (e.g. FPC Purni 1), and it was not found in the shallow stratigraphic holes in the Hay River Sheet area. It is therefore inferred to pinch out across the Simpson Desert North Sheet area.

FIG S2-NORTHWESTERN EROMANGA BASIN

NORTHERN TERRITORY



To accompany Record 1972/103

NT/A 365

The Allaru Mudstone was deposited towards the end of marine sedimentation in the Eromanga Basin. It is overlain by Winton Formation, a widespread continental deposit mainly of lithic sandstone, siltstone and mudstone.

Coarse-grained, fluvial sandstone resting disconformably on the weathered and uneven surface of the Winton Formation is probably Tertiary. The sandstone is commonly altered to silcrete. Probably younger green, fine-grained sandstone, green and yellow mudstone and siltstone, and layers of gypsum in the northwestern part of the Simpson Desert North Sheet area are in places altered to silcrete and ferricrete.

Extensive Quaternary longitudinal sand dunes cover most of the area. They are up to 300 km long, trend at 334°, are straight and evenly spaced, and are mostly about 400 m apart.

SURAT BASIN PROJECT

by

N.F. Exon

PERSONNEL: N.F. Exon

Outstanding information arising from the regional mapping of the Queensland part of the Surat Basin area was compiled as Records, Explanatory Notes and Maps and a start made with preparing a Bulletin synthesizing the geology of the Basin.

Fourteen shallow stratigraphic holes drilled in the Jurassic and Cretaceous of the eastern Surat Basin were described (Record 1972/54). Mineralogical study of the cores showed that some Mesozoic labile fluvial sands had been weathered during deposition, resulting in a sandstone consisting of quartz and clay in about equal porportions. Green, round phyllosilicate grains in the Lower Cretaceous Bungil Formation, normally described as glauconite because of their morphology, which are identical in appearance to grains common throughout the Rolling Downs Group and are believed to be marine indicators, are montmorillonite, not glauconite.

The Surat Basin sediments onlapping the western side of the Texas High and Kumbarilla Ridge, and the Ipswich-Moreton Basin sequence east of the Kumbarilla Ridge, and their relationship to each other were described (Record 1972/53 - The post-Palaeozoic rocks of the Dalby-Goondiwindi area). The Record described the Cecil Plains Syncline, a western extension of the Ipswich-Moreton Basin, in which 1000 m of Triassic volcanics and coal measures are overlain by 700 m of Lower Jurassic freshwater sediments.

On a short field trip to the Esk Valley it was noted that the Triassic Neara Volcanics are dominantly andesitic boulder beds. Thus they differ markedly from the Triassic volcanics, mainly acid lavas and tuffs, penetrated deep in the Cecil Plains Syncline, and ascribed to the Neara Volcanics by some workers.

Explanatory Notes on the Dalby and Goondiwindi 1:250 000 Sheet areas were edited and nomenclature brought up to date; the remaining outstanding notes and 1:250 000 maps of the Surat Basin are either published or in press.

Report 140 "The post-Palaeozoic rocks on the Warwick Sheet area", essentially an up-dated version of Record 1969/80, was prepared and submitted for editing.

Information on the Tertiary Lamington Volcanics of the McPherson Ranges, acquired during the regional mapping, was issued (Record 1972/17). The work shows that the previously assumed basalt-rhyolite-basalt subdivision of the 1000 m-thick late Oligocene to early Miocene Lamington Volcanics is not applicable throughout the whole outcrop area, the middle division being absent in some areas and showing rapid thickness changes in others.

A draft paper, written jointly with GSQ geologists, introduced new nomenclature for parts of the Jurassic Injune Creek Group in the Roma area where the sequence, from bottom to top, is (Hutton Sandstone), Eurombah Formation, Walloon Coal Measures, Springbok Sandstone, Norwood Sandstone Member of the Westbourne Formation, undivided Westbourne Formation, (Gubberamunda Sandstone).

The synthesis of the Queensland part of the Surat Basin will include detailed sedimentological studies of particular sequences. The emphasis will be on Jurassic to Cretaceous rather than the underlying Permo-Triassic sequence. Descriptions of units will be complemented by well-correlation diagrams, structure-contour maps, and isopach maps. The sedimentological studies will result in a clearer appreciation of the palaeogeography, palaeoenvironments, and provenances.

A 1:1 000 000 scale preliminary geological map of the northern Surat Basin was compiled and issued. The cross-sections illustrate the southerly thinning of Permian and Triassic sequences in the meridional Mimosa Syncline: Permian = 2000 m maximum, Triassic = 2000 m east of Roma; Permian = 400m, Triassic 1000 m, west of Moonie; Permian = 100 m, Triassic = 300 m, west of Goondiwindi. Thus Triassic subsidence of the Taroom Trough extended farther south than Permian subsidence.

Several correlation diagrams, and structure-contour and isopach maps have been prepared and water bores suitable for contract wireline logging in 1973 selected. Preliminary clay mineral analyses have shown that montmorillonite is generally dominant in the Surat Basin sequence, but that kaolinite predominates in aquifers. It is probable that the montmorillonite was produced largely by slow leaching, in temperate conditions, of granitic and metamorphic source rocks. In aquifers the montmorillonite altered to kaolinite soon after deposition.

OFFICER BASIN PROJECT

by

M.J. Jackson

PERSONNEL: M.J. Jackson, P.J. Kennewell (BMR), W.J.E. van de Graaff, J.C. Boegli (GSWA)

Between November 1971 and April 1972, the party reported on the results of the systematic mapping done in the 1971 field season (Record 1972/66) and commenced production of the twenty 1:250 000 geological map sheets covering the Western Australian part of the Basin. Eight sheets were completed to preliminary stage and photo-interpretation of a further four finished. Van de Graaff published a paper on the sedimentology of the Wanna Beds (see Outside Publications).

Stratigraphic drilling was carried out from May to December 1972 and detailed mapping from May to October. The objectives of the drilling were -

1) to provide hydrological information for the Western Australian Mines Department in the southwestern part of the basin. This forms part of a project aimed at evaluating the groundwater potential of the basin sediments east of Laverton for possible utilization by the developing mineral industry of the NE Goldfields Division.

2) to provide more stratigraphic information on the Mesozoic and Palaeozoic rocks that crop out in many parts of the basin. Details of thicknesses, lithologies, contact relationships and superposition of units were required to supplement the meagre surface information available and to elucidate the stratigraphy and structure more fully.

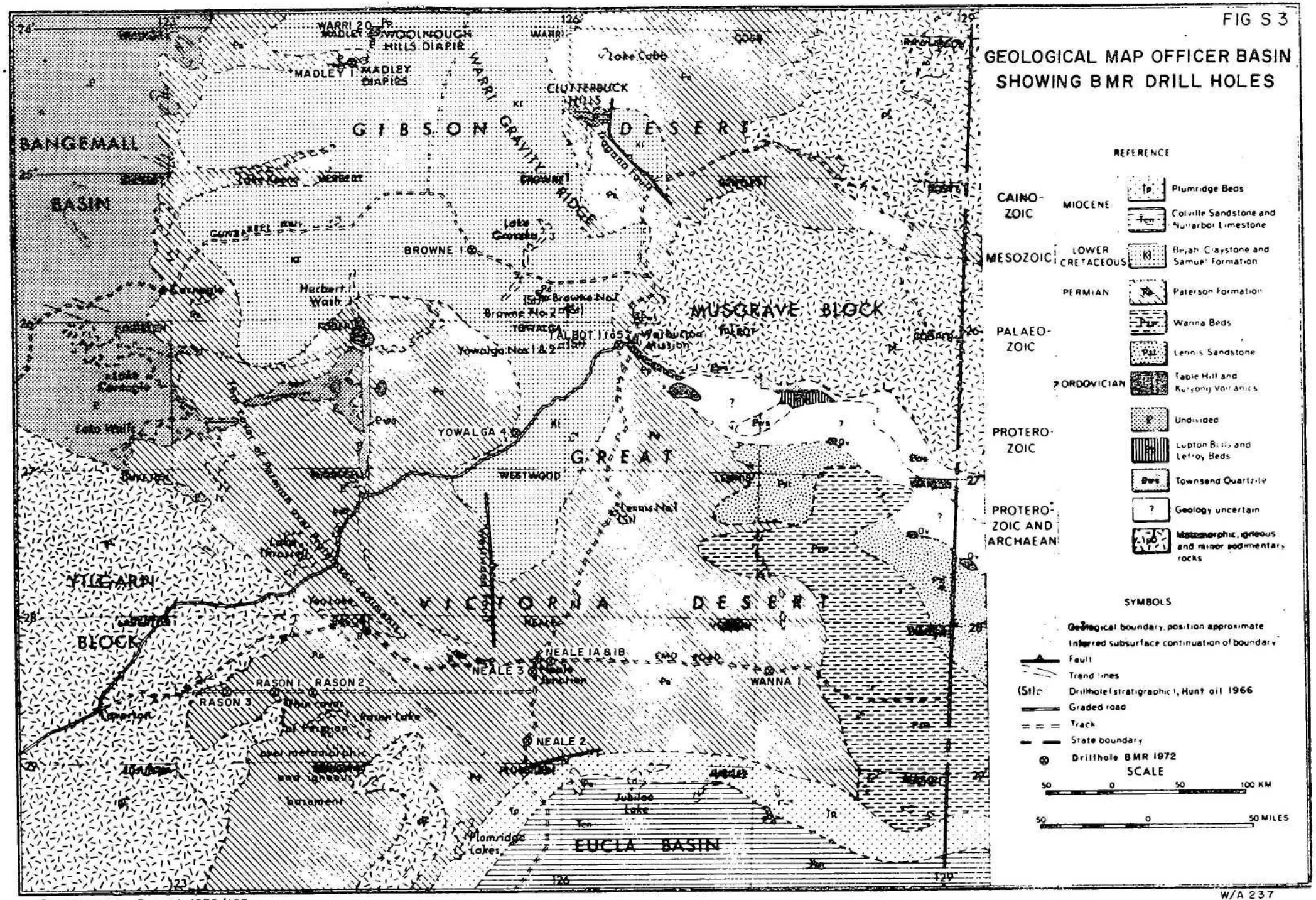
3) to establish, by closely-spaced in-line drilling, rock sequences in the very poorly exposed ?Adelaidean sediments on the southwestern and northeastern margins of the basin. This is to enable a more accurate definition of the basin to be made to allow comparison with the Proterozoic sequences in the Officer Basin in South Australia and adjoining sedimentary basins.

The drilling programme was successful and all the objectives were fulfilled despite many logistical problems. A lack of water for both drilling and camp use was the most serious, despite pre-field season investigations which indicated readily accessible ground water supplies at most of the proposed drillsites. At the end of September 1972, 15 holes had been drilled with a total depth of 1301 m. A total of 190.8 m of coring was done with a recovery of 154.7 (81%). A summary of the stratigraphic drilling completed up to the end of September is contained in Table S2.

BMR Rason 1, 2 and 3 were drilled in the southwest of the basin (Fig. S3) primarily for hydrological purposes. A resistivity survey interpretation indicated that water-saturated sediments filled depressions in the basement there. The average depth to

FIG S 3

GEOLOGICAL MAP OFFICER BASIN SHOWING BMR DRILL HOLES



REFERENCE

CAINOZOIC	MIOCENE	Tp	Plumridge Beds
		Tcn	Colville Sandstone and Nullarbor Limestone
MESOZOIC	LOWER CRETACEOUS	K	Bejah Claystone and Samuel Formation
PALAEOZOIC	PERMIAN	Pa	Paterson Formation
		Pw	Wanna Beds
		Pel	Lennis Sandstone
	? ORDOVICIAN		Table Hill and Kurrajong Volcanics
PROTEROZOIC		P	Undivided
		Pr	Lupton Beds and Lefroy Beds
		Pts	Townsend Quartzite
PROTEROZOIC AND ARCHAEAN		?	Geology uncertain
			Metamorphic, igneous and minor sedimentary rocks

SYMBOLS

- Geological boundary, position approximate
- Inferred subsurface continuation of boundary
- Fault
- Trend lines
- (St)c Drillhole (stratigraphic), Hunt oil 1966
- Graded road
- Track
- State boundary
- Drillhole BMR 1972

SCALE

50 0 50 100 KM

50 0 50 MILES

To accompany Record 1972/103

W/A 237

TABLE 57 SUMMARY OF STRATIGRAPHIC DRILLING OFFICER BASIN, W.A., 1972.

Hole Number	Position (Lat.S. - Long.E)		Total depth m	No.of cores	Length cored m	Recovery m	Recovery %	Wireline logs run				Well site geologist	Results/Remarks	Status
BMR Rason 1	28°33.5'	123° 47.5'	69.5	1	3.0	1.5	50	Gr	-	-	-	Jackson	Paterson formation 10 to 44 m then into basement, hole dry.	cased 2" pipe to T.D.
BMR Rason 2	28° 33.3'	124° 02.3'	148.6	5	9.6	6.8	70	GR	PR	NR	-	Jackson	Paterson Formation 0 to 144 m then into basement; hole dry.	cased 2" pipe to T.D.
BMR Rason 3	28° 33.3'	123° 29.8'	74.3	0	0	0	0	GR	PR	-	-	Graaff	Paterson Formation 0 to 31 m then into basement; hole dry.	cased 2" pipe to T.D.
BMR Neale 1A	28° 18.0'	125° 56.3'	66.9	0	0	0	0	-	-	-	-	Graaff	Paterson Formation throughout, hole abandoned continued in Neale 1B.	open abandoned
BMR Neale 1B	28° 18.0'	125° 56.3'	234.5	4	6.9	5.7	83	GR	PR	-	SP	Boegli	Paterson Formation overlying Nanna Beds, overlying Lennis Sandstone.	cased 3" pipe to T.D.
BMR Neale 2	28° 47.9'	125° 45.0'	73.5	1	3.0	3.0	100	GR	PR	NR	SP	Boegli	Lithology and thickness of Plumridge Beds	open abandoned
BMR Neale 3	28° 18.8'	125° 49.2'	38.3	0	0	0	0	GR	-	-	-	Graaff	Paterson Formation throughout. Drilled for water supply but hole dry.	open abandoned
BMR Wanna 1	28° 22.0'	127° 38.0'	155.0	3	8.3	4.3	52	GR	PR	NR	SP	Boegli	Paterson Formation overlying Wanna Beds. Wanna Beds thicker than 100 m.	open abandoned
BMR Yowalga 4	26° 49.5'	125° 37.3'	43.4	11	29.3	25.3	86	GR	PR	-	SP	Boegli/Jackson	Continuous core through suspected Samuel Formation, Paterson Formation.	open abandoned
BMR Talbot 1	26° 09.2'	126° 32.5'	33.0	2	4.6	2.0	43		N.A.			Boegli	Recent deposits overlying Townsend Quartzite dipping at 25° to 30°	"
BMR Talbot 2	26° 09.4'	126° 32.3'	13.7	1	3.0	2.7	90		N.A.			Boegli	Recent deposits overlying ?Lupton Beds	"
BMR Talbot 3	26° 09.6'	126° 32.1'	77.1	2	4.1	3.8	93		N.A.			Boegli	Recent deposits overlying thin Paterson Formation overlying Proterozoic siltstones dipping at 25 - 30°.	"
BMR Talbot 4	26°09.8'	126° 31.8'	69.5	1	2.6	2.1	81		N.A.			Boegli	as above	"
BMR Talbot 5	26° 10.0'	126° 31.5'	95.0	1	2.1	2.1	100		N.A.			Boegli	as above	"
BMR Browne 1	25° 32.4'	125° 17.0'	121.9	39	114.3	95.4	84		N.A.			Boegli/Cope	Continuous core through Samuel Formation; contact with Paterson Formation intersected, core in upper part of Paterson Formation.	"

N.A. - Information not yet available: GR - gamma ray: PR - point resistivity: SP - spontaneous potential: NR - normals resistivity.

basement in the area was interpreted at about 90 m and Rason 1, 2 and 3 were sited over depressions with interpreted depths of 240 m, greater than 150 m, and 150 m respectively. All holes were dry, and they intersected igneous or metamorphic basement at 44 m, 144 m, and 31 m respectively.

BMR Neale 1, 2 and 3 and Wanna 1 were drilled in the south of the basin (Fig. S3) to provide stratigraphic information on the Palaeozoic sediments that crop out intermittently on the Lennis, Waigen and Wanna Sheet areas to the north and east. Neale 1 was drilled to 205 m and intersected Paterson Formation (0-60 m), Wanna Beds (60-140 m) and Lennis Sandstone (140-205m). This drillhole represents the first section through this sequence and confirms the superposition of units that was indicated by the 1971 mapping. The top of the Lennis Sandstone is at a higher elevation than in Hunt Oil Well Lennis 1. Dolomite and silicified oolite (probably Proterozoic) crop out 40 km west of Neale 1. This information indicates that the deepest part of the basin probably lies to the north of the Neale and Vernon Sheet areas. BMR Wanna 1 intersected a sequence of claystone and fine-grained sandstone which is tentatively regarded as Wanna Beds.

BMR Neale 2 was drilled through the Plumridge Beds, a Lower Miocene fluviatile to paralic sandstone, claystone and conglomerate unit, along the northern margin of the Eucla Basin, to provide information on the lithological succession and material for palaeontological examination.

BMR Yowalga 4 and Browne 1 were continuously cored in the central part of the basin (Fig. S3) to try to establish accurately the nature of the contact between the Cretaceous Samuel Formation and the underlying Permian Paterson Formation. The junction of the two units is uncertain at outcrop as they are lithologically similar and deeply weathered also. In Browne 1, the appearance of glauconite, bioturbation and an increase in the sorting of the sediments, between 96 and 100 m, is interpreted as marking the basal Cretaceous marine transgression. Lithologies in the upper 4 to 5 m of the Paterson Formation and lower 5 m of the Samuel Formation are otherwise similar. The actual contact probably occurs in an interval of core loss. Comparison of lithologies in Browne 1 and Yowalga 4 suggests that the latter was spudded into the top of the Paterson Formation and not into Samuel Formation as first thought. The information obtained, therefore, indicates that accurate differentiation between the upper part of the Paterson Formation and lower part of the Samuel Formation will only be possible where the original sedimentary texture and mineral composition have not been markedly altered since lithification.

In-line shallow drilling southwest of Warburton to provide information on the ?Adelaidean sediments overlying the Townsend Quartzite was attempted by BMR Talbot 1 - 5. - were drilled at 600 m spacing and bottom hole cores were obtained in all holes at depths of 33, 14, 77, 70 and 95 m respectively. The core in Talbot 1 (0.8 km from the outcrop of the Townsend Quartzite) is Townsend Quartzite dipping at 25°-30°. The remaining holes bottomed in red, green, and grey claystone, siltstone and minor sandstone. The cores provide stratigraphic information at about 1,000 m spacing in the lower 6,000 m of the ?Adelaidean sequence overlying the Musgrave Block along the northeast margin of the basin. Although this information is of a very limited nature it may allow broad comparisons with better exposed sequences in the South Australian part of the Officer Basin.

A most important result of the follow-up mapping in 1972 was the recognition of the Townsend Quartzite along the eastern edge of the Robert Sheet area (Fig. S3), and marking the western edge of the basin. Outcrops of Officer Volcanics and probable Lennis Sandstone were found to the east (i.e. basinward) of the poorly defined outcrop belt of the Townsend Quartzite; an identical pattern to that found along the northeast margin of the basin. Rocks immediately overlying the Townsend Quartzite were not found, so shallow in-line drilling was undertaken in the northwest corner of the Westwood Sheet area to probe for equivalents of the Lefroy Beds and Lupton Beds that overlie the Townsend Quartzite in the Warburton area.

Detailed laboratory investigations are being undertaken to supplement the field information gathered. Stromatolites collected from the lower 10 m of the Bangemall Basin sediments on the western edges of the Throssell and Robert Sheet areas, and from diapiric intrusions within the basin, are being examined and described by W.V. Preiss of the South Australian Mines Department, Adelaide. Radiometric dating of glauconitic sandstone collected from the same sequence is planned for comparison with the ages obtained from the stromatolites.

Radiometric dating of the Officer, Table Hill and Kulyong Volcanics, was commenced in 1972 by W. Compston of the Australian National University.

NORTHEAST CANNING BASIN PROJECT

by

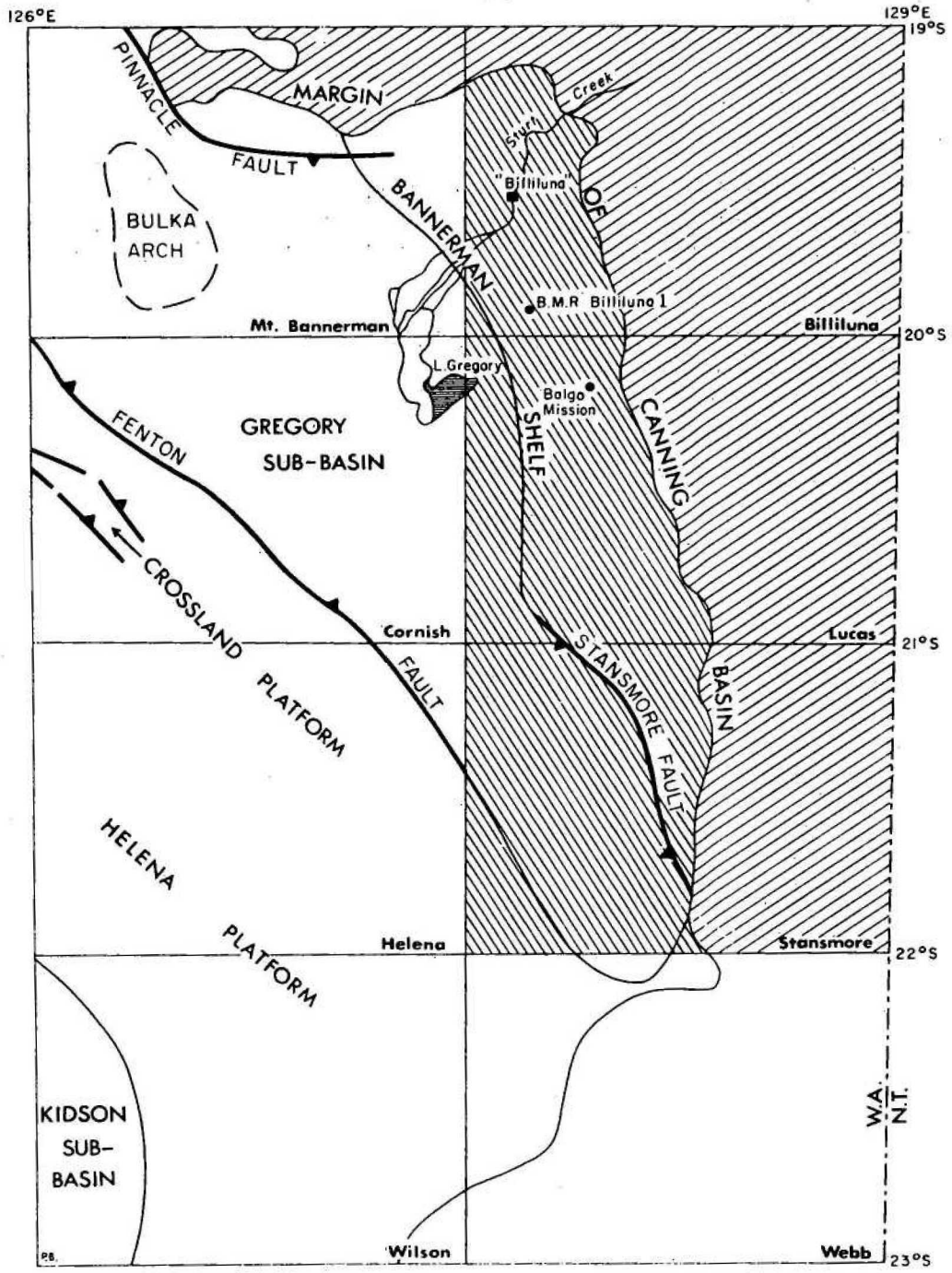
A.N. Yeates

PERSONNEL: BMR - A.N. Yeates, Miss V.L. Passmore, B.M. Radke (March-April), A.T. Wells (June), J.M. Dickins (25 July - 4 August). GSWA - R.W.A. Crowe.

The prime objective of the survey was to resume mapping of the Canning Basin, W.A. by revising the Phanerozoic geology of the Billiluna, Lucas, and Stansmore 1:250 000 Sheet areas in the northeastern part of the basin (see Fig. S4). The Granites-Billiluna Party mapped the Proterozoic geology (see Metalliferous Section) of these areas. Second edition maps and Explanatory Notes will be produced jointly by the two parties.

Preliminary photo-interpretation of the area (March and April) preceded fieldwork (May to September). Remote areas were visited by helicopter (78 hours flying time) and one shallow stratigraphic hole was drilled (BMR Billiluna 1) to 135 m.

The area is being actively prospected for petroleum and company geologists visited the party in the field.



Area mapped by Northeast Canning Basin Party

Part of area mapped by Granites-Billiluna Party (Metalliferous Section)

FIG. S4 TECTONIC MAP OF NORTHEAST CANNING BASIN SHOWING AREA MAPPED

Regional Geology

The Canning Basin contains dominantly Ordovician to Cretaceous, marine and non-marine epiclastic sedimentary rocks deposited within an intracratonic basin. In the northeast, the oldest rocks, lower Ordovician sandstone, are exposed on the Billiluna Sheet area. They unconformably overlie a folded Proterozoic quartzite basement, and are probably unconformably overlain by Upper Devonian sandstone. Carboniferous units are probably present in the subsurface but are most likely overlapped by Permian units around the basin margin.

The oldest Permian formations are fluvial sandstones (fluvioglacial elsewhere) which are overlain by a sequence dominated by marine shales and siltstones. The youngest Permian rocks in the area indicate a return to fluviatile deposition.

A low-angle regional unconformity separates the Palaeozoic formations from the Mesozoic rocks. Triassic, possible Jurassic, and Cretaceous rocks occur in the Mesozoic sequence, but are relatively thin (Table S3) and cover a relatively small area.

The major tectonic elements in the area are the Bannerman Shelf, the Gregory Sub-basin and the Crossland Platform (Fig. S4). The Stansmore Fault separates the Bannerman Shelf from the Gregory Sub-basin, an easterly extension of the Fitzroy Trough. The edge of the Crossland Platform appears in the extreme southwest of the Stansmore Sheet area and is separated by the Fenton Fault from the Gregory Sub-basin.

Results

The revised stratigraphy is shown in Table S3 and the rock relationships in Fig. S5. Previously unmapped Permian and Mesozoic units were found and the distribution of others modified. The Poole Sandstone (Permian) was found to extend into the Billiluna and Stansmore Sheet areas and the Nura Nura Member of the Poole Sandstone was recorded in anticlinal cores on the eastern edge of the Stansmore Fault. Previously unrecorded post-Permian sedimentary rocks were discovered in the Lucas and Stansmore Sheet areas. Some have been ascribed to the Godfrey Beds and the Hazlett Beds; others are probably equivalents of the Culvida Sandstone to the west.

A new stratigraphic name has been proposed for the Ordovician sandstone ("Billiluna Beds") and the previously informally named "Upper Devonian to Lower Carboniferous Knobby Sandstone" is being formalized; its age appears to be wholly Upper Devonian, based on fish faunas identified by G. Young.

Most sedimentary units show features characteristic of shallow marine, inter-tidal and terrestrial sedimentation.

Many plant and animal macrofossil collections were made from new localities and these should enable accurate dating to be made of several units.

TABLE S3 STRATIGRAPHY OF THE NORTHEAST CANNING BASIN

Age	Formation and Map Symbol	Thickness in Metres	Lithology	Fauna or Flora	Environment of Deposition	Economic Geology
Quaternary	Qa	10±	Silt, sand and gravel.		Fluvial	Some aquifers.
	Qs	5±	Sand surrounding drainage areas.		Outwash and channel floodout.	
	Qz	20±	Fine sand, dune sand		Aeolian, desert	Possible aquifer if underlain by impermeable beds.
	Qe	1	Evaporites - gypsum, caliche		Desert, salt lake.	
Undifferentiated Cainozoic	Czt	3±	Travertine (calcrete or kunkar)		Evaporitic lakes, floodouts and groundwater seepage deposits.	Excellent aquifer if encountered beneath water table.
	Czl	10±	Laterite		Fossil soil profile.	Slightly higher than background radioactivity recorded.
Cretaceous	Godfrey Beds Kg	25	Conglomerate, sandstone, siltstone	Trace fossils, macrofossils elsewhere.	Fluvial, marine elsewhere.	Sandstones could be suitable aquifers below water table.
	Hazlett Beds Kh	10±	Kaolinitic claystone	Microfossils	Lacustrine	
Mesozoic Undifferentiated	Possible equivalent of Culvida Sandstone (in part) M	50±	Sandstone, siltstone, shale	Plant debris	Fluvial - channel and floodout deposits.	Some aquifers likely below water table.
Triassic	Blina Shale Rb	30±	Micaceous siltstone, shale	Plant debris, pelecypods elsewhere.	Alluvial plain.	

TABLE S3 STRATIGRAPHY OF THE NORTHEAST CANNING BASIN (continued)

Age	Formation and Map Symbol	Thickness in Metres	Lithology	Fauna or Flora	Environment of Deposition	Economic Geology
Permian	Liveringa Formation — Condren Sandstone Member Pr	6-300	Sandstone, siltstone, thin conglomerate beds.	Plant fossils	Meandering river deposits and partly shallow marine at base.	
	Liveringa Formation — Balgo Member Po	20-250	Labile sandstone, siltstone shale, ferruginised beds, ochreous limonite.	Trace fossils, pelecypods and gastropods.	Nearshore shallow marine and tidal flat.	Contains thin beds of ochre.
	Noonkanbah Formation Pn	200	Shale, siltstone, bioclastic and fontainbleu limestones, marl. Ferruginous beds with concretions	Trace fossils, brachiopods, pelecypods, shark and fish teeth and bones.	Beach, tidal flat and shallow marine.	Potential petroleum source rock.
	Poole Sandstone Pp	250	Fine quartz sandstone, thinly bedded shale, siltstone. Very thin heavy mineral sandstones.	Rare pelecypods, gastropods.	Estuarine and beach.	Potential petroleum reservoir.
	Nura Nura Member Pa	at least 60	Calcareous sandstone, conglomerate, micaceous siltstone.	Trace fossils.	Shallow marine.	
	Grant Formation Pg	at least 50	Medium and coarse quartz sandstone, minor siltstone, conglomerate.	Wood fragments.	High-energy fluvial. Fluvioglacial elsewhere.	Excellent aquifers beneath water table.
Carboniferous	C	?	? possibly occurs in subsurface.			
Upper Devonian		14±	Medium and coarse quartz sandstone, minor conglomerate and siltstone.	Plant fragments, fish plates.	Fluvial	Excellent potential aquifers beneath water table.
Lower Ordovician		100±	Fine quartz sandstone, minor conglomerate.	Trace fossils, trilobite pygidia, gastropods, brachiopods.	Shallow marine, possibly shoreline in places.	Potential reservoir rock for petroleum.

For Proterozoic stratigraphy, see progress report of the Granites - Billiluna Party.

Proterozoic:

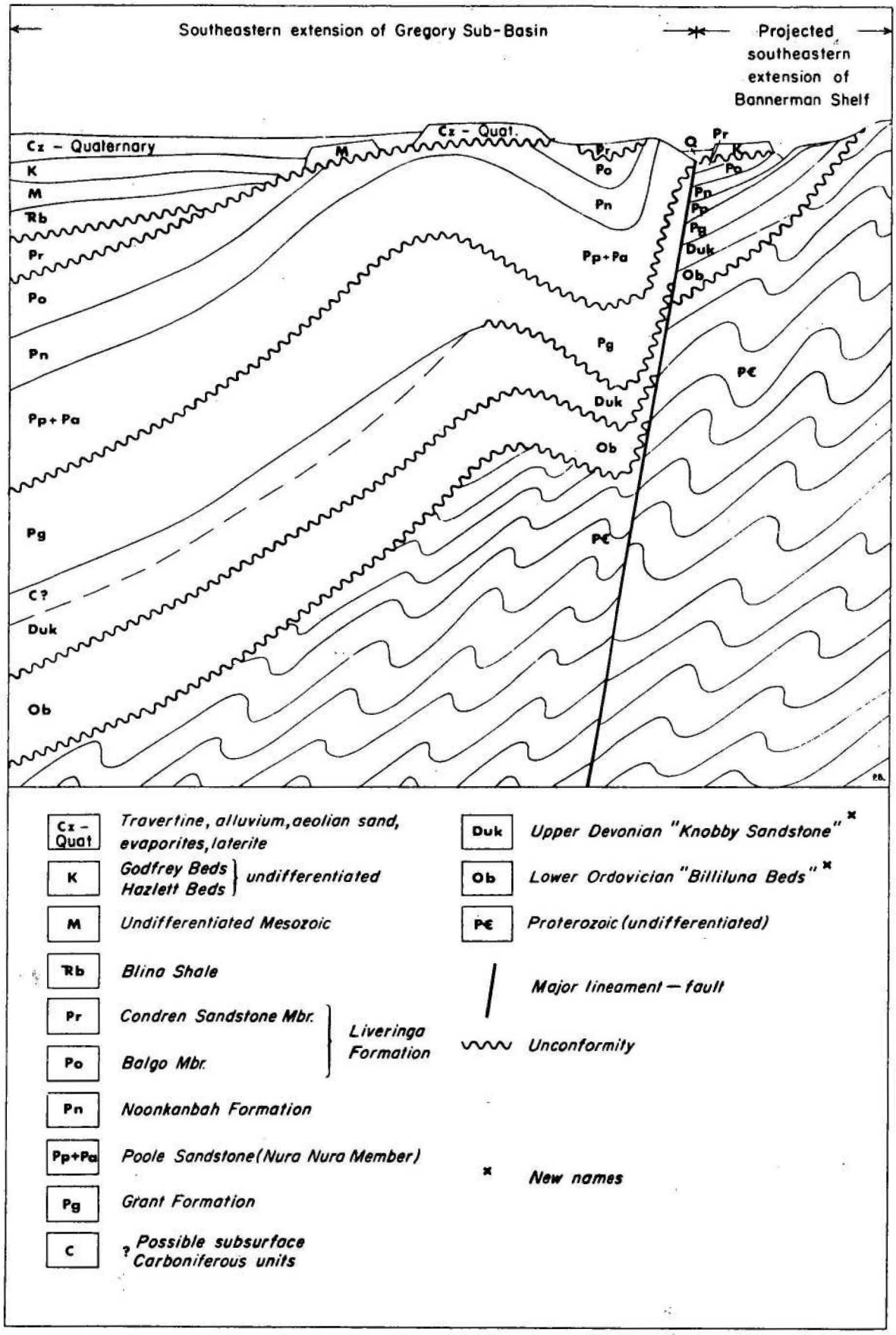


FIG. S5 ROCK RELATIONSHIPS DIAGRAM, N.E. CANNING BASIN

BATHURST-COBOURG PROJECT

by

B. R. Senior

PERSONNEL: B.R. Senior, R.J. Hughes, D. Burger (part-time)

From June to October 1972 a geological reconnaissance of Bathurst Island, Melville Island, Cobourg Peninsula and Fog Bay 1:250 000 Sheet areas was made from bases on Bathurst Island and on Cooper Creek (Alligator River Sheet area in conjunction with the Alligator River Party). Helicopter traverses were made on all four sheet areas and a boat was used to map part of the western tip of Cobourg Peninsula and islands to the north. Most rock and fossil specimens collected from the Cobourg Peninsula were destroyed by fire which will necessitate some re-collection in 1973.

Figure S6 shows the main geological features of the region.

The oldest rocks are in the southern part of the Cobourg Peninsula Sheet and consist of gneiss, granite, migmatite, dolerite and schist of the Lower Proterozoic Nimbuwah Complex. This complex is mainly restricted to the peninsula; porphyroblastic gneiss is present at White Rocks in Aurari Bay.

Orthoquartzite, conglomerate, sheared quartzite, sandstone and schist are the dominant rocks in the Fog Bay Sheet; they form a tightly folded syncline. The less deformed orthoquartzite has ripple markings, regular bedding and local graded bedding. To the east of this syncline are a few tors of biotite granite. Both rock assemblages are considered to be Proterozoic.

The Proterozoic Kombolgie Formation in southern Cobourg Peninsula forms prominent steep-sided hill masses with roughly concordant summit heights. This formation consists of bedded arenite grading from quartzose sandstone to sandstone with scattered clasts, and conglomerate. This formation also crops out at Simms Island and at Anyiminali Point on South Goulburn Island.

Probable Permian sediments occur in the southwest of Fog Bay Sheet area and consist of sandstone and siltstone with exotic clasts considered to be glacial 'dropstones'.

Cretaceous sediments are widespread on Bathurst Island, Melville Island and on the northern two-thirds of Cobourg Peninsula. The sequence is best exposed along coastal cliffs on southern Bathurst Island. Elsewhere, with local exceptions, all the Cretaceous sediments are strongly weathered. Chemical weathering has superimposed a kaolinitic, mottled and ferruginous mantle up to 40 m thick on the surface of this sequence. In places the weathering has produced a trizonal arrangement of decomposition zones forming typical laterite, in others the effects of weathering is more complex and bauxitic laterites have formed.

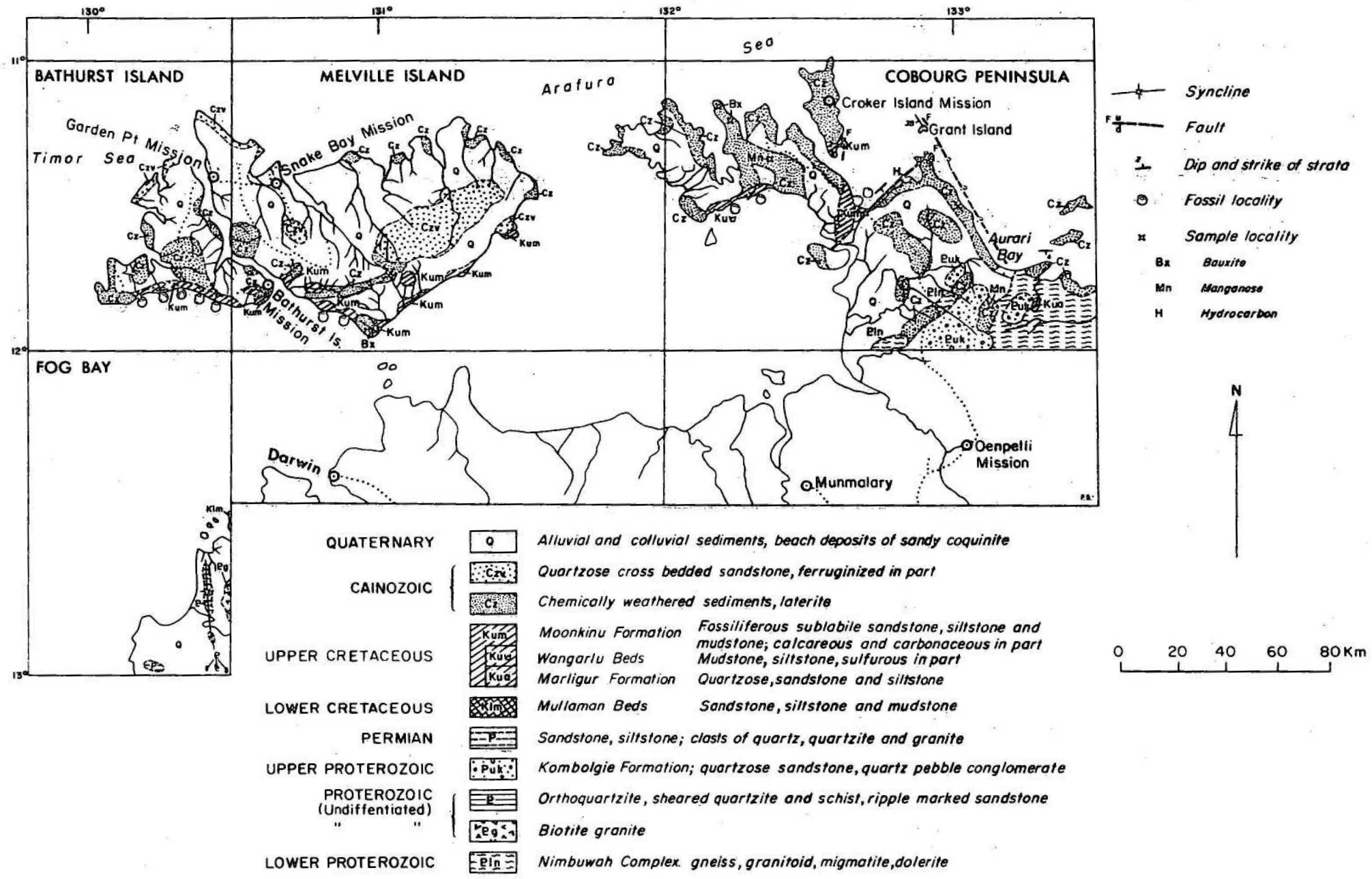


FIG. S6 GEOLOGICAL PROGRESS REPORT

BATHURST/MELVILLE/COBOURG PARTY

To accompany Record 1972/103

The name Moonkinu Formation will be proposed for the fossiliferous deltaic sequence which forms the bulk of the Cretaceous sediments in the area. In Cobourg Peninsula Sheet area there is a facies gradation from moderately deep water marine mudstone (proposed Wangarlu Beds) through deltaic sublabile sandstone and siltstone, to littoral poorly sorted quartzose sandstone and siltstone (proposed Marligur Formation). The littoral sediments fringe Proterozoic basement highs which probably formed a series of islands in late Cretaceous time. Palynology of the Moonkinu Formation indicates a Cenomanian age. Well preserved pelecypods, gastropods, and ammonites especially from southern Bathurst Island, together with the rich microfaunas should enable accurate dating of the units to be undertaken.

Cainozoic sediments are widespread and the most important of these is the Van Diemen Sandstone (proposed name) which covers most of northern Bathurst Island and northern and central Melville Island. It is a fine to medium bedded quartzose sandstone with some siltstone lenses and intraformational conglomerate. It overlies weathered Moonkinu Formation and is itself weathered and ferruginized in the upper part. No fossils were found probably because of post-depositional weathering. These sediments are thought to have accumulated in a shallow open sea similar to the present environment of sandbanks and shallows off northwest Bathurst Island. The sandstone is porous and permeable and contains fresh water aquifers which supply spring-fed streams and water bores on both islands.

Raised beach sediments, which vary from cemented shelly coquinite to calcarenite and conglomerate, are present along parts of the coastline over the entire area. They are as much as 6 m above sea level, dip seawards, and abut unconformably against older rocks; they appear to have been stranded by a fall in sea level.

Quaternary sediments are widespread but are mainly thin and consist of sand and sandy soil common in the interior of both islands. Sand dunes and beach ridges are common around parts of the coastline. Saliferous silt and mud with a high organic content occur in prograded embayments and mangrove swamps.

Heavy mineral sands on beaches around Bathurst Island, Melville Island and Fog Bay were sampled in 43 hand auger holes. This survey was designed to supplement company investigations which record the presence of ilmenite, zircon and rutile. Representative factors of each sample have been forwarded to Amdel for heavy mineral identification.

Pisolitic sediments mainly of low grade bauxite occur on Cobourg Peninsula and Croker Island. These occurrences are mainly restricted to the northern coastlines and appear to have formed due to slight northward tilting of laterite together with leaching and deflation of in situ laterite. This process has produced a residual mantle of loose to moderately indurated bauxite pisolites. Previous work indicates that tonnages and soluble alumina content is too low for economic use.

A bitumen-sand mixture was found adhering to rocks over a distance of 0.5 km along the southeast margin of Mountnorris Bay. Bitumen has been observed at this location over a number of years. A possible north-east trending offshore fault might be the location of a subsea seepage in this area.

Chemical weathering profiles containing beds enriched in iron oxide are widespread throughout the area. Manganese-bearing laterites are uncommon and of low grade.

NGALIA BASIN PROJECT

by

A.T. Wells

A paper entitled "The Ngalia Basin - recent geological and geophysical information upgrades prospects" was read at the 1972 APEA Conference in Sydney, and published. The paper includes results of the recent seismic surveys completed for Magellan Petroleum (Aust.) Ltd which cover practically the whole of the western part of the basin. Several possible fault traps for hydrocarbons have been outlined by the survey. The paper was awarded a plaque presented for the best paper at the Conference.

Further work was carried out on reprocessing samples from the basin, including x-ray diffraction studies on samples and drill core of the Mt Eclipse Sandstone supplied by a company, and palynological studies of shothole samples obtained during the geophysical survey. The shothole samples included fragments of high grade coal and microfossils that indicate a Carboniferous age. Several other samples were submitted for detailed size analysis as a comparative study between formations in the basin and as a guide to environment of transport and deposition.

It is planned to write a Bulletin and prepare 1:500 000 geological and structure maps of the basin in 1973 in conjunction with the Geophysical Branch.

DETAILED MAPPING PROJECTS

TANTANGARA AREA PROJECT

by

M. Owen

PERSONNEL: M. Owen, D.E. Gardner, A.L. Jaques (Jan-March), P.A. Langworthy (Feb-April), D. Wyborn (March-April).

The project was started in August 1971 with the object of mapping in detail the western third of the Canberra 1:250 000 Sheet area, the results to be published in the form of the Tantangara and Brindabella 1:100 000 geological maps, and accompanying texts.

From October 1971 to April 1972 an area of 1300 km^2 was mapped comprising 95% of the Tantangara and 80% of the Currango 1:50 000 sheets; the remainder of the year was spent preparing a record on the results.

Considerable advances have been made to date in understanding the complex geology of the region. The oldest sedimentary rocks, of supposed Ordovician age, comprise the Boltons Beds, a sequence of unfossiliferous, strongly deformed, fine quartzite and siltstone, in places strongly hornfelsed by the Happy Jacks Granite. The Boltons Beds appear to grade upwards into the Temperance Cherts, an unfossiliferous, strongly deformed sequence of chert, with minor basic tuff and agglomerate, slate and quartzite.

The Temperance Cherts are conformably overlain, at least in the Peppercorn Creek area, by the Nine Mile Volcanics, a sequence of basic lavas, in places showing pillow lava structures, and tuffs, which in the Kiandra to "Gooandra" area have commonly been metamorphosed to chlorite-actinolite schist. Graptolites found during the present survey in the Nine Mile Volcanics indicate a Gisbornian (Upper Ordovician) age. The Nungar Beds overlie the Nine Mile Volcanics and consist mainly of quartzite and slate, and contain graptolites of Eastonian (Upper Ordovician) age.

The earliest Silurian rocks were laid down following the late Ordovician Benambran Orogeny and comprise a flysch sequence of coarse sandstone, siltstone, and shale, showing graded bedding, the Tantangara Beds, whose age has been established by the discovery of shelly fossils. The detailed mapping has shown that a large area previously mapped as Ordovician on the 2nd edition, Canberra 1:250 000 geological map, is Tantangara Beds, as also are rocks between Blanket Hill and Nattung previously mapped as Boltons Beds. The Tantangara Beds are strongly deformed as a result of folding in the early Middle Silurian, during the Quidongan Orogeny.

The Peppercorn Beds unconformably overlie the Tantangara Beds and comprise a basal chert conglomerate passing up into sandstone, siltstone and shale. Fossils found during the present survey indicate a probable Wenlockian age for the unit. The Peppercorn Beds are considered to pass conformably up into

the Wenlockian to Ludlovian sediments of the Cooleman Plain area, where four units are recognized: the Cooleman Limestone, Pocket Beds, Blue Waterhole Beds, and Wilkinson Limestone. Complex facies relationships appear to exist between the various units.

Marine deposition ceased in the area late in the Silurian during the Bowning Orogeny and was followed by Devonian volcanism. First the Rolling Grounds Volcanics, a series of latite lavas up to 120 m thick, with shoshonitic affinities, were extruded. They may be related to the Mountain Creek Volcanics near Wee Jasper. Later the Kellys Plain Volcanics, a thick sequence of rhyolite to rhyodacite tuffs and ignimbrites were extruded.

Intrusive igneous rocks appear to represent several phases of emplacement from the late Ordovician to Middle Devonian. The largest, the Happy Jacks Granite (possibly of Lower Devonian age), is a composite body ranging from Na-enriched leucogranite to hypersthene diorite. Contacts between the various units of the granite are both gradational and sharp in different places. Other large granites are the Lucas Creek Granite, Gingera Granite, Hell Hole Creek Granite, Jackson Granite and several bodies in the Fiery Range. The age of these intrusions is probably Lower or Middle Devonian. The Cooleman Plainsarea in particular has a wide range of intrusive rocks, dominantly granodiorite, or diorite, but also including granophyre and pyroxenite. Elsewhere in the area are many small granite, syenite, diorite and gabbro intrusions and abundant quartz-feldspar porphyry dykes.

Seventy five igneous rocks have been analysed for major elements as a first step in petrogenetic studies of the intrusive and extrusive rocks of the area.

HUNTER VALLEY PROJECT

by

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

The project, to study the Lower Carboniferous geology of about 640 sq km in the Scone-Rouchel district of the Upper Hunter Valley, New South Wales, was completed during the year, and a draft report and 1:50 000 geological map prepared.

WEST CANNING BASIN PROJECT

by

E.C. Druce

PERSONNEL: BMR: E.C. Druce, R.S. Nicoll, B.M. Radke, G. Young (part time), A.T. Wilson (Technical Officer).
GSWA: P.W. Playford, J. Backhouse

The aims of the investigation were:

1. To determine the conodont sequence and lithological relationships in the Upper Devonian-Lower Carboniferous "Fairfield-Laurel" rocks.

2. To determine the morphologic and chronologic features of the Upper Devonian reef complexes of the Oscar and Napier Ranges between Fitzroy Crossing and Derby.

3. To examine closely the relationships between conodont faunas and algal growths (stromatolites).

4. To determine the change in the genetic composition of conodont faunas in depth sections.

5. To determine the relationships between faunas, lithology, and whole rock geochemistry.

6. To recover vertebrate remains from the Devonian and Carboniferous.

7. To re-examine the conodont sequence in the Devonian-Carboniferous of the Bonaparte Gulf Basin both in the reef and platform complexes.

Conodont sampling was undertaken along detailed traverses across various rock units and from continuously cored drill holes. Most samples (1000 of an estimated 1500) were processed in the field. At every fossil sample locality a lithological and geochemical sample was taken. Some thin sections and peels were made in the field. Macrofossils and vertebrates were shipped back to Canberra for preparation.

The late Devonian and early Carboniferous sediments of the Canning Basin can be divided into three units, an Upper Devonian formation (predominantly limestone), a Devonian-Carboniferous boundary formation (predominantly shale and sandstone) and a Lower Carboniferous formation (predominantly limestone).

All three units contain extensive shale beds which rarely outcrop. The sandstones are commonly friable and only outcrop where they are calcareous.

The detailed examination of the Napier and Oscar Range reef complexes showed that the distribution of conodonts with respect to facies is similar to that in the Bugle Gap area to the southeast. Fore reef faunas (mainly Famennian) are extremely abundant whereas the reef and back reef give low or no yield. In the northwestern corner of the Oscar Range a ?back-reef platform sequence rich in oolites yielded reasonably abundant late Devonian conodonts. The relationship between it and the Fairfield Formation of more basinal aspect is still unclear although outcrops of the two units are within a few kilometres of one another.

HYDROGEOLOGICAL STUDIES

HYDROGEOLOGY OF THE GREAT ARTESIAN BASIN

by

M.A. Habermehl

PERSONNEL: M.A. Habermehl, R.S. Abell (from 10 July 1972),
N.O. Jones (until 1 March 1972),
P. Ungemach (BRGM, 14 April - 11 July 1972),
M. Audibert (BRGM, from 3 July 1972),
G. Krebs (BRGM, from 15 Sept. 1972).

The hydrogeological study of the Great Artesian Basin consists of the collation and interpretation of all available geological and hydrological data on the basin, with the aim of understanding the hydrodynamic behaviour of the various aquifers.

Data are being collected from the records of Commonwealth and State authorities and used in the preparation of a digital computer simulation model of the basin. This model will simulate the basin's hydrodynamics in terms of a reconstruction of the basin's steady state conditions, the changes in these conditions before and after the start of the development of the basin ($\pm$1880), and by forecasting its future behaviour.

Panel diagrams have been prepared, using petroleum exploration well logs, on a horizontal scale of 1: 1 000 000 and a vertical scale of 1:20 000, to illustrate the geometry of the basin, litho-stratigraphy, thicknesses of formations, relative permeability of the aquifers and their interconnection.

Visual estimation of permeability of samples, taken during the 1971 field trip to the southeastern intake areas of the GAB in Queensland and New South Wales, compare well with laboratory determinations, confirming that such estimates can be used as a first approximation in determining the order of transmissivity of aquifers.

The contract for specialist assistance with the Great Artesian Basin hydrogeological project was awarded to BRGM Australia on 1 March 1972. To date the contractor has provided a simulation model expert, a hydrogeologist, and a systems analyst as well as ancillary staff consisting of a technical officer, a technical assistant, a cartographic draftsman, and a drafting assistant.

An Automatic Data Processing system was designed to manipulate the geological and hydrological data, and transcription of data into this system started in July in Brisbane.

A digital computer simulation model for the GAB multi-layered confined aquifer system was designed according to Hautush's approach for the simulation of leaky artesian aquifers and satisfactory computer runs were performed on the CSIRO - CDC 3600 and 6600.

Programming of the ADP system started. Drawing of topographic maps on a scale of 1:1 000 000 and locating and plotting on these maps of water-bores to be used in the modelling continued.

Well exposed Great Artesian Basin stratigraphic units in the Hughenden and Tambo Sheet areas were examined in October in order to familiarise members of the project team with details of lithology, permeability distribution and recharge potential.

WATER-BORE LOGGING IN THE GREAT ARTESIAN BASIN

by

M.A. Habermehl

Supervision of the contracts for water-bore logging continued. Logging under the 1972 contract was in the Northern Territory part of the western Eromanga Basin and in the north-eastern part of the Eromanga Basin in Queensland.

The objectives of the logging programme are mainly the identification of lithological units and their correlation by the use of gamma-ray logs, the measurement of porosity below the watertable by the use of the neutron logs, the identification of aquifers by use of temperature logs and measurement of discharge by use of flowmeter logs.

All logging was done in relatively shallow holes, close to the margin of the basin, in order to correlate outcrop with subsurface stratigraphy. Logging started in January and was completed in August, after 76 water-bores (11051 metres) had been logged (Table S4).

In the Northern Territory the logs enabled a good correlation of outcrop and subsurface stratigraphy to be made, as well as a distinction between Cretaceous formations. In Queensland the logging results enabled correlations of the subsurface stratigraphic sequence in the marginal facies of the basin.

TABLE S4

WATERBORE LOGGING STATISTICS 1972

Month	Logs Obtained: Gamma-ray	Neutron	Temperature	Flowmeter/ caliper
January	2	2	2	-
February	20	19	18	-
March	4	4	4	-
April	9	8	9	-
May	11	10	9	1
June	14	14	15	4
July	4	3	4	-
August	11	11	11	-
Total	75	71	72	5

1:250 000 Sheet	Logs Obtained per Sheet Area: Bores Logged	Bores Unable to be Logged	Range of Depths Logged (metres)
Northern Territory			
Hale River SG 53-5	2	2	70 - 71
McDills SG 53-7	5	5	70 -382
Finke SG 53-6	20	15	49 -148
Queensland			
Gilberton SE 54-16	3	15	79 -104
Richmond SF 54-4	18	29	62 -307
Hughenden SF 55-1	16	22	67 -285
Tangorin SF 55-5	12	9	64 -325
Total	76	97	

SEDIMENTOLOGICAL STUDIES

Members of the Sedimentology Group were mainly engaged on the five projects described below. In addition, Miss Burgis prepared a record of her work on the Broad Sound Estuary, and attended the Newcastle Symposium on the Sydney Basin. A.R. Jensen prepared brief notes on a few samples of sediments and sedimentary rocks submitted during the year, edited the first drafts of two records and one set of Explanatory Notes, attended the APEA course on Petroleum Geology, and presented a paper at the BMR Symposium.

BOWEN BASIN TRIASSIC PROJECT

by

A.R. Jensen

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 at the top. Studies aimed at environmental interpretation of the Mimosa Group and determination of the controls of sedimentation of the controls of sedimentation were commenced in 1968. Most of the time spent on the project this year has been occupied by the preparation of a final report which will be published as a Bulletin. Many of the major conclusions are recorded in the Summary of Activities for 1971, and it is now possible to elaborate on the essential controls of sedimentation.

Earth movements at the close of the Permian created a rapidly subsiding inland basin, possibly with an internal drainage system, in which coal measures were formed. Sediments of the Rewan Formation were deposited in the same drainage basin in a system of meandering and anastomosing channels, in response to a decreased rate of subsidence relative to the rate of supply of sediment. The red colour of the mudstone characteristic of the Rewan Formation is caused by the presence of finely divided hematite, derived from the erosion of red soils of the source area. When the rate of sediment supply exceeded the rate of subsidence, a major reorganization of the drainage pattern took place, together with a general increase in stream gradients as sandy sediment accumulated near the margins of the basin. Changes of relief in the source area, as well as in vegetation, local climate, and rates of erosion and sedimentation, led to podsolic weathering both in the source area and at the site of deposition; fossil soil profiles can be recognized in the mottled red and green mudstone of the basal part of the Clematis Sandstone. The newly established drainage system of braided and meandering channels spread sand towards the southeastern parts of the basin, where rates of subsidence were greatest.

The progressive increase in the mineralogical maturity of sediments of the Rewan Formation and Clematis Sandstone is related to increased chemical weathering of the source area as the relief diminished. The pattern of sedimentation is seen as an example of lithogenesis within an exogeosynclinal inland basin with a humid temperate climate.

BLACKWATER COAL PROJECT

by

W.A. Burgis

The study of the environmental significance of folds in the Upper Permian Rangal Coal Measures began in the Utah Development Company open-cut mine at Blackwater, Queensland, in 1971. The stratigraphic sequence of the coal measures in the mine area was described in the Summary of Activities for 1971 and conforms to the vertical profile produced by a meandering river: point bar deposits are overlain by floodplain sediment. The origin of mutually discordant folds observed in two dimensions in the mine highwall was attributed to differential compaction during deposition of the coal measures. As compactional features, these structures have no specific environmental significance.

Computer analysis of subsurface data during 1972 revealed that the folds above the major coal seam in the mine are domes and basins in three dimensions and that their formation was initiated by irregularities in the surface below a thick peat deposit. The folded lenses of clastic rocks between carbonaceous beds are discrete bodies which are roughly circular in plan. Therefore, the lenses formed in isolated lake basins on the floodplain, not in a simple channel.

The palaeogeographic evolution of the mine area during deposition of the coal measures was controlled by the differential compaction of organic and inorganic material and by the lateral migration of river channels. A river flowed through the mine area early during deposition of the coal measures and laid down point bar sands and overbank muds. After the river channel migrated from the area, a peat swamp formed on the floodplain. As the peat became compacted under its own weight, depressions formed in the peat surface over depressions in the buried floodplains sediments and over depressions caused by differential compaction of the underlying sand and mud. Flood water began to carry clastic sediment into the depressions in the peat. The sediment was deposited in horizontal beds in shallow, enclosed lake basins. This sediment load caused more rapid compaction of the peat below the basins than in surrounding areas. Eventually the compactional potential around the basins became greater than that of the peat below them, and the basins filled with sediment. The lenses of lacustrine sediments were incompressible relative to the peat, and as the peat around the lenses became compacted they became topographic highs, the beds within them being folded into domes. New lake basins formed on the flanks of the topographic highs. Sediments deposited in these basins were also folded into domes during a similar reversal of topography. Because the lake basins occupied different positions through time and the lenses of lacustrine sediments were folded at different times, the domes are discordant with each other. Deposition in a third set of lake basins on the floodplain ceased when a river channel migrated back to the mine area and slightly eroded the lacustrine sediment. Point bar sands were then deposited over the area.

These conclusions were presented at the BMR Symposium held in May and are set forth in a BMR Record written during 1972.

BULIMBA FORMATION

by

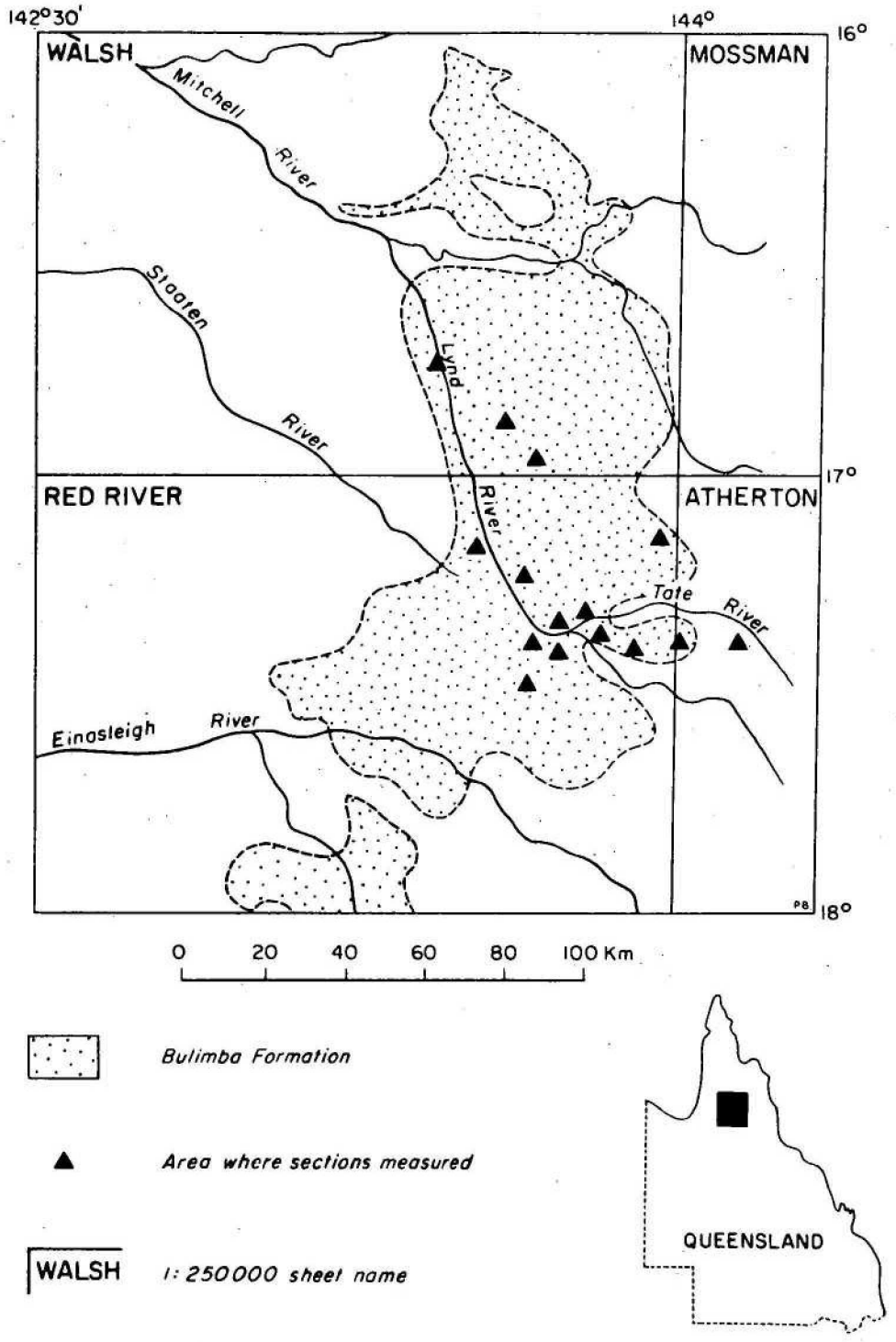
W.A. Burgis

A semi-detailed examination of the Late Cretaceous or Tertiary Bulimba Formation was made west of Chillagoe, Queensland, to determine the palaeogeography and controls of sedimentation during its deposition, and the nature of post-depositional changes which have affected it. Thirty-two stratigraphic sections were measured at isolated mesas and the edges of the plateau which occupies much of the study area east of the Lynd River (Fig. S7). Measured sections were located to assess local and regional lithological variation. Where sedimentary structures were well preserved, detailed logs of bedding types were recorded and the orientation of cross-strata measured.

The Bulimba Formation is unfossiliferous and horizontal in the study area. It consists of white granule conglomerate, claystone, and sandstone. Granule conglomerate and sandstone commonly occur in lenses which lie on erosional surfaces and pinch out into claystone. Two vertical sequences of bed types are characteristic of the formation: fining-upward sequences of granule conglomerate, sandstone, and claystone; and alternations of granule conglomerate and claystone. Cross-stratification is commonly present in granule conglomerate at the top of mesas, and low mesas of cross-stratified granule conglomerate, pebble conglomerate, and sandstone are numerous in the northwestern part of the study area.

Fining-upward sequences and rapid lateral lithological changes indicate that the Bulimba Formation is a fluvial deposit. Several isolated mesas of the Bulimba Formation are surrounded by mesas and hills of Precambrian granite and metamorphic rocks and of Upper Jurassic to Lower Cretaceous sedimentary rocks which stand at approximately the same elevation. In places the Bulimba Formation has been eroded to expose the walls of ancient valleys. It is a valley-fill deposit laid down over topography developed on older rocks.

Granule conglomerate beds commonly have a clay matrix, and many claystone beds contain abundant randomly scattered sand grains. If these textures are of depositional origin, they are difficult to explain hydrodynamically. The outlines of weathered feldspar grains have been observed in some conglomerate samples, so the clay matrix of the conglomerate may be the product of deep weathering of an originally feldspathic sediment. The texture of



BULIMBA FORMATION

FIG. S7 LOCATIONS OF MEASURED SECTIONS

sandy claystone beds may also reflect post-depositional alteration or reworking. The Bulimba Formation has been affected by at least one period of lateritization and is extensively mottled. The surfaces of its outcrops are generally ferruginized or silicified.

Further studies of the measured sections will be directed toward determining whether the controls of sedimentation varied from valley to valley, from the sides to the centre of a valley, and from time to time as the valleys filled. Reconstruction of small sections of the drainage pattern will be attempted. Results will be presented in a BMR Record.

LAKE FROME FEASIBILITY STUDY

by

A.R. Jensen

PERSONNEL: A.R. Jensen, C.J. Downes (Baas Becking Laboratory)

It has been proposed that during 1973 a joint team from BMR and the Baas Becking Laboratory should investigate an internal drainage basin in an arid development to determine if the movement of fluids and sediments could concentrate metals such as zinc, copper, lead, and uranium through evaporation or the action of sulphate-reducing bacteria. In order to test the suitability of Lake Frome for this study, a brief visit was made to the area during August-September 1972 with C.J. Downes of the Baas Becking Laboratory and geologists from the Geological Survey of South Australia and the Department of Biogeography and Geomorphology, Australian National University.

Lake Frome, a salt-covered playa about 40 km east of the Flinders Ranges, appears to be suitable because of its moderate size, relatively simple drainage pattern, and its proximity to areas of known mineralization. The lake, which is 100 km long and 45 km wide and covers an area of 2,700 km, is likely to have been an enclosed drainage basin for both fluids and sediments during the Holocene and part of the Pleistocene. At present it occasionally receives surface water from the Flinders Ranges as well as from areas to the north and south. Subsurface water migrates into the area from the Great Artesian Basin, and presumably from intake areas in the Flinders Ranges. Quaternary deposits derived from the Flinders Ranges are known to extend from the ranges eastwards towards the lake, but their thickness in the lake is unknown. It has been suggested that if any sediment has been deposited in the lake during the Quaternary, it has been subsequently lost by deflation. On the other hand, positive evidence exists that relatively recent Holocene or late Pleistocene sediments are retained in some parts of the lake, for excavations made during the brief visit this year revealed a thin

sequence of laminated sand and clay overlying older consolidated deposits. The preservation of bedding near the surface and absence of diagenetic alteration suggest that this unconsolidated sediment relates to the last time the lake was full, in the late Quaternary. Secondly, the high water-table evident even now in a drier period appears to prevent substantial loss by deflation. If deflation were active, one would expect recent aeolian deposits on the eastern shore. The dunes there however, are of considerable antiquity (probably late Pleistocene) judging by the degree of pedogenesis and the formation of hard crusts of gypsum.

Satisfactory trial pits and auger holes were made in the lake and similar sampling methods could form the basis of a program to examine sediments and fluids. A study could also be made of the carbonate mound springs, on the eastern side of the lake, in which water was found. The surface of the lake does not have sufficient strength to allow extensive travel in wheeled vehicles, even in those fitted with wide tyres, and it is therefore concluded that helicopter transport will be necessary.

On the basis of the reconnaissance survey it appears that secondary objects of the proposed investigation could include: (a) the study of the crystallization of brines in a continental environment and diagenetic modification of the salts; (b) the study of precipitation and diagenetic modification of carbonates; (c) the study of the interaction of water in the mound springs with lake sediments; (d) the study of playa sedimentation as a whole to enable recognition of similar environments in the geological column; and (e) the study of Quaternary climatic changes. Laboratory analyses would include: (a) radiocarbon dating of carbonates and carbonaceous material, mainly for stratigraphic purposes; (b) tritium dating of water samples to compare artesian water on the eastern side of the lake with subartesian water elsewhere; (c) mineralogical analysis of clastic and 'chemical' sediments for studies of provenance and lake history; (d) grainsize analysis of sediments as an aid to environment interpretation; (e) trace element analysis of fluids and sediment to detect any abnormal concentrations; (f) major element analysis of water to determine nature of dissolved salts and to differentiate waters of different origins; and (g) clay mineral analysis for studies of provenance and possibly diagenesis.

The proposed investigation is further strengthened by the fact that Dr J.M. Bowler of the Australian National University will probably be able to co-operate in the study, directing his attention to stratigraphic and mineralogical aspects as an aid to understanding Quaternary climatic and hydrologic changes. Dr Bowler, who would be supported by a palynologist, has already undertaken similar studies in New South Wales and Victoria.

HEAVY MINERAL SANDS FEASIBILITY STUDY

by

A.R. Jensen

PERSONNEL: A.R. Jensen, T.K. Zapasnik.

During the year, on a part-time basis, an investigation was commenced to determine the feasibility of future studies of the accumulation of heavy mineral sands. The opportunity was taken to accompany J. Ward of the Mineral Resources Branch when he visited heavy mineral deposits, mining companies and State Surveys in New South Wales, Queensland and Western Australia. On the east coast, the deposits at Jerusalem Creek and Stradbroke Island were examined, and on the west coast, deposits around Geographe Bay, Flinders Bay, and Eneabba.

Geological investigations are already undertaken mainly by company geologists on both the eastern and western coasts, in the delineation of orebodies from drilling. Exploration for new reserves is commonly based on grid-drilling programs, although in some areas the position of holes is influenced by local geological considerations. For example, at Jerusalem Creek, a set of old dunes parallel to a former coastline is truncated by a second, younger set. The heavy minerals are concentrated at the junction between the two dune systems at the highest strandline of the younger transgression. At Yoganup in Western Australia, the heavy minerals are concentrated at the base of a former sea cliff, again at the highest point of a marine transgression. Economic accumulations are also found at specific parts of large blowout dunes, and a knowledge of the dune morphology aids exploration. Geological controls of a more regional extent can also be employed in exploration. In the Geographe Bay area of Western Australia former strandlines can be traced using the relative height of the sand ridges above present sea level.

Geological controls such as these are, in general, well known and utilized by the operating companies. More needs to be done to decide if new approaches would be useful in exploration on land. At the present time, however, it appears that the need for research lies more with possible off-shore accumulations rather than with those on land. With this in mind, preliminary investigations have been undertaken to determine if the off-shore samples collected by Planet Metals Ltd are suitable for stratigraphic and palaeoenvironmental analysis.

ESTUARY STUDIES

BROAD SOUND PROJECT

by

P.J. Cook

PERSONNEL: P.J. Cook, W. Mayo, W.A. Burgis (part time), D.L. Gibson (part time).

No fieldwork was undertaken during 1972 and the main effort of the group was directed towards the completion of laboratory work, the processing of data and the writing up of results.

Some time was spent calibrating the BMR settling tube and writing PROGRAM GRSIZE for the production by computer of statistical parameters using the settling tube and various other techniques. Other computer programs were written or modified during the year to undertake the following functions: (a) testing for the significance of errors, (b) testing for (log) normality, (c) general summary statistics, (d) X-Y plots, (e) frequency and cumulative plots, (f) contouring, (g) discriminant analysis, (h) Q- and R-mode factor analysis, (i)stepwise regression.

Compilation of all the surface and subsurface data from Broad Sound reveals that a marked regression has occurred in the Broad Sound area over the past 5000 years. The regressive sequence everywhere consists of intertidal sands and muds which are overlain by mangrove deposits; these are in turn overlain by supratidal mudflats. This sequence is similar to that of the modern lateral succession as shown in Figure S8. Radiocarbon dating of the beach ridge sequences in the Chevron Point and Waverley Creek areas indicates that this regression is the result of depositional progradation rather than of sea level changes.

It is now known that supratidal dolomite concretions have formed in the Chevron Point area within the past 3000 years and are likely to be forming at the present day. This is the first known occurrence in Australia of a modern supratidal dolomite. Preliminary information also suggests that dolomitization and phosphatization may be associated processes in some depositional environments.

Lectures on the Broad Sound work were given to the Canberra Royal Society, the Specialist Group Meeting, and various universities. Records and external publications completed during the year are listed in the 'Publications and Records' section.

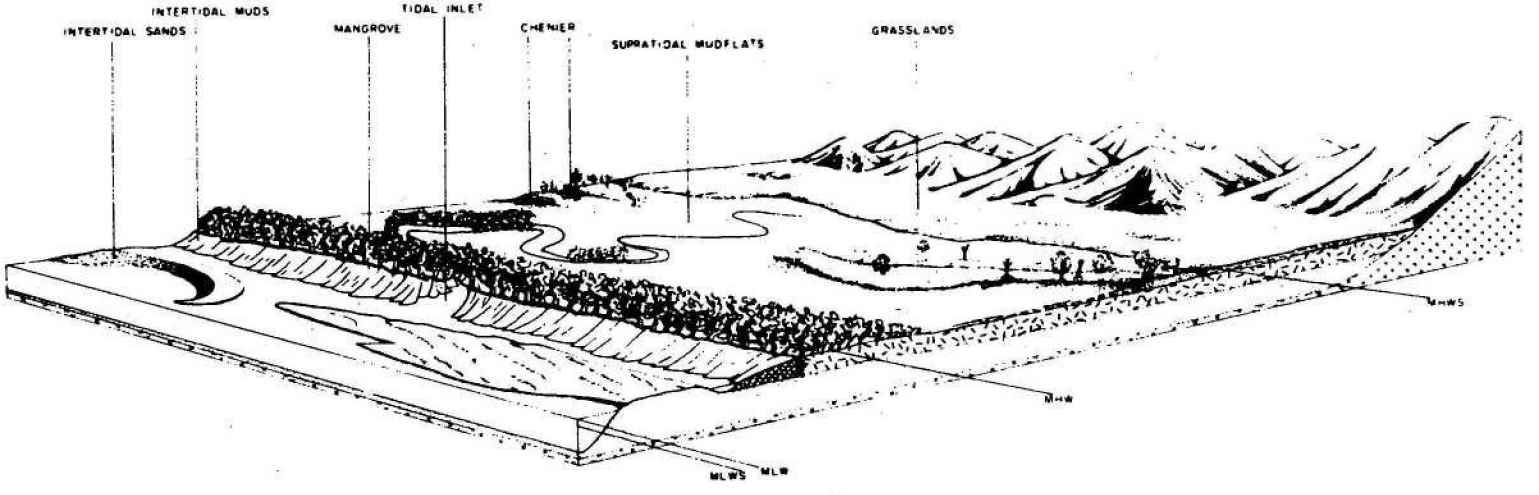


FIG S8 BROAD SOUND SEDIMENTARY ENVIRONMENTS

To accompany Record 1972/103

F55/A12/45

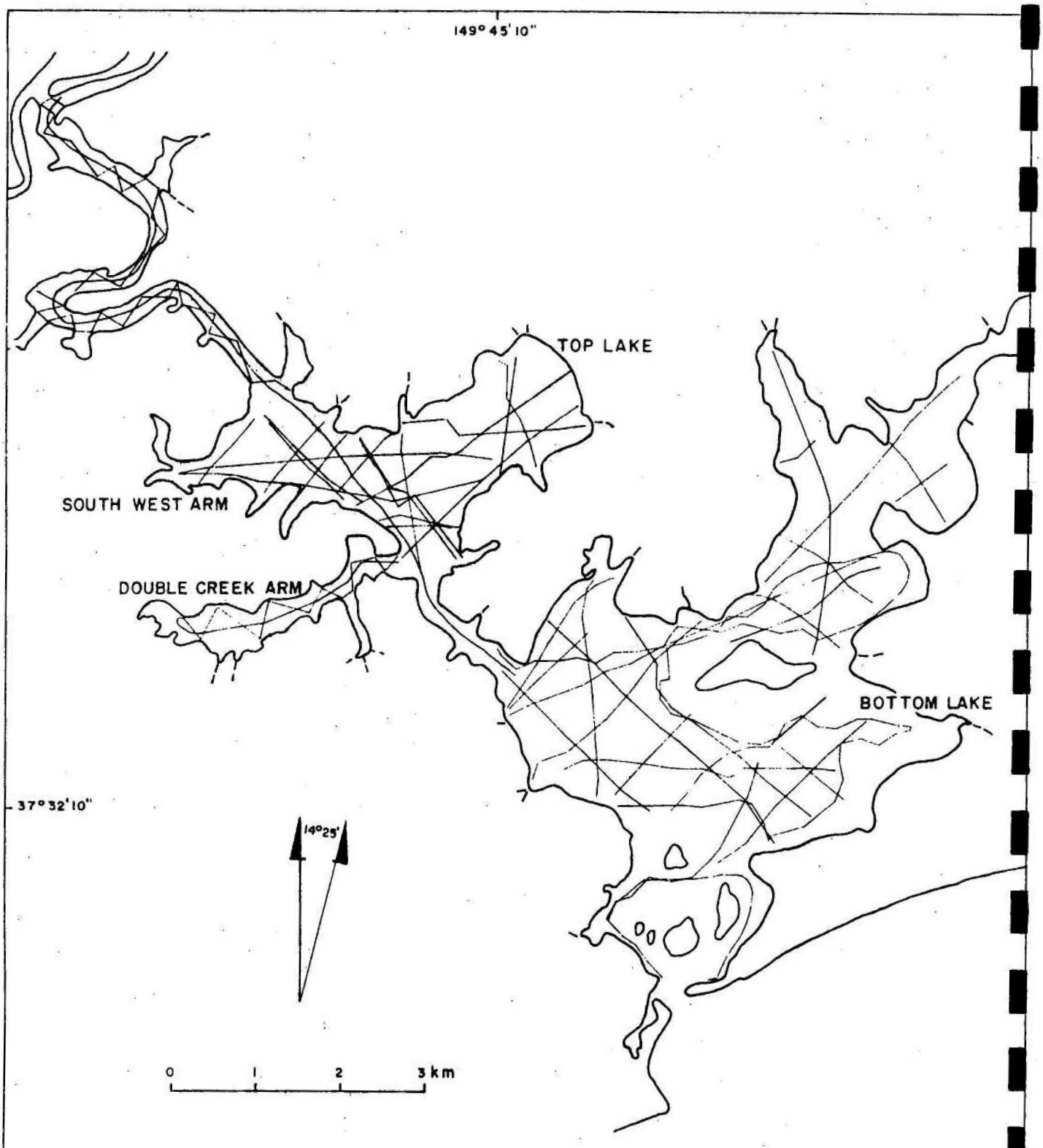


Fig S9- Mallacoota Inlet, showing location of seismic profiles

To accompany Record 1972/103

J55/A8/3

MALLACOOTA INLET PROJECT

by

G.E. Reinson (ANU)

PERSONNEL: G.E. Reinson, P.J. Cook (part time).

Most of the year was occupied with laboratory analysis of estuarine and stream sediments, soils, and estuary and catchment waters. Although the study is incomplete, the following preliminary findings are evident from these analyses:

1. The hydrology of the estuary is unusual and complex; it is governed by the irregular bottom topography, the shoreline configuration and the river discharge. The hydrological pattern has a marked effect on the sand distribution (Fig.S10).

2. Marine-derived sand is confined to the lower lake area; $CaCO_3$ in these sands is entirely of biogenic origin.

3. The areas of predominantly clay-size sedimentation are also the areas of maximum concentration of organic carbon and phosphate.

4. The dominant clay minerals are illite, vermiculite, kaolinite, and mixed layer (10-14Å) clays. On entering the brackish estuarine waters there is some transformation of expanding clays into non-expanding clays.

Seismic reflection and refraction work by the Engineering Geophysics group in Mallacoota Inlet in December (Fig. S9) showed that a complex system of Holocene? channels extend to a maximum depth of 30 m below present day sea level. Depth of penetration in the profiles was very variable owing to the presence of acoustically opaque mud in many parts of the Inlet.

The Airborne Section of the Geophysical Branch carried out a programme of colour airphotography over the whole of the Inlet in August 1972. The standard of photography was excellent, and it is possible to recognize sub-aqueous sedimentary structures and facies changes from these photographs.

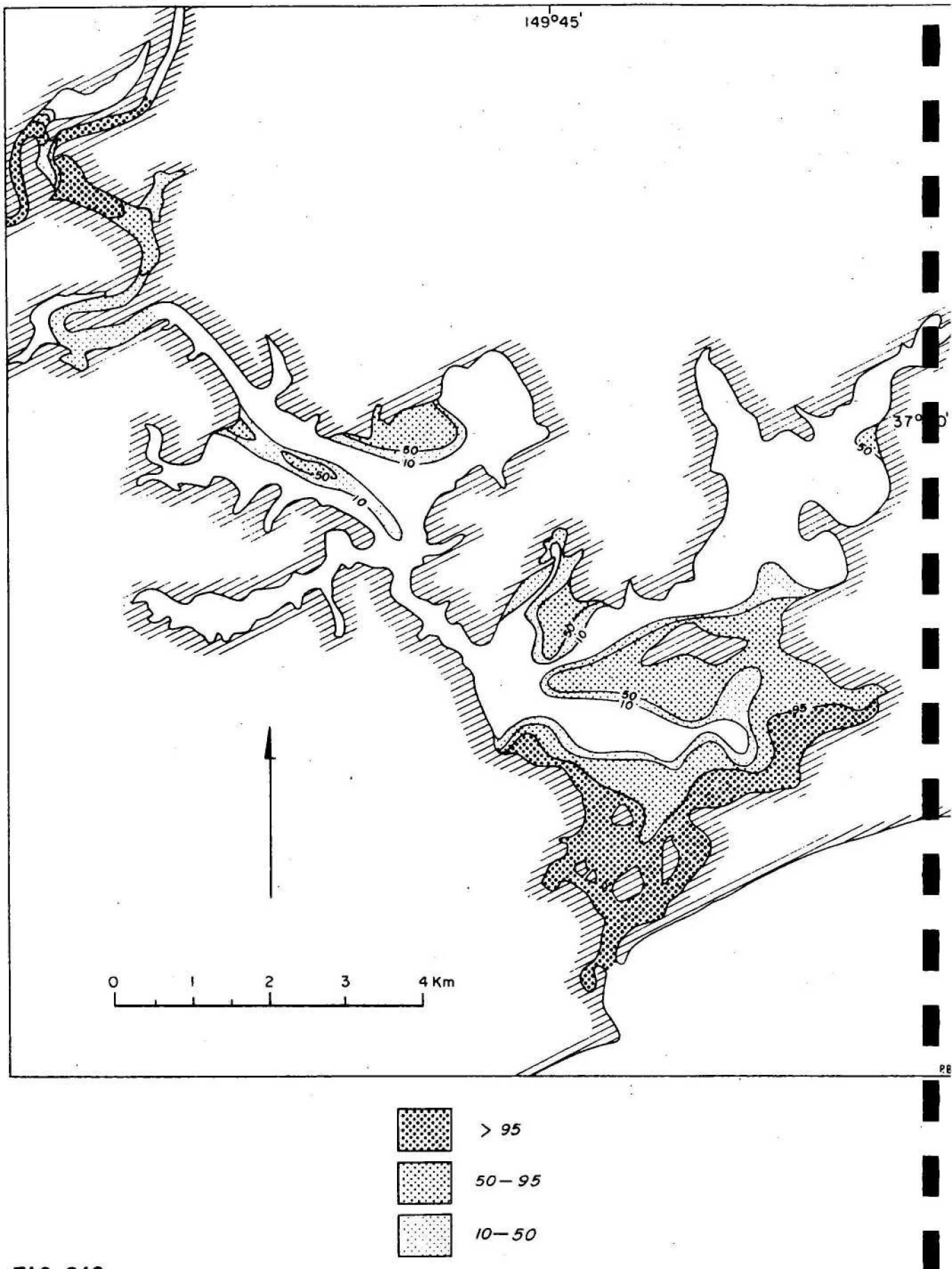


FIG S10

Mallacoota Inlet, showing percentage of sand in bottom surface sediments

MARINE GEOLOGY

by

P.J. Davies

PERSONNEL: H.A. Jones, P.J. Davies, J.F. Marshall.

The geological reconnaissance of the east Australian continental shelf between latitudes 28°S and 40°S was completed in mid-May (Fig. S11). Three hundred and thirty bottom samples were collected, and 3800 km of seismic profiles obtained. In addition, the Gascoyne Guyot (latitude 36°43'S, longitude 156°13'SE) was charted, and samples collected. Throughout the rest of the year, mechanical, petrological, and chemical analyses of the samples continued. Interpretation of the seismic and bathymetric profiles have been made. The preliminary results indicate that three main lithofacies occur on the continental shelf of New South Wales:

a. A nearshore zone of predominantly fine to coarse quartz sand and gravel. In some localities, little or no sediment is present, and bedrock is exposed. The only fine sediment encountered in the nearshore zones is in the proximity of river mouths, such as the entrance to Newcastle Harbour. The aereal distribution of such sediments is small.

b. An intermediate zone, generally deeper than 60 m, where fine-grained sediments consisting of light olive-grey, clayey sands predominate. The light grey colour is imparted by the clay, after removal of which the sand fraction is yellowish brown. Although this fine-grained lithofacies usually occupies the middle part of the shelf, it may occur farther inshore, or offshore, or may be locally absent.

c. An outer zone of medium to coarse sands with a high biogenic carbonate content. These outer shelf sands consist of quartz, molluscs, bryozoans and foraminifera.

In the eastern part of Bass Strait, three similar lithofacies occur. However, north and northeast of Flinders Island, the sediments are composed mainly of bioclastic carbonate material.

Morphologically the shelf can be divided into two zones, a shoreline zone (0-110 m), and a shelf plain zone (110-150 m). These variations reflect the relief of seismic basement. The depth of the shelf break varies from north to south, and this variation also is related to the depth of seismic basement below the sea bed. The dip of the continental slope ranges between 1°-14°, with the highest dips being recorded south of Jervis Bay. Terracing of the shelf is common, but changes in slope attributable to ancient submerged shorelines are poorly defined and impersistent. Two such changes of slope, at about -48 m and -60 m, were located in the Tweed Heads area. Dredging in these features revealed generally

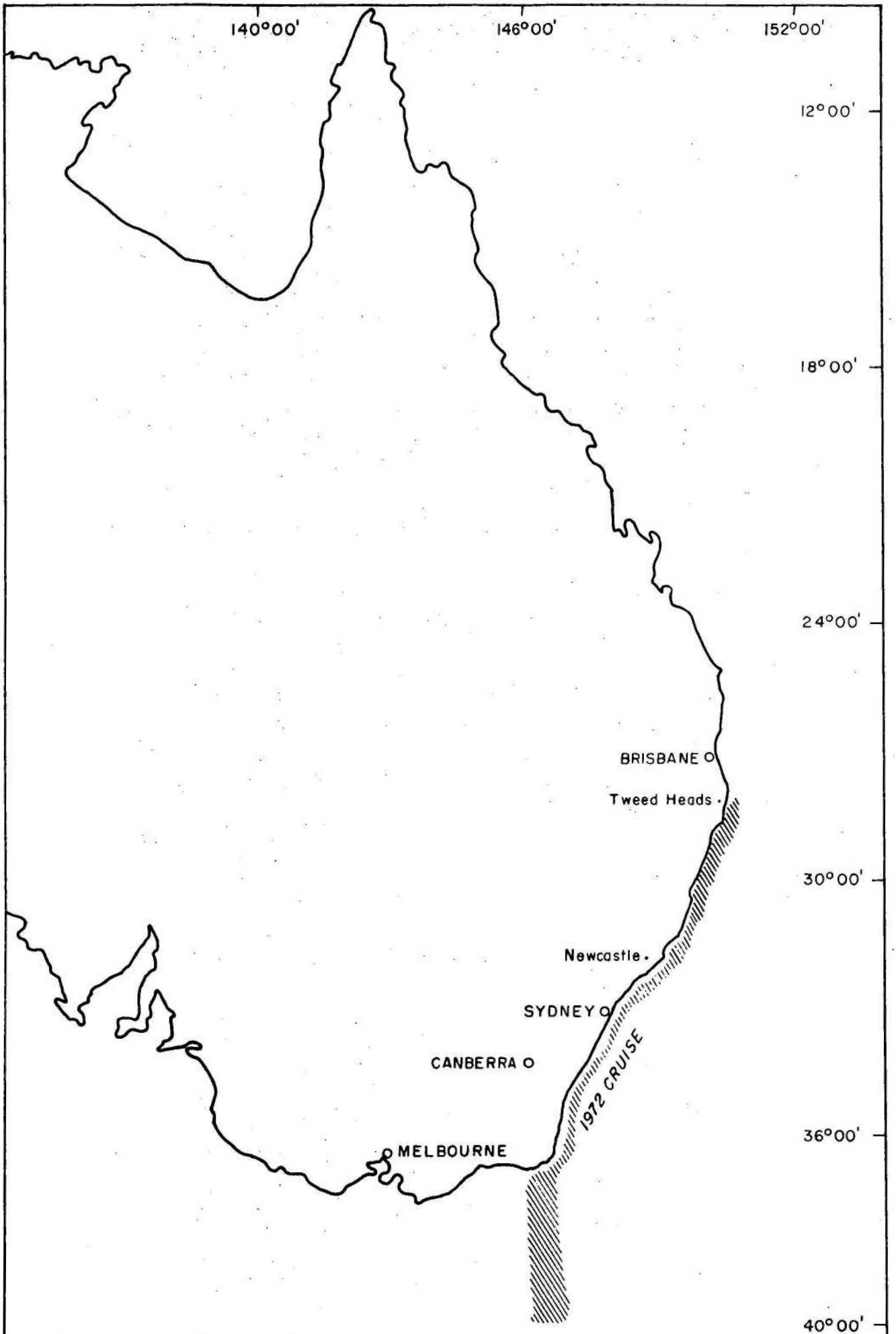


FIG S II-AREA COVERED BY MARINE GEOLOGICAL SURVEY, JAN-MAY 1972

To accompany Record 1972/103

Aus 6/29

barren sands at the surface; one sample off Tweed Heads dredged from 48 m of water contained about 1 percent heavy minerals, but the rutile content was negligible. Correlation of terraces from traverse to traverse has proved difficult until now, but detailed analysis of profiles collected during the contract bathymetric survey for the Division of National Mapping, is being undertaken. These closely spaced and accurately positioned lines may provide the necessary detail. The use of such features for identifying and delineating rates of tectonic warping of the continental shelf is being investigated.

Sketches of some of the east-west seismic profiles across the New South Wales shelf are shown in Figure S12. The basement may be divided into two zones, a region of depressions and rises west of the 110-m isobath, and a region of easterly dipping basement to the east of this depth. A pronounced basement high separates these two regions (Fig. S12 - A,B,C). Two distinct zones of differing sediment thicknesses have been delineated; they are separated by a seismic basement high on which sediments are thin or absent. The basement high forms a lineament trending NE-SW in the area between Port Stephens and Jervis Bay, and preliminary studies of the area between Port Stephens and Coffs Harbour suggest that it may extend north of Port Stephens. It does not occur to the south of Jervis Bay (Fig. S12 - D). In addition to this feature, three basement highs trending E-W are present on the shelf in the vicinity of Port Stephens, Shoalhaven Bight, and southeast of Disaster Bay. The thickest sedimentary sections on the shelf occur between Montague and Gabo Islands, and to the east of Newcastle.

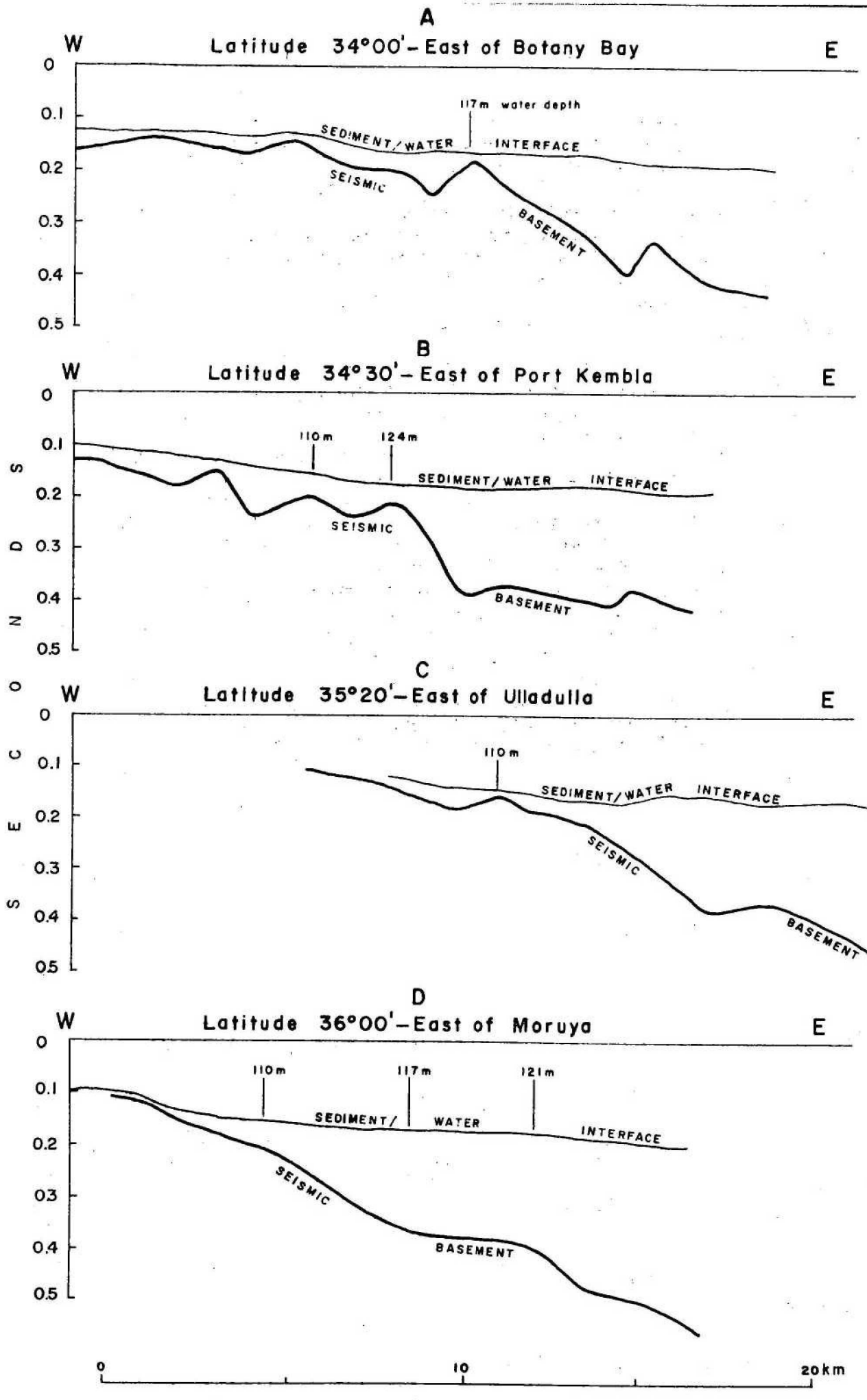


FIG S12-DIAGRAMMATIC SECTIONS ACROSS THE NEW SOUTH WALES CONTINENTAL SHELF

To accompany Record 1972/103

Aus 6/28

EVAPORITE STUDIES

by

A.T. Wells and A.J. Stewart

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

Australian-wide evaporite studies include a continuing review of existing information and shallow drilling of some outcrops of basin evaporite deposits in the Officer Basin. An account of the results of previous stratigraphic drilling of evaporites in the Amadeus Basin at Goyder Pass, Gardiner Range and Lake Amadeus was finalized (Record 1972/36).

Evaporite drilling started in September in the northern Officer Basin, W.A. at Woolnough Hills diapir, one of several similar structures in that part of the basin. The hole, BMR Warri 20 (Fig. S3; lat. 24°06', long. 124°34') intersected laminated gypsiferous dolomite, gypsum, and grey friable dolomite with gypsum crystals up to 10 cm acrosss in the first 204 m. Anhydrite first appears in the core at about 120 metres where it occurs with dolomite. Interbedded halite and anhydrite were intersected from 204 m to 208 m. The hole was prematurely abandoned at 262 m because of lost circulation and non-recovery of cores and cuttings. The next hole is to be drilled in one of the twelve domal culminations known along the arcuate linear trend of the Madley Diapirs area (Fig. S3). The central six of these diapirs have Proterozoic rocks exposed in their cores and it is proposed to drill the most westerly. This diapir has a central core of gypsum about 730 m long and 600 m wide. No large sink holes are apparent in outcrop which suggests that drilling may be possible with air.

A notable new discovery of basinal evaporites was made in the Bonaparte Gulf Basin in the Pelican Island No. 1 well drilled by Arco Aust. Ltd. The well reached a total depth of 1981 m and intersected salt from 1797 m to total depth. The well was sited on the crest of one of several intrusive bodies that have been seismically mapped in the area.

A lecture on Australian evaporite deposits and their economic significance was given by A.T. Wells at the BMR Symposium in May 1972.

Ringwood Evaporite Study (A.J. Stewart)

Petrographic and geochemical studies of the Ringwood core (BMR Alice Springs No. 3) were completed, and writing of a report on this work began. The rocks appear to be typical marine evaporites, beginning with a bituminous cherty dolomite, followed by interbedded gypsum and gypsiferous dolutite. The gypsum contains small inclusions of anhydrite, and these become more abundant down the core. Calculation of rock norms from major element analysis (Ca, Mg, SO_4, and H_2O) revealed an exponential decrease in the gypsum/anhydrite

ratio down the core, indicating that the gypsum formed by hydration of the anhydrite. Celestite ($SrSO_4$) occurs as aggregates in the gypsum, providing further evidence of the hydration of anhydrite to gypsum. The average K-content of the core is less than 0.2%, but at a depth of 87 m the K-content rises sharply to 0.62%; this was found to be caused by an influx of detrital feldspar and muscovite, these minerals being present in negligible amount in the remainder of the core.

PHOTOGEOLOGY AND REMOTE SENSING

by

W.J. Perry, C. Maffi, C.J. Simpson

1. Australian Committee for Earth Resources Technology Satellites (ACERTS)

Throughout the year the Geological Branch provided the secretariat for the interdepartmental committee ACERTS, the Australian Committee for Earth Resources Technology Satellites, which is concerned principally with Australian participation in the United States Earth Resources Technology Satellite and Skylab programmes, and also with associated programmes of remote sensing in Australia. The Director is Chairman of the Committee and W.J.Perry Secretary. Other representatives within the Department come from the Forestry and Timber Bureau, and the Divisions of National Mapping, and Energy and Water. Other organisations represented on the Committee are CSIRO and the Departments of Supply, Education and Science, Interior, Army and Primary Industry.

In January Dr Fisher accepted an invitation to attend a meeting of a U.S. House of Representatives Panel on Science and Technology with the theme "Remote Sensing of Earth Resources", and gave an address on the "International Implications of Remote Sensing".

C. Maffi attended a United Nations Panel Meeting on remote sensing in Brazil in November-December 1971. (See below).

ACERTS coordinated supplementary proposals to NASA from State authorities, universities and private companies to evaluate imagery from the ERTS-A Satellite which was successfully launched in July. The Committee also circulated investigators with information on NASA procedures for reporting results). The signing of the formal agreement between the U.S.A. and Australia on ERTS-A (now referred to as ERTS-1), a pre-requisite to Australia's receiving imagery, was completed on 6 October.

A proposal to fly side-looking radar with stereo coverage over one of the ERTS test sites on the Mount Isa-Cloncurry region was endorsed by ACERTS and funded jointly by the Bureau and the Division of National Mapping. The imagery was acquired in June, but at the end of October the contractor had not supplied all of the data. When negatives become available, it is intended to make copies of the radar mosaics and strips available to interested organizations for the cost of reproduction.

In August ACERTS disseminated information about opportunities for participation in the ERTS-B satellite experiment to all universities, and to those who had expressed an interest in the ERTS-A satellite. The Committee also arranged through the Councils mentioned below for specialist committees to be set up to

assess ERTS-B proposals in the various disciplines before they are forwarded to NASA: Australian Forestry Council, Minerals Council, Agricultural Council, National Mapping Council, and Water Resources Council.

2. Overseas Visits

C. Maffi attended a United Nations Panel Meeting on the establishment and implementation of research programmes in remote sensing from 29/11/71 to 10/12/71. The meeting was held at the Brazilian Institute of Space Research (I.N.P.E.), Sao Jose dos Campos, Brazil, and was attended by 136 delegates.

The object of the meeting was to study the organization and administration of a programme of remote sensing and to prepare recommendations on the fulfillment of such a programme. To achieve this purpose, the Panel investigated the Brazilian, Canadian, Indian and Mexican remote sensing programmes. Visits were made to the I.N.P.E. campus and aircraft, to the Geoscience and Oceanographic Institutes of the University of Sao Paulo, to the Agronomical Institute of Campinas and to the Department of Mineral Production and the Naval Research Institute of Rio de Janeiro.

The principal conclusions were:

a. Within the framework of national planning, operational remote sensing can be a contribution to the assessment, development and management of the natural resources of a nation.

b. With this aim in view, the widest possible international exchange of information on remote sensing is recommended.

c. The basic requirement for a remote sensing application programme in any country is the awareness of the potentialities and limitations of this technology. This should lead to a clear definition of the practical objectives of the programme, which should be followed by a national commitment and by the development of a well defined programme in terms of organizational requirements, trained personnel, equipment, facilities and utilization of data.

C.J. Simpson left Canberra on 27 September 1972 to study U.S.A. methods of interpreting data from the ERTS-1 Satellite.

3. Photointerpretation

Papua New Guinea: The eastern two thirds of the Wabag Sheet was photointerpreted prior to field investigations.

Northern Territory: The Cobourg Peninsula, The Granites, Highlands Rocks (northern quarter), Bathurst Island, Melville Island and Mt Peake 1:250 000 Sheet areas were photointerpreted. Assistance with photointerpretation was given to the Alligator River Party.

Queensland: The compilation of the photogeology of the 1:250 000 Coen and Cape Weymouth Sheets was completed.

Western Australia: Several airphotographs in the southwestern corner of the Helena Sheet area were interpreted to assist the Earthquake Effects Project personnel in their study of the East Canning Basin.

Australian Capital Territory: Assistance with photo-interpretation of structural features was given to the Tantangara Party.

4. Remote Sensing

Western Australia Project (Laverton and Leonora areas): Evaluation of the multispectral photography - which was taken in 1970 by the Geophysical Airborne Group - was completed. The project demonstrated that, in the environment studied, combined geophysical and photogeological interpretations (assisted by reference to all published geological reports) provided more geological data than could be interpreted from either technique considered singly.

Of the photography studied (panchromatic photography, normal colour, colour IR, black and white IR, and variously filtered panchromatic film) interpretation of normal colour in conjunction with panchromatic photographs provided more geological data than the other varieties. Visual examination and comparison of individual panchromatic photographs of various spectral bands is not recommended. Multispectral colour reconstitution techniques were not evaluated.

Cloncurry Project: As in 1971, the Photogeology Group supervised the BMR logistic support for the Remote Sensing Project of Bedford College, London University. Bedford College personnel carried out field work in the Cloncurry area from March to October 1972.

Mt Isa - Cloncurry SLAR Project: The imagery was flown in June by AeroService Corporation with equipment provided by Goodyear Aerospace Corporation. The Photogeology Group have received a 1:100 000 scale mosaic of the whole area and some photographic enlargements of the original strips that, combined with the mosaic, give stereo coverage.

Many known lithological features can be easily recognized on the imagery and are well displayed. A full evaluation of the imagery will be done in 1973.

Bowen Basin Thermal IR Project: Evaluation of the data was incomplete at the end of the period, but preliminary results indicate that cool anomalies in the post-sunset imagery are related to linear grass-covered strips that occupy positions at which weathered coal comes to the surface. The cool strips are apparently due to the presence of grass rather than trees, which appear relatively warm in post-sunset imagery.

5. Training

Mr Jim and Mr Kim, Colombo Plan students from Korea, were given training in the application of photogeological techniques to regional mapping.

BMR geologists P. Smart, S. Powell, A. Watchman, K. Johnston, B. Radke and BMR draftsmen D. Walton, M. Little, D. Pillinger were given instruction in photogeology.

A five-day course was given to 10 ANU 3rd and 4th year students.

Western Mining geologists D. Barr and D. Duncan were given a two-week course.

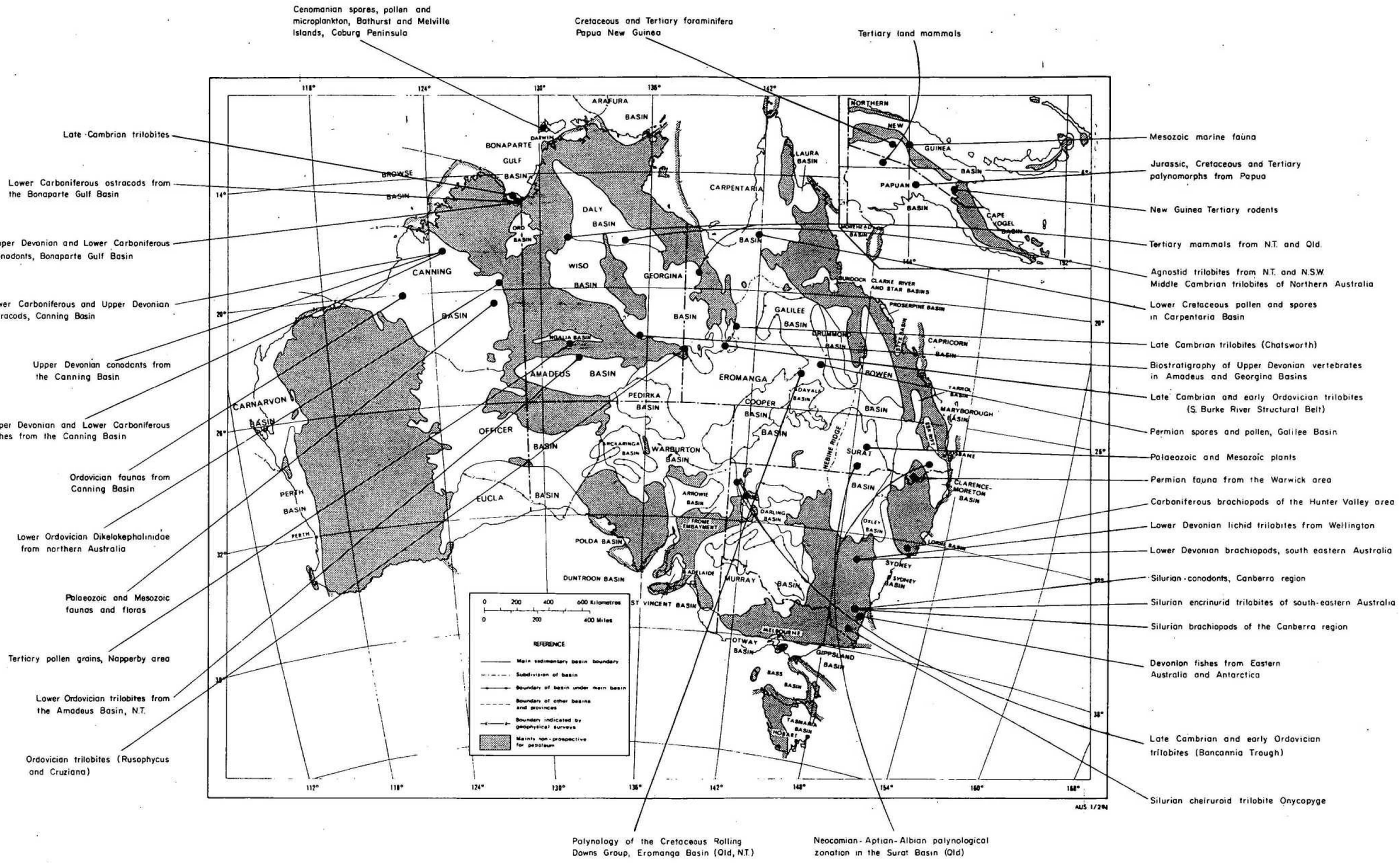


FIG S13 CURRENT PALAEONTOLOGICAL PROJECTS

To accompany Record 1972/103

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PALAEONTOLOGICAL STUDIES

R.S. Nicoll joined the Palaeontology Group in December 1971 from the State University of Iowa to work on conodonts.

E.C. Druce returned in January 1972 after spending two years at the University of Michigan where he was awarded a PhD degree following study of Devonian and Carboniferous conodont faunas from the Canning Basin.

Dr M.O. Woodburne from the University of California, Berkely is spending a year working with the Group on Australian marsupials.

Dr R.A. Cooper from the Geological Survey of New Zealand will spend four months beginning from September in comparing New Zealand and Australian Cambrian trilobites.

Specialist work under contract has been continued by A.A. Opik (Cambrian trilobites and stratigraphy) and Mary E. White (fossil plants).

In the micropalaeontological section, 2428 samples were washed for examination of their fossil content, and 1011 thin sections were prepared from a further 742 samples. In addition, polished surfaces were prepared of many samples, for which thin sectioning was not necessary. In the acid laboratory, Fyshwick, 1100 samples were digested in acid for the extraction of conodonts; this represents about 2200 kilograms of rock. In the palynology laboratory, new techniques were developed for the chemical treatment of samples, mostly mudstone and siltstone, and lignites; during the year 420 rock samples were processed.

J.M. Dickins

The Bulletin on the geology of the Bowen Basin, Queensland, was completed and the manuscript sent to the printer. Proofs of text and plates have been checked.

Description of Permian marine invertebrate faunas from the Eight Mile and Tunnel Blocks of the Warwick area, Queensland, was begun and faunas from the Northeast Canning Basin were examined. Two weeks were spent with the Northeast Canning Basin field party making fossil collections and in field mapping. The southern part of the Sydney Basin was examined with the staff and third year students of the Geology Department of the University of New England.

J.M. Dickins attended the Sydney Basin Symposium in Newcastle and gave a paper at the ANZAAS Congress on the evidence from marine invertebrates for the climate of the Permian in Australia. Examination of a marine invertebrate fauna from near Kimberley, South Africa, showed marine incursions into the main Karoo Basin in Upper Dwyka time.

Preparations were undertaken for the Third Gondwana Symposium to be held in Canberra in August 1973.

M. Plane

Work continued in 1972 on Tertiary mammal faunas from Bullock Creek, Riversleigh and Lake Ngapakaldi. More cranial and some post-cranial material of the zygomaturine genus Neohelos was prepared and mensuration and statistical work was commenced on these fossils. Comparative work has been carried out on the Neohelos specimens from Lake Ngapakaldi, South Australia. Study continued on the Thylacoleonidae, and comparative material from Queensland and New South Wales was used.

Remains of the Pleistocene genus Diprotodon were found in the Todd River, near Alice Springs. These fossils were identified and advice was given to the Resident Geologist on the recovery of vertebrate fossil material.

Dr M.O. Woodburne of the University of California arrived in Canberra in July. Woodburne and Plane then worked together on a correlation chart of all Tertiary mammal faunas in Australia and New Guinea, and a diagrammatic representation of all Australian fossil marsupial genera and their distribution in space and time.

Some time was spent preparing for an overseas visit to Britain and the United States where two conferences were attended, a paper given reviewing Australian Tertiary mammal faunas, and collections of Australian fossil marsupials studied.

J.H. Shergold

J.H. Shergold spent twelve months working in cooperation with the U.S. Geological Survey at the U.S. National Museum in Washington, D.C.

En route to the USA visits were made to the British Museum (Natural History) and the Institute of Geological Sciences in London, and the Sedgwick Museum in Cambridge, where late Cambrian type materials were examined. Whilst in England, visits were also made to classic geological sections of Cambrian age in Shropshire and North Wales. A colloquium on the Ordovician and Silurian Systems, held at Brest in Brittany, was attended, and a paper summarising data on the base of the Ordovician System in northern and central Australia was presented, and published in BRGM Memoir 73.

A considerable proportion of the time spent in the USA was devoted to examining Cambrian type trilobites in the collections of the U.S. National Museum. Many of these specimens (1700) were replicated for the purposes of facilitating descriptions of Australian materials, and to elucidate taxonomic problems. Visits were made to the American Museum of Natural History in New York, the Geological Survey of Canada in Ottawa, and further collections were examined at the State University of New York at Stony Brook. Field excursions were made to North American arenaceous type sections for the Upper Cambrian in Wisconsin and Minnesota, and to sections in Nevada, Utah, Arizona, Idaho, Oklahoma, Virginia

and Maryland at which different carbonate environments were compared and contrasted. A lecture on aspects of late Cambrian biostratigraphy in northern Australia was presented to the Palaeontological Society of Washington.

As a result of the laboratory work undertaken, the MS of Bulletin 136, late Cambrian and early Ordovician trilobites from the southern part of the Burke River Structural Belt, western Queensland, was largely completed, only the introductory passages requiring revision at the conclusion of the year.

On the return to Australia, a visit was made to the Geological Institute and Museum at the University of Tokyo, where Cambrian type collections from China, Manchuria, and Korea were assessed, and a further 300 specimens prepared for a replica reference library.

D.L. Strusz

D.L. Strusz spent much of the year curating and examining the large collections of fossils that have been made in the Canberra region. This task is now virtually complete, apart from a few small collections with very scant locality information. The encrinurid trilobites are being prepared for inclusion in the revision of the southeast Australian representatives of that group, being undertaken jointly with J.H. Shergold. The bulk of the literature for this revision, particularly concerning species that have been described from outside Australia, has now been obtained.

Collections from the Ordovician to Devonian rocks around Lake Bathurst - Tarago, submitted by Jododex (Aust.) Pty Ltd, were examined. The age determinations have been of considerable help to the company's geologists in their mapping of this area of poor outcrop and complex structure. Ordovician and Silurian fossils collected by the Tantangara party were also identified.

Notes were prepared for excursions to the Cullarin Horst (Bungendore-Captains Flat-Queanbeyan) and the Yass Shelf (Yass-Burrinjuck Reservoir), organized for the Sydney Branch of APEA and held on 14-15 October. The excursion notes have been designed for general use, for example by school parties or by visiting geologists, and supplement rather than replace the excursion notes prepared for the 1964 ANZAAS meeting in Canberra.

Joyce Gilbert-Tomlinson

Two new collections from the Canning Basin Ordovician of the Billiluna area were examined. The first, submitted by R.J. Paton, Mines Administration Pty Ltd, contains enomphaloid gastropods; the second, by geologists of a BMR field party, contains two hystricuroid trilobites. None of these fossils has been noted in earlier collections, and a large fauna is indicated.

Silurian sections were examined during a visit to the ANU's student excursion to Quidong, in southern New South Wales. A search for material to fix the familial position of the indigenous cheiruroid trilobite Onycopyge proved unsuccessful, the few specimens found being inadequately preserved.

Studies on Cruziana and Rusophycus from Ordovician sandstones of the Amadeus and Georgina Basins and northwestern New South Wales, in sequences firmly dated by body-fossils, show a stratigraphic succession of ichnospecies, and demonstrate the lateral continuity of the early Ordovician sea in all three areas. Most of the trace-fossils are of the shallow-water type, but a few suggest the occasional intervention of quiet conditions. Thus the trace-fossils, as far as known, confirm ideas on environment already suggested by the application of other techniques.

G.C. Young

June to August 1972 were spent with the West Canning Basin Field Party collecting Devonian fish remains from the Gogo Formation (Frasnian) which crops out in a number of areas around Bugle Gap, 80 km east of Fitzroy Crossing. This formation is an inter-reef limestone unit from which a large and exceptionally well preserved fish fauna was collected in 1967 by a combined British Museum/Hunterian Museum expedition. Fragmentary fish remains were collected from the Billiluna area previously discovered by Veevers and Roberts in 1966 and from several other localities in the Fairfield and Laurel Formations and from Permian limestones in the Balgo Hill area. The Gogo collection will eventually be shared with the Geological Survey of Western Australia.

A week was spent collecting fish fossil material in the Wee Jasper area (November 1971).

The preparation and description of Antarctic material has occupied most of the year. Much time was spent on preparing the antiarch component (mostly the genus Bothriolepis) in the Antarctic collection, which was made in Victoria Land during the summer season of 1970/71, and about 60% of the material has now been prepared. Preliminary photography was undertaken in December and January and detailed description of the headshield of Bothriolepis is well advanced. Descriptive work on the trunk armour has been commenced but further work is limited until preparation is complete. All material so far examined is tentatively assigned to a single species of Bothriolepis, although a great range of morphological variation is evident, a common feature in Bothriolepis. Statistical analysis of variation with size has been undertaken but results remain inconclusive until all available material has been treated.

Several days in August were spent in Melbourne examining comparative material at Monash and Melbourne Universities, and two days in Sydney in May were taken up selecting material from the Antarctic collection at the Australian Museum for transfer to Canberra.

Only a few of the major references on this work are held in the library and attempts were made during the year to improve this situation. A. Haupt assisted by translating a number of monographs by the German workers Gross and Heintz.

Preparatory and descriptive work on the Taemas/Wee Jasper fauna has progressed throughout the year. The partial remains of several new genera have been prepared, X-rayed and photographed and considerable comparative and descriptive work was carried out in April and May. Correspondence was exchanged with workers in the British Museum (Natural History) regarding forthcoming publications on their collection of the same material, which has now been under study for over ten years without any published results.

A collection of Devonian fish material from various localities sent to Professor E.S. Hills over the past twenty years was returned to the Bureau in May. Included was a collection made by Bureau geologists in 1958 in the Dulcie Range, N.T., and an antiarch plate supposedly from the Taemas area. The Dulcie Range collection has provided important new information on the biostratigraphy of Upper Devonian fishes in Australia, with the placoderm Phyllolepis in association with an arctolepid fauna of European Middle Devonian aspect. The Taemas antiarch, if confirmed, will be one of the earliest records of this group known.

D.J. Belford

D.J. Belford was mainly occupied on palaeontological work connected with the regional mapping programme in Papua New Guinea. Most work was done on samples collected from the West Sepik area; these samples ranged in age from Lower Cretaceous (or possibly Upper Jurassic) to Middle Miocene. No detailed examination of the faunas has been made; one fauna worth close examination is an assemblage of agglutinated foraminifera occurring with globotruncanids of probable Senonian age. The agglutinated species may be of value for age determination of beds lacking a planktonic foraminiferal fauna, but first need to be differentiated from agglutinated assemblages of Lower Cretaceous age.

Samples collected by the Port Moresby Resident Staff from the Port Moresby, Yule, Aroa, Bogia, Ambunti and Huon 1:250 000 Sheets were also examined during the year. Eight samples from the Naltja area, West Irian, submitted by P.T. Kennecott (Indonesia) were also examined; these were of uppermost Cretaceous or Lower Tertiary, Eocene and upper Oligocene ages.

A detailed examination of the foraminiferal faunas and stratigraphy of the Wabag area was begun. Examination of samples collected by the West Sepik follow-up survey, and the Torricelli survey, is proceeding.

During August and September the West Canning Basin field party was visited. Sections in the Napier and Oscar Ranges of the

Canning Basin, and the Burt Range area of the Bonaparte Gulf Basin, were examined.

P.J. Jones

The main project - systematic palaeontology of the Lower Carboniferous Ostracoda from the Bonaparte Gulf Basin - was continued; this work involves the description of ostracod species, and scanning electron microscopy, which has revealed morphological structures hitherto unknown in Palaeozoic ostracods. Many of these species are new, whereas others appear to be closely related to those previously described from the Lower Carboniferous rocks of Europe (the USSR in particular), and the USA.

A chart with accompanying notes were prepared (with J. Roberts, Univ. of NSW, and K.S.W. Campbell, ANU) on the correlation of Carboniferous rocks of Australia, for publication in the BMR Bulletin Series.

A short review paper on the geology of the Ord Basin was prepared for the AIMM new volume on "Economic geology of Australia and Papua-New Guinea".

Time was spent on scientific editing of three manuscripts submitted by Dr Paul Tasch (University of Wichita, Kansas) on Conchostraca from the Carboniferous and Triassic of the Canning Basin, the Lower Triassic of the Bonaparte Gulf Basin, and the Permian and Triassic of the Bowen Basin.

E.C. Druce

Work continued on Upper Devonian conodonts from the Lennard Shelf of the Canning Basin. An analysis of the genus Icriodus suggests that the minor morphological variations used to speciate it may be minor morphological changes due to ecological conditions rather than distinctive features of chronological importance.

The distribution of conodonts in time and space was studied and a concept of biofacies (fossil assemblages of most palaeontologists) was used to divide late Palaeozoic faunas. This is in press as "Upper Palaeozoic and Triassic Conodont Distribution and the Recognition of Biofacies", to be published by the Geological Society of America as part of Special Paper 141.

From April to October was spent in the Canning Basin (see Detailed Mapping Projects).

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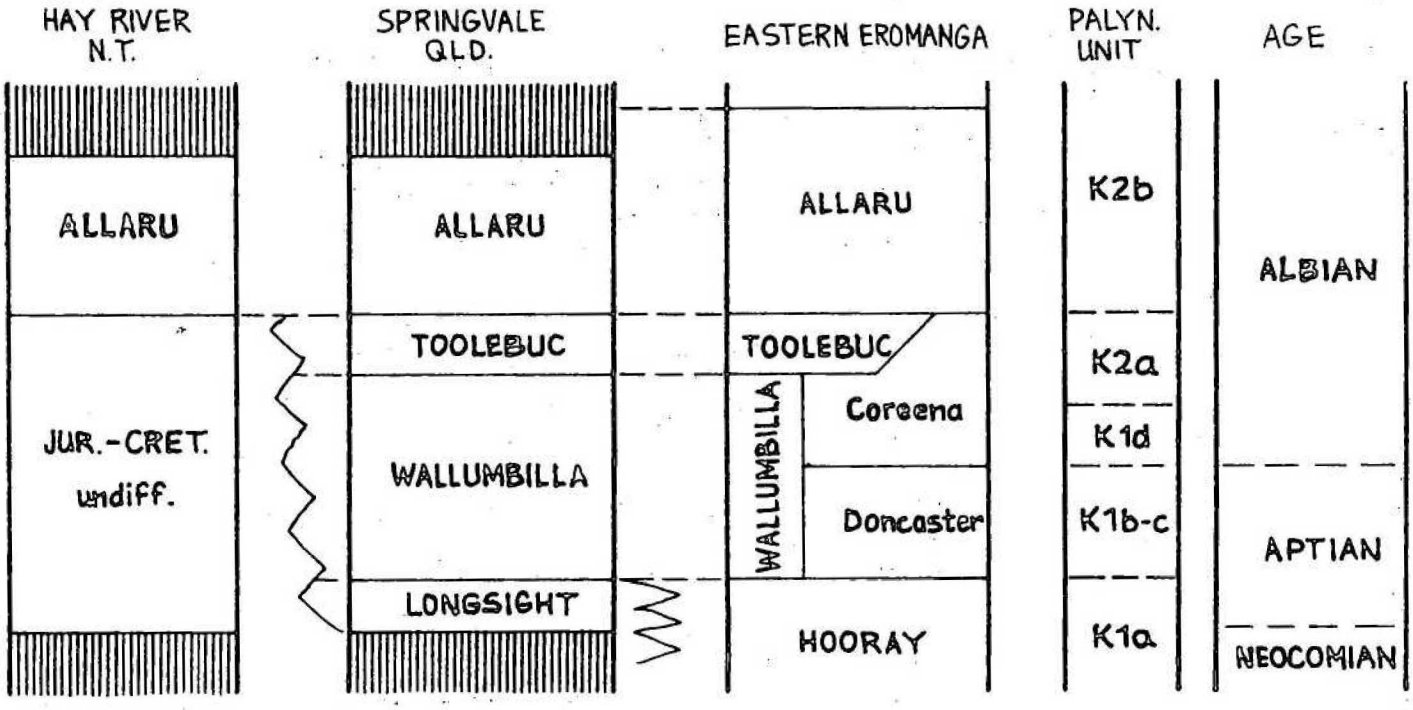

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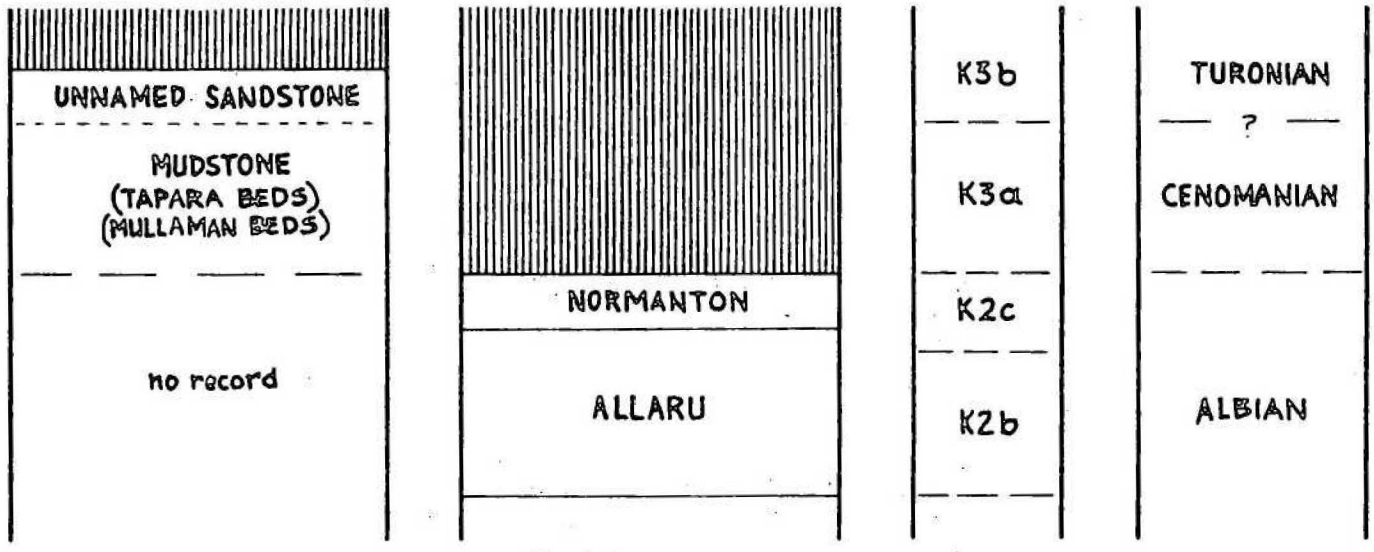

FIG S14 PALYNOLOGICAL CORRELATIONS IN THE CRETACEOUS OF QUEENSLAND AND NORTHERN TERRITORY

D. Burger

Palynological work on the Cretaceous of the Great Artesian Basin continued. A study was made of the Rolling Downs Group (Aptian-Albian) in the western part of the Eromanga Basin, the Hay River area, Northern Territory, and the Springvale area, Queensland, based on core samples from BMR shallow stratigraphic drilling, and cores and cuttings from mineral exploration drilling. Provisional results of stratigraphic palynology, in combination with field work, is shown in Figure S14. A complementary study of the Neocomian-Aptian in the Surat Basin, based on core samples from two shallow stratigraphic bores, GSQ Roma 3 and DRD 27, drilled by the Geological Survey of Queensland in the Roma area (Mooga Sandstone, Bungil Formation) is in progress.

A detailed palynological study was made of marine sediments in two oil exploration wells drilled on Bathurst Island, Northern Territory (Oil Development N.L. Bathurst Island Nos 1 and 2) and they were dated as Cenomanian. Twenty samples from cores were available for this study, and of these, seventeen yielded abundant and diverse microfloras. Based on limits of ranges of certain species, two intervals, spore units K3a and K3b, were distinguished in the palynological sequence. Stratigraphic relationship of these units with those associated with the Rolling Downs Group in the Carpentaria Basin, Queensland, is shown in Figure S14B.

Outcrop samples from the West Sepik area, Papua, were examined for plant microfossils but were too weathered for reliable age determination. Outcrop samples from Cretaceous (Cenomanian) sediments of Bathurst and Melville Islands, and Cobourg Peninsula, were examined for palynological age determination, with comparatively better results. Furthermore, palynological examination was made of samples from the subsurface in the Normanton, Walsh, Red River Sheet areas, Carpentaria Basin, Queensland (Cretaceous), and the Rodinga Sheet area, Northern Territory (Tertiary).

D. Burger joined the Bathurst-Cobourg Geological Party for the period 19 June to 6 July, and collected fossils, mainly cephalopods and pelecypods, and also some outcrop samples for palynological examination.

M.S. Norvick

A paper on the mid-Cretaceous microplankton of Bathurst Island, Northern Territory, was completed and a joint paper on the palynostratigraphy of the Cenomanian of Bathurst Island was written in collaboration with D. Burger.

Samples from the 1971 BMR Galilee Basin seismic survey and from Aust. Aquitaine Fermoy-1, Queensland, were examined for fossil palynomorphs and reports written on their biostratigraphy.

Field work with the West Sepik survey commenced in Papua New Guinea on 23 August and finished on 28 November 1971. Laboratory work associated with and following the survey included the palynological and micropalaeontological examination of samples for stratigraphic purposes. In collaboration with H.L. Davies and other members of the survey the compilation of preliminary 1:250 000 geological maps of Blucher Range and the western half of Wabag Sheet areas was completed and a provisional stratigraphic framework established.

In collaboration with H.L. Davies a lecture was presented at the BMR symposium in May 1972 on aspects of the geology of the West Sepik area.

A briefing was attended on tropical hygiene at the School of Public Health and Tropical Medicine, University of Sydney, and a report compiled for distribution to BMR personnel working in Papua New Guinea.

Field work with the 1972 Torricelli survey began in Papua New Guinea on 29 July and finished on 16 September. Compilation and micropalaeontological investigations were started on return to Canberra.

R.S. Nicoll

Collecting and processing of Silurian rocks for conodont study in the vicinity of Canberra was started, partly in conjunction with the Tantangara Field Party. Preliminary results indicate low conodont yield per sample.

Sections in the Devonian reef complex and across the Devonian-Carboniferous boundary were collected in the Canning Basin (see West Canning Basin Project). Initial processing of this material has been completed and good conodont faunas have been recovered.

Several sections of the Burt Range Formation in the Bonaparte Gulf Basin were collected but the material has yet to be processed.

METALLIFEROUS SECTION

METALLIFEROUS SECTION

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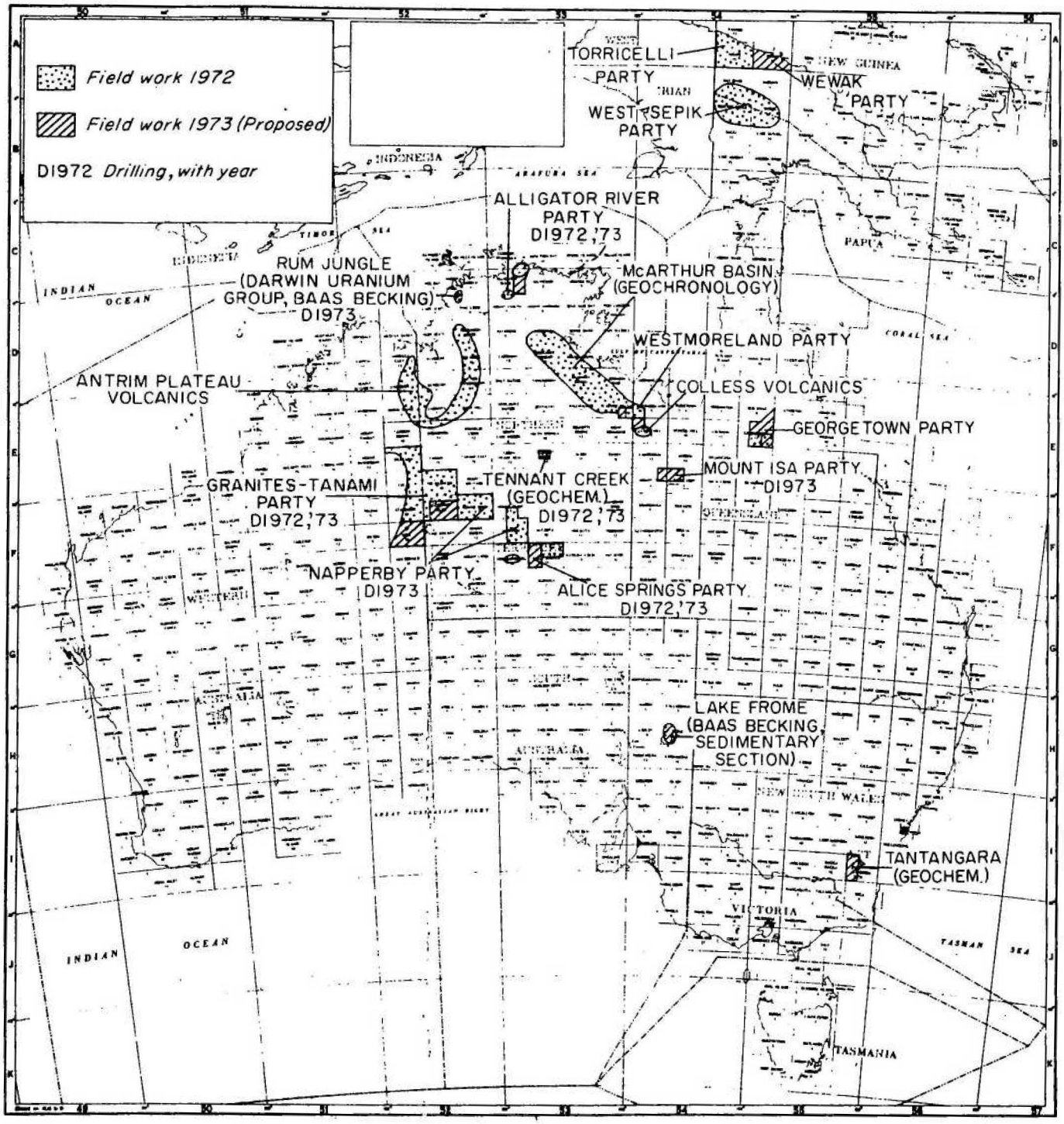


Fig MI Field activities, Metalliferous Deposits Section

SUMMARY

The report that follows summarizes the work of the Metalliferous Section from November, 1971 to October, 1972.

Figure M1 shows the areas where geological mapping and other activities took place in 1972, as well as areas where similar operations are planned for 1973.

Regional mapping was carried out in the Arunta, Granites-Tanami, Victoria River Basin, Torricelli Mountains, and West Sepik areas and in Antarctica, and semi-detailed mapping in the Alligator River, Mount Evelyn, Westmoreland, Georgetown, and Rum Jungle areas. A short time was also spent in completing a reconnaissance examination of late Cainozoic volcanoes in the PNG Highlands.

Laboratory staff provided a variety of support services for field operations, and continued project work in petrology, geochemistry, isotope geology, and geobiology.

During the year a new approach was followed with the introduction of geochemical surveys in conjunction with semi-detailed geological mapping in the Westmoreland region in the northwestern extremity of the Mount Isa Geosyncline, and in part of the Georgetown Inlier. In both projects the geochemical work was restricted to sampling and analysing stream sediments, but the work will progressively be extended to include rock, and possibly soil geochemistry to determine the regional distribution of trace elements and their relationships to rock type and mineralization. Concurrently with this work an inventory of all mineral deposits will be made, including surface mapping of those mines and prospects which are not adequately recorded.

As the projects develop, it is intended to extend the scope of the investigations to include airborne and ground geophysical surveys in a multidisciplinary approach. The broad aim of these projects is to determine the distribution, controls, and surface expression of the mineral deposits of the regions (including their geological, geochemical, and geophysical expressions) to provide a guide for future mineral exploration.

During 1972 reconnaissance mapping of the West Sepik area was completed, and mapping of the core of the mountainous area lying north of the Sepik plain, and extending from Wewak to the West Irian border, was started; fieldwork in this area will be completed in 1973.

The 1:1,000,000 geological map of Papua New Guinea was issued in Preliminary Edition during the year; the coloured edition will be available by mid-1973.

Fieldwork in the Alligator River area has shown that the main known uranium deposits and prospects are situated around the northern and eastern margins of the Nanambu Complex and the south-western margin of the Nimbuwah Complex. These complexes are made up of granite and migmatite, and it appears that uranium contained in the original sediments was driven out and concentrated during migmatization and granitization. BMR aeromagneti results show that the Nanambu Complex is the site of a magnetic low, and that its border is marked by a magnetic high. Preliminary K-Ar and Rb-Sr dating has given ages of about 1800 m.y. for the Nanambu Complex and a biotite-muscovite schist close to the Nabarlek orebody. U-Pb dating by

Hills (Macquarie) and Richards (ANU) on a single sample of pitchblende from the Koongarra lode suggests that uranium mineralization took place about 850 m.y. ago, but subsequent U-Pb and Pb dating on other deposits in the area points to the possibility of a much greater age.

Under the auspices of the Baas Becking Geobiological Research Laboratory, Dr. M.D. Muir, of Imperial College, London, visited Australia in May and June to collect Precambrian material for micropalaeontological study; many promising localities were visited, special emphasis being placed on the McArthur Group (Carpentarian).

During September and October a comprehensive suite of samples was collected from the McArthur Basin for Rb-Sr dating.

Twelve computer programmes covering a wide range of topics were completed during the year.

Two papers were prepared on the development of Archaean shields, with emphasis on the nature and origin of their oldest components.

Trace-element studies of rocks and lodes from the Tennant Creek area suggest a genetic relationship between the formation of lamprophyre and diorite magmas, and the formation of mineralizing solutions, though it is not implied that the lodes were derived from either lamprophyre or diorite magmas.

Work in the Baas Becking Geobiological Research Laboratory suggests that algal material forms complexes with such metals as Cu, Pb, and Zn; the role of these complexes in the concentration and transport of metals is being investigated. A study of the behaviour of heavy metals in brines is almost completed. Studies on the comparative taxonomy of sulphate-reducing bacteria are beginning to provide a firm basis for hypotheses on the role of these bacteria in ore genesis; the hypotheses are being tested in part in a controlled sedimentary system developed by laboratory staff.

Publications and Records issued and in various stages of completion are listed in a separate section of this Summary of Activities. Totals for the period under review are:

Bulletins: Issued 3, in press 7, with editor 3, in preparation 15.
Reports: Issued 2, in press 1, with editor 8, in preparation 6.
Maps and Explanatory Notes: Issued 5, in press 9, with editor 6, in preparation 27.
Records: Issued 28, in preparation 65.
Outside Publications: Published 31, in press 22, submitted 8, in preparation 6.

In addition 7 special maps at scales ranging from 1:50,000 to 1:1,000,000 have been issued, and 4 are in various stages of preparation.

ARUNTA PROJECT, N.T.

by

R.D. Shaw and A.J. Stewart

Personnel:

BMR: R.D. Shaw, A.J. Stewart, R.G. Warren, A.P. Langworthy, L.A. Offe, L.P. Black (part time).

ANU: M.J. Rickard, J.L. Funk, M. Yar Khan, R.W. Marjoribanks.

University of Queensland: A. Allan, S. Iyer.

Introduction

On returning from the field in October, 1971, office work by the Arunta Party included compilation of field mapping results, petrographic and petrofabric study of thin sections, and report writing. Several seminars were held between the BMR and ANU members of the party, and all Canberra-based personnel participated in the Specialist Groups' Meeting of the Geological Society of Australia, Inc., held in Canberra in February, 1972. At the end of March, 1972, the party divided into the Alice Springs and Napperby Parties. During the 1972 field season the BMR continued field support to University students.

Isotopic Dating of the Arunta Complex (Stewart)

Amdel K-Ar dated 27 samples taken from several areas in the eastern and central parts of the Arunta Complex, and the results have partly delineated the areal extent of the warming that accompanied the Alice Springs Orogeny. The area warmed includes the entire Harts Range, the Winnecke-Arltunga-White Range area, and, to a lesser extent, the Reynolds Range 1:100 000 Sheet area. The Harts Range area contains several hydrothermal deposits of copper, lead, and bismuth, and Pb dating of these deposits is in progress.

Rb-Sr dating of Arunta Complex rocks has been undertaken by L.P. Black, and his report appears in the 'Petrological, Geochemical, and Isotope Geology Laboratories' section of this Record.

Professor R.L. Armstrong, of Yale University, forwarded preliminary results of Rb-Sr dating of rocks from the Arltunga Nappe Complex. The results include a well defined whole-rock isochron of 1723±23 m.y. (Carpentarian) from the root zone of the nappe complex, and a whole-rock biotite-muscovite isochron of 320±7 m.y. (Carboniferous) from one sample in the root zone; the data indicate that biotite and muscovite completely (re)crystallized during the Carboniferous Alice Springs Orogeny, suggesting that conditions of the middle greenschist facies were attained.

Arltunga Nappe Complex (Stewart)

Stewart completed photo-interpretation of the northern and southern margins of the Giles Creek Synform, and the overlays were compiled by the party draftsman. A considerable amount of time was spend in editing and re-writing parts of Record 1971/66 "Progress Reports on Detailed Studies in the Arltunga Nappe Complex". Construction began of a three-dimensional sketch of the White Range Nappe based on serial cross-sections computer-drawn in two-point perspective.

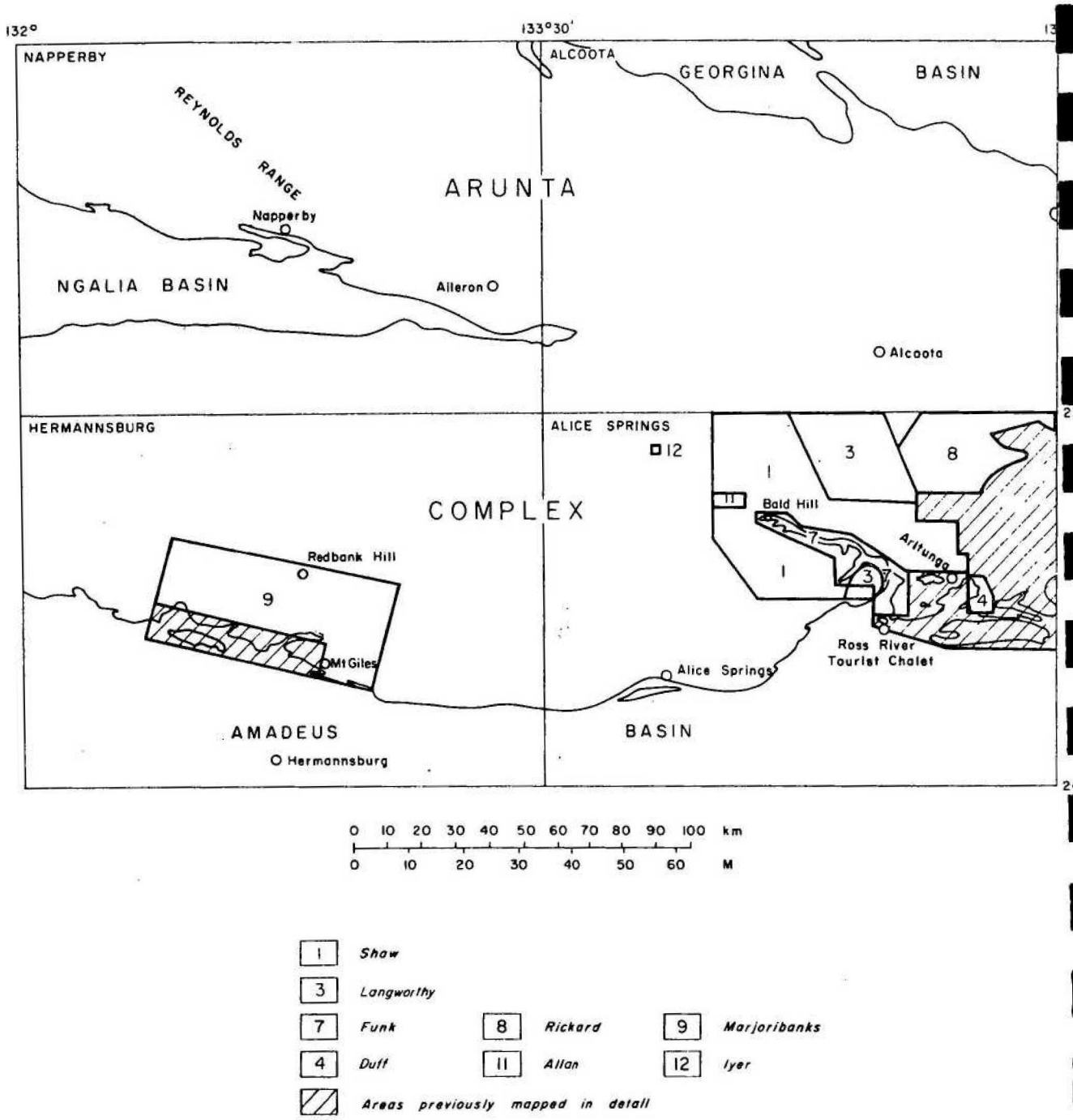


Fig M2 Locality map of Arunta Complex, showing areas mapped May — October 1972 by Alice Springs party

Alice Springs Party. (Shaw, Langworthy, Black (part time); Marjoribanks, Funk, Rickard, Duff, Allan, Iyer).

Fieldwork continued in the Alice Springs 1:250,000 Sheet area; the major part of the Laughlen 1:100,000 Sheet area was mapped by Shaw and Langworthy, the Riddoch 1:100 000 Sheet area was completed by Rickard, and detailed field studies were continued in the Arltunga Nappe Complex by Funk and Duff. Detailed mapping of an area in the Mount Giles-Redbank Hill area, Hermannsburg 1:250,000 Sheet area, was completed by Marjoribanks. As part of the regional study, specimens were collected for isotopic dating. Areas mapped are shown in Fig. M2.

The main discoveries of regional significance were two east-west trending deformed zones formed in the Precambrian. One zone is in the central part of the Alice Springs Sheet area, the other in the Hermannsburg Sheet area.

1:100,000 scale Mapping - Laughlen Sheet area. (Shaw, Langworthy).

An outline of the geology is shown in Fig.M3. A major regional thrust produced during a period of widespread amphibolite facies metamorphism, tentatively dated as Carpentarian, separates a sequence of biotite-rich felsic gneisses in the southern part of the Sheet area from granulites in the north. The thrust occurs north of the deformed zone associated with the Arltunga Nappe Complex.

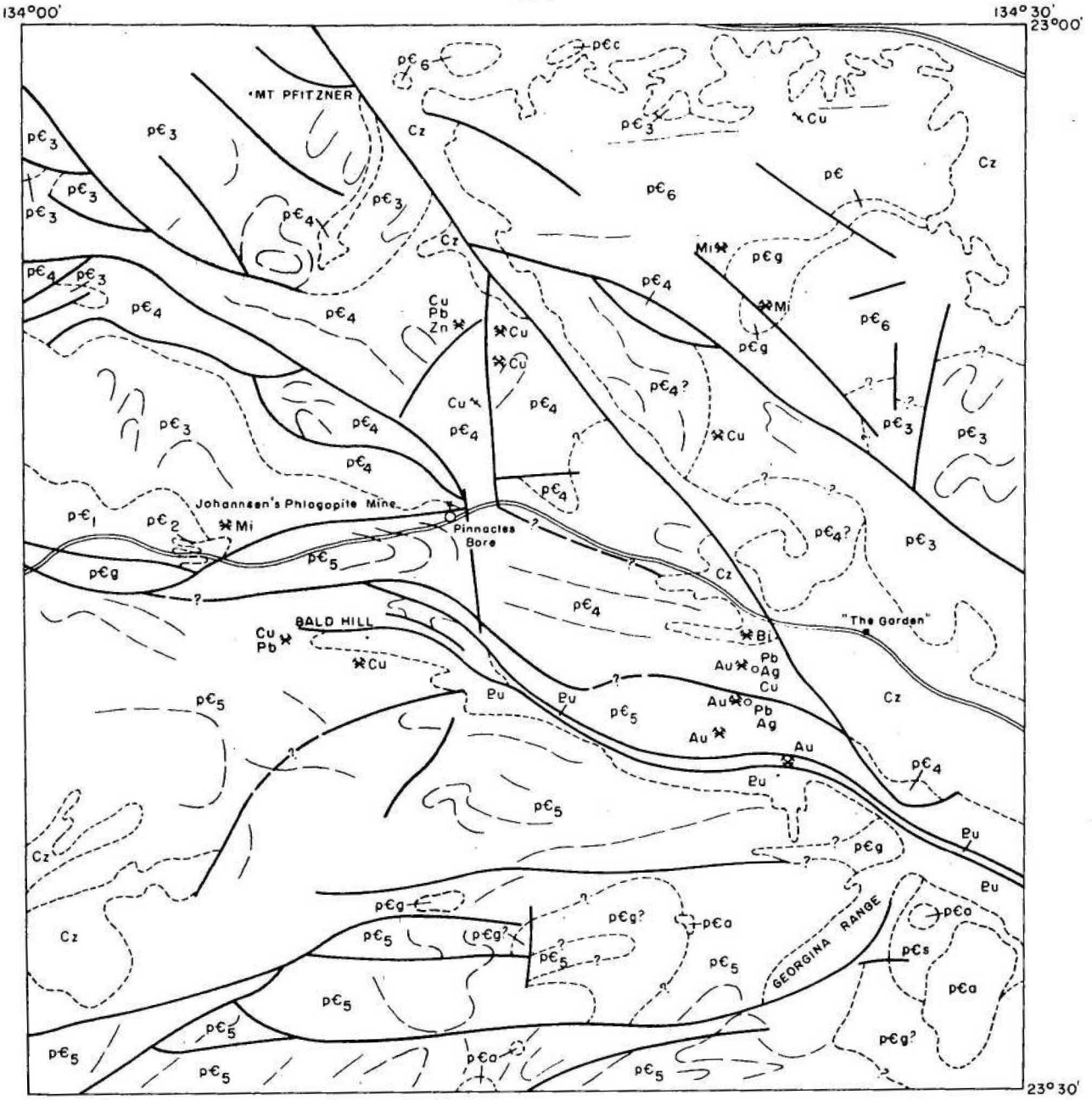
The granulite sequence consists of a thick unit of felsic and mafic granulites that generally show marked compositional layering, although one felsic granulite west of Johannsen's phlogopite mine possibly represents an anatectic adamellite that forms a basement beneath the felsic granulite (A.Allan, pers.comm.). The meta-adamellite is intruded by an anorthosite-gabbro complex. The granulites have been multiply deformed and metamorphosed. Migmatites believed to be a product of the granulite metamorphism,are formed in the cores of macroscopic folds.

The layered felsic granulites are overlain with apparent conformity by sillimanite-rich gneiss, calc-silicate rock, quartzite, and marble.

The felsic biotite gneisses that occupy most of the southern part of the Sheet area include garnet-bearing and quartz-rich varieties and rare quartzite, and may represent largely felsic to pelitic metasediments. Large parts of the gneisses are migmatised. A few small bodies of more uniform composition are porphyroblastic, and may be ortho-gneisses.

A zone of regional retrogressive metamorphism to the amphibolite facies extends as an east-west schistose zone 20 km wide across the northern half of the northeast quadrant of the Sheet area. Pegmatite veins rich in potassium feldspar, quartz, and biotite are common throughout the retrograde schist zone. Adjacent to an orthogneiss the pegmatites are muscovite-bearing.

A few relics of granulite occur within the schistose zone. The boundary with the felsic and mafic granulites to the south is in part gradational and in part faulted. Retrograde schist zones also penetrate the granulites,and several boundaries between schist and granulite are very sharp, yet unfaulted.



CAINOZOIC
- Cz — Alluvium, siltone, silcrete

UPPER PROTEROZOIC
- Pu — Heavitree Quartzite, Bitter Springs Formation

PRECAMBRIAN
- p€c — Carbonatite
- p€a — Mafic syenite
- p€s — Felspathic gneiss
- p€g — Porphyroblastic gneiss
- p€6 — Schistose mica-gneiss, calc-silicate rock, amphibolite
- p€5 — Biotite-felsic gneiss, minor biotite amphibolite, muscovite-biotite gneiss, garnet-biotite gneiss and calc-silicate rock
- p€4 — Sillimanite-garnet-biotite felsic gneiss, marble, quartzite, calc-silicate rock, amphibolite, sillimanite gneiss, kyanite-bearing biotite schist
- p€3 — Quartz-rich granulite, biotite felsic gneiss, migmatite, mafic granulite and calc-silicate rock
- p€2 — Anorthosite-gabbro complex
- p€1 — Felsic granulite

- Geological boundary, approximate
- Geological boundary, inferred
- Fault
- Fault, inferred
- Trend line
- Minor mineral occurrence
- Prospect
- Mine, abandoned
- Cu Copper
- Au Gold
- Zn Zinc
- Pb Lead
- Ag Silver
- Bi Bismith
- Mi Mica
- Road
- Bore
- Homestead

0 — 10km

Fig M3 Geological sketch map of the Laughlen 1:100 000 sheet area.

To accompany Record 1972/103

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Very narrow schist zones of a more dynamic type contain greenschist assemblages, and are thought to have been produced during a later (Silurian to Carboniferous) deformation which was most intense in the zone occupied by the Arltunga Nappe Complex. Small, marginally economic, quartz-vein copper prospects are localised in one schist zone within calc-silicate rock and marble, and another within ortho-amphibolite. Gold and lead mineralisation of the Winnecke Field is localised within the deformed zone associated with the Arltunga Nappe Complex.

A carbonatite (Gellatly, BMR Rec. 1969/77) intrudes the amphibolite facies schist zone in the central-northern part of the Sheet area. Foliation in the carbonatite is thought to have been impressed on the rock during intrusion rather than by deformation during retrogressive metamorphism.

A mafic syenite has intruded gneisses in the area east of the Georgina Range. The syenite is deformed in part, producing well foliated mica-rich schists. Potassium-rich pegmatite veins and rare calcite and calcite-barytes bodies cut the mafic syenite. A syenite-gneiss rich in potassium feldspar surrounds the mafic core.

Riddoch 1:100,000 Sheet area (Rickard).

During the 1972 field season of four weeks, mapping was extended to complete the northeastern quarter of the Riddoch 1:100,000 Sheet area. Work concentrated on tracing lithostratigraphical divisions throughout the area. These formations may be traceable over a wider region; the presence of copper and zinc mineralization in certain formations makes this an important task.

Additional detailed structural analysis in selected areas confirms earlier work indicating that at least three phases of folding and associated major stratigraphic breaks occur along slide zones. It may require further detailed work to completely elucidate the fold geometry and deformational history of the rocks in the area.

Burt 1:100,000 Sheet area. (Iyer).

Dr. Iyer continued collecting rocks for isotopic studies from granulite, kyanite schist, and greenschist zones just north of Yambah homestead.

Arltunga Nappe Complex - Western and Central Sections. (Funk, Duff).

Funk carried out additional detailed mapping between Arltunga Bore and Bald Hill. Funk now recognises two large basement-cored thrust nappes that override from the north an imbricate zone of para-autochthonous cover rocks that can be traced northwards into a zone of refoliated basement. This refoliated zone is the root zone of the nappes, and is unique in that the rocks have escaped later metamorphism. Mapping of the structurally complex basement rocks refoliated by the Alice Springs Orogeny is still incomplete. Available data, however, suggest the emplacement of a recumbent fold nappe (in what is now the refoliated zone) before the orogeny.

Duff mapped basement-cover relations within the Nappe Complex east of Arltunga Bore. He recognized a period of thrusting (associated with the development of a north-south mineral elongation) that was followed by a non-planar, non cylindrical phase of folding.

1:100,000 scale mapping, Hermannsburg 1:250,000 Sheet area. (Marjoribanks).

An area of about 1300 sq km of basement and cover rocks in the Mount Giles - Redbank Hill area was mapped at a scale of 1:20,000 by Majoribanks. The mapping completed a type area of the geology of the Hermannsburg 1:250,000 Sheet area, and is the first stage of the mapping of the Sheet area.

A zone of metasediments, deformed during four folding phases, grades northwards into a region of migmatised orthogneiss. The first and fourth phases are associated with syntectonic metamorphism to amphibolite facies grade. The fourth phase involved extensive migmatisation which began from a line marked by a thrust, itself controlled by the axial plane of a large fourth generation fold.

Within the basement the Alice Springs Orogeny produced relatively minor thrust-faulting, apparently controlled by pre-existing lineaments.

A deformed zone containing intrusions of gabbro and porphyritic adamellite separates the migmatites from a large body of hornblende granulite to the north. An anomalously large regional gravity gradient (150 milligals) suggests a major crustal feature, possibly an overthrust, corresponding to the deformed zone. The deformed zone may be worth prospecting.

Isotopic Dating (Black).

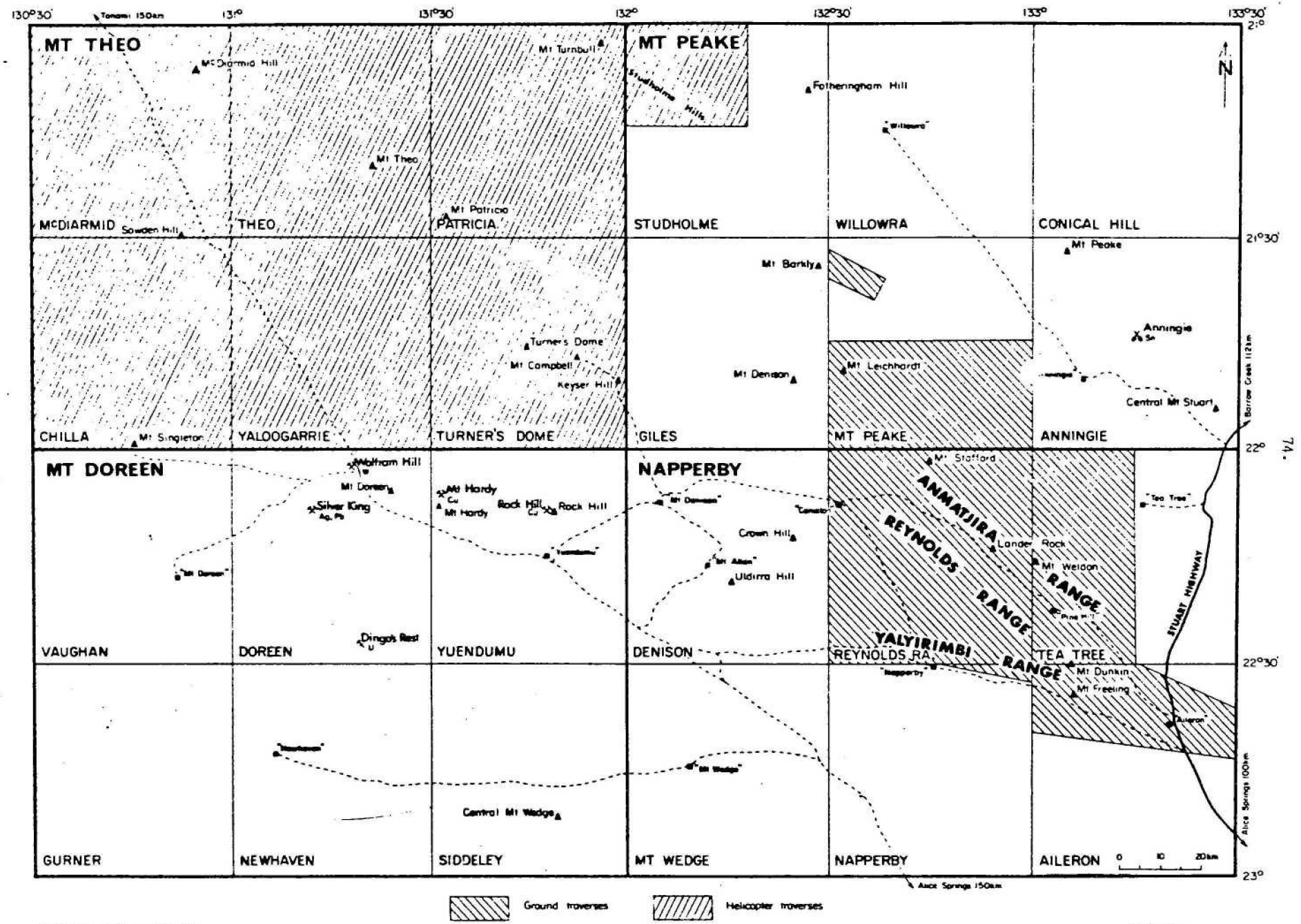
About 25 suites of samples of Arunta Complex rocks were collected for Rb-Sr dating from the Alice Springs, Illogwa Creek, Huckitta and Alcoota 1:250,000 Sheet areas. Galena has also been collected over a wide area for isotopic study.

Shallow Drilling - Alcoota 1:250,000 Sheet area. (Shaw).

The drilling of nine shallow holes, each up to 50 m deep, between the Strangways and Reynolds Ranges was commenced in mid-October. The holes are designed to obtain fresh rock to allow a study of metamorphic zonation in basement rocks covered by alluvium. One hole in the central part of the Sheet area is to obtain a fresh sample for age determination in a region of deeply weathered schist.

Napperby Party. (Stewart, Warren, Offe, Black).

Field work by the Napperby Party in 1972 consisted of mapping within the northwestern part of the Arunta Complex, sample collection for isotopic studies, and investigation of selected mineral deposits for metallogenic studies. The areas mapped are shown in Fig.M4. Mapping of the Reynolds Range 1:100,000 Sheet area was completed, and the basement rocks in the northern half of Aileron, the western half of Tea Tree, and the southern half of Mount Peake 1:100,000 Sheet areas were also mapped. The Mount Theo 1:250,000 Sheet area and the northwestern corner of the Mount Peake 1:250,000 Sheet area were mapped by helicopter.



To accompany Record 1972/103

FIG M4 AREAS MAPPED BY NAPPERBY PARTY, 1972

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Semi-detailed Mapping, Reynolds Range, Napperby, Tea Tree, Aileron, and Mount Peake 1:100,000 Sheet areas, (Fig. M5). (Stewart, Warren, Offe).

This area comprises three elongate ranges where the rocks are well exposed, separated by wide valleys of poor exposure; the three ranges meet in the southeastern part of the area. The northern, or 'Anmatjira Range' consists of a complex group of metasedimentary rocks intruded by a batholith of coarse-grained gneissic granite. The metasedimentary rocks include areas of granulite (including pelitic, basic, and acid types), pelitic gneiss, and low-grade metasediments. Granulite crops out in the southeastern half of the 'Anmatjira Range', and in the area east and west of Aileron; it comprises migmatitic sillimanite-garnet-cordierite-feldspar granulite with minor basic granulite and acid granulite in the Mount Weldon area, and similar rock-types together with psammitic granulite in the Mount Dunkin-Aileron area. The pelitic gneiss is a slightly lower-grade equivalent of the granulite, and has an assemblage indicative of the upper amphibolite facies; marble (including diopside marble and forsterite marble) accompanies the pelitic gneiss in the Mount Dunkin area. Low-grade metasediments crop out in the Lander Rock area in the northwestern part of the 'Anmatjira Range', and comprise sericite schist, andalusite-sericite schist, slate, and sandstone. The whole northeastern flank of the Anmatjira Range consists of coarse-grained gneissic granite containing megacrysts of potassium feldspar up to 8 cm across. The megacrysts are mostly stout, ovoid to lenticular augen aligned in the gneissic foliation, but where the granite is more massive they are subhedral in shape. Smaller megacrysts commonly have a thin shell of plagioclase around a kernel of potassium-feldspar, giving a Rapakivi texture to the rocks. Xenoliths of schist, gneiss, and basic granulite are common in the granite. The entire range is cut by numerous large faults which trend approximately northwest, and along these faults the rocks have been converted to tectonic schist, flaser gneiss, and mylonite, commonly accompanied by brecciated vein quartz. In the southeastern part of the range, the gneissic augen granite is intruded by a leucocratic garnet-bearing granite; this rock is regarded as a later intrusion belonging to the same batholith.

The northwestern extension of the Anmatjira Range includes a distinctive body of gently dipping, low-grade metasediments ranging from quartzite to dark hornfels with a large component of basic minerals; the rocks are not basic stratified sills as previously thought. These rocks are intruded by altered basic dykes and by several varieties of granite, including a very coarse-grained Rapakivi granite, and a finer-grained granite characterized by euhedral laths of feldspar. The granite continues into the Mount Peake 1:100,000 Sheet area, and is unconformably overlain by thick-folded beds of sandstone and pebbly sandstone, e.g., at Mount Leichhardt. Northeast of the Anmatjira Range are numerous outcrops of granite, flaser granite, and quartzite.

The Reynolds Range occupies the central part of the area, and consists of low-grade slate and shale, quartzite, and minor conglomerate, dolomite, and calc-silicate rock. A large mass of feldspathic schist with quartz augen crops out in the northwestern part of the range. The rock shows no trace of bedding, and thin section examination and chemical analysis indicate that it is a rhyolite that has undergone extensive deformation. The rock forms a large sill which was intruded along the contact of conglomerate and quartzite beds of the Reynolds Range.

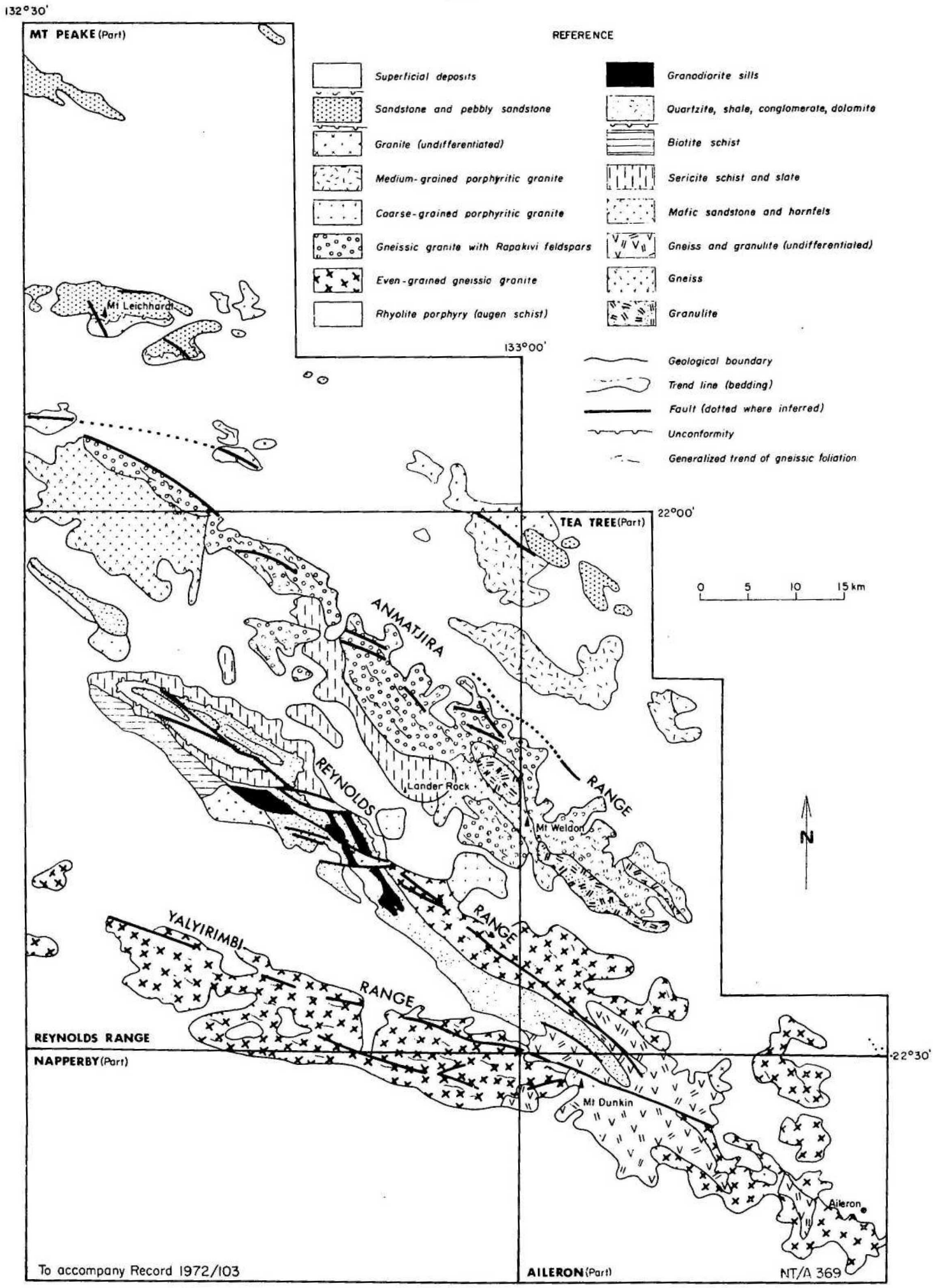


FIG M5 GEOLOGICAL SKETCH MAP OF REYNOLDS RANGE AND ADJOINING PARTS OF ARUNTA COMPLEX

Along the northeastern flank of the range, the sediments of the Reynolds Range unconformably overlie low-grade sericite schist, slate, and sandstone which are similar to the sediments of the Lander Rock area. The central part of the Reynolds Range is intruded by large sills and dykes of granodiorite which is everywhere foliated and in many places retrograded; the slate in the vicinity of the granodiorite contains abundant porphyroblasts of andalusite.

The poorly exposed area between the 'Anmatjira' and Reynolds Ranges is mostly underlain by coarse-grained gneissic granite, and a smaller body of massive porphyritic granite.

The southern range, or 'Yalyirimbi Range', as it is tentatively named, consists largely of coarse-grained gneissic granite cut by fault-zones of flaser gneiss and quartz breccia. The area between the 'Yalyirimbi' and Reynolds Ranges is almost wholly covered by superficial Quaternary deposits.

Regional Mapping, Mount Theo 1:250,000 Sheet area. (Stewart).

The Mount Theo 1:250,000 Sheet area is almost entirely level sand plain, with a few isolated hills rising above the plain (Fig. M4); the sand is generally only a few centimetres thick, and is underlain by alluvium. For descriptive purposes, the area can be divided into four equal segments striking east-west. In the northern segment, the outcrops consist mostly of brecciated vein quartz; sericite slate is next to the quartz at McDiarmid Hill. In the two central segments, the outcrops consist of folded clayey micaceous sandstone at Sowden Hill and Mount Theo, brecciated vein quartz at Mount Patricia, and scattered areas of laterite and laterite gravel ('buckshot gravel'). The southern segment has high-grade metamorphic rocks in the west, and low-grade metamorphic rocks in the east. The Mount Singleton area in the southwestern corner consists of an isoclinal syncline of quartzite and sericite schist with rare pods of actinolite rock, intruded by granite; the metasediments are correlated with those exposed in the Reynolds Range, in the Napperby 1:250,000 Sheet area. Several kilometres north and northeast of Mount Singleton are two outcrops of pelitic granulite, similar to the granulite in the 'Anmatjira Range' (provisional name to be proposed for the unnamed range north of the Reynolds Range). The remaining outcrops (Turners Dome, Mount Campbell, and Keyser Hill) consist mostly of brecciated vein quartz; weathered granite has been found on the north side of Mount Campbell; a small quartz-limonite outcrop with cellular boxwork at Keyser Hill indicates the existence of a possible gossan.

Regional Mapping, Mount Peake 1:250,000 Sheet area. (Stewart).

The northwestern corner of the Mount Peake 1:250,000 Sheet area was mapped by helicopter, during the Mount Theo survey. The rocks here, including the Studholme Hills, are mostly isolated ridges of brecciated vein quartz. One outcrop of multiply folded sericite schist and quartzite was located north of the Studholme Hills; the only other rock-types seen are medium-grained granite with a well defined platy flow structure north of the Studholme Hills, and an outcrop of tubular laterite with a distinctive 'worm-eaten' appearance in the easternmost part of the area.

Investigation of Mineral Deposits (Warren).

Warren visited the following mines and mineral prospects as part of her study of the metallogenesis of central Australia:

Copper	Tungsten	Others
Mount Hardy	Wolfram Hill	Silver King (silver, lead)
Rock Hill	Molyhil (Huckitta)	Anningie (tin)
Jervois (Huckitta)		Dingo's Rest (uranium).
Home of Bullion (Barrow Creek)		

Samples for study were collected from the lodes. Discussions with company personnel proved very useful.

Isotopic Dating. (Black).

L.P. Black collected samples for isotopic studies (Rb-Sr and Pb) from the Napperby, Mount Peake, and Mount Doreen 1:250,000 Sheet areas; his report on this work appears in the 'Petrological, Geochemical, and Isotope Geology Laboratories' section of this Record.

Reporting of Results:

The following reports on work in progress or completed to date in the Arunta Block are proposed:

1. Bulletin on the Arltunga Nappe Complex.

2. Record and Preliminary map for the geology of the Alcoota 1:250,000 Sheet area, followed by 1st Edition map and Explanatory Notes.

3. Progress Record and map for mineral deposits of the eastern Arunta Block.

4. Progress Records and Preliminary maps for Laughlen, Undoolya, Riddoch, and Fergusson Range 1:100,000 Sheet areas.

5. Progress Records and Preliminary maps for Reynolds Range, Tea Tree, Aileron, and Mount Peake 1:100,000 Sheet areas.

6. Record and Preliminary map for the Mount Theo 1:250,000 Sheet area, followed by 1st Edition map and Explanatory Notes.

7. Progress Record on isotopic dating results.

GRANITES - TANAMI PROJECT, W.A. & N.T.

by

D.H. Blake

Personnel: D.H. Blake (Party Leader), I.M. Hodgson, P.A. Smith, (until May, 1972), P.C. Muhling (GSWA , from May, 1972).

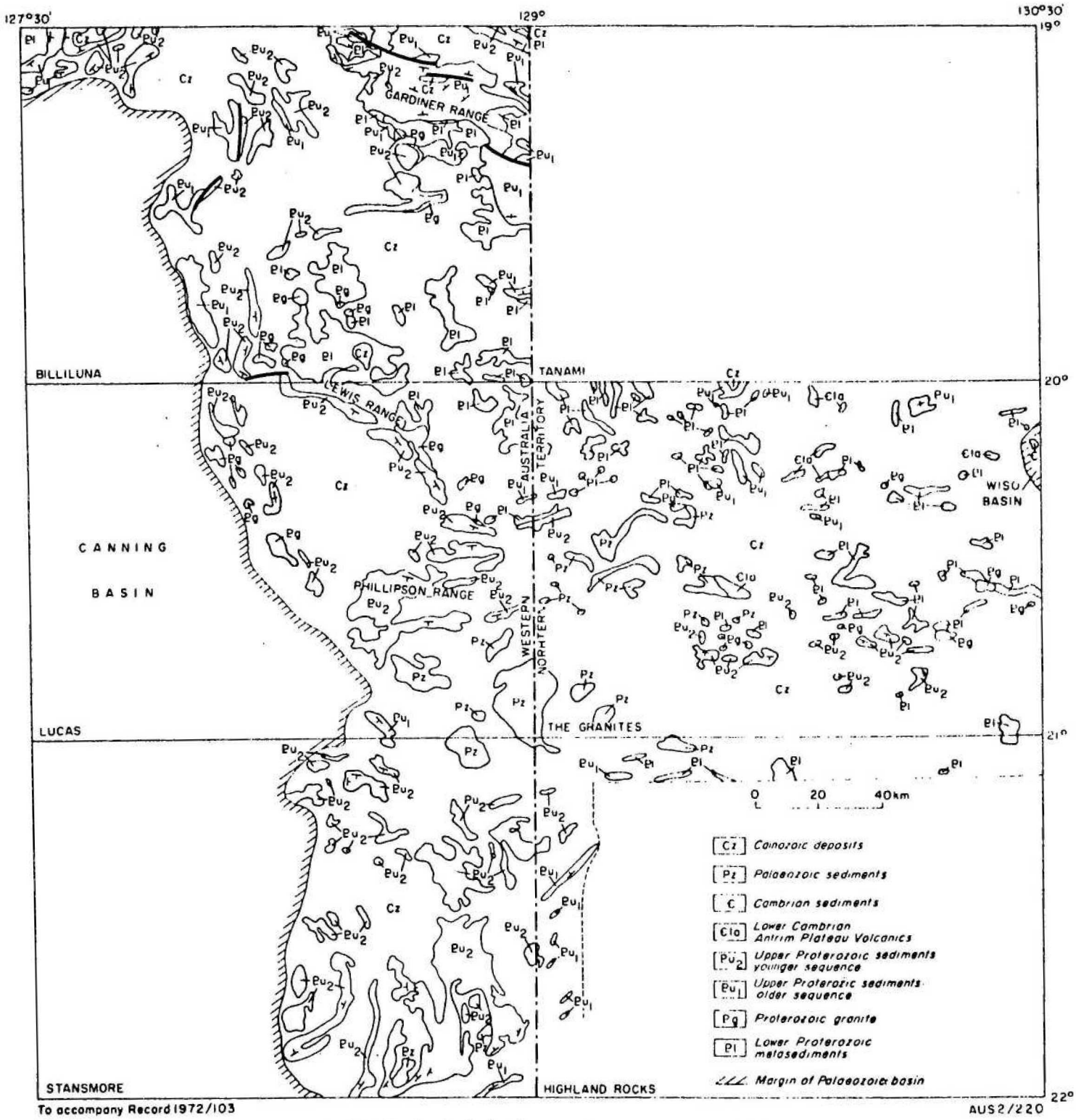
Introduction

The party is engaged in reconnaissance geological mapping of the Granites-Tanami region, an area of mainly Precambrian rocks south-east of the Kimberleys. The project was started in 1971, and is expected to be completed in 1974.

During office work from November, 1971, to May, 1972, the preliminary editions of the Birrindudu and Tanami 1:250,000 Sheets were compiled, and a BMR Record (1972/92) on the 1971 field work was completed. Reconnaissance mapping of The Granites, part of the Highland Rocks, and the Precambrian areas of the Billiluna, Lucas, and Stansmore 1:250,000 Sheet areas was carried out between the end of May, 1972, and the end of September, 1972. The last three Sheet areas were previously mapped in 1955 on a very broad reconnaissance scale by geologists from the BMR and GSWA. The field work undertaken in 1972 involved both Landrover and helicopter traverses. A BMR drilling crew under A. Zoska drilled 24 shallow stratigraphic holes in Lucas and The Granites during August and September, 1972.

The Granites-Billiluna area straddles the W.A. - N.T. border between latitudes 19° and 22°S. It is mainly semi-desert, and the annual rainfall over most of the area is less than 400 mm. The eastern part lies within the Tanami Desert and the western part is on the Great Sandy Desert. The area, like that mapped in 1971, has a low relief, consisting of hills and ridges generally less than 70 m high separated by extensive plains. The plains are crossed by east-west trending longitudinal (seif) dunes which are most numerous in the south. There are no permanent water courses and few permanent water holes except along Sturt Creek in Billiluna, but water is available from bores in all Sheet areas except Stansmore and Highland Rocks.

Two major problems in mapping the area are, first, the scattered nature of the exposures, due to the extensive cover of superficial Tertiary and Quaternary deposits, and secondly the intensely weathered condition of many of the exposed rocks. The scattered nature of the exposures makes correlations between different outcrops difficult, especially as there are few marker beds. The intense weathering involves ferruginization, lateritization, and silicification, and is due to the areas having been subject to continuous sub-aerial denudation for at least the entire Cainozoic era. It affects all rocks except some of those consisting almost entirely of quartz, and hinders rock identification both in the field and laboratory.



To accompany Record 1972/103

AUS2/220

Fig M6 Geological sketch map, Granites-Billiluna area

General Geology (Fig. M6).

The area mapped in 1972 is part of the Granites-Tanami block, an area of Precambrian rocks bounded by the Precambrian Kimberley region to the northwest, the Precambrian Victoria River area to the north, the mainly Precambrian Arunta area to the southeast, and the Palaeozoic Wiso and mainly Palaeozoic Canning Basins to the east and west, respectively.

Most of the main rock sequences mapped in the Birrindudu-Tanami area in 1971 extend into The Granites-Billiluna area. The oldest rocks exposed are low-grade metasediments, mapped as Lower Proterozoic, which are probably equivalent to the Halls Creek Group of the Kimberley area. They are intruded and thermally metamorphosed by high level granite, and both the metasediments and the granite are overlain unconformably by two sequences, mapped as Upper Proterozoic, and consisting mainly of sandstone. A series of less consolidated sedimentary rocks, possibly Palaeozoic, unconformably overlies the Proterozoic rocks. Younger rock units comprise very minor outcrops of fluvial and lacustrine deposits that may be Cretaceous; extensive cappings of laterite, minor silcrete, and widespread travertine, all three of which are probably mainly Tertiary; and very extensive Quaternary aeolian and alluvial deposits.

The ages of the pre-Tertiary rocks in the area are uncertain, as no isotopic dates are as yet available. However, specimens of granite and Proterozoic glauconitic sandstone were collected for isotopic age determinations during the 1972 field season by R.W. Page and members of the field party, and it is hoped that drill cores and outcrop samples of the Palaeozoic(?) sediments will yield datable microfossils.

The Lower Proterozoic rocks are tightly to isoclinally folded, and are characterized by very steep to vertical dips, complex minor folding, especially in the cores of major folds, and abundant quartz veins, both concordant and cross-cutting. The rocks commonly show a cleavage or foliation that is generally parallel to the bedding, and also a cross-cutting fracture cleavage. Outcrops are most extensive in Billiluna and The Granites areas and only very minor exposures occur on Stansmore. Two main rock sequences are present, a monotonous succession of interbedded cleaved greywacke and phyllite (Killi Killi Formation) in the west, and a more varied sequence of thin-banded chert, mudstone, lithic sandstone, orthoquartzite, and minor greywacke and phyllite (Mount Charles Formation) in the east. The chert is commonly ironstained and gossanous, and is at least partly secondary after dolomite. Basaltic volcanics are present locally in both sequences, but acid volcanics are very rare. The two sequences grade into each other in the northwest part of The Granites Sheet area, and may be stratigraphic equivalents. They are both overlain unconformably by Pargee Sandstone, also mapped as Lower Proterozoic, which consists of quartz sandstone, orthoquartzite, and fine conglomerate. Where unaffected by thermal metamorphism, the Lower Proterozoic rocks mostly belong to the greenschist facies of regional metamorphism, and sedimentary structures such as cross-bedding and graded bedding are generally preserved. Muscovite and porphyroblastic andalusite and chiastolite are commonly developed near intrusive granite contacts.

Granite crops out in all of the Sheet areas mapped. It is mapped as Proterozoic as it intrudes Lower Proterozoic rocks, and is overlain unconformably by Upper Proterozoic rocks. The granite ranges from fine to coarse, and commonly contains euhedral feldspar phenocrysts; pegmatitic and aplitic varieties occur locally, and mostly small dark xenoliths are common in places. The most common type is biotite granite, but biotite-muscovite granite also occurs, as on the north side of the Lewis Range in the Lucas Sheet area. The granite shows no evidence of marginal chilling. In many places the contacts are highly irregular and at several localities, as on the north side of the Lewis Range, consist of lit-par-lit injection zones.

The Upper Proterozoic is represented by an older and a younger sequence. The older sequence includes the Gardiner Formation, which consists of lithic sandstone, orthoquartzite, glauconitic sandstone, conglomerate, siltstone, and shale, and the conformably succeeding Talbot Well Formation, which consists mainly of chert (after calcareous sediments) and sandstone. These two formations crop out in the northern part of The Granites and northeast part of Billiluna. The sequence also includes folded and sheared lithic sandstone in the western and central parts of Billiluna, and coarse quartz sandstone in the west and southeast parts of Highland Rocks and Stansmore, respectively. The younger sequence unconformably overlies the older sequence in the Gardiner Range, and crops out extensively in Lucas and Stansmore. It consists predominantly of fine to medium lithic sandstone but in Stansmore also includes orthoquartzite, calcareous mudstone, and fine chert conglomerate. Outcrops of sandstone in the central part of Billiluna and in the southern part of The Granites probably also belong to this sequence. The older sequence is generally the more steeply dipping of the two, although the latter has very steep to vertical dips in parts of Stansmore, where it has been folded into a series of major anticlines and synclines. In the western part of Billiluna both sequences are overlapped by Lower Palaeozoic sandstone and conglomerate.

In the northwest corner of the area the Upper Proterozoic Rocks, previously mapped as Kearny Beds, have been correlated with the Upper Proterozoic rocks in the adjacent Gordon Downs Sheet area. The succession in this corner consists of Lower Proterozoic Olympio Formation, (Halls Creek Group) in the west unconformably overlain by Upper Proterozoic Mount Parker Sandstone (which may be equivalent to the Gardiner Formation). This sandstone is succeeded to the east by the Bungle Bungle Dolomite (which is possibly equivalent to the Talbot Well Formation), Wade Creek Sandstone, a conglomerate that is probably equivalent to the Moonlight Valley Tillite, Ranford Formation, the scarp-forming Mount Forster Sandstone, Elvire Formation, Timperley Shale, an. a sandstone correlated with the Nyuless Sandstone. The Ranford Formation and overlying formations may belong to the two sequences mapped in the ranges to the south.

In the central and southern parts of the area the Proterozoic rocks are unconformably overlain by sedimentary rocks of possibly Palaeozoic age. These younger rocks comprise the Lucas Beds, which consist of interbedded mudstone and calcareous and non-calcareous sandstone, and an overlying unit of mainly medium-grained sandstone which may be unconformable on the Lucas Beds. The Lucas Beds mostly dip very gently east, whereas the overlying sandstone is generally flat-lying. Basalt mapped as part of the Lower Cambrian Antrim Plateau Volcanics extends south from Tanami into the centre of The Granites.

The main structural features are complex domes forming basement highs, within which Lower Proterozoic rocks and granite are exposed. The largest of these domes extends across The Granites southeast from the central part of Billiluna. The domes are bounded by Upper Proterozoic rocks dipping gently outwards. Between the domes the Upper Proterozoic rocks have been deformed into mainly broad anticlines and synclines. Few major faults have been mapped; such faults are likely to be concealed beneath the Cainozoic superficial deposits. The Lucas Beds and Antrim Plateau Volcanics occupy shallow depressions that may be either tectonic or erosional.

Economic Geology.

Of economic interest are gold at The Granites and elsewhere, uranium prospects at the Killi Killi Hills, high levels of radioactivity in some of the granite, traces of copper mineralisation, and gossans. Gold at The Granites and at a few localities elsewhere within The Granites Sheet area occurs in quartz veins cutting Lower Proterozoic metasediments. At Killi Killi Hills, in Billiluna, uranium occurs with rare earth elements in xenotime that is contained within conglomerate at the base of the Upper Proterozoic Gardiner Formation, immediately overlying Lower Proterozoic greywacke and phyllite. The granite intruding the Lower Proterozoic north of the Lewis Range, in Lucas, has up to 4X background values of radioactivity, the porphyritic varieties having the highest values. In The Granites copper minerals, mainly malachite, have been found mainly in basic volcanics and associated Lower Proterozoic rocks close to granite contacts. In the same area gossanous ironstones, many of which form prominent positive topographic features, may indicate the presence of sulphide ore bodies at depth.

Reporting of Results.

The results of the 1972 fieldwork will be written up as a Record, and later incorporated in a Bulletin describing the geology of the whole Granites-Tanami region. They will also be included in Explanatory Notes of the Billiluna, Lucas, Stansmore, The Granites, and Highland Rocks 1:250,000 Sheet areas.

VICTORIA RIVER BASIN PROJECT, N.T. & W.A.

ANTRIM PLATEAU VOLCANICS AND CORRELATIVES, N.T.,W.A.,& QLD.

by

R.J. Bultitude

Personnel: R.J. Bultitude.

The interfield season was spent examining in detail samples from the Antrim Plateau, Helen Springs, Nutwood Downs, and Peaker Piker Volcanics collected during the 1971 field season. Record 1972/74, the second in a series of Records describing the geology and petrology of volcanic rocks of probable Lower Cambrian age from northern Australia, was completed. Preparation of a Record on the Antrim Plateau Volcanics was started.

A final field check of the Antrim Plateau Volcanics was carried out during 1972; a thickness of about 1,000 metres was measured through the volcanics near Bungle Bungle Outcamp (Dixon Range 1:250,000 Sheet area). The Colless Volcanics, in the Lawn Hill 1:250,000 Sheet area were also briefly examined. The distribution of the volcanics is shown in Fig. M7.

The Helen Springs, Nutwood Downs, and Peaker Piker Volcanics consist of a succession of basaltic lava flows with minor sandstone intercalations. The formations are generally poorly and discontinuously exposed, and are commonly strongly weathered, lateritized, or converted to "black soil". Labradorite, clinopyroxene (pigeonite and augite), opaque oxides, and devitrified glass or a quartzo-feldspathic residuum account for a high proportion of the total volume of the volcanic rocks. Apatite, quartz, hornblende, and brown mica are accessory components. Coarse grainsize and minor amounts of interstitial primary quartz are characteristic.

Most of the flows show a central, compact, or nearly non-vesicular, coarse-grained interior grading into a fine-grained vesicular zone in the upper, and also the basal parts. Basalts from the more massive parts of the flows contain microphenocrysts of plagioclase. However, the feldspar phenocrysts are nowhere abundant.

Vesicles are commonly filled with a variety of secondary minerals, the most common being chlorite, quartz, and chalcedony. The basalts have undergone a certain amount of alteration, the alteration being most extensive and intensive in the upper and basal parts of flows.

The results of the petrographic and chemical investigation of the Helen Springs, Nutwood Downs, and Peaker Piker Volcanics have strengthened the contention of earlier workers that the three formations belong to the same episode of volcanic activity and are correlatives. The lavas are of uniform chemical and mineralogical compositions. It is probable, therefore, that they were produced under similar physical conditions from magmas of similar chemical compisitions. Nine of the rocks analysed are tholeiitic basalts ($SiO_2 < 53\%$); the tenth is a tholeiitic andesite. The relatively high silica contents indicate that the lavas are tending towards a low-silica andesite composition. The potash content is variable, but most specimens have less than 1 percent. Soda has a very limited range (2 - 3 percent).

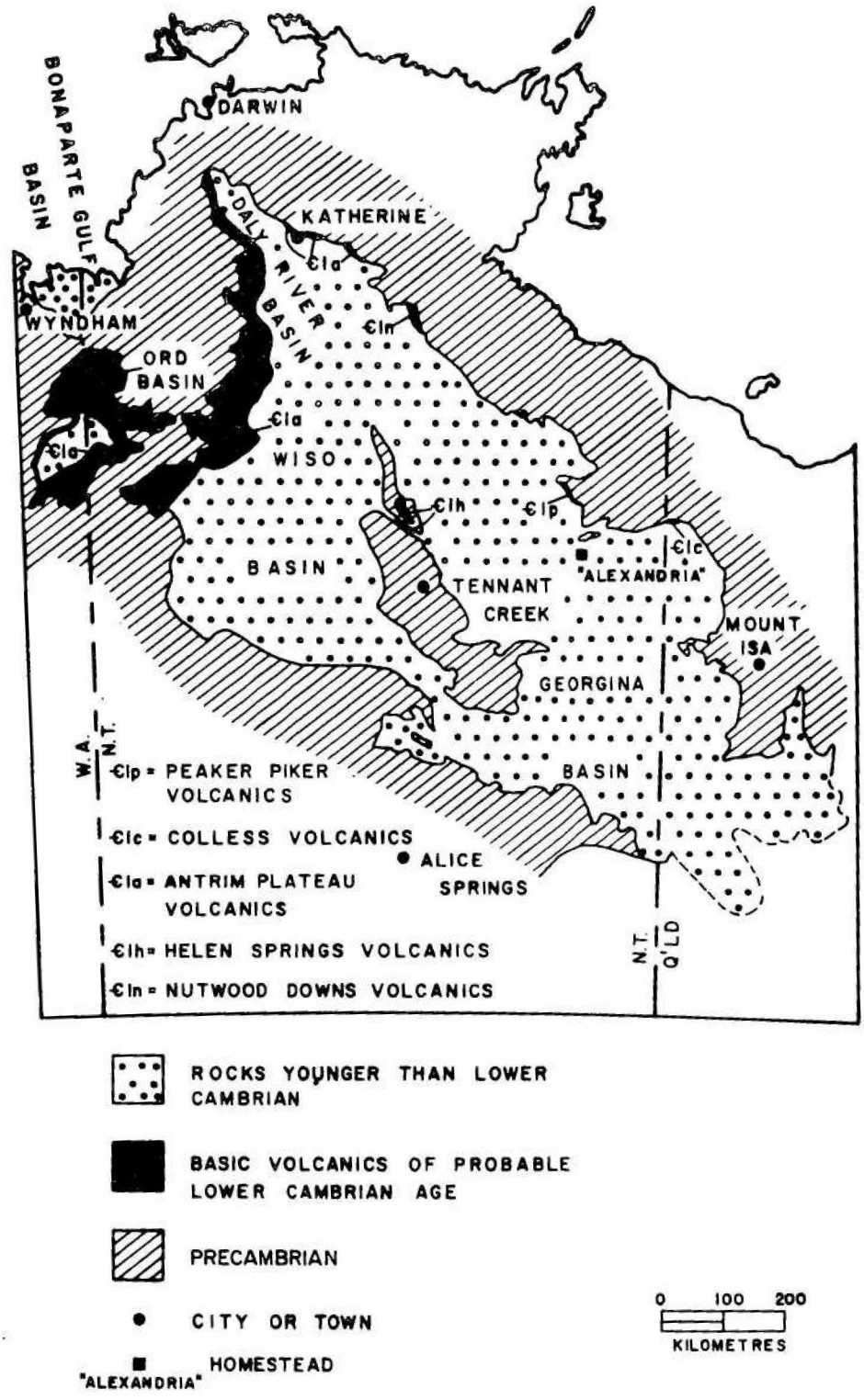


Figure M7 DISTRIBUTION OF LOWER CAMBRIAN BASIC VOLCANICS, NORTHERN AUSTRALIA

To accompany Record 1972/103

NT/A 366

The lavas from the Helen Springs, Nutwood Downs, and Peaker Piker Volcanics bear a striking resemblance, both in hand specimen and thin section, to lavas from the much more voluminous Antrim Plateau Volcanics in the Ord-Victoria region of Northern Australia. Chemical analyses of lavas from the Antrim Plateau Volcanics closely match those of the Helen Springs, Nutwood Downs, and Peaker Piker Volcanics.

Twelve specimens (ten from the Antrim Plateau Volcanics, one from the Helen Springs Volcanics, and one from the Nutwood Downs Volcanics) were submitted to the Australian Mineral Development Laboratories for K/Ar (whole rock) dating. Ages obtained on the specimens of Antrim Plateau Volcanics range from 395 ± 10 m.y., to 506 ± 10 m.y., (i.e.,from Upper Silurian to Upper Cambrian), the majority being grouped between 468 and 500 m.y., (i.e., Lower Ordovician). Ages of 511 ± 12 m.y., and 500 ± 12 m.y. were obtained on the specimens from the Helen Springs and Nutwood Downs Volcanics, respectively.

The inferred age of the Antrim Plateau, Helen Springs, and Nutwood Downs Volcanics, from the stratigraphic evidence, is Lower Cambrian. In the East Kimberley the Antrim Plateau Volcanics unconformably overlie shale - the Timperley Shale in the Albert Edward Group - dated at 666 ± 43 m.y. The Volcanics are disconformably overlain by the Blatchford Formation of late Lower Cambrian age.

The most likely explanation for the discrepancy between the ages determined by the K/Ar whole rock method and the age inferred from the stratigraphic evidence is that the lavas have lost varying amounts of radiogenic argon since their formation in the Lower Cambrian. The reason for this loss is obscure, because the degree of alteration, in most samples, does not seem sufficient to account for a loss of 15 - 20 percent of radiogenic argon.

Reporting of Results.

The results of this study will be presented in a Bulletin. This will be preceded by a comprehensive Record containing all available information.

VICTORIA RIVER BASIN, N.T.

by

I.P. Sweet

Personnel: I.P. Sweet.

Field work was completed in 1970, and Sweet was engaged in writing reports and preparing maps during 1971 and 1972.

Glauconites from the Wondoan Hill Formation have yielded Rb/Sr ages of about 1120 million years, and K/Ar ages 5-10% less. (R.W. Page, pers. comm.). This places the overlying Auvergne Group in the middle or upper Adelaidean, but does not give any conclusive evidence for the underlying Bullita, Wattie, and Limbunya Groups. However, the Bullita and Wattie Groups are both tentatively regarded as being lower Adelaidean (using 1400 m.y. as the lower boundary, as suggested by Dunn, Plumb, and Roberts), and the Limbunya Group as lowermost Adelaidean or upper Carpentarian.

Reporting of results

The introductory sections of a Bulletin "The Precambrian Geology of the Victoria River Region, Northern Territory", have been written. The Bulletin will be a brief synthesis of all information on the geology of the region, and will be accompanied by a map at a scale of 1:500,000.

Two manuscripts were prepared and submitted for publication as Reports. They are "The Geology of the Northern Victoria River Region, Northern Territory" (this supersedes Record 1970/3), and "The Geology of the Southern Victoria River Region, Northern Territory" (supersedes Record 1971/71 - "The Geology of the Waterloo, Victoria River Downs, Limbunya, and Wave Hill 1:250,000 Sheet areas, Northern Territory").

The Waterloo and Victoria River Downs Explanatory Notes were written, and submitted to the editing section. Advance copies of Port Keats, Cape Scott, Fergusson River, Auvergne, and Delamere 1:250,000 colour edition sheets were received, and the Explanatory Notes for these maps are at an advanced proof stage.

The Wave Hill and Limbunya 1:250,000 Sheets and Explanatory Notes have been edited, and are with the printers.

PINE CREEK GEOSYNCLINE, N.T.

DARWIN URANIUM GROUP

Personnel: C.E. Prichard, R.S. Needham, P.G. Smart, A.L.Watchman - (from March).

OFFICE AND GENERAL

by

C.E. Prichard

All the professional geological positions were filled throughout the year; A.L. Watchman has been attached to the Alligator River Party since March.

Certain Departmental administrative services, including payment of wages and accounts, were provided for members of the three Branches of the Bureau represented in the Darwin Uranium Group, and for regional field parties from various Branches. The number of regional parties serviced increased from six in 1971 to twelve in 1972.

The Senior Geologist represented the Department on several Promotion Appeal Committee hearings, and interviewed a number of applicants for employment or promotion during the year. He continued to exercise the Departmental delegations held.

Liaison continued with Department of Works and PMG until the Manton Seismic Station was completed, and all services connected. The Observatory Group installed the equipment, and the station started operating in July.

Company interest in the Alligator River Uranium Field remains high, and numerous company officers called to discuss the geological environment of the uranium occurrences and the current geological mapping by the Bureau. Following the announcement of release of further areas near Rum Jungle, details of work done and information available in that area have been discussed with a number of companies.

Several visits were made to the Rum Jungle Geological Party to assist in revising the Rum Jungle District geological map.

A two-day seminar on uranium, organized by Geopeko at Jabiru, was attended by geologists of the Group. The exchange of information and ideas, and the resulting discussions among company and Bureau geologists, proved stimulating and helpful to both parties.

The increasing environmental consciousness and the proposal to proclaim a large part of the Alligator River Uranium Field a national park have made it necessary to spend more time in liaison with the various authorities administering aboriginal reserves, wildlife sanctuaries, fauna and flora reserves, and similar areas where restrictions apply.

The work of the Alligator River Geological Party, whose members are drawn from the Group, is reported separately. Activities of the geophysical staff of the Group are reported in the Summary of Activities of the Geophysical Branch.

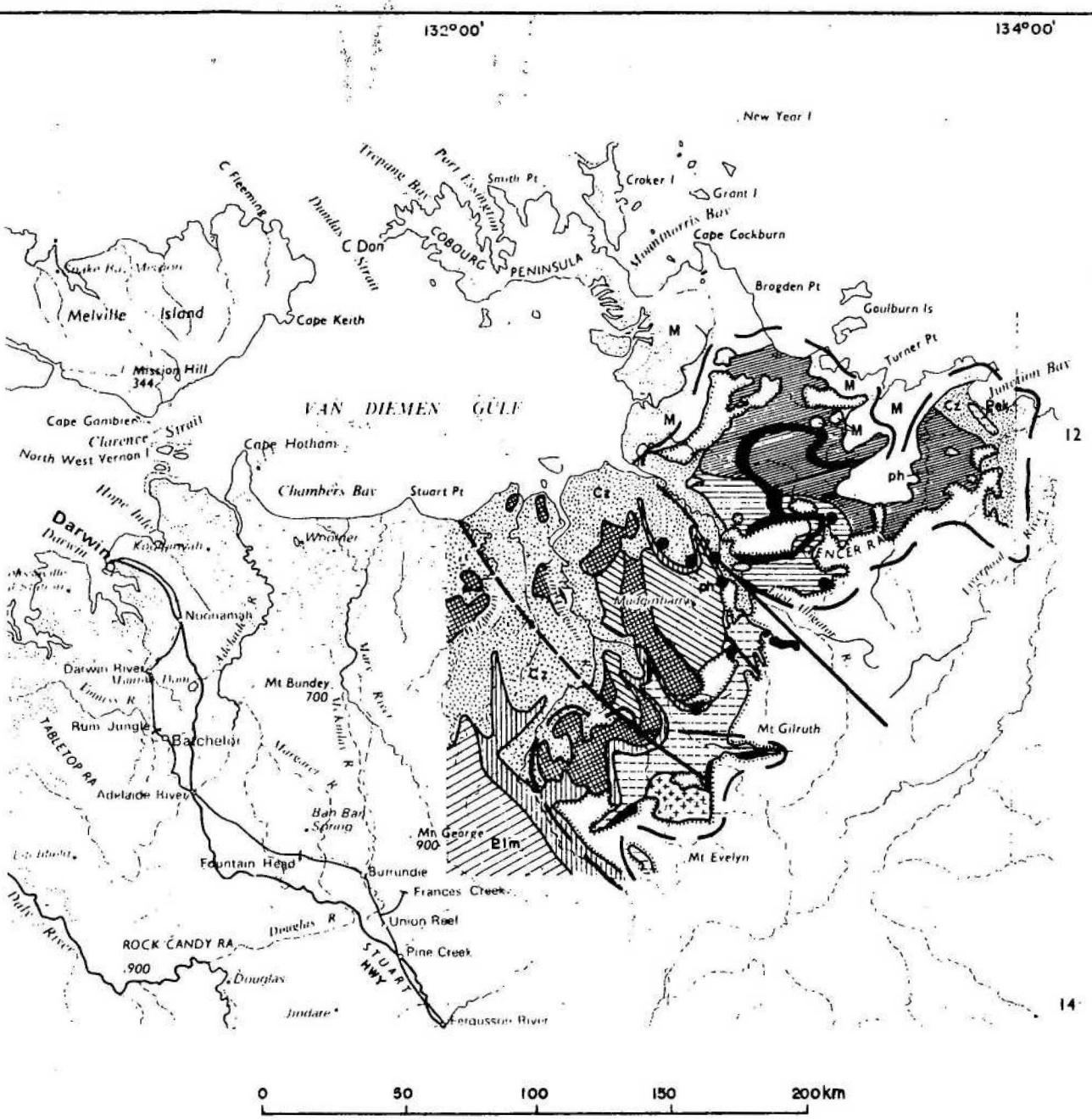


FIG M8-AREA MAPPED BY ALLIGATOR RIVER PARTY DURING 1972 FIELD SEASON

- Cz — *Sand*
- M — *Mullaman Beds*
- Pek — *Buckingham Bay Sandstone*
- *Kombolgie Formation*
- ph — *Phonolite dykes*
- *Nimbuwah Complex*
- *Nanambu Complex*
- *Dolerite*
- *Jim Jim Granite*
- *Myra Falls Metamorphics*
- *Fisher Creek Siltstone*
- *Koolpin Formation*
- *Mt. Partridge Formation*
- Elm — *Masson Formation*

and metamorphic equivalents

- *Fault*
- *Area mapped in 1972*
- *Uranium deposit or prospect*

ALLIGATOR RIVER PARTY

by

R.S. Needham

Personnel: R.S. Needham, P.G. Smart, A.L. Watchman.

Introduction

A draft progress Record on the 1971 field season's work was written, and is being edited within the Section. The Record includes maps, at 1:50,000 scale, of the Cahill and East Alligator 1:100,000 Sheet areas. Mapping was completed in the Jim Jim NW and NE, Mundogie, Oenpelli NW and NE, Wellington Range SW and SE, Goomadeer NW and NE, and Junction Bay SW and SE 1:50,000 Sheet areas.

Eleven scout holes were drilled by a BMR rotary drilling party, and several auger drill traverses were completed over poorly exposed areas.

Collection of rocks for isotopic dating was carried out by R.W. Page late in the field season. Preliminary K-Ar dating of micas from specimens collected in 1970 and 1971 has been carried out by Dr. A.W. Webb, of Amdel; the results show that the minimum age of the Nanambu Complex and biotite-muscovite schist from Nabarlek drill core is about 1800 m.y.; this date has been confirmed by Rb-Sr determinations (by R.W. Page) on six biotite and muscovite concentrates.

General Geology (Fig.M8).

Mapping in the Mundogie and Jim Jim 1:100,000 Sheet areas and in the southernmost part of the Cahill 1:100,000 Sheet area was concerned mainly with checking geological boundaries either inferred during the previous season's work or from photo-interpretation. The geology of the Jim Jim and Deaf Adder Gorge areas was investigated in the early part of the season as these areas have been proposed as sites for national parks. Both gorges have been cut in cliff-forming sandstone of the Carpentarian Kombolgie Formation, and their floors are occupied mainly by alluvium. Coarse-grained basic volcanic rocks were found close to the mouth of Jim Jim Gorge and in the upper reaches of Deaf Adder Gorge; these may be correlatives of the Stag Creek Volcanics in the South Alligator Valley. Detailed airborne radiometric and magnetic surveys of both proposed park areas by the Geophysical Branch of BMR did not reveal any radiometric or magnetic anomalies.

The Nanambu and Nimbuwah Complexes (see map) both appear to be migmatite domes produced by extensive metamorphism and migmatization of Lower Proterozoic strata. The Nimbuwah Complex appears to represent the orogenic centre of the so-called Pine Creek Geosyncline, rather than being an Archaean basement to the geosyncline. The Nanambu Complex was probably produced by localized migmatization of sediments near the western edge of South Alligator Group succession.

Granitoid rocks occur generally at the margins of the Nanambu Complex and in the northern part of the Nimbuwah Complex. They are thought to be a product of Lower Proterozoic migmatization, but could conceivably be either intrusive granites associated with, but later than, the formation of the Complexes, or remnants of an Archaean basement.

The metamorphic grade of the Nanambu Complex has generally advanced to the almandine-amphibolite facies; no detailed study has yet been made of the Nimbuwah Complex.

The margins of the Complexes are transitional into metamorphic rocks of Lower Proterozoic age. Extensive pegmatite veining is apparent within this 'transitional zone' in the Cahill 1:100,000 Sheet area. The surrounding rocks generally show a decrease in metamorphic grade to the southwest; higher grades are evident near the Nanambu Complex.

In the Cahill Sheet area, where the metamorphic grade is generally low to middle greenschist facies, the original sedimentary character of the rocks can be discerned, and thus correlated with the South Alligator Group to the south. A quartzite sequence with discontinuous development of dolomite is correlated with the Koolpin Formation, and a homogeneous series of schist and phyllite is correlated with the Fisher Creek Siltstone.

In the Oenpelli Sheet area, however, such correlations are not possible. Generally the rocks are schistose in the extreme west of the area, becoming psammitic and grading to gneisses in the central part of the Sheet area. These gneisses probably represent an extension of the Nimbuwah Complex as far west as Barnes Springs Creek.

Basic intrusive rocks are divisible into pre- and post - deformation/migmatization types. The pre-deformation type includes dolerite "sills" within the two Complexes and the Lower Proterozoic metamorphics, and may be contemporaneous with the Zamu Complex. The 'sills" are commonly strongly porphyritic and saussuritized near the top, but less altered and ophitic at lower levels. Some intrusions contain an array of syenitic differentiates.

The post-deformation types are phonolitic, and intrude the Nanambu and Nimbuwah Complexes in only two areas - within a ten-mile radius of Mudginberri homestead, and eight miles westsouthwest of Nimbuwah homestead. They are unaltered and undeformed, and range from strongly porphyritic to fine-grained.

Fieldwork proved that geological units shown as Goomadeer Volcanics on the Milingimbi 1:250,000 Sheet are in fact dolerite and gneiss. Misinterpretation of the units was probably due to the fact that both the dolerite and the gneiss form smooth, dark photo patterns similar to those formed by basic volcanics.

Structure

The Nanambu and Nimbuwah Complexes are elongated N-S; foliations within the Nanambu Complex are mostly concentric, and those in the Nimbuwah Complex trend roughly southeast. The Nimbuwah Complex may be continuous with the 'granites' at the eastern end of the Myra Falls, and at the Beatrice uranium prospect.

The Lower Proterozoic metamorphics surrounding the Complexes are structurally conformable with them.

Faulting in the area is predominantly aligned NW-NNW or E-ENE. The NW-NNW faults (e.g., along parts of the Magela, Baroalba, Nourlangie, and Jim Jim Creeks) offset the margins of the Nanambu Complex, whereas the E-ENE faults do not affect the margins of the Nanambu Complex, even though some may extend for over 150 km across the Arnhem Land Plateau. One such fault passes through the Ranger 1 orebody. A similar structure occurs adjacent to the Koongarra deposit, forming the southeastern margin of the Mount Brockman massif; it appears to curve under the Kombolgie Formation, and continue towards the Ranger 1 deposit.

Vertical displacements of up to 70 m within the Kombolgie Formation are common along major gorges all along the Arnhem Land scarp.

Economic Geology

There is no obvious connection between the position of uranium mineralization in the Alligator River Uranium Province and the level of the base of the Kombolgie Formation. Although all significant finds and several prospects are adjacent to the unconformity, it is believed that the absence of thick Cainozoic cover here has simply facilitated more efficient exploration over exposed or subcropping rocks near the escarpment.

Our mapping has accentuated the concept of an association between the quartzite/dolomite series within the Lower Proterozoic rocks (correlated with the Koolpin Formation) and mineralization west of the East Alligator River (the quartzite/dolomite series has been observed as far north as Cannon Hill).

The more important uranium deposits and prospects found to date lie adjacent to the margins of the Nanambu and Nimbuwah Complexes. It is possible that volatiles, including uranium compounds, were 'sweated out' of the sedimentary rocks during migmatization, and concentrated around the margins of the Complexes. Pegmatite dykes, some of which are uraniferous, commonly occur throughout the transition zone around the Complexes.

Dating of Uranium Mineralization (Note by W.B. Dallwitz)

Recent U-Pb age determinations by Hills and Richards (Search 3, 10, pp. 382-5, 1972) suggest that the "original" deposition of pitchblende in the Westmoreland, South Alligator valley, and Alligator River areas took place about 850 m.y. ago. Redistribution of uranium and lead took place 450-500 m.y. ago, and again possibly in the Recent, though the evidence for this last episode can be interpreted as pointing to either Recent lead loss (or uranium gain) or a continuous loss of lead by diffusion throughout the history of the deposit. However, results for only a single sample (from Koongarra) were available from the Alligator River area when Hills' and Richards' paper was submitted for publication. Subsequent work has shown that both U-Pb and Pb ages for at least one lode in that area are very much greater than 850 m.y.

Reporting of Results

Progress Records on mapping carried out in the Jim Jim, Mundogie, Oenpelli, Wellington Range, Goomadeer, and Junction Bay 1:100 000 Sheet areas, and on the results of isotopic dating will be prepared. When re-mapping of the Alligator River 1:250 000 Sheet area is completed in 1974, a Bulletin on the mapping carried out during the whole project will be prepared, as will a 2nd Edition map and Explanatory Notes.

McARTHUR BASIN, N.T.

CARPENTARIAN AGE DETERMINATION PROJECT

by

K.A. Plumb

Personnel: K.A. Plumb, A.W. Webb (Amdel).

McDougall et al. (J. Geol. Soc. Aust.12, 67, 1965) showed that the age of the McArthur Basin sediments range from about 1800 m.y. for the base, to a minimum of about 1300 m.y. for the top. They suggested that the sequence could be the type succession for a new time-rock unit, the Carpentarian, with the Cliffdale Volcanics as its base. They expressed the desirability of dating the Cliffdale Volcanics directly, and uncertainty about the younger ages which were based only on glauconite. Dunn et al. (1966) extended the concept to recognize three time-rock subdivisions in the Proterozoic of Australia. The Cliffdale Volcanics, about 1800 m.y. old, was defined as the base of the Carpentarian, and as the basal part of the Adelaidean was thought to be about 1400 m.y. old, the Roper Group was placed in the Adelaidean. The type succession for the Carpentarian was thought to be the Cliffdale Volcanics, the overlying Tawallah Group, and the McArthur Group at the top, but according to the principles laid down the determination of the top of the Carpentarian depends on the age of the base of the next youngest unit, the Adelaidean. Since then many improvements in age determination techniques, such as the dating of shales, has opened new possibilitiea for age determination in the area, and other work has suggested that the Roper Group may be older than 1400 m.y., and therefore belong to the Carpentarian.

This earlier work has therefore left two important problems to be solved:

1. To accurately determine the age of the base of the Carpentarian by direct dating of the Cliffdale Volcanics using the best techniques available.

2. To determine more accurately the age-range of the overlying McArthur Basin succession by utilizing all suitable rocks in the sequence.

The present Carpentarian Age Determination Project has been designed to solve these problems.

During September,1972, K.A. Plumb, of BMR, and A.W.Webb, of The Australian Mineral Development Laboratories, collected 121 samples from the McArthur Basin sequence. As can be seen from Table M1, these samples, if all suites prove suitable for age determination, will provide excellent control on the age of the whole sequence. In addition some shales were collected from the South Nicholson Group to test its correlation with the Roper Group. Some high-grade metamorphic rocks of unknown age from the basement in Arnhem Land were also submitted for analysis.

Dr. Webb is now studying the rocks by the Rb/Sr method at Amdel. Sufficient samples have been collected from all sites for the construction of reliable isochrons.

TABLE M1.

Units sampled - McArthur Basin Succession - Carpentarian Age Determination Project.

Rock Unit		Remarks
Dolerite sills		Intrude Roper Group
ROPER GROUP	Kyalla Member of McMinn Fm.	Shale. Near top of Roper Group
	Mainoru Formation	Shale. Near bottom of Roper Group
McARTHUR GROUP	W-Fold Shale Member Barney Creek Formation	About middle of McArthur Group
TAWALLAH GROUP	Hobblechain Rhyolite Member of Gold Creek Volcanics	Top of Tawallah Group
	Aquarium Formation	Glauconite. About middle of Tawallah Group.
	Peters Creek Volcanics	Acid volcanics. Near bottom of Tawallah Group
	Norris Granite	Intrudes Cliffdale Volcanics. Basement to Tawallah Group.
	Cliffdale Volcanics	Defined base of Carpentarian.
	Nicholson Granite	Basement to Cliffdale Volcanics.

Reporting of Results

A report will be prepared for publication by Webb and Plumb.

TENNANT CREEK REGIONAL MAPPING, N.T.

by

R.G. Dodson

Personnel: J.R. Mendum, P.C. Tonkin.

During the year map correction sheets and the partly edited Record on the Tennant Creek 1:250,000 Sheet area were returned to the authors for comment and correction. Completion of the Record, the 1:250,000 map, and the 1:100,000 Special Map is dependent on the authors, who resigned in 1971.

MOUNT ISA GEOSYNCLINE, QLD

Westmoreland Project by I.P. Sweet

Personnel: I.P. Sweet, J.E. Mitchell, J.A. Ingram, K.A. Plumb, P. Slater (GSQ)

Aims

The party was formed to carry out -

1. 1:250 000 mapping in the Precambrian of the Westmoreland 1:250 000 Sheet area in order to bring out a second edition of the Westmoreland Sheet.

2. Detailed mapping of the (mineralized) Proterozoic rocks in the area.

3. Orientation stream sediment geochemical studies

Results

During the 1972 field season the re-mapping of the Proterozoic rocks of the Westmoreland 1:250,000 Sheet area was completed, and detailed mapping was carried out mainly in the Hedleys Creek 1:100 000 Sheet area (Fig. M9). Orientation stream-sediment geochemical samples were collected from small drainage basins representative of the major rock units, and much of the area was covered by regional sampling at lower density.

Tables M2 and M3 show the units mapped during the present survey of the Westmoreland Sheet area, and the names used for the same units in earlier surveys.

Granites

A problem of stratigraphic nomenclature exists here, as Carter (1959) defined as Nicholson Granite the granites intruding the Cliffdale Volcanics. We have mapped three phases of granite in Westmoreland; it is known that the youngest intrudes Cliffdale Volcanics, and it is thought that the two older phases do likewise. The relationships of these granites to the Norris Granite in the Calvert Hills Sheet area are not known. No granites older than the Cliffdale Volcanics have been definitely recognized, and further mapping and isotopic dating will be needed to elucidate the ages and relationships of the granites.

Cliffdale Volcanics

The volcanics can be subdivided into five units, but further mapping is needed before formal members can be defined. The four lower units comprise ignimbrites, ash-fall tuffs, and lava flows; the uppermost (5th) unit is of spectacular appearance, and consists of flow-banded rhyolite. Two breccia masses have been located in the fifth unit; they probably mark volcanic vents.

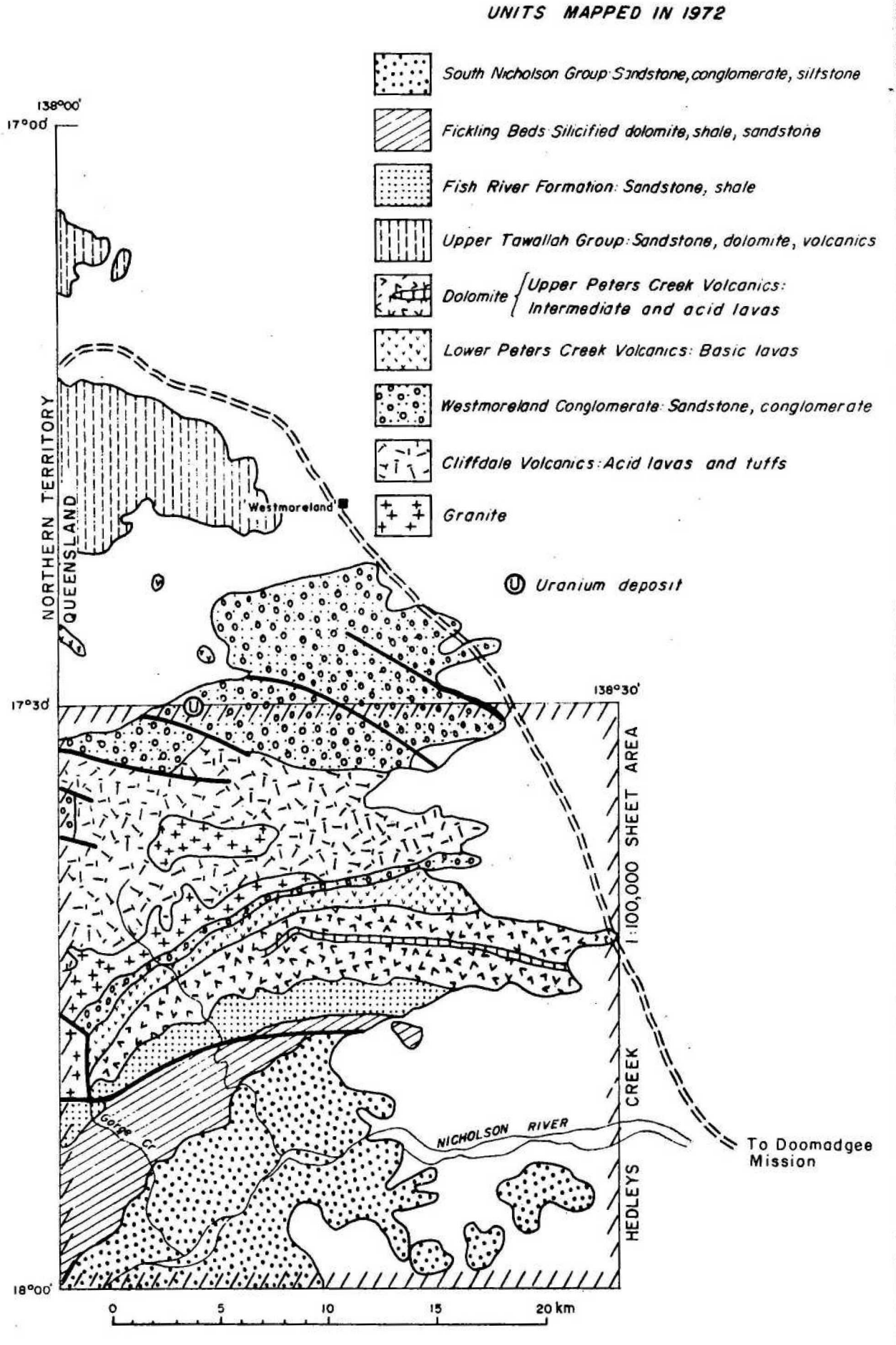


FIG M9-PROTEROZOIC GEOLOGY OF WESTERN PART OF WESTMORELAND 1:250,000 SHEET AREA

To accompany Record 1972/103

E 54/A5/3

Table M2. Stratigraphic Units Mapped in Macarthur Basin

Carter (1959) Westmoreland	Roberts et al. (1963) Calvert Hills		1972 survey Westmoreland
Gold Creek Volcanics	Tawallah Group	Masterton Formation	All units recognized in Westmoreland
Constance Sandstone		Wollogorang Formation Settlement Creek Volcanics Aquarium Formation Sly Creek Sandstone	
Wollogorang Formation		McDermott Formation	
Peters Creek Volcanics		Peters Creek Volcanics	Lower Peters Creek Volcanics (new nomenclature not decided)
Westmoreland Conglomerate		Westmoreland Conglomerate	Westmoreland Conglomerate
U N C O N F O R M I T Y			

Table M3. Stratigraphic Units Mapped in South Nicholson Basin and Basement

Carter (1959) Westmoreland	Roberts et al. (1963) Calvert Hills		1972 Survey Westmoreland
Constance Sandstone	South Nicholson Group	Mullera Formation Constance Sandstone	All units recognized in Westmoreland area
		UNCONFORMITY	
UNCONFORMITY		Fish River Formation	
		UNCONFORMITY	
Wollogorang Formation		Fickling Beds	
		UNCONFORMITY	
Peters Creek Volcanics	Peters Creek Volcanics		Upper Peters Creek Volcanics
			Lower Peters Creek Volcanics
Westmoreland Conglomerate	Westmoreland Conglomerate		Westmoreland Conglomerate
U N C O N F O R M I T Y			
Nicholson Granite	Norris Granite		"Younger granites"
Cliffdale Volcanics	Cliffdale Volcanics		Cliffdale Volcanics
	UNCONFORMITY		No older granites yet recognized
	Nicholson Granite		
	Murphy Metamorphics		

Tawallah Group

The units in the McArthur Basin have been mapped in the Calvert Hills Sheet area by Roberts et al. (1963), and the same units have been recognized in the Westmoreland area.

Westmoreland Conglomerate

Four units have been recognized, but they have not, as yet, been given formal member status. A generalized section is shown in Table M4.

Table M4

Tentative Subdivision of Westmoreland Conglomerate

Unit	Thickness	Description
4 (top)	200 m	Massive to thin bedded fine sandstone
3	300 m	Cliff-forming massive conglomerate - more easily weathered than other units
2	400 - 500 m	Massive coarse sandstone and conglomerate - weathers readily
1 (base)	about 300 m	White quartzite underlain by several different quartzitic facies; unconformable on Cliffdale Volcanics.

Peters Creek Volcanics

In the type area, south of the Cliffdale Volcanics, the Peters Creek Volcanics are made up of a lower sequence of basaltic lavas and an upper one of intermediate (and possibly acid) lavas and intrusives(?). The relationships of the various rocks within the upper series is not yet completely understood, but it appears that the lowermost of several uniform, thick sheets of reddish-brown feldspar porphyry may be a high level sill, and that vesicular rocks of similar appearance are lavas supplied from the same source. One major interbed of dolomite and shale, at least 100 m thick, has been mapped. It is speculated that the lower (basic) volcanics are the equivalent of the rocks mapped as Peters Creek Volcanics on the northern side of the Cliffdale Volcanics, and that the overlying intermediate to acid lavas and sediments are equivalent to several younger units in the Tawallah Group. This has not been proved, and further mapping will be undertaken in the Seigal 1:100 000 Sheet area (Calvert Hills) in an attempt to clarify relationships.

Fish River Formation

Previously mapped partly as Wollogorang Formation, and partly as Constance Sandstone by Carter (1959), the Fish River Formation consists of two sandstone units separated by shale. There are basic lavas in the

formation in the Calvert Hills Sheet area, but none have been observed in the Westmoreland area. The Fish River Formation disconformably (and with angular unconformity in places) overlies the upper Peters Creek Volcanics, and is overlain, probably unconformably, by the Fickling Beds.

Fickling Beds

Previously mapped as Wollogorang Formation by Carter (1959), these beds consist of silicified dolomite overlain by siltstone, shale, and fine sandstone. They have been regarded as equivalent to part of the Mount Isa Group, and have been prospected for base metal mineralization; to date only minor lead-zinc mineralization has been located.

South Nicholson Group (Constance Range Sandstone and Mullara Formation)

The youngest Proterozoic rocks belong to the South Nicholson Group, and crop out only in the southwestern extremity of the Westmoreland Sheet area. The Constance Sandstone (including two members of siltstone) occupies most of the area, and is overlain by the Mullera Formation (siltstone) in the extreme south.

Geochemical Studies

Orientation stream sediment samples were collected from drainage basins of 10-15 sq km, each of which drained only one geological unit. Basins draining the granites, Cliffdale Volcanics, Westmoreland Conglomerate, Peters Creek Volcanics, and the Fickling Beds were sampled. Between 20 and 30 samples were collected from each basin, and results from these will be analysed in order to determine the best methods for conducting regional studies at a much sparser sampling density.

Reporting of Results

A progress report (Record) on the geology and geochemistry of the Nicholson River area will be prepared. Explanatory Notes and a 2nd Edition map of the Westmoreland 1:250,000 Sheet area, to be prepared jointly with the Sedimentary Section, will be preceded by a Preliminary map.

REFERENCES

CARTER, E.K., 1959 - Westmoreland - 4 mile geological series. Bur. Miner. Resour. Aust. explan Notes. E/54-5.

ROBERTS, H.G., RHODES, J.M., and YATES, K.R., 1963 - Calvert Hills 1:250,000 geological series. Ibid. E/53-8.

CLONCURRY-MOUNT ISA PROJECT

by

G.M. Derrick

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

No new field work was started during 1972, and effort was concentrated on the completion of maps and reports for the area mapped to date (Figure M10). Some field checking of problem areas was undertaken by Derrick, who also visited a BMR ground geophysical party operating in the Marraba and Cloncurry 1:100 000 Sheet areas.

Results of Field Checking 1972

The areas or units re-examined are located southwest of Rifle Creek dam and siding, in the northwest corner of the Marraba Sheet area, parts of the Corella Formation near Timberu homestead, and the Lunch Creek Gabbro. The major conclusions are as follows:

Rifle Creek area: The relationships between the Kalkadoon Granite, the Argylla Formation, and the Mount Guide Quartzite were examined. The Kalkadoon Granite shown on the Mary Kathleen 1:100 000 Preliminary Edition, just west of Rifle Creek siding, was wrongly mapped; the area is occupied by magnetite-bearing spherulitic rhyolites of the Argylla Formation.

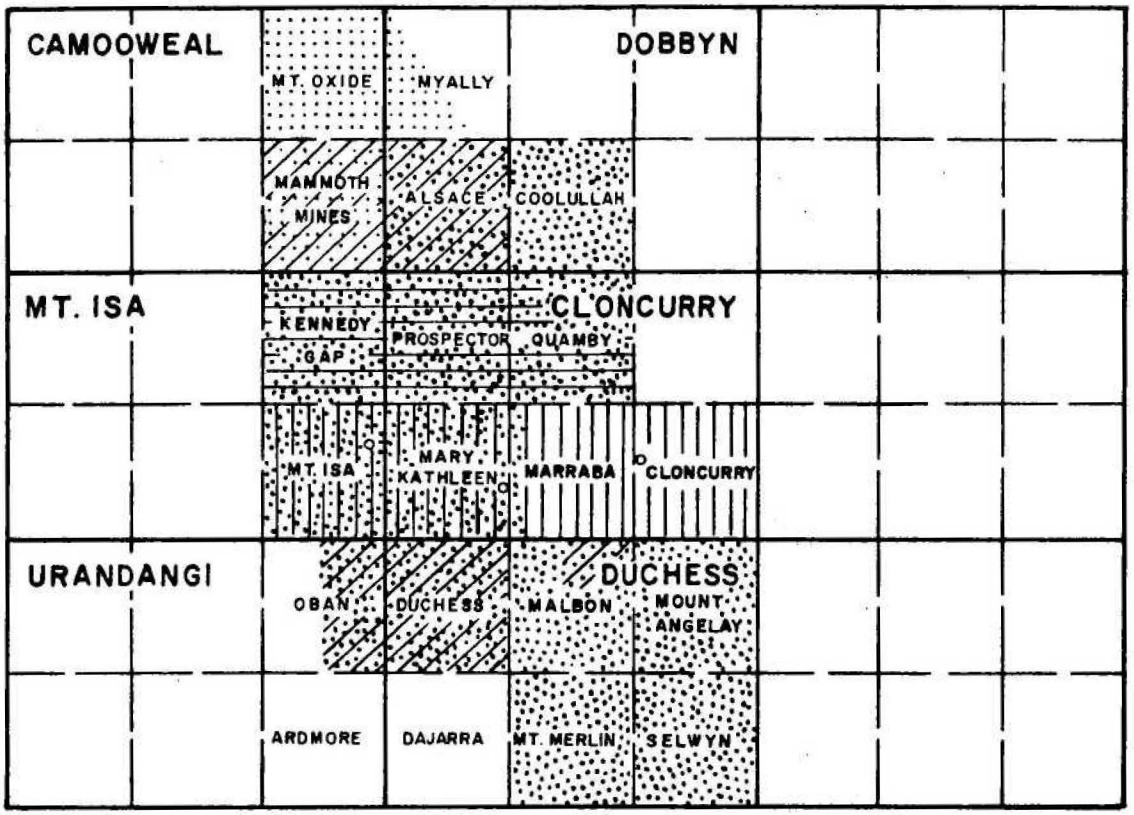
The Kalkadoon Granite-Argylla Formation contact is a faulted one, and the Mount Guide Quartzite-Argylla Formation contact is an unconformity which confirms the Kalkadoon Granite as being older than the Mount Guide Quartzite. A boulder conglomerate marks the base of the Quartzite, and it contains abundant clasts of medium-grained mica granite, sheared acid volcanics, and quartzite. The largest clast seen was a boulder of coarse granite 0.5 m by 0.3 m.

Deighton Quartzite: A study of current bedding in the quartzite showed that the southernmost part was deposited by a persistent north-trending palaeocurrent, and that palaeocurrents elsewhere were variable. The Quartzite possibly represents a broad valley-fill sand mass deposited sub-aqueously by fluviatile processes, but one cannot discount the possibility that it was deposited in near-shore shelf environment grading into a fluviatile or deltaic environment.

Corella Formation-Argylla Formation relations were re-examined in the northwestern part of the Marraba Sheet area. The Argylla Formation had previously been shown as underlying basalt and metasiltstone of the Corella Formation. Re-mapping has shown that all this area is a pelitic facies of the Corella Formation, and that the Argylla Formation underlies a thin but persistent basal quartzite which can be traced almost continuously from Lake Corella, 30 km to the south.

Lunch Creek Gabbro: A dyke of fine-grained pyroxene gabbro cuts layered biotite gabbro and diorite. The dyke was previously unrecognized, and some re-interpretation of the chemistry of the layered gabbro will be necessary.

FIG M IO-CLONCURRY-MT. ISA PROJECT
MAPPING AND COLOUR PHOTOGRAPHY



MAPPING COMPLETE: Mt. Isa, Mary Kathleen, Marraba, Cloncurry 1:100,000

MAPPING 1973: Kennedy Gap, Prospector, Quamby. 1:100,000

COLOUR PHOTOGRAPHY: Planned for 1974 for use in 1975 ?

EXISTING COLOUR PHOTOGRAPHY

FUTURE MAPPING 1974 etc. (tentative)

MT. ISA *1:250,000 SHEET AREA*

OBAN *1:100,000 SHEET AREA*

1:100,000 Base Maps available for Kennedy Gap, Prospector, Quamby, Mt. Isa, Mary Kathleen, Marraba, Cloncurry

Timberu area: In the Corella Formation, a copper-bearing belt of calc-silicate granofels and limestone was re-examined to assist with the BMR geophysical examination of the area. In a sequence about 800 m thick, two zones, one 2 m thick, and the other 5 m thick, contain disseminated copper mineralization. Over 15 minor occurrences of copper were noted over a strike length of about 1.5 km. The average grade of the mineralization is probably less than 0.4% Cu, but the area could warrant more detailed examination, particularly north of the known mineralization, where a dolerite dyke intersects the copper-bearing belt.

West of Mary Kathleen: A stratiform gossan 60 m long and up to 10 m thick was located in the Corella Formation, 12 km west-northwest of Mary Kathleen, and 1.7 km north-northwest of BMR Cloncurry No. 5 drill hole. It occurs near the base of the uppermost member of the Corella Formation in calcareous shale, and overlies thin quartzite beds. Most of the gossan is vuggy manganiferous limonite, but some banding may represent bedding in an original sulphide-rich mass. Gossan veins up to 5 cm thick cutting the country rock adjacent to the main gossan suggest that the stratiform sulphides have been mobilized in places. Assays of samples from the gossan are as follows:

Sample No.	Cu	Pb	Zn	Co	Ni	(ppm)
72201582	280	40	1300	750	330	
1583	20	30	560	470	210	
1584	50	30	690	160	180	
1585	140	50	550	570	250	
1586	200	30	320	400	190	
1587	500	20	180	430	120	
1588	110	20	150	430	190	

The high Co values are unusual; other gossans of stratiform habit at Mount Novitt, Mount Isa, and Northern Leases contain an average of 50 ppm Co.

Lady Loretta Lode: The Lady Loretta Ag-Pb-Zn deposit near the Lady Annie Mine, was visited. It was discovered about 2 years ago by the Placer-Triako group in pyritic shale and kaolinitic siltstone of the Paradise Creek Formation, 150 km north of Mount Isa. The mineralization is stratiform, and is contained in two north-plunging synclines (eastern and southern) separated by faults. Mineralization in the eastern syncline occurs over a strike length of 690 m, and some drill intersections have been very rich; e.g., drill hole P117 averaged 29.9% Zn, 12.9% Pb, and 6.3 troy oz., Ag per ton, between 404 and 433 metres.

Massive barytes underlies the ore-zone, and is localised in the axial zone of the eastern syncline.

Copper mineralization in the vicinity is confined to the Gunpowder Creek Formation, which underlies the Paradise Creek Formation. Both these units are broadly equivalent to the Mount Isa Group; the occurrence of barytes at Lady Loretta suggests a tentative correlation with other barytes-bearing sequences in the area such as at Mount Isa and at the base of the Corella Formation in the Overhang Jaspilite, between Cloncurry and Mary Kathleen.

Office Work

Records: The writing and preparation of two major Records (Marraba and Mary Kathleen) occupied nearly all of the year. Marraba (Record 1971/56) is ready for distribution; Mary Kathleen has been written, and editing should be finished by the end of the year; writing of the Mount Isa Record started in October.

Maps: Work on the 1:100 000 geological maps continued during the year, and in September Preliminary Editions (in four colours) of the Cloncurry, Marraba, and Mary Kathleen 1:100 000 Sheets were issued. These sheets are to be edited and corrected for First Edition. The Mount Isa 1:100 000 area is covered by four geological maps at 1:50 000 scale, which are to be drawn at 1:100 000 scale.

Geochemistry: Various geochemical investigations have been undertaken during the year as an adjunct to the geological mapping. They include:

(1) Geochemistry of gossans: about 70 samples of gossans and some sulphide-bearing equivalents were analysed for Cu, Pb, Zn, Co, Ni, Fe, Mn, Cd, Cr, Ag, Mo, and As. The gossans were grouped according to the type of mineralization; e.g., gossans related to lodes associated with granite, dolerite, acid volcanics, stratiform sulphide bodies, etc. The aims were to classify (if possible) gossans from known ore-forming environments, and to then relate gossans from unknown environments to certain of the established groups. A comparison of trace elements from sulphide ore and its gossanous equivalent could lead to information on the movements of trace elements in the weathering profile during gossan formation.

Analytical results and some conclusions were presented in lecture form in February, and a Record on the gossans is planned.

(2) Geochemistry of black shales: two units of acid volcanics - the older Leichhardt Metamorphics and the younger Argylla Formation - were compared geochemically. From major and minor element analyses of 15 samples of each formation, major differences were noted, e.g.,

	Leichhardt Metamorphics	Argylla Formation
Rb	140 ppm	165 ppm
Sr	190 ppm	48 ppm
K_2O	3.2%	5.4%

Copper in both formations is low - about 5 ppm. Plots of K vs Rb and Sr vs Ca also show marked geochemical separation of the two formations, and it is probable that a Sr analysis alone would serve to identify acid volcanics of unknown formation status in the Mount Isa region. The results indicate a marked evolutionary trend in acid volcanism, but there is insufficient stratigraphic control of the samples to detect variations within each formation. This approach will be examined more closely in the Prospector area in 1973.

The results of this work will be presented in a Record.

(4) Geochemistry of the Corella Formation: Major and minor element analyses of 60 samples of the Corella Formation have been made; the samples were mainly scapolite-bearing limestone, schist, cordierite-anthophyllite rock, calc-silicate rock, and calcareous granofels.

Full results will be reported in a Record, but some preliminary results for scapolite-bearing dolomitic limestones are listed below; the averages for shale and limestone (Turekian & Wedepohl, 1961) are given for comparison.

	Corella Formation	Ave. shale	Ave. carbonate
F ppm	1000	740	330
Cl "	700	150	180
Pb "	53	20	9
Zn "	17	95	20
Rb "	190	140	3

Age Determination: Age determination of granites and acid volcanics by the Geochronology group continued throughout the year.

Lectures: The following lectures were presented during the year:

(a) To Geological Society of Australia, Specialist Groups Symposium:

Carbonate breccia in the Precambrian Corella Formation of northwest Queensland - tectonic or sedimentary?, by G.M. Derrick.

Copper mineralization (excluding Mount Isa) in the Precambrian Cloncurry Complex of northwest Queensland, Australia, by I.H. Wilson, G.M. Derrick, and R.M. Hill.

Geochemistry of gossans from the Mount Isa-Cloncurry region, northwest Queensland, by G.M. Derrick.

Pseudomorphous replacement of tourmaline by prehnite, and kyanite-andalusite by topaz, by G.M. Derrick.

(b) BMR Symposium:

Economic geology of the Mount Isa-Cloncurry region, by I.H. Wilson and R.M. Hill.

The continuing search for the next Mount Isa: Geology, palaeogeography, and correlation of black shale deposits in the Mount Isa region, by G.M. Derrick.

Visitors: About twenty representatives of mining companies and consultant groups visited the Cloncurry-Mount Isa during the year.

Colour Photography and Future Work

Detailed mapping in the Mount Isa region will continue during 1973, using colour aerial photography at 1:25 000 scale. An area north of the Mount Isa-Cloncurry strip, comprising the Quamby, Prospector, and Kennedy Gap 1:100 000 Sheet areas, will be mapped. Colour photography also covers the area south of the completed Mount Isa-Cloncurry strip, but 1:100 000 topographic base maps are not yet available. Fig.M10 shows areas to be mapped in the immediate future, as well as areas covered by colour photography.

GEORGETOWN INLIER, QUEENSLAND

GEORGETOWN PROJECT

by

J.H.C. Bain

Personnel: J.H.C. Bain, B.S. Oversby; W.H. Oldham, J.W. Sheraton, D.B. Dow, S. Henley (BMR, all part time); I.W. Withnall (GSQ), L. Wall (GSQ, part time); M. Little (drafting)

Aims

The aims of the Georgetown Project, which started in 1972, are to produce revised geological maps at 1:100 000 scale, and to carry out a detailed investigation of the economic geology and geochemistry of the Georgetown Inlier, north Queensland.

Before the field season, Withnall examined all company and Geological Survey reports lodged with Queensland Mines Department, filed all relevant data on a card index, and wrote summaries of the more detailed reports. Data relating to past and current prospecting authorities and mineral leases were also placed on a card index. All available geochemical data were abstracted from company reports, and plotted on 1:250 000 scale overlays by L. Wall.

Field work in the area was carried out between early July and late September from a base camp on the Little River 63 miles west of Georgetown. Vehicle and foot traverses were made to collect stream sediment samples, to become familiar with the regional geology, and to gather information for systematic 1:100 000-scale geological mapping.

Most of the field work was directed to the collection of stream sediment samples for orientation studies for a regional survey in the Georgetown Inlier.

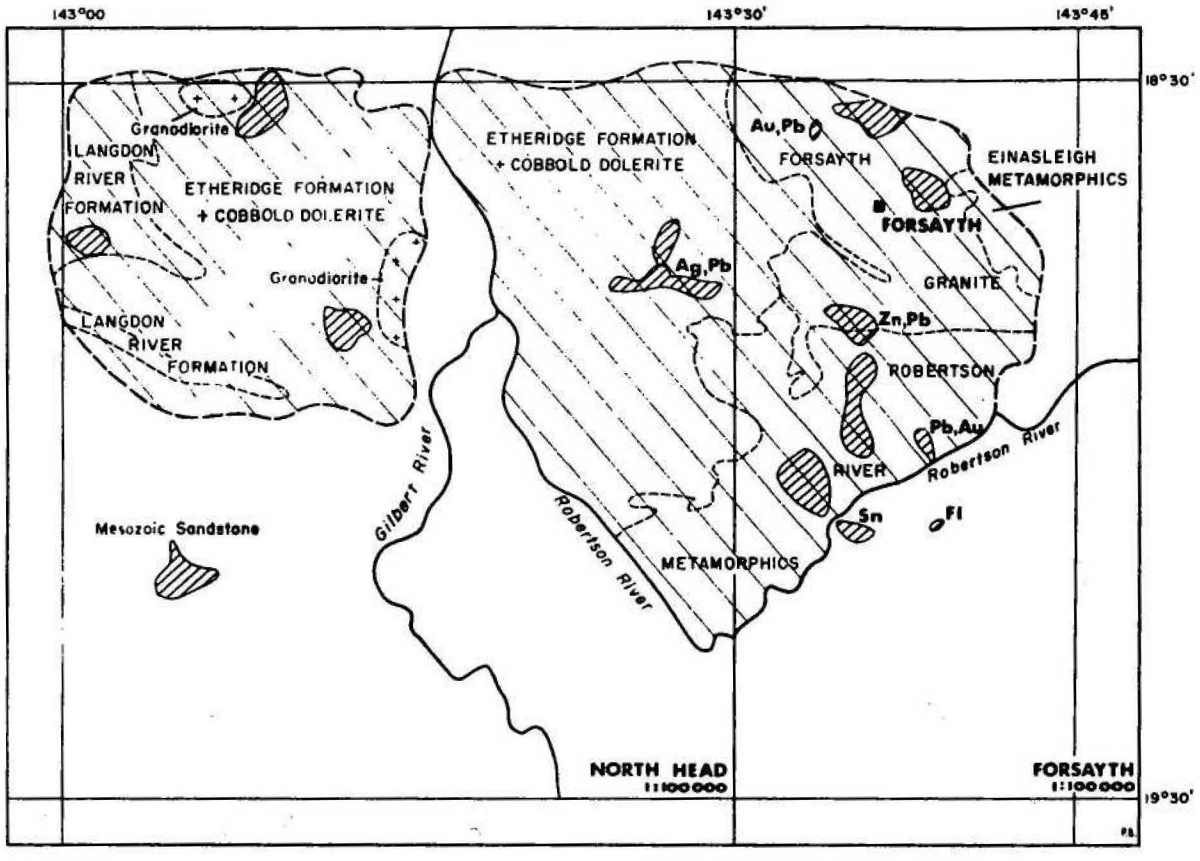
Orientation Geochemistry

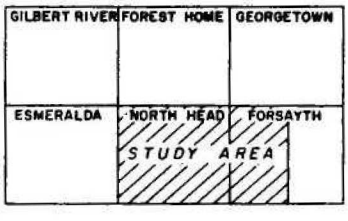
Regional geochemical surveys have been successful in delineating mineralised areas in many parts of the world, but very few data are available on the application of the method to areas where geology and weathering environment are similar to those in the Georgetown area. A large part of the area is either occupied by Precambrian quartzose sediments and metasediments intruded by granite, or else has a thin cover of residual quartz gravel derived from Mesozoic sediments, so that the geochemical response was likely to be low over most of the region. It was therefore decided that exhaustive orientation stream sediment sampling was required before committing a large effort to regional geochemical surveys. The aims of the orientation studies were:

(a) to find the effects of deep weathering on the geochemical response of the different rock types;

(b) to evolve a sampling procedure which reduces sampling variance; and

(c) to determine the maximum sampling interval suitable for the detection





Detailed orientation study areas

Regional orientation areas (sample density about 1 per 10-15 km²)

Au Dominant mineralization

PROTEROZOIC	Langdon River Formation :	*Shale, siltstone, sandstone*
	Etheridge Formation:	*Quartz siltstone, shale, chert, pyritic carbonaceous siltstone, andalusite & mica schists*
	Robertson River Metamorphics:	*Quartzite, garnet-staurolite & mica schists, pegmatite*
	Cobbold Dolerite:	*Dolerite, amphibolite*
	Forsayth Granite	*Grey foliated porphyritic granite*
ARCHEAN?	Einasleigh Metamorphics	*Granulite, amphibolite, migmatite*

FIG.M11 GEORGETOWN GEOCHEMICAL ORIENTATION SURVEY, 1972 LOCALITY DIAGRAM

To accompany Record 1972/103

E54/A12/11

of anomalous metal concentrations, and to determine the relationship of geochemical trends to the regional geology and mineralization of the area.

Orientation areas were selected to represent the major rock units and types of mineralization of the region (Fig. M11); these comprise Precambrian sediments of the Langdon River and Etheridge Formations, schists of the Robertson River Metamorphics, Cobbold Dolerite, Forsayth Granite, Palaeozoic granites, porphyries, and acid volcanics, Mesozoic sediments, and vein type Ag-Pb and Au deposits.

Altogether nearly 800 samples were collected, many of them in duplicate; except for a bulk sample from each of the detailed study areas, all consist of about 10 gm or more of -85 mesh dry sieved stream sediment. The bulk samples are being analysed for a large number of elements to decide which elements should be determined in the normal stream sediment samples. The elements will be selected for analysis in the orientation study on the basis of their potential economic and environmental significance.

All field data have been punched on tape, and a data storage programme has been written by S. Henley. The programme is in an advanced stage of development, and preliminary statistical analysis of results for the first 200 samples is proceeding.

Geology

Several familiarization traverses were made before the geochemical orientation survey was started; detailed geological observations were made where practicable during the orientation survey, and some detailed mapping was undertaken late in the field season.

The Forsayth Granite in the Forsayth 1:100 000 Sheet area was divided into six units on the basis of grainsize and mafic index:

1. even-grained leucocratic,
2. slightly porphyritic leuco- to melanocratic,
3. porphyritic melanocratic,
4. even-grained melanocratic,
5. mafic,
6. pink, even-grained, and slightly porphyritic, with variable mafic contents.

However, gradations occur between rock types in each unit and between units, and no absolutely consistent rock relationships were seen. Moreover, preliminary chemical analysis by Sheraton (North Queensland Granites Project) show that, apart from variations in Fe and Mg contents, variation within the six units is as great as variation between them; in other words, it is difficult to distinguish the units geochemically. Petrographic and further geochemical work is planned on about fifty specimens.

Specimens of Forsayth Granite, of Palaeozoic porphyries near Prestwood, and of granodiorite south of Forest Home were collected for geochemical studies and isotopic dating, and for comparison with specimens previously collected for the North Queensland Granite Project.

Reporting of Results

A Record entitled "Progress report, orientation geochemistry, Georgetown Inlier, 1972" will be prepared.

PRECAMBRIAN MICROFOSSIL STUDY PROJECT

by

K.A. Plumb

Personnel: K.A. Plumb, Dr M.D. Muir (Imperial College of Science and Technology, London)

Dr M.D. Muir of Imperial College, London, visited Australia during May and June, 1972, under the sponsorship of the Baas-Becking Geobiological Research Laboratory to study Australian Precambrian stratigraphy and collect samples for micropalaeontological research. Dr Muir spent seven weeks visiting areas throughout Australia; she was accompanied by K.Plumb, who selected the areas of interest, and acted as guide and adviser in the field.

The field of Precambrian micropalaeontology is largely unexplored outside of the Soviet Union, and is almost untouched in Australia except for a little work by overseas workers. Australia has large areas of suitable rocks possessing excellent potential for microfossils, and it is hoped that this present study will provide the basis for much future work.

Samples were collected so that:-

(a) some of the stratigraphic gaps in the present knowledge could be filled;

(b) as great a stratigraphic range as possible in any area could be covered to identify local changes;

(c) comparable material from geographically distinct areas could be obtained;

(d) a wide range of rock-types could be examined;

(e) the relationship between metal content and organic matter could be investigated.

A total of 251 samples (listed in Table M5) ranging in age from Archaean to Cambrian, were collected from widely scattered areas throughout Australia. Previous workers have described microfossils from the Hamersley Iron Formation, Paradise Creek Formation, Skillogallee Dolomite, and Bitter Springs Formation. During the present study most emphasis is being given to the McArthur Group because:-

(1) it helps fill a major stratigraphic gap in the world micropalaeontological record;

(2) a wealth of promising material is available over a large stratigraphic range and a wide area;

(3) there are abundant stromatolites closely associated with potential microfossil bearing rocks;

(4) an association exists with the HYC (McArthur River) lead-zinc deposit.

Dr Muir (pers. comm., 1972) recently discovered micro-organisms in sulphide material from the HYC ore deposit, and subsequently Dr N.J.W. Croxford (pers. comm., 1972), of Mount Isa Mines Limited, discovered micro-organisms in chert from the Amelia Dolomite of the McArthur Group. Both these preliminary discoveries are being further investigated by Dr Muir.

All the samples collected during the project have been shipped to Imperial College, London, where Dr Muir will study them by a variety of techniques including optical microscopy, transmission and scanning electron microscopy, X-ray microanalysis, and cathodoluminescence spectroscopy.

Table M5

SAMPLES COLLECTED - PRECAMBRIAN MICROFOSSIL STUDY PROJECT

Age	Locality	Rock Unit	Nos. of Specimens
Cambrian	Amadeus Basin	Goyder Formation	4
Adelaidean	Amadeus Basin	Areyonga Formation Bitter Springs Formation	5 15
	Adelaide Geosyncline	Burra Group River Wakefield Group	11 2
	East Kimberley	Stubb Formation Carr Boyd Group Bungle Bungle Dolomite	2 6 17
?Carpentarian	McArthur Basin	Roper Group	14
Carpentarian	McArthur Basin	McArthur Group	103
	Paradise Creek	Paradise Creek Formation	8
	Kimberley Basin	Kimberley Group	4
Lower Proterozoic	Pine Creek Geosyncline	South Alligator Group	10
	Hamersley Basin	Hamersley Group Fortescue Group	38 5
Archaean	Yilgarn Block		7

PAPUA NEW GUINEA

The programme of regional geological mapping of Papua New Guinea, begun by the Bureau in 1956 in the Central Highlands of the Territory of New Guinea, is nearing completion. Much of the recent mapping has been done by the Geological Survey of Papua New Guinea, but Canberra-based field parties in 1972 completed mapping in the West Sepik region, and started mapping the only unknown area remaining - the core of the mountain ranges between the Sepik River and the coast. The study of late Cainozoic volcanoes of Papua New Guinea is part of this work, and was continued during the year in conjunction with the Geological Survey of PNG.

Reporting of previous field work in the West Sepik, Eastern Papua, New Britain, New Ireland, and the Central Highlands continued, and was highlighted by the issuing of the Preliminary Edition of the 1:1 000 000 Geological Map of Papua New Guinea, which has now been edited for First (colour) Edition.

TORRICELLI SURVEY

by

D.S. Hutchison, D.B. Dow, and M.S. Norvick

Personnel: D.B. Dow, D.S. Hutchison, C.E. Maffi, and M.S. Norvick.

Introduction

Though the upper Tertiary sedimentary rocks of the northern ranges of Papua New Guinea (north of the Sepik River) have been mapped in considerable detail by oil exploration companies in recent years, very little was known about the igneous and metamorphic rocks which form the cores of the ranges. Even less was known geologically of the belt of mountainous country along the West Irian border north of the Sepik River, which is remote and difficult of access.

The objective of the Torricelli Party in 1972 was to extend the geological mapping done south of the Sepik River in 1966 and 1971 into the northern ranges, starting from the southwest near the West Irian border. Only the so-called "basement rocks" were to be mapped in detail, though it was intended to make as many traverses in the upper Tertiary sedimentary cover as necessary to obtain a good picture of all the formations mapped by the oil exploration companies.

A Bell Jetranger helicopter was used exclusively for access, and because of its high speed and rate of climb, and its ability to carry four people with field equipment, progress was much more rapid than anticipated. Thus, during the seven weeks occupied by the survey, the "basement rocks" of the Aitape and Vanimo 1:250 000 Sheet areas were mapped, and traverses were made through complete sections of the upper Tertiary sedimentary cover north and south of the ranges.

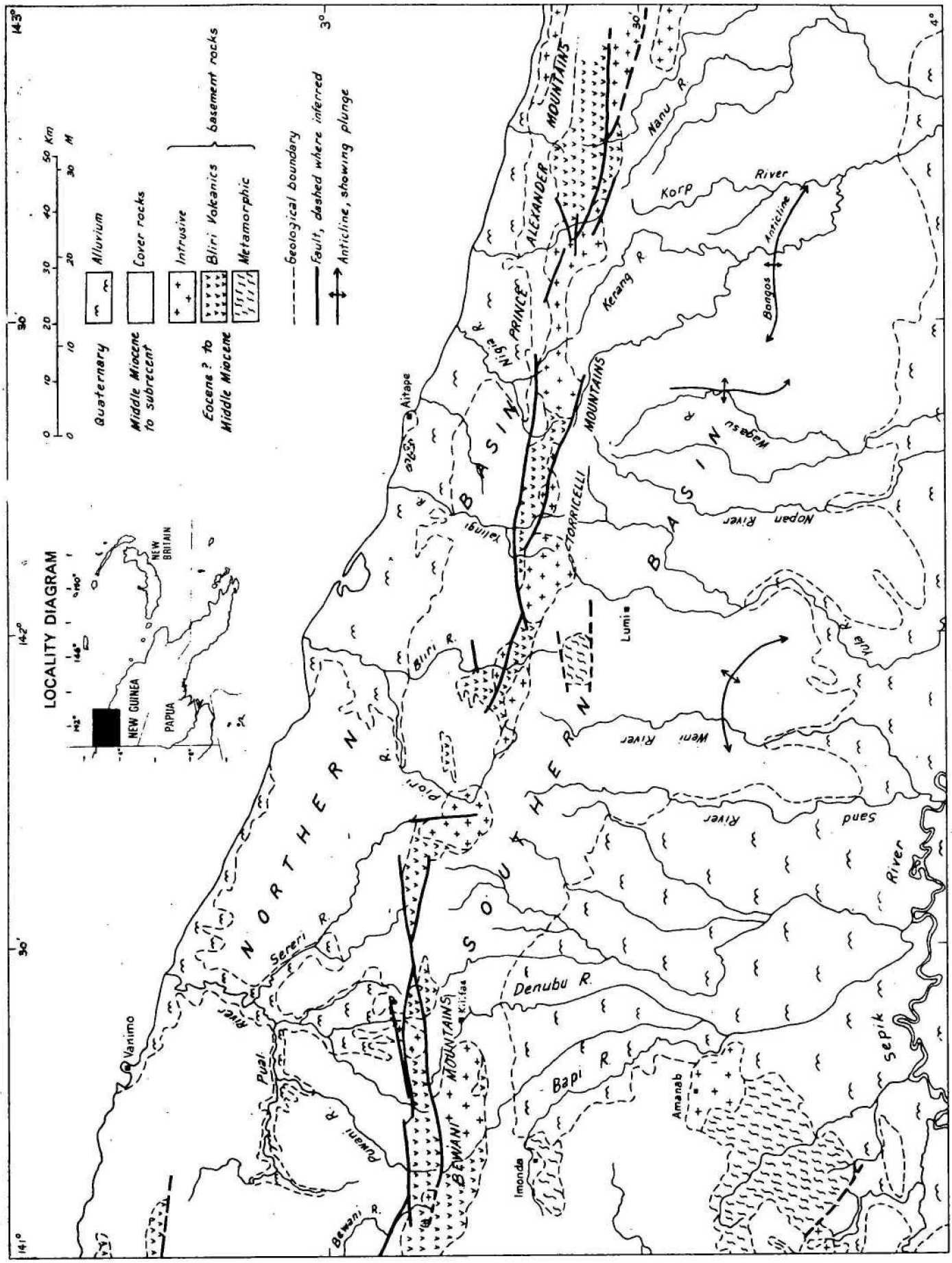


Fig. M12 GEOLOGICAL SKETCH MAP, TORRICELLI AREA, PNG

Such rapid progress necessitated rapid shifts of base camp: Amanab, an Administration Patrol Post near the West Irian border, south of the main range, was used for the first two weeks; Vanimo, the West Sepik District Headquarters on the north coast near the border, was used for three weeks; and Aitape Subdistrict Office, on the coast midway between Vanimo and Wewak, was used for the last two weeks.

Most of the streams draining the northern ranges are short and steep, and can be traversed in one day, so most of the mapping was done by day traverses from base camp. Each traverse party in this case consisted of one geologist and a native assistant, two parties being positioned with each trip of the Jetranger.

Two-day and rare three-day traverses were needed in the longer streams, and a traverse party then comprised one geologist and three native assistants to carry camping equipment. One trip of the Jetranger was needed to position such a party.

Topography

The northern ranges trend slightly south of east from the West Irian border to the coast near Wewak. They are named, from west to east, the Bewani, Torricelli, and Prince Alexander Mountains, and consist of a narrow mountain chain which, though only of moderate elevation (up to 2000 m), is very rugged in places. The belt of mountainous country along the West Irian border is of lower elevation, but is also quite rugged, especially in areas of flat-lying limestone, where a deep impenetrable karst topography has been developed in places.

In such jungle-covered country, outcrop is confined almost entirely to streams, and in the northern ranges these are short and steep and in many cases obstructed by gorges and waterfalls.

Geology (Figs. M12 and M13)

Amanab-Imonda Area

Altered gabbroic and dioritic rocks of uncertain age (Cretaceous?) are the oldest basement rocks cropping out in the Amanab-Imonda area. These rocks are characteristically altered, mafic minerals having been replaced by chlorite and, less commonly, epidote. The southernmost exposures of the basement rocks (south and southwest of Amanab) consist of low to medium-grade metamorphic rocks, which grade from north to south from fine-grained calcareous marine metasediments and fossiliferous limestone (Eocene or Oligocene age), to mainly pelitic and calcareous schists and some greenschist probably derived from basic lavas. The metamorphic foliation has a general east-southeast trend, variable but mainly steep dips, and minor secondary kink folding. Most of the metamorphic rocks are correlated with the Salumei Formation, of the south Sepik area, which is of Cretaceous to Eocene age.

The older intrusives and the metamorphic rocks have been intruded by younger dioritic, granodioritic, and minor doleritic rocks, which are distinguished from the older intrusives by their fresh, unaltered appearance.

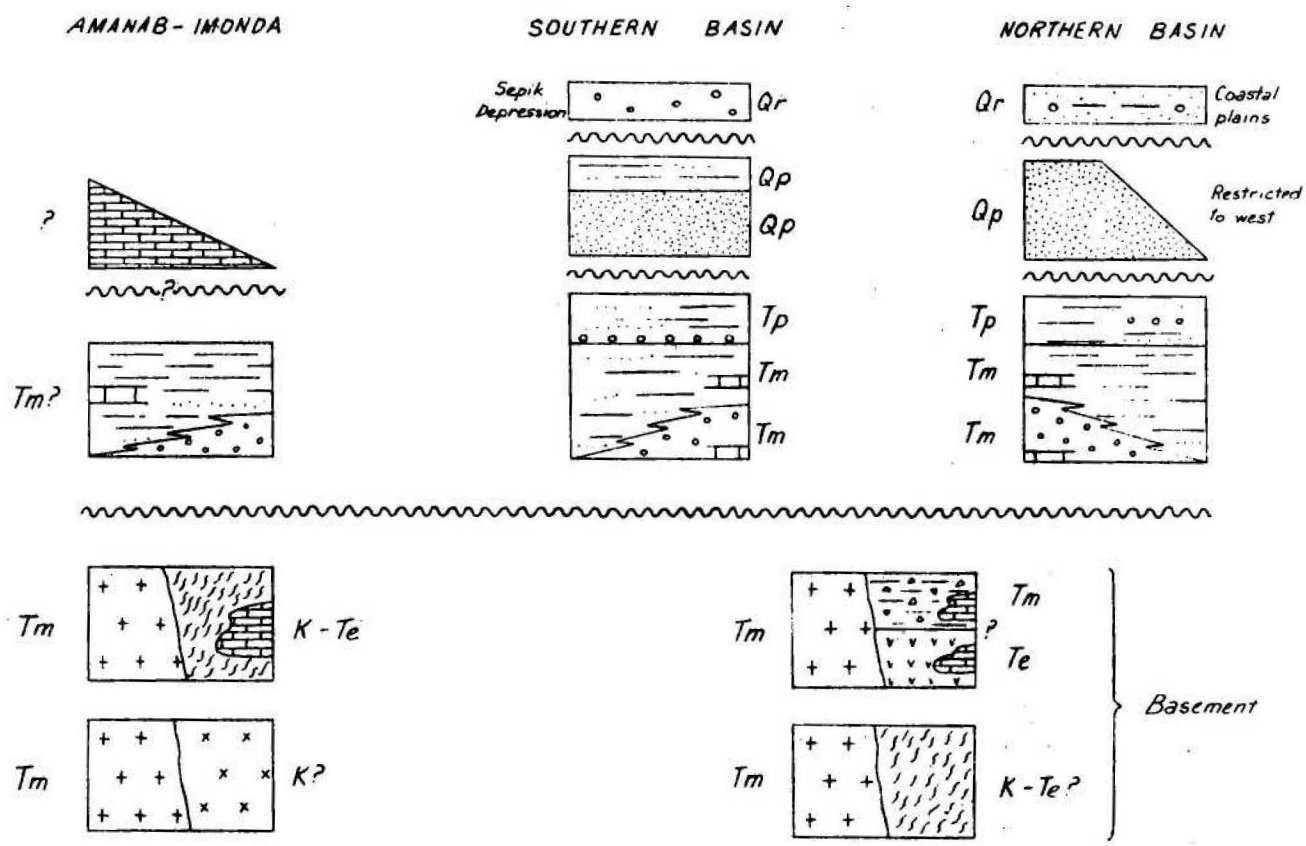


Fig. M13 STRATIGRAPHIC RELATIONSHIPS, TORRICELLI REGION, PAPUA NEW GUINEA

To accompany Record 1972/103

P/A 396

The small basement block cropping out to the south of Imonda consists of medium-grade basic and acid intrusives.

Most of the basement in the Amanab-Imonda area is unconformably overlain by a thick basal polymictic conglomerate and by foraminiferal siltstone, sandstone, and bioclastic limestone. In the Border Mountains to the west and also just south of Imonda, almost flat-lying limestone of uncertain age (called the Border Limestone) rests directly on basement. It had previously been assigned a Pleistocene age by rather tenuous correlation with the Hollandia Formation in West Irian, but it is almost certainly substantially older - probable Middle Miocene.

Bewani-Torricelli Mountains

Eocene to Oligocene. In the map area the main divide separating the Sepik River from the northern New Guinea coast is called the Bewani Mountains to the west, and the Torricelli Mountains to the east. The divide is a long, narrow, east-southeast trending range, up to 1800 m high, which drops steeply to alluvial plains on either side.

The basement rocks, which form the core of the mountains, consist of a group of basic submarine volcanics, volcanically derived sediments, and limestone, called the Bliri Volcanics, which have been intruded by the intermediate to basic igneous rocks of the Torricelli Igneous Complex. The volcanics probably range from Eocene to lowermost Miocene in age, and the intrusive rocks are probably Lower or Middle Miocene.

The Bliri Volcanics are intensely faulted, and it proved impossible to establish the succession with certainty, but it appears that a broad subdivision is possible: a lower unit, of Eocene age, characterized by red and green basalt, pillow basalt, and agglomerate interbedded with fine-grained marl and limestone; and an upper unit, of Oligocene age, which differs in having a much greater proportion of volcanolithic sediments and pyroclastic rocks. A common rock type in places throughout both units in the Bewani and Torricelli Mountains is a calcarenite or coralline limestone containing a large proportion of volcanic detritus which may be well rounded or angular, and which ranges in grainsize from fine sand to clasts up to 20 cm across.

The Bliri Volcanics, because of their extreme lateral variation, dominantly marine volcanic nature, the presence of pillow lavas, and the prevalence of volcanic material in reef detritus, are undoubtedly the product of island arc volcanism.

The Torricelli Igneous Complex is made up mainly of intermediate and basic plutonic rocks; in the Bewani Mountains the complex is predominantly intermediate in composition, and a medium-grained leucodiorite is the major rock type. Minor granodiorite, mafic diorite, and dolerite are common, generally as narrow dykes intruding the leucodiorite. In the Torricelli Mountains large masses of predominantly basic rock can be mapped

separately from the intermediate intrusive suite. In detail this basic suite shows complex relationships between gabbro, diorite, dolerite, and other minor porphyritic phases. The usual sequence of intrusion, as shown by field relationships, is gabbro-dolerite-diorite,followed by a second dolerite.

Boulders of ultramafic rocks are common in the streams draining the mountains, but they can rarely be found in situ, and then they invariably occur as pods and lenses in serpentinite gouge along fault zones.

Miocene to Recent. Sediments covering the lower Tertiary basement rocks were deposited in two deep, coeval, flysch troughs, separated by the main Bewani-Torricelli zone of basement uplift. Up to five formations, totalling more than 6000 m in thickness, can be recognized; their ages range from Middle or possible Lower Miocene to Sub-recent.

In the southern basin, a thick but laterally discontinuous basal polymictic conglomerate with lenses of bioclastic limestone is overlain by poorly consolidated, deep-water fine sandstone, graded bedded siltstone, and minor limestone, all of which are interbedded with shallow-water, channel-bedded lithic and conglomeratic sandstone. Overlying these beds, and separated by a minor unconformity, is a regressive sequence of shallow-water lithic sandstone, carbonaceous leaf-bearing siltstone, and very minor coal. All formations thin or cut out westwards, where they abut against the Amanab-Imonda basement massif.

The polymictic conglomerate is also present at the base of the succession in the northern basin. It is overlain by graded-bedded siltstone, lithic sandstone, and Globigerina marl and limestone, which were probably deposited in a deeper-water environment than the rocks to the south. In the far west the succession is capped by regressive shallow-water lithic sandstone containing abundant plant material.

The lower Tertiary rocks are broken into a very complex system of fault wedges by closely-spaced anastamosing shear-zones which trend from east-southeast to east-northeast. The shear-zones are vertical or steeply dipping, and though most have large vertical displacements, slickensides are almost invariably within 30° of the horizontal, indicating a large lateral component to the faulting. Some minor faults cut across the main range at a high angle to the regional trend, but most show only small vertical displacements.

Most of the displacement on the faults took place before the cover rocks were laid down in the Middle Miocene, but very substantial movements since the Pleistocene have been proved, and the region is still tectonically active.

Almost all the rocks of the main range, including the younger sedimentary cover, dip steeply, and are commonly overturned. As an example of the intensity of the later earth movements, a sequence of Pleistocene to Recent shallow-water sediments over 3000 m thick has been overturned against the

northern flank of the range, and now dips south at between 70° and 80°.

Away from the main range the sedimentary cover is only broadly folded. South of the Bewani-Torricelli axis the cover-rocks are exposed in a little-disturbed homocline with minor strike faulting. Broad east-west and north-south trending anticlines were probably controlled by pre-existing basement hôrsts.

Economic Geology

Exploration in the region has been largely centred around the search for petroleum, and much detailed work has been done between 1920 and the present day. To date no oil has been discovered, although several gas and oil seeps are known in the northern basin. Preparations have commenced by the Continental Oil Company of Australia to drill a well on the Bongos Anticline, about fifty kilometres west-southwest of Maprik.

Platinum derived from conglomerate of the cover sequence, forms placer deposits in the streams near Kilifas, but these are neither rich enough nor large enough to be economic.

Gold may be panned in reasonable quantities from the streams around Amanab, and most of the streams draining the main range contain traces of gold, all of which is probably derived from the intermediate and acid intrusive rocks.

Prospects for other metals seem poor. It was hoped that the region would be prospective for porphyry copper type mineralization, but most of the intrusive rocks are fresh, unaltered, non-porphyritic types, generally unsuited as hosts for this type of mineralization. Some minor copper mineralization of hydrothermal type has been found in shear-zones. Several drainage geochemical surveys have been made along the whole of the range by exploration companies in recent years, but apparently without reward.

Reporting of Results

Results of the Torricelli survey will be produced first as a Record, and later as a BMR Report. Preliminary maps and 1st Edition maps and Explanatory Notes for the Aitape and Vanimo 1:250 000 Sheet areas will also be prepared.

WEST SEPIK SURVEY

by

H.L. Davies

Personnel: H.L. Davies, D.S. Hutchison; M.S. Norvick, R.J. Ryburn, C.E. Maffi, D.J. Belford, part time; D. Coutts (gravity survey).

The West Sepik survey covers the central ranges of Papua New Guinea between Wabag and the West Irian border (May River, Blucher Range, Ambunti, and Wabag 1:250 000 Sheet areas - Fig. M14).

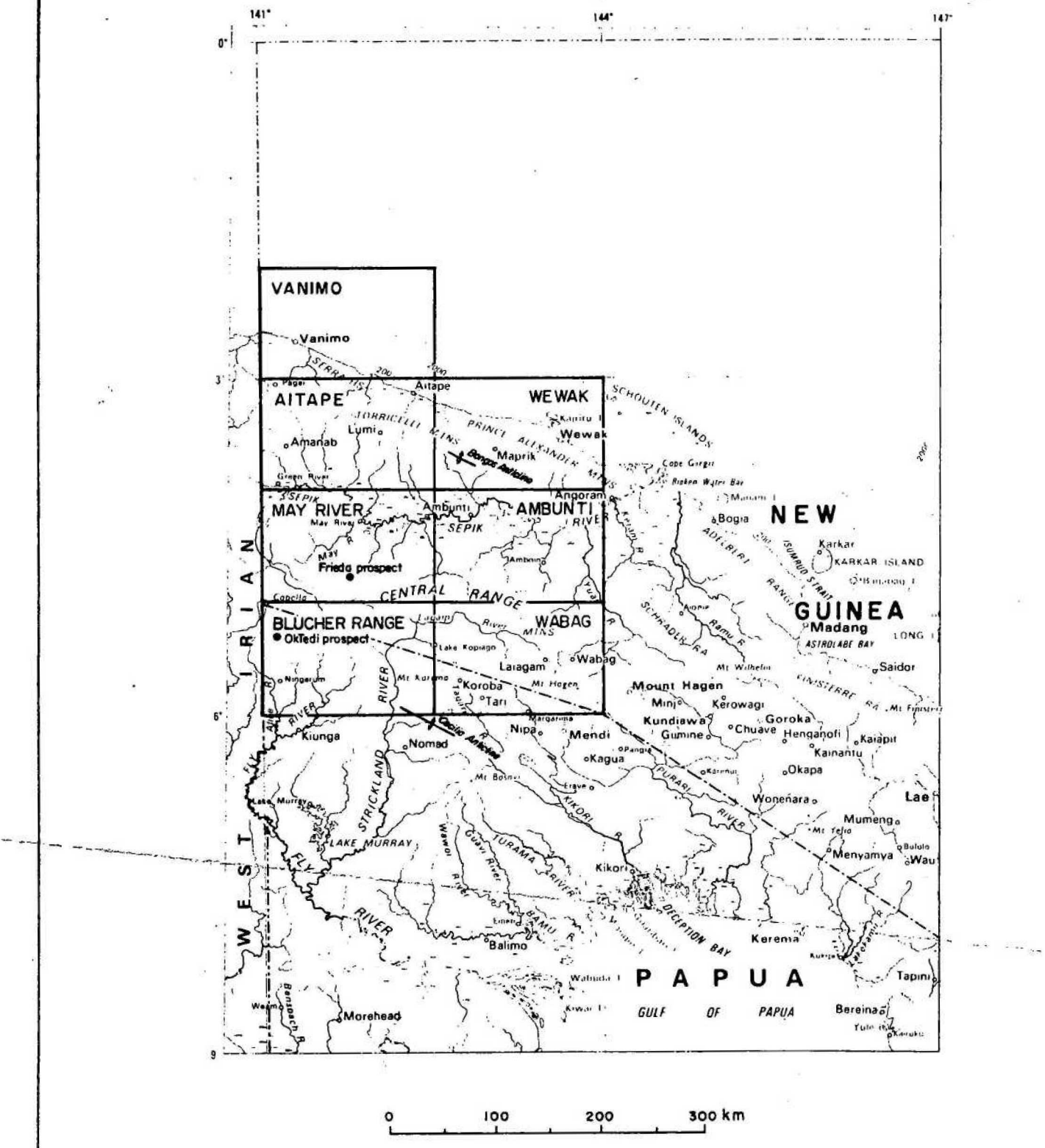


FIG M 14-TORRICELLI AND WEST SEPIK SURVEY AREAS

Most of the fieldwork was carried out in 1971, and the survey was completed in June and July, 1972, by Davies, Hutchison, Coutts, and Maffi. Field operations were based on the Frieda Prospect base camp (Carpentaria Exploration Co. Pty Ltd), the Ok Tedi Prospect base camp (Kennecott Pacific Pty Ltd), and the Laiagam Sub-district Headquarters. The main objectives were to collect more information in the Frieda Prospect area and the central Wabag Sheet area, and to clarify stratigraphic problems at Ok Tedi and in the Cecilia Anticline area. The work at Ok Tedi and the Cecilia Anticline was handicapped by bad flying weather.

Apart from the recent West Sepik survey, field work has been carried out in the area by the 1966-67 South Sepik Party, and by BP Petroleum Development. During 1972 all available information was collated at 1:50 000 scale, and Preliminary Edition maps were prepared of the Blucher Range and May River 1:250,000 Sheet areas.

The results of the West Sepik survey will be reported in a Bulletin, and Preliminary maps, 1st Edition maps, and Explanatory Notes will be prepared for the four Sheet areas covered.

Davies presented an interim report to the meeting of Specialist Groups of the Geological Society of Australia in February; Davies, Norvick, Ryburn, and Hutchison presented summaries of work in the BMR weekly lecture series, and Davies and Norvick presented interim results to the BMR Symposium in May.

EASTERN PAPUA

by

H.L. Davies

Personnel: H.L. Davies; I.E. Smith (ANU), part time.

Preparation of 1:250 000-scale geological maps and Explanatory Notes continued for Abau, Samarai, and Fergusson Island. First Edition maps and Explanatory Notes are in press; Salamaua and Tufi were issued as Preliminary Editions.

Smith continued his petrochemical study of the Pliocene-Quaternary volcanics. A first draft of a Bulletin on the geology of the southeast Papuan mainland was completed. Davies presented a paper on the geology of the Suckling-Dayman mountain block to a meeting of Specialist Groups of the Geological Society of Australia in February.

NEW BRITAIN

by

R.J. Ryburn

Personnel: R.J. Ryburn, D.E. Mackenzie (LWOP), and R.W. Johnson.

"The geology of New Britain", incorporating R.P. McNab's 1970 Record on the geology of the Gazelle Peninsula, is being written as a Bulletin, and will appear initially as a draft Record. Compilation of maps, figures, and text has been under way throughout the year.

The 1:250 000 sheets are in various stages of completion. Gazelle Peninsula is shortly to be published with Explanatory Notes; Pomio is at Preliminary stage, and is due to go for first edition editing, together with the Explanatory Notes, by the end of November. Talasea-Gasmata is virtually ready for Preliminary Edition, and Cape Raoult-Arawe is being compiled by the drawing office concurrently with the base map. Preliminary Editions of all these sheets will be reduced to 1:500 000 scale for a map to accompany the Bulletin.

During the year information has been received from exploration companies, principally BHP and Triako. Most notable is the news that the Plesyumi prospect in central New Britain is a porphyry-copper type body. This augurs well for further discoveries on the island, which has all the hallmarks of a suitable, if somewhat challenging, environment.

Liaison has been maintained with the exploration companies concerned.

NEW IRELAND

by

P.D. Hohnen

Personnel: P.D. Hohnen

Record No. 1970/49, entitled "Geology of New Ireland" by P.D. Hohnen, was modified for publication in the BMR Report series. The re-written report includes additional isotopic age determinations, eleven chemical, and ten modal analyses as well as variation diagrams.

Plots of the systems orthoclase-anorthite-albite, quartz-orthoclase-albite, K_2O-CO_2-Na_2O, and quartz-plagioclase-orthoclase, show that the New Ireland rocks have very similar trends to the 'normal' calc-alkaline rocks of the North Baining Mountains of the Gazelle Peninsula, New Britain, but they appear to have quite different trends to the 'high-K' calc-alkaline rocks of the Central and South Baining Mountains.

Isotopic age determinations (K-Ar method) of igneous rocks from New Ireland gave ages of 31.8 ± 1.0 m.y., 30.7 ± 1.0 m.y. (middle Oligocene), 17.5 ± 1.0 m.y., and 13.8 ± 0.5 m.y. (middle Miocene).

The 1:250,000 scale special map of New Ireland, which is to accompany the Report, was modified to include results of detailed mapping carried out by Swiss Aluminium Mining Australia Pty Ltd during the period 1969-1972.

CENTRAL HIGHLANDS

by

J.H.C. Bain

Personnel: J.H.C. Bain, D.E. Mackenzie (LWOP).

The writing up of the Central Highlands mapping was completed.

The Karimui 1:250,000 Preliminary map and Explanatory Notes, Ramu 1:250,000 Preliminary map, and Record 1972/35, "Baiyer-River - Jimi Valley reconnaissance geology" were prepared. Ramu Explanatory Notes are being prepared.

Corrections were made to the manuscript of the Kubor Anticline Bulletin, and papers were prepared for outside publication and for presentation at the BMR Symposium.

VOLCANOLOGICAL RESEARCH

by

R.W. Johnson and W.B. Dallwitz

Personnel: G.A.M. Taylor, R.W. Johnson, D.E. Mackenzie (L.W.O.P.), I.E. Smith (ANU), and R.A. Davies (Volcanological Observatory, Rabaul - part time)

Introduction

Field work for the systematic reconnaissance study of late Cainozoic to Recent volcanoes of Papua New Guinea ceased in November, 1971, with a helicopter-supported examination of the Highlands volcanoes. Since then, report writing and comprehensive laboratory studies on rocks collected over the last four years have continued. In part, the investigations of the volcanoes and their products were made in conjunction with R.A. Davies, of the Central Volcanological Observatory, Rabaul.

Johnson has been awarded a Commonwealth Public Service Board post-graduate scholarship, and will spend 1973 at the Imperial College of Science and Technology, London, where he will be able to consult with other workers in volcanic petrology, and continue interpretation of results and preparation of reports on volcanoes in the southern and northern parts of the Bismarck Sea.

A severe blow to the study of volcanic and earthquake phenomena in the Papua New Guinea region was dealt by the sudden death of G.A.M. Taylor, G.C., at Manam Island on 19th August, 1972. At the time, he was Acting Chief Geologist of Papua New Guinea, a position he took up on 25th July, when A.S. Renwick left to attend the International Geological Congress at Montreal.

A brief record of Taylor's recent work on volcanic rocks and volcanoes in 3 areas of Papua New Guinea is contained in the reports that follow.

Taylor had for many years been involved in a number of projects bearing on the recording and interpretation of earthquakes and other phenomena associated with volcanic activity, and he continued his efforts in these directions during the year. He was particularly interested in volcano surveillance, and took a leading part in the design and installation of instruments for recording manifestations of impending eruptions; during the period under review he prepared, in co-operation with P.M. McGregor, of the Geophysical Branch, a report (Record 1972/6) for UNESCO on research in seismology, volcanology, and tsunami occurrence in Australia and Papua New Guinea. He also prepared a report on the active volcanoes of Papua New Guinea for the PNG Resources Atlas, and joined the I.A.V. Working Group on the Mitigation of Volcanic Disasters. In co-operation with W.J. Perry, he completed contract documents for an aerial infra-red scanning survey of the Blanche Bay area, Rabaul, to locate thermal zones within the Bay and on the caldera rim.

For a considerable period, Taylor had been collecting information pointing to a possible relationship between earth tides and earthquakes and volcanic eruptions. A great deal of study and research would have been necessary to prepare a well reasoned report on this topic, but Taylor was

able to devote only very little time to the project because of more pressing commitments.

Southern Bismarck Sea Volcanoes (Johnson, Taylor, Davies)

Johnson spent by far the greater part of the year writing geological and petrological reports on the Witu Islands and on thirteen of the fifteen volcanic islands off the north coast of New Guinea, between Umboi Island in the east (off the western end of New Britain) and the Schouten Islands in the west (near Wewak). These islands were visited by Johnson and Davies during a brief field season in 1970.

The text of Record 1972/21, describing the geology and petrology of the islands between Umboi and the Schoutens, was completed in collaboration with Taylor and Davies. However, Taylor's death in August curtailed his contribution to the Record, and only fourteen of the fifteen islands were described. Taylor appeared to have finished a summary account of Karkar Island - which is incorporated in the Record - but his account of Manam Island was found in only preliminary form, and it was therefore not possible to include it.

About one hundred and twenty rock samples were selected, crushed, powdered, and forwarded to AMDL for accurate chemical analysis. These analyses, in conjunction with those received last year, established consistent differences in composition between volcanoes in different parts of the southern margin of the Bismarck Sea. On the basis of composition and the relative abundance of rock types, four volcanic areas can be recognised (excluding the Rabaul area, which was studied independently by R. F. Heming at the University of California at Berkeley):

(1) the Schouten Islands in the extreme west, consisting of low-silica andesite (53-58% SiO_2) and high-silica andesite (58-63% SiO_2);

(2) volcanoes between Boisa Island and the Cape Gloucester area, New Britain, forming a major group made up principally of basalt (up to 53% SiO_2), low-silica andesite, and some high-silica andesite;

(3) the Witu Islands, consisting predominantly of basalt, low-silica andesite, and high-silica andesite; these rocks are of particular petrological interest, as they have comparatively high TiO_2 contents;

(4) the volcanoes of Willaumez Peninsula and the central north coast of New Britain, showing compositions ranging from basalt, to andesite, dacite, and rhyolite (up to 75% SiO_2); as mentioned in last year's Annual Summary, these compositions can be related to depth to the underlying Benioff Zone; in general, they have much lower total-alkali and K_2O contents than do those showing the same silica contents from areas (1) and (2) in the western part of the arc.

Highlands volcanoes (Mackenzie, Johnson)

The beginning of November, 1971, was taken up with the latter part of a field season during which Johnson and Mackenzie, assisted by D.S. Hutchison and I.P. Sweet, collected samples for petrological study from ten Late Cainozoic volcanoes in the Highlands of Papua New Guinea. These samples are being petrographically examined and chemically analysed by Mackenzie who has tenure of a Public Service Board post-graduate

scholarship at the University of Melbourne. Mackenzie will be using this information, and the field data, for a thesis to be submitted for a PhD degree at the University of Melbourne; he is preparing a BMR Record which will describe the geology and petrography of the ten volcanoes examined in 1971.

During the 1971 field season and during subsequent petrographic examination of samples, it was confirmed that rocks of the high-K calc-alkaline and shoshonitic associations are by far the most abundant types represented in the Highlands volcanoes.

Record 1971/137, by Taylor, entitled "An investigation of volcanic activity at Doma Peaks", was issued during the year. This report was based on a visit to solfataric areas on Doma Peaks in the Eastern Highlands District by Taylor in May, 1968.

St. Andrew Strait Volcanoes, northern Bismarck Sea (Johnson, Smith, Davies)

Samples from these volcanoes, collected by Johnson and Davies in July, 1971, were examined in thin section, and, in conjunction with I.E. Smith, twenty-four rocks, many of them obsidians, were selected for analysis. Smith completed major element analyses (by X-Ray fluorescence), and these established that, contrary to two analyses presented in an earlier BMR Record, none of the acid rocks was peralkaline, although some had per-alkalinity indices of more than 0.9.

Tabar-Feni Islands, north and east of New Ireland (Taylor)

During the year, Taylor continued his work on the petrology of feldspathoid-bearing rocks from these islands, but had not completed his report at the time of his death.

Volcanoes of eastern Papua (Smith)

Major and trace-element studies of rocks collected from the late Cainozoic volcanoes of eastern Papua are being continued by I.E. Smith, formerly of B.M.R., at the Australian National University. A draft Record entitled "Late Cainozoic volcanic rocks from the offshore islands of eastern Papua" is nearing completion.

ANTARCTICA

by
R.J. Tingey and R.N. England

Personnel: R.J. Tingey, R.N. England

Introduction

The regional geological mapping of the Prince Charles Mountains was continued into the southern Prince Charles Mountains during the 1972 field season. The work of the 1972 Australian National Antarctic Research Expedition in the southern Prince Charles Mountains was primarily concerned with surveying and glaciology, and the two geologists therefore accompanied survey parties in the field. The activities of the geologists were thus governed to a certain extent by those of the surveyors, but the overall success of the operations allowed a satisfactory reconnaissance of the geology of the area to be made. During the field season, contact was made with geologists of the Soviet Antarctic Expedition, and future exchange of geological information with them is planned. Gravity meter readings were made by the geologists, surveyors, and glaciologists, but the value of the observations obtained was reduced by the lack of consistent and reliable base readings.

Geology of the Prince Charles Mountains

The results of geological work in the southern Prince Charles Mountains in the 1972 field season substantially confirm the observations of Australian and Soviet geologists who had previously visited the area. Although fragments of banded ironstone and calcareous sandstone were found in moraines, no outcrops of sedimentary rocks were discovered: only metamorphic and igneous rock types were found.

The metamorphic and igneous rocks are tentatively divided into four main groups:

1. Massive, slightly foliated granitic rocks intruded by prominent lenses and dykes of black basic igneous rocks which have been converted to amphibolite.

2. Contorted and folded metasediments and metavolcanics extensively intruded by granite and pegmatite dykes, and metamorphosed under amphibolite facies conditions; later greenschist facies metamorphism has brought about retrograde effects in places.

3. Banded metasediments with prominent white quartzite bands and interleaving dark rocks of basic igneous or pelitic origin. The pelitic rocks commonly contain the assemblage kyanite-staurolite, and were metamorphosed in the amphibolite facies, but locally later metamorphism under greenschist facies conditions has caused retrograde effects.

4. Dark banded basic or calcareous metasediments.

The distribution of these rock types is shown on the map (Fig.M15), but long-distance correlations are doubtful. The grouping of Mt Newton and Wilson Bluff rocks with those in the Mts Cresswell-Dummett-Scherger area, and the grouping of the Mt Rubin rocks with the Mt Maguire rocks must be considered tentative.

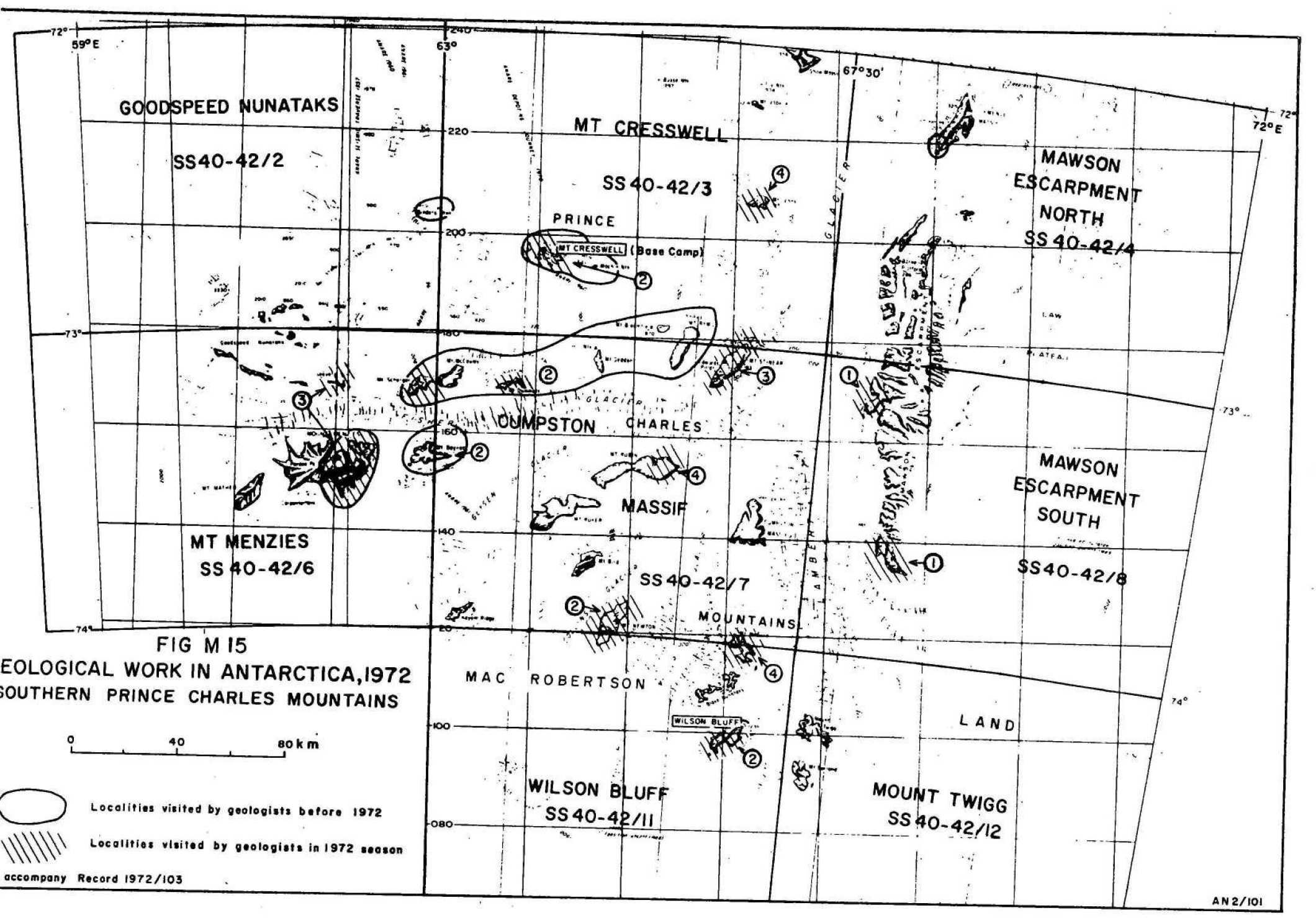


FIG M 15

EOLOGICAL WORK IN ANTARCTICA, 1972

SOUTHERN PRINCE CHARLES MOUNTAINS

accompany Record 1972/103

Age relationships between rocks of the various groups, are generally obscure; the groups are numbered in the apparent order of apparently decreasing age. Group 3 rocks overlie Group 1 rocks at Mt Stinear, and are therefore definitely younger, but other contacts between rock groups are either faulted or hidden under ice cover.

The basic dyke-rocks which intrude the metamorphic rocks are not widely distributed, and have been converted to amphibolite since their emplacement. At Mt Newton basic dykes intersect the retrograde rocks of Group 2 and at Mt Stinear basic dykes intersect the granitic basement rocks of Group 1 and the banded quartzite-rich rocks of Group 3. No basic dykes were observed cross-cutting the banded rocks of Group 4. Small granitic stocks and bosses intrude the rocks of Groups 1, 2, and 3, but were not seen to intrude the rocks of Group 4. Dykes of muscovite pegmatite intersect basic dykes at Mt Stinear.

Since returning to Canberra in March, 1972, members of the field party have made petrological studies of rocks collected during the field season, and have reviewed previous work.

During the year, Tingey completed a Record on the 1971 geological work in the Prince Charles Mountains north of latitude 72°S, and compiled 1:250 000 scale geological maps of that area. The main conclusions that can be drawn from this work are:

1. The metamorphic rocks of the northern Prince Charles Mountains include rocks of sedimentary and igneous origin which have probably been metamorphosed several times. The mineral assemblages now seen in the rocks indicate upper amphibolite facies or granulite facies metamorphism.

2. Aluminous metamorphic rocks of pelitic origin commonly contain the assemblage cordierite-sillimanite.

3. Granulite facies and hypersthene-bearing rocks are generally well banded and foliated, and folded on a large scale. They are seen only in the northern half of the northern Prince Charles Mountains, and are locally associated there with upper amphibolite-facies and migmatitic rocks.

4. Banded amphibolite-facies rocks which are extensively invaded by granite and pegmatite dykes are intensely folded and distorted, and are more common in the southern part of the northern Prince Charles Mountains than elsewhere in the northern Prince Charles Mountains and along the Mawson coast; they are not associated with the hypersthene-bearing metamorphic rocks.

5. Metavolcanics, metagabbro, and charnockite in the southernmost part of the northern Prince Charles Mountains have been metamorphosed under amphibolite-facies conditions.

The southern and northern Prince Charles Mountains are thus markedly different in a number of ways. Subdivision of the metamorphic rocks of the northern Prince Charles Mountains is generally not possible, but it has been attempted on a tentative basis for the rocks of the southern Prince Charles Mountains.

Metamorphism in the northern Prince Charles Mountains took place under low pressure-high temperature conditions, but the common assemblage kyanite-staurolite seen in rocks of pelitic origin in the southern Prince Charles Mountains indicates high pressure conditions of metamorphism.

After the field season in the southern Prince Charles Mountains, England went to Mt Wishart in the northern Prince Charles Mountains to do detailed work. Upon returning to Mawson base, the field party made a number of geological and gravity traverses along the Mawson coast. A report on the gravity work is being prepared in the Geophysical Branch. Petrological and chemical work on collected rocks on the coastal traverses has started.

Reporting of Results

A Record on the 1971 survey is being edited within the Section. A report on the 1972 fieldwork is scheduled for completion in March, 1973. First Edition maps and Explanatory Notes for the Stinear Nunataks, Crohn Massif, Beaver Lake, and Mt Hicks-Fisher Massif 1:250 000 Sheet areas are being prepared; Preliminary maps for these sheet areas have been published.

PETROLOGICAL, GEOCHEMICAL, AND GEOCHRONOLOGICAL LABORATORIES AND MATHEMATICAL GEOLOGY

Professional Staff: K.R. Walker, A.D. Haldane, A.Y. Glikson, R.W. Page, S.E. Smith, L.P. Black, J.W. Sheraton, R.N. England, S. Henley, C.W. Claxton, D. Wyborn (joined Tennant Creek Party in August), Miss R. Bennett (resigned December) and Misses B. Labonne and D.J. Pritchard (resigned September). Claxton was accidentally killed at Tennant Creek in July.

Technical Staff: G.H. Berryman, M.W. Mahon, T.I. Slezak, R.B. Hawkins (Baas Becking), J.C.W. Weekes, A. Maenner, S.E. Heggie (commenced February), G.K. Wilcocks (commenced May), W.C. Whitewell (transferred to Department of Works in December), and Miss A. Ahern (transferred to the Forestry and Timber Bureau in March).

Trainee Technical Officers: R.W. Powell; I. Donald and Miss R. Gibbs (until January).

INTRODUCTION

by

K.R. Walker

Good progress has been made on most projects. The geochronology group has had a particularly successful year following the on-line connection of its mass spectrometer to the Hewlett Packard computer; this, and a stable staff situation, has enabled data output to be doubled. The geochemical group was not so fortunate, and lack of staff has delayed the start of some projects. New appointments pending, together with moves to arrange for tape output from all major analytical equipment preparatory to interfacing them with computer facilities, will provide improved data acquisition and handling for several groups in the laboratory, if not this coming year, during later years. It was a particularly active and productive year in the fields of Geostatistics and Mathematical Geology.

There is an increasing trend toward sharing the work of exploration geochemistry between laboratory and field subsections of the Metalliferous Section, and field visits were made by laboratory staff where further geological information and sampling were needed for projects. Seven officers and one technician made trips. L.P. Black spent eight weeks with the Napperby and Alice Springs Parties, and R.W. Page two weeks each with The Granites-Billiluna and Alligator River Parties, collecting specimens for age determination. S. Henley and J.W. Sheraton joined the Georgetown Party for a fortnight, and provided petrological and geochemical

assistance. S.E. Smith, accompanied by C.W. Claxton until his death, was in the Tennant Creek area for 13 weeks collecting ironstones and other rocks for the second phase of the Tennant Creek Geochemical Project. R.N. England was seconded to ANARE in December for 3½ months to undertake reconnaissance geological work in Antarctica, and make a collection of metamorphic rocks for detailed study.

During the year one Bulletin was issued; another is in press, and four others are in an advanced stage of preparation. The Report presenting a compilation of age determinations of Australian rocks from 1966-70 is with the editor. Five Records were issued, and another twelve are about to be issued. There are, in addition, twenty in various stages of preparation. Twenty one papers were accepted for publication in outside journals, and seven others have been submitted for publication. The annual Record covering miscellaneous laboratory investigations contains 170 Laboratory Reports, and this is the first year it has been issued on open file.

Miss B. Labonne continued to do French translations for BMR officers, and acted on occasions as interpreter, as at the IGOLD Conference in April. Various other staff members attended symposia and training courses, and six contributed to the BMR weekly lecture series; R.W. Page participated also in the Bureau's symposium for industry in May. In addition, he attended the SGIGOD Symposium on 'Porphyry Coppers' held at Sydney in November, 1971. L.P. Black attended the Eighth International Radiocarbon Conference held in New Zealand during October, 1972. K.R. Walker, A.Y. Glikson, S. Henley, and S.E. Smith all contributed papers to the G.S.A. joint Specialist meeting held at Canberra in February.

The Laboratory, where possible, made contributions to world co-operative projects, and further analytical data were forwarded to the international pool of information on rock and mineral standards. Contact was maintained with the I.U.G.S. Working Group on 'Metallization Associated with Acid Magmatism'. A.Y. Glikson put forward a proposal for an international comparative study of Archaean systems as a part of the International Geological Correlation Program, sponsored by the I.U.G.S. and U.N.E.S.C.O.; to date there has been encouraging response from individual scientists in various parts of the world indicating their willingness to support the project. He made a private visit overseas during September and October, taking the opportunity to contact researchers interested in the program.

A.D. Haldane again represented the Bureau on the Standards Association of Australia sub-committee for the Analysis of Aluminium Ores. He also made a very significant contribution to the committee established by the NSW Mines Department and the Commonwealth to monitor zinc pollution in the Molonglo River System. S. Henley served as Geological Branch representative on the Department of National Development Scientific and Computing

Committee. In this same capacity he attended the T.C.U.W. meeting on ADP applications in groundwater data storage and retrieval in Sydney in May.

Periodical meetings were held this year within the Laboratory, and this provided a useful forum for discussing work on current projects.

In-service training of Trainee Technical Officers continued. Only one, R.W. Powell, remained with the laboratory for the full year.

A.D. Haldane went on behalf of the Department of Foreign Affairs to Bandung, Indonesia, for a fortnight in April to advise staff at the Mining and Metallurgy Research Centre on the operation and use of the atomic absorption spectrophotometer presented to President Suharto by Australia during his visit to this country. Haldane also presented lectures to the Canberra College of Advanced Education on the use of atomic absorption spectrophotometry in applied geochemistry, and gave a demonstration of the working of the instrument.

The year was marred by the death of C.W. Claxton, who was accidentally killed while off duty at Tennant Creek. Claxton was an enthusiastic member of the Tennant Creek Geochemical Party, and at the time of his death was making a valuable contribution to work on this project. He had only recently completed all the support chemical work needed for the geochemical study of the carbonate sequences of McArthur River. He had been collaborating in this study with M.C. Brown.

During the year much effort went into preparing recommendations for staff rearrangement, reorganization of establishment, and technical support needed to meet present and proposed future operations.

Moves are now afoot to progressively introduce data storage files for various kinds of laboratory data, and it is hoped that a successful retrieval system will eventuate. Moreover, thought and effort are now being directed to problems of rationalizing equipment operations for element determinations, to re-equipping parts of the laboratory, and to achieving improved efficiency through installing automatic sample feed equipment and computer facilities for handling data output. Much of the routine chemical work will continue to be directed to Amdel, and the Bureau still relies on outside contract services for most thin section preparation, sample preparation and mineral separation for isotopic dating, radiocarbon dating, and for a subordinate part of its age determination.

Interest in the work of the laboratories was shown by visitors, and enquiries were received from Government agencies, as well as from overseas.

The results of project work done by the three laboratory groups (i) petrology and mineralogy, (ii) geochemistry, and (iii) geochronology are reported below, together with a list of computer programs developed or completed during the year.

PETROLOGY AND MINERALOGY

by

K.R. Walker

Personnel: A.Y. Glikson, J.W. Sheraton, R.N. England, and Misses B. Labonne and D.J. Pritchard (both of whom resigned in September).

Petrological work was concentrated mainly on Queensland rocks. Major projects completed or in progress are:

(i) petrological and geochemical study of basic volcanic sequences in the Mount Isa-Cloncurry area;

(ii) structural studies supporting the Mount Isa-Cloncurry 1:100 000-scale mapping project;

(iii) petrology and geochemistry of acid rocks of the Georgetown Inlier;

(iv) storage and retrieval proposal for petrological data;

(v) preparation of a proposal for an international Geological Correlation Program.

In addition, the electron probe microanalyser was used to carry out detailed mineral analyses for a number of projects.

England has written up his work (Record 1971/119) on the mineralogical changes brought about in basic igneous rocks from the Soldiers Cap area, Queensland, and the Petermann Ranges, N.T., during progressive metamorphism to amphibolite. Since returning from Antarctica in March, he has begun to study metamorphic rocks from the Prince Charles Mountains, in particular the mineral assemblages that will assist in resolving the metamorphic history of the area. Completion of work on the Reynolds Range, Napperby 1:250 000 Sheet area, N.T., by A.Y. Glikson has been delayed pending the receipt of base maps; in the meantime information from the examination of thin sections of rocks collected during the 1971 field season has been collated.

Petrological and geochemical study of basic volcanic sequences, Mount Isa-Cloncurry area.

by

A.Y. Glikson

Following the detailed mapping of the Soldiers Cap Formation, Eastern Creek Volcanics, and Marraba Volcanics, the volcanic rocks within these formations were studied petrographically and geochemically. So far 180 specimens of volcanic rocks and intercalated sediments have been examined under the microscope, and silicate and trace element analyses have been made of 70 of them. The chemical data were plotted on a range of petrological diagrams; CIPW norms and various ratios were calculated by computer. The field information, petrographic, and geochemical data formed the basis for a report which, apart from final drawings of some figures, is now ready for presentation as a Record. This Record, which includes a chapter on statistical analysis of the chemical data by S. Henley and a chapter on the Marraba Volcanics by G.M. Derrick, will be submitted for publication as a Bulletin entitled 'Proterozoic basic metavolcanic successions, Mount Isa-Cloncurry, northwestern Queensland'. Some of the main conclusions from this study follow:

1. The Soldiers Cap Formation volcanics represent intermittent submarine outpourings of tholeiitic basalt, and syndepositional intrusion of dolerite and gabbro sills in a tectonically stable environment. The flows are commonly separated by beds of pelite, arenite, quartzite, chert, and minor jaspilite and carbonate rocks.

2. The Eastern Creek Volcanics represent rapid successive extrusions of tholeiitic to weakly undersaturated basalts in a subaerial to shallow aqueous environment, and under unstable tectonic conditions where continuous block faulting has taken place, thus accounting for strong variations in stratigraphic thicknesses. In contrast to the volcanics of the Soldiers Cap Formation, the basalts abound in amygdales and flow-top breccias. Short intermissions are represented by granite-derived clastic sedimentary intercalations.

3. The Marraba Volcanics, which postdate acid volcanism, contain abundant intercalations of sandstones; they were extruded in an environment similar to that of the Eastern Creek Volcanics.

4. Tholeiitic affinities predominate in the basalts to the almost complete exclusion of calc-alkaline or alkaline types. An overall similarity to continental tholeiites is evident.

5. Metamorphism affected the volcanic rocks in several distinct ways. The Soldiers Cap Volcanics underwent low greenschist to middle amphibolite facies, intermediate-pressure metamorphism, which resulted in the prograde recrystallization of amphibolites derived from basalts, whereas the Eastern Creek Volcanics suffered only low greenschist metamorphism

resulting in an albite-epidote-chlorite-actinolite assemblage. Although metamorphism was clearly not completely isochemical, deviation from primary composition is considered to be relatively small.

6. The Marraba Volcanics and upper sections of the Eastern Creek Volcanics show greater alteration, probably involving element exchange with the abundant sedimentary intercalations, and manifested by higher K_2O and lower CaO levels.

7. The abundant small copper deposits associated with, or occurring immediately above, the volcanic sequences are believed to be derived by synmetamorphic extraction of copper from the basalts.

Structural studies supporting the Mount Isa-Cloncurry 1:100 000 mapping project

by

A.Y. Glikson

A paper entitled 'Structural setting and origin of Proterozoic calc-silicate megabreccias, Cloncurry region, Northwestern Queensland' was published in the Journal of the Geol. Soc. Aust. Another paper, entitled 'Evolution of Early Proterozoic fault structures, Mount Isa trough, Northwestern Queensland', with G.M. Derrick and I.H. Wilson as co-authors, is in preparation. The abstract of this paper follows:

The tectonic development of the downfaulted volcanic-sedimentary Mount Isa trough is reinterpreted in the light of detailed mapping of a part of this structure. A complex succession of movements, involving early faulting of a granite basement, penecontemporaneous and syndepositional faulting, and folding and deformation related to the emplacement of granite are suggested. The continuous syndepositional faulting resulted in differential accumulation of volcanic flows and sediments in individual blocks, and brought about abrupt stratigraphic changes and thicknesses of rock units across faults.

Geochemistry of Australian granites: north Queensland volcanic and granitic rocks (Sheraton and Labonne)

by

J.W. Sheraton

Major-element analyses of all the available samples (about 580) from the Georgetown Inlier and Cairns Hinterland have been completed. Trace-element analyses of these samples are well advanced, determinations of Rb, Sr, Pb, and Th by X-ray fluorescence, and Ni, Co, Cr, Cu, Zn, Yb, Sn, Mo, Li, and Be

by atomic absorption spectrophotometry being almost complete. The final batch of elements, including Ba, Zr, Nb, La, Ce, Ga, U, and Y should be completed by February, 1972; these will be determined by X-ray fluorescence.

A progress report in the form of a Record is in the final stages of preparation. It will incorporate all the petrographic and major element data. This will be followed in mid-1973 by a Record covering the trace element geochemistry.

On the basis of major element geochemistry, as well as geochronological studies, the acid igneous rocks of the area under investigation can be divided into four groups:

1. The Precambrian Esmeralda Granite and Croydon Volcanics are characterized by high Fe/Mg and K/Na ratios. The geochemical and strontium isotope data are consistent with an origin by anatexis of K-rich crustal rocks.

2. The Precambrian Forsayth and Robin Hood Granites are geochemically heterogeneous, and possibly represent intrusions of more than one age.

3. The Devonian Dumbano Granite and Dido Granodiorite have relatively low Fe/Mg and K/Na ratios. They include significant proportions of basic to intermediate rock types, and were probably derived, at least in part, by differentiation of basic magma.

4. The Upper Palaeozoic igneous rocks form a geochemically rather homogeneous and typically calc-alkaline suite, characterized by Fe/Mg and K/Na ratios intermediate between those of groups 1 and 3. The overwhelmingly acid compositions of these rocks suggest an origin by anatexis of crustal materials rather than by differentiation of basic magma, although the rather low initial Sr^{87}/Sr^{86} ratios indicate that a significant proportion of mantle-derived material (possibly basic volcanics) was also present in the source rocks. It is therefore postulated that the acid magmas may have been largely derived by melting of Hodgkinson Basin sediments with associated basic volcanics carried beneath the Georgetown Inlier on a descending plate of oceanic crust. The existence of such a subduction zone would also explain the variation in age of the acid igneous rocks which range from Middle Carboniferous near the south-western edge of the Georgetown Inlier to Middle Permian in the Hodgkinson Basin. Lateral migration of the subduction zone away from the continental margin together with the widening of the Hodgkinson Basin would lead to a complementary migration of the magma source.

Comparison of the geochemical results with experimental data on silicate melts indicates that the Croydon Volcanics, Esmeralda Granite, and the majority of the Upper Palaeozoic acid igneous rocks crystallized under rather low water-pressure conditions (less than about 1000 bars). This is consistent with the fact that the magmas were able to reach the surface before crystallizing.

The tin-bearing Esmeralda, Elizabeth Creek, and Finlayson Granites are all rather leucocratic granites with relatively high K/Na ratios. All have associated greisens, and fluorite or tourmaline or both are characteristic accessory minerals.

Storage and retrieval proposal for petrographic and geochemical data. (Glikson and Henley)

by

A.Y. Glikson

A computer-oriented edge-punch card for storage and retrieval of petrological, mineralogical, and geochemical data and relevant notes has been designed. The card may be used manually in desk files, in a central file cabinet, or for the input, and, in part, output of computer data. The computer data can be punched on four IBM cards. The combination of the various modes of application of the card enablesit to be used for a wide range of purposes, including field mapping projects and specialized petrological and geochemical investigations, or both. Keys for the retrieval of data through edge punching are provided, as well as abbreviations of rock, mineral, and textural names for computer coding. A computer programme for print-out of chemical data in a format appropriate to the card has been written. The card is intended for general use by BMR geologists, and at the first stage will be undergoing a trial period.

Studies of Archaean rocks

by

A.Y. Glikson

A paper entitled 'Early Precambrian evidence of a primordial oceanic crust and island nuclei of sodic granite' has been submitted to the Geological Society of America Bulletin for publication. Another paper entitled 'Archaean trondhjemitic suites in Western Australia and Northwestern Scotland', with J.W. Sheraton as senior author, has been accepted for publication in Earth and Planetary Science Letters. A note entitled 'Early Precambrian ultrabasic-basic associations: relict terrestrial maria or ancient oceanic crust?' was prepared as a discussion of a concept propounded by D.H. Green, who suggested a genetic analogy between greenstone belts and lunar maria. The Archaean model put forward in the above papers gained strong support from some South African geologists, notably C.R. Anhaeusser, of the University of Witwatersrand.

A submission was put forward for an international comparative study of Archaean systems as a part of the International Geological Correlation Project, sponsored by the IUGS and UNESCO.

Approval was granted by the Director to forward this proposal on an individual basis to the Chairman of the Australian National Committee for the Geological Sciences. Subsequently, an endorsement of the proposal was received from 45 geoscientists of high standing from Canada, U.S.A., U.K., Denmark, South Africa, Rhodesia, India, and Australia. The submission of the proposal to the IGCP panel was subsequently approved by the National Committee for the Geological Sciences.

Major Instrument Laboratories and supporting facilites

by

K.R. Walker and S.E. Smith

Work in the Major Instrument Laboratories provided analytical support for various projects, mainly within the Geological Branch. In addition, much of the service work necessary to satisfy requests for analyses was done in these laboratories.

In the Electron Probe Microanalyser Laboratory (England, Pritchard, and Hawkins) Miss Pritchard took over the operation of the instrument from December, 1971, to September, 1972, during which time 101 analyses of minerals were performed. Fifty were of orthopyroxenes and clinopyroxenes in rocks from the Lunch Creek Gabbro, submitted by G.M. Derrick. This is a tholeiitic intrusion in which the compositional variations of its pyroxenes show that differentiation was only slight. The rocks were affected by metamorphism, but this was insufficient to alter compositional variations resulting from normal differentiation. Those clinopyroxenes unaffected by subsequent alteration follow a normal tholeiitic trend. Other grains, many of which contain abundant exsolution lamellae, and have their margins altered to hornblende, are a good deal richer than the normal varieties in Ca, and poorer in Al and Ti. It is suggested that the composition of these augites has been affected by the metamorphism.

Other microprobe work included the analysis of garnets from the Croydon area (Queensland) and the Owen Stanley Metamorphics (Papua New Guinea). After Miss Pritchard's resignation, R.N. England resumed operating the microprobe for ad hoc determinations; he also commenced a study with R.W. Johnson of pyroxenes from tholeiitic volcanic rocks from the islands in the Bismarck Sea.

In the Direct Reading Optical Spectrograph Laboratory (Slezak), 1000 samples were quantitatively analysed. This amounted to 16 000 element determinations for the year, and contributed to the investigation of rocks from the Tennant Creek, Broad Sound, McArthur River, Talasea, and Rabaul areas. In addition, 300 samples were analysed semiquantitatively, mainly to assist in the interpretation of X-ray diffraction patterns.

In the X-ray Diffraction Laboratory (Berryman), 2540 mineral identifications were made for Metalliferous Section field parties, and as part of projects in other Sections. Such projects included the Estuary Study Project and the Phosphate Cell Dimension Project of the Phosphate Group.

In the X-ray Fluorescence Laboratory (Sheraton), about 650 samples were analysed for major elements. The majority of these were for the North Queensland Granite Project and the Tennant Creek Geochemical Project. Three hundred and forty two samples were analysed for Rb, Sr, Pb, and Th, comprising 280 for the Granite Project and 62 for I.B. Lambert (Baas Becking). Determination of Ba, Zr, Nb, La, Ce, Ga, U, and Y on the Granite Project samples has commenced.

A maintenance contract for the X-ray spectrometer was arranged, and a thorough overhaul of the equipment was completed in September.

In the Thin Section Laboratory (Maenner), 1260 thin sections, 112 polished sections, and 40 polished thin sections were prepared. In addition, about 200 specimens received other forms of preparation - for chemical analyses, exhibition and so on - through rock slabbing and, in some cases, polishing. A new 10" cut-off saw was installed.

The Sample Preparation Laboratory (W.C. Whitwell to 31/12/71; S.E. Heggie from 1/2/72) prepared samples for analysis by direct-reading optical spectrograph and X-ray fluorescence spectrometer. In all, 66 samples were crushed and ground, and 670 fusion discs and 790 powder pellets were made. In addition 628 pellets were pressed for mass absorption determinations.

GEOCHEMISTRY

by

A.D. Haldane

Personnel: A.D. Haldane, S.E. Smith, C.W. Claxton (died July, 1972), D.J. Pritchard (to September, 1972), D.Wyborn.

The main activities for the year have centred round a study of zinc pollution in the Molonglo River and the regional geochemical survey of the Tennant Creek goldfield. In addition, contributions were made to the Standards Association of Australia analysis of bauxite study, and to the analysis of international rock standards.

Zinc pollution in the Molonglo River

by

A.D. Haldane

Personnel: A.D. Haldane and Technical Staff.

Detailed sampling of the Molonglo River, Queanbeyan River, and Lake Burley Griffin system has been in progress since June, 1970. The Departments of Works and the Interior carry out the sample collection, and the analytical work is undertaken by the Bureau. Data on pH, specific conductance, zinc, and iron for daily, weekly, and monthly samples have been compiled, and are currently being studied by a joint Commonwealth-New South Wales Government Working Group. A preliminary report has been prepared covering the results to date for zinc levels, recommendations for further chemical testing, and consideration of the mechanical stability of the mine dumps at Captains Flat. The Chemical Laboratory will continue to assist with chemical analyses and interpretation in the proposed joint ACT-NSW monitoring program.

Geochemistry of the Tennant Creek Goldfield

by

A.D. Haldane

Personnel: A.D. Haldane, S.E. Smith, C.W. Claxton; D. Wyborn, Technical Staff.

Preliminary planning for this work was completed in December 1970, and a two-stage joint project was agreed to by Geopeko Ltd, Australian Development Ltd, the N.T.A. Mines Branch, and the BMR. Field work for Phase I, which was concerned with the silicate rocks, was completed in 1971, and chemical analyses were begun. During the past year chemical analyses for Phase I and field work for Phase II were completed. Phase II field work comprised (i) the collection of samples from most of the ironstone outcrops, (ii) detailed sampling of selected major ironstone bodies, (iii) supplementation of the surface sampling with core from diamond drilling, (iv) collection of miscellaneous samples for age determination, magnetic and density measurements, and supplementary surface material for Phase I. In all, about 1100 samples of surface material and drill core were collected for Phase II, and some further core from unmineralized rocks will be provided by the N.T.A. Mines Branch.

Chemical analysis on the silicate rocks from Phase I included the determination of the major elements SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, P_2O_5, and TiO_2 by X-ray fluorescence analysis, together with chemical check analyses for Fe_2O_3, MgO, Na_2O, and K_2O. Trace elements were determined by direct reading spectroscopy and atomic absorption spectrophotometry. Those determined were Li, Rb, Sr, Ba, Ag, Pb, Bi, Zn, Cd, Cu, Co, Ni, Cr, Mn, Be, Zr, V, Sc, Y, and Ti. Analytical data for Phase I have now been obtained for twenty-eight elements on 480 samples taken from nine rock-types. A preliminary compilation of the data has been made in preparation for statistical analysis by computer. The main features of the chemical data can be described as follows.

In mapping the Tennant Creek 1:250,000 Sheet area. J.R. Mendum has described nineteen types of granitic rock ranging from granodiorite to granite, and from fine-grained to coarse-grained porphyritic varieties. Chemically the granitic rocks show remarkable uniformity in their sodium and potassium contents throughout the 1:250,000 Sheet area, and, with the exception of a fine-grained sodic granite along the southern margin of the Tennant Creek Granite, they are regarded as co-magmatic. Variations in the trace element levels can be readily correlated with variations in the ferromagnesian mineral content of the granites. There are no anomalous levels of base metals.

Of the other igneous rocks, lamprophyre and diorite show occasional anomalous values for Ag, Pb, Zn, Cd, Cu and Co. These are elements also associated with many of the ironstone lodes, and there may, therefore be a genetic relationship between the generation of the lamprophyre and diorite magmas, on the one hand, and the formation of the mineralizing solutions, on the other. It is not suggested, however, that either lamprophyre or diorite is the source of the lodes, which lie in a semi-circular arc around the southern and western sides of the Tennant Creek Granite. The relationship between the emplacement of the granite and the generation of the lamprophyre and diorite magmas and the mineralizing solutions needs further investigation.

Porphyries form a heterogeneous group which has been divided chemically into four sub-groups, namely, intrusive quartz-feldspar porphyry of similar composition to the granite, ignimbrites characterised by high K_2O/Na_2O ratio, a low-sodium group and a small group with a high sodium content which may be associated with the granitic rocks.

The view that the porphyries are generally derived directly from the Warramunga sediments is untenable on the basis of their chemical composition; the low-sodium group is a possible exception, as this is the only one showing any chemical similarity with the sediments.

Introduced carbonate rocks are associated with some of the lodes at Tennant Creek. They consist of calcite, dolomite-calcite (the most abundant type), or dolomite-magnesite, and talc is commonly associated with the magnesian types. All are characterized by a high manganese content.

The trace element data for the Warramunga sediments have not been analysed fully. Anomalous values occur for zinc and copper. The sampling of the sediments is naturally biased by the necessity of obtaining samples of unweathered rock exclusively from diamond drill core from exploration drilling. The distribution of trace elements as at present known does almost certainly not represent that for the Warramunga sediments as a whole, but rather the middle (mineralized) Pw_3 and Pw_6 members as defined by Mendum. The hematite shales do not appear to differ significantly in their bulk chemistry from the other fine-grained Warramunga sediments.

The chemical analyses have been supplemented by petrographic descriptions of over one hundred thin sections representing all rock types, and including all samples showing anomalous chemical composition. This has substantially clarified the reasons for the compositional variations in such groups as the porphyries, and the fine-grained sediments.

Minor Investigations.

Miscellaneous and service work has been minimal owing to staff shortage. The main activities have been the analysis of 600 granite samples from the North Queensland Granite Project for Li, Zn, Ni, Cr, Be, Mo, and Pb; investigations of working parameters for the determination of chromium by atomic absorption; analytical support for the study of gas condensates from volcanoes in Papua New Guinea; and participation in the U.S. Geological Survey co-ordinated analysis of standard geochemical reference samples.

GEOCHRONOLOGY

by

R.W. Page

Personnel: R.W. Page, L.P. Black; M.W. Mahon (T.O/2).
Miss R. Bennett (resigned December, 1971).

The Geochronology Group shares the joint isotope laboratory facilities at ANU. The Hewlett Packard computer is now "on-line" to the solid source mass spectrometers, on which a total of 620 isotopic analyses of Rb and Sr were made. These included spike and standard calibrations of various kinds. The "on-line" facility has enabled the output of the group to be doubled. Forty two argon analyses on the gas-source mass spectrometers were also made during the year.

The past year has been the first in which the group has operated at its full staff strength. This has enabled considerable progress to be made on three major projects, and a number of smaller age studies in Queensland, Northern Territory, and Papua New Guinea. In addition, three new projects have been started recently. Geochronological work in the areas concerned is summarized below.

Arunta Complex, N.T.

by

L.P. Black

Twelve previously collected samples of the Huckitta Granodiorite, Inkamulla Granodiorite, and Mount Schaber Granodiorite were analysed in late 1971. The data did not yield a satisfactory isochron relationship, presumably because of the wide geographical distribution of the sampling sites. A different approach, involving intensive sampling at individual localities, was employed during a seven week visit to the field in June-July, 1972., It is hoped that the samples collected from these restricted localities were originally in isotopic equilibrium. If this is so, they should plot on an isochron diagram without geologically significant scatter, unlike the previously collected samples.

About sixty sites were sampled on the Napperby, Mount Peake, Alcoota, Alice Springs, Huckitta, and Illogwa Creek 1:250,000 Sheet areas, and several potential sampling sites were examined in the Hermannsburg 1:250,000 Sheet area. In addition, about one dozen lead ore samples have been collected for dating by the lead method.

Georgetown-Herberton-Mount Garnet area, Qld.

by

L.P. Black

A total of 265 Rb-Sr analyses have been carried out during the past year, as well as 3 K-Ar analyses. The majority of the Rb-Sr measurements were on total rock samples, although emphasis has now shifted towards the dating of mica concentrates. About 100 of the Rb analyses were performed by isotope dilution, the remainder by X-ray fluorescence.

Work has proceeded on most of the Palaeozoic and Precambrian rocks in the area. That on the Palaeozoic material is currently at an advanced stage. Satisfactory whole-rock isochrons have been obtained for the Newcastle Range Volcanics, Nanyeta Volcanics, Walsh Bluff Volcanics, Slaughteryard Creek Volcanics, Watsonville Granite, Bakerville Granodiorite, and several small masses of the Elizabeth Creek Granite. Whole-rock samples of the Nymbool Granite, Kalunga Granodiorite, and Hammonds Creek Granodiorite show some scatter on the isochron diagram; further work is in progress to discover the cause of the scatter. Isochrons for the Featherbed Volcanics indicate that this unit is more complex than originally thought, and that there may be three or more distinct ages within these volcanics. The linear array defined by the whole-rock samples from the Gurrumba Ring Complex yields an "age" which is clearly too old. However, an age obtained from biotite extracted from the Gurrumba Gabbro is compatible with the observed field relationships.

Mica dating by the Rb-Sr method has, in addition, been extended to further rock units in order to define more precise ages and/or support the ages determined by the whole-rock method. These units include the Mareeba Granite, Almaden Granite, Herbert River Granite, Elizabeth Creek Granite, Watsonville Granite, Nymbool Granite, Kalunga Granodiorite, Bakerville Granodiorite, Hammonds Creek Granodiorite, Ixe Monzonite, the diorite near Petford, Dido Granite, and Dumbano Granodiorite.

Delineation of the Precambrian history is still at a fairly preliminary stage, and further field sampling is required. The age study is somewhat complicated by an apparent widespread heating of the area in the late Palaeozoic which has consequently reset many of the mineral ages. In addition, the rock samples examined to date are considerably depleted in Rb with respect to Sr; these samples also attest to variation in initial ratio within rock-types. However, some progress has been made with muscovite which has been found to be more retentive of radiogenic Sr than biotite, and further work with this mineral is planned. Rock units investigated to date comprise the Forsayth Granite, Esmeralda Granite, Robin Hood Granite, and the Dargalong and the Einasleigh Metamorphics.

Mount Isa-Cloncurry area, Qld.

by

R.W. Page

The analytical side of the Rb-Sr whole-rock work is nearing completion on several intrusive and volcanic suites sampled in 1971. One hundred and eighty of the 380 samples collected have been or are being worked on. These include representatives of the Burstall Granite, Naraku Granite, Wonga Granite, Sybella Granite, Argylla Formation, and Leichhardt Metamorphics. Although most of the prime data on all the suites is available, only that on the Burstall Granite has so far been reduced and interpreted. A Rb-Sr isochron age of around 1480 m.y. and initial Sr^{87}/Sr^{86} of 0.71 have been obtained.

Papua New Guinea

by

R.W. Page

Geochronological work in Papua New Guinea was of limited extent, and consisted mainly of the further delineation of ages of porphyry copper mineralization in the West Sepik area and in the eastern part of West Irian. Pliocene K-Ar ages of 3 to 5 m.y. continue to be obtained on the porphyries in the West Sepik area and on the Antares Pluton of West Irian. The associated copper mineralization may even be younger than this Pliocene age. This is evidenced in the Ok Tedi Prospect, where the age of the unaltered southern part of the body has been recently determined at about 4 m.y., whereas the mineralization event is Pleistocene at 1.1 to 1.2 m.y. This study is continuing.

Dating of the glaucophane schists in the West Sepik area is currently in hand. Preliminary K-Ar data on the Gwin Metamorphics gives an age of 21 m.y., suggesting possible correlation with the previously dated Ambunti Metamorphics (22-24 m.y.) to the east.

K-Ar dating of plutonic rocks from New Britain was completed during the year, and a clear pattern of late Oligocene-early Miocene ages is revealed. The isotopic ages (22-28 m.y.) are in good agreement with the stratigraphic evidence for the age of plutonism. This work is currently being written up.

Reconnaissance K-Ar dating of eight granodiorites and dioritic rocks from the Torricelli Range of North New Guinea was undertaken in co-operation with the Continental Oil Company. Jurassic, Cretaceous, and mid-Tertiary ages were obtained on different plutonic bodies. The results are in agreement with the known stratigraphy, but until mapping is complete cannot be properly evaluated.

Other work of a reconnaissance nature was some K-Ar dating on three Quaternary volcanic centres (Mount Hagen, Crater Mountain, Mount Sugarloaf) in the Highlands. Concordant ages of around 200,000 years were obtained on the three areas. A thorough geochronological study of the New Guinea Highlands volcanoes should be undertaken in the future.

Precise XRF determinations of Rb and Sr were made on 40 samples from several Quaternary volcanic centres. Sr^{87}/Sr^{86} values had been previously determined on the same samples. The purpose of these measurements was to provide data which might throw light on the genesis of the rocks.

Alligator River area, N.T.

by

R.W. Page

Eleven minerals from gneisses and schists of the Nanambu Complex, Myra Falls Metamorphics, and other parts of the Lower Proterozoic sequence were dated by (Dr. A.W. Webb, Amdel) by the K-Ar method. In general, quite consistent minimum ages of around 1800 m.y. were obtained. The 1800 m.y. age was confirmed by Rb-Sr measurements on six biotite and muscovite concentrates, but whole-rock analyses will be necessary for a proper understanding of the area.

Victoria River area, N.T.

by

R.W. Page

Eight glauconites and three whole-rock samples of glauconitic sandstone from the basal Wondoan Hill Formation of the Victoria River Group were analysed by the K-Ar (Amdel) and Rb-Sr techniques. The K-Ar ages form a close grouping with a mean of 1079 $\pm$ 14 m.y. (standard deviation). The pooled Rb-Sr age of the samples is about 1120 m.y. The small difference between the two results is fairly well within the experimental uncertainties. This early to mid-Adelaidean age now allows much firmer correlations between the Victoria River sequence and East Kimberley sequence.

Antrim Plateau Volcanics, N.T.

by

R.W. Page

Early in the year about ten samples of the Antrim Plateau Volcanics (whose stratigraphic age is known to be Middle to Lower Cambrian) were dated by the K-Ar method (Amdel) at around 470-510 m.y. This Lower Ordovician age is younger than that established on stratigraphic grounds, and a Rb-Sr study of the samples was begun to help resolve the apparent anomaly. The total rock Rb-Sr work yields a wide scatter of points if all samples are considered. However, samples from a restricted area (near Limbunya No.1 drillhole), do define a Lower Cambrian isochron of about 580 m.y. Mineral work will be done soon in an attempt to yield a more precise "internal" isochron.

Cape York, Queensland.

by

W.B. Dallwitz.

Dr. J.A. Cooper, of the Geology Department, University of Adelaide, is completing the Rb-Sr dating of igneous and metamorphic rocks collected in Cape York in 1970. Most of the analyses were carried out by Cooper and Miss R. Bennett, but a number of additional analyses were required to overcome difficulties which arose during the interpretation of the results; these analyses were performed during 1972 by M. Mahon.

Mathematical geology and geostatistics

by

S. Henley

Development of twelve computer programs took place during the year, and these were applied to a number of problems: the plotting of contour and discontinuity maps for Carpentaria Basin topographic data, to assist structural interpretation; isopach and structure contour maps for the Bowen Basin area; calculation of norms and plotting of cumulative frequency curves for analyses of Bismarck Archipelago volcanics, and comparison of the latter with simulated models; and the initiation of an index of computer programs.

A paper on "Computer Processing of Geochemical Data" was read at the G.S.A. Joint Specialist Groups' meeting on 18th February, and meetings as Geological Branch representative on various committees were attended: notably the Technical Committee on Underground Water meeting on A.D.P. applications (Great Artesian Basin project in particular) in groundwater data storage and retrieval (Sydney 1-4 May), and the Department of National Development Scientific Computing Committee (21 April and 14 September).

Miss A. Mavros assisted Henley from 1 May to 23 July, correcting and modifying a number of programs.

Computer programs developed during the period under review are listed in Table M6.

TABLE M6

COMPUTER PROGRAMS DEVELOPED IN 1971-72.

Name	Purpose	Amount of Development in 1971-2.	State of Completion
BLOCK	Plotting of stacked sections as a block diagram.	50%	100%
X12	Processing of XRF trace element data	5%	100%
SCATPLOT	Plotting of scatter diagrams (e.g., geochemical variation diagrams).	100%	100%
CUMCURVE	Plotting of cumulative frequency curves	100%	100%
ENTROPY	Computation of relative entropy	100%	100%
RANDSIM	Generation of random numbers from mixed distribution types	100%	100%
MOVAVCON	Plotting of moving average contour maps	100%	100%
ENDMEM	Translation of multivariate data into terms of end-members, supplied or extracted from data set	100%	100%
BMRPROGS	Index of computer programs in Geological and Mineral Resources Branches	100%	100%
KWIKS	Lineprinter plotting of data maps	100%	100%
NLM	Non-linear data compression for visual presentation	100%	100%
POLYREG	Polynomial regression	20%	100%

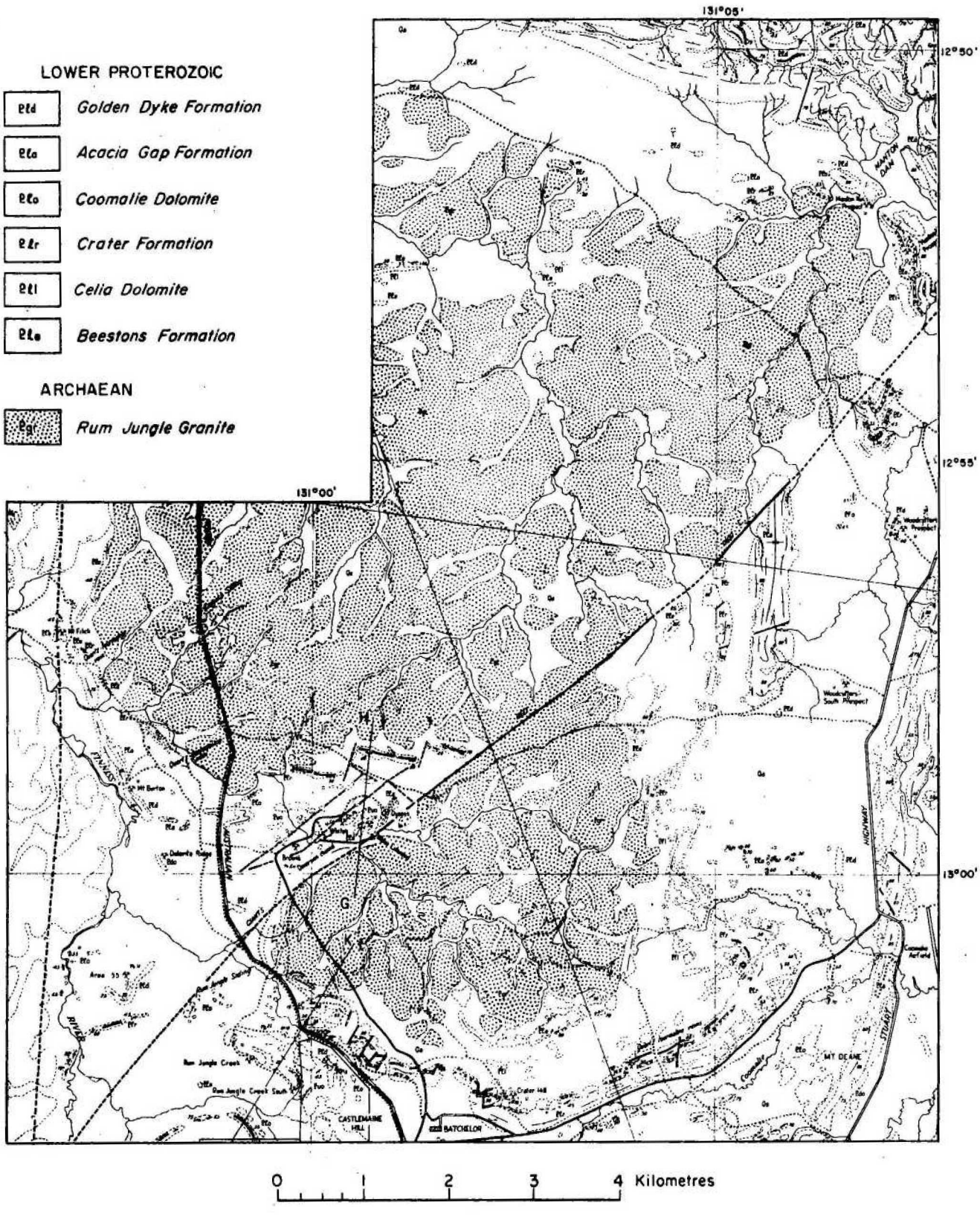


FIG. M16 **RUM JUNGLE COMPLEX**

To accompany Record 1972/103

D52/A8/478

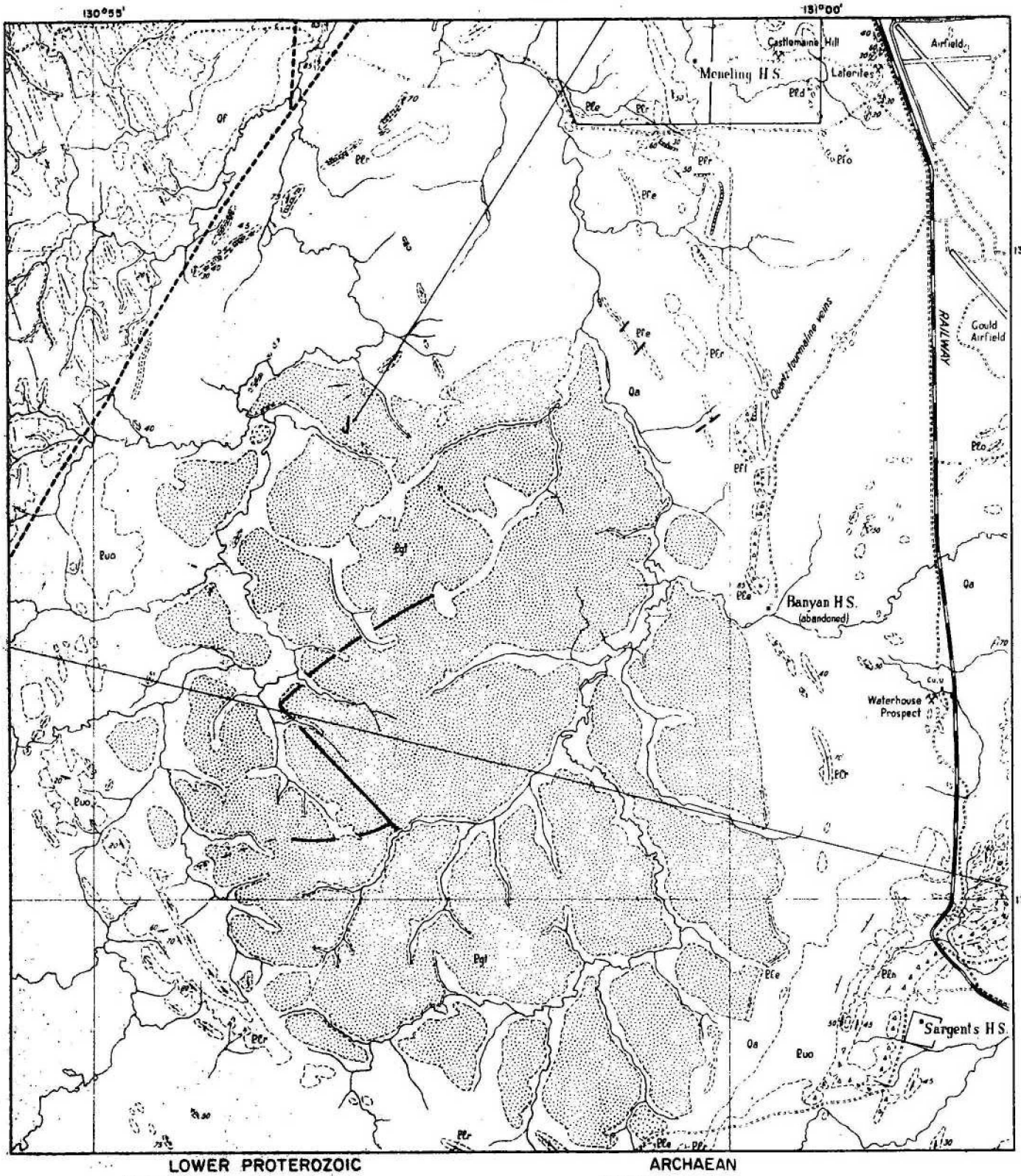


FIG.M17 **WATERHOUSE COMPLEX**

To accompany Record 1972/103

D52/A8/479

BAAS BECKING GEOBIOLOGICAL RESEARCH LABORATORY

MINERALOGICAL GROUP

Personnel: W.M.B. Roberts, J. Ferguson, K. Johnson (from March, 1972) - BMR; C.J. Downes, I.B. Lambert - CSIRO.

Rum Jungle area, N.T. (Roberts, Johnson)

Work on the up-dating of the Rum Jungle Special sheet was commenced in March. The new sheet will be defined by the co-ordinates 130°50'E to 131°15'E, and 12°45'S to 14°15'S, and will be at a 1:100 000 scale.

Before the start of the field season in June, most of the available geological and geophysical information on the area was studied and collated. Amphibolites from drill cores from Mount Burton, Rum Jungle Creek South, and Brown's Deposit were examined in thin section to determine their origin; it was concluded that the amphibolites studied are of sedimentary origin.

The geology of the areas around the Rum Jungle and Waterhouse Complexes is shown in Figs. M16 and M17.

The 1972 field season began on 1 June, and finished on 28 September, during which time much of the geological detail of the existing Rum Jungle Special sheet was checked and found to be substantially correct. However, some alterations will be necessary; for example, an outcrop at Mount Deane, mapped as dolerite, actually consists of carbonaceous and chloritic sediments. From the field observations alone there appears to be no evidence to justify placing a major fault running N-S through Mount Fitch; however, a gravity survey (BMR Record 1971/20) indicates a sharp falling away of the basement near the supposed fault.

One of the major problems in the area is the distinction between the Beestons and the Crater Formations, and consequently also between the Celia and Coomalie Dolomites. This has led to several ambiguities on the present map. A gravity survey (BMR Record 1970/1) indicates that, along its eastern margin, the surface of the Rum Jungle complex dips eastward at about 20°, and field mapping shows that the sediments dip eastwards at between 50° and 80°. Consequently, if the sediments were originally deposited on this 20° basement slope then their present steep dips, combined with evidence of extensive dynamic metamorphism in the Crater and Beestons Formations, imply that a tectonic event has strongly folded the sediments over the granitic basement into their present attitudes. If this is so, the present interpretation of the geology may be wrong in that the apparent continued steep dips of the sediments along the flanks of the granite, as shown on the present Rum Jungle sheet, may be due to recumbent folding, and if this is the case the Beestons/Celia/Crater/Coomalie Formations may be a repetition of a single basal conglomerate overlain by a dolomite layer.

Although a great deal of drilling has been done in the area, most of the holes put down by TEP and BMR are in the Golden Dyke Formation. Stratigraphic drilling is needed to solve geological problems which arose as a result of the 1972 field work.

Interaction of algae and metals (Ferguson and Bubela)

A number of stratiform and vein-type sedimentary Pb-Zn sulphide deposits of Precambrian age have high organic carbon contents which may reflect the presence of a large algal population in the sedimentary basin during metal deposition.

Objective of investigation. To provide quantitative data on the ability of living algae and dead algae and their decay-products to accumulate and transport metals under conditions relevant to the depositional and early diagenetic phases of ore genesis. These data are to be applied particularly to a consideration of the Woodcutters Pb-Zn deposit to test the hypothesis that the concentrations of metals into veins resulted from their transportation through the sediments as complexes with organic compounds derived from algae (Roberts, 1972).

Materials. Metals chosen for study are Pb(II), Cu(II), Zn(II), Fe(II) & (III), Mn(II), Ag(I). Both the McArthur River and Mount Isa ore deposits were formed in the Precambrian under highly saline conditions. It was therefore considered that, of the present-day algae, the halophilic, blue-green algae are the most suitable for study. However, owing to the difficulties of growing these algae, a blue-green, non-halophilic alga, Eucapsis sp., is being cultivated, but is not yet available in sufficient quantity for experimental work.

Progress. Large quantities of bacteria-free blue-green algae are not available at present, and a naturally occurring algal population collected from metal-rich acid spring waters at Corin Dam, ACT, is being used for most experiments. This material

contains the green filamentous alga Ulothrix sp. and minor amounts (less than 10% of the total algal cell count) of a unicellular green alga, Chlamydomonas sp., and unidentified blue-green algae. Two unicellular green algae grown in laboratory cultures are also being used. They are a species of Chlamydomonas which grew selectively from innocula of the Corin Dam algal material and a bacteria-free culture of Chlorella vulgaris.

Interactions of the metals Cu(II), Pb(II), Zn(II), with particulate organic matter and the interactions of Cu(II) with "soluble"* organic matter derived from the above algae have been investigated by shaking aqueous solutions of the metals with homogeneous suspensions of the algal materials. The algal suspensions have been varied, as far as practicable, from almost completely "whole cell" suspensions to suspensions in which most cells have been broken, and their contents released. A Ulothrix sp. suspension used in most experiments contains about 25% unbroken cells.

Results so far have been obtained mainly with Ulothrix sp., and refer to metal adsorption by particulate matter of the algal suspension. Preliminary results with Cu(II) indicate that metal complexing by "soluble" inorganic and organic materials is also significant.

Conclusions reached to date are:

1. The metals Cu(II), Pb(II), and Zn(II) can be adsorbed under some conditions from aqueous solutions. Under optimum conditions, M/Cp ratios up to 5×10^{-2} (where M is the decrease in metal concentration in solution, and Cp is the concentration of particulate organic matter in solution) can be obtained.

2. Adsorption is extremely rapid in the case of Pb(II) and Cu(II), being complete within the time of mixing. Reaction with Zn(II) is slower, but is 90% complete within 15 minutes of mixing.

3. The metal adsorption is an equilibrium reaction which is strongly pH-dependent, and is readily reversible. Metal uptake is favoured by high pH's, and at pH's below about 4 metal-algal interactions are unlikely to be significant.

4. The metal uptake is strongly dependent on the concentration of algal materials and metals in solution. At a fixed algal concentration and increasing metal concentration, the ratio M/Cp does not increase linearly, but appears to tend towards a saturation value. At a fixed metal concentration (metal in excess) dependence on the concentration of algae is much closer to linear.

5. The amount of metal taken up is only marginally affected by the addition of large amounts of NaCl to the solution. Only 10% less Cu(II) is removed from a 16% NaCl solution than is removed from a salt-free solution under the same conditions. This suggests that the algal materials can effectively complex heavy metal ions even in the presence of large amounts of metal-chloride complexes.

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* Soluble organic matter plus particulate organic matter not sedimented by centrifuging at 198 400 g.

Results obtained so far indicate a significant difference in the behaviour of Cu(II) and Pb(II), compared to Zn, towards algal materials. On a molar basis, significantly more Pb(II) and Cu(II) are complexed than Zn(II) (and Cd(II)) under the same conditions. Also, "competition" experiments using bimetallic solutions indicate that Cu>Pb>Zn and Cd in complexing ability with the algal materials.

Physical Chemistry of Brines (Downes)

There is wide acceptance of the theory that ore-transporting solutions contain other salts in addition to the ore components. It is therefore important to determine the effect of these salts on the solution-chemistry of the ore components, especially with regard to their influence on the solubility relations which govern the solution, transport, and deposition of ores in sedimentary environments.

The isopiestic vapour pressure method has been used to measure the chemical potential of water in brines of various salinities. Experiments on several systems involving base metal ions have been completed, and a thermo-dynamic method has been developed to evaluate the activity coefficient of traces of the base metal ions in brines. Manuscripts describing the results have been prepared.

Systems containing manganese, cobalt, and nickel ions in sodium and calcium chlorides have been studied. Experiments on analogous systems containing copper ions are in progress, but there have been some difficulties with this work in which a copper amalgam electrode is used to measure the activity of copper ions. Electrochemical cells of a new design are being constructed. If successful, these cells will also be suitable for the study of the complexing of zinc in chloride brines.

The behaviour of copper ions in brines is being studied at present, and emf methods are being developed for the study of systems containing lead and zinc. A manuscript describing results for brines containing manganese ions has been submitted for publication.

Field study of transport and deposition of base metal ions (see also (Downes and Jensen) (see also page 37)

A reconnaissance survey was carried out in August, 1972, in the Lake Frome area, South Australia. The survey was made to test the feasibility of using Lake Frome to study whether the movement of fluids and sediment into an internal drainage basin in an arid environment could concentrate metals such as zinc, copper, lead, and uranium, through evaporation or the action of sulphate-reducing bacteria, and to determine the influence of provenance on the spatial distribution of these elements. Lake Frome appears to be suitable because of its moderate size, relatively simple drainage pattern, and its proximity to areas of known mineralization. The fact that it receives water from the Great Artesian Basin is an added reason for selecting this lake rather than Lake Torrens.

Secondary objects of the investigation are:

Geochemical

1. To study crystallization of brines in a continental environment, and diagenetic modification caused by differentiation of brines through tilting.

2. To study precipitation and diagenetic modification of carbonates.

3. To study the interaction of water from a mound spring with the lake sediments - especially if the artesian water carrie higher than average trace elements.

Sedimentological

1. To study sedimentation in an Australian playa to enable similar environments in the geological column to be recognized.

2. To provide more information on Quaternary climatic changes.

3. To contribute to the stratigraphic studies being made in areas adjacent to the lake by the Geological Survey of South Australia.

Iron sulphide precipitation at Talasea, New Britain, PNG (Lambert and Ferguson)

The investigation was carried out to determine the nature, origin, distribution, and morphology of iron sulphides in a geothermal environment.

The study has been completed, and a Record has been prepared. The most important conclusions were:

1. Iron sulphide concentrations are significantly higher (5-10%) than those found in sediments not influenced by thermal activity (usually 1-5%), but are limited to the vicinities of thermal spring activity.

2. The unstable iron sulphide phase, hydrotroilite, can persist in the thermal pool sediments, and is the major iron sulphide present.

3. Under more oxidizing conditions hydrotroilite is absent, and pyrite and marcasite are present.

4. Most of the pyrite in the banks of thermal pools occurs as large euhedral crystals; framboidal textures were not seen.

Geochemical studies on natural environments (Lambert)

A study of the sulphur isotope ratios of sulphides from the Mount Gunson copper deposits S.A. has been completed in collaboration with T. Donnelly of the CSIRO Division of Mineralogy. The results appear to confirm earlier conclusions that the lagoon sulphides have been formed from older sulphides in the west through precipitation by bacteria.

The Talasea iron sulphides have been examined with the electron probe microanalyser. These studies have shown that there is no zoning in the sulphide grains, and that the sulphides contain a small amount of cobalt.

Experimental diagenesis and metamorphism (Lambert)

The object of this study is to investigate the mineralogical and textural changes that could occur in stratiform ore deposits during diagenesis and metamorphism.

Studies on the low-temperature synthesis of metal sulphides from organic sulphur (cystine) have continued. It has been shown that humic acids have no marked effect on the rates of reaction.

Lambert left for Japan in July to take up a Japanese Government Scholarship. He will study sulphide ore deposits in Japan, and will be absent until February, 1973.

BAAS BECKING GEOBIOLOGICAL RESEARCH LABORATORY

BIOLOGICAL GROUP

Personnel: P.A. Trudinger, B. Bubela, G.W. Skyring, H.E. Jones, A.D. Agate (part time), Miss L.A. Chambers.

Research has continued on three major projects which have been the subjects of previous summaries. These are:

1. Physiology and biochemistry of sulphate-reducing bacteria.
2. Concentration of metals by bacteria.
3. The taxonomy and evolutionary status of sulphur-metabolizing organisms.

The project on concentration of metals by bacteria will be completed in about four months. The project on the biological oxidation of manganese has been phased out.

Two new projects which have been initiated are:

1. Investigation of early diagenetic changes in an artificially controlled sedimentary system, and
2. Algae as agents of metal accumulation and carbonate formation.

Dr. A.D. Agate resigned in June to take up a position as Professor and Head of the Microbiology Department of M.E.S. College, Poona, India.

Sulphur isotope fractionation by sulphate-reducing bacteria.

(Chambers and Trudinger with J.Smith, CSIRO Division of Mineralogy, Ryde).

The objective is to evaluate the use of sulphur isotope ratios to discriminate between biogenetic and non-biogenetic sulphides. A continuous culture system is being used which allows the degree of discrimination between the stable isotopes of sulphur during the reduction of sulphate to sulphide to be examined under strictly controlled steady-state conditions. A large number of samples have been collected, but most of these remain to be analysed. Initial results indicate that two processes may operate in isotope discrimination, one a kinetic process leading to $\delta^{32}S^*$ values of about 17 $^{o}/_{oo}$, and a second process leading to much higher fractionation factors. Experiments with radioactive S^{35}-labelled compounds indicates that the second process may be an enzyme-catalysed exchange of sulphur atoms between sulphide and sulphate.

$$*\delta^{32}S = \frac{^{32}S/^{34}S \text{ (sulphide)} - {}^{32}S/^{34}S \text{ (sulphate)}}{^{32}S/^{34}S \text{ (sulphate)}} \times 1000$$

Quantitative aspects of sulphide ore genesis.
(Trudinger, Lambert, Skyring).

A theoretical study was carried out in an attempt to determine whether, in the light of modern knowledge, biogenesis of stratiform sulphide ores is a feasible proposition. The physico-chemical limits of bacterial sulphate reduction were examined, and it was concluded that there are few geochemical factors which, by themselves, would prevent the process from taking place in sedimentary environments. Modern biochemical studies on the evolution of organisms suggest that the sulphate reducing bacteria may have developed in the Precambrian. Comparisons were made between rates of biological sulphate reduction, organic carbon production (which supports sulphate reduction) and ore deposition. The results indicate that, though the rates of sulphate reduction and carbon fixation are sufficient to account for the Roan Antelope and Kupferschiefer deposits, a number of restrictive conditions would be necessary for the production of other stratiform ores such as those of Mount Isa and McArthur River.

Chemistry of sulphate-reducing bacteria. (Jones, Skyring).

Studies have continued on the porphyrinic pigments from the sulphate-reducing bacteria. The interest in these pigments stems from their possible relationship to similar organic molecules which are found in a variety of modern and ancient sediments. Some of these sulphate-reducing bacteria have been shown to contain a cytochrome of the d-type which hitherto had been thought to be associated only with aerobic respiration. The presence of this cytochrome in the strictly anaerobic sulphate-reducing bacteria may be of considerable evolutionary significance. Studies are also in progress on a green porphyroprotein, desulphoviridin, which appears to be associated with the transformation of sulphate to sulphide in sulphate-reducing bacteria of the genus Desulphovibrio.

Relationships amongst dissimilatory sulphate-reducing bacteria.
(Skyring).

These studies were aimed at determining the extent of the natural relationships between sulphate-reducing bacteria, and to obtain information on the evolution of bacterial sulphate reduction in terms of geological time. The three main enzymes involved in sulphate reduction in all the named species of Desulphovibrio and Desulphotomaculum have been compared by electrophoretic procedures, and the comparison is being extended to a set of 40 named cultures of the sulphate-reducing bacteria. The results have revealed a number of inter-species and inter-generic similarities. They suggest that the genetic machinery governing sulphate reduction may have been conserved for a considerable time, and lend some credence to the view that modern sulphate reducers may be representatives of earlier forms of this class of bacteria.

Simulated sedimentary system. (Bubela, Ferguson).

An experimental tank has been constructed to enable biological, mineralogical, and chemical changes occurring during early diagenesis to be studied. The tank is equipped with facilities for collecting samples for chemical analysis, the measurement of oxygen tension, and pH and Eh, and for collecting cores up to 40 mm in diameter with a minimum disturbance to the environment. A novel end-piece for coring equipment was devised which allows unconsolidated core samples to be collected. A patent is being applied for. A scanning X-ray technique with a resolution of 0.1 mm was developed to enable banding within cores to be examined. Instrumentation permitting the introduction of liquids or gases into the lower parts of the sediments has been designed; this will allow alteration of redox or metal concentration of the system after the tank has been filled. Preliminary checking of the equipment has been completed, and the tank has now been charged with sedimentary materials which simulate to some extent the McArthur River environment.

Algae and their significance in stratiform ore deposition. (Bubela).

A survey of the available literature is being made in an attempt to estimate the degree to which algae may have participated in the formation of dolomitic sulphide deposits. It is hoped that this survey will bring to light avenues for fruitful experimental work, particularly on the production of carbonates by algae.

Concentration of metals by sulphate-reducing bacteria. (Jones, Trudinger, Chambers).

This project is almost completed. Electron micrographic studies of sulphate-reducing bacteria have revealed the presence of internal granules of presumptive FeS. The granules are absent from the bacteria when either iron or sulphide is absent from the medium. It is possible that this phenomenon may have some relationship to the formation of framboidal sulphides in nature.

OVERSEAS VISITS

L.P. BLACK

L.P. Black attended the Eighth International Radiocarbon Conference held at Lower Hutt, New Zealand, from 18th to 25th October as official B.M.R. delegate. Professor W.F. Libby, the originator of the radiocarbon dating technique, was present as Honorary President of the conference. Subjects discussed comprised secular variations of carbon-14 experimental techniques, carbon-14 variations in ocean water and fresh water, radiocarbon in soil development, application of carbon -14 techniques. sample contamination, and reference standards.

A report on the conference has been prepared.

A.Y. GLIKSON

A.Y. Glikson undertook a private overseas trip from 5th September to 2nd November, 1972. During this time he visited the following organizations:

(1) U.S. Geological Survey, Menlo Park and Denver.
(2) Yale University, New Haven.
(3) Columbia University, Lamont Doherty Institute, New York.
(4) The Institute of Geological Sciences, London.
(5) Imperial College of Science and Technology, London.
(6) Geological Survey of Greenland, Copenhagen.
(7) The Danish Mineralogical Institute, Copenhagen.
(8) The University of Leiden, The Netherlands.
(9) University of Witwatersrand, Economic Geology Research Unit, Johannesburg.

Field excursions were conducted over a period of two weeks in the Barberton Mountainland, Eastern Transvaal. Brief examinations of significant geological features were also made in the Bavarian Alps and the Tirolese Alps. Lectures on "Early Precambrian evidence of a primary ocean crust and island nuclei of sodic granite" were delivered in San Francisco, Denver, Yale, Imperial College, Copenhagen, Leiden, and Johannesburg, and on the Proterozoic of central Australia and northwestern Queensland in Denver, Copenhagen, and Johannesburg. In the following a brief account of meetings and discussions held with officers of the USGS, IGS, IC, G.S.G., and the EGRU is presented.

U.S. Geological Survey

Menlo Park was visited on the 8/9 and Denver during 11-12/9. Discussions were held with R.G. Coleman, acting head of the Branch of Field Geochemistry and Petrology, H. Cornwell, and D.J. Milton, regarding methods and objectives of petrological and geochemical follow-up work of field mapping, nickel mineralization, and Lunar and Martian photo-geology. In Denver, discussions were held with Z.E. Peterman, head of the Branch of Isotope Geology, F. Barker, C. Hedge, and W. Hamilton, concerning the proposed Archaean comparative study within the IGCP, mode of evolution of greenstone belts, Cordilleran Precambrian geology, applications of isotope geology to Archaean studies, geochemistry of trondhjemitic rocks, and geotectonics of the Precambrian in Australia and South Africa.

Institute of Geological Sciences

The Petrological Section, Geological Museum, Geochemical Division, and Overseas Division were visited during the period 25/9-27/9, and discussions held with R.K. Harrison (chief petrographer), R. Dearnley (petrologist), F.W. Dunning (Curator), P.J. Moore (Geochemical Division), J.E.T. Horne (mineralogist), and N.J. Snelling (isotope geology). Subjects discussed were petrographical problems, data storage and retrieval, rock classification and storage, analytical procedures, and particular problems in Precambrian geochronology. In the Overseas Division, discussions were held with D. Bleackley who gave me a description of the activities of his division, and with J.P. Berrange on the geology of the Guiana Shield.

Imperial College of Science and Technology

The visit to Imperial College included discussions with Professor J. Sutton and Dr. J. Watson, and with students regarding the IGCP and Archaean problems in general.

Geological Survey of Greenland

This organization was visited during the 2/10-5/10; the visit included examination of rock specimens and slides and photographs of Archaean and Proterozoic rocks of Greenland. A group discussion on the proposed IGCP Archaean comparative study was organized by the Director, Ellitsgaard Rasmussen. Discussions were held with D. Bridgwater, J.H. Allaart, N. Henriksen, F. Kalsbeek, and J.S. Myers on various aspects and problems of Greenland Precambrian geology. At present the Survey concentrates on 1:100 000-scale mapping of various parts of the Precambrian and Caledonide belts; the quality of the outcrops and the complexity of the field relationships are unparalleled by anything previously seen by Glikson. Although the establishment of the Survey includes only 17 geologists, they manage to cover large areas by recruiting a large number of university geologists during the summer for field work in various parts of Greenland.

Economic Geology Research Unit and Department of Geology, University of Witwatersrand

These departments were visited on the 13/10 and the 31/10, and discussions were held with Prof. D.E. Pretorius, D. Hunter, C.R. Anhaeusser, T. Clifford, and J. Ferguson regarding the IGCP, correlations of the Archaean in South Africa and Western Australia, the geology of Eastern Transvaal and Swaziland, Archaean and Proterozoic geotectonic trends, nature of the original crust, and related subjects. A one-day tour of the Johannesburg-Pretoria granite dome was made in the company of C.R. Anhaeusser, and a three-day tour of the Barberton Mountainland with Prof. Pretorius. Following the latter tour, Glikson hired a VW, and carried out a 10-day examination of type sections of the Onverwacht (basal ultrabasic-basic volcanics of the Archaean Swaziland System), Fig Tree, and Moodies Formations. A considerable number of samples, including ultrabasics, pillow lavas, pelagic sediments, and black cherts were collected, partly for studies by ANU geochemists and isotope geochemists, and partly for the petrological reference collection in BMR. The excursion in the Barberton area proved of special interest, as this terrain constitutes the the most complete model of Archaean greenstone belts to be found anywhere in the world, and its study has direct application to that of the Yilgarn and Pilbara shields in Western Australia.

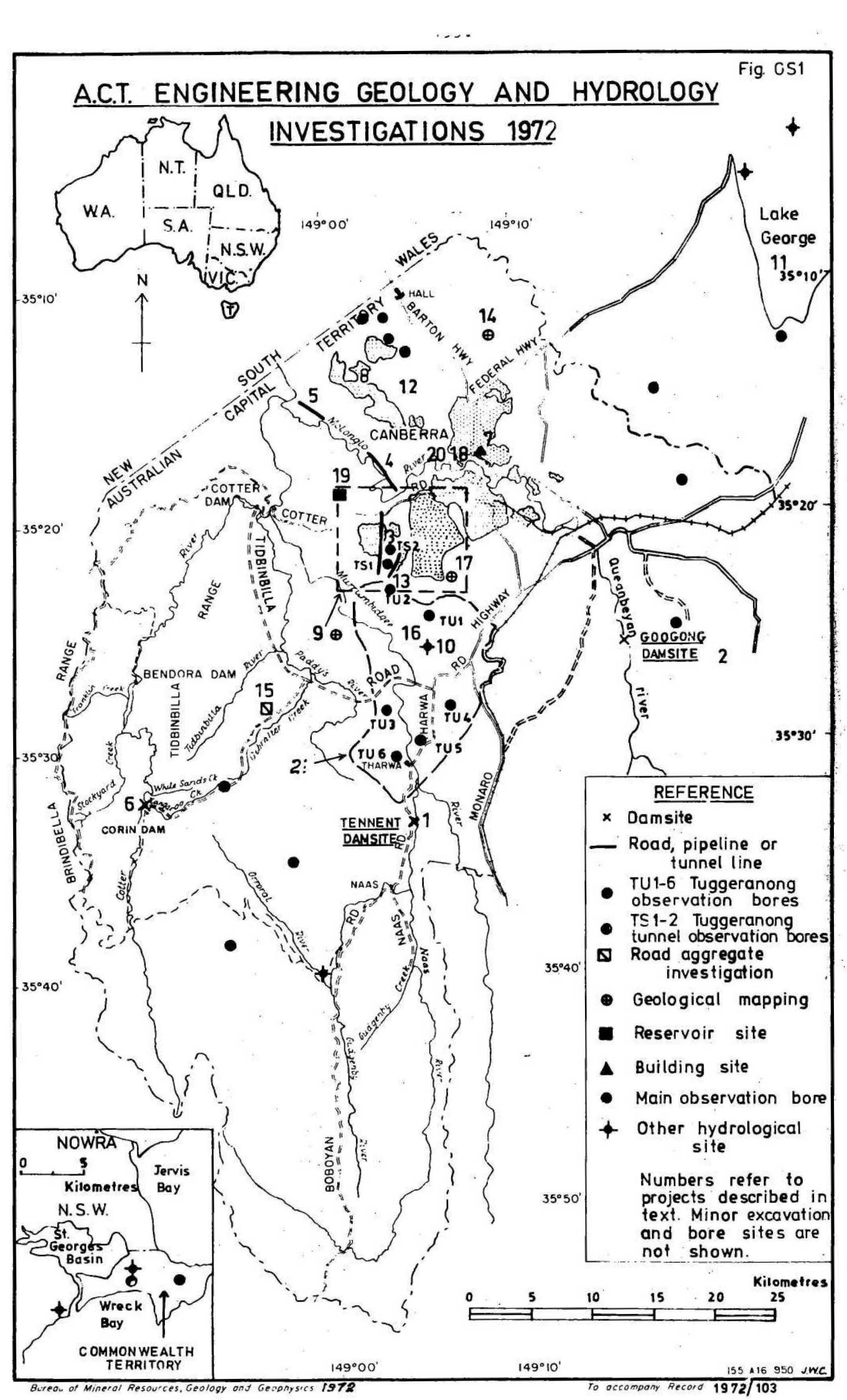
GEOLOGICAL SERVICES SECTION

GEOLOGICAL SERVICES SECTION

Contents.

Fig. GS1

A.C.T. ENGINEERING GEOLOGY AND HYDROLOGY INVESTIGATIONS 1972



GEOLOGICAL SERVICES SECTION

SUMMARY

Numerically, the Section's staff was at, or near, full strength throughout the year, but the Indexes and Mineral Reports group suffered through having the Class 3 geologist engaged in other duties and the Engineering Geology Group because of an unfilled Geologist Class 3 position. The latter was filled in September.

As usual, the Engineering Geology Sub-Section had a heavy workload. Some additional staff was made available from time to time and in April an additional special-purpose, limited duration Geologist, Class 2, position was created to provide the necessary geological services during construction of two major sewer lines. The year saw two major developments - the completion of the group's first major highway investigations and the servicing of its first major tunnel construction project. In keeping with these developments, great emphasis was placed on training. The issue of an Engineering Geology Manual was an important step in the training and management of the group. Other major activities of the group included further mapping and geotechnical investigations in the Tuggeranong development district and a start on the Gungahlin district, and the resumption of work (for design purposes) on the Googong damsite, Queanbeyan River. Hydrological work in and around the A.C.T. was maintained throughout the year, including maintenance of observation points and readings at Jervis Bay. The year has been a dry one; the low rainfall is reflected in the decline in the level of Lake George.

The Map Editing and Compilation Group edited 30 maps, and made important contributions to the compilation of four regional and special-purpose maps.

With the aid of several former cadets, Volume 5H of the International Stratigraphic Lexicon was completed. A study of the occurrence in Australia of uranium and tin was initiated during the year.

The appointment in July of an experienced museum curator has enabled plans for the proper organization of the museum to be put in hand. It is expected that, as a result, much more effective use will be made of material already in the museum and substantial acquisitions of display material will be made.

In March the Chief Draftsman, Geological Drawing Office, was convener of, and host to participants in, the 5th Conference of Chief Draftsmen of the State Mines Departments and B.M.R. Production by the Drawing Office exceeded that in 1971.

Sixteen Records were issued during the year and 24 Records were in preparation at the end of the period.

GENERAL

The Assistant Chief Geologist (Geological Services) (E.K. Carter), in addition to routine supervisory and administrative matters, continued to provide liaison between Commonwealth Department of Works' head office engineers and the geological field staff of the P.N.G. Geological Survey on P.N.G. hydro-electric schemes. In the course of two visits to P.N.G.

the Ramu 1 (under construction), Yonki Dam (design investigation), Musa, L. Wahgi, and U.Tua hydro-electric schemes were inspected. The P.N.G. G.S. annual programme conference was also attended.

He sat on four Departmental or other committees, attended the Government Geologists' Conference in Perth and related field excursions, and attended several interstate technical meetings.

Specific matters of concern to the Section with which he dealt included: B.M.R. reorganization, Volume 5H of the International Stratigraphic Lexicon, stratigraphic nomenclature, A.C.T. terrain evaluation survey, museum, and the rock types map of Australia, scale 1:10 000 000. He gave two lectures on aspects of engineering geology to post-graduate students of the Australian National University, and he carried out the office duties of the Assistant Director (Geology) for a total of three weeks.

A.C.T. ENGINEERING GEOLOGY AND HYDROLOGY

by E.G. Wilson, A.T. Laws and G.M. Burton

ORGANIZATION

E.G. Wilson commenced duty as Geologist, Class 3, on 18 September and it became possible to reorganize the Sub-Section into two functional groups to meet the very heavy load for engineering geological services being encountered as a result of the growth of Canberra.

Staffing at the end of October 1972 was:

Supervising Geologist - G.M. Burton (Geologist Class 4).

Group A Senior Geologist - A.T. Laws (Geologist Class 3) - Hydrogeological and Regional Development Group. This group provides services to the National Capital Development Commission (NCDC), Department of the Interior (DI), Australian Water Resources Council (AWRC), and rural landholders in the Australian Capital Territory. The services usually cover the engineering geological mapping of major regional urban areas and hydrogeological and soils investigations.

Staff assisting Mr. Laws are: J.A. Saltet (Geologist Class 2, acting); P.D. Hohnen (Geologist Class 1, temporarily assigned); P.H. Vanden Broek (Geologist Class 1); P.A. Lang (Technical Assistant Grade 2, temporarily assigned); J.R. Kellett (Technical Officer Class 1). Three field hands (L. Pain, M. Eveston and A.D. McCormick) also assist.

Group B Senior Geologist - E.G. Wilson (Geologist Class 3) - Major construction and Special Projects Group. This group provides services to Department of Works (CDW), and other authorities. Services include feasibility, design, construction and maintenance investigations for major structures, such as dams and tunnels, and special smaller investigations.

Staff assisting Mr. Wilson are: G.A.M. Henderson (Geologist Class 2); D.C. Purcell (Geologist Class 2); G.B. Simpson (Geologist Class 1); A.W. Schuett (Technical Assistant Grade 2). Two field hands (V.P. Carberry and one temporary) assist this group.

A submission has been lodged seeking to change most of the field hand positions to permanent technical positions, in keeping with the work required of the occupants of the positions.

For a major part of the year under review the projects now supervised by E.G. Wilson were supervised by A.T. Laws or G.M. Burton.

G.M. Burton, besides directly supervising several major projects, spent a large part of the year on administrative matters. As convener of the AWRC Sub-Committee on the Groundwater Resources Maps of Australia, he supervised the final stages of this project: the four maps have now been proof-printed and the text, Groundwater

Resources of Australia, was brought to the late manuscript stage. Burton was also a member of the AWRC supervisory panels on the operation of representative basins, and research into the extraction of water from unconsolidated sediments. He assisted Dr. Carter on committees associated with the Googong and Ord Dams.

GENERAL

The work completed in November and December of 1971 is covered as part of the general report on 1972 because many 1971 projects continued into 1972.

Important aspects of the twelve-months' work were:

(a) Tunnelling: Geological investigations for tunnel design and construction have become a major activity of the group since 1971. Construction of the Tuggeranong Tunnel, a six-mile sewerage tunnel, was commenced, and two short sewerage tunnels at Belconnen were almost completed. The design investigation into the Molonglo Valley Interceptor Sewer (which includes two major tunnels) was completed and the draft report supplied to the design engineers. The feasibility of major trunk sewers for central Canberra were examined.

(b) Urban geology and roads: More detailed investigations of major urban developments and freeways are being requested by the NCDC. A new type of investigation was used in the Tuggeranong Development area; the report will be completed in October. Detailed investigations of the Tuggeranong and Molonglo Freeways and other roads were carried out.

Changes in the type and detail of investigations has required strong emphasis on training in soils, tunnelling and rock mechanics. Details of these are given later.

An Engineering Geological Manual, commenced in 1971, was completed and issued. The manual is in loose leaf binder form permitting up-dating and modification. It is designed to standardize methods in the sub-section and to assist in the training and induction of engineering staff.

Engineering geological training still lags in Australian Universities. Hopeful signs, however, are the course evolving at the Canberra College of Advanced Education and a series of lectures for honours students at the Australian National University; Dr. Carter and G.M. Burton delivered several of the lectures and Mr. Burton led one excursion for the ANU course. The Australian Mineral Foundation is also proposing to conduct courses in 1973. The Australian Geomechanics Society and Institution of Engineers have become more active in conducting excellent seminars in fields such as rock mechanics and tunnelling where geology has a major role. The balanced attendance and resulting discussion of engineers and geologists from Government authorities and private consultants and contractors are not only providing useful geotechnical training, but are also assisting in better interdisciplinary communication between geologists and engineers which is inherently weak in Australian universities.

DAMSITES AND SEWER LINES

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

The Tennent Damsite, which was previously investigated as an alternative to the Googong Damsite, proved to be a suitable site, and may be required for construction in the future. A draft report on the drilling and other site investigations carried out in 1970 and 1971 was partly edited and amended, and most of the working plans were redrawn in the drawing office.

Googong Damsite, Queanbeyan River (G.B. Simpson, J.A. Saltet - Locality 2)

The advance copy of the feasibility report for the construction of Googong Dam was revised and prepared for issue as a restricted record. An investigation of the micro-seismicity of the dam storage area was carried out by the Geophysical Branch; support for this project was provided by field staff from the Section, who regularly monitored the recording equipment.

G.B. Simpson commenced the geological work associated with the design investigation for Googong Dam in August. A site office was established, and a drilling programme drawn up, comprising 808 metres of drilling and the use of a core-orienter for structural data. The first part of the drilling programme commenced in September and consisted of three holes to assess the suitability of the proposed diversion tunnel route. Eight costeans that were excavated by bulldozer were mapped. Detailed mapping of exposures at the damsite, and of limestones in the storage area is to be carried out during this investigation. Electrical resistivity surveying is being carried out by the Engineering Geophysics Group along the tunnel line and in the spillway area, in an endeavour to trace shear zones that were not detected by seismic refraction methods.

Corin Dam, Cotter River (G.A.M. Henderson - Locality 6)

At a joint B.M.R.-Commonwealth Department of Works (CDW) visit to Corin Dam in January 1972, concern was expressed about the nature of the scouring in the spillway discharge area. The exposed rock was closely examined and mapped at a scale of 1:240. It was concluded, in consultation with CDW officers, that damage to the spillway structure in the immediate future was unlikely, and that no remedial measures should be taken; however, periodic photography and inspection of the area were recommended.

* The numbered localities in the report on engineering geology and hydrology are shown in Fig. GS1.

Tuggeranong Sewer Tunnel and Appurtenant Works (D.C. Purcell, G.B. Simpson - Locality 3)

Construction of the sewer tunnel from Tuggeranong to Weston Creek began in May; excavation is by conventional drill-blast methods, and breakthrough is expected by September 1974. Tunnelling commenced at the Tuggeranong portal late in June, and at the Weston Creek portal during August; about 460 metres of the 9150 metres long tunnel has been excavated. A full geological service is being provided for the Commonwealth Department of Works (CDW), who are supervising construction of the work. The tunnel is being driven through acid volcanic rock: dacites and rhyodacites of Silurian age, and all excavations are being systematically logged for future reference. The rock has proved to be hard and strong in tunnelling from the Tuggeranong portal, and little support has been required; however, tunnelling from the Weston Creek portal has encountered some water, and the tunnel, which lies at shallow depths in partly weathered rocks has required considerable support.

Molonglo Valley Interceptor Sewer (D.C. Purcell, G.B. Simpson)

Construction of the Molonglo Valley Interceptor Sewer is due to commence early in 1973. The route investigation was completed and a detailed geological report covering two tunnel routes (Localities 4 & 5) and several miles of buried pipeline route was prepared for incorporation in the tender document issued by CDW. Geological assistance is to continue during construction of the sewer.

Belconnen Sewer Tunnels (D.C. Purcell - Locality 12)

CDW supervised the construction of two tunnels, 430 metres and 92 metres long, which are to become part of the 54-inch (137 cm) Belconnen sewer main. Regular inspections and geological advice were provided during construction, and fortnightly geological reports were issued to CDW. The tunnels were driven through dacite, adamellite and mudstone; tunnelling conditions in the dacite were fairly good, but were poor in the mudstone and adamellite which required considerable support. Tunnelling commenced in March, and was completed in early October.

URBAN GEOLOGY

Tuggeranong Urban Development Area (A.T. Laws, J.A. Saltet, P. Vanden Broek, J. Kellett - Locality 21)

A detailed study of the proposed Tuggeranong Urban Development Area has been undertaken at the request of the National Capital Development Commission (NCDC). Aspects covered include hard rock geology, soils, hydrology, slopes and slope stability,

excavation and foundation characteristics, resources, and possible refuse disposal sites. The report, which was completed in October, was designed to help the Town Planning section of NCDC in determining design constraints within the Tuggeranong area.

Detailed mapping of the hard rock was carried out by Saltet; Vanden Broek and Kellett investigated the soils, whilst Laws carried out hydrological investigations. More than 50 auger holes were drilled by Kellett and field hands in the various soil horizons, and six bores were drilled for observation of groundwater levels (Location TU 1-6). Detailed inventories of creek incisions, springs, seepages and weathering profiles were compiled, and from the collected data, factors related to slope stability, and excavation and foundation characteristics were established.

Gungahlin Urban Development Area (A.T. Laws, P. Hohnen, J. Kellett - Locality 14)

The preliminary feasibility investigation of the Gungahlin area commenced in October, with Hohnen studying the stratigraphy, Kellett the soils, and both, with the assistance of Laws, contributing to the hydrology of the area.

Tuggeranong Town Centre (P. Vanden Broek - Locality 16)

A detailed investigation into the proposed Tuggeranong Town Centre has commenced at the request of NCDC. Field studies, including drilling, commenced in late September, and are continuing.

Civic Centre (G.A.M. Henderson - Locality 7)

In a letter to NCDC in January, BMR suggested that a geological survey of the Civic Centre area be carried out to provide basic information for planning future development. All available geological data were compiled and a programme of seismic refraction work has been recommended; this may be followed at a later date by a number of drill holes in critical areas.

In November 1971, NCDC requested geological information on a proposed building site bounded by Ainslie Avenue, Ballumbir Street, Bunda Street and the future extension of Allara Street. Following seismic refraction work by the Geophysical Branch, a geological report recommended four drill holes, but the drilling has yet to be carried out.

Woden - Weston Creek Area (G.A.M. Henderson - Locality 9)

All available geological information in the Woden - Weston Creek area was compiled, and some additional mapping carried out to provide an interpretation of the stratigraphy and structure of the area. Thin section study of the massive porphyries provided some assistance in the field distinction between intrusive and extrusive porphyries.

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

Excavations in Belconnen were mapped from time to time, and new information was incorporated in the geological compilations of the area.

Isaacs Development (G.A.M. Henderson - Locality 17)

In May, a request was received from NCDC for geological advice on the proposed suburb of Isaacs, located in the southeast part of the Woden Valley. Seismic refraction traverses and augering were recommended after a preliminary geological inspection.

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

Monitoring of the network of observation bores in the ACT continued under the care of the technical staff. Water levels were lower than those for the corresponding period last year (1971); this is a reflection of the very dry winter in the ACT this year.

Possibly observation bores B5, B6, B7 and B8, which were due to be backfilled may continue to operate in 'park areas' of the Belconnen Urban Development area. Observation bore B15 appears to have collapsed following the attempt to develop it with explosives in 1971. Three observation bores, programmed for 1972, were not drilled, but it is hoped that they will be completed early in 1973.

Laws sited two bores for rural properties, and provided advice on groundwater supplies to several prospective landholders.

Lake George (Locality 11)

Routine monthly gaugings, and measurements of salinity and pH were continued. Schuett carried out a detailed sampling of the lake in May. The lake has continued to show the effects of drought; the winter months of 1972 had low rainfall and the lake level has fallen from 1.601 metres in October, 1971 to 1.119 metres in September, 1972. The gauging station at Kenny's Point went out of service as the area of the lake diminished, and it was dismantled in May 1972. The stratigraphic hole, that was partially drilled in 1971, has not yet been completed.

Jervis Bay (See inset map, Fig. GS1)

Schuett visited Jervis Bay twice during the year to carry out routine maintenance of observation bores, to measure water levels, and to collect water samples for conductivity and pH testing.

Drainage Problems (A.T. Laws, J.A. Saltet, P. Hohnen)

Saltet and Laws carried out further investigations into the drainage problems at the Canberra Grammar School. The soil profile was augered and five piezometers were installed. A technical note was prepared and forwarded to CDW, who subsequently prepared plans for the installation of drainage pipes; the pipes are to be laid in the presence of a geologist.

Hohnen investigated a drainage problem in Ainslie; seven auger holes were drilled and equipped as piezometers. An old stream channel that is filled with an almost impermeable clay transects the area. A thin sandy clay aquifer is confined within relatively impermeable clays and charging of this aquifer with water under pressure has been responsible for seepage and poor drainage. A technical note has been completed and recommendations were forwarded to the Commonwealth Department of Works.

Miscellaneous

At the request of office-bearers of the National Fitness Centre, Laws visited a block of land adjacent to the Tidbinbilla Reserve to give advice on the likely availability of groundwater in the area. Evidence from springs and seepages indicated good prospects for groundwater, but no formal request for an investigation was received.

Following a request from B. Fitzgerald, of the Commonwealth Department of Works, Laws visited the site for a proposed major building at Government House to give informal advice on the likelihood of groundwater seepage. The design of the building was subsequently changed and groundwater problems are not considered likely to occur.

Laws visited the Queanbeyan River near the proposed damsite to comment on the suitability of two sites for a gauging weir to replace the existing one at the damsite. A technical note is in preparation.

MAJOR ROADS INVESTIGATIONS

Molonglo Freeway (G.A.M. Henderson - Locality 18)

Geological information was provided to the consulting engineers for the Molonglo Freeway, Rankine and Hill; a study of joint orientations was also made to help the engineers determine optimum batter slopes.

Tuggeranong Freeway Stage II (P. Vanden Broek, J. Kellett - Locality 13)

A report setting out the geology, soils, geomorphology and seismic investigations along Stage II of the Tuggeranong Freeway was completed in March. Meetings with the consultants, Rankine and Hill, have since led to an additional seismic survey at locations where large cuts are to be made.

Isabella Plains Arterial Road and Drainage Investigations (P. Vanden Broek, J. Kellett - Locality 10)

A report setting out the conclusions and recommendations for the drainage problems at Isabella Plains was completed in July. Since that time, at meetings with NCDC officers, the constructional and design problems associated with subsurface water and low permeability soils in the plains were considered.

MATERIALS

Rural Roads (P. Hohnen, P. Vanden Broek, R. Hansen, P. Lang, J.R. Kellett)

The search for suitable material for the construction of rural roads in the ACT has continued throughout the year. Reports dealing with gravel deposits suitable for roadwork in the Williamsdale and Naas areas were prepared, and a technical note was prepared on a gravel deposit near Gibraltar Creek on the Corin Dam road (Locality 15). Advance copies of reports on these investigations were sent to clients during October.

The search for gravel in the Paddy's River area was still in progress in October, and adequate reserves of suitable material have yet to be found; a technical note on this project is in preparation. Both plastic and non-plastic gravel are urgently required in the Uriarra area, and work commenced in that area in the second week in October.

MISCELLANEOUS

Black Mountain Stratigraphic Hole (G.A.M. Henderson - Locality 20)

An attempt was made, by drilling a stratigraphic hole at the southern foot of Black Mountain, to establish the relationship between the State Circle Shale and siltstones on Black Mountain Peninsula that had been assigned to the Pittman Formation. Diamond drilling commenced in June 1971, and drilling was discontinued at 138 metres in March 1972. The results were inconclusive.

Mount Stromlo Water Treatment Plant: Balancing Storage Reservoir (G.B. Simpson - Locality 19)

The site of the proposed balancing storage reservoir was investigated to determine the most suitable methods of excavation, and the means of supporting the maximum design cut. The results of surface mapping, seismic traverses and diamond drilling were included in the 'Information for Tenderers' documents, and a BMR Record is in preparation.

Crustal Movements in Dalton-Gunning Area (G.B. Simpson)

The Dalton-Gunning area, 58 kilometres north of Canberra, has a record of minor seismicity, and a laser beam survey had been proposed for the measurement of any crustal movements in the area. Geological mapping was carried out to determine the geological structure of the area. It was concluded that the area was unsuitable due to the difficulty of measuring the small expected movements, and the absence of an identified plane of movement. A report of the geological investigation has been prepared and will be presented as a BMR Record.

Terrain Evaluation Study - Canberra (G.B. Simpson, G.A.M. Henderson)

A joint CSIRO-BMR terrain evaluation study is being carried out over approximately 2600 square kilometres of the Canberra area. Geology at group and formation levels has been plotted on overlays of 1:50 000 scale black and white air-photographs. Preliminary terrain mapping at the same scale has been carried out by CSIRO's Division of Applied Geomechanics under the supervision of Mr. K. Grant. Fieldwork, including augering of the soil profile, has commenced and will be completed in December 1972.

Science Teachers Excursion

G.M. Burton and G.A.M. Henderson organized and led an excursion on engineering geology for the ACT Secondary Schools Science Teachers Association.

Foreign Students Training

In co-operation with the Department of Foreign Affairs, specialist training in engineering geology and hydrogeology was given to two Korean geologists and major training schedules were arranged for two students due later this year. Miscellaneous small training help was also given.

TRAINING

The Bureau arranged for Professor E.H. Davis, Professor of Engineering (Soils Mechanics) of Sydney University to give a basic course in soils engineering to engineering geologists and geophysicists of the Bureau between 22 and 26 May. Representatives of the Department of Works and Defence and the New South Wales and Victorian Geological Surveys were invited and attended: an invitation was issued to the Queensland Survey but was declined with regret.

Report writing and editing remain as major difficulties of the sub-section. Geological report writing appears to be universally difficult, but a special degree of precision is required, and creates special problems, in engineering geological reports; precision is needed because of the general requirements of safety and economy of public works and the now very common quasi-legal disputes involved in civil engineering contracts. To overcome these problems G.M. Burton and A.T. Laws attended parts of editing courses, and G.A.M. Henderson and G.B. Simpson attended writing courses conducted by K.A. Townley and H. Oldham.

A.T. Laws attended a two-week seminar at the University of N.S.W. on Water Resources Management.

D.C. Purcell and G.M. Burton attended a one-week course in Rock Mechanics at the University of New South Wales.

G.M. Burton, P.H. Vanden Broek and J.R. Kellett attended several lectures of the 6th Australian Road Research Board. Burton also attended a one-day symposium on tunnelling and the annual study tour of the Australian National Committee on Large Dams.

MAP EDITING AND COMPILATION

by

G.W. D'Addario

STAFF: G.W. D'Addario, W.D. Palfreyman (from 13 March), D.J. Grainger (from 6 March), Miss R.L. Grainger (to June), J.M. Fetherston, Miss J.W. Wedgbrow (from 20 January).

GENERAL

Map Committee meetings were held in December 1971 and June 1972. Sub-committee meetings on priorities and progress in map compilation were called on 17 April and 29 September. G.W. D'Addario attended meetings of the Automated Cartography Study Group on 1 May and 9 October. Field geologists were given training in map editing to improve the preparation of maps. Advice was given to authors on various aspects of map compilation during preparation of preliminary editions of the 1:250 000 geological series and special maps. Authors' corrections for coloured editions of the 1:250 000 geological series have been included in the duties of the sub-professional staff of the Group. A number of additional symbols were approved for use in preliminary maps and in the Papua New Guinea geological maps.

EDITING

Six special maps (three at 1:1 000 000 scale, one at 1:10 000 000, one at 1:5 000 000 and one at 1:50 000 000) and twenty-four 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)

New information was gathered and compilation of the solid geology and Cainozoic overlays amended for most of the northwestern portion of the Territory. The work included the photointerpretation of Bathurst and Melville Islands, Cobourg Peninsula, the Granites, Fog Bay, and Highland Rocks. Line work of the geological overlay is completed. The compilation of the geological reference cross-sections and the plotting of mineral occurrences were completed. An additional reference showing Groups and Formations, with lithological description, is being compiled. A review of the geology of the Northern Territory (BMR Record 1972/91) for publication in the Encyclopedia of World Geology was despatched to Professor R. Fairbridge, Editor, Columbia University, N.Y., U.S.A.

Papua New Guinea Mineral Deposits Map, Scale 1:2 500 000 (D.J. Grainger, R.L. Grainger)

The map was designed to record, using non-confidential information, the distribution of mineral deposits. The commodities won from or present in each deposit are shown and the importance of the deposit is indicated. Metals, mineral fuels, and industrial minerals are shown but not the occurrence of construction and fluxing materials or groundwater.

Explanatory notes will supplement the map by providing information on the deposits. The notes are divided into chapters by commodity groups. Within each chapter the data on individual commodities are presented in tabular form.

In March, R.L. Grainger completed the collection of data which had been started in July 1971. D.J. Grainger began work on the map in June and by the end of September the compilation at 1:1 000 000 scale and the tabulation of data for the explanatory notes had been completed. Explanatory notes are being written. It is proposed to issue the map and notes as a Bulletin.

Geology of Australia - Distribution of Main Rock Types, Scale 1:10 000 000 (P.E. Simpson, W.D. Palfreyman)

Two hand-coloured prints of the map, a tectonic sketch map from BMR Record 1971/88 modified for use as a text-figure, and a chapter (issued as BMR Record 1972/107) for the explanatory volume of the Soil Map of the World published by FAO and UNESCO, were sent to Mr. K. Northcote, Division of Soil, CSIRO, Adelaide.

Papua New Guinea Geological Map, Scale 1:1 000 000 (J.H.C. Bain and others)

Compilation of the mineral deposit data was completed by R.L. Grainger. The map was edited after new information on the geology of the mainland, New Britain and New Ireland had been added.

SPECIAL PROJECTS

Joint BMR-CSIRO Terrain Evaluation Survey - Canberra Region

Data from geological maps were transferred onto air-photo overlays for field and office use by CSIRO. (See also report in ACT Engineering Geology and Hydrology).

INDEXES, TECHNICAL FILES AND MINERAL REPORTS

STAFF: Mrs. B. Hall, R. Towner (from January), Mrs. J. Hodgson (resigned in April), F. Perussich (transferred in March), R. Grainger (from May, resigned in October), R. Hughes (December to February); A. Watchman, D. Wyborn, L. Offe, and K. Johnson during January and February; University student R. Clarke, during 1971/72 vacation.

STRATIGRAPHIC INDEX (R. Towner, J. Hodgson, F. Perussich, B. Hall, R. Grainger)

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 bi-monthly 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.

Work commenced on reducing the backlog of unindexed serials published between 1967 and 1971.

Bibliographic references to publications were filed by 1:250 000 Sheet areas. The references were also cross-indexed under broad subject headings.

A meeting of the Stratigraphic Nomenclature Committee was held in February 1972. The section assisted the Convenor in the preparation of Minutes and Reports for the Geological Society of Australia.

As a result of this meeting, work commenced on maintaining a register of Antarctic names, registering of soil terminology and making preparations for the filing of approved definitions of stratigraphic names.

The Register of stratigraphic units in Papua New Guinea and West Irian was updated and a list of proposed names prepared and sent to the Indonesian Geological Survey.

Bibliographic information on stratigraphic names for Papua New Guinea as well as a list of approved definitions of stratigraphic units were sent to the Geological Survey of Papua New Guinea.

INTERNATIONAL STRATIGRAPHIC LEXICON (F. Perussich, R. Towner, R.Hughes, B. Hall; A. Watchman, D. Wyborn, L. Offe, and K. Johnson during January and February)

Work was completed on Volume 5h - Australia General - of the International Stratigraphic Lexicon, to be published by the Centre National de la Recherche Scientifique, Paris.

Volume 5h is an Australia-wide index to the State Lexicons to which has been added all stratigraphic names indexed up to December 1968.

It lists -

(1) Name of Unit
(2) State
(3) Reference to first publication of stratigraphic name
(4) Volume and page number in previous lexicon
(5) Age

The lexicon will not have a description of each stratigraphic unit as do the published state lexicons. In this volume, 5h, the stratigraphic units have been re-arranged according to age as well as the alphabetical listing.

TECHNICAL FILES

Filing of unpublished data and newspaper clippings under 1:250 000 Sheet areas continued.

References to CSIRO Mineragraphic and Ore-dressing Reports, to company reports held in the Phosphate Sub-section, and to Metallogenic Map Data Sheets were placed on appropriate Technical Files.

Card indexes of Bureau Records, and PSSA applications and reports filed by 1:250 000 Sheet areas were kept up to date.

The set of 1:250 000 Topographic Maps and Mines Department Authority to Prospect Maps were maintained.

Many enquiries from Bureau officers and visitors were answered from the information contained in the various indexes and filing systems.

MINERAL REPORTS AND INDEX (J. Ingram)

An office study of the mode of occurrence and distribution of Australian uranium and tin deposits was initiated and continued through much of the year. The study is part of a larger, long-term, plan to develop a cadre of officers with a thorough knowledge of the geology of Australian mineral commodities; each officer in the cadre will specialize in a few commodities only.

In furtherance of the study of uranium deposits, in June Mr. Ingram visited the East Alligator, N.T. uranium deposits and an occurrence in the Ngalia Basin. He later undertook field work in the Westmoreland area, in the extreme northwest of Queensland, and inspected uranium occurrences in the area and in adjoining parts of the Northern Territory.

The mineral index was maintained throughout the year by the addition of references to mineral occurrences found in incoming literature and newspapers.

MUSEUM AND TRANSIT ROOM

by

D.H. McColl

MUSEUM

STAFF: D.H. McColl (since July), G.C. Young (part time), P.A. Lang (transferred to Engineering Geology, September), A. Haupt (part time).

Museum Collections and Displays

The mineral displays in the corridors and foyer of the Bureau were continued with slight variations and interchange of specimens drawn from the registered museum collections.

The Askew and Doo collections were checked by stocktake, and a catalogue and current valuation of the Campbell collection prepared for the first time. (Approximately 860 specimens, value estimated at $10,700). X-ray diffractometer investigations of complex groups of minerals in this collection were undertaken.

A collection of Australian ores, slabbed and surfaced for display, were prepared and despatched to the Venice Trade Fair and subsequently to the Australian Embassy in Bonn for permanent display. A temporary display of minerals and crystals was arranged for the Canberra Gem Society in October.

Minor rock collections were received from Fiji, Canada and Mount Isa; also 460 miscellaneous new mineral, rock and fossil specimens were added to the registers. The meteorite collection has been expanded and now contains thirty specimens.

Rock Storage and Registration

Considerable culling and tidying of the Fyshwick storage facilities was carried out at the beginning of the year. Compactus shelving has been obtained and will be installed early in 1973 to improve the capacity of the rock store.

Newly registered rocks and other samples investigated by Bureau personnel total approximately 8000 which have been partly stored in 190 new boxes in the store shelving.

Commonwealth Palaeontological Collection

Type fossil numbers CPC 12907 to CPC 13525 have been allocated to various authors during the year. Collating of type specimens into the strongroom has been continued: 6000 specimens are now in security storage. Particular attention has been given to the microfossil types, which have been completely systematised.

Exchanges and Loan of Specimens

Loan of museum fossil materials was arranged or investigated on behalf of museums, universities or geological surveys in Holland, England, New Zealand, Canada, Adelaide, Brisbane and Melbourne.

An exchange was negotiated with the Australian National University and others are being investigated with English and French institutions.

A major collection of Hunter Valley macrofossils collected by J. Roberts was sorted and packed into 92 drums for dispatch to him at the University of New South Wales.

Education and School Collections

A display of ore minerals was specially arranged at different times for the benefit of four visiting groups of high school children. A display and explanation of the essential features of the rock classification was prepared in August for a visit by students of Canberra Technical College.

A collection of thirty of the more important rocks and minerals was donated to Belconnen High School, with a set of minerals illustrating Moh's hardness scale. Various questions were answered and specimen identification carried out for individual teachers and students.

The sets of ores and igneous, sedimentary, and metamorphic rocks used in the geology training course for Bureau technical staff were maintained and improved.

Field Work

G. Young was engaged for 11 weeks in June, July and August on field work in the Canning Basin area of Western Australia Collections of Upper Devonian fish fossils and some invertebrates were made in this area; they contain unusually well-preserved material which is likely to be of international palaeontological significance.

D. McColl and P. Lang made brief excursions in the vicinity of Canberra to obtain samples of local significance for the educational collections.

Visitors to the Museum

Various sections of the collections have been made available for inspection by official and casual visitors. Amateur interest has been catered for by elementary identification of several hundred rock, mineral and fossil samples, and answering of queries from various clubs and institutions.

D. McColl and G. Young visited the Canberra Gem Society to give illustrated addresses to monthly meetings.

TRANSIT ROOM

Samples submitted for thin sectioning and other detailed laboratory investigations are forwarded by the officer in charge (D.W. Lea). The average throughput has been about 800 samples per month. Systematic storage and cataloguing of petrological thin sections has continued; the collection now contains 7000 specimens. A register of loans has continued to be maintained.

Liaison continues between the transit room and museum by way of the standardised sample submission system, with computerised data retrieval the ultimate objective.

GEOLOGICAL DRAWING OFFICE

by

H.F. Boltz and P.A. Boekenstein

The 5th Conference of Chief Draftsmen of State Mines Departments and BMR was held at the Bureau from 20 - 24 March, 1972. Delegates from all states and ACT attended. Seminars were held on the following subjects:

(i) Employment of draftsmen on geological field compilation
(ii) Compilation and production of "special" maps
(iii) Trainee scheme for draftsmen in the CPS
(iv) Application of colour in geological map design
(v) Position of Australian cartographers in world cartography.

Two displays of recently published BMR maps were assembled and sent to the 24th International Geological Conference held in Montreal, Canada, 21 - 25 August, 1972.

Three draftsmen worked in the field with geological parties: Miss D.M. Pillinger, Napperby and Alice Springs parties; M. Little, Georgetown party; D. Walton, the Granites-Billiluna party.

P. Fuchs, draftsman with the Darwin Uranium Group temporarily joined the drawing office to gain experience in BMR detailed mapping methods.

M. Nancarrow visited the PNGGS in Port Moresby to advise on BMR drafting procedures, methods, and standards presently applied to map compilation.

Experimentation was carried out with computer and plotter applications to:

(i) Surface and sub-surface interpretation in shallow dipping sediments

(ii) Sub-surface 3 dimensional structural interpretations from cross sections

(iii) Scaling of graphical data using independently variable x and y axes factors.

Considerable time was spent on the compilation and fair drawing of the Tectonic Map of Australia and New Guinea, and the Metallogenic Map of Australia, and both maps were supervised during their printing stages.

Production (M. Nancarrow, K. Matveev, H. Hennig, R. Molloy)

1. Preliminary Edition Maps

	1:100 000	1:250 000	Other scales
Printed:	3	20	6
Drafting in Progress:	2	19	-

2. Field compilation bases (all scales): 111

3. Photo-centre transfer: 3300 photographs

4. 1st or 2nd Edition Maps

	1:250 000	Other scales
Printed:	28	11
Printing in progress:	6	1
Fair drawn:	11	9
Fair drawings in progress:	13	4
Compilation in progress:	-	4
Reprinted:	5	3
Reprinting in progress:	4	-

5. Text figures or diagrams

	Completed	In progress
(i) Records and miscellaneous	633	49
(ii) Reports	31	-
(iii) Explanatory Notes	49	2
(iv) Bulletins	335	-

6. Preparation of BMR Symbol Booklet for reprinting.

7. Preparation of BMR Pictorial Index of activities.

PAPUA NEW GUINEA GEOLOGICAL SURVEY

PAPUA NEW GUINEA GEOLOGICAL SURVEY

Contents

INTRODUCTION

by

A. Renwick

1972 was the year of the quiet revolution in the organisation of the Papua New Guinea Geological Survey. For nearly 26 years its professional officers had been attached to the Administration from the BMR. On 1st September, positions for 17 geologists and geophysicists were created in the Papua New Guinea Public Service and the Commonwealth officers of the Geological Survey accepted contract service with the Administration. At the same time, full responsibility for the functions of the Geological Survey was transferred to the Administration.

So smooth was the transition that there is some danger of the importance of some of the changes which are involved being overlooked. The close link between the BMR and the Geological Survey is to be retained at the request of the Administration, but the cost of BMR activities of direct benefit to Papua New Guinea will in future have to be requested and paid for by the Administration.

One event this year overshadowed all others for the staff of the Geological Survey; the sudden death of G.A.M. Taylor, G.C., on Manam Island on 19th August. At the time of his death, Tony Taylor was acting Chief Government Geologist. He was well known, respected and liked throughout Papua New Guinea, and he will be long remembered by the people of this country whom he served so well and with such courage. But he will be remembered especially by his colleagues and those others who have enjoyed the privilege of his friendship.

HEADQUARTERS

by

A. Renwick

OFFICE OF THE CHIEF GOVERNMENT GEOLOGIST

A. Renwick continued in the office of Chief Government Geologist throughout the year. G.A.M. Taylor (BMR) acted for three weeks until his death, and S.K. Skwarko acted for the remaining four weeks of Renwick's absence on overseas duty in Canada.

In Canada, Renwick studied the organisation of the 24th International Geological Congress and attended its sessions and a pre-Congress excursion to the mines of Quebec and New Brunswick.

In addition to his routine professional, administrative and financial duties he continued as a member of the Mining and Petroleum Advisory Board, as Chairman of the Scientific Advisory Committee to the National Parks Board, and as a member of the Advisory Committee on Seismology and Earthquake Engineering, the Chairmanship of which he relinquished in August.

In November he attended the inaugural meeting of CCOP/SOPAC in Suva, Fiji.

DRAWING OFFICE

The output of the drawing office increased and improved as the training of the indigenous drafting assistants advanced. Places have been requested for two of them for further practical training at the BMR.

LIBRARY, ARCHIVES AND CLERICAL SERVICES

A new edition of the Catalogue of Data Files was prepared for printing, and cataloguing and indexing have been maintained.

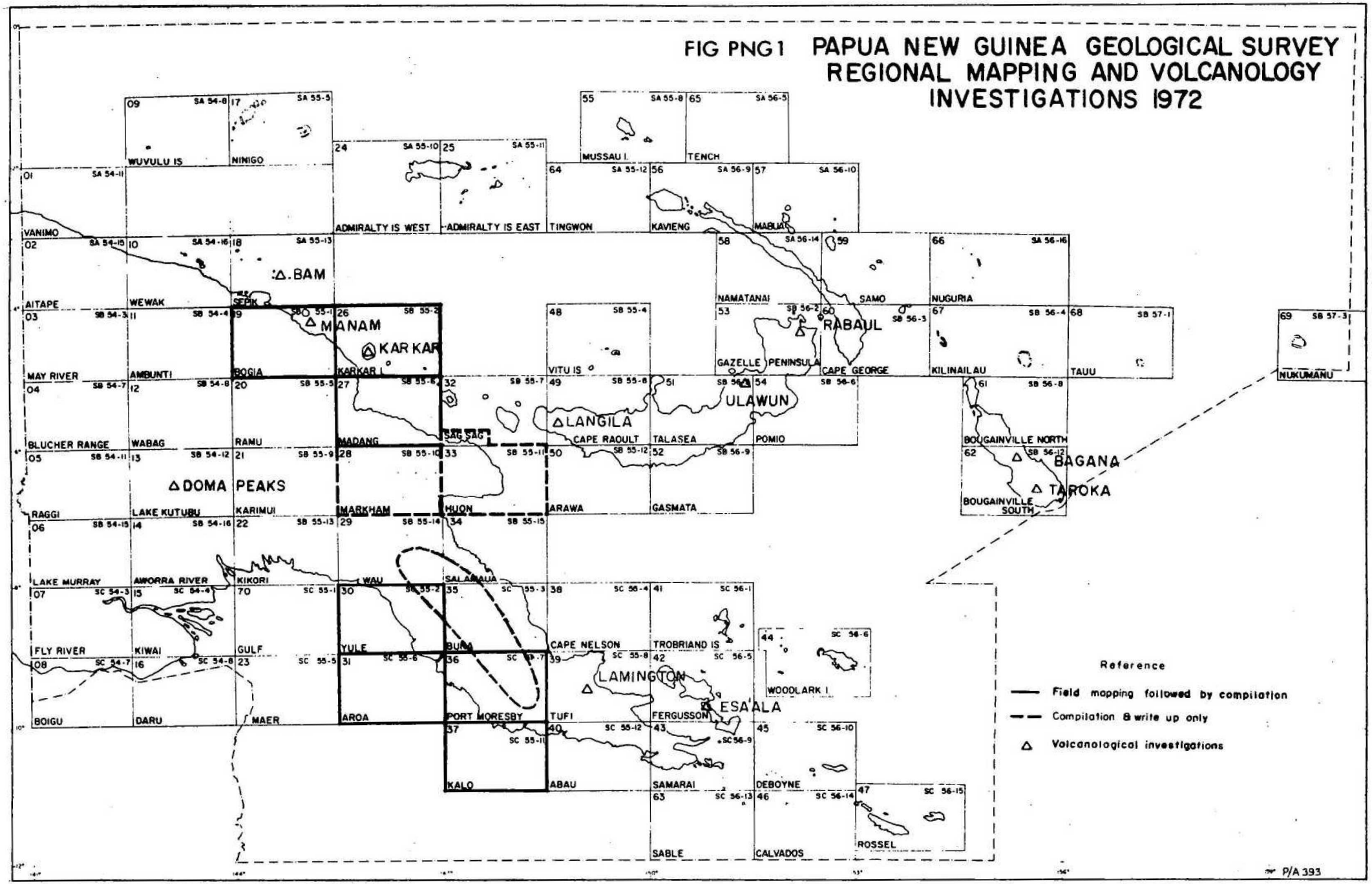


FIG PNG1 PAPUA NEW GUINEA GEOLOGICAL SURVEY
REGIONAL MAPPING AND VOLCANOLOGY
INVESTIGATIONS 1972
WUVULU IS
NINIGO
MUSSAU I.
TENCH
ADMIRALTY IS WEST
ADMIRALTY IS EAST
TINGWON
KAVIENG
MABUA
VANIMO
BAM
AITAPE
WEWAK
SEPIK
MANAM
KAR KAR
NAMATANAI
SAMO
NUGURIA
RABAUL
MAY RIVER
AMBUNTI
BOGIA
KARKAR I.
VITU IS
GAZELLE PENINSULA
CAPE GEORGE
KILINAILAU
TAUU
NUKUMANU
BLUCHER RANGE
WABAG
RAMU
MADANG
SAG SAG
LANGILA
CAPE RAOULT
TALASEA
ULAWUN
POMIO
BOUGAINVILLE NORTH
BAGANA
TAROKA
BOUGAINVILLE SOUTH
RAGGI
LAKE KUTUBU
KARIMUI
MARKHAM
HUON
ARAWA
GASMATA
DOMA PEAKS
LAKE MURRAY
AWORRA RIVER
KIKORI
WAU
SALAMAUA
LAMINGTON
ESA'ALA
WOODLARK I
FLY RIVER
KIWAI
GULF
YULE
BUNA
CAPE NELSON
TROBRIAND IS
BOIGU
DARU
MAER
AROA
PORT MORESBY
TUFI
FERGUSSON
KALO
ABAU
SAMARAI
DEBOYNE
SABLE
CALVADOS
ROSSEL
Reference
Field mapping followed by compilation
Compilation & write up only
Volcanological investigations
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REGIONAL MAPPING AND MINERAL INVESTIGATION

STAFF

S.K. Skwarko: Continued as the Head of Section. He acted as Chief Government Geologist for one month. He travelled twice to Canberra.

D.J. Grainger: Was transferred to the Bureau of Mineral Resources, Canberra in February, 1972.

G.P. Robinson: Attended the International Symposium on Oceanography in Wellington, New Zealand.

P.E. Pieters: Took charge of the Mineral Investigation Sub-Section after Grainger's departure.

I.H. Crick: Was transferred at the end of September to the Central Volcanological Observatory in Rabaul.

C.M. Brown: Joined the section in October, 1971 as a Geologist Class 1.

A.L. Jaques: Joined the section in March, 1972 as a Geologist Class 1.

REGIONAL MAPPING

INTRODUCTION

The period saw large areas of mainland Papua New Guinea geologically mapped by members of the Section at a scale of 1:250,000 (Fig. PNG 1). Fieldwork in the Yule Sheet area was completed, as was that in the Madang, Karkar Island and Bogia Sheet areas. In addition, the geological maps for the Port Moresby and Huon Sheets were drafted. The geology of the Huon Peninsula was written up and preliminarily edited. Some of the geology of the Port Moresby and Yule Sheet areas was also written up.

PROJECTS AND INVESTIGATIONS

1. Bogia - Karkar - Madang 1:250,000 by A.L. Jaques
(Field mapping by G.P. Robinson, P.E. Pieters, C.M. Brown, A.L. Jaques)

(a) Bogia - Karkar Sheets

The area covered by these sheets comprises 17,500 sq km. It consists of the Adelbert Range in the southeast and the northwest portion of the Schrader Range in the southwest, separated by 9,600 sq km of sago swamps of the Sepik - Ramu lowlands which are the northern extremeity of the Ramu - Markham fault zone obscured by the Quaternary alluvium deposits.

(i) Northwest Schrader Range

The oldest rocks recognized are Cretaceous(?) volcanics. These are unconformably overlain by Eocene(?) dark shale, slate and argillite overlain in turn by a Miocene(?) unit of variable lithology. Pliocene(?) fossiliferous calcarenite and calcilutite are overlain by Pleistocene piedmont type deposits of paraconglomerate sandstone and siltstone.

Eugeosynclinal conditions usually characteristic of the Oligocene - Miocene of northern New Guinea seem to be confined to the Cretaceous in the Schrader Range. The lack of volcanics and high degree of sorting of clastics in the Miocene suggests miogeosynclinal activity in that period.

The regional north-northeastern dip changes to an east-northeastern one in the west. Large, weakly curvilinear fault zones parallel to the regional strike cause intense shearing and small scale folding.

(ii) Adelbert Range

The Adelbert Range has a central core of Miocene(?) volcanics interbedded with limestone and sandstone. The northern and southern flanks of the range contain nearly flat lying Miocene-Pliocene piedmont type deposits of paraconglomerate, sandstone and siltstone. Raised reefs and paraconglomerate outcrop along the coast. The flanking sediments seem to be draped over the north-tilted fault blocks of the Miocene volcanics and limestone outcropping in the centre of the range. This creates an impression of an anticlinal structure. Small folds present are probably related to the uplift.

(b) Madang Sheet

The Madang Sheet covers an area of 8,500 sq km and consists of the rugged Finisterre Range with peaks up to 4,000 m and in the southwest of the northern slopes of the Bismarck Range. These ranges are separated by the topographic depression of the Ramu-Markham fault zone which in the area is 5 km wide and extends 50 km to the southeast; it is formed of Quaternary alluvium.

The Finisterre Range is a strongly uplifted and dissected fault block mountain chain with blocks tilted to the north-northeast. The oldest rock recognized is poorly consolidated siliceous argillite of Oligocene(?) age which crops out on the southern flank of the range. The Finisterre Volcanics overlie this unit forming a narrow, elongate northwest trending zone corresponding to the high and rugged central portion of the range. Lowermost Miocene limestone conformably overlies the volcanics to the north. Piedmont type deposits in turn overlie the limestone in the north and the argillite on the southern flank. Young raised reefs and paraconglomerate crop out on the Rai Coast.

The Bismarck Range in the southwest corner of the Sheet consists of argillite, slate and phyllite with a well developed cleavage dipping steeply to the southwest. The bedding dips predominantly to the northeast. Pre-Miocene limestone unconformably overlies the metamorphic sequence and crops out around Mt Helwig.

The fundamental structure of the Finisterre Range consists of tilted fault blocks which were strongly uplifted in the Pliocene and Pleistocene. The Ramu - Markham fault zone marks one of the lines of collision between the northerly-moving Australian plate and the north-westerly moving Pacific plate. Conjugate shear systems were formed by this collision, an example being the Nankina fault zone which is marked by a concentration of earthquake epicentres, strong shearing, and vertical bedding.

2. Port Moresby, Kalo and Aroa 1:250 000 Sheets by P.E. Pieters
(Critical fieldwork by P.E. Pieters, compiled and written up by Pieters)

The area covered by the Port Moresby, Kalo and Aroa 1:250 000 Sheets is located in the Central District of Papua New Guinea and is bounded by longitudes 146°35'E and 148°30'E and latitudes 9°00'S and 10°12'S.

Geomorphologically the area is dominated by the southeast - trending Owen Stanley Range which is an impressive more or less linear mountain chain forming the backbone of the eastern Papua peninsula.

The Owen Stanley Metamorphics of Cretaceous and possibly older age are subdivided into two formations i.e. the Brown River metamorphics and the Emo River metamorphics. The Brown River metamorphics comprise predominately metasediments with minor intercalations of metavolcanics. Their grade is greenschist facies with a sequence of three zones of progressive metamorphism based on mineralogical and textured changes from south to north perpendicular to the regional trend of the Owen Stanley Range. The zones in order of increasing metamorphism are: chlorite zone, biotite zone and garnet zone. The Emo River metamorphics consist predominantly of low grade metamorphosed basic to intermediate volcanics, volcanogenic sediments and plutonic rocks with minor intercalations of metasediments and calcareous metamorphics. Except for the mineral assemblages typical of the lower grades of the greenschist facies the metamorphics contain also the minerals glaucophane, lawsonite and pumpellyite suggesting an environment of metamorphism intermediate between the lawsonite-glaucophane and greenschist facies. The Emo River metamorphics and possibly a portion of the Brown River Metamorphics appear to form a shallow dipping sheet-like body which overlies the steeply dipping Brown River metamorphics.

The mafic and ultramafic rocks of the Papuan Ultramafic Belt separated from the Owen Stanley metamorphics by the Owen Stanley-Timeno Fault zone. The Belt consists of three zones which are the ultramafics at the bottom, then gabbro and basalt at the top. The ultramafics are interpreted by Davies as oceanic mantle and the gabbro and basalt as oceanic crust. The age of crystallisation of the gabbro and basalt is Jurassic and/or Cretaceous.

To the south, the Owen Stanley metamorphics grade into the Upper Cretaceous sediments of the Goldie River consisting predominantly of shale and siltstone with thin and massive beds of lithic and arkosic sandstone and minor intercalations of polymict conglomerate and basic volcanics.

South of the Goldie River sediments and separating them from the Port Moresby Beds occurs the Oligocene Sadowa Gabbro. This is a huge composite intrusive body of mostly gabbroic rocks.

The Upper Cretaceous-to-Eocene Port Moresby Beds crop out in a belt along the coast of the Port Moresby 1:250 000 Sheet area. They comprise a wide variety of rocks the more important being cherty argillite, calcareous sandstone, chert, calcareous argillite and shale and dark shale.

The Upper Oligocene and lower Miocene limestone and volcanics occur scattered in the Port Moresby area and a veneer of lower Miocene volcanics and limestone is unconformably overlying the Port Moresby Beds between the Kemp Welch and Marshall Lagoon.

East of the Goldie River sediments there is a thick pile of massive basic submarine volcanics intruded by gabbro and dolerite. The age of these volcanics is not certain; they could be upper Paleocene to lower Eocene or middle Miocene in age.

The Sogeri Plateau and other smaller plateaux in the Port Moresby 1:250 000 Sheet area are developed on Pliocene volcanics. Pliocene volcanics are also exposed in the extreme northern part of the Port Moresby and Aroa 1:250 000 Sheet areas and in the Kalo 1:250 000 Sheet area.

Mainly Quaternary volcanics make up the Hydrographers Range and the Managalese Plateau, where extinct volcanic centres are still preserved. Quaternary valley fill volcanics occur also in the higher part of the Owen Stanley Range.

Alluvial deposits are most widespread around the mouths of the Brown and Vanapa Rivers and between the mouths of the Kemp Welch and Mori Rivers.

3. Yule 1:250 000 Sheet by C.M. Brown
(Critical fieldwork by C.M. Brown, compiled and written up by C.M. Brown)

The Yule 1:250 000 Sheet area is located on the south coast of Papua between latitudes 008° and 009° south and longitudes 145°30' and 147° east. The total land area is 9,000 sq km, with waters of the gulf of Papua covering the southwest of the Sheet area.

The northwest trending coastline is backed by a coastal plain 30 km wide with occasional northwest trending coastal limestone hills. From the plain there is a gradual rise through sub-horizontal dissected volcanic plateaux to the extremely rugged mountainous country of the northeastern sector where steeply dipping volcanics, sediments and metamorphics form narrow steep-sided ridges which make up part of the Owen Stanley Range. The sub-horizontal volcanics culminate in the isolated peak of Mount Yule (3,266m).

The stratigraphic units consistently strike in a northwesterly direction and young towards the coast. In the northeast Cretaceous or older metamorphic rocks crop out over an area of about 600 sq km and consist of dominantly pelitic material which grades from sheared slate to phyllite. Rarer metamorphics are identifiable as sub-greywacke, quartzite and conglomerate with interbeds of volcanic and volcanically derived material. In the Loloipa valley north of Tapini somewhat higher grade schists have been up faulted. These include quartz mica, quartz garnet mica, epidote quartz mica,

green metavolcanics actinolite schist with many assemblages containing blue-green amphiboles including glaucophane. The general facies is greenschist with the upfaulted Loloipa valley assemblages plotting in the high pressure greenschist facies.

Grading off the metamorphics are dynamically deformed sediments of Cretaceous to lower Miocene age initially similar in character to the metamorphosed sediments. They cover an area of about 150 sq km. Toward their top, limestone of Eocene age in places partly interfingers with and is partly overlain by the green, sheared, chloritised submarine volcanics.

Both the metamorphics and the deformed sediments are near vertical with a dominant northeasterly dip; they are greatly faulted with many near vertical reverse angle faults. On the small scale, metamorphics are folded into recumbent isoclines - cleavage being parallel to bedding, with faults paralleling axial planes. The small scale structures in the overlying sediments show primary slumping, bedding contortions, small scale faults, with isoclinal folds accompanied by brecciation and shearing in more homogenous beds.

All the above discussed rocks are unconformably overlain by upper Miocene to Pliocene andesitic to basaltic volcanics, which form isolated remnant caps along certain ridges in the northeast while further to the south and west develop into plateaux with a gentle southwesterly dip. The initial upper Miocene volcanism was followed by a minor period during which the deposition of volcanically derived sediments predominated. Renewed volcanism transgressed these sediments and older volcanics. They became generally uplifted to now form north-east facing steep scarps. Particularly in the Mount Yule area dioritic intrusives occur mainly as dykes and minor bodies.

As they descend to the coastal plain the volcanics become concealed beneath Quaternary sediments. At the coast and in the south of the map area however, are anticlinal structures consisting of middle Miocene reef limestone flanked by upper Miocene volcanically derived tuffaceous sandstone, conglomerate, agglomerate, ash-derived siltstones and limestone. These are in turn flanked by similar lithologies of Pliocene age. The initiation of these anticlinal structures was probably contemporaneous with structural events to the northeast with the later sediments being draped around the still rising anticlinal structures.

The vast coastal plain area, some 4,000 sq km, is covered by mud, silt, sand, minor conglomerate, minor reef limestone from a variety of environments, raised beaches, various salt and freshwater permanent and seasonal swamps with former river courses in many places forming minor ribbon shaped ridges of sandy material.

MINERAL INVESTIGATIONS

by

S.K. Skwarko

The Minerals Investigation Subsection spent most time completing existing projects and only a few minor new ones were started.

Compilation of the mineral occurrences map of Papua New Guinea at the scale of 1:1 000 000 was continued by D.J. Grainger until his departure to Canberra, and later by P.E. Pieters in collaboration with him. Grainger in addition wrote a chapter on Fuel Minerals for the note to accompany the map.

Pieters prepared a mineral resources map of Papua New Guinea at the scale of 1:2 500 000 for the Jacaranda Press.

Grainger examined in detail and wrote reports on some limestone deposits in both the Morobe and the Central Districts.

The indexing and filing of confidential statutory reports from mining and petroleum companies was continued by Pieters and Brown, both of whom also maintained the private companies activities card cross-index system. In addition Pieters made assessments of the exploratory work conducted in numerous Prospecting Authorities due for renewal.

A large number of samples sent in by the general public were identified and briefly described.

MISCELLANEOUS

by

S.K. Skwarko

S.K. Skwarko spent 10 days in May making a thorough collection of fossils from the Kuta Formation in the Kundiawa-Mount Hagen area. The collected fauna is currently being technically prepared in the Palaeontological Section, BMR, Canberra. Its identification will - it is hoped - solve the problem of the age of the formation, which could be anything from Middle Permian to Middle Triassic.

Skwarko technically prepared, identified, and dated about 40 collections of fossils submitted by a B.M.R. West Sepik Party. They consist almost entirely of ammonites, but contain belemnites and a few bivalves. They range in age from Bajocian (Middle Jurassic) to Upper Cretaceous.

He travelled twice to Canberra; once to complete the preparation and identification of the Mesozoic fossils, and the second time to introduce a visiting Russian professor of palaeontology to the Cretaceous biostratigraphy of Australia and Papua New Guinea.

Skwarko edited one Note on Investigation, and the MS of the "Geology of the Huon Peninsula" to be published as the Bureau of Mineral Resources Bulletin, P.N.G. Series.

P.E. Pieters spent two weeks with the West Sepik (BMR) field party checking the interpretation of the Side Looking Radar Imagery.

Over thirty visitors - mostly private company geologists - visited the Section in the course of the year.

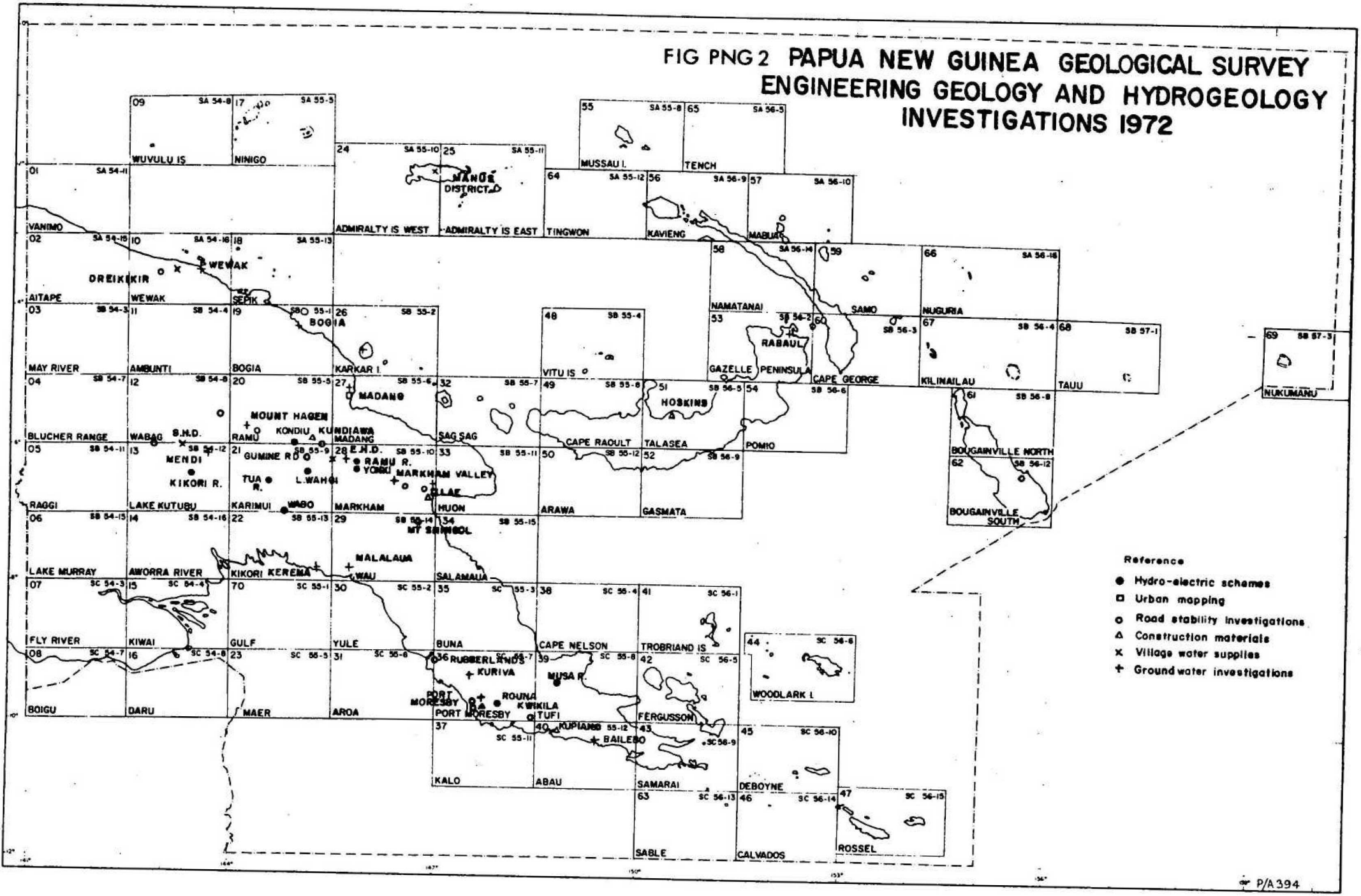
FIG PNG 2 PAPUA NEW GUINEA GEOLOGICAL SURVEY
ENGINEERING GEOLOGY AND HYDROGEOLOGY
INVESTIGATIONS 1972
WUVULU IS
NINIGO
MANUS DISTRICT
MUSSAU I.
TENCH
VANIMO
ADMIRALTY IS WEST
ADMIRALTY IS EAST
TINGWON
KAVIENG
MABUAR
NAMATANAI
SAMO
NUGURIA
AITAPE
WEWAK
DREIKIKIR
SEPIK
BOGIA
KARKAR I.
VITU IS
RABAUL
GAZELLE PENINSULA
CAPE GEORGE
KILINAILAU
TAUU
NUKUMANU
MAY RIVER
AMBUNTI
BOGIA
MADANG
HOSKINS
BLUCHER RANGE
WABAG
S.H.D.
MOUNT HAGEN
RAMU
KONDIU
KUNDIAWA
MADANG
SAG SAG
CAPE RAOULT
TALASEA
POMIO
BOUGAINVILLE NORTH
MENDI
GUMINE RD
E.H.D.
RAMU R.
YONKI
MARKHAM VALLEY
KIKORI R.
TUA R.
L.WAHGI
LAE
RAGGI
LAKE KUTUBU
KARIMUI
WABO
MARKHAM
HUON
ARAWA
GASMATA
BOUGAINVILLE SOUTH
MT SERIMOL
MALALAUA
WAU
LAKE MURRAY
AIWORRA RIVER
KIKORI
KEREMA
SALAMAUA
FLY RIVER
KIWAI
GULF
YULE
BUNA
CAPE NELSON
TROBRIAND IS
WOODLARK I
RUBBERLANDS
KURIVA
MUSA R.
PORT MORESBY
ROUNA
KWIKILA
TUFI
FERGUSSON
BOIGU
DARU
MAER
AROA
KUPIANO
BAILEBO
KALO
ABAU
SAMARAI
DEBOYNE
SABLE
CALVADOS
ROSSEL
Reference
Hydro-electric schemes
Urban mapping
Road stability investigations
Construction materials
Village water supplies
Ground water investigations
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ENGINEERING GEOLOGY AND HYDROGEOLOGY

by G. Jacobson, J.M. Furstner, L. Macias, B. Weber

STAFF

G. Jacobson: Remained in charge of the Section throughout the year.

J.M. Furstner: Joined the Section in April and was based in Yonki as Ramu 1 Project Geologist.

J. Harris: On recreation leave from 21st September for three months.

L.F. Macias: Remained with the Section throughout the year.

B. Weber: Remained with the Section throughout the year.

INTRODUCTION

The Engineering Geology and Hydrogeology Section was engaged in more than 50 projects and investigations concerned with civil engineering development in Papua New Guinea (Fig. PNG 2). Engineering geological investigations were undertaken for the Commonwealth Department of Works, the Department of Public Works and other authorities concerned with hydro-electric power and road construction, slope stability investigations, groundwater utilisation and construction materials.

District surveys of village water supplies continued and two more Districts were surveyed. Systematic appraisals of groundwater resources were undertaken in several areas, in particular for town and institution water supplies. Sources of construction materials were evaluated in connection with road construction, especially in the Highlands, and with wharf and aerodrome construction. Geological investigations were undertaken of several major road routes and special studies were made of slope stability problems in relation to road construction and buildings. A programme of detailed geotechnical mapping of the larger towns was initiated and maps are being prepared for Port Moresby, Lae and Madang. Geological evaluation of potential hydro-electric schemes continued and an engineering geologist was engaged full-time at the Ramu 1 Hydro-electric Project, at present under construction.

During the year, 20 Notes on Investigation were issued and another 10 are in preparation.

HYDRO-ELECTRIC PROJECTS

Introduction

Geological services in connection with the investigation, design and construction of hydro-electric projects were provided to the Commonwealth Department of Works as follows.

Construction of the Ramu 1 Hydro-electric Project, Eastern Highlands District (Furstner)

The Ramu 1 Hydro-electric Project is in the Eastern Highlands District, near Kainantu, 200 km west of Lae, at an altitude of about 1200 m

above sea level. The Project will utilise 210 m of fall in the Ramu River and will have a maximum capacity of 75 megawatts (MW). It will supply power to Lae, Madang and the New Guinea Highlands.

The civil works are being carried out by Hyun Dai Construction Co. Ltd., of South Korea and cost $11 million. They consist of a diversion weir, pressure and access shafts both 210 m deep, an underground power station, a tailwater tunnel 2.1 km long, a diversion tunnel (to divert the Ramu River while the weir is under construction) and an access road 5 km long to the outlet portal of the tailwater tunnel. By the end of September, 1972, the access road to the outlet portal area was nearly completed. The pressure shaft and access shaft were sunk to depths of 17 m and 26 m respectively in poor rock conditions (weathered greywacke and dolerite) requiring steel support. The diversion tunnel and tailwater tunnel had been driven to lengths of 90 m and 50 m respectively in generally good rock conditions. Geological services consist of recording of and advising on the geology exposed in the excavations and are provided full time by an engineering geologist who forms part of the Commonwealth Department of Works supervisory team.

Yonki Damsite Investigation, Eastern Highlands District (Jacobson)

The Yonki Damsite on the Ramu River will provide a storage for the Ramu 1 Hydro-electric scheme. Site investigations of two possible damsites upstream of the Ramu 1 intake works, are being undertaken by the Commonwealth Department of Works. The dam will probably be an earth and rock fill dam 52 m high, and including about 1.5 million m^3 of fill.

The present site investigation has included costeaning and pitting in the damsite area and augering and pitting in possible borrow areas for earth fill and gravel. The dam will probably be founded on Quaternary conglomerate in the river bed with lacustrine clay, sand and gravel on the abutments. The lacustrine beds are prone to landslides and the area is highly seismic. Possible construction materials investigated include clay which forms alluvial terraces upstream in the Ramu River, clay derived from weathered bedrock, and gravel from the Ramu River and its flood plain. Rock for riprap is expected to be available from sandstone or limestone outcrops in the project area.

Musa Gorge Hydro-Electric Scheme, Northern District (Macias, Pounder)

Reports on the 1971 investigations were completed. Investigations in 1972 were concentrated on damsites No. 1 and 2 in the Musa Gorge. A geophysical survey was done by a Bureau of Mineral Resources field party and some additional geological mapping was done. An access road from Pongani to the Musa Damsite was constructed by the Commonwealth Department of Works.

Wabo Damsite, Purari River, Gulf District (Jacobson)

The Wabo Damsite on the Purari River was investigated by the Nippon Koei Company, Consulting Engineers, of Tokyo, Japan. Several diamond drill holes were completed and a rock core testing programme undertaken.

The proposed dam will be founded on sandstone and shale dipping 40° upstream. The shale slakes rapidly on exposure to the air and the site is suitable for an earth and rock fill dam. A dam with crest height of 120 m would generate about 900 MW.

Rouna No. 3 Hydro-Electric Project, Central District (Jacobson)

The Rouna No. 3 Hydro-Electric Scheme on the Laloki River will provide an additional 12 MW for the Port Moresby power supply. It will consist of diversion works and headrace pipeline leading to a surface penstock and power station, and will approximately duplicate the existing Rouna No. 1 Hydro-Electric Project.

Geological advice was provided to the Commonwealth Department of Works and Consulting Engineers during the design of the scheme. Construction of the pipeline began mid-1972.

Lower Wahgi Hydro-Electric Scheme, Chimbu District (Harris)

A proposed scheme near Nomane on the Wahgi River in the Chimbu District involves a diversion weir and a tunnel 12 km long, and would develop about 300 m of head, producing about 900 MW. The tunnel would be driven in Mesozoic sedimentary rocks. Slaking mudstone crops out over much of the tunnel route with hard sandstone at the intake area and hard argillite at the outlet portal. High cover (up to 1,000 m) is expected over much of the tunnel line.

Tua River Hydro-Electric Schemes, Southern Highlands District (Jacobson, Harris)

The proposed Upper Tua Hydro-Electric Scheme involves a high dam to develop 1000 MW. The preferred damsite is on limestone which contains several caves. The limestone also crops out over part of the reservoir rim, and there would be a steep hydraulic gradient through the left abutment. Exploration failed to find any extensive cave systems but the feasibility of the scheme, which would involve a dam 180 m high, remains questionable. Three possible alternative damsites were mapped upstream in the Tua River, where shale and sandstone of the Chim Formation crop out. These three damsites would be generally suitable for construction of a fill dam, although a major problem would be the supply of suitable construction materials. All four damsites would impound a reservoir mainly in Chim Formation shale which is susceptible to landslides.

A brief helicopter reconnaissance of another possible Hydro-electric scheme lower on the Tua River was also made.

Kondiu Damsite, Chimbu District (Jacobson)

A possible damsite on the Wahgi River at Kondiu in the Chimbu District is being considered for a possible hydro-electric scheme. In the damsite area, granodiorite is overlain by Kuta Limestone and Kondaku Tuff. The best site for a dam 150 m high is on massive sandstone in the Kondaku Tuff. An alternative site also being considered is on granodiorite which is deeply weathered in the abutments and therefore not so favourable for construction of a high dam.

Kikori River Hydro-Electric Schemes (Jacobson)

Photogeological studies were made of proposed hydro-electric schemes on the Kikori River in the Southern Highlands District. The hydro-electric potential of the river is very high but many of the proposed schemes would be founded on Karst limestone and their feasibility has not been established.

HYDROGEOLOGY

Introduction

The programme of village water supply surveys continued in conjunction with the Department of Public Works and the Division of District Administration. Hydrogeological appraisals for town and institution water supplies were undertaken for the Public Works Department. Advice on the siting of bores was given to Government departments and private interests. Compilation of data concerning groundwater resources in Papua New Guinea continued.

Southern Highlands District Village Water Supply Survey (Harris)

In the Southern Highlands District a large number of missions, villages, schools, hospitals and aid posts were visited. In many parts of the district people live in scattered houses or small hamlets and in these areas recommendations for improved water supplies were restricted to central meeting places. Most of the people obtain water from small springs and creeks. Serious shortage of water was only encountered in villages on limestone ridges where drainage is underground.

The installation of sanitary dugwells was recommended in alluvial valleys and on river banks. Where feasible, spring development was recommended. On hilltops and ridge 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 and cut the survey time considerably.

Eastern Highlands District Village Water Supply Survey (Macias)

A village water supply survey of the Eastern Highlands District was completed. The survey team visited 65 villages and 5 primary T schools. Most of the terrain is hilly and villages are situated on ridges. The recommended water supply schemes were mainly reticulation systems from creeks and springs. Only a few wells and rainwater catchments were recommended.

Manus District Village Water Supply Survey (Weber)

A village water supply survey of the Manus District was completed. A total of 37 villages were inspected and improvements were recommended to existing water supplies. Most of the proposed schemes are for rainwater catchments but several wells were sited and some reticulated systems were recommended. Most of the Manus villages are on coastal foreshores and coral islands.

East Sepik District Village Water Supplies (Harris)

Three bores were sited for the Local Government Council at Yangoru, and two dugwells were sited for the Local Government Council at Dreikikir in the East Sepik District.

Central District Water Supplies (Jacobson, Harris, Macias, Weber, Pounder)

A programme of percussion drilling for village, institution and re-settlement scheme water supplies continued throughout the year, using Mines Division drilling rigs.

Kuriva Settlement Scheme. Four bores were sited and successfully drilled for smallholders at the Kuriva Settlement Scheme, about 40 km north of Port Moresby.

Sogeri Plateau. Successful bores were completed at several villages on the Sogeri Plateau, about 40 km east of Port Moresby. Bores were also constructed at the Sogeri High School. Three bores drilled in the area were abandoned as dry holes.

Kwikila. Groundwater data compiled for the Kwikila area, 70 km southeast of Port Moresby, was summarised in a Note on Investigation. An additional bore was completed for the Kwikila High School supply.

Bailebo Settlement Scheme. Several bores were successfully completed at the Bailebo Settlement Scheme in Amazon Bay. The scheme is mainly on gravelly alluvium with good aquifers but drilling is difficult owing to boulders.

Port Moresby. Bores were successfully completed at the Wildlife Laboratory, Moitaka Agricultural Station; Jackson's Airport; Post & Telegraphs Station, Goldie Road; and Ilimo Farm, Sogeri Road. Several other bores and dugwells were sited in the Port Moresby area.

Markham Valley Groundwater Investigation (Jacobson)

A Bureau of Mineral Resources geophysical party measured three gravity profiles across the Markham Valley to determine the depth to bedrock and assist the search for deep aquifers. The results are being evaluated.

Bores were constructed at several villages near Kaiapit and a bore was sited for the Kaiapit town supply.

Daru Groundwater Investigation, Western District (Pounder)

A data census of wells at Daru was undertaken and included topographic levelling, water table measurements, conductivity measurements and sampling for chemical and bacteriological testing. Most of the wells are polluted by human faeces and some are contaminated with sea water. As the town has a population of 5,000 this represents a major public health problem. It may be possible to develop a safer supply from shallow wells outside the town area, in the south of Daru Island.

A geophysical party from the Bureau of Mineral Resources carried out a resistivity survey to establish whether it is feasible to obtain an adequate groundwater supply. Preliminary results indicate that supplies of fresh groundwater are limited. Artificial recharge of the tuff aquifer may be possible.

Kerema Hospital Water Supply, Gulf District (Pounder)

Two wells were constructed for the hospital water supply at Kerema. Sand and gravel filters were used to overcome the problem of fine running sand. The estimated yield of each well is 2.3 m^3 per hour, sufficient for the hospital supply.

Wewak Groundwater Investigation, East Sepik District (Harris)

A Note on Investigation was completed on groundwater for the Wewak town supply. Recommendations for additional pump testing and geophysical investigation were made. Results of the drilling investigation are inconclusive owing to the lack of supervision of the drilling, and inadequate aquifer development and screening.

Lae Groundwater Investigation (Pounder)

A data census of bores in the Lae area was carried out, and a report is being completed.

Drops in water levels have been reported from bores in the Lae town area and at the Lae Institute of Technology and Army Barracks. A geophysical survey has been recommended to determine depths to bedrock, with a view to deepening some of the existing bores.

A bore was sited for drilling contractors about 8 km northeast of Lae.

Rabaul Groundwater Investigation (Pounder)

A data census of bores and wells in the Rabaul and Kokopo areas was carried out. A large number of samples were taken for chemical analysis and a report is being compiled.

Mendi Hospital Aquifer Test, Southern Highlands District (Macias)

An aquifer test was carried out on a bore for hospital supply at Mendi. The bore penetrates a fractured basalt aquifer, and there is an observation bore about 2 m away. The safe yield was estimated at about 8.2 m^3 per hour although the water was muddy when pumped at this rate, and surging was recommended.

Mount Hagen Aquifer Tests (Macias)

Two pump tests were carried out at Mount Hagen. At the dugwell in Kala Creek proposed for hospital supply, a 24 hour pump test at 3.2 m^3 per hour established a steady drawdown of 2 m, with a recovery rate of 0.8 m in 1 hour. At the Police Barracks dugwell, a 24 hour pump test at 6.8 m^3 per hour established a steady drawdown of 1.3 m with a recovery rate of 0.7 m in 1 hour.

A Note on Investigation summarising groundwater investigations in the Mount Hagen area was produced.

Malalaua High School Water Supply, Gulf District (Macias)

A brief appraisal was made of possible groundwater sources for the Malalaua High School Supply. A dugwell was recommended in the sedimentary rocks underlying the proposed school site.

Kainantu High School Water Supply, Eastern Highlands District (Jacobson)

A bore was sited at Kainantu High School and an aquifer was intersected at a depth of 35 m. The bore was tested at 4.1 m^3 per hour, sufficient for the school supply.

Karkar Island Water Supply, Madang District (Weber)

The possibility of supplying the Karkar High School and Miak Hospital with groundwater was assessed. The terrain is underlain by impervious agglomerate and tuff, and it is unlikely that the required amount of water (90 m^3 per day) can be obtained from a bore. An existing spring has sufficient yield for the school and hospital supply. Construction of a small overflow concrete dam was recommended to protect the spring from salt water contamination.

Madang Groundwater Investigation (Macias)

The main aquifers in the Madang area are in coral limestone and in alluvial gravel. Both confined and unconfined aquifers are present. Salt water has been struck in several boreholes and there is evidence of salt water intrusion in the Madang Hospital area. Additional drilling was undertaken during the 1972 dry season to augment the town supply.

Bogia Groundwater Investigation, Madang District (Macias)

An appraisal was made of the possibility of using groundwater for the Bogia town supply. Good quality groundwater has been obtained from dugwells in coquina and coral limestone in parts of the town. Recommendations were made for pumping tests to establish the safe yield of the existing wells and estimate if sufficient groundwater is available for the town supply.

ENGINEERING GEOLOGICAL MAPPING OF URBAN AREAS

Introduction

A programme of detailed engineering-geological mapping of urban areas has been initiated as an aid to engineers and development planners. Geological factors in development planning of urban areas include the seismic response of foundations, slope stability, groundwater and construction materials.

Port Moresby (Harris)

Engineering-geological data for the Port Moresby area was compiled on 1:4,800 topographic sheets. Augering was done in alluvial areas, and boreholes were logged during current site investigations undertaken by the Commonwealth Department of Works. Several alluvial and colluvial map units have been distinguished and an engineering-geological map is being compiled at a scale of 1:25,000.

Lae (Weber)

An engineering-geological map of the Lae area is being compiled at 1:25,000. Information concerning foundation conditions has been collected and is being evaluated. Recommendations are being made for a seismic survey in Lae to assess the response of foundation soils to earthquakes.

Madang (Macias)

An engineering-geological map of the Madang town area was compiled at a scale of 1:10,000 for reduction to 1:25,000. The units mapped are: Miocene sedimentary rocks; Pliocene mudstone; raised coral limestone; coral reefs; alluvium in the Gum River; and fill in the town area.

Groundwater and construction materials data was compiled and discussions were held with town planning consultants on geological factors in development.

ROAD INVESTIGATIONS

Pavement Failures in the Port Moresby area (Weber, Pounder)

Pavement failures are common on sealed town roads in Port Moresby, and an investigation was undertaken at the request of the Commonwealth Department of Works to ascertain if geological factors are involved. The investigation included a survey of the occurrence and types of failures, augering and soil mechanical testing. Several kinds of failures were differentiated, affecting the seal or the shoulders or by sinking of the entire pavement with or without failure of the road. The sinking type of failure is possibly due to geological factors; the other failures are stress induced and caused by poor construction techniques. Failures where sinking of the pavement occurs are mainly confined to highly plastic, moisture sensitive alluvial clays. Moisture variations under the edges of the seal are considered to cause the failures.

Markham Valley Route Location (Jacobson)

A photogeological study of the river course changes in historical times of the Markham tributaries was completed. Proposed re-alignments of the Highlands Highway will traverse areas where the rivers are liable to sudden changes of course. The time-scale and direction of future river movements are difficult to predict.

Kundiawa - Gumine Road, Chimbu District (Harris)

An investigation of the geology of the Kundiawa - Gumine Road Chimbu District, was undertaken for the Department of Public Works. The road passes through extremely rugged country along the Wahgi River Gorge. The road is underlain by mudstone, sandstone, indurated tuff, slate, phyllite and granodiorite and some of the rocks are deeply weathered. Construction materials should be readily available along the road. Slopes in the area are steep but are mostly stable.

Wapenamanda - Baiyer River Road, Western Highlands District (Harris)

The geology of a possible road route from Wapenamanda to Baiyer River was investigated with Consulting Engineers for the Department of Public Works. From Wapenamanda the route follows the Lai River north-eastwards, then turns east across the lower slopes of the Mount Hagen Range to Baiyer River. Slope stability problems are anticipated in the Gai River Gorge, where natural landslides were observed in Hagen Volcanics and the underlying Maril Shale.

Tari - Poroma Road, Southern Highlands District (Harris)

The Department of Public Works proposes to upgrade the existing Tari-Poroma road and re-align certain sections. The road is underlain by weathered volcanic ash soils; hard and strong limestone; and deposits of carbonaceous lacustrine clay.

No problems of cut slope stability are anticipated but the use of weathered ash soils in earthworks may present problems. Construction materials should be readily available along the road.

Rubberlands - Aroa River Road, Central District (Jacobson)

Site investigations for the Aroa River bridge site were undertaken by the Commonwealth Department of Works. Alluvial silt overlies gravel, with bedrock occurring below a depth of 20 m. Several possible sources of construction materials in the area were inspected, the most promising being river gravel and laterite at Lolorua Estate, close to the proposed road alignment.

Kwikila - Marshall Lagoon Road, Central District (Weber)

A section of the proposed road alignment between Kwikila and the Ormond River was inspected with engineers of the Department of Public Works. The alignment traverses both flat alluvial terrain and hilly terrain which is developed on Port Moresby Beds and gabbro. No particular problems are anticipated.

SLOPE STABILITY INVESTIGATIONS

Rock Cuts on the New Kagamuga - Kudjip Road, Western Highlands District (Harris)

Inspections were made of a deep rock cut on the Kagamuga - Kudjip Road, 18 km east of Mount Hagen. A stability analysis of joint sets in the granodiorite showed that potentially unstable joint-bounded wedges occur. Additional safety measures were recommended.

Harris also inspected a new cut near the Komun River bridge. Reduction of the slope angle of an unstable batter in mudstone was recommended to avoid the possibility of bedding plane sliding failures.

Sections of the New Highlands Highway, Chimbu District (Harris)

The new Highlands Highway between Kundiawa and Minj follows the Wahgi River Valley. Near Kundiawa it crosses re-entrants formed by rotational slumps in the overburden, on embankments. Slumping of the soils beneath the embankment has caused major failures.

Remedial works recommended included drainage of unstable soils and re-alignment of parts of the road.

Bahai's Temple Site, Lae (Jacobson)

A proposed temple site for the Bahais was inspected in the Atzera Range near Lae. Providing the steeply dissected northeast corner of the block is avoided, slopes on the site should be stable.

Bougainville Villages (Jacobson)

Two Bougainville villages have been affected by landslides as a result of construction operations. At Parakake a landslide initiated by a road cut has affected village gardens but the village is in no immediate danger. At Moroni village, which is on a ridge top overlooking the Panguna mine, debris slides caused by dumping spoil over the ridge may affect some houses.

Dreikikir to Wasisi Road, East Sepik District (Jacobson)

Slip failures of embankments are common in the Dreikikir area of the East Sepik District. The slips are earthflows and the fill material is a low strength clay derived from weathered shale. For road construction in this area, fills should be minimised as far as possible and should be constructed with careful drainage and compaction.

Mount Shungol, Morobe District (Weber)

The stability of a repeater station on top of Mount Shungol in the Herzog Mountains, southwest of Lae, was inspected. During construction of the station, spoil was pushed over the sides of the summit ridge, and debris slides have developed within this material. The foundation area of the station is considered stable but the spoil material needs to be stabilised by filling cracks with clay and re-establishing vegetation.

CONSTRUCTION MATERIALS

Introduction

Systematic surveys of aggregate sources for road and concrete construction were made in two Highlands districts. Special studies were made of aggregate for wharf and aerodrome construction and detailed studies were made of construction materials in the Port Moresby area. Close liaison was maintained with the Materials Testing Laboratory of both the Commonwealth Department of Works and Department of Public Works in Port Moresby.

Aggregate for the Lae Wharf (Weber)

An investigation of aggregate sources for the Lae Wharf construction was undertaken for the Commonwealth Department of Works. Extensive gravel deposits occur around Lae but contain soft and weathered particles which cannot be eliminated by large-scale processing. The Butibum and Busu River gravels are probably the most economic sources of aggregate but a water-tight concrete and strict quality control of processing will be needed to overcome the deficiencies of the aggregate.

Aggregate for Kupiano Airstrip, Central District (Weber)

Possible sources of aggregate for the Kupiano Airstrip were investigated with engineers of the Public Works Department. Terrace gravels were recommended for use as base course material and a combination of terrace gravel and river gravel for surface course. Several sources of top course material were inspected, tested and found suitable for pavement construction, when blended.

Construction Materials in the Chimbu District (Weber)

A survey of sources of construction materials in the Chimbu District were carried out. The survey included sources of construction materials along the Highlands Highway, Gumine Road and Gembogl Road, and for the town of Kundiawa. The developed deposits are large enough but quality is not high enough to supply the requirements of the Highlands Highway. Low-grade, easily winnable construction materials are available and are considered suitable for the feeder roads to the Highlands Highway.

Aggregate for Hoskins Aerodrome, West New Britain (Weber)

An investigation was made of sources of aggregate for pavement and sealing for the construction of Hoskins Aerodrome. Pumice-aggregate was recommended for pavement construction and quarried andesite for sealing aggregate.

Quarry Sites in the Port Moresby area (Weber, Harris)

The search for quarry sites in the Port Moresby area continued with investigations at Mount Eriama and Barune, neither of which proved satisfactory.

At Mount Eriama a diamond drillhole was completed at 45 m in calc-silicate hornfels. The quality of the rock is variable and about 20 percent of the material will be unsuitable for high quality aggregate. Results of testing on Mount Eriama hornfels indicate that poor bitumen-adhesion and aggregate-reaction of the material are likely to occur.

A limestone deposit at Barune was mapped and investigated with bulldozer trenches and three diamond drillholes. No quarryable rock was found although the limestone is suitable for low grade roadmaking aggregate.

Operating quarries near Port Moresby were mapped and test results were compiled in a Note on Investigation.

"Diorite" as a Roadmaking Material In Port Moresby (Weber)

"Diorite" is a local name for a variety of weathered rocks including tuff, gabbro and mudstone. "Diorite" pits in the Port Moresby area were mapped and a testing programme was carried out by the Commonwealth Department of Works to assess the properties of the materials.

VOLCANOLOGY

STAFF

R.A. Davies: Became Head of the Section in December, 1971, after returning from leave.

INTRODUCTION

by

R.A. Davies

Throughout 1972 the professional cadre was fully staffed, with three volcanologists and two seismologists. Several projects, previously deferred because of pressure of routine duties, were pursued in detail. A critical review of tiltmeter data and operating procedure elucidated problems encountered in Rabaul, Manam and Esa'ala. Two new stations were added to the Rabaul Harbour Network, and experimental work carried out during the year, has improved the seismic surveillance of the Rabaul caldera. The thermal surveillance programme for Rabaul was upgraded; the number of temperature surveillance points was increased and the thermal condition of Blanche Bay is being examined. An infrared aerial survey of the Bay is planned for the end of 1972. The gas condensate collecting programme was extended during the year, and samples collected at Rabaul and other volcanic centres are being compared.

Volcanic activity in Papua New Guinea during 1972 was at a low level compared with previous years. Manam, Bagana and Ulawun volcanoes were in vapour emission phases and Langila was in mild eruption intermittently during the year.

The first of the new telemetered seismic surveillance stations was installed in July, at Mount Lamington, and sites were chosen for stations at Karkar Island, Ulawun volcano, Mount Yelia and Doma Peaks.

ROUTINE DUTIES

VOLCANOLOGY (R.A. Davies)

Blanche Bay

Weekly temperature readings were taken at 54 points at thermal areas at Sulphur Creek, Rapindik, Sulphur Springs, Rabalanakaia, Tavurvur and Vulcan. Two component water-tube tiltmeters at the Central Observatory and Sulphur Creek Station and two portable tiltmeters at Tavurvur Station, were read daily. The Rabaul Harbour Network seismograms were read daily for volcano-seismic events. Other daily functions included monitoring atmospheric temperature and pressure, and rainfall, at the Central Observatory.

Manam Island

Water tube tiltmeter and volcano-seismic data from Tabele Observatory, portable tiltmeter data from Waris Station, and observations of volcanic activity from both centres, were forwarded by coded telegrams to the Central Observatory throughout the year. A part-time observer maintains Waris Station.

D'entrecasteaux Islands

Weekly temperature readings taken at Deidei and Numanuma on Fergusson Island and at Dobu Island, were forwarded to the Central Observatory throughout the year. Bimonthly readings were taken at Iamalele and Kalo Kalo on Fergusson Island, and at Bolubolu on Goodenough Island.

Daily water-tube tiltmeter data and all seismograms from the Esa'ala Observatory were forwarded weekly to the Central Observatory.

Mount Lamington

Tiltmeter readings were forwarded at irregular intervals from Agenahambo Station to the Central Observatory during the year. Lamington station seismograms were forwarded from Popondetta every week. A part-time observer took over duties from the Technical Assistant in July.

Ulawun Volcano

Tiltmeter readings were forwarded from Ulamona Station to the Central Observatory throughout the year.

Bagana Volcano

Tiltmeter readings were forwarded weekly from Piva Station to the Central Observatory throughout the year.

Reporting Network

All centres participating in the Reporting Network were encouraged, via a general circular, to forward regular monthly Volcanological and Seismological Report Forms to the Central Observatory. Over thirty new reporting centres were incorporated in 1972, and the total number of reporting centres now exceeds two hundred and thirty.

SEISMOLOGY (R.J.S. Cooke)

Weekly seismic bulletins were issued, containing teleseismic phases and data from the larger Papua New Guinea regional earthquakes. The data published were obtained from the Rabaul Central Observatory (supplemented where necessary by data from a Harbour Network Station), Esa'ala, Tabele, Lamington and Kobuan stations. The function of issuing bulletins of Kobuan data was transferred to the Port Moresby Geophysical Observatory from the beginning of August, 1972.

Teleseismic and main regional phases were sent by telegram regularly to the Environmental Research Laboratories, Boulder, Colorado, U.S.A., for inclusion in the Preliminary determinations of hypocentral data.

Final data, revised where necessary, is provided to the International seismological Centre, Edinburgh, Scotland, for publication in its Bulletins.

STATIONS AND EQUIPMENT

by

R.A. Davies, R.J.S. Cooke, N.O. Myers

BLANCHE BAY

Central Observatory (RAB)

The World Wide Standard Seismograph system, the two Wood-Anderson components and the two-component Omori seismograph operated satisfactorily throughout the year.

Rabaul Harbour Network

In general, operation of the system was satisfactory. However, cable faults near TAV (Tavurvur) and diesel supply failure at VUL (Taviliu) resulted in the loss of records from TAV for 6 days in January, and from VUL for 14 days during May, June and August. The Pony telemetry system at Tanaka (TKA) was replaced by a TM-1 unit in January, and the equipment recovered from TKA was installed at Matupit Island (MTP) on 26th January. R. Jones (Institute of Geological Sciences, U.K.) installed a spare set of I.G.S. telemetric seismic equipment at Raluana Point (RPT) on 10th May, at the request of Observatory staff. To accommodate these changes, two Helicorder channels were made available, by ceasing operation of the Central Observatory triggered seismograph and the Sulphur Creek seismograph.

Accelerograph Instruments

Two accelerographs were operated for the Port Moresby Geophysical Observatory, one located in the Observatory office and the other in the Sulphur Creek tunnel. The office instrument appears to be the more sensitive, being triggered by shocks felt at Modified Mercalli intensity of about IV and above. Twelve earthquakes triggered this instrument during the year. Films and batteries in these instruments are changed by Rabaul staff, but maintenance is carried out by Port Moresby staff.

POPONDETTA

Agenahambo Station (AGE)

The Willmore seismograph was closed down and returned to Rabaul in April. Only water tube tiltmeters are being maintained at this station, and these were serviced in July.

Lamington Station (LMG)

The Mount Lamington station and the Popondetta base station were re-equipped with TM-1 telemetry and control gear in July. At the same time, the temporary base station previously established at the Popondetta Police Station was closed. The new equipment was installed at permanent premises in Bendora Street.

D'ENTRECASTEAUX ISLANDS

Esa'ala Observatory (ESA)

A technical inspection was made during April, when all equipment was checked and calibrated. During this visit, a telephone line was erected between the Observatory and the Esa'ala Post Office. Operation of this Observatory has, in general, been satisfactory.

MANAM ISLAND

Tabele Observatory (TBL)

Seismograph calibration was checked and tiltmeters serviced in April. Operation throughout the year was satisfactory.

Waris Station

One of four portable tiltmeters was removed in April, and the remaining three instruments were serviced.

SPECIAL PROJECTS AND INVESTIGATIONS

Bismarck Sea Volcanic Arc (R.A. Davies)

Work was completed on some aspects of the volcanic geology and petrology of the islands in the Bismarck Sea between West New Britain and Wewak. The final manuscript was compiled at B.M.R. Canberra by co-author R.W. Johnson and will be issued as a B.M.R. Record.

Eruptive History of Bam Island (R.A. Davies)

The eruptive history of Bam Island was compiled using published and unpublished reports, and information contained on Central Observatory files. The history suggests that eruptive activity has been fairly mild and intermittent in character during the last few centuries. Instrumental data are included. The report has been issued as a Note on Investigation.

Volcanic conditions at Karkar Island and Mount Lamington (R.A. Davies)

A Note on Investigation was prepared on the present level of activity at these two centres. Despite several reports of increased activity at Karkar Island, investigations since 1970 confirmed that there has not been any rise in temperature at fumaroles on Bagiai cone. The smaller (Ulamam) cone is devoid of fumaroles.

The extensive fumarolic areas on Mount Lamington's dome were revisited in 1971. The highest temperature recorded on the dome was 375°C and many fumaroles yielded temperatures of over 150°C. These conditions appear to be normal for Mount Lamington.

Doma Peaks Investigation (R.J.S. Cooke)

Ten days seismic recordings was carried out in late October, 1971, at a site 12 km from the volcano - no volcanic or very close tectonic events were recorded. Possible sites for a telemetered surveillance station were investigated. Four days of traverses inside

the "caldera" revealed previously unknown volcanic phenomena - a new warm spring area where a temperature of $32\frac{1}{2}^{o}C$ was measured, a cold sulphur depositing spring, and a stagnant pool of an acrid, choking gas.

The work was carried out in conjunction with the B.M.R. Highlands Volcano survey. A Note on Investigation has been prepared.

South Bougainville Volcanoes Investigation (R.J.S. Cooke & I.H. Crick)

This work was done during December 1971 in response to report that "Mt. Taroka" had erupted. Aerial inspection of the Taroka-Loloru group of volcanoes and of Mt Bagana was carried out. A ground inspection was made of some of the thermal areas near Lake Loloru, at which temperatures and physical conditions appeared either stationary or to have declined slightly since previous inspection. No basis for the eruption report could be discovered. A Note on Investigation has been prepared.

Tinami Village Seismic Disturbances (R.J.S. Cooke)

A report of continuous ground shaking, underground noises, and ground collapse, leading to the voluntary evacuation of Tinami village (Adelbert Range, Madang Sub-District) was investigated in August, 1972. The reported features and evacuation were found to have resulted directly from the large earthquakes in the area on January 19th. The village is now re-occupied and $2\frac{1}{2}$ days seismic recordings nearby revealed no unusual seismic activity. There were no volcanic phenomena in the area, although a story was frequently heard detailing a now defunct gas vent a few miles away, which was active 15 or 20 years ago. A Note on Investigation has been prepared.

Manam Island Special Seismic Investigation (R.J.S. Cooke)

A brief period of seismic recording at Abaria on the opposite side of Manam Island to the permanent observatory, in late August 1972 revealed that the discrete volcanic shocks recorded at the observatory were not recognizable at Abaria, perhaps owing to its lower elevation and its greater distance from the volcanic centre. Additional work is planned for the near future to test the effectiveness of seismic recording at several different altitudes on the island. This awaits the clearing of an access track above the observatory, and the provision of a calibration device for the field seismograph.

Location of Earthquake in Papua New Guinea (R.J.S. Cooke & V.F. Dent)

The existing rapid graphical method for locating Papua New Guinea earthquakes, developed previously by Cooke, was extended considerably by providing graphs applicable to the most important of the new seismic stations established during the last few years. A Note on Investigation has been prepared.

Seismicity of the Gazelle Peninsula - South New Ireland Region (R.J.S. Cooke)

The seismicity of the area centred on Rabaul and with radius about 150 km is being studied by using the Rabaul Harbour Network of seismic stations as a simple array, capable of measuring azimuth of approach and angle of emergence of the seismic waves. The potential accuracy of this method in this distance range is greater than that obtainable by other methods. It is hoped that a clearer picture will emerge of the complex merging of several distinct seismic zones in this area, and the possible links with volcanism at Rabaul.

Rabaul Caldera Seismic Activity (R.J.S. Cooke)

Seismic events within the Rabaul caldera were recognized in early December, 1971. They have been occurring frequently ever since, although their rate of occurrence has declined steadily from a broad peak of about 150 per month in January - April 1972. Rereading of records in the months before December, 1971 shows such events to be extremely rare (may be 1 or 2 per month). The events are apparently of tectonic type although very small and shallow, and their relationship with volcanism in the area is not understood at present. Six events have been felt within small areas. A location method had been designed prior to the commencement of the activity, and the events were found to lie in two main zones. One of these is linear and extends from about Matupit Island to the approximate position of the 1878 Vulcan Island eruption (i.e. it passes about 2 km to the east of the present Vulcan cone), corresponding to no known geological or topographical feature. The other active zone appears to be related to the caldera ring fracture, as it is arcuate in shape and passes from Escape Bay, across the harbour entrance, past Raluana Point to the south-eastern margin of Keravia Bay. The Rabaul Harbour Network of seismic stations has been modified in the light of this distribution of activity, by the closure of Sulphur Creek station, and the installation of new stations at Matupit Island, and Raluana Point. Ten explosive charges, so positioned as to lie in or near all the active zones, were detonated on 23rd June, 1972, to improve the accuracy of the location method. Three Notes on Investigation are being prepared on different aspects of the investigation of this activity.

Manam Island, Volcanic Activity, 1964-71 (I.H. Crick)

Work continues on the preparation of an account of volcanic activity of Manam, 1964-71, including seismic and tiltmeter data. Large amounts of vapour containing usually fine ash, were ejected from the main vent during this period and a small tongue of lava was disgorged from one of the southern vents in January, 1966.

Blanche Bay Survey (I.H. Crick)

An account of temperatures taken in Blanche Bay by a thermister device and of work done by H.M.S. Hydra, which surveyed part of the Bay floor, is being prepared. Echo-sounding revealed the presence of a small hill with a crater-like summit depression 4 km to the east of Vulcan, 70 metres high, at a depth of 110 metres. Bathy-thermograph records showed that temperatures from 0 - 100 m depth were isothermal, but between 100 m to 130 m depth temperature dropped sharply from 28°C to 23°C, a feature which may prove useful in detecting any underwater thermal activity at depths greater than 130 m.

Rabaul fumarole temperatures (I.H. Crick)

An investigation into the fluctuation of fumarole temperatures in Rabaul is at present held up, pending the arrival of a new thermograph.

Temperatures from one fumarole in Tavurvur crater show a regular rise and fall over a range of 30°C, which correlates directly to the rise and fall of the tide in Blanche Bay. Temperatures from other fumaroles examined so far show little variation.

Volcanic gas condensates (I.H. Crick)

Gas condensates were collected at three-monthly intervals in the Rabaul area during 1972, as part of a continuing programme to enhance surveillance of the Rabaul caldera. Difficulties in analysing the samples due to the oxidation of H_2SO_3 to H_2SO_4 after the sample has been collected, have produced inconsistent results, from which no conclusions can be drawn at present. Gas condensate samples from Mt Lamington and Karkar Island have been collected. It is planned to collect condensates from other volcanoes in P.N.G., in order to provide basic information on the types and relative concentrations of gas being emitted from each volcano, and to test the value of the results in the prediction of eruptions.

Tiltmeter Investigation (D.A. Wallace)

An investigation is proceeding on the problems encountered in the interpretation of tiltmeter data, such as the effects of temperature, pressure and tidal movements. An account will be prepared and issued as a Note on Investigation.

Langila Volcano Investigation (V. Dent and D. Wallace)

An account of a field investigation of Mt Langila together with a summary of eruptive history up to July 1972 and discussion of the volcano-seismic characteristics of the area, is to be issued as a Note on Investigation.

Eastern Papua Seismicity (V.F. Dent)

A catalogue of seismic events in the D'Entrecasteaux Islands and surrounding areas 1957-65 was completed, and issued as a Note on Investigation. The few epicentres published for this region suggest the presence of a linear earthquake zone across the Solomon Sea. The smaller earthquakes of the last few years are being located in this study, to give more information on the detailed form of this zone, particularly in the volcanic areas. Seismic storms in the D'Entrecasteaux Islands in the past have aroused fears of a renewal of volcanic activity in the area. It is hoped to reveal the relationship of these storms to the regional seismicity. Notes on Investigation on these aspects of East Papuan seismicity are in preparation.

TECHNICAL DEVELOPMENTS

by

N.O. Myers

Portable Seismograph

A small portable seismograph has been developed, specifically for use under local field conditions. It is of light weight, and simple

to operate. The system comprises:

(a) Willmore MK1 seismometer
(b) Sprengnether type R6034 smoked paper recorder
(c) Bulova type TE-11 chronometer
(d) TA34 amplifier unit, consisting of A-655 pen amplifier supplied with the recorder and a TA43 pre-amplifier.
(e) Labtronics type 21 time signal receiver.

The recorder, chronometer and amplifier are assembled as a single unit, which with transit case weighs only 20 lbs. Provision has been made to enable the recorder to be used as a chronograph, by recording radio time signals along with chronometer time marks, for comparison purposes. An additional provision enables the recorder to be connected to a field radio telemetry system. Power is supplied by primary (dry) batteries, with a capacity for three weeks continuous operation.

In the future it is intended to replace the type 21 radio receiver with a smaller lightweight unit capable of being mounted within the recorder case. It is also intended to add a calibration unit. Three portable seismograph units have been constructed.

TM-1 Permanent Seismic Surveillance System (N.O. Myers)

Field tests on the newly developed type TM-1 telemetry system commenced in January and proceeded smoothly. The system has been designed for volcanic surveillance. The remote seismometer and VHF radio transmitter are located at or near to the volcano, and the recorder and associated timing equipment is situated at a base station some distance away, preferably at a town or settlement.

The first of these systems was installed in July, at Mount Lamington and Popondetta in the Northern District. The principal components of the system are:

At the remote site:

(a) Willmore MK11 seismometer
(b) Type TM-B2 sub-carrier modulator
(c) Philips type FM1680 VHF transmitter, modified for 500 MW output.
(d) 9 element Yagi antenna
(e) 12 volt battery supply using air depolarised cells.

At the base station:

(a) A Sprengnether type R6038 smoked paper recorder, fitted with a TA38 amplifier unit.
(b) Labtronics type 705 crystal chronometer.
(c) Type TMC-B control unit.
(d) Philips type FM1680 VHF receiver.
(e) Labtronics type 21S time signal receiver.
(f) Westat constant potential rectifier (battery charger)
(g) Labtronics type TS-1 power supply, for supplying the recorder.
(h) Power for the equipment is derived from a 12 volt lead acid battery.

To ensure continuity of timing, two chronometers are used. These are interconnected in the control unit, to provide a means of automatically switching from the No. 1 chronometer to the No. 2 chronometer, should the No. 1 unit fail. Alternatively, this may be over-ridden with a manual switch operation.

Should discharge to the minimum permissable voltage occur, provision has been made for automatic isolation of the battery from the equipment.

VOLCANIC ACTIVITY

by

R.A. Davies

Manam Island

Summit activity throughout the year (up to October) was at the lowest level since the mid-1950's. The slight upsurge in activity experienced towards the end of 1971, in which the major event was the strong ejection of brown vapour from the main vent on 12th November, had ceased by the end of November, 1971.

The main and southern vents continued to emit white vapour throughout the year. During April and June some of the emissions appeared to be light-grey in colour.

One ash fall occurred at Tabele on the 22nd February, 1972. On the 21st April, weak rumbling explosions were heard at Tabele during the day, and a glow was observed over the summit late that evening.

The observer at Waris often reported hearing rumbling explosions, of varying intensity (from the main vent) and at intervals of 15-40 seconds. Strong fumarolic activity in the main crater is probably accompanied at all times by explosive acoustic effects, but wind direction influences greatly the intensity of sound heard at Waris.

Volcano-seismic activity has remained at a generally low level since September, 1971, when it was at its highest for several years. During 1972 the average number of volcanic shocks recorded was approximately 10 per day, and the events had an average maximum double amplitude of 1.0 mm. Four small peaks in volcano-seismicity occurred during the year - from 26th January to 3rd February, 9th - 15th April, 15th - 21st July, and 14th-27th August. The largest number of volcanic shocks recorded daily was 377 on 11th April, with an average maximum double amplitude of 2.9 mm; followed closely by 373 shocks with an average maximum double amplitude of 3.2 mm on the 19th July.

Tiltmeter readings at Tabele were somewhat erratic for the first three months of the year, but stabilised after the water-tube tiltmeters were cleaned and adjusted. Readings showed a definite trend which indicated a slight tumescence of the summit during May and June, and again in August. By the beginning of September the overall change in tilt since May was less than 2 seconds of arc. Portable tiltmeters at Waris did not indicate any trends during the year, and readings were generally erratic.

Langila Volcano

Explosive activity continued intermittently throughout the year, with the highest level of activity occurring during the period April-August. On several occasions erupted ash columns reached heights of up to 20,000 feet. No damage was caused to surrounding settlements, where the only noticeable effect was the deposition of a thin veneer of windborne ash. On two occasions in June, a bright glow above the crater was seen to accompany an eruption of black ash.

A volcanological team conducted a ground inspection of Langila Craters, and made seismic recordings in the Cape Gloucester area during the period 27th June - 5th July. Only one volcano-seismic event was recorded, which correlated with a black ash eruption, and red glow from No. 2 crater. It was found that since the previous inspection of No. 2 crater in 1970 the position of the vent had shifted to the NW side of the crater floor; its former position was on the NE side of the crater floor.

Bagana Volcano

No eruptions occurred at Bagana during 1972, and summit activity consisted of fluctuating vapour emission. Information from portable tiltmeters at Piva Mission station indicated a gradual tumescence of the volcano, and this trend appears to be continuing (September).

Ulawun Volcano

Mid vapour emission continued from summit vents throughout 1972 and there were no reports of stronger activity. Inspection in February showed that vegetation is re-established on most parts of the area devastated by the nuée ardente in 1970. Tiltmeter information from Ulamona Mission showed that there were no marked trends during the year.

Karkar Island

Fumarolic conditions on Bagiai cone were rechecked in April, 1972, and it was found that temperatures were similar to those recorded in June, 1971. The highest temperature observed was 90°C. Reports received since 1970 which suggested increased vapour emission on Bagiai have not been confirmed, and it is concluded that varying atmospheric conditions determine the quantity of vapour observed. Sites for the telemetered seismic surveillance station were selected in April.

Mount Lamington

Activity on the summit dome remained unchanged throughout the year, and consisted of mild vapour emission from several fumarolic areas. Ground inspection of the dome was made in July, to examine and collect condensates at the high temperature fumaroles. The highest temperature recorded was 375°C, near the summit spine, though it is believed that temperatures of over 400°C may exist in some inaccessible fumaroles. Such high temperatures must be considered normal for Lamington, though at other Papua New Guinea centres not in eruption, temperatures do not exceed 102°C.

The radial component tiltmeter at Agenahambo indicated little variation in ground movement through 1972. Readings from the tangential component for the first half of the year were considered unreliable, owing to an instrument fault.

Blanche Bay

Temperatures remained at the same level as in previous years. Tavurvur and Rabalanakaia crater fumaroles registered generally a steady 99°C, with occasional sharp drops of between 5° to 20°C being recorded in Tavurvur. The highest temperature recorded was 100°C, at two points in Trabalanakaia. Temperatures at Vulcan, Sulphur Springs and Rapindik fluctuated widely throughout the year, depending on the level of the tide, and the maximum temperature recorded was 99°C at Sulphur Springs.

D'Entrecasteaux Islands

Apart from a few temperature points at which fluctuations of up to 10°C were recorded, temperatures at the thermal areas of Deidei, Numanuma, Iamalele, and Kalo Kalo (Fergusson Island), Dobu Island and Bolubolu (Goodenough Island) showed little variation over the past year. The highest temperatures recorded (104°C) were at Point 1 in the Deidei thermal area.

PUBLICATIONS AND RECORDS

PUBLICATIONS AND RECORDS

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PUBLICATIONS AND RECORDS

INTRODUCTION

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, 1972.

The reports of the Branch are listed in the following categories:

(1) Bulletins
(2) Reports
(3) Explanatory Notes and maps
(4) Articles and papers published in outside (i.e. non-Bureau) publications.
(5) Unclassified Bureau Records (unpublished)
(6) P.N.G. Geological Survey Notes on Investigations (unpublished)

The status of standard series maps (which are not issued without explanatory notes) in also shown pictorially in the Frontispiece; other, special purpose or small-scale, coloured maps are referred to under "Map Compilation"(p172) or "Geological Drawing Office" (p.179), 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 educational 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

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112	SHERGOLD, J.H.	Late Cambrian trilobite fauna from the Gola Beds, Western Queensland	Published
115	[4]PLAYFORD, G.	Lower Carboniferous spores from the Bonaparte Gulf Basin, W.A. and N.T.	Published
123	[1]RANDAL, M.A.	Wiso groundwater	In press
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	Published
	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	

Bulletins published or in press (cont.)

	DERRICK, G.M.	New Leucite lamproites from the West Kimberley, Western Australia	
	GLIKSON, A.Y.	Petrology and geochemistry of metamorphic Archaean ophiolites near Kalgoorlie, Western Australia	
126	PALAEONTOLOGICAL PAPERS, 1969:		In press
	1 FLOOD, P.G.	Uncinulus Australis, a new Rhynchonellid species from the Lower Devonian of Southern New South Wales	
	[4]PLAYFORD, G.	Permian Flora from the Beaver Lake Area, Prince Charles Mountain, Antarctica	
	[1]RANDAL, M.A.		
	5 KEMP, ELIZABETH M.	i. Palynological Examination of samples	
	5 WHITE, MARY E.	ii. Plant Fossils	
	SHERGOLD, J.H. [1]de KEYSER, F.	A new Conocoryphid Trilobite from the Middle Cambrian of Western Queensland	
	SKWARKO, S.K. COOK, P.J. ARMSTRONG, R.A.	Middle and Upper Triassic Mollusca from Yuat River, Eastern New Guinea	
	SKWARKO, S.K.	On the discovery of Lalodiidae (Bivalve, Triassic) in New Guinea	
	SKWARKO, S.K.	A correlation chart for the cretaceous system in Australia	
	GILBERT-TOMLINSON, Joyce	The lower ordovician gastropod teiichispra in Northern Australia	
127	[4]von der BORCH, C.C.	Marine geology of the Huon Gulf region, New Guinea	Published
130	DICKINS, J.M. [1]MALONE, E.J.	Geology of the Bowen Basin, Queensland	In press
131	SMITH, S.E. WALKER, K.R.	Primary element dispersions associated with mineralization at Mount Isa, Queensland	Published
132	[1]OLGERS, F.	Geology of the Drummond Basin, Queensland	In press
133	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.	In press
134	[4]LINK, A.G. DRUCE, E.C.	Ludlovian and Gedinnian conodont stratigraphy of the Yass Basin, N.S.W.	In press

Bulletins published or in press (cont.)

135	1 WILLMOTT, W.F. PALFREYMAN, W.D. 2 WHITAKER, W.G. 1 TRAIL, D.S.	Metamorphic and igneous rocks of Cape York Peninsula and Torres Strait Islands	In press
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.	In press
138	1 de KEYSER, F.	The geology of the Middle Cambrian phosphorites and associated sediments of northwest Queensland	In press
139	GEOLOGICAL PAPERS, 1970		In press
	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.	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. SIMPSON, C.J.	Notes to accompany a geological map of Rossell Island, Southeastern Papua	
	1 VEEVERS, J.	Stratigraphy and structure of the continental margin between North-West Cape and Seringapatam Reef, Northwest Australia	
	PLUMB, K.A. 1 BROWN, M.C.	Revised correlations and stratigraphy nomenclature in the Proterozoic carbonate complex of the McArthur Group, Northern Territory	
140	PALAEONTOLOGICAL PAPERS, 1970-71		In press
	BURGER, D.	Palynological observations in the Carpentaria Basin, Queensland	
	NORVICK, M.S.	The microplankton genus Disphaeria Cookson & Eisenack emended.	

140 PALAEONTOLOGICAL PAPERS, 1970-71 cont/...

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.	
	SKWARKO, S.K.	First report of Domerian (Lower Jurassic) marine Mollusca from New Guinea	
	OWEN, M.	Upper Cretaceous planktonic Foraminifera from Papua-New Guinea	
	SHERGOLD, J.H.	Index and bibliography of Australian Cambrian trilobites	
142	JOHNSON, R.W. DAVIES, R.A. WHITE, A.J.R.	Ulawun Volcano, New Britain	Published
144	FORMAN, D.J. SHAW, R.D.	Deformation of crust and mantle in central Australia	In press
145	WARREN, R.G.	The metallogenic map of Australia and Papua New Guinea - an explanatory memoir	In press
146 4	JOPLIN, G.A.	Chemical analyses of Australian rocks: Part II, Igneous and metamorphic, 1962-1969	In press

IN PREPARATION

121 1	OPIK, A.A.	Xystridurid trilobites	With editor
136	SHERGOLD, J.H.	Late Cambrian trilobites from the Burke River Structural Belt	In prep.
	BAIN, J.H.C. MACKENZIE, D.E. RYBURN, R.J.	Geology of the Kubor Anticline New Guinea	With editor
	BLAKE, D.H. HODGSON, I.M. 4 MUHLING, P.C.	Geology of the Granites-Tanami region, Northern Territory and W. Australia	In prep.
1	BOFINGER, V.M.	Geochronology of the East Kimberley region, W.A.	With editor
	BURGER, D.	Cenomanian spores and pollen grains from Bathurst Island, N.T.	In prep.
	COOK, P.J. MAYO, W.	Sedimentation in a tropical estuary (Broad Sound Queensland)	In prep.
	COOK, P.J. MAYO, W.	Geochemistry of a tropical estuary (Broad Sound, Qld.)	In prep.

Bulletins in preparation (Cont.)

DAVIES, H.L. NORVICK, M.S. HUTCHISON, D.S. RYBURN, R.J.	Geology of the Western Central Ranges of Papua New Guinea	In prep.
DERRICK, G.M. 2 WILSON, I.H. HILL, R.M. GLIKSON, A.Y.	Precambrain geology of Northwest Queensland from Cloncurry to Mount Isa	In prep.
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	In prep.
1 GELLATLY, D.C. 2 SOFOULIS, J. DERRICK, G.M.	Precambrian geology of the Kimberley Region, W.A.: The West Kimberley	In prep.
GLIKSON, A.Y. DERRICK, G.M. HENLEY, S.	Proterozoic basic meta-volcanic succession Cloncurry-Mount Isa region, Queensland	In prep.
HALDANE, A.D. SMITH, S.E.	Geochemistry of the Tennant Creek mineral field.	In prep.
JENSEN, A.R.	Permo-Triassic stratigraphy and sedimentation in the Bowen Basin, Queensland	In prep.
JONGSMA, D.	Marine geology of the Arafura Sea	With editor
JONES, H.A.	Marine geology of the northwest Australian continental shelf	With editor
JOHNSON, R.W.	Geology and petrology of late Cainozoic volcanoes along the southern margin of the Bismarck Sea, Papua New Guinea.	
MARSHALL, J.F.	Marine geology of continental shelf between Capricorn Channel and Sandy Cape	In prep.
NORVICK, M.S.	Stratigraphic palynology of the Cenomanian of Bathurst Island, N.T.	In prep.
4 PAGE, R.W. MACDOUGALL, Ian	The geochronology of igneous and metamorphic rocks in the New Guinea region	With editor
PLUMB, K.A.	Precambrian geology of the Kimberley Basin, W.A.	In prep.
1 RANDAL, M.A.	Hydrogeology of the Southeast Georgina Basin	In prep.

Bulletins in preparation (cont.)

[1]ROBERTS, H.G. [1]PLUMB, K.A. [1]DUNN, P.R.	Geology of the Carpentaria Proterozoic Province: Arnhem Land, N.T.	In prep.
[1]ROBERTS, J. OVERSBY, B.S.	The Lower Carboniferous geology of the Rouchel district, Upper Hunter Valley, N.S.W.	In prep.
RYBURN, R.J. JOHNSON, W. MACKENZIE, D.E.	Geology of New Britain, Papua New Guinea	In prep.
SENIOR, B.R.	Geology of the Central Eromanga Basin, Queensland	"
SHERATON, J.W. [1] LABONNE, B. DERRICK, G.M.	Petrology and geochemistry of acid rocks of Georgetown area, Queensland.	"
SMITH, I.E. DAVIES, H.L. BELFORD, D.J.	Geology of southeastern Papua	
STEWART, A.J. SHAW, R.D. et al.	The Arltunga Nappe Complex, N.T.	In prep.
SWEET, I.P.	Geology of the Victoria River Basin, Northern Territory	"

REPORTS

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	Published
140	[2]EXON, N.F. [2]REISER, R.F. [2]CASEY, D.J. [2]BRUNKER, R.L.	The past Palaeozoic rocks of the Warwick Sheet area, Queensland and N.S.W.	With editor
142	[1]MOLLAN, R.G.	Geology of the Eddystone, Taroom and Western part of the Mundubberra Sheet areas	Published
143	EXON, N.F. [1] GALLOWAY, M.C. [2] CASEY, D.J. [2] KIRKEGARDE, A.G.	Geology of the Tambo, Augathella areas, Queensland	In press
144	[2]CLARKE, D.D. [1]PAINE, A.G.L. JENSEN, A.R.	The geology of the Proserpine 1:250,000 Sheet area, Queensland	Published

Reports (Cont.)

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	With editor
149	[4]FOLDVARY, G.Z. [4]SANDERSON, J.L.	Catalogue of palaeontological collections, University of Sydney	Published
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.	In press
152	1 GELLATLY, D.C. DERRICK, G.M. PLUMB, K.A.	Geology of the Lansdowne 1:250 000 Sheet area, W.A.	With editor
153	1 GELLATLY, D.C. 2 SOFOULIS, J. DERRICK, G.M. 1 MORGAN, C.	The older precambrian geology of the Lennard River 1:250 000 Sheet area, W.A.	"
154	GELLATLY, D.C. DERRICK, G.M. 2 SOFOULIS, J. 2 HALLIGAN, R.	Geology of the Charnley 1:250 000 Sheet area, W.A.	"
162	1 BENNETT, Rosalind PAGE, R.W.	Catalogue of age determinations on Australian rocks, 1966	With editor
164	[1]OLGERS, F. [1]FLOOD, P.G.	Palaeozoic geology of the Warwick and Goondiwindi 1:250 000 Sheet areas	With editor
165	ETHERIDGE, M.A. IRVING, S.	Theses in Australian Universities	With editor
	BAIN, J.H.C. McLEOD, I.R. GRAINGER, D.J.	Geology of the eastern side of Prydz Bay, Antarctica	In prep.
	1 BENNETT, Rosalind PAGE, R.W.	Catalogue of isotopic age determinations carried out on Australian rocks, 1967-70.	With editor
	BLAKE, D.H. HODGSON, I.M. SMITH, P.A.	Geology of the Birrindudu and Tanami areas, Northern Territory	In prep.
	HOHNEN, P.D.	Geology of New Ireland, Papua New Guinea	In prep.
	[1]MIEZITIS, Y.	Compilation of geological and geochemical information from the Hundred of Goyder, Rum Jungle district, N.T.	In prep.

Reports (Cont.)

[1]MORGAN, C.M. SWEET, I.P. [1]PONTIFEX, I.R.	The geology of the northern part of the Victoria River Basin, N.T.	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.	With editor
SWEET, I.P. [1]MENDUM, J.R. BULTITUDE, R.J. [1]MORGAN, C.M.	The geology of the southern part of the Victoria River Basin, N.T.	In prep.
WELLS, A.T. STEWART, A.J. KENNEWELL, P.J.	Evaporite occurrences and exploration in the Amadeus Basin.	In prep.

EXPLANATORY NOTES AND MAPS

(1972 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
A54/11	Vanimo	1972	In prep.		DOW, D.B.	
A54/15	Aitape	1972	In prep.		DOW, D.B.	
A56/9,14,15 B56/3	New Ireland (Special)	1970	1971 (dyeline only)	In prep.	HOHNEN, P.D.	
B54/3	May River	1966, 1971 and 1972	1969	In prep.	DAVIES, H.L. HUTCHISON, D.S.	In prep.
B54/4	Ambunti	1966, 1971 and 1972	1969	In prep.	DOW, D.B. HUTCHISON, D.S.	In prep.
B54/7	Blucher Range	1971, 1972	In prep.	In prep.	DAVIES, H.L. HUTCHISON, D.S.	In prep.
B54/8	Wabag	1966, 1971 and 1972	1969	In prep.	DAVIES, H.L. HUTCHISON, D.S.	In prep.
B55/5	Ramu	1971	1972	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	1972	In prep.	BAIN, J.H.C. MACKENZIE, D.E.	In prep.

B55/14	Wau	1968	In prep.		DOW, D.B. SMIT, J.A.J.	In prep.
B55/15	Salamaua	1970	1972	In prep.	PAGE, R.W. DAVIES, H.L.	In prep.
B56/2	Gazelle Peninsula	1968	1971	In press	DAVIES, H.L.	In press
B56/5-9	TaLasea-Gasmata	1969	In prep.		RYBURN, R.J.	In prep.
B56/6	Pomio	1969	1972		RYBURN, R.J.	In prep.
C54/8- C55/5	Daru-Maer Island	1968	1970	1972	WILLMOTT, W.F. WHITAKER, W.G.	Publ.
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	In press	SMITH, I.E.	With editor
C56/5	Fergusson Island	1969	1971	In press	DAVIES, H.L.	With editor
C56/9	Samarai	1969	1971	In press	SMITH, I.E.	With editor
D51/12	Montague Sound	1965	1967	1971	ALLEN, A.D.	Publ.
D52/7	Cape Scott	1968	1970	1972	MENDUM, J.R.	In press
D52/10	Medusa Banks	1965	1969	1971	PLUMB, K.A. PERRY, W.J.	Publ.
D52/11	Port Keats	1967/8	1970	1972	MORGAN, C.M.	In press
D52/12	Fergusson River (2nd ed.)	1967 1968	1970	1972	PONTIFEX, I.R. MENDUM, J.R.	Publ.
D52/15	Auvergne	1967	1970	1972	PONTIFEX, I.R. SWEET, I.P.	In press

D52/16	Delamere	1966-68	1970	1972	SWEET, I.P.	In press
D54/3	Weipa	1972	In prep.		SMART, J.	
D54/4	Cape Weymouth	1967, 1972	1969		WILLMOTT, W.F., POWELL, S.	Awaiting Sedimentary Section contribution.
D54/7	Aurukun	1972	In prep.		SMART, J.	"
D54/8	Coen (part)	1967	1969		WHITAKER, W.G.	"
D54/12	Torres Strait (part)	1968	1970		WILLMOTT, W.F.	
D54/12	Ebagoola	1967, 1972			TRAIL, D.S. GRIMES, K.	"
D54/15	Rutland Plains	1970	Aug. '71	In press	NEEDHAM, S. DOUTCH, H.F.	With editor
D54/16	Hann River	1972			WHITAKER, W.G. GRIMES, K.	Awaiting Sedimentary Section contribution,
E51/3	Yampi	1966-67	1970	With authors for modifications	GELLATLY, D.C. SOFOULIS, J.	With authors for modifications
E51/4	Charnley	1965-67	1969	1972	GELLATLY, D.C. HALLIGAN, R.A.	In press
E51/8	Lennard River	1965-67	1969	2nd ed. 1972	DERRICK, G.M. PLAYFORD, P.E.	With editor
E52/3	Waterloo	1969	1972	In prep.	SWEET, I.P.	In prep.
E52/4	Victoria River Downs	1966-69	1972		SWEET, I.P.	In prep.
E52/7	Limbunya	1969	1971	In press	MENDUM, J.R.	In press
E52/8	Wave Hill	1966-69	1971	In press	BULTITUDE, R.J.	In press

E52/11	Birrindudu	1971	1972		BLAKE, D.H. HODGSON, I.M. SMITH, P.A.	In prep.
E52/14	Billiluna (2nd ed.)	1972	In prep.		MUHLING, P.C. PASSMORE, V.L. YEATES, A.N.	In prep.
E52/15	Tanami	1971	1972		BLAKE, D.H. HODGSON, I.M. SMITH, P.A.	In prep.
E53/14	Tennant Creek	1970-71	In prep.	In prep.	MENDUM, J.R.	In prep.
E54/1-2	Mornington-Cape Van Dieman	1970	1971	In prep.	GRIMES, K.	In prep.
E54/3	Galbraith	1970	1971	In press	NEEDHAM, S. DOUTCH, H.F.	With editor
E54/4-E55/1	Walsh - Mossman 2nd Ed.	1970-71	1972	In prep.	GRIMES, K.	In prep.
E54/5	Westmoreland 2nd Ed.	1970	1972	Awaiting Metalliferous Section contribution		
E54/6	Burketown	1969	1970	In press	INGRAM, J.A.	With editor
E54/7	Normanton	1969-70	1971	In press	SIMPSON, C.	With editor
E54/8-E55/5	Red River - Atherton. 2nd Ed.	1970-71	1972	In prep.	SMART, J. GRIMES, K.	In prep.
E54/9	Lawn Hill (2nd ed.)	1970	1972	In prep.	GRIMES, K.	In prep.
E54/10	Donors Hill	1969	1970	In press	INGRAM, J.A.	With editor
E54/11	Croydon	1969	Ready for printer	In prep.	DOUTCH, H.F.	In prep.

E54/12	Georgetown .2nd Ed.	1969-70	1972	Awaiting Metalliferous Section contribution		
E54/14	Dobbyn ,2nd.Ed.	1969	1971	In press	SMART, J.	In press
E54/15	Millungera	1969	1971	In press	GRIMES, K.	In press
E54/16	Gilberton 2nd Ed.	1969	1970	In press	SMART, J.	In press
F52/2	Lucas (2nd Ed.)		1972	In prep.	MUHLING, P.C. CROWE, R.W.A.	In prep.
F52/3	The Granites		1972	In prep.	HODGSON, I.M.	In prep.
F52/6	Stansmore (2nd Ed.)		1972	In prep.	HODGSON, I.M. YEATES, A.N.	In prep.
F52/11	Lake Mackay	1968	1969	1972	NICHOLAS, T.	In press
F52/12	Mount Doreen	1967-68	1st 1968 2nd 1969	1972	WELLS, A.T.	In press
F53/9	Napperby	1968	1969	1972	EVANS, T.G.	In press
F53/10	Alcoota	1970-71			WARREN, R.G.	
F55/1	Hughenden	1963	1964	With editor	PAINE, A.G.L. VINE, R.R.	With editor
F55/3	Bowen	1961, 1964/5	1967	1972	PAINE, A.G.L.	In press
F55/4	Proserpine	1962-65	1968	1971	PAINE, A.G.L.	Publ.
F55/14	Jericho		1967	In press	SENIOR, Daniele	In press
G53/4	Simpson Desert North	1971	1972	With editor	MOND, A.	With editor

G53/8	Simpson Desert South	1971	1972	With editor	YEATES, A.N.	With editor
G54/2	Machattie (2nd Ed.)	1969		In press	SENIOR, B.R.	With editor
G55/13	Toompine	1968	1969	1971	INGRAM, J.A.	Publ.
G55/14	Wyandra	1968	1969	1971	THOMAS, B.M.	Publ.
G55/15	Homeboin	1969	1970	1972	SENIOR, B.R.	Publ.
G56/13	Dalby	1968	1969	In press	MOND, A.	With editors
H54/3	Tickalara	1967	1968	1972	GALLOWAY, M.C. SENIOR, Daniele	Publ.
H55/1	Eulo	1968	1969	1972	SENIOR, B.R.	Publ.
H55/2	Cunnamulla	1968	1969	1972	THOMAS, B.M.	Publ.
H55/3	Dirranbandi	1969	1970	1972	GRAHAM, Barbara K.	In press
H55/4	St. George	1969	1970	1972	SENIOR, Daniele	In press
H56/1	Goondiwindi	1968	1969	In press	SENIOR, Daniele	In press
ANTARCTICA						
	Stinear Nunataks	To 1971	In prep.		TINGEY, R.J.	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, 1972
1:50 000		
Herberton and Mount Garnet mineral locality maps, Qld	BLAKE, D.H.	Printed
1:100 000		
Tennant Creek (Special) N.T.	MENDUM, J.R. TONKIN, P.C.	In preparation
Cloncurry Mary Kathleen Qld. Marraba	DERRICK, G.M. et al.	Preliminary edition issued
Mount Isa, Qld D	DERRICK, G.M. et al.	In preparation
1:500 000		
Cape York area, Qld.	WILLMOTT, W.F. et al.	Printed
Ngalia Basin	WELLS, A.T. et al.	In preparation
West Kimberley, W.A.	GELLATLY, D.C. et al.	Compilation in progress
Burdekin River region, Qld.	PAINE, A.G.L. CAMERON, R.L.	Printed by Geographic Branch 1972
Kimberley Basin	PLUMB, K.A.	In preparation
Victoria River	SWEET, I.P.	In preparation
New Britain, PNG	RYBURN, R.J.	In preparation
1:1 000 000		
Geological map of Papua New Guinea	BAIN, J.H.C. CAMERON, R.L. et al.	Preliminary edition printed.
Central Eromanga Basin	SENIOR, B.R.	Geological section to be drawn

OTHER MAPS (cont.)

Scale and Name	Authors	Position as at 31st October, 1972
Solid geology, Bowen Basin	DICKINS, J.M. MALONE, E.J.	Printed
Surat Basin	EXON, N.F.	Preliminary edition issued
Bowen Basin geophysical	DICKINS, J.M. MALONE, E.J.	In press
Arafura Sea	JONGSMA, D.	Fair drawing in progress
Rowley Shoals, W.A.	JONES, H.A.	" " " "
Scott Reef, W.A.	JONES, H.A.	" " " "
Metamorphic map of central Australia	FORMAN, D.J.	In press
1:2 500 000		
Mineral deposits of Papua New Guinea	CAMERON, R.L. GRAINGER, D.J.	Being compiled; notes to be written
Geological map of Northern Territory	D'ADDARIO, G.W.	Preliminary edition being compiled
1:5 000 000		
Metallogenic map of Australia	WARREN, R.G.	Printed, text in press
Tectonic map of Australia	DOUTCH, H.F. et al.	Printed
1:20 000 000		
Lithological map of Australia	THOMAS, P.E.	To accompany 1:5 000 000 Soil Map of Australia (compiled by others). Compiled.

OUTSIDE PUBLICATIONS

2	ABELE, C., PAGE, R.W.	Stratigraphic and isotopic ages of Tertiary Basalt at Maude and Airey's Inlet, Victoria, Australia.	Roy. Soc. Vic. Proceedings (in press.)
4	BLACK, L.P., RICHARDS, J.R.	Isotopic composition and possible genesis of ore leads in North-eastern Queensland, Australia.	Econ. Geol., 67, (in press.)
4	BLACK, L.P., RICHARDS, J.R.	Rb-Sr study of the igneous rocks of N.E. Queensland.	J. Geol.Soc. Aust., 19. (in press.)
1 5	BLACK, L.P., MORGAN, W.R., WHITE, M.E.	Age of a mixed Cardiopteris-Glossopteris flora from Rb-Sr measurements on the Nychum Volcanics, North Queensland.	J. Geol.Soc. Aust., 19. (in press.)
	BLAKE, D.H.	Geomorphology of eastern Papua.	CSIRO Land Res. Ser. (in press.)
	BLAKE, D.H.	Volcanic Landforms.	Encyclopedia of Papua and New Guinea, vol.2, 598-599.
	BLAKE, D.H.	Western District.	Encyclopedia of Papua and New Guinea, vol.2, 1187-1193.
	BLAKE, D.H.	Geology of eastern Papua	CSIRO Land Res. Ser. (in press.)
4	BLAKE, D.H., OLLIER, C.D.	Alluvial plains of the Fly River, Papua.	Zeitschr. Geomorph. N.F. Suppl. Bd 12, 1-17.
4	BLAKE, D.H., PAIJMANS, K.	Reconnaissance mapping of land resources over large areas in Papua New Guinea.	Aust. Geograph. Studies. (in press.)
3	BUBELA, B.	Effect of copper on the growth of Bacillus stearo-thermophilus.	Zentralblatt für Bakteriologie (in press.)
3	BUBELA, B.	Simulated Sedimentary System.	(in prep.)
3	BUBELA, B., POWELL, T.G.	Effect of copper on the composition of bacterial cell wall peptides.	Zentralblatt für Bakteriologie (submitted.)

3 3	CHAMBERS, L.A., TRUDINGER, P.A.	Cysteine and S-sulpho-cysteine biosynthesis in bacteria.	Archiv. Mikrobiol., 77, (1971), 165-184.
4 3 4	CHILDS, C.W., DOWNES, C.J., PLATFORD, R.F.	Thermodynamics of aqueous sodium and potassium dehydrogen orthophosphate solutions at 25°C.	Australian Journal of Chemistry. (in press.)
	COOK, P.J.	Reply to discussion by Wopfner and Milton.	Amer.Assoc. Petroleum Geol. 56, (5), 969-970.
	COOK, P.J.	Reply to discussion by Ranneft.	Amer.Assoc. Petroleum Geol. 1972. (in press)
4	COOK, P.J., POLACH, H.A.	A chemical sequence at Broad Sound and evidence against a Holocene high sea level.	Submitted to Marine Geol. (in press.) 1972.
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1971/3	KELLETT, J.R.	Soil survey, Division of Watson, Canberra, A.C.T.
1971/39	PURCELL, D.C.	Seismic surveys and related geological investigations of engineering projects in the A.C.T. from August 1969 to January 1970.
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1971/55	JOHNSON, R.W.	Geology and Petrology of Bamus volcano, Lake Hargy area and the Sulu Range, New Britain.
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1971/94	1 2 1 1	WILLMOTT, W.F. WHITAKER, W.G. PALFREYMAN, W.G. TRAIL, D.S.	Igneous and metamorphic rocks of Cape York Peninsula and Torres Strait
1971/98	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.
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1971/104		WHITE, Mary E.	Report on 1969 collection of plant fossils from the Moolayember Formation and Clematis Sandstone.
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1971/137		TAYLOR, G.A.M.	Investigation of Volcanic Activity, Doma Peaks, TPNG.
1971/139		CARTER, E.K.	Musa River hydro-electric scheme, Eastern Papua; conclusions and recommendations from 1970 geological and geophysical investigations.
1971/140		SALTET, J.A.	Visit to the Hydro-electric Commission, Tasmania, May, 1970.

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1972/13	DAVIES, R.A.	The 1970 Eruption of Alawun Volcano.
1972/14	PLUMB, K.A.	Precambrian fossils in Australia.
1972/15	MAFFI, C.	The UN Panel Meeting on the establishment and implementation of research programmes in remote sensing. Brazil.
1972/17	EXON, N.H.	Lamington Volcanics - McPherson Range
1972/18	SIMPSON, G.B.	Geology of the Googong Reservoir, Queanbeyan River, N.S.W.
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1972/31	WHITE, Mary E.	Mesozoic plant fossils, Croydon, Qld.
1972/32	SMART, J., et al.	Recent Geological Mapping, Carpentaria Basin.
1972/37	PLUMB, K.A.	Tectonic Evolution of Australia - A Summary.
1972/38	3 BUBELA, B. POWELL, T.	Effects of Cu on Bacterial Cell Wall Peptides.
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1972/54	EXON, N.F.	Shallow stratigraphic drilling, Eastern Surat Basin, Qld, 1966, 67 and 68.
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IN PREPARATION

x Indicates that advance copies (of engineering geology reports) have been supplied to the client department or authority.

v Indicates that a detailed technical note has been issued; several such notes are to be grouped to form appropriate Records.

1967/33	JOYCE, A.	Redistribution of elements by dispersion.	With editor
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1972/65	GIBSON, D.L.	Clay mineralogy of Recent Sediments, Broad Sound area, Qld.	"
1972/74	BULTITUDE, R.J.	Geology and petrology of Helen Springs, Nutwood Downs, and Peaker Piker Volcanics.	In prep.
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1972/100	HENLEY, S.	A computer program for plotting cumulative frequency curves and gradient curves.	"
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[4]BROWN, M.C. CLAXTON, C.W.	Geochemistry of carbonate sequences of the McArthur River area, N.T.	Being written
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[1]COOPER, J.A.	On the age of uranium mineralization at Nabarlek, 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

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[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.	"
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[v]LABONNE, B.	Petrographic examination of marble samples from Yarraloola, W.A.	
[v]LAWS, A.T. SALTET, J.A.	Groundwater drainage near Canberra Grammar School, Monaro Crescent, Red Hill, A.C.T.	
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PAPUA NEW GUINEA NOTES ON INVESTIGATION

The following Notes were issued by the P.N.G. Geological Survey in the period under review.

71-019	G. JACOBSEN L.F. MACIAS	Groundwater Investigations in the Mount Hagen Area Western Highlands District.
71-023	G. JACOBSEN	Hydrogeology of the Kwikila-Rigo Area, Central District, Papua.
71-026	B. WEBER	Pavement failures in Port Moresby, Papua.
71-034	B. WEBER	Construction materials for Kupiano Airstrip, Central District, Papua.
71-035	L.F. MACIAS	Village Water Supply Survey, Northern District, Papua.
71-036	L.F. MACIAS	Geological Investigation of the proposed road from Pongani to the Musa Gorge area, Northern District, Papua.
72-001	B. WEBER J. HARRIS G. JACOBSEN	Quarry sites in the Port Moresby area.
72-002	R.W. JOHNSON R.A. DAVIES	Volcanic geology of the St Andrew Straight Islands, Bismarck Sea, Papua, New Guinea.
72-004	G. JACOBSEN	Slope stability problems on the Dreikikir to Wasisi Road, East Sepik District.
72-006	B. WEBER	Construction materials for Hoskins Aerodrome West New Britain District.
72-008	B. WEBER	Construction materials for Lae Wharf.
72-009	J. HARRIS	Slope stability of some sections of the New Highlands Highway, Chimbu District.
72-010	J. HARRIS	Geological Investigation of the Poroma to Tari Road, Southern Highlands District.
72-011	J. HARRIS	Geological Investigations of the Kundiawa to Gumine Road, Chimbu District.
72-020	J. HARRIS	The Geology of the proposed Wapenamanda to Baiyer River Road, Western Highlands District.