COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1968 / 121

Annual Summary of Activities
Geological Branch 1968

ANNUAL SUMMARY OF ACTIVITIES

GEOLOGICAL BRANCH

1968

Records 1968/121

ANNUAL SUMMARY OF ACTIVITIES

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SUMMARY

Regional mapping parties decreased from five in 1967 to four in 1968 but field work on special or detailed projects was at about the same level as in 1967 (see Fig. S1).

In Queensland two regional parties operated in the Eromanga and Surat Basins and a third in the adjacent Texas High region. They completed seven 1:250,000 Sheets and mapped the greater part of two others. Bureau drilling rigs were used for shallow scoutholes in the Eromanga and Surat Basins; up to 31st October, a total footage of 6,920 was drilled, of which 980 were cored. Work continued on the Bowen Basin Bulletin and a special project was begun on an environmental analysis of the Triassic Mimosa Group in the Bowen Basin. A report on sedimentation in the Upper Permian and Lower Triassic of part of the Bowen Basin was completed in draft.

In the Eromanga Basin a light aircraft was used for 43 hours for bore spotting and general reconnaissance. Wire-line logging of waterbores by contract was continued, and 156 bores were logged by gamma-ray; differential temperature logs were run in 89 of these, and flowmeter and caliper logs in 48. The 1968 contract was still in progress at the 31st October.

In the Northern Territory one field party completed the regional mapping of the Ngalia Basin and adjacent basement rocks on three 1:250,000 sheets. The hydrogeology project continued in the Georgina Basin and early results show an increase in groundwater salinity basinwards off the Precambrian margins and southwards along the Georgina River drainage system: this confirms trends noted from previous work. Compilation and collation of hydrogeological data in the Wiso Basin and environs continued.

Three special project parties worked in the Amadeus Basin area on tectonic problems. One confirmed moderate to high grade (kyanite and staurolite) regional metamorphism in the south-western margin of the Amadeus Basin during the late Precambrian or Cambrian Petermann Ranges Orogeny, and proved the existence of an unconformity beneath the Dean Quartzite. Another party is using macro and micro techniques of structural analysis to solve the method of emplacement of the Arltunga Nappe Complex in the north-eastern margin of the Amadeus Basin. Detailed mapping of the Gosses Bluff structure by the U.S.G.S. and the B.M.R. is providing further evidence that it is an astrobleme. Evaporites within the Bitter Springs Formation of the Amadeus Basin were tested by drilling. The first drill hole encountered 832 feet of gypsum, anhydrite and claystone.

The Photogeological Group completed four 1:250,000 Sheets and had four others in progress on 31st October. Some detailed photo-interpretation and fracture-trace analysis was carried out for the engineering geology group.

The Sedimentary Petrology Group examined some cores and cuttings from wells in the Sydney Basin while on exchange in the Petroleum Exploration Branch. Surface and borehole samples from the Wiso and Georgina Basins were studied to assist interpretation of the Cambrian Geology.

The Palaeontological Groups worked on many projects. Important new collections of Tertiary mammals were made at Camfield in the Northern Territory and Riversleigh in Queensland. Examination of core material from commercial drilling in the Canning Basin has added considerable knowledge on the distribution and nature of the Ordovician in the basin. Other highlights have been the work on the marine Triassic faunas of New Guinea, the Ordovician graptolites of the Canning Basin, and the description of the trilobites of the Cambrian and other systems and their application to field geology. The work on the trilobites has been carried out by B.M.R. palaeontologists and by Dr. A.A. Opik. Description of Upper Devonian and Lower Carboniferous brachiopods and associated stratigraphic applications has been carried out by Dr. J. Roberts of the Smithsonian Institute, Washington. Preparation of the catalogues of fossil type specimens has continued.

The Mobile Conodont Laboratory operated in Western Australia and western and eastern Queensland: conodont zones erected previously in other areas could be recognized. A study of Tertiary limestone sections from Christmas Island revealed five faunal assemblages. Shallow stratigraphic drilling in the marine Lower Cretaceous of the northern and eastern Eromanga Basin established detailed relationships of palynological zonation with lithostratigraphy. Angiospermous pollen grains from Aptian, Albian, and younger formations in the Great Artesian Basin have been subject to continued stratigraphic and spore systematic study.

During the year a palaeontologist studied overseas on a Harkness Fellowship, and another geologist returned from overseas study on a Commonwealth Public Service Board Scholarship. A palaeontologist spent three months overseas on an official visit.

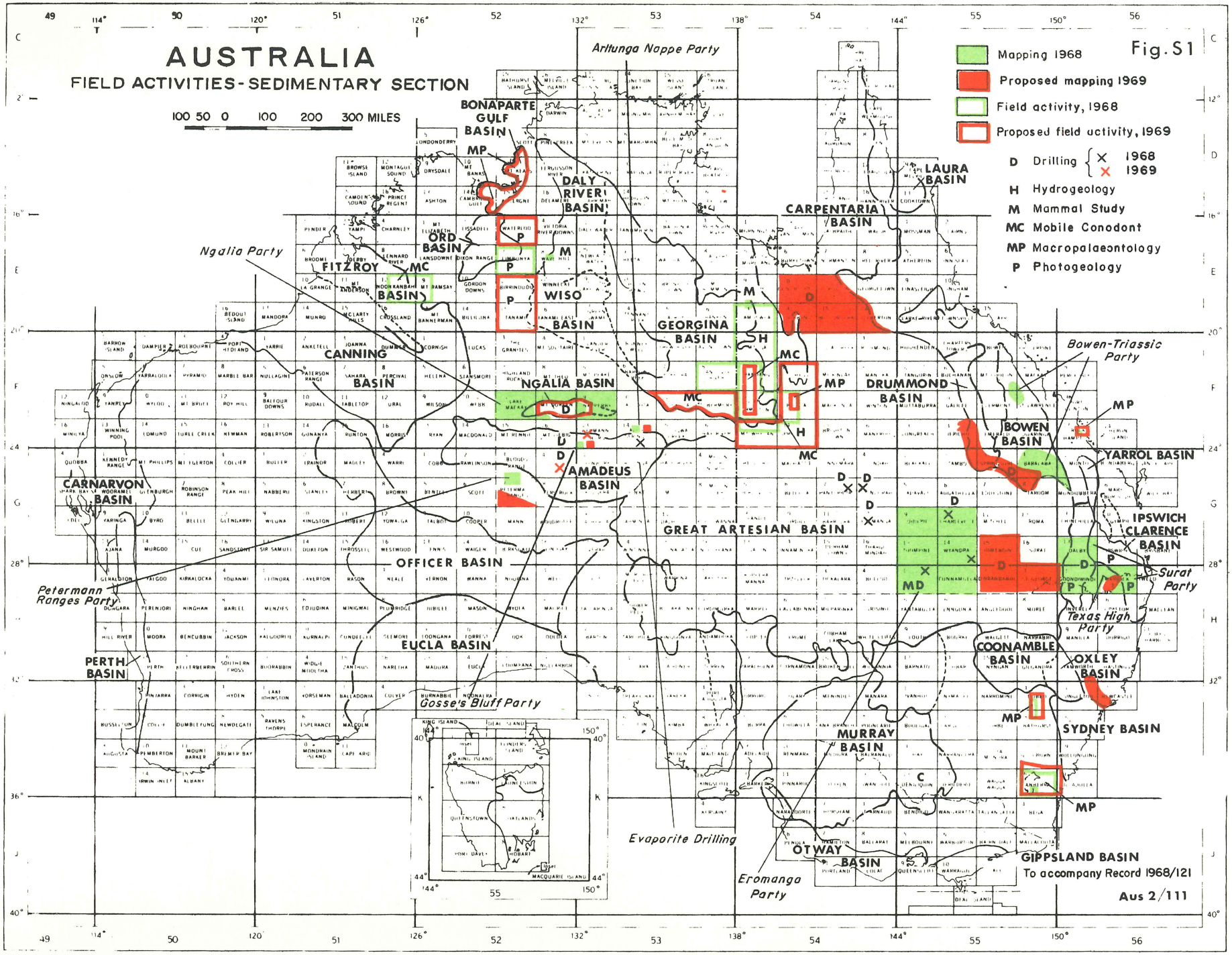
Five specialists were employed on a part time basis by the Sedimentary Section of the Bureau of Mineral Resources. They offered advice to the section and worked on a wide variety of projects.

Bureau publications issued from the Sedimentary Section during the year consisted of four Bulletins, one Report, and three Explanatory Notes. Twenty-seven papers for external publication were published or accepted for publication. The status of publications and Records at 31/10/68 is shown in Appendix S-1, and on that date the totals were:

Bulletins:	issued	4;	in press	7;	edit in progress	10
Reports:	"	1;	"	"	5;	"	"	"	2
Explanatory Notes:	"	3;	"	"	11;	"	"	"	21

External Publications: published 19, accepted or in press, 8.

Records: issued 27.


AUSTRALIA
FIELD ACTIVITIES - SEDIMENTARY SECTION
100 50 0 100 200 300 MILES
Fig. S1
Mapping 1968
Proposed mapping 1969
Field activity, 1968
Proposed field activity, 1969
D Drilling × 1968 × 1969
H Hydrogeology
M Mammal Study
MC Mobile Conodont
MP Macropalaeontology
P Photogeology
Arltunga Nappe Party
BONAPARTE GULF BASIN
LAURA BASIN
DALY RIVER BASIN
CARPENTARIA BASIN
ORD BASIN
Ngalia Party
FITZROY BASIN
WISO BASIN
GEORGINA BASIN
CANNING BASIN
NGALIA BASIN
DRUMMOND BASIN
Bowen-Triassic Party
BOWEN BASIN
YARROL BASIN
CARNARVON BASIN
AMADEUS BASIN
GREAT ARTESIAN BASIN
IPSWICH CLARENCE BASIN
OFFICER BASIN
Petermann Ranges Party
Surat Party
Texas High Party
EUCLA BASIN
PERTH BASIN
COONAMBLE BASIN
OXLEY BASIN
Gosse's Bluff Party
MURRAY BASIN
SYDNEY BASIN
Evaporite Drilling
OTWAY BASIN
GIPPSLAND BASIN
Eromanga Party
To accompany Record 1968/121
Aus 2/111

Bowen Basin Regional Survey

by

J.M. Dickins

Personnel: J.M. Dickins

Report Writing: For the Bulletin, draft sections on the stratigraphy have been checked and drafts prepared for the introduction, Permian Palaeontology and Economic Geology. A.W. Webb has provided MS for a section on radiometric age determinations. Some drawing of the maps and other illustrations has been done.

A joint paper with E.J. Malone was prepared on the Regional Subdivision of the Back Creek Group which has been published in the Queensland Government Mining Journal.

Bowen Triassic Project

by

A.R. Jensen and P.J. Alcock

Personnel: A.R. Jensen and P.J. Alcock

Visitors: Prof. J.C. Crowell (University of California) and Mr. V. Gostin (A.N.U.) 29/6/68 - 30/6/68; Mr. W.J. Perry (B.M.R.) 30/7/68 - 1/8/68; Dr. K.A.W. Crook (A.N.U.) 28/7/68 - 3/8/68; Mr. J.N. Casey (B.M.R.) and Dr. C.E.B. Conybeare (A.N.U.), 28/8/68 - 30/8/68; Dr. E.M. Kemp (B.M.R.) 6/9/68 - 11/9/68.

Duration of field season: 3/6/68 to 11/9/68.

Details of study: The principal aim of the 1968 field season was to establish a stratigraphic framework for the outcropping Triassic Mimosa Group. This represents the first part of a study aimed at environmental analysis of the Triassic sequence of the Bowen Basin. Sections were measured, and outcrops examined and sampled in detail in the northern, central, south-eastern, and western parts of the outcrops area (see fig. 52).

The basic tripartite division of the Mimosa Group into Rewan Formation, Clematis Sandstone and Moolayember Formation, established during regional mapping of the basin, was confirmed as a basin-wide phenomenon except in the south-eastern outcrop area where it is possible

Fig S 2

MIMOSA GROUP

BOWEN BASIN - QUEENSLAND

LOCATION OF FIELD INVESTIGATIONS

SCALE

AJ (Rt)

BH-I (Rr, Rc Ri)
AH

BA(Rt)

BB-BE(Rr)

BJ(Rc)

BF-G (Rr, Rc Ri)
AE-F

AB-D(Rt)

AC (Rt)

NEBO

CLERMONT

CAPELLA

EMERALD

BLACKWATER

ALPHA

DUARINGA

BL-BP (Rr-Rc)

SPRINGSURE

BARALABA

CB(Re)

ROLLESTON

MOURA

CG(Re)

THEODORE

AR-S(Rm)

AT(Rm)

AV(Rm)

CH(Rt-Re)

CD(Rt-Re)

CC(Rr)

TAROOM

Outcrop of Mimosa Group

Major road

CB (Re) — Measured section showing designation and unit encountered

Rr — Rewan formation
Rc — Carborough Sandstone
Re — Clematis Sandstone
Rt — Tenat Formation
Rm — Moolayember Formation

Additional sample collection sites

To accompany Record 1968/121

Q/A179

that a two-fold division would be more practical. The sandstone mapped as Clematis in this area appears to wedge out southwards, and subsurface studies will be required to examine this possibility. The correlation of Carborough Sandstone and Teviot Formation of the northern outcrop area with the Clematis Sandstone and Moolayember Formation of the southern areas appears satisfactory although there is some value in retention of the northern nomenclature when a more restricted geographic connotation is required for the northern outcrops.

Subdivisions of the Triassic formations have been mapped in places, but their precise areal extent has not been established. The Rewan Formation consists of a lower sequence of labile sandstone interbedded with grey mudstone and minor red mudstone, and an upper sequence of interbedded red mudstone and labile sandstone. This subdivision was recognized everywhere except in the south-eastern area where outcrop is insufficient to establish the lithological sequence. The upper unit is in some areas exposed in cliffs formed essentially by the more resistant Clematis Sandstone, a fact not previously recognized in descriptions of the northern part of the basin.

The Clematis Sandstone can also be divided into two units, the lower of thinly bedded, fine to coarse grained, quartz rich sand interbedded with brown, grey, and red mudstone; and the upper consisting of thickly bedded very coarse to medium grained pebbly quartz-rich sandstone with little interbedded mudstone. This subdivision is not recognized in the south-eastern outcrop area where the sandstone mapped as Clematis Sandstone contains a relatively high proportion of lithic fragments, and a light coloured matrix of uncertain origin.

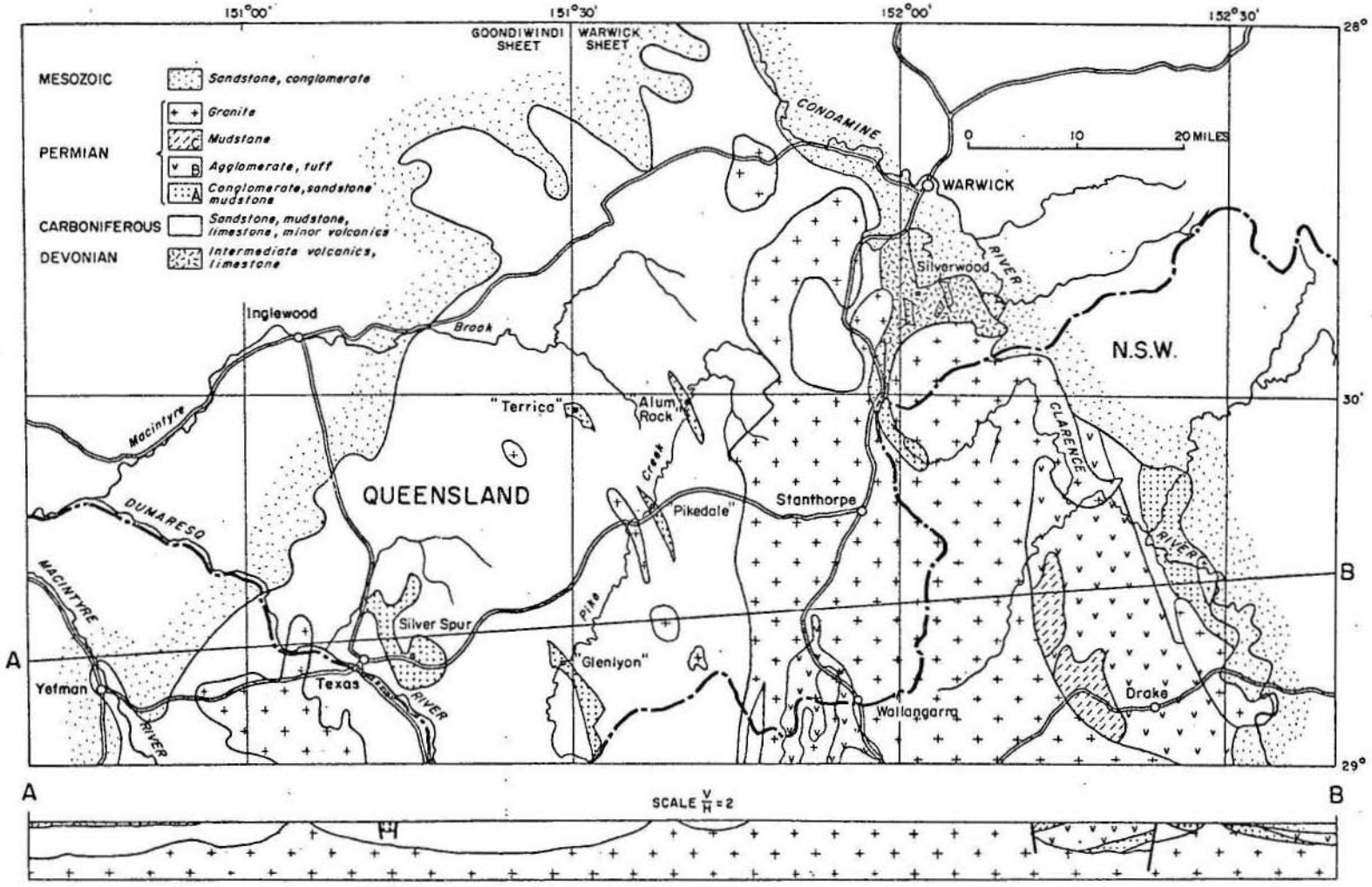
The Moolayember Formation is divisible into two units in the south-eastern and south-western (Carnarvon Range) areas, although the units do not necessarily correspond to one another across the basin. In the south-western area where the unit is about 2,000 feet thick, the lower third consists of fine to medium grained sandstone, silty mudstone and carbonaceous mudstone. This lower unit is tentatively correlated with the whole of the Teviot Formation which is only 500 feet thick. The upper unit in the south-western area consists mainly of brown mudstone interbedded with lithic sandstone and minor carbonaceous mudstone. The sandstone is more lithic than sandstone of the lower unit and it commonly contains mud clasts and, less commonly, coal laminae.

In the south-eastern area, where the unit reaches a maximum thickness of 5,500 feet, the lower third of the sequence is characterized by conglomerate and pebbly sandstone with interbedded mudstone. The upper unit consists mostly of brown mudstone with interbedded lithic sandstone.

No single criterion can be used as a basin-wide definition of the boundary between the Clematis Sandstone and the Moolayember Formation. The characters which serve to distinguish the Moolayember Formation from the Clematis are: 1) relatively high proportion of interbedded mudstone 2) more lithic sandstone 3) more thinly bedded.

FIG. S3

GEOLOGICAL SKETCH MAP – TEXAS HIGH



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AUS 1/243

One or more of these variables have been used to define the boundary between the two units. Lensing and interfingering of rock types characteristic of one or other of the units is common in the transition zone between the units, particularly in the northern area.

Measurements of the orientation of cross-bedding have not yet been evaluated. Preliminary results indicate that the Moolayember Formation was deposited by south-easterly moving currents in the northern and south-western areas, and by south-westerly moving currents in the south-eastern area.

Texas High Party

by

F. Olgers

Personnel: F. Olgers; P.G. Flood

Visitors: W.J. Perry (B.M.R.) spent six weeks mapping with the party. The N.S.W. part of the High was visited by geologists of the Geological Survey of N.S.W., and the Queensland portion of the New England batholith was studied by Mr. A. Robertson of the Geological Survey of Queensland. Fossils were collected at numerous localities, both previously established and new, and were provisionally determined in the field by Drs. J.M. Dickins and D.E. Strusz (B.M.R.). E. Druce (B.M.R.) processed the limestones of the region for conodonts. The party was visited by G.W. Tweedale (Q.G.S.).

Duration of Field Work: 3/6/68 to 25/10/68

Geology: The previously established stratigraphic nomenclature has not been used in this preliminary report because it requires extensive modification.

The Texas High (Fig. 53) consists largely of tightly folded and extensively faulted Carboniferous rocks and intrusive granite. South of Warwick is a small inlier of Devonian rocks; the remainder of the High is made up by Permian rocks which occur mainly in small infolded or down-faulted blocks, the largest of which is in the Drake region.

Devonian rocks including andesitic lava, agglomerate tuff limestone, conglomerate, chert, and fossiliferous limestone lenses crop out in a small area south of Warwick. The relationship with the Carboniferous sequence is not known. The Permian rocks are infaulted.

Carboniferous rocks occupy most of the area west and north of the batholith, and occur in a narrow north-northwest trending inlier in the Drake region. The sequence consists of monotonously interbedded, commonly graded sandstone, siltstone, mudstone and tuff, with local developments of chert, jasper, massive sandstone, intraformational conglomerate and poorly fossiliferous limestone with associated basic lavas. The conglomerates and coarser grained sandstones are mainly in the west of the area. Carboniferous fossils have been found at numerous localities, but the sequence may range down into the Devonian. The Carboniferous sequence was intensely deformed, particularly in the west, and eroded before the Permian rocks were laid down.

Permian rocks occur in five outliers west of the batholith (Silver Spur, Glenlyon, Terrica, Alum Rock, Pikedale), in four fault blocks in the Devonian strata south of Warwick, in inliers in the granite north-east of Stanthorpe (Maryland Creek) and at Wallangarra, and they occupy a large area in the Drake region east of the batholith and west of the Mesozoic sediments of the Clarence Basin.

Three subdivisions, here referred to as units A, B, and C, (from the base upward), have been made in the Permian sequence. Unit A, comprising mainly conglomerate, pebbly sandstone, and pebbly mudstone, lithic sandstone, and minor rhyolite, basalt, tuff, and limestone occurs in the outliers west of the batholith, makes up the Maryland Creek inlier and the fault blocks south of Warwick, and occupies a north-northwest trending narrow belt along the eastern margin of the Texas High. The unit unconformably overlies and is infaulted into the Carboniferous and Devonian rocks.

Units B and C are confined to the southern part of the area mapped. Unit B, comprising mainly massive agglomerate and tuff with some flows and sedimentary interbeds including a small lense of crinoidal limestone, crops out in the Drake area, where it is faulted against the Carboniferous rocks, and occurs as a large irregularly shaped roof pendant on the batholith at Wallangarra. The relationship between units A and B is not known because of faulting (see section A B). Unit C, consisting mainly of poorly fossiliferous silty mudstone, conformably overlies the volcanics west of Drake.

Intrusives The northern part of the New England batholith occupies the central part of the Texas High and intrudes the Devonian, Carboniferous and Permian rocks. Several granite types have been mapped out. Smaller granitic bodies intrude the sediments both east and west of the main batholith.

Great Artesian Basin

by

R.R. Vine

The Great Artesian Basin is a large hydrological basin containing parts or all of several sedimentary basins. Study of the basin is still mainly at the stage of stratigraphic and structural interpretation as a basis for future hydrological work. Present activity is divisible into two parts:

(a) Field mapping of parts of separate sedimentary basins; this is reported separately under the title 'Surat Basin' and 'Eromanga Basin'.

(b) Whole basin analysis.

WHOLE BASIN

Personnel: R.R. Vine, M.C. Galloway (1/6/68 - 19/10/68)

Report Writing: Stratigraphic studies made in 1967 (reported in last annual summary) developed a good understanding of sub-surface geology and its relation to outcropping sequences. Work in 1968 has been concentrated on preparing for publication a series of maps and explanatory notes in the Eromanga Basin combining the results of previous surface mapping and this new understanding of the sub-surface geology. Additionally, several records on petrological work and drilling in previous years were completed.

Wire-line logging of water bores:

Logging under the 1967 contract did not start until August 1967. After a break due to the rainy season (mid-November to February) operations were resumed in March 1968, and completed in May. During the operations gamma-ray logs were obtained from 116 bores; differential temperature logs were also obtained from 49 of the bores, and 28 of these were logged by flowmeter and caliper. Electric logs were also obtained from uncased sections of 3 bores. The combination of the logs enables some doubts about interpretation of parts of gamma-ray logs to be resolved, serves to identify aquifers and distinguish between utilized and non-utilized aquifers in flowing bores.

Logging operations under the 1968 contract started in August 1968. By the end of October about 40 bores had been logged with the gamma-ray and differential temperature tools, and nearly half of them with flowmeter and caliper. The uncased part of one bore was also logged electrically. No interpretations have yet been made on logs from the 1968 contract, but the main area in which logging was carried out is within that mapped by the Eromanga Party, and the logs will be interpreted as part of the subsurface study of that party.

Surat Basin Party

by

N.F. Exon

Personnel: N.F. Exon (party leader), B.M. Thomas (until 17/5/68), A. Medvecky (from 18/3/68), D. Burger (part time), B.M.R.; R. Reiser (G.S.Q.).

Visitors:

J. Crowell (University of California, Santa Barbara)		20/ 6/68 - 27/ 6/68
R.J. Allen, A.R. Gray	(G.S.Q.)	8/ 7/68
W.J. Perry	(B.M.R.)	26/ 7/68 - 29/ 7/68
P. Mann	(B.M.R.)	2/ 8/68 - 5/ 8/68
T. Langford-Smith, H. Stockwell	Geography Dept. University of Sydney	6/ 8/68
R. Gould	(University of Queensland)	16/ 8/68 - 19/ 8/68
J.N. Casey	(B.M.R.)	31/ 8/68 - 2/ 9/68
E. Conybeare	(A.N.U.)	
P. Alcock	(B.M.R.)	12/ 9/68 - 13/ 9/68
E. Kemp	(B.M.R.)	12/ 9/68 - 23/ 9/68
R. Vine	(B.M.R.)	16/ 9/68 - 29/ 9/68
D.J. Casey	(G.S.Q.)	7/10/68 - 9/10/68
G. Tweedale	(G.S.Q.)	7/10/68 - 12/10/68

Duration of Field Work: 7/6/68 to 21/10/68.

Area Mapped: Dalby, Goondiwindi, Warwick.

Scout Drilling: Period 20/10/67 to 10/11/67

A BMR Mayhew 1000 rig drilled 2520 feet and cored 410 feet in 10 holes (7 on Chinchilla and 3 on Surat)

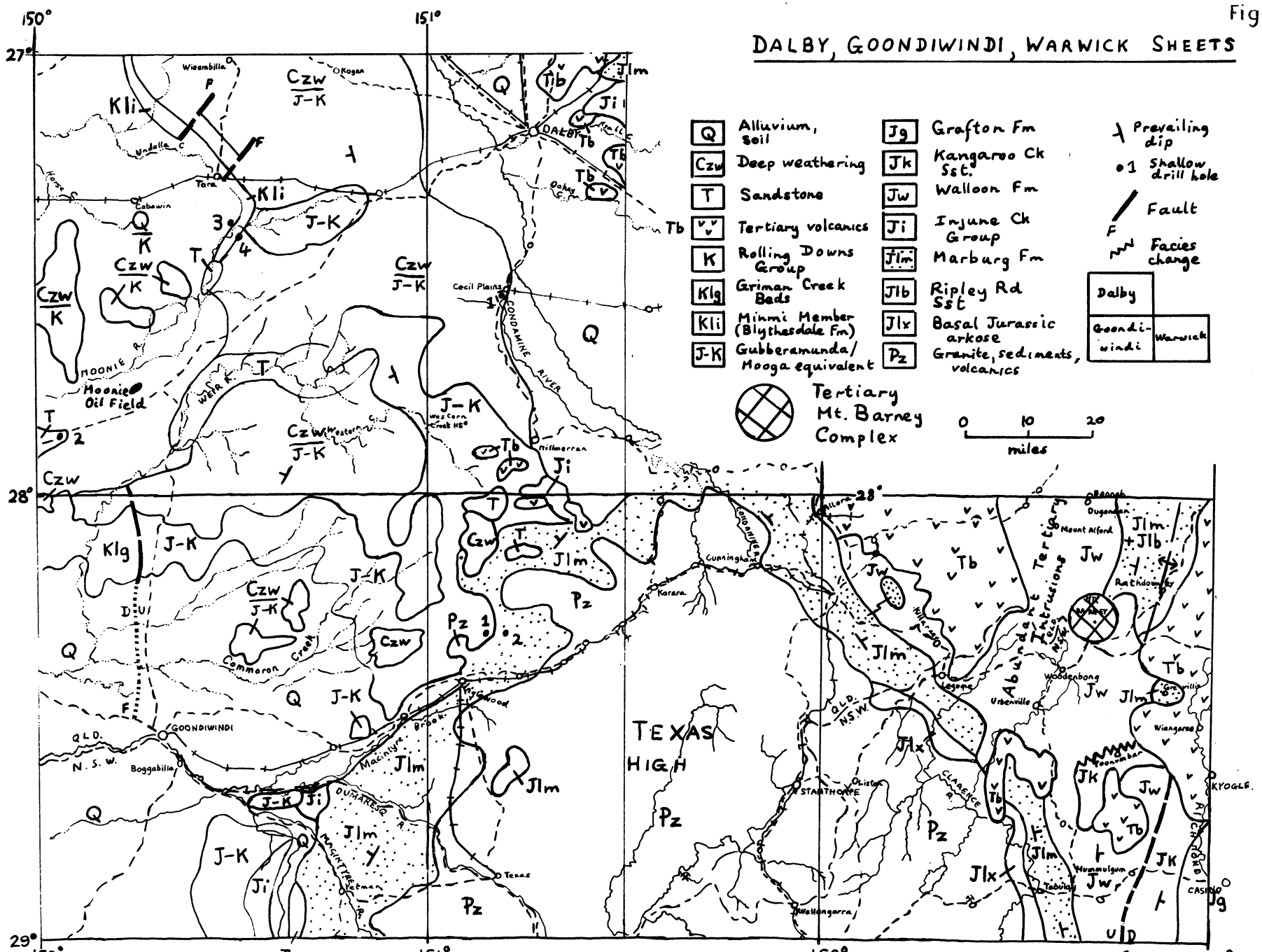
Period 1/7/68 to 1/8/68

A BMR Fox-Mobile rig drilled 1300 feet and cored 130 feet in 7 holes (1 on Chinchilla, 4 on Dalby and 2 on Goondiwindi).

Period 28/10/68 to 29/11/68

Drilling of holes on Goondiwindi and Warwick commenced, using a BMR Fox-Mobile rig.

DALBY, GOONDIWINDI, WARWICK SHEETS

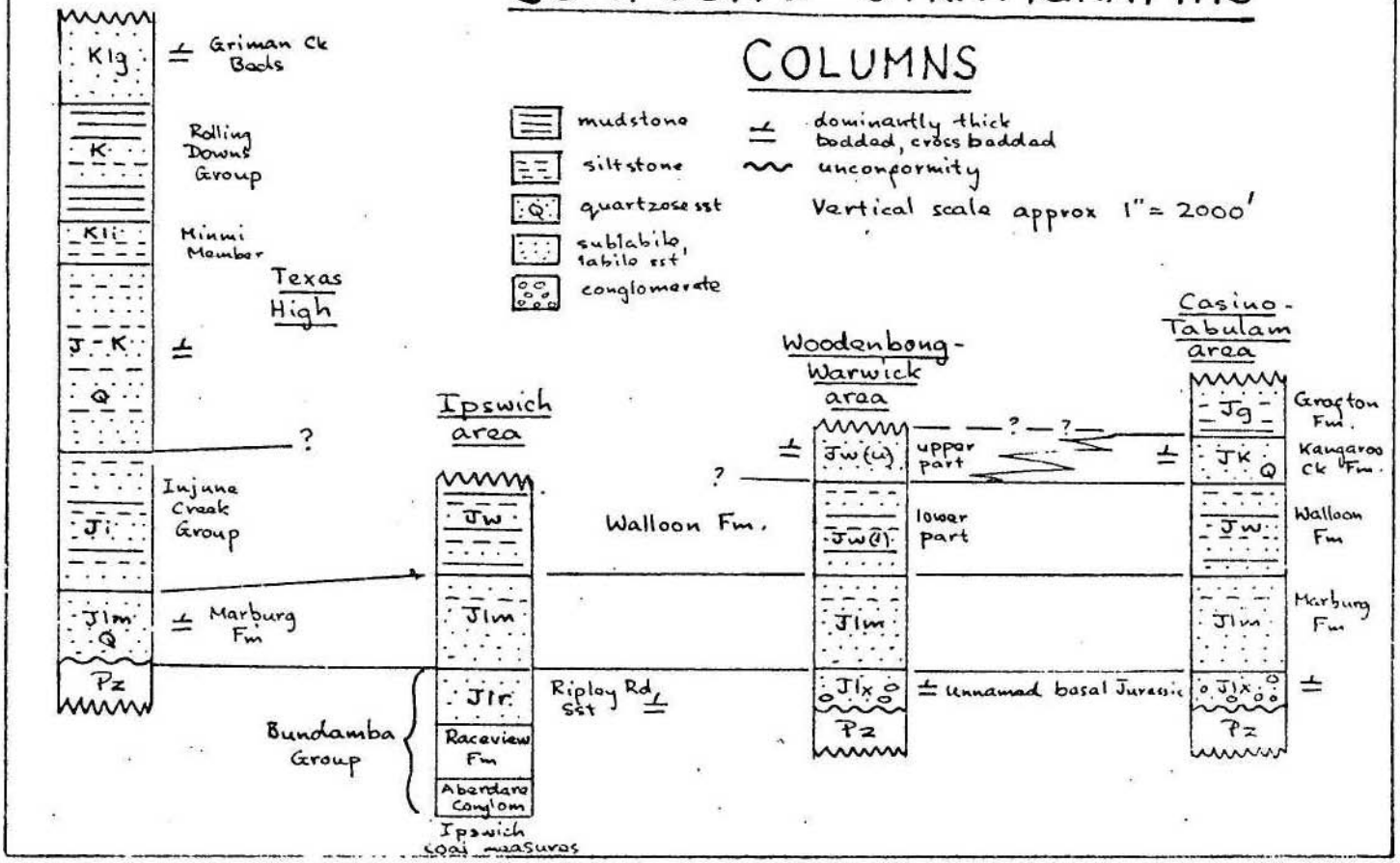


To accompany Record 1968/121

Fig.S4

AUS 3/75

COMPOSITE STRATIGRAPHIC COLUMNS



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Most of these holes were drilled for one or more of the following purposes:

(1) Obtain lithological information on formation boundaries.

(2) Obtain palynological information for age and correlation.

(3) Discover the bulk lithologies of poorly outcropping units.

All were successful in one or more of these aims. Unfortunately electric and gamma logs for correlation purposes were generally not obtained because of logger breakdowns. Chinchilla No. 1 was drilled to sample a bentonite sequence for testing, and it also was successful.

Geology: The area mapped (fig. S4) forms part of the eastern side of the Surat Basin and the western side of the Clarence/Moreton (Ipswich) Basin. Rocks of Jurassic to Quaternary age, and their unconformable contact with the underlying Palaeozoic sequence, were mapped. The Palaeozoic sequence - siliceous sediments, volcanics and granites - forms the Texas High, which separates the two basins in this area. The Mesozoic sequence is conformable throughout.

Exposed sequence

1. On the western side of the Clarence/Moreton Basin massive arkoses and conglomerates (Jlx; Fig. S5) derived from local sources, overlie the Palaeozoic (basement) complex. This sequence is up to 500 feet thick, but pinches out north of Warwick. It is quite unlike the Bundamba Formation lithologically, although the bedding features are similar. Hence we suggest that a new name should be applied to it instead of the name "Bundamba Formation" used by earlier workers.

2. Right around the Texas High a fairly well bedded, cross-bedded sequence of quartzose to feldspathic sandstone (Jlm) with some conglomerates is present. This is more labile east of the high where it is identical to the Marburg Formation of the type area. West of the high it appears to have been transported further, and is cleaner. This unit is derived entirely from granites and Palaeozoic rocks, in varying proportions. It is about 800 feet thick.

3. East of the Texas High the coal-bearing Walloon Formation (Jw) (up to 1500 feet of labile sandstone, siltstone and mudstone) overlies the Marburg Formation. The lower part of the unit as exposed in the type area is dominantly fine grained and thinly bedded. However, along the State border an upper, sandy, thickly bedded part overlies the lower part. This varies from feldspathic to sublabile.

West of the Texas High the same interval is represented by the Injune Creek Group (Ji) which consists largely of fine grained, thinly bedded labile sandstone and siltstone. Although everywhere present in oil wells (up to 2000 feet thick), and present in the north and south in outcrop, it pinches out against the high in the area around Inglewood.

4. In the Clarence/Moreton Basin there is about 500 feet of quartzose, thickly bedded, crossbedded sandstone, the Kangaroo Creek Sandstone (Jk), overlying typical Walloon sediments in the area south of Kyogle. We have found that this is an equivalent of the upper part of the Walloon Formation in Queensland. In the area around Toonumbar there is a transitional sequence with quartzose sandstone at the base grading up into typical Walloon sediments.

5. A lithic sandstone, siltstone and mudstone unit, the Grafton Formation (Jg), is the youngest Mesozoic formation in the Clarence/Moreton Basin. It may range into the Cretaceous. It does not occur north of Kyogle and it is not known whether it is equivalent, in part, to the upper Walloon of Queensland.

6. In the Surat Basin is a sequence of about 2000 feet of labile to quartzose sandstone with lesser siltstone and mudstone (J-K) overlying the Injune Creek Group. This is equivalent to the Gubberamunda Sandstone, Orallo Formation and Mooga Sandstone of the Roma area. Although this sequence can be subdivided in oil wells to the west, it cannot be in outcrop.

7. Overlying unit J-K, the Minmi Member of the Blythesdale Formation (Kli) can be recognized as far south as Tara. On eastern Roma this is equivalent to the Minmi, Nullawurt and Kingull Members near Roma town. This unit crops out poorly on Dalby as a fine clayey sandstone. In the subsurface glauconitic sandstone and carbonaceous siltstone and mudstone predominate. The unit is about 400 feet thick.

8. In general, the various overlying units of the Rolling Downs Group (K) crop out poorly. The only area in which the group could be confidently subdivided (although subdivisions are evident in well logs) is northwest of Goondiwindi where typical sediments of the Griman Creek Beds (Klg) crop out. These are dominantly medium grained labile sandstone, glauconitic in part, and contain rare freshwater pelecypods.

9. Deep weathering, especially of the porous unit J-K, is very widespread on Dalby and northern Goondiwindi. A profile of perhaps 10 feet of ferruginized and silicified material, and 100 feet of leached pallid material is typically developed. This forms plateaux which obscure the true dip of the Mesozoic sediments. Variable stripping of the profile has occurred, and relatively unaltered sediments are commonly found in creek beds.

10. Quaternary deposits are very extensive on Dalby and Goondiwindi, alluvium and residual soils covering most of the western third of these Sheets. The Condamine, Dumaresq and Macintyre Rivers, in particular, have very broad flood plains. Deposits of the Condamine River are up to 400 feet thick and contain Pleistocene vertebrates.

11. Eastern Warwick is physiographically dominated by the products of Tertiary volcanism, and there have been many workers in this field. Acid and intermediate plugs, sills and dykes occur in profusion from Mount Alford to Urbenville - almost always in areas of Walloon sediments. The most spectacular of these is the Mount Barney Complex consisting of plugs, ring dykes and sills of granophyre and other acid rock types. A similar complex exists at Mount Alford.

Extensive volcanism is related to two major areas - that of the Main Range north of Legume and that of the Mount Warning Shield Volcano near Tweed Heads. In both areas the volcanic cycle is similar, although trachyte is the dominant "acid" volcanic in the Main Range and rhyolite in the Mount Warning sequence.

In the Main Range more than 1000 feet of basalt, interbedded with massive trachyte flows, each up to 400 feet thick, makes up the lower part of the sequence. The upper part of the 3000 feet thick Main Range Volcanics is entirely basaltic.

The Mount Warning Volcano provided up to 2000 feet of basalt, overlain by many hundreds of feet of rhyolite, tuff, agglomerate and conglomeratic sediments (Binna Burra Rhyolite, Nimbin Rhyolite etc.). Another 1000 feet of basalt completes the sequence.

We believe that the acid and intermediate extrusives are local phenomena and any widespread subdivision of the volcanic sequence based on their occurrence would be erroneous. Certainly, in the Main Range at least three trachytes separated by basalt occur at Spicer's Gap. "Acid" volcanism probably occurred in the same broad period everywhere, but each flow could be of a different age to the next. The area just east of the Main Range, with its numerous intrusions, was a focus for much of the acid volcanism. The numerous basaltic sills and dykes suggest that some basaltic eruptions were also centred in this area. Other vents could be obscured by the Main Range sequence.

Radioactive dating of basalts in the Main Range indicates an early Miocene age for much of the volcanism, and this age can probably be applied to all the Tertiary volcanism of this area. The faulting and warping of the basin probably terminated with this volcanism.

Major advances on earlier ideas

1. The Goondiwindi Fault (Goondiwindi) was identified at the surface whereas previous workers had recognized it only in the subsurface.

2. On Dalby and Goondiwindi the subdivision "Bundamba, Walloon, Blythesdale" has been re-identified after careful tracing from east and west as "Marburg, Injune Creek Group, J-K".

3. The "Bundamba-Marburg" sequence as mapped on southern Warwick has been shown to be erroneous. Most of this sequence is typical Marburg. The basal arkose Klx, which is only part of the "Bundamba" as shown on earlier maps, can be mapped separately and should be given a new name.

4. The Kangaroo Creek Sandstone is an equivalent of the upper part of the Walloon Formation.

5. There is very little rhyolite in the volcanic sequence of the Tweed Range just east of Warwick.

Subsurface sequence. A sedimentary sequence of Permian to Lower Cretaceous age overlies pre-Permian basement rocks. Oil is produced from the Lower Jurassic Precipice Sandstone at Moonie.

Miscellaneous. Bentonite and coal are very common in the Walloon Formation of Warwick. Neither is worked at present.

At the beginning of the season Exon accompanied J. Crowell (University of California) and A.G. Kirkegaard (GSQ) on a re-examination of presumed glacigene rocks on Springsure. Glaciers were present nearby during deposition of the lower part of the Joe Joe Formation (Upper Carboniferous or Lower Permian) and the Cattle Creek Formation (Lower Permian). The Ingelara Formation (Lower Permian) may or may not be glacigene. The Peawaddy Formation (Upper Permian) is not glacigene.

EROMANGA BASIN PARTY 1968

by

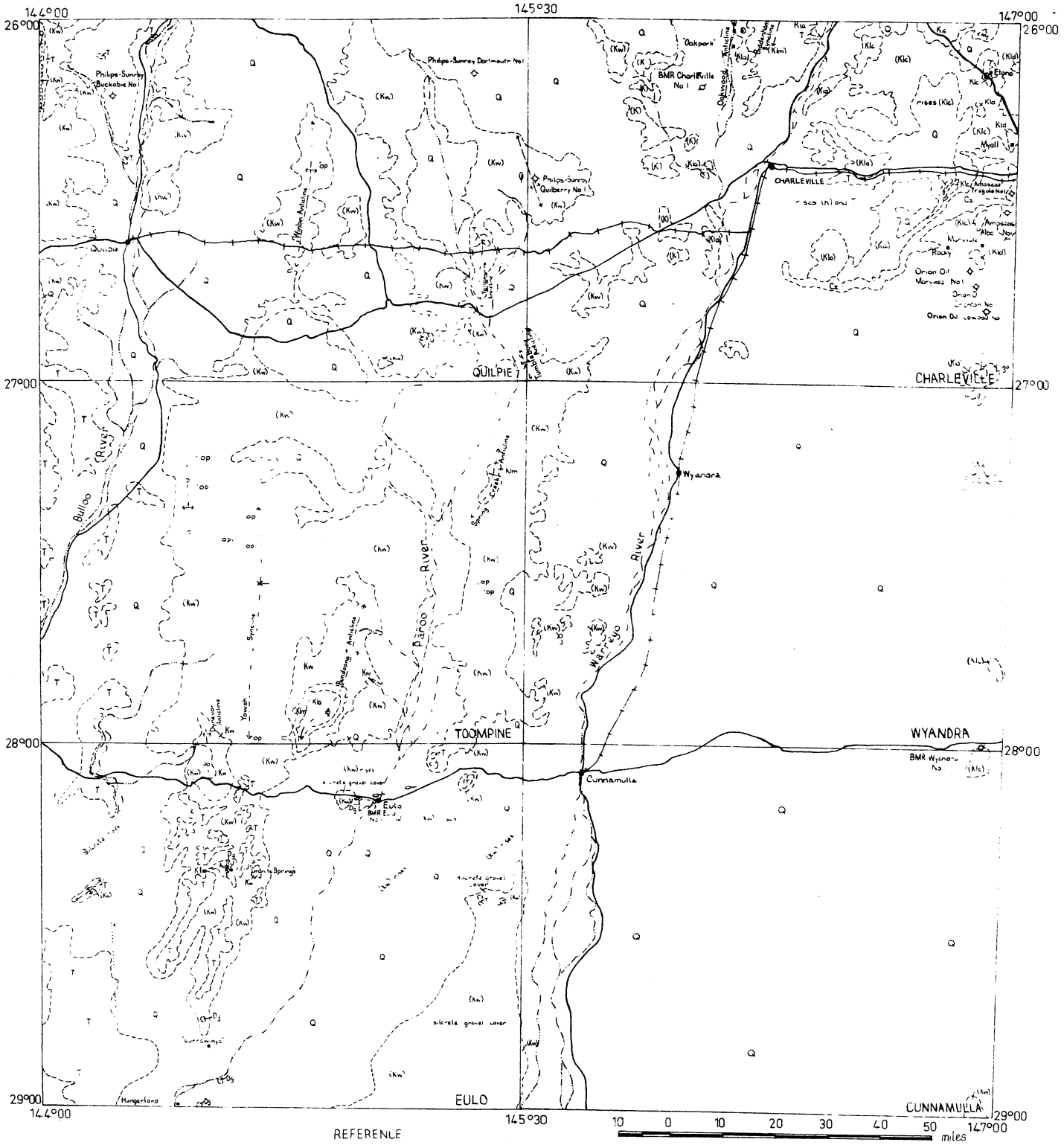
B.R. Senior

Personnel: B.R. Senior (Party Leader), J.A. Ingram, B.M. Thomas, Daniele Senior

Visitors:			
	J. Brooks	Q.G.S.	25/ 6/68 - 25/ 6/68
	R.R. Vine	B.M.R.	2/ 6/68 - 17/ 5/68
			and 1/ 9/68 - 22/ 9/68
	Prof. J.A. Mabbutt	Univ.of N.S.W.	1/ 9/68 - 22/ 9/68
	M. Plane	B.M.R.	30/ 8/68 - 5/ 9/68
	Dr. P. W. Williams	A.N.U.	30/ 8/68 - 5/ 9/68
	Prof. R.A.Binns	Univ.of New England	21/10/68 - 24/10/68
	Dr. J. Veevers	Macquarie Univ.	18/ 8/68 - 19/ 8/68
	A. Rundle	" "	18/ 8/68 - 19/ 8/68
	P. Campbell	" "	18/ 8/68 - 19/ 8/68
	Prof. T. Langford Smith	Univ. of Sydney	8/ 8/68 - 8/ 8/68

LOCALITY AND PROGRESS MAP: EROMANGA BASIN 1968.

Fig. S6



REFERENCE

QUATERNARY	Q	Alluvium, sand, red soil, gravel
CAINOZOIC	Cz	Quartz sandstone, conglomerate
TERTIARY	T	Silcrete, quartz sandstone
WINTON FORMATION	Kw	Labile sandstone, siltstone, mudstone
MACKUNDA Fm	Klm	Sandstone, siltstone, mudstone
ALLARU MUDSTONE	Kla	Mudstone, siltstone
TOOLEBUC LIMESTONE	Klo	Limestone, coquinite
WALLUMBILLA Fm	Klc	Corexina Member: Sandstone, siltstone, mudstone, intraformational conglomerate
	Kld	Doncaster Member: Mudstone, in part calcareous
	Dg	Devonian? metamorphics: green schist, chlorite, minor pegmatite and quartz veins

Brackets around symbol indicate chemically altered (leached, ferruginized, and silicified) sediments

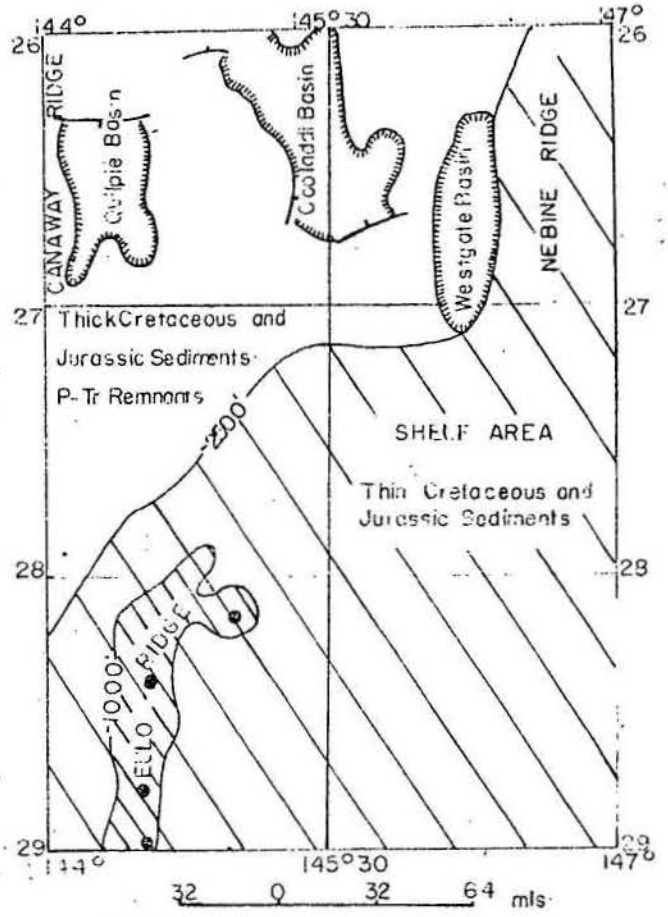
- Fault, inferred
- Fault
- Anticline
- Syncline
- Dry and abandoned oil exploration well
- BMR Stock Hole
- Fossil locality
- Plant fossil locality
- Fossil bone locality
- Opal mine
- Homestead
- Spring
- Abandoned gold mine

To accompany record 1968/121

Q/A180

GENERALIZED SUB-CROP & TECTONIC MAP.

Fig. 2.a



LEGEND Diagram 2a.

- Margin of Pre-Permian Basin Sediments
- Basement contour
- Granite outcrop
- Fault- tick on downthrown side

P ~ Permian
Tr ~ Triassic

Fig. S7a

Rock Relationship Diagram: Granite Springs Area

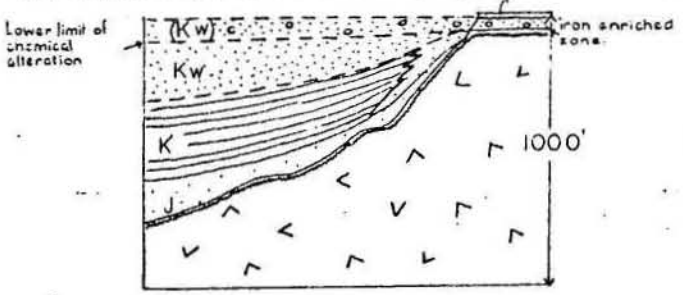
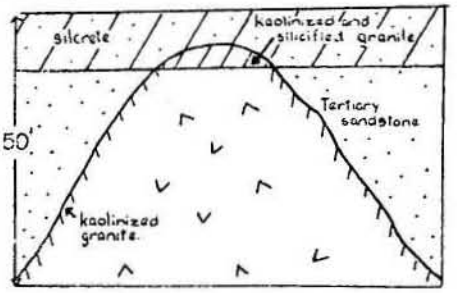


Fig. S7b

Relationship of Silcrete to the Granite: Currawinya Area



LEGEND Diagram 2b.

Tertiary	T	Silcrete (Silicified quartz sandstone)
Cretaceous	(Kw)c	Chemically altered (leached, silicified, & ferruginized) sediments Prolific ironstone on contact with granite
	Kw	Labile sandstone
	K	Massive mudstone & shallow marine shelly sandstone
Jurassic	J	Sandstone (quartz)
Devonian		Granite

Area Mapped: Quilpie, Charleville, Toompine, Wyandra, Eulo and Cunnamulla 1:250,000 Sheet areas.

Aircraft Survey: A Cessna 182 chartered from Goss Air Taxis was flown for a total of 43 hours in 9 days, excluding positioning time. It was used to plot positions of water bores, main roads, and homesteads which post date the aerial photography, and for geological reconnaissance. The aircraft saved several weeks of field time.

Geology: Figure S6 is a generalized geological map which shows the major structural features and includes a generalized description of each rock unit.

The mapped area lies in the eastern part of the Eromanga Basin and is separated from the Surat Basin by the basement Nebine Ridge. This ridge trends south and broadens into a shelf area. Cretaceous and Jurassic sediments in this area are approximately 2000 feet in thickness. A second shallow basement ridge, the Eulo Ridge, is represented by several granite outcrops. North west of the shelf area the depth to the basement gradually increases, with possibly Triassic and thick Jurassic sediments occurring. Three geophysically - defined pre-Permian Basins occur in this area. These basins have steep faulted margins, and are structural remnants of the Adavale Basin. Up to 20,000 feet of sediments are preserved in these basins. The morphology of the basement is shown on the generalized sub crop and tectonic diagram (Fig. S7a).

The Jurassic and marine Cretaceous sedimentary cover thins towards the Eulo Ridge. Littoral deposits occur locally, indicating that the ridge was an elevated area during the sedimentation. The present granite outcrops were islands for part of the time in the Cretaceous sea, and some may not have been completely submerged during the Cretaceous marine transgression (Fig. S7b).

Chemically altered (kaolinized, ferruginized, and silicified) Winton Formation sediments were formed during a period of deep chemical weathering in Upper Cretaceous or early Tertiary, time. These sediments are widespread and are usually overlain unconformably by Tertiary quartz sandstone. Within the Tertiary sandstone are highly indurated silcrete beds (silicified quartz sandstone). Silcrete scarps 10 to 20 feet thick are especially well represented on Eulo Sheet. Silcrete is normally confined to quartz-rich host rocks. Near Currawinya homestead the top 4 feet of the granite outcrop, together with the Tertiary cover are silicified to silcrete. The silicified granite indicates that it was close to the landsurface at the time of silicification in early ?Tertiary time. (Fig. S7c).

In the Eulo Ridge area Jurassic aquifers lie very close to the land surface. Where they are at the surface there are springs of clear water. Where the aquifers are close to the surface any fracture, joint, or fault allows seepage which brings up mud derived from the Cretaceous mudstones. The mud dries when it reaches the surface forming a hard crust. Numerous detrital pebbles and some boulders are elevated by the continual upward movement of the flowing mud.

The maximum height of the mounds is 20 feet. Cretaceous concretions incorporated in the flowing mud are transported to the surface. Carbonate coatings and deposits of tufa in many areas on Eulo Sheet, suggest that spring activity was formerly much more active than at present.

Drilling Results: A BMR Fox Mobile rig drilled 22 stratigraphic scout holes on 8 Sheet areas in the Eromanga Basin. A total footage of 3100 feet was achieved. This figure includes 440 feet of coring, of which 332 feet of core was recovered.

Drilling activity in the Eromanga Basin was divided into three phases.

1. Follow up drilling in areas adjacent to the mapped area, which involved 3 holes with 1170 feet of drilling and 80 feet of coring.

2. Opalfield drilling to test the feasibility of using a drilling rig for prospecting for precious opal.

3. Stratigraphic drilling within the mapped area.

The reasons for drilling and synopsis of results are summarized below:

Downfolded Tertiary sediments below 170 feet of Quaternary and late ?Tertiary deposits were intersected in Canterbury Scout No. 4. This hole was sited near the axis of the Cooper Syncline and was successful in confirming the presence of this major synclinal feature.

Cores for palynological determination were recovered from Windorah Scout No. 5. It is hoped to establish the upper age limit of the Winton Formation from a study of the spores and pollens.

Bulloo Scout No. 1 was drilled for stratigraphic information. It established the thickness of the Winton Formation and a core of Mackunda Formation was recovered, in an area where the presence of the Mackunda Formation had been in doubt.

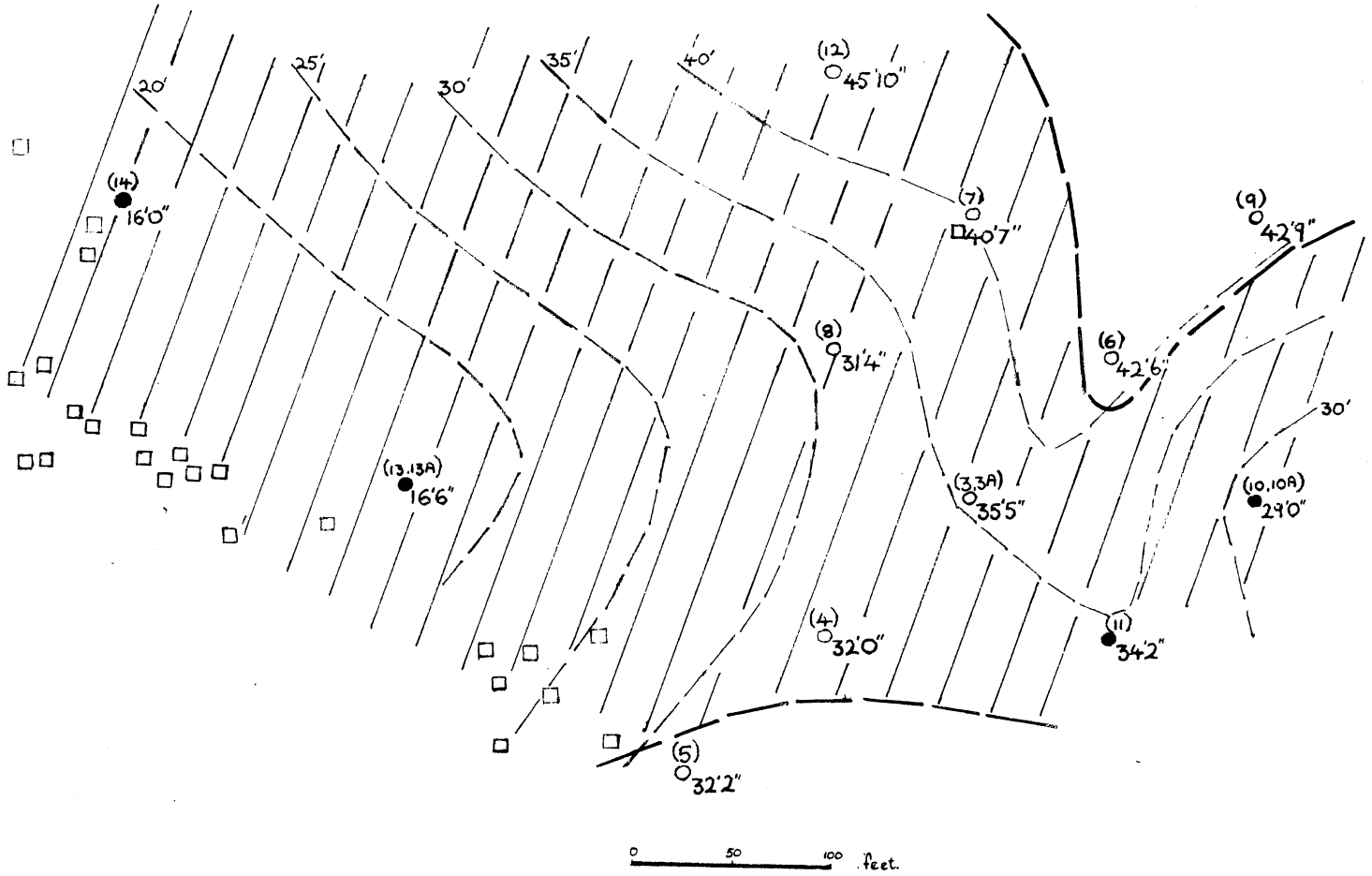
The opal field drilling (Fig. S8) was carried out primarily to see if a rig could be usefully used as a prospecting tool. Drilling was mainly at 100 feet centres. It enabled an opalized band to be followed and some precious opal was obtained in a few cores. It is likely, therefore, that a small rig could be used economically to prospect for extensions of known opalized bands.

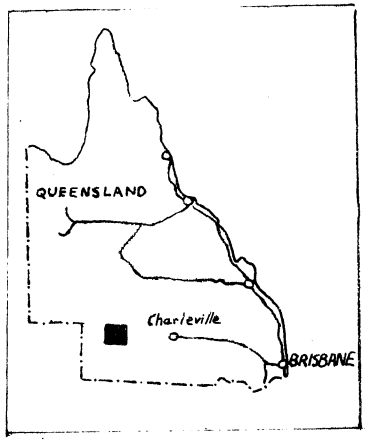
The precious opal occurrences were all at structurally high levels but extremely localized. The amount of drilling was insufficient to provide any worthwhile addition to the discussion of the current theory that, in an area of opalization, precious opal is generally confined to the bottoms of basins.

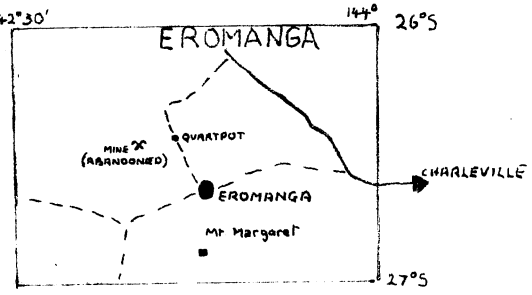
Eulo Scout No. 1 was drilled to a total depth of 490 feet. The hole was successful in determining the nature of the Cretaceous and Jurassic sequence and to collect cores for palaeontological study.

RESULTS OF DRILLING AT QUARTPOT OPAL MINE EROMANGA

Fig S 8







20' Contours on opaline horizon

Area of opalisation
– blue potch and precious opal

□ Shaft

(4) ○ B.M.R. scout hole – number

○ 32'2" Depth to opaline horizon below arbitrary datum

● Depth to precious opal horizon below arbitrary datum

To accompany record 1968/121

G54/A12/3

Charleville No. 1 was drilled near the axis of the Oakpark Anticline and Wyandra No. 1 was drilled on south east Wyandra Sheet. Both were drilled to identify Cretaceous Formations and to collect cores for palynology.

A suspected meteorite crater was drilled on Dirranbandi Sheet area. Three holes were drilled to depths of 270, 50, and 100 feet. The results were negative; only late Tertiary and Quaternary unaltered sediments were intersected.

Mobile Conodont Laboratory

by

E.C. Druce

Personnel: E.C. Druce, P.J. Jones.

Duration of Field Work: 3/8/68 to 26/10/68

Area Studied: Boulia region, Western Queensland, Stanthorpe area, South Queensland.

Scout Drilling: A BMR Leyland Fox rig drilled 12 holes to a total depth of 1475 feet of which 101 feet were cored. The holes were drilled on Boulia (2) Glenormiston (9) and Mt Whelan (1).

Drilling Results: Conodonts were recovered from all cores except Boulia 1A which penetrated dolomite at 289 feet and Glenormiston 10 on Mt Whelan which penetrated 160 feet of Middle Cambrian ("Devoncourt" equivalent). One unexpected result was the considerable thickness of ?Marion Formation in the region of 21 mile bore (Glenormiston), up to 140 feet in Glenormiston 4.

Geology: In the region west of Boulia it was possible to recognize conodont zones erected by Druce & Jones in the Black Mountain area to the east. It appears that all members of the Ninmaroo Formation are diachronous, and are younging.

Very poor conodont recovery, about 4.0% was encountered in the Stanthorpe region and only one fauna was identified as Lower Devonian this came from Silverwood on the Warwick Sheet.

Other Work: The Mobile Conodont Laboratory spent one week in April (15th - 19th) in the Wellington area of N.S.W. collecting conodonts from the Lower Devonian Garra Formation.

Queensland Mammals

by

M.D. Plane

Fossil Mammals of the Carl Creek Limestone, N. Queensland. New and interesting fossil mammal material was obtained from the Carl Creek Limestone, near Riversleigh Station in Northern Queensland. This material will add substantially to our knowledge of the ?late Oligocene - early Miocene faunas of Northern Australia. Here, as at Canfield, the power driven hammer has made the collecting of specimens practicable whereas previously no effective method existed for obtaining specimens embedded in hard limestone. Laboratory preparation of this material has commenced.

The South-west Eromanga Basin party discovered fossil vertebrates on Penaroo Station during regional mapping west of Eulo. Further collections were made in the field and crocodiles, varanid lizards, turtles and fish, as well as the marsupial genera Diprotodon, Zygomaturus, Wallabia, Sthenurus and Procoptodon, have been identified. This assemblage allows us to date the deposits from which they were collected as late Pleistocene.

Wiso, Daly, and Georgina Basins

by

M.A. Randal

Personnel: M.A. Randal, M.C. Brown (part-time), K.G. Smith (transferred to Petroleum Exploration Branch, March 1968)

Field Work: No field work relevant to the Wiso and Daly Basins was undertaken this year. In the Georgina Basin, M.A. Randal spent the period mid-March to late May collecting bore-water samples in the Camooweal, Mount Isa, Urandangi, Glenormiston, Sandover River, and Tobermory Sheet areas. Other than detailed work on specific problems by the Georgina Phosphate Party (reported elsewhere) no geological mapping was undertaken in the Georgina Basin. The year's activities have been mainly report writing and map compilation based on previous field seasons, and can be divided into two aspects - geological and hydrogeological.

Geological Reports and Maps: The explanatory notes and compilations for first edition geological maps of the Helen Springs (Randal & Brown), Beetaloo (Brown & Randal), Newcastle Waters (Randal), Daly Waters (Brown), and Larrimah Sheet (Randal) areas were completed and edited, and are now in press. The explanatory notes and geological compilation of the Bonney Well Sheet area (Smith) are with the map editors; the preliminary map of this area was issued early in the year. The explanatory notes and first edition geological map of the Elkedra Sheet area (Smith) was published. K.G. Smith corrected the first edit of Bulletin 111 - The Geology of the Georgina Basin - and the manuscript is again with the editors.

M.C. Brown prepared a record on Middle Cambrian and (?)Upper Cambrian sedimentary rocks in the northern part of the Northern Territory, and it is now being edited within the section. This report deals with outcrop, scouthole, and waterbore data from the Wiso and Daly Basins, and the Barkly Tableland portion of the Georgina Basin. It delineates two types of sequence in all three basins - an older sequence of mainly carbonate rocks containing early Middle Cambrian shelly fossils, and an overlying sequence of red sandstone, siltstone, and carbonate rocks which may extend into the Upper Cambrian.

Hydrogeological Investigations:

Randal continued work on a bulletin on the groundwater in the Wiso Basin and environs. This bulletin synthesizes the hydrological and geological data of over 500 waterbores and 20 scoutholes in the area from Katherine to Tennant Creek and westward to Hooker Creek and Wave Hill. The report describes the geology of the three geological basins involved and their relationships, and discusses the effect of geological structure and environment on the occurrence and geochemistry of the groundwater. The region under discussion adjoins the central part of the Barkly Tableland, the groundwater regime of which was previously studied and described in Bulletin 91: the newer study supports the conclusions made in the previous one.

During the year over 500 waterbores in the south-eastern part of the Georgina Basin were linked by barometric traverse to third order instrument-levelled benchmarks, and water samples for detailed analyses were obtained from 380 of them. During the programme water conductivity and temperature were measured in the field. This work is part of the continuing study of the effects of lithology and geological structure on the occurrence and quality of groundwater in the mainly carbonate rocks of the Georgina Basin. Very little of the data from the 1968 survey have yet been studied and collated. However, preliminary salinity contours based on the field conductivity measurements indicate an increase in salinity basinwards off the Precambrian rocks of the Mount Isa region in the east. There is an increase in salinity southwards along the Georgina River Drainage system which confirms a trend noted earlier in the Ranken and Avon Downs Sheet areas (Bulletin 91). This study will continue during 1969 and the results will ultimately be published as a Bulletin.

Miscellaneous: M.A. Randal visited the Victoria River Party during helicopter operations in the Fergusson River Sheet area. Revisits to various outcrops of the Adelaidean Tolmer Group (erected by Randal in 1963) were made with geologists of that party to acquaint them with the characteristic features of the unit in an effort to enable correlations to be made with other Adelaidean units to the south in the Delamere and Auvergne Sheet areas. The results of this work are reported in the summary prepared by that party.

In August the New South Wales Geological Survey organized a field study tour for university lecturers in stratigraphy, and Randal accompanied the tour as the invited B.M.R. representative. The tour was mainly of Lower Palaeozoic rocks of the Bancannia Trough, west of the Darling River, although Adelaidean rocks near Broken Hill, and Cretaceous rocks about Milparinka and Tibooburra were also examined. Representative specimens from the various sequences - especially carbonate rocks - were collected, and will be lodged in the museum.

NORTHERN TERRITORY

Amadeus Basin - Petermann Ranges Party

by

D.J. Forman

Personnel: D.J. Forman, R.N. England, R.W.R. Rutland (Adelaide University, 30/6/68 to 4/7/68).

Duration of Fieldwork: 23rd May to 13th August.

Area Mapped: Detailed mapping of 150 square miles in the Petermann Ranges and Pottoyu Hills between Ruined Ramparts and Curdie Range. Metamorphic mineral reconnaissance along Petermann Ranges and Olia Chain (130 miles).

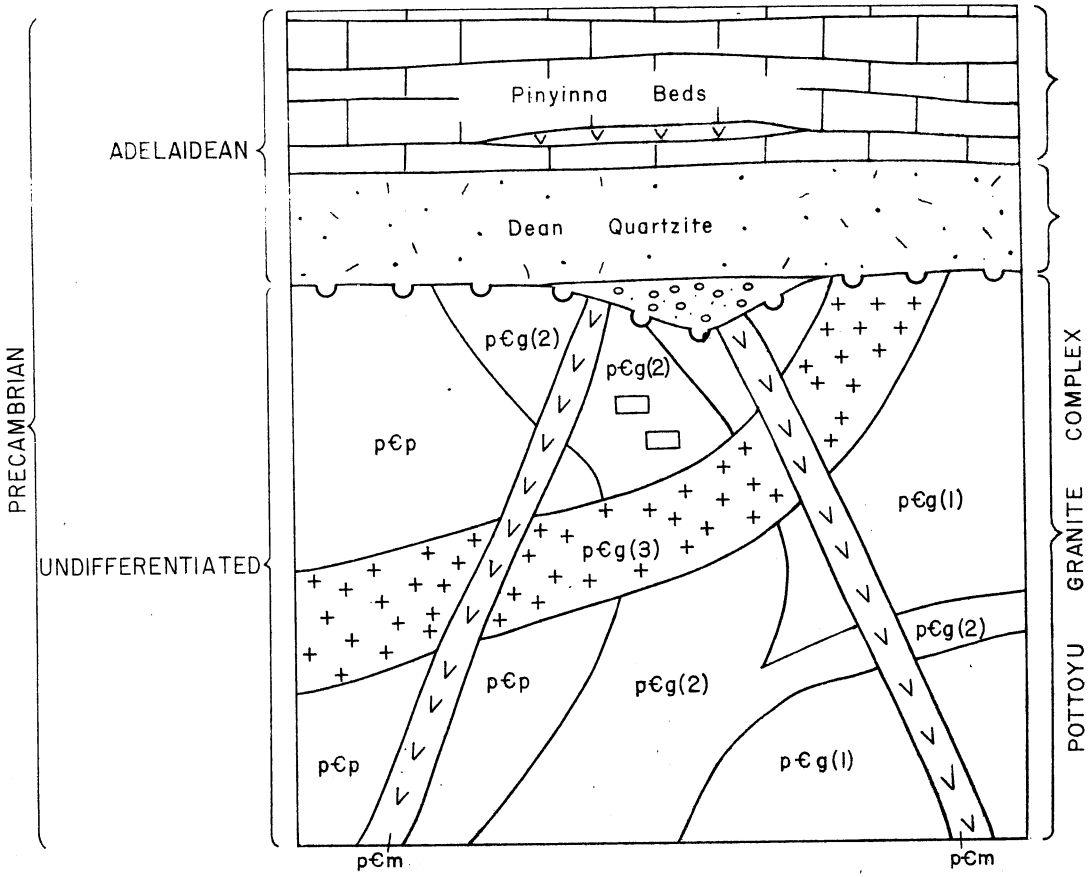
Geology: A part of the synclinal core of the Petermann Ranges Nappe and the granitic rocks beneath it were mapped to establish:-

(a) the stratigraphic and structural relations,
(b) the metamorphic history and the grade of metamorphism before and after nappe formation.

The stratigraphic and structural relations in the area between the Ruined Ramparts and Mount Curdie are summarized in figure S9. The oldest rocks in the area form the Pottoyu Granite Complex. The complex contains at least three types of granite and a porphyry. The oldest granite is very coarsely porphyritic and contains large ovoid phenocrysts of microcline.

Fig. S9

RELATIONSHIP OF ROCK UNITS — PETERMANN RANGES



Quartz – actinolite – biotite – epidote schist
Quartz – sericite schist
Quartz – talc – dolomite schist
Calcite schist, dolomite schist
Quartz – chlorite – sericite – carbonate schist
Kyanite quartzite
Kyanite – muscovite – quartz schist
Kyanite – muscovite – ? pyrophyllite – quartz schist. Quartzite

POTTOYU GRANITE COMPLEX

p€m *Mafic dykes metamorphosed to quartz – actinolite – biotite – epidote schist (includes gabbro metamorphosed to biotite – garnet tremolite – actinolite rock)*

p€p *Quartz – feldspar porphyry*

p€g(3) *Fine, medium and coarse, even-grained granite*

p€g(2) *Coarse porphyritic granite (phenocrysts ovoid to subhedral)*

p€g(1) *Very coarse porphyritic granite (very large ovoid phenocrysts)*

} *metamorphosed*

To accompany Records 1968/121

G52/A7/2

It is intruded by a coarse porphyritic granite with ovoid to subhedral phenocrysts. Both these granite types and a large body of quartz-feldspar porphyry are intruded by a fine, medium and coarse, even-grained granite. The quartz-feldspar porphyry is in intrusive contact with the coarse porphyritic granite (pεg(2)) but relative ages are not known. The three granite types and the quartz-feldspar porphyry are intruded by mafic dykes. The Pottoyu Granite Complex and the mafic dykes that intrude it are overlain unconformably by the Dean Quartzite. Valley fills of conglomeratic quartzite occur over the uneven unconformity surface at several localities. The Pinyinna Beds conformably overlie the Dean Quartzite.

The metamorphic history: Regional mapping had previously established that the Pottoyu Granite Complex intrudes the Olia Gneiss.

The metamorphic and geological history is as follows:-

(1) Metamorphism of the Olia Gneiss
(2) Intrusion of the Pottoyu Granite Complex (about 1.2 b.y.age)
(3) Intrusion of mafic dykes
(4) Weathering and erosion
(5) Marine transgression and deposition of the Dean Quartzite and Pinyinna Beds.
(6) Metamorphism of the Olia Gneiss, Pottoyu Granite Complex, mafic dykes, Dean Quartzite and Pinyinna Beds during the Petermann Ranges Orogeny (about 0.6 b.y. ago).

The grade of metamorphism reached during the first metamorphism of the Olia Gneiss is still unknown. The second metamorphism, during the Petermann Ranges Orogeny, produced:- epidote amphibolite in the mafic rocks intruding the Pottoyu Granite Complex; kyanite and staurolite within the Dean Quartzite, chlorite and talc in the Pinyinna Beds, and quartz-biotite-actinolite-epidote in mafic rocks within the Pinyinna Beds.

Important conclusions: (1) Establishment of the unconformity beneath the Dean Quartzite and above the Pottoyu Granite Complex (age about 1.2 b.y.) gives a maximum age for the Dean Quartzite and adds weight to the correlation with the Heavitree Quartzite.

(2) The northern side of the Musgrave Block has undergone at least two metamorphisms:one at 1.2 b.y.,or older, and one at about 0.6 b.y., during the Petermann Ranges Orogeny.

(3) The presence of kyanite in the Dean Quartzite on the bottom limb and middle limb of the Petermann Ranges Nappe proves metamorphism took place at a considerable depth and therefore supports the nappe hypothesis.

(4) Considerable reserves of low-grade disseminated kyanite occur in the valley fills at the base of the Dean Quartzite.

(5) The gabbros intruding the Pottoyu Granite Complex should be mapped as a preliminary step in determining their economic potential.

Arltunga Structural Party

by

A.J. Stewart

Personnel: A.J. Stewart

Visitor: Professor R.L. Armstrong, Yale University, 29/9/68 -11/10/68.

Duration of Field Work: 1/9/68 to 31/10/68 (continuing)

Area Covered: Arltunga Nappe Complex, 50-70 miles east of Alice Springs.

Geology: Three areas of basement rocks of the Arunta Complex have been studied in order to ascertain the rock-types present and to compare the types and orientations of the mesoscopic structures in these rocks. The first area is situated in the autochthonous rocks west of and structurally below the lower nappe of the Arltunga Nappe Complex. The dominant rock-type of this area is a heterogeneous granitic gneiss, foliated and lineated and in many places layered. Occurring within the gneiss are large bodies of diorite and amphibolite and smaller masses of epidosite, pegmatite, and a tough dark-coloured fine-grained dyke rock of unknown composition. A mixed body of hornblende gneiss and granite crops out in the northern part of the area. The gneiss shows considerable folding, commonly isoclinal, and occurrences of superposed folding are numerous. The strike of the foliation varies throughout the area, but the lineations (both linear grain orientations and fold axes) are concentrated around a line plunging 45 degrees north-west.

The second area studied is situated in the western part of the lower nappe of the Arltunga Nappe Complex. Most of these rocks are metasedimentary and comprise interlayered marble and calc-silicate rock, kyanite-muscovite schist, muscovite-quartz schist, amphibolite, quartzite, feldspathic schist, actinolite-muscovite schist, biotite gneiss, sheared granite, and pegmatite. The overall dip of the rocks is to the east at a moderate angle, but folding is common, particularly in the marble and calc-silicate rocks and in the biotite gneiss. The folding is mostly isoclinal with axial planes in the plane of the foliation and axes plunging about 15 degrees south-east. Linear grain orientations plunge similarly, and the poles to foliation form a band which though rather broad has an axis which also plunges in this direction. Boudinage of calc-silicate layers and of pegmatite is fairly common, but the boudins plunge east and have been folded by the isoclinal folding.

The third area studied is situated at the western end of the upper nappe of the Arltunga Nappe Complex. The rocks here are mostly metavolcanics and lack penetrative structures, but a large body of interbedded marble and talc schist is also present, and the poles to schistosity form a girdle whose B-axis plunges west-north-west at about 40 degrees.

The constancy of direction of the lineations throughout each area, the differences in this direction from one area to the next, and the large differences between all three of these directions and the macroscopic B-axis of the nappe complex, which plunges due east at about 20 degrees, are of considerable significance as they indicate that the penetrative mesoscopic structures of the basement rocks in these areas bear no relation to the macroscopic form of the Arltunga Nappe Complex.

Amadeus Basin Evaporite Drilling - Alice Springs

B.M.R. Stratigraphic No. 3 (Ringwood)

by

A.J. Stewart

Personnel: A.J. Stewart, A. Glikson (10/8/68 - 15/8/68)

Duration of Drilling: 24/7/68 to 19/8/68

Visitors: Messrs H. Lachlan, B. Williams, A. Churchill, A.T. Wells, T.G. Evans, and R.N. England (all B.M.R.), I. Faulks of the Resident Geologists' Office, Alice Springs, Professors C.E. Marshall and T. Vallance and Dr. G. Maxwell of the University of Sydney, Professor A.H. Voisey of Macquarie University, Dr. E. Conybeare of the Australian National University, Professor B. Nasher and Dr. B. Engel of the University of New England, Dr. B. Marshall of the University of New South Wales, Mr. R.T. Mathews of the University of Melbourne, Messrs. R. Peters and J. Taylor of Todd River Station, and Mr. M. Collings of Ringwood Station.

Drilling: From 24th July to 19th August a Bureau Mayhew-1000 rig air-drilled one hole into the Ringwood Dome, a body of gypsum in the Bitter Springs Formation (Adelaidean) located 66 miles east of Alice Springs. Total depth reached was 852 feet. Continuous coring started at 107 feet and was maintained to 830 feet; overall core recovery was 92%. No fluids were encountered. The hole was logged electrically by the Welex Division of the Halliburton Company, and the logs run were Laterolog, Acoustic-Velocity, and Gamma-ray.

Drilling Results: The lithology of the core comprises interbedded and brecciated gypsum, anhydrite, and claystone, the last in considerably smaller amount than the first two. The three rock-types are present throughout the hole, but the ratio of gypsum to anhydrite changes noticeably with depth. In the upper 300 feet gypsum predominates over anhydrite, whereas in the lower 552 feet anhydrite predominates over gypsum. The change is gradual, and from about 250 feet to 450 feet the two minerals exist together in approximately equal amounts. This relation suggests that the gypsum formed by hydration of the anhydrite and that this took place at the present location of the salt body. Some recrystallization of the gypsum to a much coarser-grained form also occurred in the upper part of the body.

Gosses Bluff Joint U.S.G.S. - B.M.R. Study

by

D.J. Milton and A.Y. Glikson

Personnel: D.J. Milton (U.S.G.S.), A.Y. Glikson (B.M.R.), P.R. Brett (U.S.G.S.; 21/6/68 - 10/7/68)

Visitors: Prof. Mabutt (University of N.S.W.), 5/6/68; T. Pearce (Magellan Petroleum), 11/7/68; B.Williams (B.M.R.), H. Lockland (B.M.R.), W. Wentworth, M.P. 2/8/68 - 3/8/68; J. Dooley (B.M.R.) 26/8/68 - 30/8/68; B. Barlow (B.M.R.) 2/9/68 - 10/9/68; I. Faulks (B.M.R.) 12/9/68 - 13/9/68.

Duration of Field Season: 23/5/68 - 23/9/68

Area Covered: Gosses Bluff central depression (P.R. Brett), Cliff ring (D.J. Milton), Outer rim (A.Y. Glikson)

Drilling: Scout drilling in the outer rim was carried by B.M.R. drilling team No. 4, over the period 1/6/68 - 23/7/68, using a Foxhole mobile rig. Altogether, 23 holes were sunk, totalling 1565 feet, of which 348 feet were cored.

Drilling Results: The drilling afforded the definition of the structural boundary of Gosses Bluff in various directions from the centre, and the elucidation of structural problems in various parts of the outer rim. Continuous cores were taken from breccia troughs south of Gosses Bluff, providing material for a study of the origin of the breccia. The rig was further used for gaining information on the geology in unexposed parts of the outer rim.

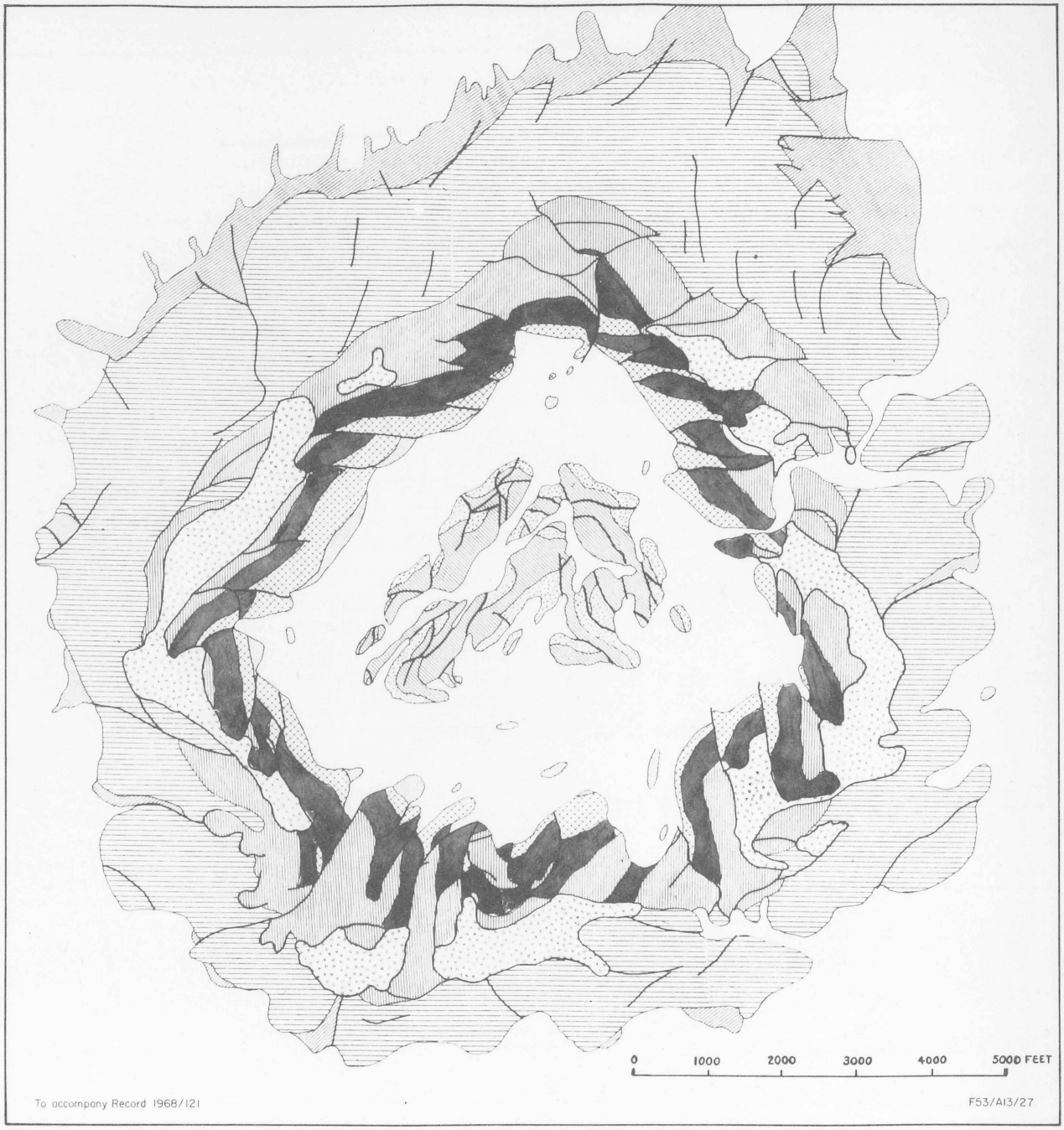


Figure S9A.

GEOLOGICAL SKETCH MAP OF GOSSES BLUFF

QUATERNARY — Alluvium
? — Breccia
DEVONIAN–CARBONIFEROUS — Pertnjara shale; Pertnjara sandstone
DEVONIAN — Mereenie Sandstone
ORDOVICIAN — Mereenie (?) Sandstone; Carmichael Sandstone; Stokes Siltstone; Stokes sandstone; Stairway (?) Sandstone
Fault

Geological Results: (1) Gosses Bluff, Central Structure (D.J. Milton, P.R. Brett).

The Central Structure (Fig. S9a) consists of plates of bedrock of the Stokes Siltstone (and possibly uppermost Stairway Sandstone), Carmichael Sandstone, Mereenie Sandstone, and the lower units of the Pertnjara Group, dipping steeply and facing outward. The plates are characteristically several hundred yards long, and although they show only minor internal deformation, are sharply bounded by fault zones. Mapping has shown a remarkable pattern. The structure is bilaterally symmetrical about a north-south axis, but the northern and southern halves are quite different. In the north the faults tend to run roughly north-south in the Stokes Siltstone, east-west in the Carmichael Sandstone and Mereenie Sandstone and again north-south in the Pertnjara Group. In the south the pattern is reversed: the faults in the Stokes run roughly east-west, in the Carmichael and Mereenie north-south, and in the Pertnjara east-west. Structural details indicate that the plates have moved inward as well as from ten to fifteen thousand feet upward, to lie on a shortened perimeter. The pattern of deformation apparently represents adjustment in response to this shortening, analogous in a very crude way to folding of a cloth pulled through a ring. Why the particular pattern of deformation resulted, rather than some alternative, remains an outstanding problem.

Milton with P. Fisher measured 89 shatter cones. The orientations of individual striations, an average of 20 per locality, were measured and plotted on a stereogram to portray the cone. At a few localities all striations were taken from a single physical cone, generally striations from several cone segments at one locality were combined to yield the spatial cone. At all but three or four localities, a single spatial cone or a cone plus a few anomalous striations was obtained, even from segments that appeared unrelated at first sight. A minority of segments belong to negative cones with apices opposed to the usual orientation. Such negative cones exactly match the complementary branch of the positive cone, indicating that cones can develop in either direction from the point of initiation and that negative cones are not produced by reflected shock waves, as has been suggested.

Cone axes lie at an angle to the bedding decreasing from 70° to 80° near the centre to 10° to 20° two miles outside the Bluff. If the beds are rotated to the horizontal, cone axes point upward and generally toward a focus above the centre of the structure. Some of the deviations of cone axes from a single focus clearly reflect rotation of plates in the plane of bedding during emplacement. Other deviations, however, cannot be reduced by any geometric manipulation of beds. The latter deviations indicate that, if shatter cones form normal to an advancing shock front, the shock front can not have propagated as a simple expanding sphere but perhaps was refracted at contacts of different lithology. A computer programme for handling shatter cone data is under development. Complete analysis should shed light on the mechanism of shatter fracturing, on the movement of bedrock plates during emplacement and on the propagation of the shock pulse.

The shatter cones indicate shock propagating outward and downward from a shallow central focus at a time when the strata was approximately flat lying. At a later time (perhaps by only a few seconds) the rock that composes the Bluff was drawn upward and inward. Such a history would result from a near surface shock-producing event. It is our belief that impact is the only such event that occurs naturally.

Geological Results: (2) Gosses Bluff, Outer rim (A.Y. Glikson)

The outer rim of the Gosses Bluff structure, constitutes approximately 100 square miles of dune, gravel and travertine covered plain, with outcrops occurring as low hills and along creeks. These outcrops, although sparse, are important with respect to the study of the structure, of which the Gosses Bluff rise constitutes only the centre. The area was first mapped by P.J. Cook (1966). The present work included 2 inch-mile remapping, a search for new outcrops and observations on breccia outcrops. The following is a brief review of the main results.

The circular structure terminates at distances varying between 4 and 7 miles from the centre of Gosses Bluff. The boundaries of the deformed zone with the little-disturbed strata of the Missionary plain appear to be abrupt. The circular pattern around the bluff, as represented on space photographs, is imparted by the travertine - covered pediment, and by the dune patterns, and does not appear to be directly related to the underlying structure. The structural pattern within the deformed zone is essentially similar to that of the central structure. The structural elements of the outer rim, however, are larger in scale than those of the central part. Thus, individual rock plates and breccia troughs are larger on the outer rim. Both elements tend to strike tangentially to the bluff, but locally deviate to radial orientations, which may correspond to the bilateral symmetry of the central structure.

The breccia troughs are interpreted as relics of the original crater breccia, caught between radially advancing bed rock plates, and subsequently under overturned blocks of the central uplift. The overturned plates disintegrated at their fronts into mega-breccia, overlying fine crater breccia. The fine breccia often intrudes overlying bed rock plates. An original proximity of the mega-breccia to the centre of impact is supported by its shatter coned state. The shock-melted flow breccia of Mt. Pyroclast overlies heated quartzitic breccia, in turn overlying normal breccia. The flow breccia appears to lie over the irregular surface of the quartzitic breccia. Blocks within the flow breccia have often escaped complete melting.

Petrography: The intensity of the shock at different points in the structure must be determined from the petrographic effects. Most specimens of sandstone from the Bluff show the cleavage and other planar elements in quartz characteristically developed by shock, notably along the $(10\bar{1}3)$ $(10\bar{1}1)$, and (0001) planes. It is hoped that observation of the specific planar elements developed in individual specimens can be correlated with very recent experimental shock work to indicate the peak pressures attained at various points in the structure. Etching

of polished thin sections reveal complex Dauphine twinning of quartz grains with the composition planes parallel to planar elements. The twinning is presumably shock induced, although it is apparently not known whether such twinning occurs in ordinary rock quartz.

The sandstone clasts in the suevitic breccia of Mt. Pyroclast were apparently almost completely transformed to liquid or glass, although some contain relict grains of quartz showing a high concentration of planar elements. No glass remains-the silica has entirely recrystallized as quartz. Some of this quartz is pseudomorphous after tridymite, which presumably crystallized as the mass cooled.

As an outgrowth of the Gosses Bluff project, Milton in informal co-operation with T. Pearce of Magellan Petroleum Corporation has been examining the stratigraphy of the Mereenie Sandstone locally and has divided it into two units, possibly separated by an unconformity. The lower unit consists of light coloured uniform thin bedded sandstone. It is tentatively considered to be of Ordovician age, as it appears entirely conformable with the Carmichael Sandstone. This unit is about 350 feet thick at Gosses Bluff and in the Gardiner Range to the south. In the Macdonell Ranges it is 50 to 100 feet thick in the vicinity of Goyder Pass, is apparently absent near Tyler Pass, and re-appears and thickens westward to several hundred feet near Stokes Pass and near Deering Creek. A considerably thicker and lithologically more varied upper unit if of Devonian age, as indicated by arthrodire plates from Gosses Bluff. The base of this unit is marked by conglomerate throughout the western Macdonells and by grit with rare pebbles at Gosses Bluff. In the Gardiner Range near Areyonga the base of the upper unit is not marked by coarse material, but the lithologic distinction of the units is maintained.

Ngalia Basin Party

by

A.T. Wells

Personnel: A.T. Wells (Party Leader), T.G. Evans, T. Nicholas (25/6/68-25/8/68) and A. Glikson (15/9/68-29/9/68)

Visitors: Dr. D. McNaughton and T. Pierce, of Magellan Petroleum Corporation 14/9/68-20/9/68. Dr. C.E.B. Conybeare, A.N.U., and A. McGee, Magellan Petroleum Corporation, 22/8/68-25/8/68. J. Watts, new B.M.R. recruit, 12/9/68-28/9/68. An inspection tour of the Amadeus Basin led by A.T. Wells was undertaken from the 10-21st August. Participants on the tour from various Universities were as follows -

Prof. C.E. Marshall)
Assoc. Prof. T. Vallance) Sydney University
Assoc. Prof. W. Maxwell)

Prof. B. Nashar)
Dr. B.A. Engel) Newcastle University

Dr. C.E.B. Conybeare - Australian National University
Mr. R.T. Mathews - University of Melbourne
Prof. A. Voisey - Macquarie University
Dr. B. Marshall - University of New South Wales
Dr. D. Milton of the U.S. Geological Survey was on part of the tour.

Duration of Field Work: Commenced 12/6/68, ceased 27/9/68.

Sheet areas mapped: Lake Mackay, Napperby, Mount Doreen (in part.)

Helicopter Survey: 45 hours were flown in a Bristol Sycamore Mk. 4 Helicopter chartered from Associated Helicopters Pty. Ltd. The survey took place from the 12/7/68 - 29/7/68 and involved 13 flying days during which 170 geological observation points were visited.

Scout Drilling: Three holes were drilled on the Napperby Sheet area, between 3/8/68 and 20/8/68, by the No. 2 seismic party Fox Mobile rig. Total footage for these three holes was 1337 feet and a total of 13'4" of core was obtained.

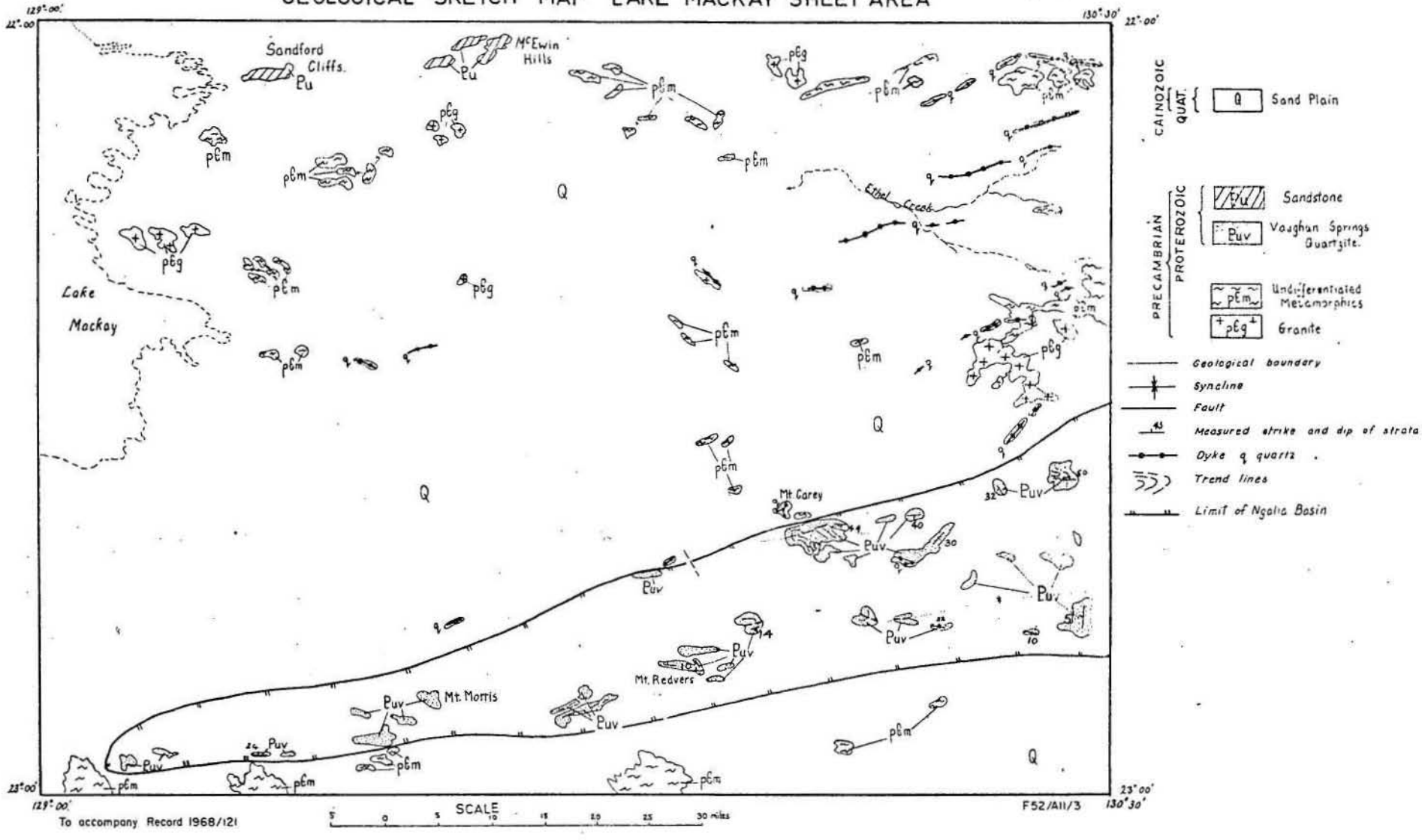
Geological Results: In the early part of the year a record on the geology of the central part of the Ngalia Basin, N.T. (Rec. 1968/38) was completed and issued.

Mapping of the Ngalia Basin was completed. In addition reconnaissance traverses were made in areas of neighbouring basement outcrops on the Lake Mackay, Mount Doreen and Napperby Sheet areas. The Lake Mackay Sheet area covers the western part of the Ngalia Basin and the Napperby Sheet area the eastern part and the results of mapping on each sheet will be discussed separately.

Lake McKay Sheet area: A geological sketch map of the Lake Mackay Sheet area is shown in Figure S10. Only the Proterozoic Vaughan Springs Quartzite, the basal formation of the Ngalia Basin sequence, crops out in the Lake Mackay Sheet area. Outcrops of this formation extend as far westwards as longitude 129°10' and isolated outcrops occur in an east-north-east trending narrow belt across the southern half of the Sheet area. The westernmost exposures of the quartzite are only about 12 miles from outcrops of the Heavitree Quartzite in the Amadeus Basin to the south on the Mount Rennie Sheet area and their proximity supports the previously proposed correlation of the two formations. It was also shown that the Central Mount Wedge Beds, the basal quartzite mapped at the southern margin of the Ngalia Basin on the Mount Doreen Sheet area to the east, was contiguous with outcrops of the Vaughan Springs Quartzite.

GEOLOGICAL SKETCH MAP LAKE MACKAY SHEET AREA

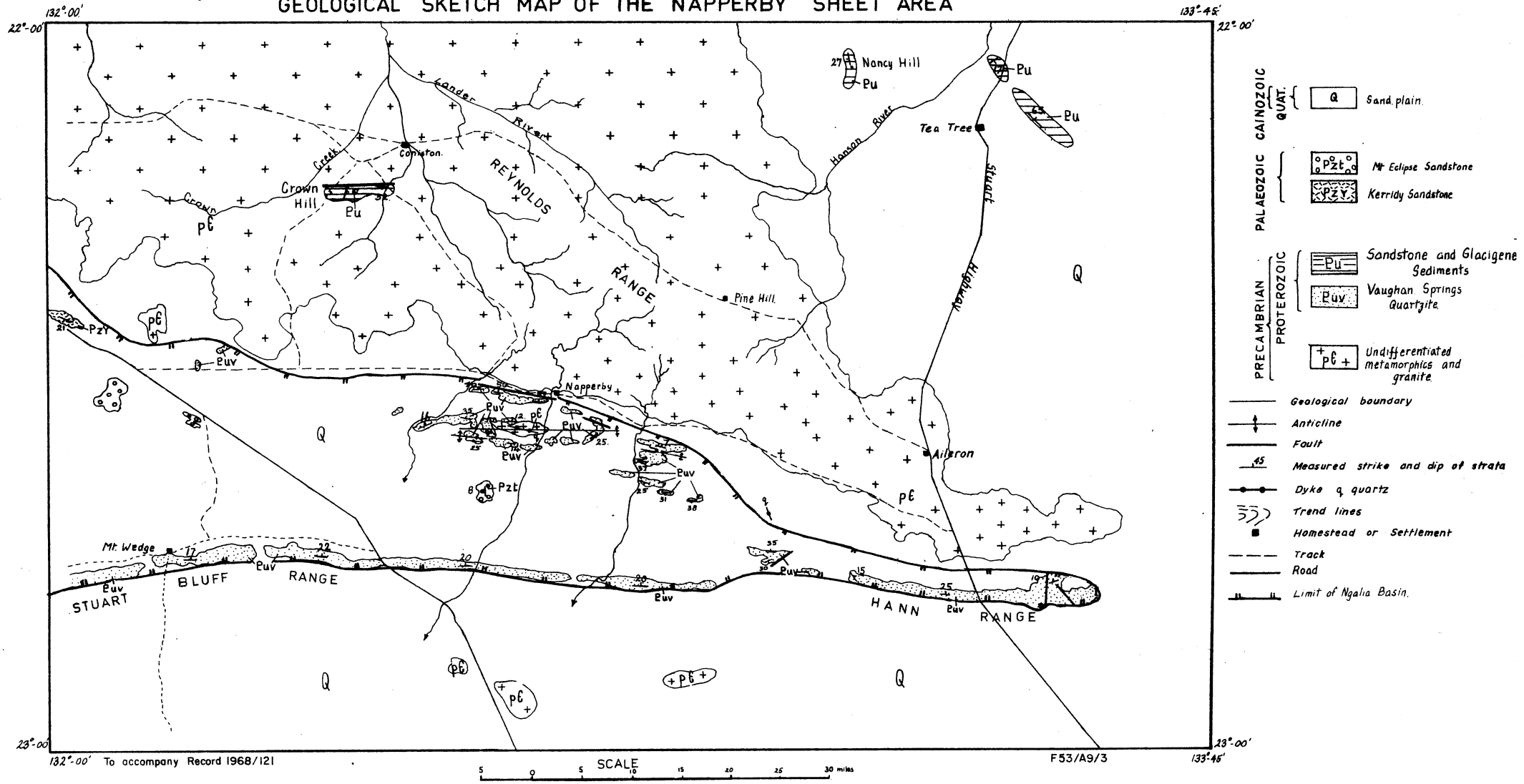
Fig. S10



To accompany Record 1968/121

Fig SII

GEOLOGICAL SKETCH MAP OF THE NAPPERBY SHEET AREA



132°-00' To accompany Record 1968/121

F53/A9/3

The Vaughan Springs Quartzite unconformably overlies Precambrian crystalline basement rocks and consists mainly of coarse and medium grained, silicified, quartz sandstone with granule and pebble conglomerate beds common near the base of the formation. The top of the formation is not exposed.

A few outcrops of the Treuer Member of the Vaughan Springs Quartzite are present in the Lake Mackay Sheet area and consist of cross-laminated and thin-bedded siltstone and fine grained, silicified, thin bedded, and in places glauconitic, sandstone. Much of the surface of the outcrop is covered by a thin veneer of evaporites which may indicate the presence of interbedded evaporites at depth. The only complete section in the member occurs about 5 miles southeast of Mount Carey where it is about 4500 feet thick. Numerous intra-formational breccias are common at this locality and have probably been formed by the disintegration and recementing of mud cracks in the siltstone.

Two isolated outcrops of sediments of similar lithology to the Vaughan Springs Quartzite occur outside the margin of the Ngalia Basin. At the McEwin Hills medium grained, partly silicified and pebbly, dark brown sandstone unconformably overlies micaceous schists. At Sandford Cliffs a fine grained, white sandstone is present but no contacts with basement rocks were found. At both localities the sandstone is preserved in west-plunging synclines. Sandstone identical with the Vaughan Springs Quartzite occurs in the Alec Ross Range to the northwest of Lake Mackay in Western Australia.

Small scattered outcrops of Precambrian basement rocks were mapped on the Lake Mackay Sheet area and these consist mainly of granite, granitic gneiss, quartzite and quartz-mica schist. West trending quartz dykes are common and some are up to 12 miles in length.

The Vaughan Springs Quartzite occurs in hogbacks and cuestas that generally strike east. No clear structural pattern is apparent from the scattered outcrops except that the beds along the northern margin of the basin are more deformed than those along the southern margin. The northern margin may be in part fault bounded as found on the Mount Doreen Sheet area. The inconsistency in the attitude of the quartzite beds has probably been caused by block faulting in the basement.

Napperby Sheet area

A geological sketch map of the Napperby Sheet area is shown in Figure S11. The Ngalia Basin trends easterly in a narrow wedge shaped area across the centre of the sheet and terminates at about longitude 133°40'. Three formations of the Ngalia Basin sequence are exposed, the Palaeozoic Kerridy Sandstone, Carboniferous Mount Eclipse Sandstone and the Proterozoic Vaughan Springs Quartzite. The Vaughan Springs Quartzite trends easterly along the southern margin of the basin in a practically unbroken cuesta from the Stuart Bluff Range in the west to the Hann Range at the eastern end of the Basin.

Outcrops of the Vaughan Springs Quartzite at the northern edge of the basin are mainly concentrated in an area south of Napperby Homestead and in places the quartzite dips steeply northwards towards nearby outcrops of granitic basement rocks. Thrust faults along the northern margin of the basin may have displaced crystalline basement over the Proterozoic sediments. The most easterly outcrops in the Ngalia Basin are north-dipping beds of Vaughan Springs Quartzite and outcrops of gneiss and granite occur about two miles north of the ridge. The central area of the basin is devoid of outcrops apart from small exposures of the Carboniferous Mount Eclipse Sandstone.

Complete sections through the siltstone and fine sandstone of the Treuer Member of the Vaughan Springs Quartzite are exposed but the total thickness is only about 400 feet. Concretions of specular hematite up to 1 foot across are present in the siltstone, and the sandstone beds overlying the Vaughan Springs Quartzite are in places completely replaced by specular hematite.

The three shallow stratigraphic holes on the Napperby Sheet area were sited near outcrops of the Vaughan Springs Quartzite to identify the overlying formation as no complete section in the quartzite is known. The drilling showed the presence of a thick sequence of Tertiary clays, silcrete and ironstone and one bottom hole core included some lignite at 456 feet. Another hole terminated in the Treuer Member of the Vaughan Springs Quartzite. The presence of thick Tertiary sediments was not anticipated and there may be extensive basins present between the ridges of quartzite with at least 500 feet of Quaternary and Tertiary sediments.

Two outcrops of glacigene sediments of probable Proterozoic age were discovered at Crown Hill and Nancy Hill outside the margin of the Ngalia Basin. At Crown Hill about 200 feet of boulder beds unconformably overlie Precambrian mica schists. These beds are succeeded by several hundred feet of interbedded pebbly arkosic sandstone, thin-bedded sandstone and laminated siltstone. At Nancy Hill there are three tillites separated by massive quartz sandstone. The lowermost tillite unconformably overlies basement rocks.

Reconnaissance traverses were made in areas of basement rocks in the northern part of the Napperby Sheet area to supplement the photo interpretation of this region. The main rock types encountered were granitic gneiss, porphyroblastic gneiss, garnet gneiss, various types of schist, granite and quartzite. The quartzite occurs in prominent ridges mainly in the Reynolds Range.

Future programme: Close liaison was maintained with the B.M.R. seismic party during the year. Seismic traverses were carried out on the Mount Doreen Sheet area and it is apparent from the results that no satisfactory tie is possible between the reflecting horizons and the exposed formations.

To overcome this problem it is proposed to drill two stratigraphic holes on traverse line H near the Patmungala Syncline, one to a depth of about 2000 feet and the second to about 3500 feet. These two holes would positively identify the three prominent reflecting horizons. The deepest horizon occurs at depths of about 15,000 feet in the centre of the Ngalia Basin.

In addition it is proposed to drill fifteen shallow stratigraphic holes with an average depth of 400 feet to obtain stratigraphic information in key areas where there are incomplete sequences or large areas of no outcrop.

Northern Territory Mammals

by

M.D. Plane

Stratigraphy and Vertebrate Palaeontology of the Camfield Beds, Northern Territory. This, the continuation of a study commenced in 1966, involved the preparation examination and identification of fossils collected in the field. Further successful collecting was undertaken during the year and substantial additions were made to the fauna. The preparation of the material is slow but rewarding as many of the animals are new to science. A preliminary account of the discovery of the Camfield fossils with some identifications appeared in the February 1968 edition of the Australian Journal of Science. This work is continuing with increased tempo and it is hoped that the arrival of new preparation tools will further alleviate the difficult preparation problems.

WESTERN AUSTRALIA

Mobile Conodont Laboratory

by

E.C. Druce

Personnel: E.C. Druce, A.T. Wilson

State Geologists attached: P.Playford, A. Cockbain.

Visitors: W. Koop, R. McTavish (Wapet) 21/6/68 - 24/6/68.
M. Peterson (Brigham Young Univ, Utah) 2/7/68 - 26/7/68
J. Jell (Univ. Qld.) 2/7/68 - 26/7/68

Duration of Field Work: 23/4/68 to 2/8/68.

Area Studied: Bugle Gap, Western Australia

Geology: Over 800 samples were processed from varying lithologies in the Bugle Gap Reef Complex of the Canning Basin. The conodont recovery rate was over 90%.

AUSTRALIAN CAPITAL TERRITORY

A.C.T. Palaeontology and Stratigraphy

by

D.L. Strusz

Personnel: D.L. Strusz and J. H. Shergold (part-time).

Field Work: One week of February was spent with vacation students and B.M.R. geologists in the Bredbo area south of Canberra, carrying out detailed mapping of the Silurian Cappanana Beds and Colinton Volcanics. Two days were spent north and east of Bungendore, checking stratigraphic relationships in the Palaeozoic. A collection of Silurian corals was made from the Mount Fairy Beds, and of Devonian corals from Limestone Creek near Lake Bathurst. The latter proved of particular interest in that it yielded several specimens of Calceola, a coral not previously found in southeastern New South Wales. In Eurasia this coral is not known in beds older than late Lower Devonian, and is characteristic of the Middle Devonian.

One day was spent in the Devonian north of Wee Jasper, collecting from the old Cave Flat locality, exposed by the low level of Burrinjuck Reservoir. As well as topotypic Xystriphyllum mitchelli, the limestone yielded a relatively large number of more or less fragmentary arthrodire fish.

An excursion to the east of Canberra, organized by the C.S.I.R.O., in connection with a symposium on land evaluation, was attended.

Laboratory Work and Writing: Most time was occupied in compiling information on the geology and geomorphology of the Canberra 1:250,000 sheet. The bibliographic data are being issued as a Record, and Explanatory Notes for the sheet have been completed. When some problem areas have been checked, a more detailed account, possibly restricted to the Palaeozoic, will be issued. The most important of these problem areas is at Cooleman Plains, which is being studied in 1968 by an honours student of the Australian National University.

A short account of the geology of the A.C.T. has been prepared for the Department of the Interior.

The large fossil collections already accumulated by the B.M.R., from the Canberra sheet are being examined in detail, although during 1968 this has been very subordinate to the preparation of Explanatory Notes.

NEW GUINEA

New Guinea Mammals

by

M.D. Plane

New Guinea Fossil Mammals. A month was spent at Pureni, Southern Highlands District, Papua, where fossil vertebrates were collected. Carbonaceous material and rocks were taken for radiogenic dating and palynology. Preliminary palynology indicate that this deposit may throw some light on late glaciation in the New Guinea highlands while the first carbon date of 44,000 years indicates a Pleistocene age for the fossiliferous horizons and implies that the diprotodontid in the fauna is a tropical relict. Work is continuing.

MACROPALAEONTOLOGY

Introduction

by

J.M. Dickins

No change in the palaeontological staff has taken place during the year, however, as a result of re-organization an additional technical assistant has been appointed. Dr. J. Roberts is working overseas on a Harkness Fellowship.

Dr. S.K. Skwarko visited Japan, U.S.S.R., Poland, England, U.S.A., and Mexico.

Specialists work under contract has been continued by Dr Irene Crespin (catalogue of Australian type specimens), Mr. R. W. Day (Cretaceous faunas from the Great Artesian Basin), Dr. A.A. Öpik (Cambrian crustaceans) and Mrs. M.E. White (plants).

Annual Report

by

J.M. Dickins

Preparation of the Springsure Report, Bowen Basin, Queensland was completed for despatch to the printer. A paper with E.J. Malone on the Regional Subdivision of the Back Creek Group of the Bowen Basin was prepared and published in the Queensland Government Mining Journal. Preparation of the Bulletin, Geology of the Bowen Basin, was continued. Drafts on an introductory section including Physiography and Geophysics and a section on Economic Geology have been completed. Dickens attended the 3rd Newcastle Symposium on the Sydney Basin, and as convener organized the Symposium on the Permian of Australia as part of the Special Meeting of the Geological Society of Australia in Canberra in May. He participated in the associated field examination of the Permian of the South Coast of N.S.W. He participated in a field visit to Carboniferous and Permian of New England area organized in connection with the opening of the new building of the Department of Geology of the University of New England, Armidale and attended the official opening and the Seminar on Australian Mineral Resources. In September he joined the Texas High Field Party and examined and made fossil collections from the Drake, Warwick and Texas areas.

Considerable time was spent in administration and management of the section. The fossil collections at Fyshwick have been re-organized. A number of reports were read and commented on and proofs of papers and reports were corrected.

Fig. S12

CURRENT PALAEONTOLOGICAL PROJECTS IN AUSTRALIA AND NEW GUINEA

Tremadocian conodonts from Bonaparte Gulf Basin and Daly River Basin

Triassic and Jurassic faunas from New Guinea

Tertiary Land mammals

Upper Cretaceous and Tertiary Foraminifera, T.P.N.G.

Jurassic, Cretaceous and Tertiary palynomorphs from Papua

New Guinea Tertiary rodents

Tertiary mammals from N.T. and Qld.

Upper Devonian brachiopods from the Bonaparte Gulf Basin

Reworked Ordovician conodonts in the Upper Palaeozoic rocks of the Bonaparte Gulf Basin

Lower Carboniferous brachiopods from the Bonaparte Gulf Basin

M. Cambrian Oryctocephalid trilobites from Qld, N.T. and N.S.W.

Cambrian faunas from Qld.

Tertiary larger Foraminifera Christmas Island

Dolichometopid trilobites of Qld and N.T. and Templetonian and Ordian xystridurid trilobites of Australia.

Lower Carboniferous ostracods, Bonaparte Gulf Basin

Cambrian Crustacea Bradorilda Mt. Isa area, Qld.

Lower Carboniferous and Upper Devonian ostracods, Canning Basin

Tremadocian conodonts from the Black Mt. area, Qld

Upper Devonian conodonts from the Canning Basin

Permian faunas of the Bowen Basin

Ordovician graptolites from the WAPET Canning Basin bores

Upper Cambrian conodonts from the Georgina Basin

Permian and Triassic palynostratigraphy of Bowen Basin

Upper Devonian conodonts from the Mt. Morgan area, Qld

Upper Devonian receptaculitids from Fitzroy Basin, W.A.

Lower Devonian conodonts from the Yarrol Basin, Qld

Jurassic and Cretaceous palynomorphs from the Great Artesian Basin

Ordovician faunas from Canning Basin

Mesozoic faunas from the Great Artesian Basin

Lower Ordovician Dikelokephalinidae from northern Australia

Carboniferous conodonts from the Yarrol Basin, Qld.

Palaeozoic and Mesozoic plants

Revision of the Jurassic faunas of W.A.

Devonian, Carboniferous and Permian faunas from Warwick, Drake and Texas

Devonian conodonts from the Garra Area

Lower Triassic ostracods of the Perth Basin

Siluro-Devonian corals of eastern Australia

Cretaceous anpiosperm pollens from the Perth Basin

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

Silurian encrinurid trilobites of south-eastern Australia

To accompany Record 1968/121

M(P) 142

Annual Report

by

J. Gilbert-Tomlinson

Systematic descriptions of fossils: Study of the dikelokephalinid trilobites of northern Australia is nearing completion and the paper will be completed by the end of the calendar year. A detailed investigation of the morphology of this poorly-known group not only refutes the systematic position postulated in the Treatise of Invertebrate Palaeontology, but paves the way for a study of a genus of the family not positively identified in northern Australia, but not uncommon in lower Ordovician rocks of Tasmania, the cosmopolitan Asaphopsoides. By arrangement with Mr M.R. Banks of the University of Tasmania, the University material will be made available for description in conjunction with the Bureau collection made by the author. The preservation is unusually good and adds considerably to our knowledge of the family, particularly the ventral exoskeleton.

Routine examination of fossils: Subsurface samples from Western Australia (Total McLarty No. 1, Canning Basin) and South Australia (Continental Munyarai No. 1, Officer Basin; Delhi Lake Frome No. 2) were examined. The sequence penetrated in McLarty No. 1 (1) confirms the value of the Goldwyer Shale as a stratigraphic landmark, (2) preserves part of a post-Goldwyer Ordovician sequence previously suspected, and suspected only, from WAPET Parda No. 1, and, (3) as usual, adds little to the knowledge of the pre-Goldwyer formations and the time of initiation of the Basin. The South Australian material proved to be singularly uninformative. The only fossils from Munyarai No. 1 are vertebrate scales recovered from the upper part of the sequence (above 3000 feet). They are no older than middle Silurian and possibly no older than upper Devonian, but no upper limit to their range can be drawn, and no decision on the environment can be made. No fossils were noted in the Lake Frome samples, and thus the company's postulated correlation with the superficial early Middle Cambrian Wirrealpa Formation can be neither confirmed nor denied.

Surface samples examined consist of Devonian fishes. The first collection was made by D.L. Strusz, who, taking advantage of the exceptionally low level of Burrinjuck Dam, recovered them from beds that had been under water for forty years. The fossils consist of relatively small fragments of the dermal armour of large arthrodiran placoderms, probably belonging to undescribed taxa. The second collection is from the Amadeus Basin; it was forwarded for examination by Magellan Petroleum Corporation, and is considered by D. Milton to originate from the Parke Siltstone of the Pertnjara Group. The fossils can be identified as placoderm fishes but are too poorly preserved for precise determination.

Annual Report

by

M.D. Plane

During 1968 M. Plane spent a month in New Guinea, two months in the Northern Territory and Queensland, ten days in Central Australia and the Darling Downs and the remaining time in Canberra.

Visit to Central Australia and Queensland. Emeritus Prof. G.G. Simpson of Harvard University and the American Museum of Natural History was accompanied to the Alcoota fossil vertebrate locality north-east of Alice Springs and to the late Pliocene and Pleistocene localities on the Darling Downs.

Administrative duties were carried out and responsibility for the Palaeontology group was assumed while J.M. Dickins was overseas and in hospital. Professional correspondence with colleagues overseas and in Australia was engaged in and visitors from museums and universities were received.

Annual Report

by

S.K. Skwarko

During 1968 S.K. Skwarko spent three months on official duty overseas, a fortnight with the Sepik Party in New Guinea, and a week in Perth, and most of the remaining time in Canberra. He was engaged on three major projects:

1. The revision of the Middle Jurassic marine macrofossils (mainly Bivalvia) from Western Australia. This, the continuation of the previous years' project involved the technical preparation, examination, and identification of several thousand of fossils collected personally in the field or obtained on loan from scientific institutions throughout Australia. Their description, drawing, and photography was done in Canberra,while the comparison with the overseas forms took place mainly during Skwarko's three-week stay at the Natural History Museum in London, but also in Japan, United States and Mexico. Past determinations of fossils were substantiated or corrected; a number of fossils new to science were described and illustrated for the first time; evidence for affinities between Australian and European species was strengthened in some cases. The study, though advanced, is not yet completed.

2. Description of the Ordovician graptolites from the Canning Basin bores and the determination of their value in stratigraphic correlation and dating. Skwarko spent five weeks at the University of Warsaw doing research on these faunas under the guidance of two world graptolite experts, Prof. R. Kozlowski and Doc. Dr. A. Urbanek. Technical preparation of fossils met with unforeseen difficulties, and the study though advanced could not be completed on time.

3. Identification, description and dating of Triassic and Jurassic faunas from New Guinea. A number of fossils of these ages were collected by Skwarko while in New Guinea, while others were sent or brought in by the B.M.R. field geologists. Their preparation, description, photography and partial identification was done in Canberra, while comparison with overseas forms both in Japan, U.S.S.R., and the U.S. completed the major phase of this study.

In addition to these, Skwarko performed the following short-term duties:

a. Supervised the technical preparation of the Mesozoic fossils from Australia and New Guinea.

b. Engaged in professional correspondence, and received visitors both from overseas and from other parts of Australia.

c. Checked final draft for his contribution to Bulletin 108; proof read his contribution to Bulletin 80.

d. Spent a week in Perth extracting Ordovician and Mesozoic fossils from the WAPET cores for his research.

e. Dated a number of fossil collections sent in from New Guinea and Western Australia.

Annual Report

by

D.L. Strusz

Palaeontology: Two important continuing projects, one fairly closely connected with A.C.T. Palaeontology, have been in progress during 1968:

1. Silurian encrinurid trilobites of southeastern Australia (with J.H. Shergold). Work in 1968 has been mainly concerned with the species erected by Etheridge and Mitchell, particularly from Yass. A week was spent in Sydney examining collections from Yass and Canberra held by the Australian Museum, the Mining and Geological Museum, and the University of Sydney. Some of the specimens, including most of Etheridge and Mitchell's types, were borrowed for further study in Canberra. A day was also spent with A.G. Link of the Australian National University, examining outcrops of the "Lower Trilobite Bed" at Yass. It is from this horizon that many of the Yass encrinurids were collected.

2. Siluro-Devonian corals of eastern Australia. In December 1967, three days were spent in the Wellington - Molong area of N.S.W., collecting from the early Devonian Garra Formation with J. Pickett (Geol. Surv. N.S.W.), B.D. Webby (Univ. Syd.), and E.C. Willey (Univ. N. Eng.). Willey was mainly concerned with ostracodes, and Pickett with sponges. In October 1968, one week was spent in Brisbane, preparing jointly with J.S. Jell a paper on the Devonian rugose coral Cyathophyllum (Radiophyllum).

About four weeks of September-October were occupied with assisting the Texas High Party by searching the pre-Permian rocks for fossils. One week was spent at Silverwood, south of Warwick, collecting in the Devonian. Sufficient new material was obtained to permit a revision of this fauna, previously described by D. Hill in 1940. In the remaining time, limestones in the Limevale - Texas-Pikedale - Glenlyon area were investigated. Some of these had previously been thought to be of Siluro-Devonian age, but in none could evidence to support that assumption be found. Some of the limestones were without fossils (probably a result of both their initial oolite composition, and their subsequent shearing and recrystallization), but the others yielded small collections of Lower Carboniferous (Visean) corals. As the accompanying rocks are essentially the same in all cases, it has been concluded that there is no evidence for pre-Carboniferous strata in the area.

A collection of corals from the Chinchilla Sheet was examined for N. Exon, and proved to contain Lower Carboniferous corals, amongst them the characteristic species Lithostrotion stanvellense.

Some time was also devoted to the gathering of information from which was compiled a revised list of palaeontological research projects being undertaken in Australia, or on Australian fossils.

Annual Report

by

J.N. Shergold

During the period October 1st, 1967 to September 30th, 1968 J.H. Shergold was engaged on the following activities.

1. On returning from the field in September 1967, Bulletin 104, Oryctocephalidae (Trilobita: Middle Cambrian) of Australia, was completed and submitted for publication in December. This Bulletin describes the morphology and relationships of thirteen species of Middle Cambrian trilobites belonging to the family Oryctocephalidae, from the Northern Territory, Queensland and northwestern New South Wales.

2. Fossils collected by the 1967 Northwest Queensland Phosphate Party were examined during November and December. A report on these was compiled and appended to B.M.R. Record 1968/67.(F. de Keyser - The Cambrian of the Burke River Outlier).

3. A programme to describe and illustrate the late Cambrian trilobite faunas of northern Australia was initiated. As a first phase in this, a study has been made on the faunas of the Gola Beds and the results written up as Bulletin 112. This is at first draft stage of completion. Twenty five species, distributed among nineteen genera, have been described. The faunas are largely new.

4. Concurrently, trilobites collected during the 1967 field season from Black Mountain, Mount Ninmaroo, Mt. Datson and Dribbling Bore, Boulia region, are in the course of preparation with the hope that these will facilitate correlations in the Chatsworth and Ninmaroo Limestones of western Queensland.

5. To facilitate the above studies an index of Upper Cambrian agnostids has been developed. Illustrations, synonymies, localities and horizons of all previously described species are card indexed. Additions are made periodically.

6. In collaboration with D.L. Strusz, descriptions of east Australian Encrinuridae are under preparation. Type and other specimens, borrowed from the National Museum of Victoria and the Australian Museum, have been studied, and are being prepared for statistical interpretation.

7. Since March reports written on samples submitted for determination by private companies included two for Continental Oil Company of Australia, and three for Mines Exploration Pty. Ltd. In addition five reports have been compiled to date for the 1968 Georgina Phosphate Party on Cambrian fossils from the Undilla and Georgina Basins (Mt Isa, Cammoweal, Lawn Hill, Mt Drummond, Ranken, and Avon Downs 4-mile Geological Sheets).

MICROPALAEONTOLOGY

Introduction

by

G.R.J. Terpstra

Three thousand one hundred and nineteen samples were washed, picked and prepared for study of their microfaunal content.

Eight hundred and sixty one thin sections were made and nine hundred and sixteen polished rock sections were prepared.

One thousand and eleven samples were treated with acid (in weight about 8000 lbs) in order to extract conodonts.

Ninety seven samples were treated for technical experiments in order to improve on or find new methods of treatment.

Eighty seven drawings for illustrations were completed.

Three hundred and ninety one samples were processed for their spore and microplankton content.

Dr. P.R. Evans (Palynologist) resigned from the B.M.R. at the end of 1967.

Dr. Elizabeth M. Kemp (Palynologist) joined the B.M.R. on the 5th June, 1968.

Dr. H. Binnekamp (Micropalaeontologist) joined the staff of the micropalaeontological section in December 1967.

Visitors during the year to the laboratory were the following:

Mr. A. Partridge micropalaeontologist Geological survey N.S.W., who studied the collection of Lower Cretaceous type specimens and laboratory techniques. Dr. J. Sperraza of the Esso Exploration Company to study the benthonic fauna encountered in samples from the "Oil Shaft" Victoria. Mr. R. T. O'Brien of B.H.P. Central Reserve Laboratory, N.S.W. to discuss the results of the examination of micro-faunas from outcrop samples of Groote Eylandt N.T., and Dr. S. Schuyleman, micropalaeontologist of B.P. Petroleum Dev. Co., Melbourne, for general discussions.

Discussions were held with representatives of manufacturers of the Scanning Electron Microscope, as it is the intention to instal such an instrument for special studies of micro-organisms.

The reports by individual authors follow.

Annual Report

by

G.R.J. Terpstra

G.R.J. Terpstra continued the examination of cuttings from a series of deep wells drilled in the Great Artesian Basin area, Queensland, in order to establish more closely the boundary between the marine and non-marine Lower Cretaceous sediments. The wells examined for this purpose with the respective top of the marine sequences in feet are: Dullingari No. 1 (Delhi Santos) 2610 feet; Naryilco No. 1 (Delhi Santos) 1720 feet Orientos No. 1 (Delhi Santos 2040 feet; Binerah Downes No. 1 (Clarence River) 730 feet; and the Phillips Sunray Wells: Bonnie No. 1 660 feet; Bury No. 1 240 feet; and Carlow No. 1 570 feet. Research on the quantitive occurrences of Hedbergella infracretacea (Glaessner) for a closer correlation of the Toolebuc Phosphate deposits, has been carried out on samples from twenty shallow bores from the Northern Eromanga Basin Queensland, supplied for this purpose by the Kennecott Exploration Company. Routine examinations of surface samples collected by field parties from Queensland, Northern Territory, Papua and New Guinea, and cores and cuttings from subsidized wells have been carried out. Miocene, (F1-F2 stage), Lower Miocene "Te" stage, Oligocene and Eocene ages were established from limestone samples of various areas in New Guinea and Papua by means of Larger Foraminifera. Time was spent on administrative matters and on the supervision of preparing records of the reports on plant fossils, collected by the field parties and determined by the palaeobotanist specialist Mrs. M.E. White.

Annual Report

by

D.J. Belford

The foraminiferal sequence in Tertiary limestone from Christmas Island has been examined together with Dr. C.G. Adams from the British Museum (Natural History). Five faunal assemblages have been recognized; these are, from the base upward:

A. An Eulepinina - Spiroclypeus - Miogypsinoides "Dantamensis" assemblage.

B. An Eulepidina - Spiroclypeus assemblage.
(It is possible that A is the face-reef equivalent of the bottom part of B).

C. A Miogypsinoides - dehaarti - Amphistegina - Cypsina marianensis assemblage.

D. A Miogypsina neodispansa assemblage.

E. A Flosculinella bontangensis assemblage. Assemblages A and B are lower "e" stage in age, and C and D are upper "e" stage. Assemblage E (known from only one locality) is the only indication of beds of possible lower "f" age.

Oriented thin sections of foraminifera are now being prepared, in an attempt to determine specific ranges in the limestone. A new species of the genus. Heterostegina, which may be a good marker, occurs in assemblage B.

Routine work continued on outcrop and subsurface samples from Western Australia and Papua - New Guinea, and reports were written as required.

Annual Report

by

J.G. Binnekamp

J.G. Binnekamp joined the micropalaeontological section in December 1967. He started a study of the Foraminifera from a Miocene - Pliocene section in the Upoia - Kerema area, Papua, collected by an A.P.C. survey. The Foraminifera from side-wall cores from Hope Island No. 1 (Western Australia) were examined and the results reported. Examination of samples collected by the Kubor Range field party (New Guinea) was carried out. Time was spent in re-organizing the existing collections of Foraminifera.

Annual Report

by

P.J. Jones

The significance of marine Ostracoda from the Lower Triassic sequence of the Perth Basin is discussed in a paper (Bull. 108-6) now in press. Four species (2 palaeocopes and 2 podocopes) are described from the Kockatea Shale of BMR 10, Beagle Ridge Bore (on Dongara), adding to the scant knowledge of marine Lower Triassic ostracods throughout the world. It also provides an example of relict Palaeozoic ostracods living in Early Triassic times, and will be referred to as such in a paper read by Dr I.G. Sohn of the U.S. Geological Survey, at the November meetings of the Geological Society of America.

A joint paper (Bull. 110) with E.C. Druce on Upper Cambrian and Lower Ordovician (Tremadocian) conodonts from the Burke River structural belt (on Boulia), western Queensland, was sent to press. Fifty-three form-species are described, and six assemblage zones are established in the Tremadocian, which can be used for intercontinental and local correlation. Phylogenetic relationships of the conodonts and rates of sedimentation are also discussed. A sequel to this work was the preparation of a joint statement on the Cambrian-Ordovician boundary, which was submitted for consideration by the subcommission on Cambrian stratigraphy of the IUGS at the September meetings of the IGC, Prague.

The first draft of a paper describing the Lower Ordovician (Tremadocian) conodonts from the Bonaparte Gulf Basin and the Daly River Basin has been completed. Forty-one form-species are described, and their distribution in measured sections show that the Tremadocian assemblage zones based on the limestone facies of the Boulia region, western Queensland, can be recognized in the arenitic facies of north-western Australia.

During the year biostratigraphical contributions to papers were published on (i) Upper Silurian or Lower Devonian thelodont scales in the Cravens Peak Beds, Toko Range, western Queensland (Johnstone et. al.,), (ii) Upper Devonian palaeontology of the Bonaparte Gulf Basin (Roberts, Jones & Druce), and (iii) Upper Cambrian and Lower Ordovician conodonts of the Boulia region, western Queensland (Druce & Jones).

Miscellaneous tasks included work on:-

(i) Ordovician conodonts, whilst operating the Mobile Conodont Laboratory for six weeks during BMR drilling of the Cambro-Ordovician sequence of western Queensland (Glenormiston, Boulia).

(ii) Upper Cambrian conodonts from the Gola Beds (Boulia), which were identified, and their stratigraphical significance reported on for J.H. Shergold.

(iii) Uppermost Devonian ostracods from WAPET Doran No. 1 Well (Core 15 at 2945 feet), Canning Basin, W.A.; a report was provided for W.J. Koop (WAPET).

(iv) Lower Carboniferous (Visean) ostracods from AOD Bonaparte No. 2 Well, which can be used for correlation with AOD Bonaparte No. 1 Well.

(v) Lower Cretaceous (Albian) ostracods from BMR Scout Bore No. 1 (Surat), Surat Basin, Queensland (in Thomas & Reiser, 1968, unpubl.).

Annual Report

by

E.M. Kemp

E.M. Kemp joined the micropalaeontological section at the beginning of June. June and July were spent in familiarisation with the work of the section, in attending an induction course within the Bureau, and in assessing problems of Triassic and Permian stratigraphy in the Bowen and Surat Basin areas.

These assessments were made with a view to selecting areas where detailed taxonomic work would find the most useful stratigraphic application. Some updating of the palynological species catalogue was made during the course of this survey.

A visit was paid to the Bowen Triassic and Surat Basin field parties during September. Samples from exposures of the Moolayember and Rewan Formations in their type areas were collected and processed for palynological examination. Some rich assemblages, including a suite of megaspores from near its base, were recovered from the Moolayember. Preliminary study of these assemblages shows rapid palynofacies changes occurring within the formation, but does not yet permit evaluation of de Jersey's correlation of the sequence in the Moolayember area with the basal 2000 feet of the Mimosa Syncline sequence of the formation. Megaspores from different horizons within the Moolayember have been picked preparatory to their description, in the hope that they will provide another tool for stratigraphic subdivision.

It is intended to try to carry stratigraphic refinements emerging from current studies of Triassic microfloras being undertaken at the Geological Survey of Queensland into the subsurface of the Bowen and Surat Basins. To this end the preparation of core and cuttings samples from UKA Cockatoo Creek No. 1 has been commenced.

During the period under review, palynological determinations were made, when preservation permitted, on samples from Sun Oil Barcoo No. 1, and Continental's Munyarai No. 1. While D. Burger was in the field determinations were also made on BMR wells Chinchilla No. 9 and Dalby Nos. 2,3, and 4. The palynology of the Lower Cretaceous section in BMR Eddystone 50 was reviewed.

Annual Report

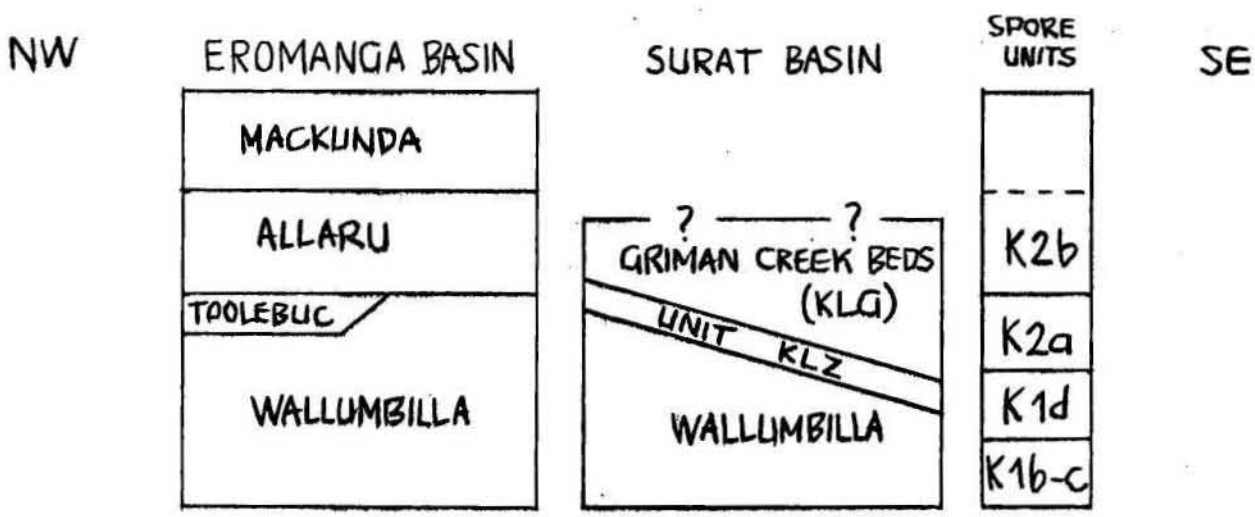
by

D. Burger

Palynological studies were made of Jurassic and Cretaceous sediments in the Great Artesian Basin, Queensland, in close co-operation with regional field mapping by the B.M.R. and the Geological Survey of Queensland. The major projects and results were the following:

1. Study of drill core and cuttings from the B.M.R. drilling programme in the marine Lower Cretaceous of the northern and eastern Eromanga Basin established the detailed relationship between the palynological zonation and lithology. Using these results a comparison was made with other Lower Cretaceous formations, subsequently drilled in the Surat Basin. Initial correlation of Aptian and Albian formations in these Basins is shown in Figure S13.

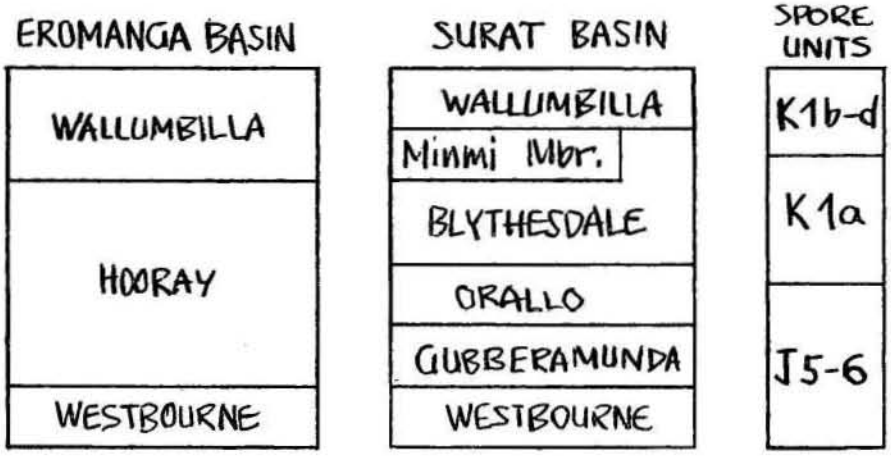
FIGURE S 13



The youngest Cretaceous strata in the Surat Basin area, units Klz and Klg, show transgressive tendencies as they appear to be of younger palynological age near the western margin of the Basin than in the central area. The youngest Cretaceous strata preserved form the palynological equivalent of the Allaru Mudstone.

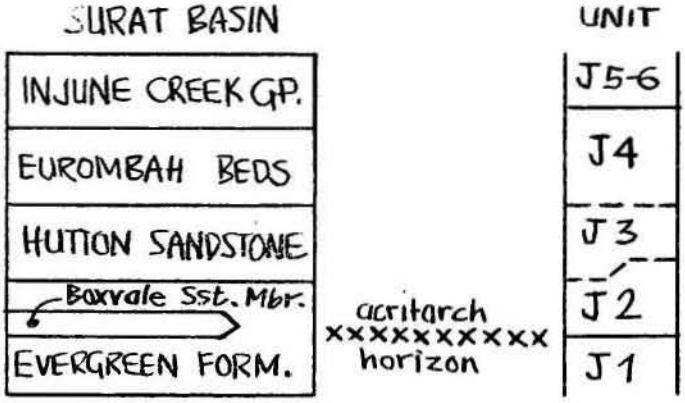
2. Upper Jurassic to approximately Neocomian formations of the eastern Eromanga and Surat Basins were correlated. A slight time discrepancy was established in the first fully marine Cretaceous beds of the Wallumbilla Formation (Fig. S14). This indicates that marine transgression in the Eromanga Basin began earlier than in the Surat Basin. New spore information confirms the correlation of the Hooray Sandstone with the Gubberamunda, the Orallo and most of the Blythesdale Formations.

FIGURE S 14



3. Palynology of Lower Jurassic sequences in oil wells and shallow bores in the Eromanga and Surat Basins confirms earlier concepts of spore relationship to lithology and indicates the existence of a brief interval in the palynological sequence, prior to spore unit J5,

FIGURE S 15



which is defined as unit J4 and includes microfloras that contain Leptolepidites verrucatus. Recognition of this unit permits more accurate correlation of formations previously lumped in the interval of J2-4 and which include water and oil producing sediments.

Beds containing acritarchs are restricted to the Surat Basin area where they have been found in or adjacent to the Boxvale Sandstone Member of the Evergreen Formation.

4. Angiospermous pollen grains from Aptian, Albian and younger formations in the Great Artesian Basin are subject to continued stratigraphic and spore-systematic study. Small, smooth-walled tricolpate forms are known from the Aptian upwards and dominate the angiosperms in probably lower Upper Cretaceous microfloras. Ornamented tricolpate forms appear in the Albian and remain relatively scarce in higher assemblages. Future spore zonation of the Upper Cretaceous will be partly based on restricted time distribution of these types.

5. Isolated palynological investigations, connected with deep drilling in search for oil and natural gas, were carried out on subsurface samples (cores, sidewall cores, cuttings) from Queensland and New South Wales.

Annual Report

by

E.C. Druce

Work continued on Cambrian faunas from Queensland; Ordovician faunas from Queensland, Northern Territory and New South Wales, Silurian faunas from A.C.T., and N.S.W., and Devonian faunas from N.S.W., Western Australia and Queensland.

The Mobile Conodont Laboratory spent over six months in the field.

SEDIMENTARY PETROLOGY

by

A.R. Jensen and M.C. Brown

Personnel: M.C. Brown, P.J. Alcock, A.R. Jensen; Miss K.M. Lachno (University of Sydney).

Both Alcock and Jensen spent part of the year examining core and cuttings from wells in the Sydney Basin for the Petroleum Exploration Branch. By June, Alcock had completed studies of material from Woronora (A.O.G.) No. 1 and Stockyard Mountain (F.D.N.L.) No. 1. Jensen and Miss Lachno completed the examination of core and cuttings through the Farley, Rutherford, Allandale and Lochinvar Formations of East Maitland (Planet) No. 1.

The sequence penetrated by East Maitland No. 1 well was without exception impermeable and of low porosity. The lack of porosity was firstly a function of the overall fine grained nature of the sediment, and secondly the result of cementation of the few sand intervals in which original porosity was high.

From February to May, M.C. Brown was engaged on the petrology of Middle and ?Upper Cambrian sedimentary rocks in the northern part of the Northern Territory. This project comprised (a) microscopic examination of thin sections of surface and borehole samples from the northern part of the Wiso Basin, and the north-western part of the Georgina Basin, and (b) an appraisal of borehole records and previous geological literature on the Daly, Wiso, and north-west Georgina Basins.

Results indicate that Middle and ?Upper Cambrian sedimentation in the northern part of the Northern Territory seems to have extended well beyond the present outcrop and subcrop margins; and that the Daly, Wiso, and Georgina Basins were probably continuous soon after the start of the early Middle Cambrian transgression.

Early Middle Cambrian sediments (containing the trilobites Xystridura and Redlichia) were, in the main, deposited under shallow sea water of normal salinity containing a good supply of nutrients. They are dominantly fossiliferous calcilutite with some skeletal and oolitic calcarenite and calcareous siltstone. These normal marine sediments were followed conformably by later Middle Cambrian and possibly also Upper Cambrian sediments dominantly of intertidal to terrestrial deposition, consisting of dolomite, dolomitic siltstone (usually red and chocolate-brown), and fine to very fine sandstone. The area of intertidal to terrestrial sedimentation probably extended from near the Queensland border at least as far west as the East Kimberleys.

Results of this study were presented at the G.S.A. Specialists' Symposium in May.

PHOTOGEOLOGY

by

C. Maffi

Personnel: W.J. Perry (part-time until February 1968); C. Maffi; C.J. Simpson (joined staff 1st July 1968).

Visitors: Mr. B.S. Nadhamuni Naidu, Geologist, Department of Geology & Mining, Gujarat State India 23/9/68.

Photo-Interpretation Completed: The following photogeological maps at 1:250,000 scale were completed.

Northern Territory: Limbunya.

Queensland: Goondiwindi; Warwick; Ipswick (western part).

Detailed photo-interpretation and fracture-trace analysis: Upper Ramu Gorge Hydro-electric Scheme (N.G.); Musa River Hydro-electric Scheme (Papua); North Molonglo Outfall Sewer Project (A.C.T.).

Photo-Interpretation in Progress: at 31st October, 1968.

Northern Territory: Waterloo; Birrindudu; Tanami.

Territory of New Guinea: New Britain (construction of photomosaics and photo-interpretation).

Field Work: Maffi visited the Waterloo area from 18th June to 9th July to check the photo-interpretation.

General: Colour airphotos of an area of the Ngalia Basin flown in 1967 in co-operation with the Airborne Group (Geophysical Branch) were checked in the field against panchromatic airphotos by A.T. Wells. The colour photos showed clearer contrast - between the various formations - than panchromatic photos taken with the same lens at the same altitude. Stereoscopic marks for the evaluation of dips and altitude differences on airphotos were calculated and designed: their production was in progress at 31st October, 1968. A stereoscopic projector for 50 mm slides was designed; a preliminary model was successfully tested and it is hoped that a final model for training and lecturing purposes will be made soon. A light table with correct colour temperature for viewing colour transparencies was designed.

Five new staff members were briefly trained in photo-interpretation. Perry and Maffi attended certain sessions of the Geological Society Specialist Symposium held in Canberra from May 27th to May 31st.

A display was arranged for 3rd year A.N.U. students in July.

On behalf of the Sedimentary Basins Section, Geological Branch, the Bureau employed a number of specialists on a contract basis. They were engaged on a wide range of subjects, and their activities are given in the following reports.

1. Mr. R.W. Day of the Geology Department of the Australian National University has examined and reported on fossils collected from near Surat. He recorded marine and freshwater forms.

2. Dr. A.A. Öpik has completed the manuscripts of "Dolichometopid Trilobites of Queensland, Northern Territory and N.S.W." and the "Templetonian and Ordian Xystridurid Trilobites of Australia". He is at present working on "Agnostids of the family Ptychagnostidae and Diplagnostidae of Northern Territory and N.S.W." and "Trilobites of Asian Affinities of the Middle Cambrian of Northern Australia".

3. Dr. Irene Crespin continued work on cataloguing fossil type specimens. The N.S.W. catalogue is nearing completion and a considerable amount of work has been done on the second A.C.T. catalogue.

4. Mrs. Mary E. White has examined plant fossils from New Guinea, the Surat Basin area, Charters Towers region, the Drummond Basin area and from the Mt. Eclipse sandstone Northern Territory. Her results have been reported in the B.M.R. records listed in Appendix S1.

5. Dr. C.E.B. Conybear (A.N.U.) During the period 21st August to 2nd September, 1968, Dr. C.E.B. Conybeare accompanied Mr. J.N. Casey on a tour of areas in the Ngalia, Bowen, and Surat Basins. The first five days were spent with A.T. Wells examining key localities throughout the Ngalia Basin sequence.

In the Bowen Basin, Dr. Conybeare examined parts of the Rewan and Moolayember Formations, and the Clematis Sandstone, in the south-western part of the outcrop area near the Carnarvon Highway; all units seem to have been deposited in a fluviatile or lacustrine environment.

The final three days of the trip were spent with the Surat Basin Party examining Tertiary sandstone, various Jurassic units (including the Orallo Formation and Fossil Wood Member) equivalent to the lower part of the Blythesdale Group, and to the underlying Walloon Caol Measures and Marburg Formation; the Jurassic sediments include those deposited in point bar, flood plain, backswamp and lacustrine environments.

6. Professor J.A. Mabbutt of the School of Geography, University of New South Wales, spent two weeks with the Eromanga Party. He carried out a geomorphological reconnaissance of much of the area mapped by the 1968 field party (including 8½ hours of aerial reconnaissance). He discussed several problems with party members, particularly the role of a fragmented zone of a deep-weathering profile as a duricrust. Professor Mabbutt will write a report on his visit for incorporation in the record of the mapping of the area. He will also provide pictorial representations of landforms to accompany Explanatory Notes for some of the sheets.

D.J. Forman's Public Service Board Scholarship awarded in 1965 was extended for six months. The Scholarship ended in January on the successful completion and defence of his Ph. D. thesis at Harvard University. He returned to duties at the B.M.R. in March. The thesis "Palaeotectonics of Precambrian and Palaeozoic rocks of Central Australia" was submitted for editing as a bulletin and several short papers are being taken from it for outside publication and for inclusion in the Bulletin on the Geology of the Amadeus Basin.

J. Roberts holder of a Harkness Fellowship of the Commonwealth Fund of New York has been overseas firstly at the Smithsonian Institute, Washington and now at the Department of Geology, University of Illinois, Urbana where he has been continuing his studies of Devonian and Carboniferous brachiopods from Western Australia.

B.K. Graham was engaged in various tasks including:

a) Data Filing and Indexing

1) Subsidy applications and completion reports on wells and geophysical surveys received under the Petroleum Search Subsidy Scheme, were circulated and filed. Summary cards were prepared for all well applications and reports.

2) Sedimentary Basin index cards were kept up to date as applications, reports and other references were received.

3) Material received from exploration companies, and data from other sources such as scout reports and press releases, were added to the well progress files.

4) Punch cards summarising some well applications were prepared, and together with cards on applications and reports, prepared by other officers of the section, were punched and filed.

5) Queries from other officers and visitors concerning data available on specific areas were dealt with, and the filing and indexing systems used by the Section described to visitors.

b) Map Compilation

1) Geological Map of the World: Australia and Oceania (1:5,000,000 scale). - The last of the map sheets being prepared for this project by the B.M.R. were completed. Compilation of the general legend sheet to complete the series is attendant upon the preparation of the final two map sheets by the New Zealand Geological Survey.

2) Compilation continued of Sheet 15 (Australia and New Guinea) of the International Geologic Atlas at 1:10,000,000 scale.

c) Field Mapping

During February, a week was spent in the Bredbo area of New South Wales supervising, with other geologists, field mapping by a group of vacation student employees.

S.K. Skwarko

S.K. Skwarko spent three months abroad on a Bureau of Mineral Resources sponsored tour which took him to Japan, the U.S.S.R., Poland, the U.K., the U.S.A., and Mexico. The purpose of the trip was examination of collections of Mesozoic fossils held by scientific institutions in those countries, to make a detailed study of the Canning Basin Ordovician graptolites, and to do a comparative study of the Western Australian Jurassic faunas.

Skwarko arrived in Fukuoka, Japan, on the 29th April and spent two days at the local university with Dr. Hayami, a specialist on the Jurassic and Cretaceous faunas of Japan, before proceeding to Kumamoto. At the faculty of Education, Kumamoto University he examined collections of fossils from Malaysia and held discussions with Dr. Tamura. He spent the next four days in Hiroshima at the University for a round of discussions with Dr. Nakano, one of the world's leading workers on Trigoniidae. Then he proceeded to Tokyo for a brief visit to the university before flying on to Mescow. At the Tokyo university Skwarko was shown the type collections of Japanese Mesozoic fossils by Professor Kobayashi.

Skwarko arrived in Moscow on 9th May to find the University and the Academy of Science closed because of protracted celebrations to mark the 23rd anniversary of victory of Bolshevism over Hitlerism. In Leningrad, however, where he also stayed three days he met Dr. Kiparisova and her several colleagues with whom he held discussions regarding the New Guinea Triassic faunas newly discovered.

The next five weeks Skwarko spent in Poland at the Department of Paleozoology, Warsaw University, where he made a detailed study of the Canning Basin Ordovician graptolites under the guidance of two of the worlds-foremost experts in the field, Prof. R. Kozlowski and Doc. Dr. A. Urbanek. In London, where he arrived on the 21st June Skwarko spent three weeks at the British Museum (Natural History) comparing the Western Australian Middle Jurassic faunas with the European equivalents.

Six days were spent by Skwarko at the Geological Survey in Washington with Dr. Pojeta on Ordovician faunas, and five days in Mexico City at the Palaeontology Department, Ciudad Universitaria on Jurassic faunas with Dr. G. Alencaster.

Skwarko arrived back in Canberra on 30th July.

APPENDIX S-1

STATUS OF RECORDS AND PUBLICATIONS ON 31st OCTOBER, 1968

PROJECT / AUTHOR	TITLE		FORM OF PUBLICATION	STATUS
			Bulletin B Report R Explanatory Notes E.N. External Publication E.P. Records C	
BOWEN BASIN				
DICKINS, J.M., and MALONE, E.J.	Geology of the Bowen Basin, Queensland		B	In prep.
MALONE, E.J., and others	Geology of the Duaringa and Saint Lawrence 1:250,000 Sheet areas, Queensland		R121	In press
MOLLAN, R.G., and others	Geology of the Springsure 1:250,000 Sheet area, Queensland		R123	In press
MOLLAN, R.G., and others	Geology of the Eddystone, Taroom and western third of the Mundubbera 1:250,000 Sheet areas, Queensland		R	With editor
MALONE, E.J.	MOUNT COOLON	SF-55/7	E.N.	Ready for printing
MALONE, E.J.	SAINT LAWRENCE	SF-55/12	E.N.	With map editor
KIRKEGAARD, A.G. *	DUARINGA	SF-55/16	E.N.	MS prepared
EXON, N.F.	EDDYSTONE	SG-55/7	E.N.	In press
FORBES, V.R.*	TAROOM	SG-55/8	E.N.	In press
MOLLAN, R.G.	SPRINGSURE	SG-55/3	E.N.	Issued
OLGERS, F.	EMERALD	SF-55/15	E.N.	Ready for printing

*G.S.Q.

OLGERS, F.	CLERMONT	SF-55/11	E.N.	Ready for printing
DICKINS, J.M., and MALONE, E.J.	Regional Subdivision of the Back Creek Group (= Middle Bowen Beds), Bowen Basin, Queensland		E.P.	Published
MALONE, E.J.	Devonian of the Anakie High area, Central Queensland		E.P.	Published International Symposium on the Devonian System, Calgary, 1967
TEXAS HIGH				
OLGERS, F.	Buchanan		E.N.	With editor
OLGERS, F.	Geology of the Drummond Basin, Queensland		C/B	In prep.
SURAT BASIN				
EXON, N.F., REISER, R.F., JENSEN, A.R., BURGER, D., and THOMAS, B.M.	The geology of the Chinchilla 1:250,000 Sheet area southern Queensland		C 1968/53	Being assembled
THOMAS, B.M., and REISER, R.F.	The geology of the Surat 1:250,000 Sheet area, Queensland		C 1968/56	Issued
EXON, N.F., and DUFF, P.G.	Jurassic bentonite from the Miles district, Queensland		C 1968/49	Issued
EXON, N.F., LANGFORD-SMITH, T., and McDOUGALL, I.	The age and geomorphic correlation of deep-weathering profiles, silcrete and basalt in the Roma - Amby region, Queensland		E.P.	Final draft completed
EROMANGA BASIN				
VINE, R.R.	Geology of the northern Eromanga and Galilee Basins, Queensland		B	In prep.

EXON, N.F., and others	The Geology of the Tambo-Augathella area		R	With Editors
CASEY, D.J.	MANUKA	SF-54/8	E.N.	In press
CASEY, D.J.	TANGORIN	SF-55/5	E.N.	Ready for press
EXON, N.F.	TAMBO	SG-55/2	E.N.	With Editors
CASEY, D.J., and GALLOWAY, M.C.	BLACKALL	SG-55/1	E.N.	In progress
VINE, R.R.	MUTTABURRA	SF-55/9	E.N.	In progress
VINE, R.R.	RICHMOND	SF-54/4	E.N.	With map editors
SENIOR, B.R.	CONNEMARA	SG-54/3	E.N.	Ready for press
SENIOR, B.R.	JUNDAH	SG-54/4	E.N.	Ready for press
GREGORY, C., and VINE, R.R.	CANTERBURY	SG-54/7	E.N.	With Editor
GREGORY, C., and VINE, R.R.	WINDORAH	SG-54/8	E.N.	With Editor
SENIOR, B.R.	BARROLKA	SG-54/11	E.N.	With Editor
SENIOR, D.A.	DURHAM DOWNS	SG-54/15	E.N.	With Editor
GALLOWAY, M.C.	TICKALARA	SH-54/3	E.N.	In prep.
GALLOWAY, M.C.	ADAVALE	SG-55/5	E.N.	With map editors
GALLOWAY, M.C.	AUGATHELLA	SG-55/6	E.N.	In prep.

INGRAM, J.A.	Notes on opalization in South-Western Queensland		C 1968/47	Issued
GALLOWAY, M.C.	Petrology of sediments from the Longreach - Jericho - Lake Buchanan area, Queensland		C 1967/80	Issued
GALLOWAY, M.C.	The petrology of some Mesozoic sediments from the Tambo, Augathella, Eddystone and Mitchell 1:250,000 Sheet areas, Queensland		C 1967/81	Issued
GALLOWAY, M.C., and INGRAM, J.A.	Drilling in the Eastern Eromanga Basin, 1966		C 1967/82	Issued
VINE, R.R.,and GALLOWAY, M.C.	Shallow stratigraphic drilling and coring, northern Eromanga Basin, 1963-64		C 1965/244	In prep.
SENIOR, B.R., and others	The geology of the Barrolka, Eromanga, Durham Downs, Thargomindah, Tickalara and Bulloo 1:250,000 Sheet areas, Queensland		C 1968/35	Issued
EXON, N.F.	Petrography of some thin sections from the Tambo area,Queensland		C 1968/36	Issued
GEORGINA BASIN				
SMITH, K.G.	Geology of the Georgina Basin		B 111	With editor
RANDAL, M.A.	Groundwater in the Barkly Tableland, N.T.		B 91	Issued
NICHOLS, R.A.H.	Petrology of some carbonates in the Georgina Basin		B 94	Editing deferred
SMITH, K.G., and others	Stratigraphic drilling in the Georgina Basin		R 124	With printer
RANDAL, M.A., and BROWN, M.C.	HELEN SPRINGS	SE-53/10	E.N.	Ready for press
BROWN, M.C., and RANDAL, M.A.	BEETALOO	SE-53/6	E.N.	In press
SMITH, K.G.	ELKEDRA	SF-53/7	E.N.	Issued
SMITH, K.G.	BONNEY WELL	SF-53/2	E.N.	With map editor

WISO BASIN

RANDAL, M.A.	Groundwater in the Wiso Basin & Environs		B	In preparation
BROWN, M.C.	DALY WATERS,	SE-53/1	E.N.	Ready for press
RANDAL, M.A.	NEWCASTLE WATERS	SE-53/5	E.N.	Ready for press
RANDAL, M.A.	LARRIMAH	SD-53/13	E.N.	Ready for press
RANDAL, M.A.	Groundwater in the Northern Wiso Basin		E.P.	Published in Water Resources Newsletter No. 9
RANDAL, M.A., and BROWN, M.C.	Geology of the Northern Wiso Basin		C 1967/110	Issued
BROWN, M.C.	Middle and (?)Upper Cambrian Sedimentary rocks in the Northern Part of the Northern Territory		C	In preparation

AMADEUS BASIN

COOK, P.J.	The Stairway Sandstone		B95	With editor
FORMAN, D.J.	Palaeotectonics of Precambrian and Palaeozoic rocks of central Australia		B	With editor
WELLS, A.T., and others	The Geology of the Amadeus Basin, Central Australia		B100	With editor
FORMAN, D.J., and others	Regional geology and structure of the north-eastern margin of the Amadeus Basin, Northern Territory		R103	Issued
WELLS, A.T., and others	Geology of the north-east Amadeus Basin		R113	In press
COOK, P.J.	HENBURY	SG-53/1	E.N.	In press
COOK, P.J.	RODINGA	SG-53/2	E.N.	In press

QUINLAN, T., and FORMAN, D.J.	HERMANNSBURG	SF-53/13	E.N.	In press
RANFORD, L.C.	MOUNT LIEBIG	SF-52/16	E.N.	Ready for press
RANFORD, L.C.	MOUNT RENNIE	SF-52/15	E.N.	In press
MILLIGAN, E.N.	ILLOGWA CREEK	SF-53/15	E.N.	Ready for press
SHAW, R.D.	HALE RIVER	SG-53/3	E.N.	In press
STEWART, A.J.	KULGERA	SG-53/5	E.N.	Issued
STEWART, A.J.	McDILLS	SG-53/7	E.N.	In press
WELLS, A.T.	MACDONALD	SF-52/14	E.N.	In press
WELLS, A.T.	FINKE	SG-53/6	E.N.	Ready for press
WELLS, A.T.	ALICE SPRINGS	SF-53/14	E.N.	Ready for press
COOK, P.J.	The Gosses Bluff cryptoexplosion structure		E.P.	Jour. Geol. 76 (2)
MILTON, D.J., and BRETT, P.R.	Gosses Bluff Astrobleme- the central uplift		E.P.	Abstract Geol. Soc. Am. Tucson meeting, 1968
SCHMERBER, G.	A petrological study of the sediments from Erldunda No. 1 Well, Amadeus Basin, Northern Territory		C 1966/182	Issued

NGALIA BASIN

WELLS, A.T., EVANS, T.G., and NICHOLAS, T.	The geology of the central part of the Ngalia Basin. N.T.		C 1968/38	Issued

A.C.T.

STRUSZ, D.	. A review of the Palaeozoic geology of the Canberra region -- title provisional	R	In prep.
	. Canberra 1:250,000 geological sheet (SI 55-16)	E.N.	With editor
	. Bibliography of books, papers, reports and theses in which reference is made to the geology or geomorphology of the Canberra 1:250,000 Sheet, with selected references to adjacent areas.	C 1968/94	In prep.

BONEPARTE GULF BASIN

VEEVERS, J.J.	Sedimentology of the Upper Devonian and Carboniferous Platform sequence of the Boneparte Gulf Basin	B109	Ready for press
VEEVERS, J.J., and ROBERTS, J.	Upper Devonian and Carboniferous geology of the Boneparte Gulf Basin	B97	In press
VEEVERS, J.J., and KAULBACK, J.A.	Lower Palaeozoic rocks of the Boneparte Gulf Basin	R109	In press

MACROPALAEONTOLOGY

DICKINS, J.M.	Correlation of the Permian of the Hunter Valley, New South Wales and the Bowen Basin, Queensland	B80	In press
DICKINS, J.M.	Discovery of the Crinoid Calceolispongia in the Permian of Queensland	B80	In press
RUNNEGAR, B.M.	Eurydesma and Glendella gen. nov. (Bivalvia) in the Permian of Eastern Australia	B	With editor
SHERGOLD, J.H.	Oryctocephalidae (Trilobita: Middle Cambrian) of Australia	B104	In press
SHERGOLD, J.H.	A late Cambrian trilobite fauna from the Gola Beds, western Queensland	B112	In prep.
SHERGOLD, J.H.	New fossils from the Duchess area, western Queensland	B	In prep.
SKWARKO, S.K.	The first report of Neotrigonia from New Guinea	B92	Issued
"	Lower Triassic and Middle Jurassic fossils at Enanty Hill, Mingenew, Perth Basin, Western Australia	B92	Issued
"	Some Ordovician graptolites from the Canning Basin, Western Australia. 1. On the structure of Didymograptus artus Elles & Wood	B92	Issued
"	Aptian (Lower Cretaceous) 'Apiotrigonia' from the Melligo Quartzite, Dampier Peninsula, W.A.	B80	In press
"	Bibliography of the Mesozoic palaeontology in Australia and New Guinea	B108	In press
"	Some Ordovician graptolites from the Canning Basin, Western Australia, 2, 3, 4	B	In prep.
"	Revision of the marine Jurassic faunas of Western Australia	B	In prep.
"	First Middle Triassic marine mollusca from New Guinea	B	In prep.

STRUSZ, D.	Rhizophyllum and Calceola from the Devonian of N.S.W. (collected papers)	B108	In press
STRUSZ, D.	(With J.S. Jell) Cyathophyllum (Radiophyllum) from the Devonian of eastern Australia	B	In prep.
THOMAS, G.A.	Devonian Spiriferidae from northwestern Australia	B56	Ready for press
VEEVERS, J.J.	Upper Devonian and Lower Carboniferous calcareous algae and stromatolites from the Bonaparte Gulf Basin, northwestern Australia	B	With editor
GILBERT-TOMLINSON, Joyce	Bothriolepsis in northern Australia	B80	In press
DICKINS, J.M.	Correlation chart for the Permian System in Australia with accompanying notes and bibliography. Proc. 1st International Symposium on Gondwana Stratigraphy and Palaeontology	E.P.	In press
DICKINS, J.M.	The Permian of Australia and New Zealand and Theories of Tectonism. Proc. Continental Drift Symposium, Montevideo, October, 1967	E.P.	In press
DICKINS, J.M.	Correlation and subdivision of the Permian of Eastern and Western Australia. Rep. int. geol. Congr., 22	E.P.	In press
DICKINS, J.M., GOSTIN, V.A., AND RUNNEGAR, B.N.	Correlation and age of the Permian Sequence in the southern part of the Sydney Basin, New South Wales. DOROTHY HILL COMMEMORATIVE VOLUME, A.N.U. Press, Canberra, Australia	E.P.	In press

PLANE, M., AND GATEHOUSE, C.G.	A new vertebrate fauna from the Tertiary of Northern Australia. Aus. J. Sci. 30.7.1968	E.P.	Published
SHERGOLD, J.H.	A reappraisal of the north American species of the Siluro-Devonian trilobite genus Scotiella. Peabody Mus. nat. Hist. Yale Univ. Postilla 112, pp. 1-20, pl. 1-3	E.P.	Published
"	On the occurrence of the trilobite genera Acaste and Acastella in Victoria. Proc. Roy. Soc. Vic. 81(1), pp. 19-30, pl. 3-5	E.P.	Published
"	With J. Shirley: The faunal-stratigraphy of the Ludlovian rocks outcropping between Craven Arms and Much Wenlock, Shropshire. Geol. J. 6(1), pp.119-138	E.P.	Published
"	With M.G. Bassett: The position of the Wenlock/Ludlow boundary in the Silurian graptolite sequence. Geol. Mag. 104(4), pp. 395-6(correspondence)	E.P.	Published
STRUSZ, D.	Chlamydophyllum, Iowaphyllum and Sinospongophyllum (Rugosa) from the Devonian of New South Wales. Palaeontology 10(3), 1967	E.P.	Published
"	On Cyathophyllum mansfieldense Dun 1898: Lower Devonian, Loyola, Victoria. Proc. Roy. Soc. Vic. 81(1), 1968	E.P.	Published
"	Lower and Middle Devonian of the Molong Geanticline, New South Wales, Australia. Internat. Symp. Devonian System Calgary, 1967, vol. 2, 1968	E.P.	Published

STRUSZ, D.	Cystiphyllum americanum var. australe Etheridge Jnr 1892, from North Queensland. Stratigraphy and Palaeontology: Essays in honour of Dorothy Hill	E.P.	In press
SHERGOLD, J.H.	Cambrian palaeontology. Appendix in: de Keyser, F. - The Cambrian of the Burke River Outlier	C 1968/67	Issued
SKWARKO, S.K.	Bibliography of the Mesozoic palaeontology of Australia and eastern New Guinea	B 108 C 1968/16	In press Issued
STRUSZ, D.	Carboniferous rugose corals from the Chinchilla Sheet. Appendix ix	C 1968/53	
GILBERT-TOMLINSON, Joyce	The report of the Devonian Symposium of 1967, to which the author is a contributor, has been published	E.P.	Published

MICROPALAEONTOLOGY

BELFORD, D.J.	Paleocene planktonic foraminifera from Papua and New Guinea	B 92-1	Issued
BELFORD, D.J.	Additional Miocene and Pliocene planktonic Foraminifera from Papua and New Guinea	B 92-2	Issued
BELFORD, D.J.	Occurrence of the genus Draffania, Cummings in Western Australia	B 92-3	Issued
BELFORD, D.J.	"Upper Devonian and Carboniferous foraminifera, Bonaparte Gulf Basin, Western Australia (Systematic paper)	B 108	In press
DRUCE, E.C.	Devonian Conodonts from the Garra Beds, N.S.W.	B	In prep. (Dec. 1968)
DRUCE, E.C.	Ordovician Conodonts from the Amadeus Basin	B	In prep. (Oct. 1969)

DRUCE, E.C.	Upper Palaeozoic conodonts from the Bonaparte Gulf Basin, northwestern Australia	B 98	In press
DRUCE, E.C.	Frasnian conodonts from Mount Morgan, Queensland	B 108	In press
DRUCE, E.C.	Lower Devonian conodonts from the Northern Yarrol Basin, Queensland	B 108	In press
DRUCE, E.C.	Carboniferous conodonts from the Yarrol Basin, Queensland	B 108	In press
DRUCE, E.C., and JONES, P.J.	Cambro-Ordovician conodonts from the Burke River structural belt (Queensland)	B 110	Ready for press
EVANS, P.R.	Pre-Cretaceous stratigraphic palynology in eastern Australia	B	In prep.
JONES, P.J.	Upper Devonian Ostracoda and Eridostraca from the Bonaparte Gulf Basin, Northwestern Australia	B 99	Issued
JONES, P.J.	Marine Ostracoda (Palaeocopa, Podocopa) from the Lower Triassic of the Perth Basin, Western Australia	B 108 - 6	In press
JONES, P.J.	Lower Ordovician conodonts from the Bonaparte Gulf Basin and the Daly River Basin, northwestern Australia	B	In prep.
JONES, P.J.	Lower Carboniferous Ostracoda from the Bonaparte Basin	B	In prep.
KEMP, E.M.	Angiospermous pollen grains from the Osborne Formation (Cretaceous) Perth Basin, W.A.	B or E.P.	In prep.
LLOYD, A.R.	Neogene Foraminifera from H.B.R. Wreck Island No. 1 bore and Heron Island bore, Queensland: Their taxonomy and stratigraphic significance; Part 2 - Nodosariacea and Buliminacea	B 108	In press

LLOYD, A.R.	Lower Cretaceous Radiolaria from the Northern Territory, Australia	B 92	Issued
BELFORD, D.J.	"Carboniferous foraminifera, Bonaparte Gulf Basin, Western Australia" (with B.L. Manet, Univ. of Montreal). (Discusses the stratigraphic and palaeographic significance of the fauna)	E.P.	To be published in Micropalaeontology
BURGER, D.	Angiospermous pollen grains from the Great Artesian Basin (Cretaceous) Queensland	E.P.	In prep.
DRUCE, E.C.	Statistical analysis of Upper Cambrian and Lower Ordovician (Tremodocian) conodonts from Western Queensland	E.P.	In prep. (Dec. 1968)
DRUCE, E.C., and JONES, P.J.	Stratigraphical significance of conodonts in the Upper Cambrian and Lower Ordovician sequence of the Boulia region, Western Queensland	E.P.	Published in Aust. J. Science
DRUCE, E.C., JONES, P.J., ROBERTS, J.	Palaeontology and correlation of the Upper Devonian of the Bonaparte Gulf Basin, Northwestern Australia	E.P.	Published in Inter. Symp. Devonian System, Calgary, Canada
DRUCE, E.C. (with F.H.T. Rhodes & R.L. Austin	British Aronian (Carboniferous) conodont faunas and their value in local and international correlation	E.P.	In press
DRUCE, E.C. (with F.H.T. Rhodes and R.L. Austin)	Statistical analysis of British Carboniferous conodonts	E.P.	In prep. (Dec. 1968)
EVANS, P.R.	Upper Carboniferous and Permian palynological stages and their distribution in eastern Australia	E.P.	In press, Revista geol. Assn Argent.

EVANS, P.R.	Upper Devonian and Lower Carboniferous miospores from the Mulga Downs Beds, N.S.W.	E.P.	Published in Aust. J. Sci.
EVANS, P.R.	The Late Palaeozoic miospore genus Diaphanospora Balme and Hassell 1962	E.P.	In preparation, place of publication to be decided
JONES, P.J., and DRUCE, E.C.	Stratigraphical significance of Conodonts with the Upper Cambrian and Lower Ordovician sequence of the Boulia Region, Western Queensland	E.P.	Published in Aust. J. Science
JONES, P.J. et al.	The Devonian of Western and Central Australia	E.P.	Published in Inter. Symp. Devonian System Calgary, Canada
BELFORD, D.J.	The foraminiferal fauna and age of samples from the Wide Bay - Open Bay area, East New Britain	C 1968/82	Issued
BURGER, D.	Stratigraphy and Palynology of Upper Mesozoic Sections and some deep wells in the Surat Basin, Queensland	C 1968/24	Issued
BURGER, D. et al.	The Geology of the Chinchilla 1:250,000 Sheet area, Southern Queensland	C 1968/53	In prep.
BURGER, D.	Palynology of marine Lower Cretaceous strata in the northern and eastern Eromanga Basin, Queensland	C 1968/82	Issued
JONES, P.J.	Lower Cretaceous (Albian) Ostracoda in B.M.R. Surat No. 1 (Scout Bore). Appendix III in Thomas and Reiser	C 1968/56	Issued
TERPSTRA, G.R.J.	Micropalaeontological examination of samples from the Menyamya Survey and Sepik area, N.G.	C 1968/33	Issued
TERPSTRA, G.R.J.	Micropalaeontological examination of samples from the Surat area, submitted by B.M. Thomas, Appendix V	C 1968/56	Issued

SEDIMENTARY PETROLOGY

JENSEN, A.R.	Upper Permian and Lower Triassic sedimentation in part of the Bowen Basin, Queensland	C 1968/55	In prep.

PHOTOGEOLOGY

(Upper Ramu River Hydro-Electric Project)

MAFFI, C.	Statistical analysis of photogeological linear features. Appendix to: J.R.L. Read - Preliminary Geological Report on the proposed development of the Upper Ramu River Gorge, N.G., for hydro-electric power	C 1967/142	Issued

(Victoria River Basin)

MAFFI, C.	Report on photo-interpretation of the Limbunya 1:250,000 scale Sheet, N.T.	C 1968/28	Issued

(Surat Basin)

MAFFI, C.	Report on photo-interpretation of the Goondiwindi 1:250,000 scale Sheet, Queensland and New South Wales	C 1968/29	Issued
MAFFI, C.	Report on photo-interpretation of the Warwick 1:250,000 scale Sheet, Queensland and New South Wales	C 1968/57	Issued

(North Molonglo Sewer Project)

SIMPSON, C.J.	North Molonglo Outfall Sewer Project - Photo-geological analysis	C 1968/122	Being assembled

SPECIALISTS

OPIK, A.A.	The Mindyallan fauna of N.W. Queensland	B 74	Issued
OPIK, A.A.	The Ordian Stage of the Cambrian and its Australian Metadoxididae	B 92	Issued
OPIK, A.A.	Ordian (Cambrian) Crustacea Bradoriida of Australia	B 103	In press
OPIK, A.A.	Redlichia of the Ordian (Cambrian) of northern Australia and New South Wales	B 114	In press
OPIK, A.A.	Nepeid trilobites of the Middle Cambrian of Northern Territory	B 113	Ready for press
OPIK, A.A.	Dolichometopid trilobites of Northern Territory, Queensland and New South Wales	B	MS not typed
OPIK, A.A.	Templetonian Ordian Xystridurid trilobites of Australia	B	Illustrations being drafted, MS not typed
MABBUTT, J.A.	Pictorial representations of landforms to accompany Explanatory Notes of Barrolka, Durham Downs and Eromanga 1:250,000 Sheet areas	E.N.	With editors
MABBUTT, J.A.	Geomorphology of the south-west Eromanga Basin	Appendix to: C 1968/35	
WHITE, Mary E.	Report on 1966 collection of plant fossils from the Drummond Basin, Queensland	C 1967/68	Issued
WHITE, Mary E.	Report on 1966 collections of plant fossils from the Surat Basin; South-west Eromanga Basin; Delamere, N.T., and Proserpine Districts of Queensland	C 1967/78	Issued

WHITE, Mary E.	Report on plant fossils in Sample R.A. 115 from the Sepik district, P.N.G.	C 1967/161	Issued
WHITE, Mary E.	Report on 1967 collection of plant fossils from the Surat Basin, Queensland	C 1967/162	Issued
WHITE, Mary E.	Report on 1967 collection of plant fossils from the Charters Towers region of Queensland	C 1968/61	In prep.
WHITE, Mary E.	Plant fossils from the Mount Eclipse Sandstone, Ngalia Basin, N.T. Appendix I	C 1968/38	Issued
WHITE, Mary E.	Fossil plants of the Drummond Basin. Appendix to Bulletin	B	In prep.

METALLIFEROUS DEPOSITS SECTION

METALLIFEROUS DEPOSITS SECTION

CONTENTS

TABLE

ILLUSTRATIONS

SUMMARY

This report summarizes the work of the Metalliferous Deposits Section from November, 1967, to October, 1968. Figures M1 and M2 show areas where field work was carried out in 1968 and areas which it is proposed to map in 1969.

Regional mapping was carried out in the Victoria River Basin, Cape York, northwest Queensland, and three areas in New Guinea.

The Victoria River party mapped the Precambrian geology of the Delamere and Cape Scott 1:250,000 Sheet areas, completed mapping the Precambrian rocks of the Auvergne and Port Keats Sheet areas, and remapped the Precambrian geology of the Fergusson River Sheet area; possibilities for finding economic mineralization in the region do not appear to be promising.

A three-year programme of regional mapping of the igneous and metamorphic rocks and late Palaeozoic sediments of Cape York Peninsula and the Torres Strait islands was completed. Geological problems in the previously mapped Cape Weymouth Sheet area were investigated, and samples for isotopic dating were collected throughout the area mapped in 1966-68. Minor tin, tungsten, gold, copper, and lead mineralization occur in the area mapped this year.

Reconnaissance of parts of the Cloncurry 1:250,000 Sheet area was carried out during July/August as a prelude to 1:100,000 mapping to begin in 1969.

The Kubor Range party mapped about 3,500 square miles of the New Guinea highlands using land vehicles, light aircraft, and a helicopter. Methods of operation with the helicopter were generally similar to those used in the South Sepik area, but some modifications were necessitated by terrain, weather, and the complexity of the geology. Prospects for economic deposits of metallic minerals in the area mapped appear to be poor.

Systematic regional mapping of Papua east of longitude 149° began in March. Two visits were made to the area in March/April and September/October. Features of special interest in the area are large-scale thrust faulting in the west, syenite and feldspar porphyry in the southern and eastern mountains, and reports of recent vulcanism in the north. Spectacular evidence of Tertiary to Recent faulting has also been recorded in the northern hills area. The Cape Vogel Basin appears to have prospects for petroleum, especially offshore.

A brief reconnaissance of New Britain was made during March in preparation for mapping scheduled for February/April and July/September, 1969; photomosaics and photogeological maps are being prepared.

Editing of the East Kimberley Bulletin is almost complete, and the 1:500,000 map to accompany it has been published. The Bulletin on the Lamboo Complex is with the editor. The production of Explanatory Notes and maps for the East Kimberley and Kimberley Basins is in various stages of completion.

Records on a number of aspects of the geology of the West Kimberley area have been completed, and others are in preparation.

Writing of the two Bulletins on the Carpentaria Province continued; the Arnhem Land Bulletin is with the editor for preliminary editing, and preparation of a Report on the basement rocks of Arnhem Land is almost complete.

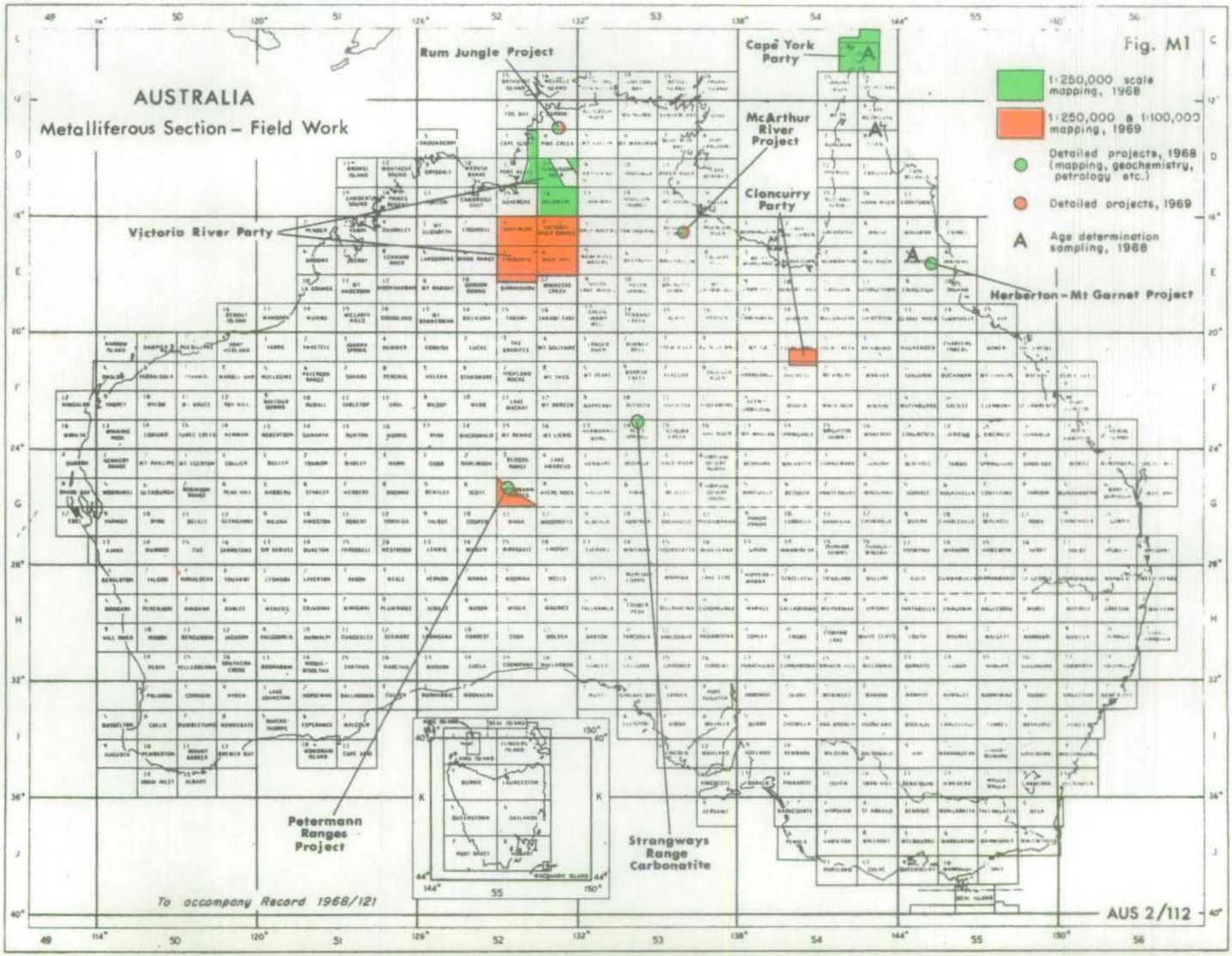
Preparation and revision of maps and reports for the Burdekin Region continued throughout the year. Modifications necessitated by the results of isotopic dating were incorporated.

Follow-up auger drilling, geochemical sampling and radiometric probing carried out in parts of the Acacia Gap area have confirmed lead and zinc anomalies which warrant diamond drilling. Reconnaissance testing is in progress in the Manton area. Only minor base-metal and uranium mineralization was detected by further diamond drilling of geochemical and radiometric anomalies. Drilling to test radiometric anomalies to about 200 feet depth revealed that radioactivity was generally much less in fresh rock than in weathered. Acceptance of an offer for further exploration and development at Woodcutters L5 anomaly by E.Z. - Geopeko was recommended. Preliminary tests following the recognition of magnesite by T.E.P. in the Mount Fitch area have shown that this mineral is widespread as a major constituent of the Celia and Coomalie Dolomites.

As a result of compilation in the Embayment Area, Rum Jungle, a diamond drilling programme to test for uranium mineralization between White's and Dyson's open cuts has been recommended. Re-examination of the stratigraphy of the Batchelor Group confirms that these sediments rest unconformably on the Rum Jungle Complex, though it is possible that small granite bodies locally intrude the sediments; the widespread occurrence of tourmaline in the sediments supports the suggestion that some of the granite is intrusive into the Lower Proterozoic sediments.

Field work in the McArthur River area was aimed at establishing the stratigraphic setting of the Barney Creek Formation, which contains the HYC zinc lead deposit, making detailed description of stratigraphic sections, and collecting samples for petrographic and chemical studies.

Three weeks were spent in the Herberton/Mount Garnet area to locate mines (about 150) which had previously been missed, to collect samples for isotopic dating, and to check geological mapping. A Record on the work in this area has been issued, and it is now planned to make minor additions and modifications to the text and map, and to have the report in the hands of the editor for processing as a Bulletin by April next year.


AUSTRALIA
Metalliferous Section – Field Work
Fig. M1
1:250,000 scale mapping, 1968
1:250,000 & 1:100,000 mapping, 1969
Detailed projects, 1968 (mapping, geochemistry, petrology etc.)
Detailed projects, 1969
A Age determination sampling, 1968
Rum Jungle Project
Cape York Party
McArthur River Project
Cloncurry Party
Victoria River Party
Herberton – Mt Garnet Project
Petermann Ranges Project
Strangways Range Carbonatite
To accompany Record 1968/121
AUS 2/112

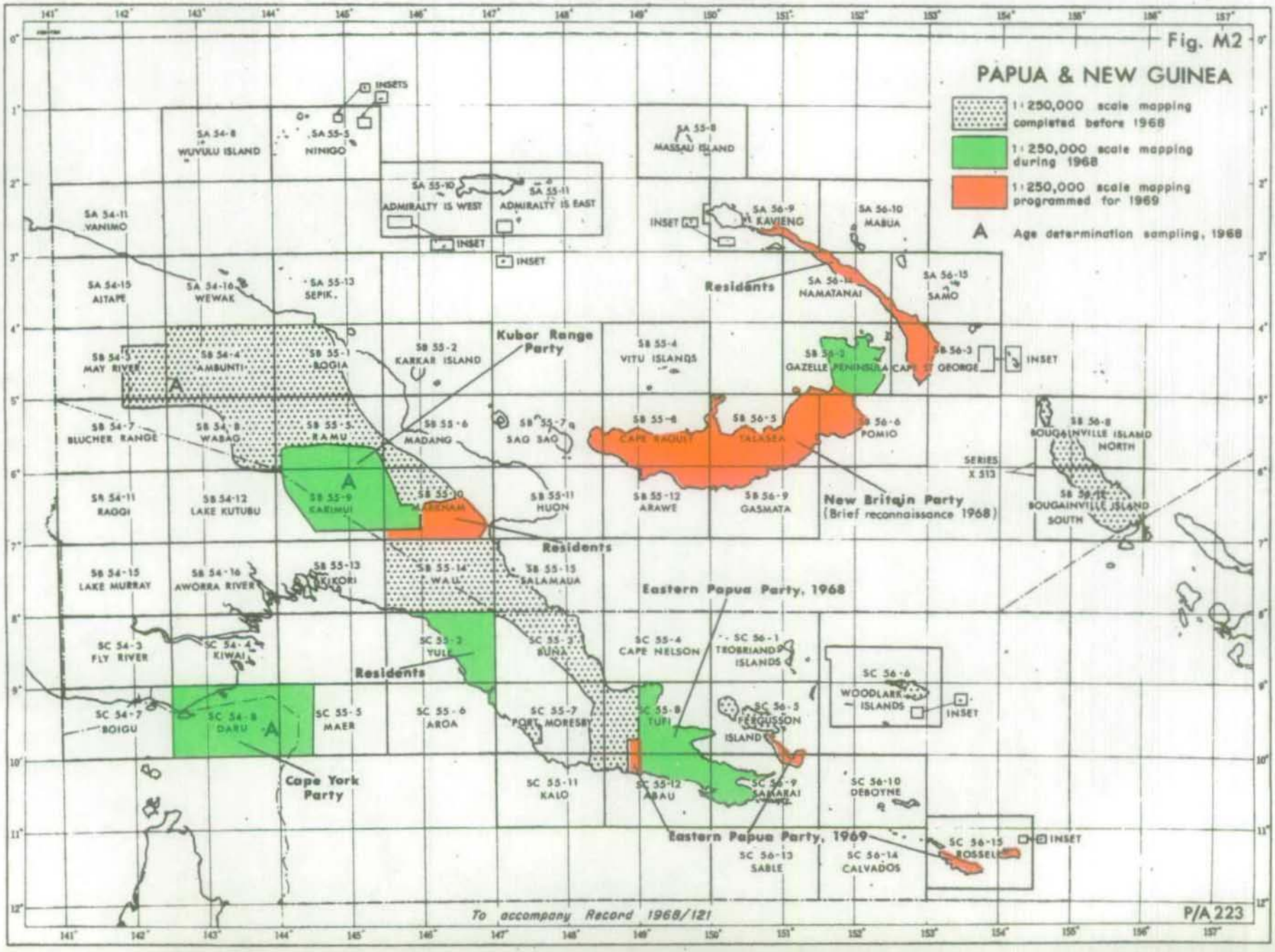


Fig. M2
PAPUA & NEW GUINEA
1:250,000 scale mapping completed before 1968
1:250,000 scale mapping during 1968
1:250,000 scale mapping programmed for 1969
A Age determination sampling, 1968
INSETS
SA 54-8 WUVULU ISLAND
SA 55-5 NINIGO
SA 55-8 MASSAU ISLAND
SA 55-10 ADMIRALTY IS WEST
SA 55-11 ADMIRALTY IS EAST
INSET
SA 56-9 KAVIENG
SA 56-10 MABUA
SA 54-11 VANIMO
SA 54-15 AITAPE
SA 54-16 WEWAK
SA 55-13 SEPIK
Residents
SA 56-14 NAMATANAI
SA 56-15 SAMO
SB 54-3 MAY RIVER
SB 54-4 AMBUNTI
SB 55-1 BOGIA
SB 55-2 KARKAR ISLAND
Kubor Range Party
SB 55-4 VITU ISLANDS
SB 56-3 GAZELLE PENINSULA
CAPE ST GEORGE
SB 54-7 BLUCHER RANGE
SB 54-8 WABAG
SB 55-5 RAMU
SB 55-6 MADANG
SB 55-7 SAG SAG
SB 55-8 CAPE RAGUL
SB 56-5 TALASEA
SB 56-6 POMIO
SB 56-8 BOUGAINVILLE ISLAND NORTH
SERIES X 513
SB 54-11 RAGGI
SB 54-12 LAKE KUTUBU
SB 55-9 KARIMUI
SB 55-10 MARKHAM
SB 55-11 HUON
SB 55-12 ARAWE
SB 56-9 GASMATA
New Britain Party (Brief reconnaissance 1968)
SB 56-11 BOUGAINVILLE ISLAND SOUTH
Residents
SB 54-15 LAKE MURRAY
SB 54-16 AWORRA RIVER
SB 55-13 KIKORI
SB 55-14 WAU
SB 55-15 SALAMAUA
Eastern Papua Party, 1968
SC 54-3 FLY RIVER
SC 54-4 KIWAI
SC 55-3 YULE
SC 55-4 CAPE NELSON
SC 56-1 TROBRIAND ISLANDS
SC 56-6 WOODLARK ISLANDS
Residents
SC 54-7 BOIGU
SC 54-8 DARU
SC 55-5 MAER
SC 55-6 AROA
SC 55-7 PORT MORESBY
SC 55-8 TUPI
SC 56-5 FERGUSSON ISLAND
Cape York Party
SC 55-11 KALO
SC 55-12 ABAU
SC 56-9 SAMARAI
SC 56-10 DEBOYNE
Eastern Papua Party, 1969
SC 56-13 SABLE
SC 56-14 CALVADOS
SC 56-15 ROSSEL
To accompany Record 1968/121
P/A 223

Work on the chemistry of phosphate deposition, on trace elements in phosphates, and on solubilities and synthesis of phosphates continued. A project on the geochemistry of carbonate rocks in the McArthur and Victoria River areas is being carried out in conjunction with field geologists. A study of the adsorption of trace elements on to iron hydroxide is continuing, but experimental difficulties have placed limitations on the range of investigations which can be profitably carried out. Analysis of stream sediments from New Guinea, phosphate determinations on basic igneous rocks from north-west Queensland, trace element determinations on plant materials from Woodcutters, and miscellaneous analytical determinations were carried out. Monthly monitoring of the Molonglo River system for zinc continued, and the laboratory participated in a survey of the accuracy of analysis of samples of ores being conducted by the Institute of Geological Sciences.

Trace element determinations were carried out by direct-reading optical spectrograph on rocks from the Kimberley region, northeast Queensland, and Mount Isa. A geochemical, geological, and mineralogical report on the Mount Isa project is being prepared in co-operation with geologists from Mount Isa Mines Ltd. Information on compositional trends in pyroxenes and olivine during late-stage crystallization of iron-rich tholeiites was obtained in the final stages of study of the Palisades Sill, New Jersey.

Routine analysis of rocks by X-Ray fluorescence began in September; a computer programme devised by T. Quinlan has largely eliminated difficulties arising, among other things, from inadvertent omission of operating instructions from paper punched tape. Rb and Sr determinations on rocks and minerals for the Age Determination Laboratory were carried out as required. A joint project on the geochemistry of Australian granites, in which K.R. Walker and A.D. Haldane will participate, was begun on a collection of about 600 samples from north-eastern Queensland. Over 200 minerals were identified by X-Ray diffraction.

Standards are being prepared to calibrate the electron microprobe for the analysis of a range of materials, and a computer programme is being modified to handle the corrections necessary for the conversion of data from the probe to actual element concentration values. Projects to be undertaken include a study of the mineral chemistry of metamorphic rocks in the Petermann Ranges, and determination of compositions of co-existing minerals from the Papuan Ultramafic Belt.

Installation of new equipment in the rock sectioning laboratory was completed in August.

143 mineral and whole-rock samples from Queensland, Northern Territory, Western Australia, T.P.N.G., and Antarctica were dated during the year. The results from the Burdekin River region have proved very useful in elucidating the complex geological history of this part of the Tasman Geosyncline.

The Biological Group of the Baas Becking Laboratory carried out studies on the precipitation of iron sulphides in biological environments, the banding of metal sulphides in gels, the formation and occurrence of paraffins in black shales, the physiology of sulphate-reducing bacteria, the biochemistry of sulphur-metabolising organisms, sulphur-isotope fractionation by sulphur-oxidising organisms, methods of analysis of sulphur compounds, the organic metabolism of thiobacilli, and metal toxicity of micro-organisms. The Mineralogical Group studied mineral synthesis and transformation in the systems Fe-S and Cu-Fe-S, the mobilization of galena and sphalerite in folds in Mount Isa ore, and the formation of sulphide bands in gels. Equipment for studying the physical chemistry of sulphide precipitation was assembled, and experimental work was started in the latter part of the year.

The programme of volcano surveillance was expanded, and installation and design of instruments for this work was continued in close co-operation with Professor Newstead (ANU). Information was compiled for the World Map of Post-Miocene Volcanoes, and for the I.U.G.G. Tsunami Committee. Field investigations were carried out in a number of thermal areas.

A note on the first known occurrence of carbonatite in Australia has been submitted for publication in the Australian Journal of Science.

Compilation of a revised tectonic map of Australia is well in hand.

Experimental aerial colour photography was carried out in central Australia, but the results are not yet available. Photography carried out last year gave encouraging results.

Members of the Section took part in a Specialists' Symposium of the Geological Society of Australia in May. Four of the papers presented will be published in a special issue of the Society's journal.

Training in certain aspects of field and laboratory work related to mineral exploration was given to a U.N. Fellow and an I.A.E.A. Fellow.

Two members of the Section went on overseas visits during the year.

Quartz and sapphirine were found together in nature for the first time in a rock from Antarctica, and a note on the occurrence and its significance has been published in "Nature".

Publications and Records issued, and publications in press or in preparation, are listed in Appendix M1. Following are totals for the period under review:

Bulletins	- Issued nil, in press 1, with editor 4, in preparation 3.
Reports	- Issued 3, in press 5, with editor 5, in preparation 10.
Records	- Issued 31.
Explanatory Notes	- Issued 3, in press 9, with editor 4, in preparation 9.
Outside publications	- Published 18, in press 7, submitted for publication 12, in preparation 7.

REGIONAL PROJECTS

FIELDWORK

VICTORIA RIVER PARTY, N.T.

I.R. Pontifex, C.M. Morgan, I.P. Sweet, J.R. Mendum, A.G. Reid, R.G. Horne

Between November,1967, and April,1968, work proceeded on the compilation of the record on the Precambrian geology of the Auvergne 1:250,000 Sheet area. From May to September the party mapped the Precambrian geology of the Delamere and Cape Scott 1:250,000 Sheet areas, completed mapping the Auvergne and Port Keats 1:250,000 Sheet areas, and remapped the Precambrian geology of the Fergusson River 1:250,000 Sheet area (map and Explanatory Notes published in 1959). A helicopter was used for 129 flying hours. The helicopter was invaluable, not only for transport to otherwise inaccessible areas, but also as a means of finding outcrop in poorly exposed units.

Geology (Fig. M3)

The stratigraphy of the Auvergne and Bullita Groups is summarized in Table M1.

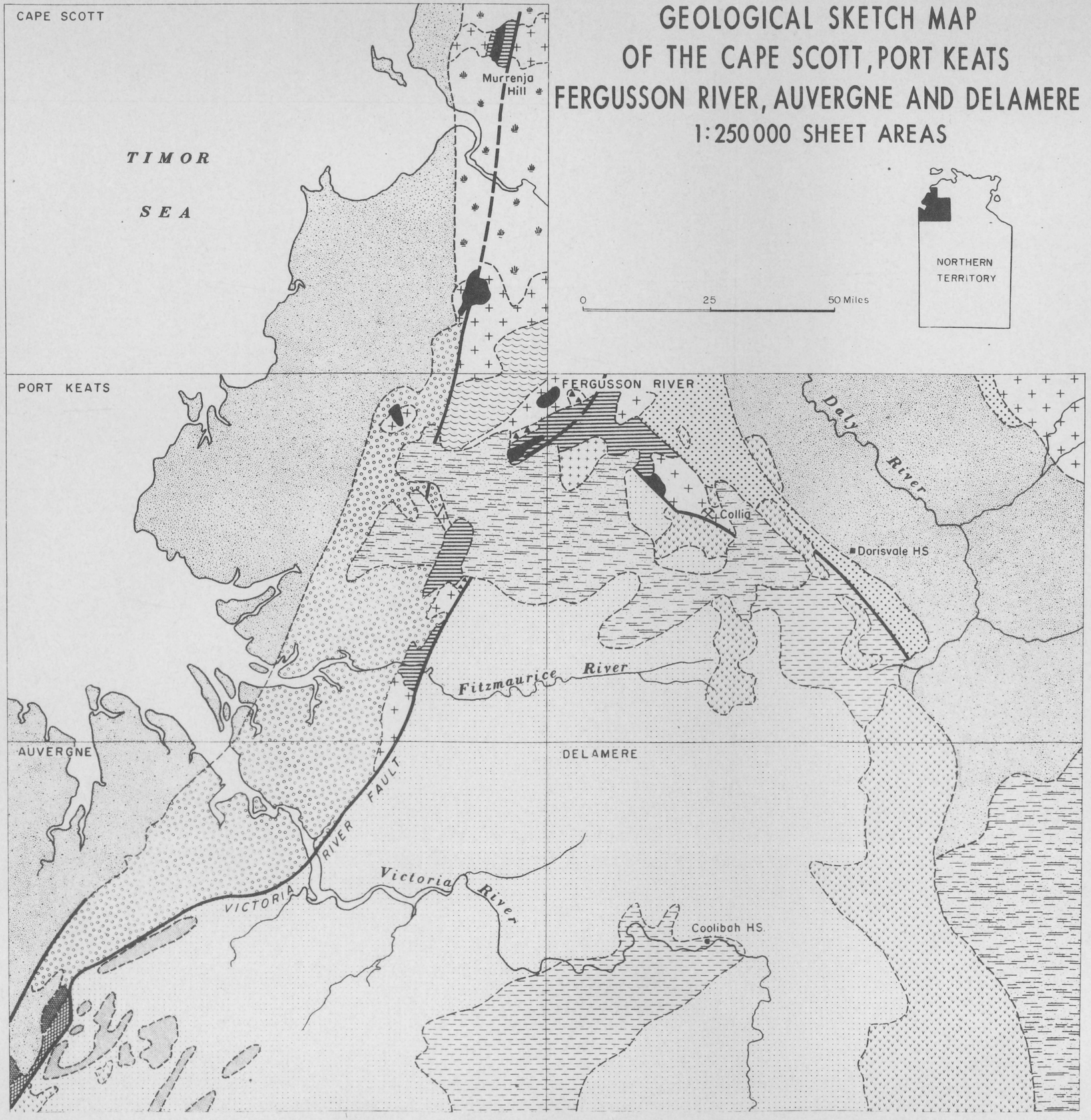
The ages of all units mapped so far have been derived from their relations with units previously dated in this and other areas.

Rocks of the Pine Creek Geosyncline crop out in a belt lying along the eastern sides of the Port Keats and Cape Scott Sheet areas, and in a smaller belt trending south-east into the Fergusson River Sheet. The Chilling and Noltenius Formations are Lower Proterozoic sediments consisting of sandstone, quartz greywacke, mica schist, andalusite schist, and siltstone. Acid tuff and lavas are interbedded with them. The sediments are intruded by sills and dykes of dolerite and gabbro.

Lower Proterozoic granite intrudes all other units of the geosyncline. The granite along the eastern edge of the Cape Scott Sheet area (the Litchfield Complex) intrudes the Archaean Hermit Creek Metamorphics, and is bordered by a migmatite zone. The granite west of Murrenja Hill (northern part of Cape Scott Sheet area) may be of Archaean age.

Diorite crops out in the north-west of the Fergusson River Sheet area, but its relationships to other rocks are not known.

GEOLOGICAL SKETCH MAP OF THE CAPE SCOTT, PORT KEATS FERGUSSON RIVER, AUVERGNE AND DELAMERE 1:250 000 SHEET AREAS

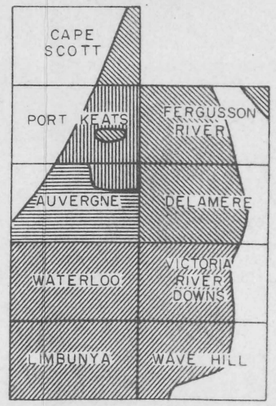


REFERENCE

Mesozoic		Undifferentiated
	Unconformity	
Palaeozoic		Undifferentiated
	Unconformity	
		Antrim Plateau Volcanics
	Unconformity	
Upper Proterozoic		Duerdin Group
	Unconformity	
		Auvergne Group and Bullo Formation
	Unconformity	
		Bullita Group
		Tolmer Group
Upper or Middle Proterozoic		Fitzmaurice Group and Legune Formation
	Unconformity	
Lower Proterozoic		Granite
		Diorite
		Acid Volcanics and Tuffs
		Chilling and Noltenius Formations
		Dolerite and Gabbro Sills
		Lamboo Complex
Archaean		Hermit Creek Metamorphics
		Halls Creek Group

Geological boundary
Fault
Marsh

PROGRAMME OF VICTORIA RIVER PARTY



1:250,000 SHEET AREAS

Mapped in 1967
Mapped in 1967 and 1968
Mapped in 1968
To be mapped in 1969

To accompany Record 1968/121

NT/A 179

TABLE M.1 : PROTEROZOIC STRATIGRAPHY OF NEWLY RECOGNIZED UNITS OF THE VICTORIA RIVER BASIN IN THE AUVERGNE, DELAMERE, PORT KEATS, AND FERGUSSON RIVER 1:250,000 SHEET AREAS

GROUP	FORMATION	PREVIOUS NAME	THICKNESS (feet)	LITHOLOGY	STRATIGRAPHIC RELATIONSHIPS
	Bullo River Sandstone	Px	1000	Reddish brown pebbly quartz sandstone, minor conglomerate	Lies conformably on Black Point Member
	Black Point Member	Puy_3	200	Reddish brown felspathic quartz sandstone, minor conglomerate	Lies on Shoal Reach Formation, possibly unconformably
AUVERGNE GROUP	Shoal Reach Formation	Puy_2	200	Dolomite, sandy and silty dolomite, minor siltstone, shale	
	Spencer Sandstone		500	Sandstone, silty sandstone, minor dolomitic sandstone	
	Lloyd Creek Dolomite		250	Dolomite, oolitic and stromatolitic, sandy and silty dolomite	
	Pinkerton Sandstone	Puy_1	300	Massive quartz sandstone, siltstone, minor shale	
	Saddle Creek Formation	Puy	300	Basal cross-bedded sandstone, upper siltstone, minor shale and oolitic dolomite	
	Angalarri Siltstone		1000	Siltstone, grey-green shale, minor dolomitic siltstone, limestone	
	Jasper Gorge Sandstone		200 - 600	Massive quartz sandstone, minor conglomerate, siltstone	
	Stokes Range Formation		1000	Purple and green-grey shale, fine and medium-grained sandstone	
	UNCONFORMITY				

TABLE M.1 (Continued)

	Coolibah Formation		600	Purple and green massive siltstone, grey sandstone and dolomite	Lies conformably on Skull Creek Formation or Bardia chert. May be a lateral equivalent of Waterbag Formation (Tolmer Group)
BULLITA GROUP	Skull Creek Formation	Skull Creek Limestone	1000	Dolomite, limestone, carbonate-rich siltstone and fine sandstone	Conformable on Timber Creek Formation. May be lateral equivalent of Hinde Dolomite (Tolmer Group)
	Bardia Chert Member	Dempsey Chert	100	Massive laminated chert, brecciated chert	Conformable on Skull Creek Formation
	Timber Creek Formation		200 Base not exposed	Siltstone, dolomitic siltstone, fine sandstone, dolomite	Base not exposed. May be lateral equivalent of Stray Creek Member (Tolmer Group)

Fitzmaurice Group (New Name). Sediments occupy the mobile belt which extends from the south-western part of the Auvergne Sheet area to the south-eastern part of the Cape Scott Sheet area. They belong to the Carpentarian or Adelaidean, and unconformably overlie rocks of the Pine Creek Geosyncline. The Group consists of two formations of sandstone with minor grit and conglomerate, separated by a formation of grey siltstone, shale, and minor sandstone, and the upper sandstone is conformably overlain by interbedded siltstone and sandstone.

The Tolmer Group, consisting of sandstone, siltstone, and dolomite, occurs in the north-eastern part of the Fergusson River 1:250,000 Sheet area. It probably underlies the Auvergne Group, and may be an extension of the Bullita Group. It is separated from the latter by a fault.

Victoria River Basin Sequence. The Proterozoic sediments of this basin comprise the majority of the Precambrian outcrop in the region. The sediments have been divided into the Bullita Group, the Auvergne Group which unconformably overlies it, and the Bullo Sandstone and Black Point Member which in turn overlie the Auvergne Group, possibly with an unconformity. The Auvergne Group (New name) comprises the Jasper Gorge Sandstone, the Angalarri Siltstone and the Yambarra Beds (name no longer used) which were recognized in the Auvergne 1:250,000 Sheet area in 1967. The character of these units on the Sheet areas mapped in 1968 is essentially the same as defined for the Auvergne Sheet. A new formation, the Stokes Range Formation, has been recognized on the Delamere Sheet area at the base of the Auvergne Group. The Bullita Group (New name) includes the previously recognized Skull Creek Formation.

The Antrim Plateau Volcanics cover large areas of the Delamere and Fergusson River 1:250,000 Sheet areas. They consist of vesicular and non-vesicular basalts up to 300 feet thick. Elongate bodies of arkosic sandstone and conglomerate which cut the volcanics are thought to be valley-fill deposits laid down between periods of vulcanism. Cross-bedding in the sandstones indicates a sediment supply from the south-east. In the Fergusson River Sheet area the volcanics are underlain by up to 150 feet of what is probably a basal Cambrian conglomerate.

Economic Geology

The only mine in the area which is currently productive is the Collia Tin Mine (Group Suppliers), where small quantities of cassiterite are being won from alluvium. Traces of cassiterite can be seen in the surrounding Soldiers Creek Granite. Tin mines at Muldiva and Buldiva Creeks, and gold mines at Fletcher's Gully and Woolngi (all on the Fergusson River 1:250,000 Sheet) have been abandoned.

Planet Gold are at present carrying out an airborne radiometric survey over the mobile belt.

About two percent of disseminated pyrrhotite occurs in a small granite plug or lens in the diorite 50 miles north-west of Wombungee Outstation in the north of the Fergusson River 1:250,000 Sheet area.

Reefs of barytes are common about 10 miles south-west of Dorisvale Homestead. These are in the Coolibah Formation and in sandstones associated with the Antrim Plateau Volcanics. Small disseminated crystals of barytes also occur in the Coolibah Formation near Coolibah Homestead.

Local inhabitants report finding nodules of native copper in the Antrim Plateau Volcanics in the Delamere 1:250,000 Sheet area. This type of mineralization was not found during the 1968 survey.

CAPE YORK PARTY, QUEENSLAND

W.F. Willmott, W.D. Palfreyman, W.G. Whitaker (G.S.Q.), D.S. Trail

The 1:250,000 scale mapping of the igneous and metamorphic rocks and late Palaeozoic sediments of Cape York Peninsula was completed in 1968, when two-months were spent mapping the Torres Strait area. Time was also spent investigating geological problems in the Cape Weymouth 1:250,000 Sheet area, previously mapped in 1967, where C.D. Branch helped to elucidate the structure and stratigraphy of acid volcanic rocks. Samples for isotopic dating were collected throughout the Walsh, Hann River, Ebagoola, Coen, and Cape Weymouth 1:250,000 Sheet areas and in Torres Strait.

Geology of Torres Strait (Fig. M4)

Carboniferous(?) acid pyroclastic rocks form the bulk of the islands in the southern part of Torres Strait and a strip of coast on the adjacent mainland. They are intruded by Permian(?) granitic rocks which predominate in the islands north of Hawkesbury Island, and which extend with the volcanics to the south coast of Papua. Recent basic pyroclastic rocks and basalt form small islands extending from the Murray Islands, 150 miles north-east of Thursday Island, to Daru in Papua.

The acid pyroclastic rocks comprise four distinct rock types. The first is a welded crystal tuff with abundant large crystals of quartz and feldspar in a sparse fine-grained matrix; it forms the mainland coast for a few miles east and west of Cape York, and the islands near Mount Adolphus Island. The second is a welded tuff in

GRANITIC AND VOLCANIC ROCKS IN TORRES STRAIT

142° 143° 144° Fig M4

11° 10°

PAPUA

TORRES STRAIT

CORAL SEA

GREAT BARRIER REEF

CAPE YORK PENINSULA

DARU

Bramble Cay

Boigu I

MABADUAN I

Saibai I

Dauan I

Stephens I

Darnley I

Murray Is

Reefs

Warrior

Gabba I

Yami I

Mabuiag I

Badu I

Moa I

Hawkesbury I

Thursday I

Hammond I

Booby I

Horn I

Prince of Wales I

Possession I

Peak Pt

Cape York

Mount Adolphus I

Albany I

Jardine

Mzs

Czv

Pzv1

Pzv2

Pzv3

Pzv4

Pzp

Pzg

0 10 20 30 40 MILES

0 10 20 30 40 50 KILOMETRES

CAINOZOIC

Coral limestone

Basic volcanics — Czv — *Ash, basalt.*

MESOZOIC

Sandstone — Mzs

PALAEOZOIC

Intrusive porphyry — Pzp

Biotite granite — Pzg

Acid pyroclastics

Pzv4 — *Welded tuff with clean grey glassy matrix*

Pzv3 — *Intensely welded tuff*

Pzv2 — *Welded tuff with dirty block glassy matrix*

Pzv1 — *Welded crystal tuff*

To accompany Record 1968/121

C54/A/2

which crystals of quartz and euhedral pink feldspar are scattered in a dark dirty glassy matrix; it forms most of the mainland coast for 25 miles south-west of Cape York, islands near this coast, and Wednesday Island and parts of Horn Island and Prince of Wales Island, 20 miles north-west of Cape York. Similar tuff forms other islands up to 50 miles north of Thursday Island. Rock fragments in this tuff also contain euhedral pink feldspar crystals; in places these crystals range up to half an inch long, and appear to have grown after the deposition of the tuff.

The third type of pyroclastic rock is a hard, intensely welded tuff which contains abundant small crystals of white feldspar and clear quartz in a dark grey groundmass; it forms several of the islands within 5 miles of Thursday Island. Similar tuff is altered at Booby Island, and is recrystallized at and near Mua Island and Badu Island, at Gabba Island and Dauan Island, and at Mabaduan in Papua.

In some exposures of metamorphosed tuff muscovite is abundant; in others small thin lenses of biotite give the rock a clear foliation, paralleled in places by elongated fragments of pumice; garnet occurs locally in the foliated tuff. Recrystallization is not necessarily most intense where the tuff is in contact with granite.

The fourth type is a welded tuff with scattered small crystals of quartz and feldspar in a clean light grey groundmass. At the north end of Prince of Wales Island it overlies the second and third types of tuff, and dips steeply away from them. This zone of steep dips, and a similar zone along the west coast of Prince of Wales Island, may represent the original limits of an ash flow.

Biotite granite, with a wide range of textures and compositions, is the predominant rock-type exposed between Hawkesbury Island and Mabaduan, in Papua. A distinctive type of grey coarse-grained granite, with small pink euhedral phenocrysts of feldspar, crops out in the north-eastern part of Mua Island, along the east coast of Hawkesbury Island, in the Duncan Islands, at Dauan Island, and at Mabaduan; it is intruded by aplite and pegmatite. Elsewhere the biotite granite is generally a red rock, which is in many places leucocratic with only a small quantity of biotite or chlorite, and a large proportion of quartz. A few fresh exposures of granite contain hornblende as well as biotite.

Intrusive porphyry or porphyritic microgranite cuts acid pyroclastic rocks at Mabuiag Island and Horn Island, and large dykes of similar porphyry cut the biotite granite at Badu Island and the Duncan Islands. The porphyry is a grey rock composed of small phenocrysts of feldspar in a microcrystalline groundmass; in large bodies the groundmass is coarser, and clots of hornblende are visible in it.

Recent basic volcanics form Bramble Cay and Stephens, Murray, and Darnley Islands, about 150 miles north-east of Thursday Island, and Daru Island in Papua.

Bedded ash with limestone fragments is truncated by a wave-cut platform at Daru Island, and each of the three Murray Islands is an eroded ash cone. The bedded ash ranges from fine-grained to coarse-grained with an increase in fragments of olivine basalt; some ash beds contain fragments of limestone. At Darnley Island ash is overlain by a pile of vesicular olivine basalt several hundred feet thick. A late flow of olivine basalt has breached one of the ash cones in the Murray Islands; Stephens Island and Bramble Cay are composed of basalt.

Mineralization occurs in altered acid pyroclastic rocks near Cape York, where cassiterite has been won from alluvium and from lodes, in which it is associated with metallic sulphide minerals. Copper staining is evident in similar altered volcanics at Possession Island, where gold was formerly mined. Gold was also mined at Horn Island, and sulphides of copper and of lead are evident there, principally in the porphyritic microgranite.

In the north-eastern part of Hammond Island, chalcopyrite is disseminated within a zone about 20 feet thick within biotite granite at its contact with tuff. Only a small part of the granite body is exposed on Hammond Island; it appears to extend under the sea.

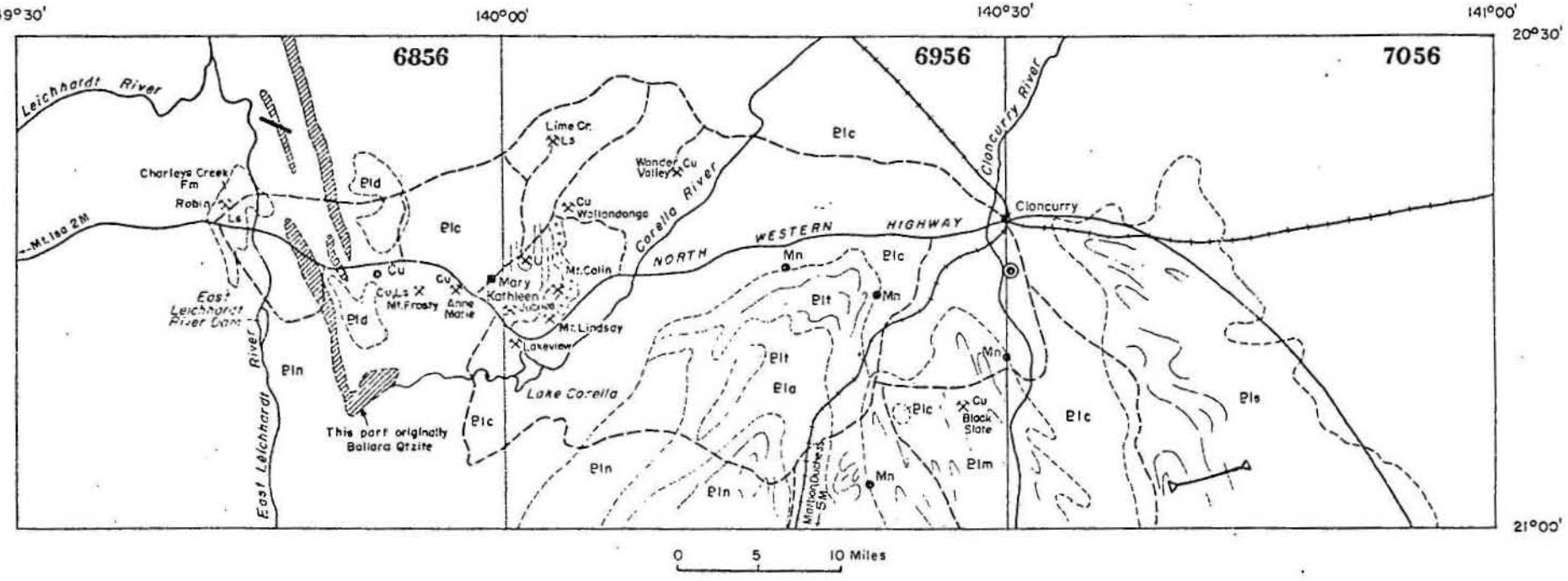
Wolfram was previously mined at Mua Island, where it occurs in quartz lodes in foliated metamorphosed volcanics near the south coast, and in quartz lodes in biotite granite near the north coast. Wolfram also occurs in quartz lodes in granite at North Possession Island, near Mua Island, and is associated with copper stains and arsenopyrite in porphyry dykes cutting granite on the west coast of Badu Island.

NORTH-WEST QUEENSLAND PROJECT

G. M. Derrick

Introduction

Reconnaissance of parts of the Cloncurry 1:250,000 Sheet was undertaken during July and August as a prelude to the proposed start on 1:100,000 mapping of the Precambrian belt in 1969. The object of this survey was to gain information on lithology, structure, and economic geology of the various rock units, assess areas of special complexity, examine some of the stratigraphic relationships determined by Carter et al. (1961), and locate tracks and possible base camp sites for 1969. The survey was operated from the Georgina Phosphate Party base camp at Camooweal.



- Photo interpreted extension to Charleys Cr. Fm.
- Pld — Deighton Quartzite
- Plm — Marimo Slate
- Burstall Granite
- Plc — Corella Formation
- Pls — Soldiers Cap Formation
- Plt — Mitakoodi Quartzite
- Pla — Marraba Volcanics
- Pln — Argylla Formation

- Geological boundary
- Fault
- Fold trend lines
- Cu — Mine or prospect visited
- Mn — Mineral occurrence. U - uranium, Cu - copper, Mn - manganese, Ls - limestone
- Type section
- Proposed base camp.
- Highway
- Track
- Railway
- 7056 1:100,000 Series

Southern half of Cloncurry 1:250,000 Sheet area showing areas visited in 1968 and 1:100,000 areas to be mapped from 1969 onwards

To accompany Record 1968/121

F54/A2/7

Regional Geology (Fig. M5)

Most units lying between the East Leichhardt River and Cloncurry were examined in varying detail. In the Soldiers Cap Formation the type section was traversed, and andalusite-garnet schists studied in detail. A sequence of pillow lavas was noted in the Mitakoodi Quartzite. The contact between the Quartzite and the Marimo Slate appears unconformable, but this has not been established in the field. The upper part of the Mitakoodi Quartzite is probably equivalent to the Answer Slate, in the Duchess Sheet area. The Argylla Formation, mainly acid volcanics, is less extensive than originally mapped, and photo-interpretation in the East Leichhardt River area shows that much of the formation is actually Charley's Creek Formation. In the same area the Ballara Quartzite appears to be equivalent to the Charley's Creek Formation also. The Corella Formation includes limestone, marl, siltstone, shale, and quartzite, and metamorphic and metasomatized equivalents. Some acid volcanics have been found in the unit near Mary Kathleen, but these are probably part of the Argylla Formation. Calc-silicate breccia is widespread, and two types, transported and intraformational, are evident. Relations with the Marimo Slate remain enigmatic. At one locality the Marimo Slate is younger, whereas in another it shows possible interfingering relationships with the Corella Formation.

At Mary Kathleen the axis of the syncline containing the orebody was delineated in detail; south of the mine it is truncated by a combination of strike and transverse faulting. The metasomatic rocks at Mary Kathleen are best developed in the east limb of the syncline adjacent to the Burstall Granite.

The Marimo Slate is carbonaceous, graphitic, concretionary, and pyritic, and is locally cupriferous. Two distinct slate units were delineated, and it is hoped to correlate these more precisely with the Kuridala and Stavely Formations in the Duchess Sheet area.

Economic Geology

Manganese deposits occur in linear zones adjacent to contacts between the Marimo Slate, Corella Formation, and Mitakoodi Quartzite. In most places the manganese is associated with iron-enrichment and silicification in zones of strike faulting, but in some localities massive manganese oxide occurs in areas devoid of faulting. These concentrations possibly reflect original sea-floor deposits, and thus may mark an unconformity.

Copper: a number of small copper shows in the Marimo Slate which have been opened up in recent months were examined. They all contain malachite, chrysocolla, and azurite in narrow quartz stringers subparallel to cleavage and/or bedding in the host slate. There is no obvious igneous source of the copper, which could be redistributed syngenetic material.

Other copper deposits examined include the Jubilee and Mount Lindsay (both operating), Mount Colin, and Wollondonga. The Jubilee lode is roughly conformable with steeply dipping amphibolite and mesocratic gneiss, which is usually feldspathised and veined by stringers of quartz, calcite, and actinolite. The ore is chalcopyrite with minor bornite, in a pyrite-pyrrhotite-quartz-calcite gangue. Mount Lindsay, Wollondonga, and Mount Colin all occur close to the contact between the Corella Formation and the Burstall Granite. All occupy east-west fracture systems, and the Mount Lindsay and Mount Colin deposits are characterized by massive siliceous gangue which appears to have replaced calcite.

Only one small copper occurrence was located which appeared to have been overlooked by past prospectors. Iron-stained segregations of malachite occur scattered through a massive limestone lens 400 yards south of the main road between Mary Kathleen and Mount Isa, 7 miles east of the East Leichhardt River. Although small, the deposit resembles the Mount Frosty deposit 5 miles to the east, which, though primarily mined for limestone flux, contained extremely massive and rich pockets of copper sulphide.

Limestone: The Lime Creek and Robin limestone deposits are the current source of flux for Mount Isa Mines. The Robin is the larger deposit of the two, and occurs in the Charley's Creek Formation. The Lime Creek deposit is in the Corella Formation, and the quality of the product is at present being affected by quartz veins and segregations of pyrrhotite.

Ilmenite occurs in a quartz-biotite-hornblende-apatite-scapolite vein cutting biotite amphibolite of the Leichhardt Metamorphics, in a road cut 3 miles west of Mary Kathleen. The ilmenite forms large tabular crystals up to 3 cm. across, and the apatite occurs as euhedral crystals up to 3 cm. diameter. The vein is of mineralogical interest only.

KUBOR RANGE PARTY, N.G.

J.H.C. Bain, D.E. Mackenzie, R.J. Ryburn (full time), D.B. Dow (supervisor), R.J. Tingey, I.E. Smith, G. Cifali, and R.W. Page (part time)

From June to September, the Kubor Range Party mapped about 3500 square miles of the New Guinea Highlands. This area is extremely rugged with deeply incised rivers and mountain peaks about 12,000 feet. By contrast with the area mapped by the Sepik Party in 1966-67, the greater part of this region is the most densely populated part of New Guinea.

Access

Development has been more rapid than elsewhere in the Territory: the Lae-Mount Hagen road runs through the area, and there are numerous poorly formed roads in the Wahgi Valley between Mount Hagen and Goroka, but many of these become impassable after heavy rain. There are sixteen airstrips within the mapped area, although all but three are open only to light aircraft.

Traverse equipment and methods developed by the Sepik Party had to be slightly modified as a result of the easy access by vehicles, the high density of foot tracks, and the ready availability of local labour. The roads were traversed using four-wheel-drive vehicles, and the intervening country mapped by one and two-day traverses along streams and walking tracks.

During the last five weeks of the survey a helicopter was used to extend the area mapped, and position parties in areas that required revisiting. The area south of the Kubor Range is sparsely populated, is covered with dense jungle, and contains no roads and few walking tracks. An inflatable rubber raft was used to map a forty-mile section of the Tua River.

Helicopter Operations

Helicopter operational methods were based on experience obtained in the South Sepik in 1967. However, the Highlands survey encountered a number of new problems due to the nature of the country, and the weather. The geology of the area is complex, and photo-interpretation between spot observations can not be made with confidence. Also, the area is poorly endowed with helicopter landing sites, and it was necessary for traverse parties to walk for up to four days to cover the more inaccessible parts.

Several methods of working were used:

(1) Spot observations were made as a necessary prelude to the planning of traverses in most areas.

(2) In many cases a geologist and native assistant were placed in the field in the morning, and picked up the same afternoon. This method was economical only whilst working close to the helicopter base (i.e., within 20 miles).

(3) Frequently the most economical and geologically rewarding method was to position a geologist and his three carriers for traverses of up to four or five days' duration. This was made possible by the use of light-weight traverse equipment devised by Bureau field parties over the last three years.

The helicopter base was moved twice to ensure that the machine operated only within its most economical range (30 mile radius). Light aircraft were used to facilitate rapid and economical movement of personnel and equipment between fly camps. To make full use of the helicopter it was found imperative that the party consist of at least five or six geologists. The party leader generally remained in base as co-ordinator, and made use of any free time on the helicopter with reconnaissances and day trips. His duties were to ensure the smooth and efficient functioning of the helicopter programme which had to be as flexible as possible to accommodate changes due to contingencies such as bad weather, unexpected geological problems, or sickness of party members.

Geology (Fig. M6)

The bulk of the rocks in the Wahgi Valley are dark grey to black shale, siltstone, and green tuffaceous sandstone of Upper Jurassic to Upper Cretaceous age (Maril Shale, Kondaku Tuff, and Chim Group, respectively). The basal unit of the Upper Jurassic shale (a thin bed of black shale breccia and conglomerate) lies unconformably on the Kubor Massif of partly metamorphosed sediments and volcanics (Omung Beds) intruded by granodiorite (Kubor Granodiorite).

Overlying the Mesozoic sediments in the Wahgi Valley is a massive biohermal limestone of Eocene to Oligocene age (Chimbu Limestone) which in turn is overlain conformably by tuffaceous sandstone, pebble conglomerate, and volcanics of Lower Miocene age (Movi Beds), and by the Lower Miocene ("f_{1-2}" stage) Daulo Volcanics. In the Okapo and Karimui areas the Lower Tertiary rocks are absent, and Tertiary "e" and "f_{1-2}" stage limestone, sandstone, siltstone, and conglomerate lie unconformably on Upper Cretaceous shale. In the Nebilyer Valley the Eocene to Oligocene limestone is overlain conformably by ?Lower Miocene shale and siltstone of the Tambul Beds.

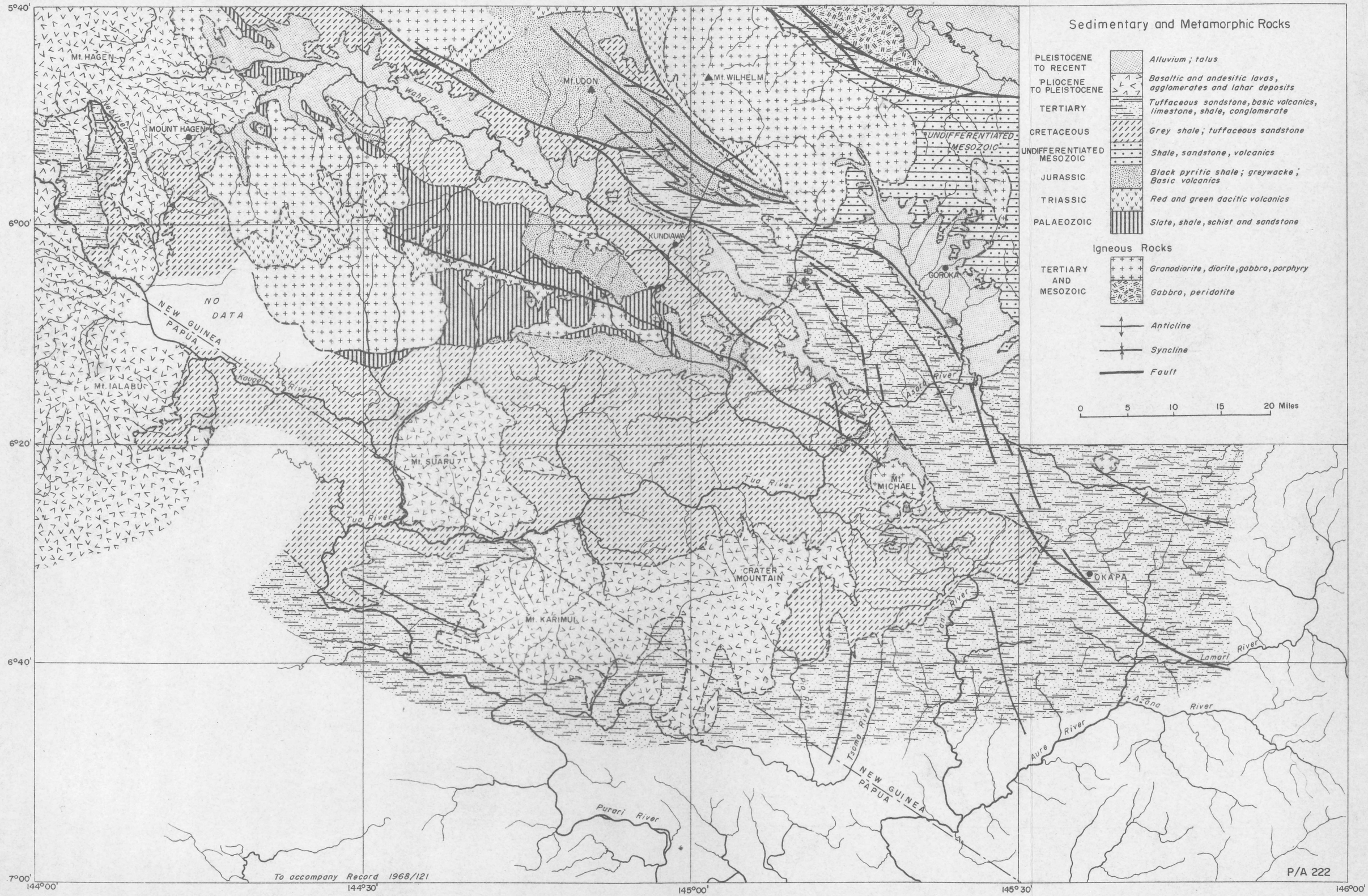
Early ?Pleistocene volcanism formed the volcanoes of Mount Hagen, Mount Giluwe, Mount Ialibu, Mount Suaru, Mount Karimui, and Crater Mountain, and lavas and lahar deposits derived from these centres have blanketed much of the surrounding country.

Economic Geology

No metallic mineral occurrences likely to be of economic interest were found within the mapped area. The plutonic intrusives, especially the Mount Michael porphyritic diorite, contain some disseminated pyrite, but no copper sulphides were seen. A very small alluvial gold deposit at Kuta near Mount Hagen is no longer producing.

GEOLOGY - NEW GUINEA HIGHLANDS

Fig. M 6



Limestone aggregate derived from the prominent Chimbu Limestone cliffs is favoured as foundation and surfacing material for the major roads within the Chimbu District. Reserves are virtually unlimited.

Syngenetic pyrite is common throughout the Upper Jurassic Maril Shale, and a shale-pyrite breccia over 20 feet thick was found in association with amygdaloidal volcanics penecontemporaneous with the shale. No other sulphides are present.

EASTERN PAPUA PARTY

G. Cifali, I.E. Smith, H.L. Davies, and P. Hohnen , R.F. Heming, and P. Pieters from the Resident Staff.

Activities

The regional mapping of Eastern Papua followed on directly from H.L. Davies' mapping of the Papuan Ultramafic Belt. For the purpose of the project, Eastern Papua has been defined as the area east of longitude 149°E, including Normanby Island, the Samarai Group of islands, and the Louisiade Archipelago.

Preparatory work for the survey began in January, and helicopter-supported field work was carried out between 4th March and 7th April. The helicopter was used jointly by the regional mapping party and by a regional gravity party consisting of B.C. Barlow and J. Milsom.

The party visited the International Nickel Southern Exploration Ltd camp, and saw the first stages of drilling at the Doriri Creek nickel prospect.

Davies completed a simplified geological map at 1:50,000 scale of the entire Ultramafic Belt, and prepared, in co-operation with D.B. Dow, a Record on helicopter operations in Papua-New Guinea. Davies and Milsom prepared the first draft of a paper entitled: "Geology and Gravity of Eastern Papua", a preliminary note for outside publication.

On 30th June, Davies left Canberra for Stanford University, California, where he will spend a year completing a Ph.D. thesis on the Papuan Ultramafic Belt. En route to the U.S.A. Davies visited Cyprus, France, and Switzerland to study occurrences of ultramafic rocks.

From April to July the party was busy with the examination of thin sections, the compilation of field observations, the drafting of a report and 1:250,000 geological map for the March-April field work, and preparation for follow-up field work. Simultaneously,

D.J. Belford, examined specimens for micropalaeontological dating.

The follow-up survey was conducted between 9th September and 7th October, after Cifali and Smith had spent a fortnight in the Highlands with the Kubor Range Party. Some time was spent on Cape Vogel Peninsula with R.S. Bickel, Senior Research Geologist with General Exploration Company of California. This Company is assessing the oil potential of the Cape Vogel area.

On 8th and 9th October Cifali and Smith attended the Territory's annual programme conference in Port Moresby.

Geology (Fig. M7)

Eastern Papua can be subdivided in three main physiographic units which largely coincide with structural units:

(a) the Suckling-Dayman block;

(b) the southern and eastern mountains and foothills;

(c) the northern hills and plains, of which the Cape Vogel geosyncline is the most important element.

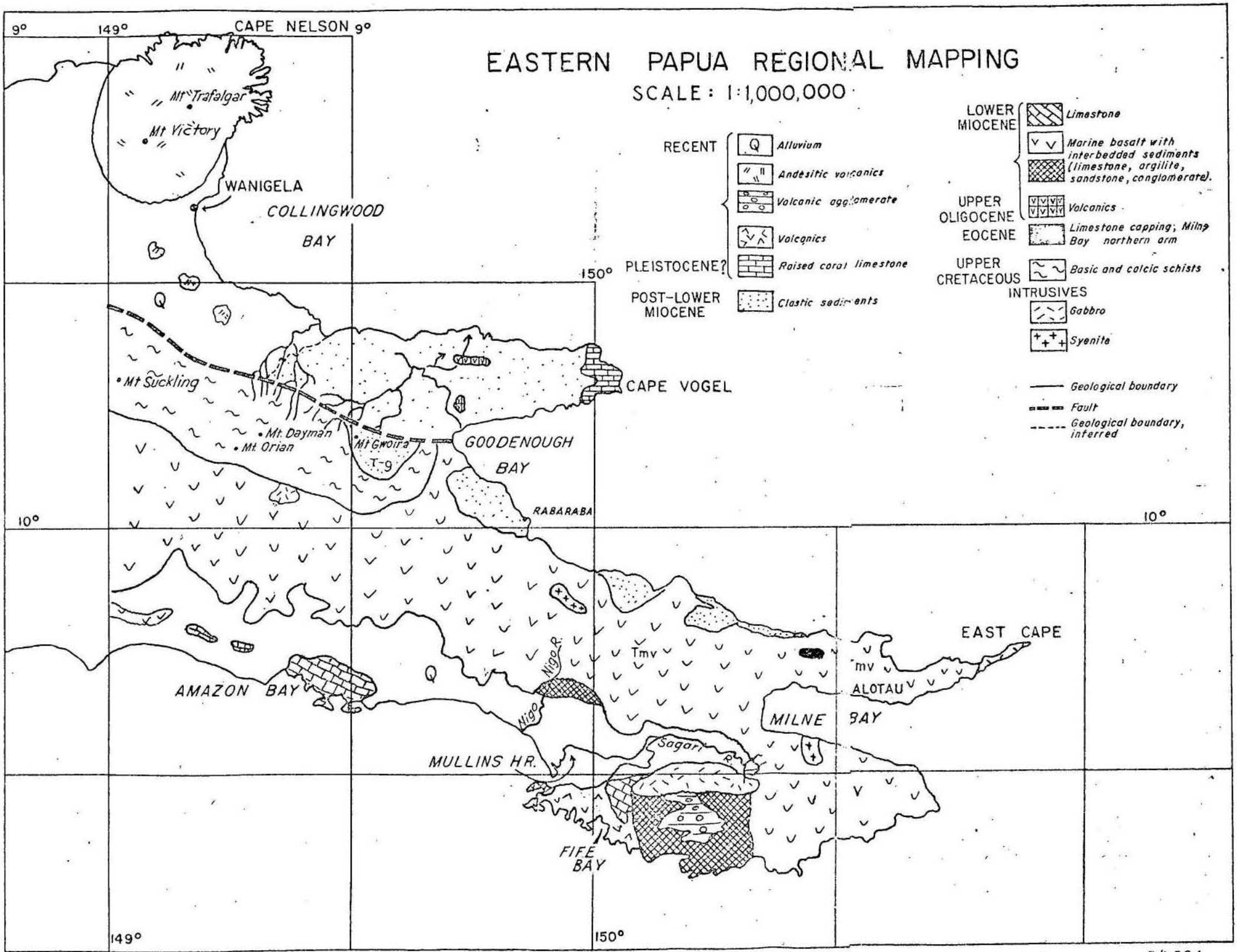
The Suckling-Dayman block is a broad east-west anticline of low-grade Upper Cretaceous basic and calcic schists (greenschist facies) with a core of less altered basalt and ?limestone. The schists may have been formed as a result of ?Eocene thrust faulting, and have been arched up by post-Lower Miocene vertical movements.

The age (Upper Cretaceous) of the schists is based on palaeontological evidence from a sample of partly recrystallized limestone. The age of the underlying less sheared basalt is not known, as no fossils have been found in it,and no isotopic dating has been carried out. If it is assumed that thrusting took place in the Eocene, the basalt could not be younger than early Eocene; nevertheless, the possibility that this basalt belongs to the Dawa Dawa beds (lower Miocene) must be considered. If this possibility should be confirmed, then the Upper Cretaceous schists would represent a pile of sediments metamorphosed some time between the Cretaceous and the Miocene, and then transported (gravity sliding? tangential compression?) over the basalt. Evidently this problem warrants further investigation, in terms of both field and age relationships.

The Southern and eastern mountains and foothills consist of Lower Miocene submarine basalt and minor limestone and volcanogenic sediments; these are intruded by gabbro, some peridotite, and scattered syenite and feldspar porphyry bodies. A volcanic agglomerate (Recent) forms a capping in the south-eastern part of the area.

EASTERN PAPUA REGIONAL MAPPING

SCALE: 1:1,000,000



To accompany Records 1968/121

P/A 224

The northern hills and plains are almost entirely post-Lower Miocene sediments with some Quaternary to Recent volcanics. The main structural unit in this area is the Cape Vogel Basin. The sediments on the Cape Vogel Peninsula were deposited on an upper Oligocene-lower Miocene volcanic basement. An orogeny which began after the lower Miocene, and is still continuing, has produced spectacular vertical movements, and probably westerly and north westerly strike-slip movements.

In the area of the northern hills, Cape Nelson is a point of interest. The Cape has been built up by two volcanoes, Mount Victory and Mount Trafalgar. They both were thought to have been dormant in modern times, but Mr Cridland, a retired magistrate now living at Wanigela and Tufi, verbally reports having seen a red glow and steam at the top of Mount Victory during the thirties. Furthermore, in 1932 he spoke with two natives who could remember an eruption, and described two "rivers" which came down burning the vegetation on their way. From the reports Mr Cridland estimates that this eruption took place about 1890.

Economic Geology

The offshore petroleum prospects of the Cape Vogel Basin may turn out to be the greatest economic potential of the area. Alluvial gold and platinum have been worked south of Milne Bay. Phosphatic limestone is present in places along the southern coast of Papua, but it does not appear to be of economic significance.

NEW BRITAIN PARTY

R.J.R. Ryburn

A brief reconnaissance was made by R.J. Ryburn during March in preparation for the geological mapping scheduled for February-April and July-September, 1969. Plantations, missions, and government patrol posts along the south coast were visited by boat, and traverses were made in the Central Baining area of the Gazelle Peninsula, and to the north of Jaquinot Bay in the Kol area.

The island is composed of lower to middle Tertiary island arc volcanics and volcanically derived sediments intruded in places by basic and intermediate plutonic rocks, and overlain in the Jaquinct Bay and Kandrian areas by extensive, flat-lying, Miocene limestone. Quaternary volcanics are confined to the Rabaul area, the north coast between Wide Bay and the Willaumez Peninsula, and the western end of the island. Raised Quaternary coral-reefs fringe the south coast.

The mapping will be carried out during two visits coinciding with the dry season on the south and north coasts, respectively. The first visit will start in the Wide Bay - Open Bay area to the south of the Gazelle Peninsula, where geological mapping is being carried out by R.P. Macnab of the New Guinea resident staff. Base camp will be set up on the south coast at Jaquinot Bay, and later shifted to Montagu or Fulleborn Harbour. Depending on weather and mapping progress, a further camp may be established on the north coast near Hosking. Most of the north coast will be mapped in the second visit between July and September. A helicopter will be used for 12 weeks.

Compilation of photomosaics and photogeological maps by C. Maffi and R.J. Ryburn is in progress.

REPORT WRITING

KIMBERLEY PROJECT, W.A.

D.B. Dow, K.A. Plumb, D.C. Gellatly, G.M. Derrick, J. Sofoulis (GSWA)

The Kimberley Project has been divided into three parts for report writing - the East Kimberley (two bulletins), the Kimberley Basin, and the West Kimberley (reported elsewhere). A bulletin and 1,500,000-scale map will be published on each of these parts.

Editing of the bulletin on the East Kimberley is almost complete, and the 1,500,000 map has been published. A bulletin on the Lamboo Complex in the East Kimberley is with the editor.

The production of Explanatory Notes and coloured maps of the East Kimberley and Kimberley Basin at 1:250,000-scale is now well under way. Twelve map sheets are involved: 5 maps and 2 explanatory notes have been printed; 3 explanatory notes are with the printer; fair drawing is in progress on 3 maps; 2 maps and 5 explanatory notes are with the editor; and 2 maps and explanatory notes are almost ready for the editor.

WEST KIMBERLEY PROJECT , W.A.

D.C. Gellatly, G.M. Derrick, and J. Sofoulis (GSWA)

Fieldwork for this project, which commenced in 1966, was completed in late 1967. Writing of Records is well under way. Those on the Older Precambrian Geology of the Lennard River Sheet area, the Yampi Sheet area, and the Pillara Range Precambrian Inlier (Noonkanbah, 1:250,000 Sheet area) have been completed; those on the Charnley Sheet area, and the Oscar Range Inlier (Lennard River Sheet area) are now being written. Short records on "Proterozoic Palaeocurrent Directions in the Kimberley Region", and on "Cross-bedded Tidal Sand Ridges in King Sound, northwestern Australia", have also been completed. Work currently in progress includes also short reports on the chromite-bearing ultrabasic rocks of the Mount Ramsay Sheet area, and on the Narlarla lead-zinc deposits of the Lennard River Sheet area (in conjunction with J.A. McDonald, formerly of CSIRO).

All three geologists have spent some time on other projects during the year: D.C. Gellatly on the petrography of carbonatites and associated rocks from the Alice Springs area; G.M. Derrick on preliminary detailed mapping in the Cloncurry area; and J. Sofoulis on mapping in the Kalgoorlie area.

CARPENTARIA PROJECT, N.T.

P.R. Dunn, K.A. Plumb, (H.G. Roberts)

Writing of the two bulletins on "The Geology of the Carpentaria Proterozoic Province" continued. The Arnhem Land bulletin is with the editor for preliminary editing. A report on the petrology of the igneous and metamorphic basement rocks in Arnhem Land is almost complete.

The coloured editions of the Arnhem Bay - Gove and Blue Mud Bay - Port Langdon 1:250,000 Sheets were printed during the year.

BURDEKIN RIVER REGION, QUEENSLAND

A.G.L. Paine, D.E. Clarke (GSQ, Part time)

Work proceeded during 1968 on the compilation of maps and reports. No visits were made to the field. The Sheet areas covered by the project are shown in Figure M8. Progress is as follows:

Hughenden Sheet area

No further work was done in the year ending 30/10/68. It is hoped to revise the Sheet area Record (1965/93) for publication in the Report Series, and to revise the map and write the Explanatory Notes before the end of 1968.

Townsville Sheet area

The Explanatory Notes were finalised in November last year, and had reached the page-proof stage in March, 1968. The geological map had reached the second proof stage in July, but delays were being experienced owing to shortcomings in the fair drawing and the complexity of the map. Further revision of the draft of the Report on the geology of the Sheet area was carried out during the year, and the latest isotopic dating results were incorporated in the text and map.

Ayr Sheet area

The Explanatory Notes were in the editor's hands all year, but revision was carried out from time to time to incorporate recent modifications to the regional geology (mainly arising out of isotopic dating results). Printing of the coloured geological map was completed in September. Final revision of the Report on the Sheet area was completed in July.

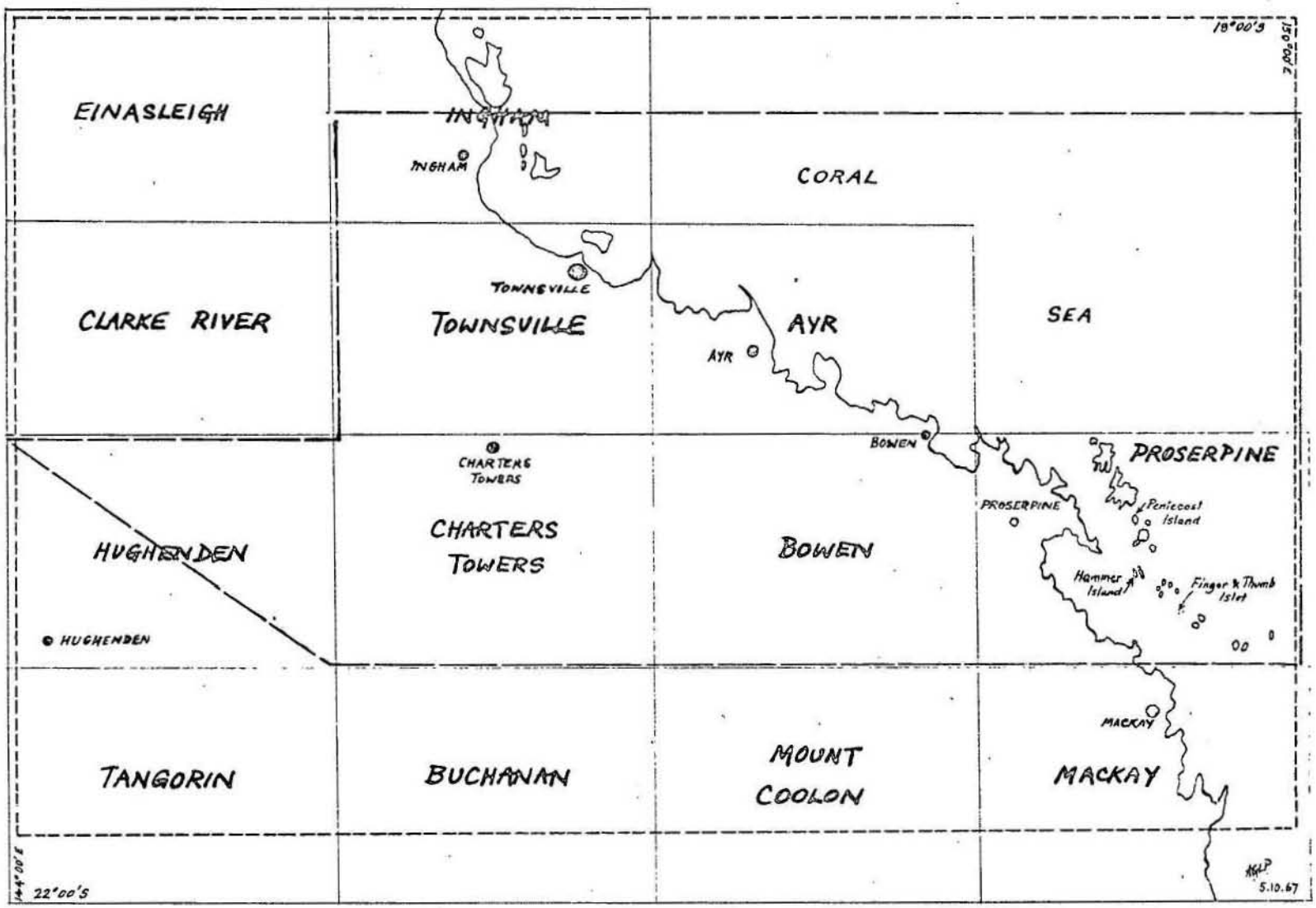
Charters Towers Sheet area

The Record on the Sheet area (1967/104) was released in January. It was extensively rewritten for the Report Series, and the results of detailed mapping of the Ravenswood 1 mile area (D.E. Clarke) and of the re-mapping of the Drummond Basin (F. Olgers) were incorporated. The draft of the Report was handed to the editor in August. The Explanatory Notes were written during the year, and the map was prepared for Standard Edition; both were handed to the map editing section in August.

Bowen Sheet area

The Preliminary Edition of the map was issued in October, 1967. August and September of this year were devoted to writing the Record on the Sheet area; this is scheduled for completion in November. As a result of re-mapping of the Drummond Basin (F. Olgers), and of isotopic

BURDEKIN RIVER REGIONAL PROJECT
QUEENSLAND



AYR ..... 1:250,000 Sheet area

——— ——— ——— Margin of 1:500,000 map to accompany Bulletin

- - - - - - - - - - - - Margin of 1:1,000,000 map for Burdekin-Townsville Resources Series

To accompany Record 1968/121.

Q/A 104

FIG. M8.

age determinations revision of the geological map has become necessary, and it has been decided to produce a Second Preliminary Edition to accompany the Record. Revision of the map is 70 percent complete. Minimal additional revision is anticipated for the Standard Edition. Writing of the Explanatory Notes is scheduled for 1969.

Proserpine Sheet area

The Record on the geology of the Sheet area (1968/22) was released in August, 1968. It is anticipated that virtually no revision of the Record will be necessary for the Report Series, and a copy of the Record has been handed to the editor. Writing of the Explanatory Notes and preparation of the map for Standard Edition are scheduled for 1969.

Regional Synthesis

Compilation of a regional 1:500,000 geological map will start before the end of the year. A synthesis of the geological history of the region is to be written in 1969 as a B.M.R. Bulletin, in joint authorship with D.H. Wyatt of G.S.Q.

General

The first draft of a Record on the geology of the Ravenswood 1-mile Sheet area was received from D.E. Clarke in March. It was edited and returned to the author for revision in April. The revised draft was received in June, and it is hoped that the Record and 1-mile geological map can be submitted to the supervisor for editing in November.

A lecture on the progress of the regional mapping project was given at B.M.R. in January.

A paper entitled "Palaeovulcanology of central eastern Queensland" was delivered at the Specialist Scientific Meeting of the Geological Society of Australia in May, and the paper was approved by the Director for publication in the Journal of the Society.

Paine attended the Annual Field Conference of the Queensland Division of the G.S.A. at Mount Morgan and Rockhampton in early June, and benefited greatly from this opportunity to see something of the regional and economic geology of a neighbouring part of the Tasman Geosynclinal Zone.

A.W. Webb is responsible for all isotopic dating results obtained from the Burdekin River Region in the past 4 years. The dating shows that the region has undergone an unusually rich and varied succession of intrusive and extrusive events throughout the Phanerozoic, and a sound and stimulating basis has been established for further geological work in the area. A total of 240 individual determinations were made (including 125 from the Bowen Sheet area) on 173 specimens by K-Ar or Rb-Sr methods. Highlights of the 1968

dating were:

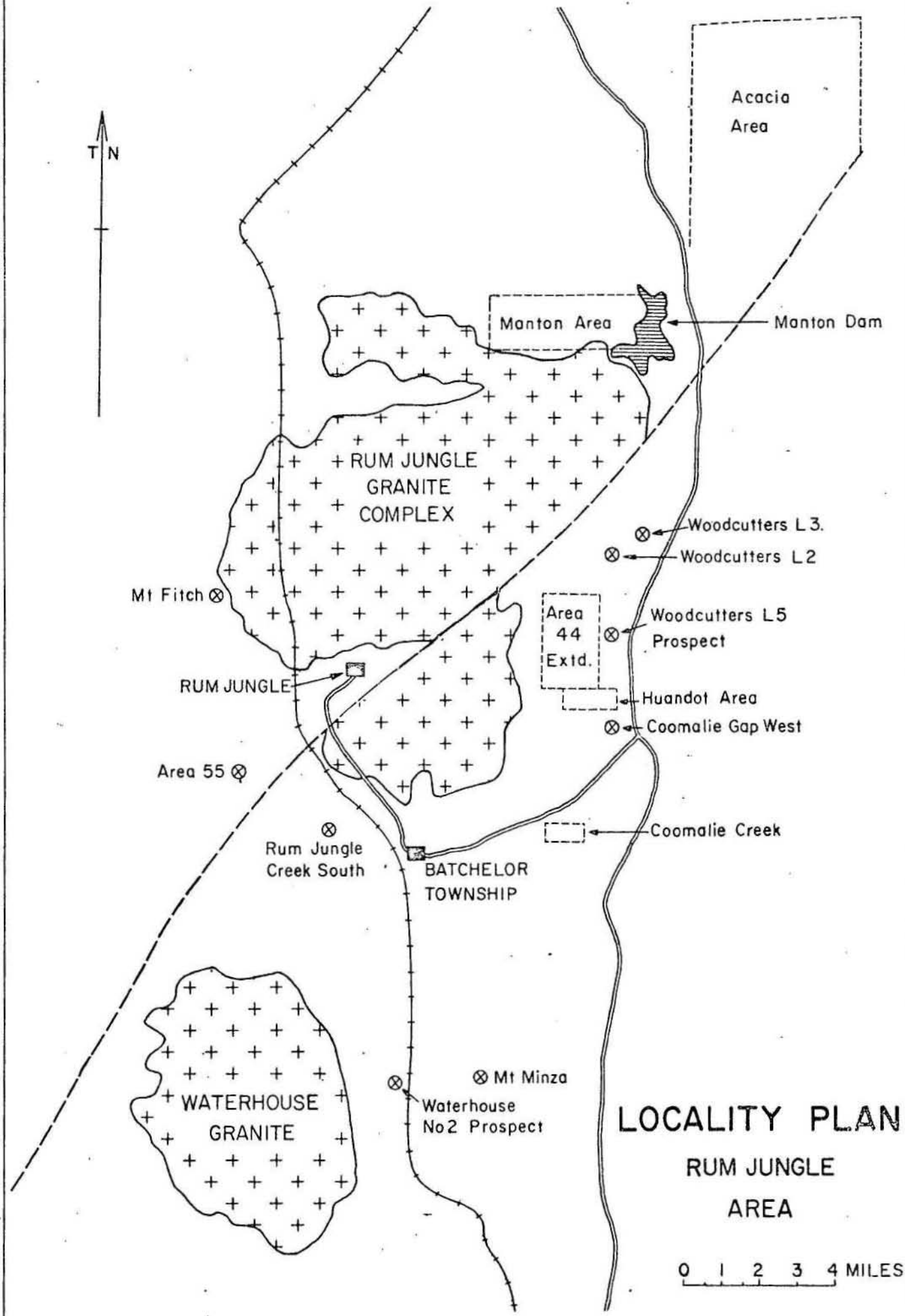
(1) A provisional Rb/Sr whole-rock isochron of 510 m.y. (Cambrian) on the Mount Windsor Volcanics. The Mount Windsor Volcanics (and therefore the Cape River Beds, which include them) are the first dated sequence of Cambrian rocks in the Tasman Geosynclinal Zone in Queensland.

(2) Two distinct Rb/Sr whole-rock isochrons from the Ravenswood Granodiorite Complex, one at 454 m.y. (Middle Ordovician), the other at 394 m.y. (Silurian-Devonian boundary). Previously, K/Ar mineral ages of 400, 420, and 440 m.y. were regarded as unreliable, and it was thought that the Ravenswood Granodiorite Complex could be wholly younger than the Silurian to early Devonian Sedimentary Succession in the Kangaroo Hills Trough and Broken River Embayment. However, the Rb/Sr work has now shown that there were two distinct sedimentary/plutonic cycles in the region in the early Palaeozoic, the first (Cambrian-Ordovician) represented by the Cape River Beds and most of the Ravenswood Granodiorite Complex, and the second (Silurian-early Devonian) by the Kangaroo Hills Trough Succession and by the Lolworth Igneous Complex, Dumbano Granite, and the younger phase of the Ravenswood Granodiorite Complex.

(3) A distinct intrusive epoch at about 330 m.y. (mid. Carboniferous) has emerged from Rb/Sr dating of the Oweenee Granite and granites in the southern half of the Ingham Sheet area. Most of these specimens had previously given ages of about 280 m.y. by the K/Ar method.

(4) K/Ar whole-rock dating of the Nulla Basalt has indicated five, probably distinct, eruptive pulses between 4.5 and 1 million years ago, confirming the late Pliocene to Pleistocene age suspected from the field mapping.

Fig M9



To accompany Record 1968/121

NT/A180

DETAILED PROJECTS

FIELDWORK

DARWIN URANIUM GROUP

C.E. Prichard, A. Taube, J.L. Willis

During 1968, the geological staff of the Darwin Uranium Group undertook auger drilling and geochemical surveys, supervised diamond drilling and rotary-percussion drilling programmes, and carried out general geological investigations in the Rum Jungle area. Localities referred to in this summary are shown in Fig. M9.

Follow-up auger drilling, geochemical sampling, and radiometric probing have been carried out on parts of the Acacia Gap Area and the Coomalie Gap West Area. In the former, lead and zinc anomalies were confirmed, and warrant diamond drilling. In the latter, high single hole values were confirmed, but do not form a drilling target.

Two areas termed Huandot and Coomalie Creek were systematically investigated. A strong radiometric anomaly was indicated in the Huandot Area with maximum values at about 20 feet depth, but radioactivity fell off rapidly below this level. In the western part of the area, extensive but weak lead and zinc anomalies occur. Weak scattered base metal anomalies are also indicated in the Coomalie Creek Area, and this area also contains more extensive but mostly shallow radiometric anomalies of moderate intensity.

Wider spaced systematic reconnaissance testing and mapping of the Manton Area were still in progress at the time of writing (October, 1968).

Diamond Drilling

Two drills were made available throughout the year by Northern Territory Administration Mines Branch. One contract drill worked until April, 1968, and further contract drilling was about to begin at the time of writing (October, 1968). Nine holes have been completed, and two are in progress.

One hole was completed at the Woodcutters L5 Prospect without intersecting ore (D.D.H. 67/10).

At the Woodcutters L2 Anomaly, three holes were completed, but only minor base metal mineralization well below ore grade was intersected (D.D.H. 67/12, 67/13 and 68/4).

One hole drilled on the Woodcutters L3 Anomaly tested a geophysical I.P. anomaly, and showed that it was due to carbonaceous shale at the Coomalie Dolomite/Golden Dyke Formation boundary (D.D.H. 67/15.

Two EM anomalies with associated IP and SP anomalies in the Coomalie Gap West Area were drilled, and found to be caused by a very carbonaceous bed near the base of the Golden Dyke Formation (D.D.H. 68/1 and 68/2).

In Area 44 Extended, two holes sited to test geochemical anomalies were completed; they located minor base metal mineralization well below ore grade (D.D.H. 67/14 and 68/3). Two holes are in progress testing two other geochemical anomalies.

Rotary-Percussion Drilling

Twenty four holes were drilled by a Mayhew drill made available by the B.M.R. Petroleum Technology Section to test radiometric anomalies to 200 feet depth. Almost invariably, radioactivity was much less in fresh rock than in overlying weathered rock.

Magnesite

Following indications of magnesite-rich material obtained by Territory Enterprises Pty Ltd during metallurgical investigations in the Mount Fitch area, a sampling and testing programme was undertaken on Lower Proterozoic carbonate rocks throughout the Rum Jungle district. Results to date indicate that crystalline dolomite samples from surface outcrops and subsurface drill intersections both from the Coomalie Dolomite and the Celia Dolomite are generally magnesite-rich, whereas fine-grained calcilutite samples from the same formations do not contain magnesite as a major constituent.

Woodcutters L5 Prospect

Applications for the further exploration and possible development of this lead-zinc-silver prospect were invited by the Commonwealth Government in December, 1967, and acceptance of an offer by Electrolytic Zinc Company of Australasia Ltd and Peko-Wallsend Investments Ltd has since been announced.

RE-EXAMINATION OF STRATIGRAPHY, RUM JUNGLE AREA, N.T.

Y. Miezitis

During the year work was carried out at Rum Jungle with the following objectives in view:

(a) detailed compilation of existing surface and underground information in the Embayment Area between Intermediate and Dysons open cuts to outline areas of potential uranium and base metal mineralization.

(b) re-examination of the Lower Proterozoic metasediments in the field to establish the relationship between the four formations of the Batchelor Group.

(c) re-examination of the Batchelor Group - Rum Jungle Complex ("granite") contact in conjunction with (b).

(a) Compilation in the Embayment Area at Rum Jungle has established zoning of mineralization in a complex synclinal structure within 400 feet of the surface. The zoning consists of a gradual transition from base metals in the south-west to uranium in the north-east. However, base metal mineralization is also known to exist 700 to 1100 feet below surface in the south-western part of the synclinal structure. Assuming that zoning of mineralization is repeated in depth, it is possible that uranium mineralization may occur in the north-eastern part of the synclinal structure, which has not been tested beyond 400 feet below the surface, and a diamond drilling programme has been recommended to test this portion of the structure.

(b) The Lower Proterozoic meta-sediments of the Batchelor Group overlie the Rum Jungle Complex unconformably, and consist of successive clastic and carbonate formations. The complete stratigraphic section is developed south of the Rum Jungle Complex, where four formations are present:

LOWER PROTEROZOIC	Batchelor Group	Coomalie Dolomite	Dolomite, calcilutite, crystalline magnesite, silicified tremolitic carbonate rock
		Crater Formation	Quartz greywacke, greywacke, arkose, granule and pebble conglomerate, banded iron conglomerate, quartz sandstone, siltstone
		Celia Dolomite	Dolomite(?), crystalline magnesite, silicified carbonate rock breccia, silicified and ferruginised tremolitic carbonate rock
		Beestons Formation	Arkose, greywacke, siltstone, conglomerate, arkose conglomerate
		---------- unconformity ----------	
		Rum Jungle Complex	Coarse granite, granite gneiss, metadiorite, leucocratic granite, schist

It has been suggested that, owing to structural deformation, the stratigraphic sequence has been repeated within the stratigraphic column shown above. Under these conditions the Beestons Formation would be equivalent to the Crater Formation and the Celia and Coomalie Dolomite would be similarly equivalent.

Sedimentary structures re-examined so far within the Batchelor Group have been "right way up", and do not support stratigraphic repetition due to large-scale isoclinal folding. There is no conclusive evidence to suggest that movements along strike faults may be responsible for possible stratigraphic repetition within the Batchelor Group.

The Beestons Formation and the Celia Dolomite appear to lens out about 2 miles north-west of Batchelor township and again just south of Manton Dam. It is therefore suggested that the meta-sediments previously mapped as Beestons Formation and Celia Dolomite north of Mount Fitch and in the Celia Embayment are probably equivalents of the Crater Formation and the Coomalie Dolomite, respectively.

(c) Observations made during the re-examination of the Batchelor Group - Rum Jungle Complex contact tend to confirm that the meta-sediments rest unconformably on an older granitic basement. Granite intruding schist was found at two localities near the meta-sediment - "granite" contact but there is no conclusive evidence in the field as to whether the intruded schist is part of the Archaean basement or the Lower Proterozoic meta-sedimentary succession.

The conclusion of the re-examination is that most of the basement constituting the Rum Jungle complex is older than the meta-sediments of the Batchelor Group. However, there is a possibility that, locally, small granite bodies intrude the Lower Proterozoic sediments. This possibility is strengthened by the fact that tourmaline has been found in the sediments in a number of places: it occurs as coarsely radiating masses, as a replacement of the matrix of coarse sandstone belonging to the Crater Formation, as joint fillings in that Formation, and as a component of quartz veins, including some in White's orebody.

McARTHUR RIVER PROJECT, N.T.

M.C. Brown (Sedimentary Basins Section)

Geology

Field work (10th June to 26th August) was aimed at establishing the stratigraphic setting of the Carpentarian Barney Creek Formation, which contains the HYC zinc-lead deposit, and collecting samples from the Barney Creek and the enclosing dolomite units for petrographic and chemical studies. Field work involved measurement, detailed description, and sampling of stratigraphic sections in the Barney Creek Formation and underlying and overlying dolomite units, as well as some detailed mapping in outcrop areas of the Barney Creek Formation. Locations of stratigraphic sections are shown on Figure M.10. Visitors were D.W. Bennett (5th to 14th August) and P.R. Dunn (11th to 14th August).

Following the detailed mapping by Carpentaria Exploration Company geologists and B.M.R. field work in 1967, the Barney Creek Formation (which near old McArthur River homestead contains the HYC deposit) is known to have been deposited over most of the central part of the Bauhinia Downs 1:250,000 Sheet area. It conformably overlies the Emmerugga Dolomite, and is overlain by the Reward Dolomite.

This year's field work has resulted in further clarification of the stratigraphic relationships and the depositional environments of these units. Broadly, the three units were deposited during a major cycle of transgression and regression. The lower well-bedded member of the Emmerugga ("Mara Member") consists of dolomite with stromatolites and terrigenous sediments, deposited under mainly intertidal conditions; the upper member (Mitchell Yard Member) consists mainly of clean dolomite deposited probably below low tide level in water shallow enough for abundant precipitation of carbonate by algae. The laminated shaly and tuffaceous dolomite and carbonate - and sulphide-bearing shales of the Barney Creek Formation were deposited in deeper water less favourable for carbonate precipitation. Shallowing of the sea resulted in deposition of cleaner carbonate sediments (the Reward Dolomite).

In detail, the two members of the Emmerugga can be subdivided, the "Mara Member" into two units, and the Mitchell Yard Member into three units. The middle unit of the Mitchell Yard Member contains sandy and silty dolomite, sandstone, siltstone with halite casts, oolites, and stromatolites. It appears to have been deposited during a minor regression interrupting the major cycle of transgression. The top unit varies considerably in thickness, and is in part laterally equivalent to the Barney Creek Formation. In some areas, where the top unit is thin, the top unit and the middle unit of the Mitchell Yard have been mapped by Carpentaria Exploration Company geologists as

part of the Barney Creek Formation. Stratigraphic relationships between the Barney Creek Formation and the Emmerugga Dolomite are shown diagrammatically in Figure M.11. This interpretation differs in detail from that of Carpentaria Exploration Company geologists, which is based partly on stratigraphic drilling of the HYC deposit.

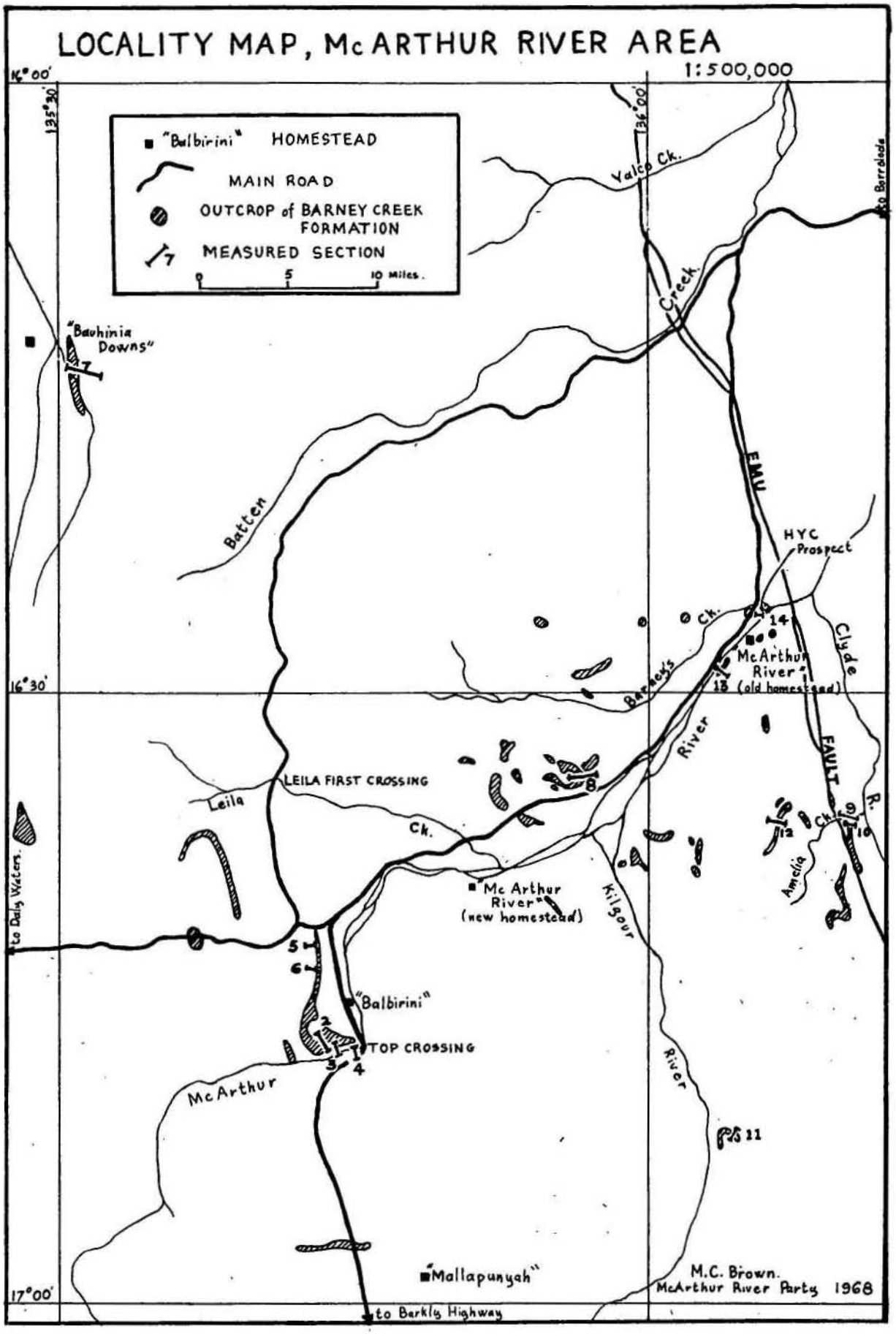
Near the Emu Fault, relative upward movements have occurred during deposition of both the Emmerugga Dolomite and the Barney Creek Formation. The upper unit of the Mara Member and the two lower units of the Mitchell Yard Member are missing from sequences near the fault (east of the HYC deposit and farther south near Amelia Creek), and the Barney Creek Formation at the HYC prospect contains coarse breccias with blocks apparently derived from uplifted areas of Mara Member and Tawallah Group sandstone to the east. The top unit of the Mitchell Yard Member is abnormally thick between the HYC deposit and the Emu Fault, and appears to have built up as a shallow bank during deposition of the Barney Creek Formation in deeper water. The build-up of clean dolomite east of the HYC deposit is regarded as a reef (the Cooley Reef Member of the Barney Creek Formation), by Carpentaria Exploration Company geologists.

The zinc-lead sulphide deposit and associated pyritic sediments in the Barney Creek Formation near old McArthur River homestead seem to have accumulated in a local downwarp near the Emu Fault. The stratigraphic information collected to date does not provide direct indications of the salinity of the water near the sea floor in this depression, but there is no evidence that the Barney Creek Formation was deposited in a basin with restricted access to the open sea, and the water at and near the surface may have been of normal salinity.

HERBERTON-MOUNT GARNET AREA, Q.

D.H. Blake (CSIRO), W.B. Dallwitz, & R.M. Tucker (GSQ)

In May and June three weeks were spent in the Herberton-Mount Garnet area to locate mines which had been missed in previous work, to collect samples for isotopic dating, to carry out check geological mapping, and to visit some of the more inaccessible parts of the area by helicopter. The fieldwork for this project, as originally envisaged, is now complete, but there is scope for a special study of mineral zoning, which is exceptionally well exemplified in the Herberton 1-mile Sheet area; a study of the broad structural control for the lodes, and of the mineralogy of lodes in different structural and lithological environments could be carried out at the same time. The Bureau is indebted to G.A. Stewart, Chief of the Division of Land Research, for making available the services of D.H. Blake to take part in this work.



Bureau of Mineral Resources
Geology & Geophysics

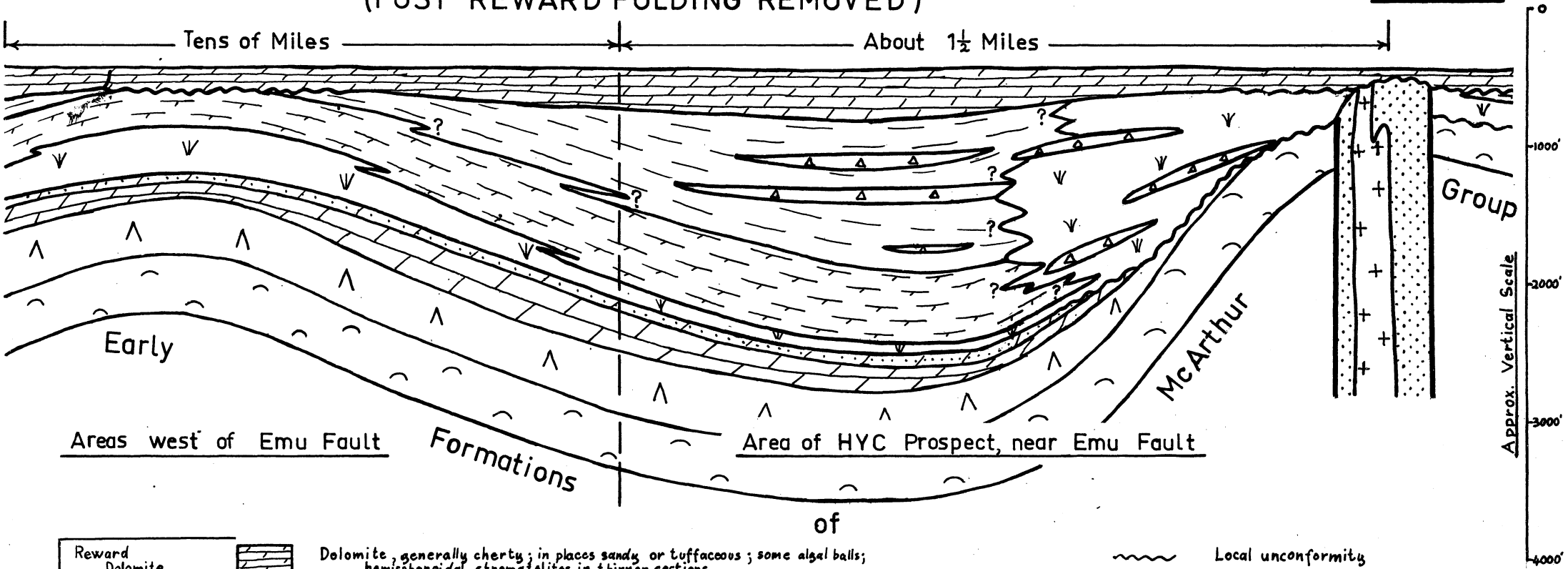
to accompany Records 1968/121

E53/A3/25

STRATIGRAPHIC RELATIONSHIPS of EMMERUGGA DOLOMITE, BARNEY CREEK FORMATION, and REWARD DOLOMITE

(POST-REWARD FOLDING REMOVED)

FIG. M11



Reward Dolomite		Dolomite, generally cherty; in places sandy or tuffaceous; some algal balls; hemispheroidal stromatolites in thinner sections.
Barney Creek Formation	HYC Member	Shales, tuffs, and tuffaceous shales with pyrite (also Pb, Zn, Cu sulphides); dolarenite and dolomite breccia interbeds.
	Teena Laminated Dolomite Mbr.	Laminated tuffaceous and shaly dolomite; dolomitic tuff and shale.
Emmerugga Dolomite	Mitchell Yard Member	Thick and thin bedded clean dolomite with small radiating algal growth structures; pink tuff interbeds common.
		Dolomite with some stromatolites; silty, sandy, and tuffaceous dolomite; oolite; sandstone; rare halite casts.
		Thick-bedded clean dolomite, with wisps and tubules of dolomite spar.
	"Mara Member"	Dolomite, with hemispheroidal and conical stromatolites; some oolite, silty dolomite, and dolomitic siltstone; halite casts.
		Dolomite, generally cherty, with hemispheroidal stromatolites; siltstone and silty dolomite interbeds; halite casts.
Tawallah Group		Silica-cemented quartz sandstone; microsyenite intrusions.

Local unconformity

Fault.

Coarse breccias; with blocks derived from "Mara Member", Tawallah Group sandstone, & microsyenite intrusions.

Bureau of Mineral Resources Geology & Geophysics

to accompany Records 1968/121 E53/A3/21

REPORT WRITING

RUM JUNGLE PROJECT, N.T.

Y. Miezitis, C.E. Prichard, J.E.F. Gardener, W.J. Langron

It is proposed that two Reports on this project be prepared during 1969, one dealing with the results of the compilation of data from the Hundred of Goyder, and the results of exploration in the Woodcutters area.

COMPILATION OF DATA - RUM JUNGLE AREA

Y. Miezitis

The compilation of geological, geochemical, and radiometric data on standard map sheets, and the formulation of recommendations for follow-up investigations, are now essentially complete; the major effort will now be directed to the correlation of the above data with geophysical results, and the preparation of a generalized account for publication.

HERBERTON-MOUNT GARNET AREA, Q.

D.H. Blake (CSIRO)

A Record (1968/79) on the work carried out in the Herberton-Mount Garnet area has been completed. It is planned to make minor modifications and additions to the text and map (including the presentation of information on mines located this year), and have the report in the hands of the editor for processing as a Bulletin in the first half of next year. Owing to resignation of staff from the Age Determination Group it will probably be advisable not to wait for the isotopic dating results before completing the Bulletin.

Dr Blake has spent a great deal of his own time in preparing the report on this project.

LABORATORIES

CHEMISTRY

A.D. Haldane, J. Ferguson, D.W. Bennett, Miss H.R. Lord

Chemistry of Phosphate Deposition - Work was completed on the distribution of nickel, cobalt, copper, chromium, manganese, zinc cadmium, and lead in rock phosphates from deposits of sedimentary and avion origin. 220 samples from deposits in Africa, the Middle East, Pacific Islands, U.S.A., Christmas Island, and Australia were examined. Full evaluation of the data has not yet been made, but broadly the trace element concentrations appear to be related more to locality than to any other factor. In the Christmas Island deposits the influence of volcanic rocks is clearly evident in the trace element assemblage.

Experimental work on the solubility of natural and synthetic apatites has shown that the environmental conditions are critical, and such factors as sol formation and the presence of traces of carbon dioxide can lead to large differences in reported solubility data. Solubilities determined so far range from 1 to 5 parts per million P_2O_5, which is greatly in excess of the values commonly accepted for the saturation limit for natural systems. Materials used include apatite, crandallite/millisite, barrandite, and synthetic hydroxy-apatite. Examination of the literature has demonstrated that much of the solubility data quoted for synthetic apatite is unsound owing to the presence of whitlockite in the material used.

Investigation of various methods for the chemical synthesis of hydroxy- and carbonate-apatites has established that the methods of Larsen (hydroxy-apatite) and Romo (carbonate-apatite) give pure monomineralic products. It was also evident that sorption phenomena resulting from the colloidal nature of "apatite" formed either by replacement or precipitation has been responsible for much of the confusion concerning the nature of these apatites and their solubility in water.

Geochemistry of Carbonate Rocks - A study of Precambrian carbonate rocks from the McArthur River and Victoria River areas has been commenced as a joint project involving chemists and geologists. Samples have been collected from measured sections in the McArthur River area, and detailed analyses are in progress. Attention will be directed at variations in calcium/magnesium ratios, and at silica and trace element contents in relation to the depositional sequence and mineralization.

Genesis of Iron Formations - The aim of current investigations in this project is to establish the extent of adsorption of trace elements (initially copper, lead, zinc, nickel, and cobalt) by precipitating iron oxide as a function of concentrations, and mode and rate of formation of the oxide. It is hoped that a comparison of the experimental data with results obtained for the trace element content of natural iron deposits will provide information on the origin, transport mechanisms, and environment of deposition.

Experimentally the work has proved difficult owing to the low concentrations involved, the accurate pH control required without the use of buffer systems, time limitations (experiments cannot be prolonged much beyond 5 days), and the colloidal nature of the precipitated oxide phase. Suitable techniques have been developed for measurement of the amounts of trace elements precipitated as a function of the pH of the system both in the presence and absence of iron. This work should provide data on which elements are preferentially adsorbed, the maximum concentrations likely to be obtained, the pH separation between precipitation of trace elements in the presence and absence of iron, and the effect of whether or not the iron oxide is formed by pH change or by change in Eh value.

Routine and Miscellaneous Investigations - A collection of 230 stream sediment and rock samples from an area of ultramafics in the South Sepik River district, T.P.N.G., was analysed for the New Guinea Regional Party. Results from the stream sediments showed a number of anomalous copper values corresponding with reported areas of copper mineralization.

A suite of 58 Precambrian basic volcanic and intrusive rocks adjacent to the Burke River Inlier was analysed to determine their average phosphate content.

One hundred and sixty drill core samples from Dobbyn were analysed for sulphide sulphur for correlation with geophysical results.

The Geological Branch Laboratory was invited to participate in a survey of the accuracy of ore analysis being conducted by the Institute of Geological Sciences. The survey covers the analysis of ores and concentrates of copper, lead, zinc, and tin. Analytical work on these samples has been completed.

Other routine analyses include trace element analysis on plant materials from the Woodcutter's Prospect, Rum Jungle; the Whitewater Volcanics from Lansdowne, W.A.; and bottom sediment samples from Matupi Harbour, New Britain. Sundry analyses of dolomites, chromites, laterites, and water samples, totalling about 150 in all, were also carried out.

The monthly monitoring of the zinc contents in the Molonglo River system on behalf of the Department of the Interior continued throughout the year.

DIRECT READING SPECTROGRAPH

K.R. Walker, S.E. Smith, Z. Roksandic

The laboratory has been fully occupied with project work during the year. Staff employed consisted of two professional officers and one technical assistant (Z. Roksandic). In addition, a Technical Officer position has been approved, but has not been filled to date.

During the year 5100 element determinations were made by the direct reading optical spectrograph, mainly on samples of Hart Dolerite, Bagstowe Ring Complex, amphibolites and granulites from the Canadian Shield, and samples of shales and basic rocks from Mount Isa.

(A) The Mount Isa Geochemical Project

This project is being undertaken in collaboration with Mount Isa Mines Ltd. The B.M.R. has been responsible for the geochemical part of the investigation, and Mount Isa Mines for the mineralogical and petrological part. It is proposed to publish the final results of the investigation jointly, but a interim report by Smith and Walker on the primary element dispersions in the vicinity of mineralization at Mount Isa and their significance for ore genesis, is in the final stages of preparation, and will be presented separately as a B.M.R. report.

The joint study is a comprehensive investigation of the host rocks of the Mount Isa orebodies, and includes a chemical and petrological investigation of the basic igneous rocks that occur in the vicinity of mineralization. The Ag-Pb-Zn mineralization forms typical bedded or concordant orebodies in the Urquhart Shale, whereas the adjacent Cu orebodies take the form of disseminated mineralization in silica-dolomite masses which occur as discordant bodies of reconstituted rock within the Urquhart Shale. Results of the original chemical programme, which involved the determination of the composition and the primary trace element dispersions in the host rocks and the altered basic igneous rocks, showed that an understanding of the genesis of the copper orebodies might be possible by a further investigation of selected rocks in the vicinity of mineralization. A visit was accordingly made to Mount Isa during May to collect additional material, which has since been analysed; a brief petrographic examination of the basic igneous rocks has also been made; these results have been incorporated in the report, which now contains all data obtained from whole-rock analyses undertaken during the project, comprising:

(i) 1225 samples analysed by direct reading optical spectrograph for Ge, Cu, Mg, Fe, Mn, Co, Ni, V, Mo, Ca, Sr, Ba, Ti, Sc, Y, La, and Zr - 20,825 determinations.

(ii) 1075 samples analysed by atomic absorption spectrometer for Ca, Ag, Pb, and Zn - 4300 determinations.

(iii) 70 petrographic examinations by microscope.

(iv) 23 silicate analyses by X-ray fluorescence spectrograph. From the interpretation of these results, the conclusions reached can be briefly summarized as follows:

(a) Sampling interval was too coarse to confidently establish the characteristics of element dispersions around Ag-Pb-Zn mineralization.

(b) Distinctive element dispersions are apparent around Cu mineralization, and element distributions between orebodies, host rocks, and altered basic rocks in the vicinity of mineralization explain in part, at least, the genesis of the Cu mineralization.

(c) Variations in host rock composition, combined with the results of the mineralogical and sedimentological studies being conducted by Mount Isa Mines, should greatly assist the subdivision of these rocks into prospective and non-prospective types, and into appropriate stratigraphic units.

(d) The results of the combined studies should indicate the direction that future investigations should take in the search for ore extensions and for similar mineralization elsewhere.

(B) Element distributions in tholeiitic intrusions

Study on this project during the year has involved further analytical and microscope work. Twelve selected samples of Hart Dolerite, from N.W. Western Australia, were analysed for Cu, Fe, Mg, Ca, Cr, Ni, V, Mn, Ti, Sr, Ba, Sc, Y, La, and Zr. The samples covered the complete range of fractionation shown in a single intrusion. Data plotted in the form of variation diagrams show that the Hart Dolerite is an Fe-rich tholeiite in which element behaviour follows a normal pattern for this magma type. Two manuscripts reporting in detail the study of element behaviour in tholeiitic magma during fractional crystallization, as exemplified by the Palisades Sill, New Jersey, were submitted and accepted for publication. One of the most interesting and important discoveries arising out of this study was on the pyroxene and olivine relationships in late-stage crystallization of Fe-rich tholeiites. Until now it has been generally believed that two pyroxenes, one Ca-rich and the other Ca-poor, crystallize in co-tectic equilibrium during the early and middle fractionation stages, and that in the late stages only one pyroxene, a ferroaugite, crystallizes as a continuation of the normal augite trend. However, study of the pyroxenes from the Palisades Sill revealed that in late stages the Ca-poor pyroxene trend apparently bifurcates beyond the two-pyroxene field of the pyroxene quadrilateral, and is represented by an orthopyroxene-fayalite trend and a ferroaugite trend characterized by

pyroxene that is more Ca-rich than the normal ferroaugite previously recognized in differentiated tholeiites.

(C) Miscellaneous projects

1. A set of colour projection slides of typical igneous and metamorphic rocks was prepared for use by senior students in N.S.W. schools.

2. A sequence showing the direct reading optical spectrography was included in a documentary film by the A.A.E.C. on uranium search in Australia.

3. A summary of the Geological Branch petrological and geochemical laboratory activities was prepared for use by visitors; visitors were received from overseas, industry, universities, and government organizations.

4. As opportunity permitted some further investigations were made into sample preparation procedures to improve reproducibility and efficiency.

X-RAY LABORATORY

C.D. Branch, G.H. Berryman, Z. Roksandic

X-ray fluorescence analysis

Routine silicate analysis of rocks, using the Philips automatic X-ray fluorescence spectrometer (PW1210), started in September. About 30 complete analyses in duplicate are made each week. So far, 80 rocks from Wau, T.P.N.G., Mount Isa, Queensland, Snowy Mountains, New South Wales, and the Bagstowe Ring Dyke Complex, Queensland, have been analysed. In addition, 62 rocks and minerals were analysed for Rb and Sr for the Age Determination Group.

Several developments during the year have led to steady progress towards the full utilization of the equipment for silicate analysis:

Sample preparation. The sample preparation procedures devised by Z. Roksandic, and reported last year, have been only slightly modified. Rocks are crushed in a jaw crusher to minus $\frac{1}{4}$ inch fragments. Pieces $\frac{1}{8}$ to $\frac{1}{4}$ inch across are selected by hand, and ground for 60 sec. in a chrome-plated Siebtechnik Pulverizer. In this way 99% of the sample is reduced to minus 200 mesh size with no iron contamination. The sample is weighed, heated for two hours at 1000°C, reweighed, and the loss calculated. A fusion disc and a powder button are then prepared for analysis. With no interruptions Roksandic can handle about 30 samples each week: 531 discs and 448 buttons were completed this year.

Instrumental techniques. A scaler and a timer (each with visual display), an IBM output writer, and a dead-time corrector have been installed. The artificial standard obtained from C.S.I.R.O. in 1967 has been recalibrated, and significant changes were found for P (7% change) and Si (2% change). T. Quinlan has made a major contribution to the success of the X-ray fluorescence programme by completing a computer programme that copes with all human errors that may occur with data input on the paper punch tape. As a result the sample/channel/time/counts data for 30 to 80 samples in duplicate on the tape are now converted in a few minutes to silicate analyses, matched to sample numbers, and typed out in full. Calculated norms and locality data will be added to the type-out soon.

Instrument operation. G.H. Berryman was appointed on 11th June as Technical Officer Grade 2 in the X-ray laboratory. He is now competent to operate the X-ray spectrograph and the X-ray diffractometer simultaneously, and to maintain a high throughput of samples on both instruments.

Geochemistry of Australian Granites

In this project the aim is to test whether any correlation exists between the distribution of major and trace elements, the ore mineral suites, and the tectonic environments of different granites, and thus to test the hypothesis proposed by C. Branch in B.M.R. Bulletin 76 about the origin of some granite magmas.

About 600 granite samples from northern Queensland have been selected for the initial study because this area contains granites in close proximity which have different tectonic environments (synorogenic to post-orogenic), different ore mineral suites (Au, Ag-Pb-Zn, Sn-W-Bi-F, Cu), and different ages (Precambrian to Mesozoic). The area has been mapped by B.M.R. field parties during the past 12 years (Georgetown Inlier and environs: White, B.M.R. Bulletin 71, and Branch, B.M.R. Bulletin 76; Townsville-Charters Towers area: Paine et al.; Cape York: Trail et al), so the geological setting of the granites is well known.

The silicate analyses of the granites have just been started, and should be completed early in 1969. The granites will then be analysed by X-ray fluorescence for about 50 trace elements: this will involve the preparation of artificial standards, the development of analytical techniques, and the measurement of absorption coefficients, before the actual determination of trace element concentrations can be undertaken. Radioactive element determinations required for this project will be carried out by A.D. Haldane using gamma-ray spectrometry, and about 10 of the lighter trace elements will be determined by K.R. Walker using the direct-reading optical spectrograph.

A report on the major element geochemistry should be completed by mid-1969, and a report on the trace element data by mid-1970. Hypotheses evolved in this project will be tested in late 1970 using granite samples from mineralized areas in other parts of Australia.

X-ray diffraction analysis

The Philips diffractometer (PW1010) was used to identify 223 minerals for 16 geologists in the B.M.R., and to prepare standard charts for an additional 210 minerals.

Other Activities

C. Branch visited the Cape York Party from 24th June to 3rd July. He mapped a large area of Upper Palaeozoic ash and pumice flows with W. Willmott, and established the stratigraphic succession in the area.

The Queensland section of the symposium on Palaeo-vulcanism organized by the Geological Society of Australia, and held in Canberra on 28th and 29th May, was arranged by C. Branch, and he presented a paper on the 'Phanerozoic volcanic history of northern Queensland'. This paper has been approved by the Director for publication in J. geol. Soc. Aust.

Several other lectures were given by C. Branch:
21st November, 1967: Geology of the Agate Creek area, Qld, to Canberra Gem Society.
30th November, 1967: Careers in geology, to Canberra Boys' Grammar School.
3rd April, 1968: Geochemistry of granites, to B.M.R.
4th April, 1968: Granites, to second year adult education class, A.N.U.

Photographic teams from the Australian Atomic Energy Commission and the Antarctic Division of the Department of Supply shot film sequences in the X-ray laboratory during the year.

PETROLOGY, MINERALOGY, AND MINERAGRAPHY

C. Branch, I. Pontifex, R. England

Owing to other commitments, petrological and mineralogical work was severely curtailed during the year; no project work was carried out, but sundry examinations of rocks and ores were carried out for other staff members. However, the electron micro-probe, which had previously been used only for trace element studies in sulphide mineral assemblages, was brought into use on a wider range of problems towards the end of the year.

Collection of a variety of standards is under way, and a number of mineral specimens which may make suitable standards are being checked on the probe for compositional homogeneity to ensure that the composition of a small region used as a standard will be the same as the rest of the specimen which is chemically analysed.

A computer programme is being adapted to handle the complicated series of corrections required to convert the raw data output from the probe to actual element concentration values.

Among miscellaneous small jobs undertaken with this instrument was the examination of a black monazite from Taiwan, which was known to be unusually rich in silica. Although there were abundant quartz inclusions, a high and constant Si/P ratio found by the probe in the monazite host strongly suggested that a large amount of Si was actually substituting for P in the lattice. This requires a tetravalent cation to balance the charge, and, because there was little or no Th, Ce^{4+} seemed the only possibility. This may be the first recorded occurrence of this ionic species in monazite or any other naturally occurring mineral.

Work in the immediate future will be concentrated on problems of metamorphic petrology and mineral chemistry of the Petermann Ranges, especially in relation to compositional variation of the micas, which is expected to be indicative of their chemical and metamorphic environment. In addition, a project on the compositions of coexisting minerals from the Papuan Ultramafic Belt is to be undertaken.

ROCK SECTIONING LABORATORY

T. Zapasnik

Installation of new equipment in the laboratory was not completed until August. Despite this, 912 thin sections, 447 polished sections, and 121 slabs and blocks were prepared during the year.

AGE DETERMINATION

A.W. Webb, V.M. Bofinger, R.W. Page, Miss R. Bennett

One hundred and forty three mineral and whole-rock samples from the Burdekin River region, Cape York, Arunta Complex, West Kimberleys, Papua-New Guinea,and Antarctica were dated during the year, and several calibrations of argon, rubidium, and strontium tracers were carried out.

The interpretation of the dating of the rocks of the East Kimberleys and Bowen Basin has been written up in the form of Ph.D. theses by Bofinger and Webb. This work has been summarized for inclusion in the Bulletins for these areas.

Miss Bennett joined the section in March, and worked with Webb on samples from the Burdekin, Cape York, and the Arunta Complex while learning the techniques of Rb-Sr chemistry and mass-spectrometry. Recently, she commenced work on Rb-Sr dating of several rock suites from the West Kimberleys. Some of this work has involved comparisons of isotope-dilution and X-ray fluorescence for Rb/Sr measurements. The latter method is just as precise, and supersedes the previously used technique involving "rough" X-ray fluorescence analysis followed by separate Rb and Sr isotope dilution analyses.

For six weeks during July and August, Page was mapping with the Kubor Range Party, N.G.. During the season further samples for dating were collected from the Kubor Range, Frieda River, and Yanderra regions.

Webb, Page, and Bennett attended the Geological Society of Australia Specialist Symposium held in Canberra in May. Webb presented two papers: (i) "Isotopic Age Determinations in Queensland and their Relation to the World Geochronological Scale", and (ii) McDougall, I., and Webb, A.W., "Isotopic dating of Cainozoic Volcanics of Eastern Australia".

Bofinger resigned from the Bureau in February, and Webb in July.

A summary of the results for projects undertaken during the year is given below.

Burdekin Project (Webb, Bennett)

Seventy samples were completed from this region during 1968. Total rock K-Ar ages on samples from the Nulla Basalt indicate at least five distinct episodes of extrusion in the Plio-Pleistocene, between 4.5 and 1 m.y. ago.

Rb-Sr total rock ages of granites near and just to the west of Townsville fall in the range 265 to 280 m.y. The Oweenee Granite and similar bodies to the north gave a Rb-Sr isochron at 330 m.y. (Lower Carboniferous), which is somewhat greater than ages previously obtained by the K-Ar method.

The Lower Palaeozoic Ravenswood Granodiorite Complex and Lolworth Igneous Complex have been analysed byRb-Sr work on total rocks, and by K-Ar using separated minerals. The Ravenswood Granodiorite yields two distinct Rb-Sr isochrons of 458 ± 23 m.y. (initial ratio = 0.7073) and 398 ± 6 m.y. (initial ratio = 0.7052); the K-Ar mineral ages span the same range, but show no apparent correlation with the Rb-Sr results. The Lolworth Igneous Complex gives a Rb-Sr isochron of 424 ± 8 m.y. (initial ratio = 0.7097), whereas the K-Ar mica ages are about 395 m.y. Work is in progress on Rb-Sr dating of the Cape River Beds and Mount Windsor Volcanics, and preliminary results indicate both formations are Lower Palaeozoic. For the Cape River Beds, an isochron age of 483 ± 20 m.y. (initial ratio = 0.7295) was obtained.

Cape York

Twenty-three samples from this area have been processed. Several K-Ar mineral ages for the Kintore Adamellite fall near 370 m.y., but incomplete total rock Rb-Sr data suggest that the mass is far older. Samples analysed so far from the Cape York Metamorphics do not give a definite isochron, but appear to be older than Cambrian.

Arunta Project

Six of the seven samples available have been analysed, and the resultant isochron is not within experimental error. Four of the six samples lie on an isochron representing an age of 1710 ± 50 m.y. (initial ratio = 0.7029).

West Kimberleys (Bennett)

This project on Precambrian rocks has been recently undertaken in an attempt to correlate the results with those previously found in the East Kimberleys. Fifty samples from sixteen rock units are available. Rb-Sr analyses of six samples from the Kongorow Granite give an isochron of 1776 ± 100 m.y. (initial ratio = 0.7079). Work on the other rock suites is in progress.

Territory of Papua-New Guinea (Page)

A major geochronological project is continuing in the Highlands and Sepik districts in New Guinea. Dating of the Bismarck Granodiorite by the K-Ar and Rb-Sr methods has been done, and although the data point to loss of radiogenic daughter products from some minerals, it is clear (on the basis of Rb-Sr whole rock determinations) that this is a Middle to Upper Tertiary intrusion.

Jurassic and Triassic ages have been obtained from the Kubor Granodiorite, and as recent field work indicates a number of non-contemporaneous intrusions in the area, further analyses are required to resolve the sequence of events.

Analytical work is almost complete on the dating of the stratigraphically-controlled Tertiary lower "f" stage Daulo and Tarua Volcanics. Ages of around 14 m.y. are somewhat younger than predicted from the presently accepted absolute time-scale.

Reports have been submitted to H.L. Davies and R.P. Macnab on the dating of volcanics and intrusions in the Papuan Ultramafic Belt and Gazelle Peninsula. K-Ar analyses of five mineral concentrates from the C.R.A. prospect on Bougainville Island are being undertaken.

Antarctica (Bofinger)

Rb-Sr analyses of 25 total rock and mineral samples (from 10 rocks) from Enderby, Kemp, and MacRobertson Lands, were completed. The results are inconclusive, as samples were taken from localities too widely separated to permit any interpretation of age relationships.

BAAS-BECKING GEOBIOLOGICAL LABORATORY

BIOLOGICAL GROUP

P.A. Trudinger, B. Bubela, D.P. Kelly, H.E. Jones, Miss L.A. Chambers

The work of the biological group has continued along the general lines outlined in the previous summary of activities.

A. Iron Sulphides in Biological Environments

Particular emphasis is currently being placed on the precipitation of iron sulphides in biological environments. Preliminary studies have shown that the iron sulphide formed in cultures of sulphate-reducing bacteria is microcrystalline, and gives a pyrite electron-diffraction pattern although it is amorphous to X-rays. There is also a strong tendency for this microcrystalline material to be attached to organic matter, and to aggregate into structures with some superficial resemblance to natural "framboidal" pyrite. The conditions governing the formation of this pyritic material are under investigation.

A second feature of the biological system is the ability of the microorganisms to form metal sulphides from extremely dilute metal solutions (less than 1 ppm total heavy metal ion). The nature of the metal sulphides formed and the degrees of concentration which can be achieved are being studied.

B. Banding of metal sulphides in Gels

A study was made of the precipitation behaviour of mixtures of metals diffusing through gels containing sulphide of either chemical or biological origin. The separation of several pairs (and more complex mixtures) of metals was achieved, each metal precipitating as a well-defined band (or bands). The work has been discussed in relation to the formation of banded metal sulphide deposits in a paper submitted for publication.

C. Alkanes derived from microorganisms (in collaboration with Division of Mineral Chemistry, CSIRO)

A study is being made of the paraffinic and isoprenoid hydrocarbons generated from selected microorganisms subjected to high temperatures and pressures. The results will be correlated with those on the occurrence of similar paraffins in the black shales associated with certain mineral deposits and in sedimentary muds.

D. Physiology of sulphate-reducing bacteria

Current studies are directed towards the nutritional requirements of the thermophile Desulphotomaculum nigrificans; in particular, the effects of oxygen, nitrogen, hydrogen, carbon sources, and nitrogen sources on the growth and metabolism of this organism are being investigated. The studies will be extended to Desulphovibrio in due course, but at present we are experiencing difficulties in the isolation of species of this genus.

In association with this work the isolation and identification of any organic sulphides produced by the bacteria is being undertaken.

E. Pigments of D. nigrificans

During the course of the studies outlined above (D) a novel oxidation-reduction pigment in D. nigrificans was detected. Its chemical nature and its role in sulphate reduction are under investigation.

F. Comparative biochemistry of sulphur-metabolizing organisms

As part of the general investigation into possible evolutionary relationships of the sulphur-metabolizing organisms, the enzymes leading to the formation of the sulphur amino acid, cysteine, are being examined in a range of microorganisms.

The results to date indicate that cysteine biosynthesis in sulphate-reducing bacteria and sulphur-oxidizing bacteria follows a similar pattern to that occurring generally in heterotrophic bacteria despite the specialized sulphur metabolism of the first two groups of microorganisms.

During the course of this work a new route for cysteine biosynthesis in certain soil bacteria was uncovered. Some preliminary characterization of this system is being undertaken with the view to publishing a short note.

G. Sulphur isotope fractionation by sulphur-oxidizing organisms

A total of 115 samples have been despatched to Dr Rafter, D.S.I.R., New Zealand, for analysis. These represent samples from the oxidation of thiosulphate by thiobacilli, as well as those from chemical degradation experiments. The work has now been curtailed pending results from Dr Rafter.

H. Analysis of sulphur compounds

Analytical methods for inorganic sulphur compounds suitable for use in conjunction with the sulphur isotope work are being developed. In particular the cyanolytic method is being studied in detail: a paper has been submitted for publication.

I. Organic metabolism of thiobacilli

The influence of organic matter on the activities of sulphur-oxidizing organisms is being studied with particular reference to

1. The toxicity of phenylalanine (a natural amino acid) to thiobacilli.
2. The metabolism of simple organic acids.
3. Sulphur amino acid synthesis in vitro.

J. Metal toxicity

Studies on the influence of heavy metals on the activities of various microorganisms are continuing. Particular attention is being paid to the effect of oxygen on copper toxicity, as the results so far show that copper is generally much more toxic to organisms under anaerobic than under aerobic conditions.

MINERALOGICAL GROUP

W.M.B. Roberts, C.J. Downes, J.A. McDonald, I.B. Lambert

The work of the mineralogy section has involved investigations in three main fields -

1. Mineral synthesis and transformation
2. Physical chemistry of sulphide precipitation from dilute aqueous solutions

3. Mineragraphic investigations to determine the effect of metamorphism on sulphide deposits.

The investigations on mineral synthesis are concerned with the study of the Fe-S part of the system Cu-Fe-S; the first phase, the synthesis of pyrite, and the determination of the chemistry of its formation, has been completed. Preliminary investigation of the effects of temperature and pressure on the iron sulphides has commenced, and it is hoped that results from the work may provide useful information on post-depositional events which have affected the ore minerals.

Work on mineral transformation in the system Cu-Fe-S has shown that, starting with covellite and iron sulphide, the application of pressure and temperature up to 200°C produces complex mineral assemblages containing up to six phases. Detailed determination of the mineralogy will be carried out by microprobe analysis.

The physico-chemical investigations on precipitation from dilute aqueous solutions commenced during the latter part of the year. The earlier part of the year was spent in assembling equipment for this work, and in an extensive literature search for information, both geological and chemical, relevant to the programme.

The mineragraphic investigations were centred around a study of lead-zinc ore from Mount Isa, and the principal effort was an attempt to determine the cause of the minor crenulations in this deposit. The work involved the use of electron probe microscopy to determine the movement of minor elements in the sulphides, as well as detailed measurements on the mobilization of galena and sphalerite in the folds. The conclusion reached was that the folding was of tectonic origin rather than due to slumping. The formation of sulphide bands in gels was investigated, and a paper on the results of this work was prepared jointly with a member of the biological group.

Dr McDonald resigned in July, and Dr Lambert joined the Group late in October.

MISCELLANEOUS

VOLCANO SURVEILLANCE, CRUSTAL STUDIES, AND GENERAL VULCANOLOGY - G.A.M. Taylor

Activities during the current year have been devoted chiefly to liaison with A.N.U. on instrument installations in New Guinea, organization of a crustal study project in the Rabaul area, field investigations of volcanic areas in New Guinea, the preparation of reports for international organizations, and organizing a symposium on palaeovulcanology.

Instruments for Volcano Surveillance

Installation of the first phase of the telemetered seismic network at Rabaul Observatory was completed this year. Professor Newstead (A.N.U.), who is responsible for the design of the telemetering electronics, visited Rabaul in May, and made recommendations on modifications which will improve the operational characteristics of the equipment. Filters, an earthquake monitoring device, and an experimental draft-free amplifier have been made for incorporation in the network.

The design section of the Geophysical Branch of the Bureau is carrying out modifications on a bubble-type tiltmeter which is normally used for field investigations of active volcanoes.

Crustal Study Projects

A crustal study project was carried out in the Rabaul area in October-November, 1967, to supply data on seismic velocities and crustal structure which will assist the volcano surveillance network. Contributions to this project were made as an original proposer-member of the planning committee and as a participant in the field. A geological map of the study region was compiled to assist in interpretation of the geophysical data derived from the project. Assistance was given in the preparation of a summary of last year's results; the summary has been distributed to Territory people in the study region.

An extension of the crustal study project is planned for 1969. A reconnaissance was carried out on 32 prospective recording sites in New Britain, New Ireland, and adjacent islands with regard to access, terrain, accommodation, and special requirements. Information was also gathered on communication, transport, and location fixing requirements which will assist in programming next year's survey.

Specialists' Meeting

A specialists' meeting under the auspices of the Geological Society of Australia was held in Canberra in May. As convenor of the section on palaeovulcanology Taylor invited contributions on the

subject of Phanerozoic Vulcanism in Australia and New Guinea. A good response was received, and the papers, when published in a special volume of the G.S.A., will provide the first comprehensive review of vulcanism in Australia.

Reports for International Organizations

Our contribution to the world map of post-Miocene volcanoes was completed; this project was sponsored by the International Association of Vulcanology and Chemistry of the Earth's Interior. The material submitted consisted of maps and information sheets covering coordinates, height, condition of activity, and lava type for 839 post-Miocene volcanic centres in Australia and Melanesia. A short report on this compilation was prepared for the ECAFE meeting in Tehran. For the same meeting a report was also prepared on installation of a telemetered seismic network at Rabaul.

Information on tide gauge records available in Australia and New Guinea is being gathered for the IUGG Tsunami Committee which plans to publish a marigram atlas of the Pacific.

Field Work

Field investigations were carried out at Rabaul, where temperatures in the fumaroles of Tavurvur volcano were higher than normal; at Wau, where investigations are continuing on the cause of high temperature in a vent situated in the Koranga open cut area; at Doma Peaks, in the Southern Highland District, where sulphurous vents were discovered in a crater believed to have been extinct. Laboratory work on material from the Wau and Doma Peaks areas is continuing, and reports are in preparation. A brief report on observations at Doma Peaks has already been passed on to the Senior Resident Geologist in Port Moresby.

PROBABLE CARBONATITES, STRANGWAYS RANGE AREA, CENTRAL AUSTRALIA -

P.W. Crohn, D.C. Gellatly

A probable carbonatite occurrence - the first to be recorded in Australia - has been recognized in the Strangways Range, about 60 miles north-north-east of Alice Springs. At this locality, four lenses of crystalline carbonate rocks containing magnetite, apatite, and zircon occur in a north-east trending zone about 3 miles long and half a mile wide; the largest of these lenses has a surface extent of about 2,000 by 2,000 feet.

The carbonate rocks show banding due to differences in texture and variations in the contents of non-carbonate minerals, and range from dolomitic and calcitic non-foliated rocks to gneissose rocks composed largely of calcite and biotite. The bulk of the magnetite, apatite, and zircon occurs in the non-foliated rocks, in which apatite may form massive aggregates up to two feet across, magnetite forms twinned octahedra up to three inches across, and zircon typically occurs as prismatic crystals up to two inches long and one inch across.

The rocks surrounding the carbonate lenses are schist, gneiss, and basic igneous rocks of the Arunta Complex of probable Archaean age, and small lenses of basic rocks and of aegirine-augite and sodic amphibole-bearing pegmatite occur within the carbonates. However, the actual contacts of the carbonate rocks with the Arunta Complex or the pegmatites are not exposed.

The occurrence has been known at least since 1944, when it was examined as a possible source of apatite for superphosphate manufacture by H.B. Owen (B.M.R. Record 1944/44). However, the current investigation, leading to the recognition of these rocks as probable carbonatites, arose out of a visit to the locality by P.W. Crohn in 1965 in connection with a low-level aeromagnetic survey then being undertaken by the B.M.R. Towards the end of 1967, a number of specimens of diamond drill core from the occurrence were made available by Geopeko Ltd, who had undertaken an investigation of the area in 1966, and the locality was re-visited by P.W. Crohn in July, 1968.

Thirteen samples of the drill core provided by Geopeko Ltd have been analysed for trace elements at the Australian Mineral Development Laboratories, Adelaide, and a number of thin sections have been examined by D.C. Gellatly.

Features indicative of a carbonatite origin, apart from the magnetite-apatite mineral assemblage, include a trace element assemblage characterized by high values of niobium (20 to 450 ppm) and rare earths (up to 700 ppm La, 100 ppm Pr, 300 ppm Nd and 200 ppm Y), and relatively high values of barium (250 to 1,000 ppm) and strontium (800 to 1,500 ppm), as well as the presence of phlogopite showing reverse pleochroism (i.e., maximum absorption normal to (001)), and the occurrence in one specimen of small aggregates of a pale grey-brown microcrystalline highly birefringent material, thought to be columbite after pyrochlore.

A preliminary account of the occurrence has been submitted for publication in the Australian Journal of Science.

TECTONIC MAP OF AUSTRALIA - K.A. Plumb

Plumb is a member of the A.C.T. Tectonic Map Committee of the Geological Society of Australia which is currently compiling a Tectonic Map of Australia (see Annual Summary of Activities - Map Compilation Section).

Plumb was convenor of a Symposium held in May to consider the time classification of the Precambrian for the Tectonic Map. He presented a new chart of up-to-date isotopic ages together with a new time-classification of Precambrian tectonic cycles (as distinct from a stratigraphic time-scale) and a classification of Platforms, most of which lie on a Precambrian Basement. These classifications have been adopted by the combined Tectonic Map Committee for use on the Tectonic Map.

The final compilation of the Tectonic Map of Australia is now in progress. Plumb is individually responsible for compiling data on the Northern Territory and the Kimberley Region of Western Australia.

AERIAL COLOUR PHOTOGRAPHY - W.J. Perry, P.R. Dunn

The aerial colour photography obtained during 1967 was studied, and ground assessment made in the Rum Jungle area.

The Rum Jungle photographs proved very useful for distinguishing some vegetation types (the purpose for which it was planned) and soil variations. It does not greatly assist in the mapping of rock types in this tree-covered terrain.

The Ngalia Basin photographs clearly distinguished rubble-covered areas of poor outcrop in which the glacial Mount Doreen Formation occurs. These areas were much less easy to see on panchromatic film taken from the same height. The Ngalia Basin photographs showed that colour photographs in this type of terrain would be extremely useful for picking areas of maximum outcrop for section measuring, and for mapping of structurally complex areas.

The type of low-level photographs taken at Tennant Creek would be very valuable for detailed mapping (e.g., at 400 ft to an inch) of mines or mineral deposits.

In an effort to follow up the potential of colour photographs in structurally complex areas further photography was planned in three areas of the Arunta Complex near Alice Springs. During October, 1968, the Bureau's DC3 was used to photograph the three areas from heights of 4000 feet and 8000 feet above ground level. The Gosses Bluff area was also flown from 6000 feet above the ground. The results of this photography are not yet available.

SPECIALIST SYMPOSIUM OF THE GEOLOGICAL SOCIETY OF AUSTRALIA

During May the Geological Society of Australia held a specialist symposium in Canberra. The symposium comprised the following sessions: Permian of Australia; palaeovulcanicity; environmental analysis in sedimentology; granulite facies; and tectonic map of Australia. Members of the metalliferous section took part in four of these sessions:

Permian of Australia

A.W. Webb - Isotopic age determinations in Queensland and their relation to the world geochronological scale

Palaeovulcanicity

P.R. Dunn	- Northern Australian plateau volcanics
C.D. Branch	- The Phanerozoic volcanic history of northern Queensland
A.G.L. Paine	- The Phanerozoic vulcanism of central eastern Queensland
I. McDougall (ANU) A.W. Webb	- Isotopic dating of Cainozoic volcanics of eastern Australia
D.B. Dow	- Post-Palaeozoic vulcanism in New Guinea
G.A.M. Taylor	- Post-Miocene volcanoes in Papua-New Guinea

Environmental analysis in sedimentology

D.C. Gellatly	- Cross-bedded tidal sand-ridges of King Sound, Western Australia

Tectonic map of Australia

K.A. Plumb	- Precambrian tectonic development of northern Australia
K.A. Plumb	- A proposal for the tectonic subdivision of the Precambrian in Australia

Some of these contributions will be published in a special publication of the Geological Society of Australia.

TRAINING OF UNITED NATIONS AND I.A.E.A. FELLOWS

United Nations Fellow Mr A. Annamalai and International Atomic Energy Authority Fellow Mr C.J. Wu joined the Bureau on 3/6/68 and 17/6/68, respectively, for training in various aspects of geological, geochemical, and geophysical investigations. In Mr Annamalai's case, this has been concerned mainly with the analysis of geochemical prospecting samples by atomic absorption spectrophotometer, and with field geochemical surveys undertaken by the Darwin Uranium Group. In Mr Wu's case, emphasis has been placed on mineral identification by thin section microscopy, and on field geochemical and geophysical investigations, particularly in the search for radioactive minerals.

OVERSEAS VISITS

H.L. DAVIES

H.L. Davies was granted a Public Service Scholarship to attend Stanford University to complete his Ph.D. course between July, 1968, and August, 1969. Davies left Australia on 10th July, and visited Gyprus, France, the Alps, the Geological Congress at Prague, London, and the U.S.G.S. and Canadian Geological Survey

before arriving in San Francisco at the end of September.

In Cyprus Davies visited the copper and pyrite mining operations. The mineralization is associated with basic pillow lavas and ultrabasic rocks similar to those present in the Papuan Ultramafic Belt.

After visiting Cyprus he joined a party of experts in ultramafic and structural geology on a tour of ultramafic localities in France, Switzerland, and Italy, and of examples of structural deformation in the Alps. The tour ended at Prague, where the International Geological Congress was attended until it was disbanded because of political disturbances. Davies did not have an opportunity to deliver his paper on the Papua Ultramafic Belt.

From Prague he went to London to have discussions with J. Milsom about a paper they are writing together entitled "Eastern Papua geology and gravity - progress results".

Eighteen days were spent between London and San Francisco visiting the United States Geological Survey in Washington, the Geological Survey of Canada in Ottawa, and the South-West Pacific Gravity Group at the University of Wisconsin in Madison, Wisconsin.

Study was started at Stanford University on September 23rd.

W.B. DALLWITZ

After attending the International Geological Congress in Czechoslovakia, W.B. Dallwitz spent about two weeks in West Germany before continuing, on schedule, visits to the U.K., Canada, and the U.S.A..

Dallwitz attended a pre-sessional excursion to the Bohemian Massif; this was very well organized, and excellent maps and other illustrations, including large-scale photographs of rocks in thin section, were shown at the outcrops. Only one day of scientific sessions was held in Prague before the Congress began to break up following the entry of troops belonging to the Warsaw Pact countries.

Among geological features visited in West Germany were the Kaiserstuhl complex of alkaline rocks and niobium-bearing carbonatite, near Freiburg, and the Ries Crater (astrobleme) in Bavaria. The fall-out rock (suevite) at the Ries Crater seems to be remarkably similar to that at Gosses Bluff, after making due allowance for devitrification of glass at the latter locality. Highlights of a visit to the Institute of Geological Sciences in London were discussions with Dr J.R. Hawkes on tin mineralization in Cornwall, and with Dr T. Deans on carbonatites and related rocks. A very instructive reference collection of the latter is laid out in Dr Deans' office.

In Canada the offices of the Geological Survey and the Sudbury area were visited. Recent studies suggest that the norite and associated Cu-Ni-Pb mineralization at Sudbury were emplaced as a result of impact by an extra-terrestrial body.

In the U.S.A. visits were made to the three principal offices of the U.S.G.S. (Washington, Denver, and Menlo Park). A great variety of laboratory research is going on at all three places, and particular emphasis is given to applied geochemistry and improvement of analytical techniques for geochemical prospecting. As a direct result of the so-called heavy metals programme a completely new gold orebody and the largest known deposit of barytes in the U.S.A. have been discovered. It is considered that more emphasis should be placed on systematic geochemical surveys in the course of our regional mapping in Australia.

The Kennecott and Anaconda laboratories at Salt Lake City were inspected; these laboratories provide a wide range of facilities for geological, geophysical, and geochemical studies related to exploration. Experimental work on rock alteration during mineralization is regarded as important for understanding the conditions under which orebodies are formed.

Dallwitz left Australia on 8th August, and returned on 12th October.

CO-EXISTING QUARTZ AND SAPPHIRINE IN GRANULITE (W.B. Dallwitz)

Quartz and sapphirine - $(Mg, Fe)_2 Al_4O_6 (SiO_4)$ - have been found together in nature for the first time in quartz-rich granulite collected by I.R. McLeod in Enderby Land, Antarctica, some years ago. Previously sapphirine had been recorded only in rocks rich in Mg and Al, and low in Si. A note on the occurrence has been published in Nature.

The sapphirine-bearing rocks occur in a gneiss-granulite-charnockite terrain, and it is interesting to note that a research student at the A.N.U. has recently outlined a stability field for co-existing quartz and sapphirine at temperatures of about 1100°C and pressures of about 9 kilobars. Further delineation of this and neighbouring fields containing orthopyroxene, cordierite, garnet, and sillimanite should help to elucidate the conditions under which charnockites and granulites have formed.

APPENDIX M.1

PUBLICATIONS

BULLETINS

No. 82	WALPOLE, B.P., DUNN, P.R., RANDAL, M.A., CROHN, P.W.	The geology of the Katherine-Darwin Region, Northern Territory	Page proofs returned to printer
No. 84	de KEYSER, F., LUCAS, K.G.	The geology of the Hodgkinson Basin, Queensland	Ready for press
No. 106	DOW, D.B., GEMUTS, I.[2]	Precambrian geology of the Kimberley Region, East Kimberley	Ready for press
No. 107	GEMUTS, I.[2]	Metamorphism and igneous activity in the Lamboo Complex, East Kimberley area, Western Australia	With editor
	ROBERTS, H.G., PLUMB, K.A., DUNN, P.R.	Geology of the Carpentaria Proterozoic Province, N.T.: Arnhem Land	With editor
	BLAKE, D.H.[4]	Geology and mineral resources of the Herberton-Mount Garnet area, Herberton Tinfield, North Queensland	First draft complete
	DOW, D.B., SMIT, J.A.J., BAIN, J.H.C., RYBURN, R.J.	Geology of the South Sepik Region	First draft complete
	DUNN, P.R., ROBERTS, H.G., SMITH, J.W., PLUMB, K.A.	Geology of the Carpentaria Proterozoic Province, N.T.: Roper River to the Queensland border	Writing in progress

1 Geological Survey of Queensland
2 Geological Survey of Western Australia
3 Geological Survey of New South Wales
4 C.S.I.R.O.
5 A.N.U.
6 Mount Isa Mines Ltd

	PLUMB, K.A.	Precambrian geology of the Kimberley Region: Kimberley Basin	Writing to begin in 1969
	GELLATLY, D.C., SOFOULIS, J., [2] DERRICK, G.M.	Precambrian geology of the Kimberley Region: West Kimberley	Writing to begin in 1969
	PAINE, A.G.L., WYATT, D.H. [1]	The geology of the Burdekin River Region, Queensland	Writing to begin in 1969
	BAIN, J.H.C.	Geology of the New Guinea Highlands	Writing to start in 1969

REPORTS

No. 106	BEEVERS, J.R.	A chemical investigation of the potential of sorption in ore genesis	Published
No. 107	BRANCH, C.D.	Short papers on vulcanology from the Rabaul Observatory	Published
No. 115	TRAIL, D.S.	Mineralized Tertiary rocks of Woodlark Island, New Guinea	Published
No. 45	WHITE, D.A., SHIELDS, J.W., IVANAC, J.F.	The Union Reefs Goldfield, Northern Territory	In press
No. 105	YATES, K.R. de FERRANTI, R.Z.	The geology and mineral resources of the Port Moresby-Kemp Welch area, Papua	In press
No. 114	DUNNET, D., HARDING, R.R.	Geology of the Mount Woodcock 1-mile Sheet area, Northern Territory	In press
No. 117	HARDING, R.R.	Catalogue of isotopic age determinations on Australian rocks, 1962-65	In press
No. 118	TRAIL, D.S., McLEOD, I.R., COOK, P.J., WALLIS, G.R. [3]	Geological investigations by the Australian National Antarctic Research Expedition, 1965	In press

No. 126	PAINE, A.G.L., HARDING, R.R., CLARKE, D.E. [1]	The geology of the north-eastern part of the Hughenden 1:250,000 Sheet area, Queensland	With editor
No. 127	WYATT, D.H., [1] PAINE, A.G.L., HARDING, R.R., CLARKE, D.E. [1]	The geology of the Townsville 1:250,000 Sheet area, Queensland	With editor
No. 128	PAINE, A.G.L., GREGORY, C.M., CLARKE, D.E. [1]	The geology of the Ayr 1:250,000 Sheet area, Queensland	With editor
	WYATT, D.H. [1] PAINE, A.G.L., CLARKE, D.E. [1] GREGORY, C.M., HARDING, R.R.	The geology of the Charters Towers 1:250,000 Sheet area, Queensland	With editor
	CLARKE, D.E., [1] PAINE, A.G.L., JENSEN, A.R.	The geology of the Proserpine 1:250,000 Sheet area, Queensland	With editor
	ROBERTS, H.G., GEMUTS, I., [2] HALLIGAN, R. [2]	Adelaidean and Cambrian stratigraphy of the Mount Ramsay 1:250,000 Sheet area	Ready for editor
	DOW, D.B.	Palaeozoic rocks of the Hardman, Rosewood and Argyle Basins, East Kimberley Region, Western Australia	Ready for editor
	PAGE, R. W.	Catalogue of isotopic age determinations carried out on Australian rocks in 1966	Ready for editor
	PAINE, A.G.L., CLARKE, D.E., [1] GREGORY, C.M.	The geology of the northern half of the Bowen 1:250,000 Sheet area, Queensland	Writing in progress
	PLUMB, K.A.	Petrography of the igneous and metamorphic basement rocks of Arnhem Land	Writing in progress

MIEZITIS, Y.	Compilation of geological and geophysical information from the Hundred of Goyder	Writing in progress
SMITH, S.E., WALKER, K.R.	Primary element dispersions associated with mineralization at Mount Isa, Queensland	Writing in progress
PAGE, R.W., BENNETT, R. (Miss)	Catalogue of isotopic age determinations on Australian rocks in 1967	Writing in progress
BRANCH, C.D.	Major element geochemistry of the granites from North Queensland	Writing to start in 1969
PRICHARD, C.E., Geophysicist	Exploration of the Woodcutters area, near Rum Jungle, N.T. 1964-67	Writing to start in 1969

OUTSIDE PUBLICATIONS

BOFINGER, V.M., COMPSTON, W.	A re-assessment of the age of the Hamilton Group, New York and Pennsylvania, and the role of inherited radiogenic Sr^{87}	Geochim. Cosmochim. Acta 31, 2353-2359
BOFINGER, V.M., COMPSTON, W., VERNON, M.J.	The application of acid leaching to the Rb-Sr dating of a Middle Ordovician shale	Geochim. Cosmochim. Acta 32, 823-833
DALLWITZ, W.B.	Chemical composition and genesis of clinoenstatite-bearing rocks from Cape Vogel, Papua: a discussion	Rept XXIII Session Internat. geol. Congr. Section 2, 229-42
DALLWITZ, W.B.	Co-existing sapphirine and quartz in granulite from Enderby Land, Antarctica	Nature, 219, (5953), 476-7
DAVIES, H.L.	Papuan Ultramafic Belt	Rept XXIII Session Internat. geol. Congr. Section 1, 209-20

MORGAN, W.R.	The petrology of some Cainozoic basaltic rocks from the Atherton Tableland and Einasleigh-Mount Garnet areas, North Queensland	Proc. Roy. Soc. Qld, 80(1), pp 1-12
WEBB, A.W., McDOUGALL, I.[5]	A comparison of mineral and whole rock potassium-argon ages of Tertiary volcanics from Central Queensland, Australia	Earth and Planet. Sci. Lett., 3, 41-47
MORGAN, W.R.	The geology and petrology of Cainozoic basaltic rocks in the Cooktown area, north Queensland	J. geol. Soc. Aust. 15(1), 65-78
PERRY, W.J., ROBERTS, H.G.	Late Precambrian glaciated pavements in the Kimberley region, Western Australia	J. geol. Soc. Aust. 15(1), 51-56
WHITAKER, W.G.,[1] WILLMOTT, W.F.	The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula : Part 1 - The southern area	Qld Govt Min. Jour., 69(802), 344-355
BUBELA, B.	Effects of temperature on growth characteristics of Bacillus stearothermophilus	Aust. J. Biol. Sci., 21, 439
KELLY, D.P.	Incorporation of acetate by the chemoautotroph Thiobacillus neapolitanus strain C	Arch. Mikrobiol., 58, 99
KELLY, D.P.	Fluoroacetate toxicity in Thiobacillus neapolitanus and its relevance to the problem of obligate chemoautotrophy	Arch. Mikrobiol., 61, 59
McDONALD, J.A.	Metamorphism and its effect on sulphide assemblages	Mineralium Deposita, 2(3), 200-220
ROBERTS, W.M.B.	Sulphide synthesis and ore genesis	Mineralium Deposita, 2(3), 188-199
SADLER, W.R., TRUDINGER, P.A.	The inhibition of microorganisms by heavy metals	Mineralium Deposita, 2(3), 158-168

TRUDINGER, P.A., BUBELA, B.	Microorganisms and the natural environment	Mineralium Deposita 2(3), 147-157
TRUDINGER, P.A., KELLY, D.P.	Reduced nicotinamide adenine dinucleotide oxidation by Thiobacillus neapolitanus and Thiobacillus strain C	J. Bacteriol., 95 1962
BLAKE, D.H.	Post-Miocene volcanoes of Bougainville, Territory of Papua and New Guinea	Bulletin volcanologique (in press)
BRANCH, C.D.	Phanerozoic volcanic history of northern Queensland	J. geol. Soc. Aust. (submitted)
CROHN, P.W., GELLATLY, D.C.	Probable carbonatites in the Strangways Range area, central Australia	Aust. J. Sci. (submitted)
DAVIES, H.L., MILSOM, J.	Geology and gravity of Eastern Papua - progress results	Tectonophysics (submitted)
DUNN, P.R., BROWN, M.C.	North Australian plateau volcanics	J. geol. Soc. Aust. (submitted)
PAINE, A.G.L.	Palaeovulcanology of central eastern Queensland	J. geol. Soc. Aust. (submitted)
TAYLOR, G.A.M.	Post-Miocene volcanoes in Papua-New Guinea	J. geol. Soc. Aust. (submitted)
WALKER, K.R.	The Palisades Sill, New Jersey - a re-investigation	Geol. Soc. Am. Sp. Pap. 111 (in press)
WALKER, K.R.	A mineralogical, petrological and geochemical investigation of the Palisades Sill, New Jersey	Geol. Soc. Am. Mem. 115 (Poldervaart Volume) in press

WEBB, A.W.	Metallogenetic epochs in Eastern Queensland	Proc. Aust. Inst. Min. Metall. (submitted)
WEBB, A.W.	Geochronology of the igneous rocks of eastern Queensland	J. geol. Soc. Aust. (submitted)
KELLY, D.P.	Biochemistry of inorganic sulphur compound oxidation by microorganisms	Aust. J. Sci., (submitted)
ROBERTS, W.M.B.	The formation of pyrite from hydrated iron oxide in aqueous solution at 200°C	Mineralium Deposita (in press)
ROBERTS, W.M.B.	The chemistry of pyrite formation in aqueous solutions and its relation to the depositional environment	Mineralium Deposita (in press)
TRUDINGER, P.A., ROY, A.B.[5]	The biochemistry of inorganic compounds of sulphur	Monograph, Cambridge University Press (in press)
TRUDINGER, P.A.	Assimilatory and dissimilatory metabolism of inorganic sulphur compounds by microorganisms	Adv. Microbiol. Physiol., 3 (in press)
BUBELA, B., McDONALD, J.A.	Formation of banded sulphides : metal ion separation and precipitation by inorganic and microbial sulphide sources	Nature (submitted)
KELLY, D.P., CHAMBERS, L.A., TRUDINGER, P.A.	Cyanolysis and colorimetric estimation of trithionate in mixture with thiosulphate and tetrathionate	Anal. Chem. (submitted)
McDONALD, J.A.	Some effects of deformation on sulphide-rich bands in lead-zinc orebodies, Mount Isa, Queensland	Econ. Geol. (submitted)

BRANCH, C.D.	Geochemical and structural evolution of the Bagstowe Ring Dyke Complex, northern Queensland	In preparation
GELLATLY, D.C.	Cross-bedded tidal megaripples from King Sound, Western Australia	In preparation
PAINE, A.G.L.	Pentecost Island - an Australian porphyry copper body ?	In preparation
PLUMB, K.A., BROWN, M.C.	Revised stratigraphic correlations in the McArthur Group, Carpentaria Proterozoic Province, N.T.	In preparation
RYBURN, R.J., DOW, D.B.	Glaucophane schists and eclogites from New Guinea	In preparation
SMITH, S.E., WALKER, K.R., van den HEUVEL, H., [6] CURTIS, P. [6]	A mineralogical and chemical study of the sediments and basic igneous rocks at Mount Isa, Queensland, and the implications for ore genesis	In preparation
WHITAKER, W.G., [1] WILLMOTT, W.F.	The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula, Queensland. Part 2 - The Coen-Iron Range area	In preparation

RECORDS

ISSUED

1967/8	A brief comparison of the Precambrian of Australia and the Canadian Shield	K.E. EADE (Geological Survey of Canada)
1967/41	Geochemical and radiometric investigations, Gould area, Northern Territory, 1966 (Mount Minza and Waterhouse No. 2 areas)	D.G. SEMPLE
1967/42	Geochemical and radiometric investigations, Prospects L1, L2, L3 and L6, northern part of Woodcutters area, Rum Jungle East, Northern Territory, 1966	D.G. SEMPLE
1967/43	Note on investigation 66201, copper deposits in the Upper Warangoi area, East New Britain	R.P. MACNAB
1967/53	Milne Bay, Papua - Geological reconnaissance	H.L. DAVIES
1967/75	Minor metalliferous investigations - Northern Territory Resident Geological Section - Pine Creek 1:250,000 Sheet area, 1965	
1967/86 (Part 2)	Miscellaneous chemical investigations carried out in the Geological Laboratory, July-December 1967	Compiled by E. WOODHEAD
1967/87	Coal at Gove Peninsula	R.G. DODSON
1967/98	Geology of the Keveri area, Eastern Papua	R.P. MACNAB
1967/104	The geology of the Charters Towers 1:250,000 Sheet area, Queensland	D.H. WYATT [1] A.G.L. PAINE D.E. CLARKE [1] C.M. GREGORY R.R. HARDING

1967/107	Papuan Ultramafic Belt	H.L. DAVIES
1967/108	ANARE 1961 geological traverses on the MacRobertson Land and Kemp Land Coast	D.S. TRAIL
1967/127	Resident geological section, Tennant Creek: Minor investigations (Blue Moon, Hopeful Star, Southern Star, Perseverance, Bullpup, Helen Springs, Power of Wealth)	
1967/128	Iron ore reconnaissance survey, Ban Ban and Woolwonga area, Northern Territory	J.W. SHIELDS, A. TAUBE
1967/129	Regional geochemical survey - Ayr 1:250,000 Sheet area, Queensland	N.J. MARSHALL
1967/130	Notes on the geology and mineral deposits of Canada and Australia. A comparison based on an exchange visit to the Geological Survey of Canada, February, 1966, to March, 1967	P.W. CROHN
1967/131	Report on an exchange visit to the Geological Survey of Canada	P.W. CROHN
1967/134	Annual Summary of Activities, Geological Branch, 1967	
1967/141	Summary of B.M.R. exploration, Rum Jungle area, 1967	P.W. CROHN, J.E.F. GARDENER, W.J. LANGRON, C.E. PRICHARD
1967/150	Preliminary report on compilation of geological, geochemical and radiometric data in the central portion of the Hundred of Goyder, N.T.	Y. MIEZITIS
1967/154	The Woodcutters L5 Prospect, Rum Jungle area, N.T.	P.W. CROHN, W.J. LANGRON, C.E. PRICHARD

1968/7	Geochemical and radiometric investigations Rum Jungle East, N.T., 1967 (Area 44 Extended, and Coomalie Gap West, northern section)	D.G. SEMPLE
1968/8	Geochemical and radiometric investigations Acacia area, N.T., 1967	D.G. SEMPLE
1968/22	The geology of the Proserpine 1:250,000 Sheet area, Queensland	D.E. CLARKE,[1] A.G.L. PAINE, A.R. JENSEN
1968/25	Programming helicopter operations in New Guinea, Sepik Party, 1967	D.B. DOW
1968/26	Igneous and metamorphic rocks of the southern part of the Cape York Peninsula, Queensland	D.S. TRAIL, I.R. PONTIFEX, W.F. WILLMOTT, W.D. PALFREYMAN, W.G. WHITAKER[1]
1968/30	Catalogue of radiometric age determinations carried out on Australian rocks in 1966	Compiled by R.W. PAGE
1968/48	The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula, Queensland	W.G. WHITAKER[1] W.F. WILLMOTT
1968/63	The use of helicopters in geological mapping in Papua-New Guinea	H.L. DAVIES, D.B. DOW
1968/79	Regional and economic geology of the Herberton-Mount Garnet area, Herberton Tinfield, North Queensland	D.H. BLAKE[4]
1968/114	Probable carbonatites in the Strangways Range area, central Australia	P.W. CROHN, D.C. GELLATLY

IN PREPARATION

1968/66	Eastern Papua reconnaissance geology	H.L. DAVIES, I.E. SMITH, G. CIFALI, D.J. BELFORD
1968/80	The geology of the South Sepik region	D.B. DOW, J.A.J. SMIT, J.H.C. BAIN, R.J. RYBURN
1968/101	Resident geological section, Tennant Creek, minor investigations: Bishops Creek area; Three Keys Goldmine; Skipper Extended Goldmine; Comet Reserve; Hopeful Star Extended; and Cu prospect 21m S.W. of Banka Banka Homestead	B.A. TAPP, A. TAUBE
1968/102	Summary of B.M.R. exploration - Rum Jungle 1968	P.W. CROHN, C.E. PRICHARD, J.E.F. GARDENER
1968/117	The geology of the Auvergne 1:250,000 Sheet area (Victoria River Basin), N.T.	I.R. PONTIFEX, C.M. MORGAN, I.P. SWEET, A.G. REID
1968/121	Annual Summary of Activities, Geological Branch, 1968	
1968/124	Cross-bedded tidal megaripples from King Sound, Western Australia	D.C. GELLATLY
1968/126	The older Precambrian geology of the Lennard River 1:250,000 Sheet area, SE 51-8, Western Australia	D.C. GELLATLY, J. SOFOULIS,[2] G.M. DERRICK, C.M. MORGAN
	Proterozoic palaeocurrent directions in the Kimberley region, Western Australia	D.C. GELLATLY, G.M. DERRICK, K.A. PLUMB
	The Pillara Range Precambrian inlier Noonkanbah Sheet area, Western Australia	J. SOFOULIS[2], D.C. GELLATLY
	Geology of the Yampi 1:250,000 Sheet area, Western Australia	J. SOFOULIS[2], D.C. GELLATLY,[2] G.M. DERRICK, R.A. FARBRIDGE[2], C.M. MORGAN

The Precambrian geology of the Oscar Range inlier, Lennard River Sheet area, Western Australia	D.C. GELLATLY, G.M. DERRICK
The geology of the Charnley 1:250,000 Sheet area, Western Australia	G.M. DERRICK, D.C. GELLATLY, J. SOFOULIS[2], R. HALLIGAN[2]
Chromiferous ultrabasic rocks near Eastman's Bore, Mount Ramsay 1:250,000 Sheet area, Western Australia	D.C. GELLATLY, J. SOFOULIS[2]
Explanatory notes on the Medusa Banks 1:250,000 Geological Sheet SD 52/10, Western Australia	K.A. PLUMB, W.J. PERRY
Textures and genesis of the Narlarla lead-zinc ores, Lennard River Sheet area, Western Australia	D.C. GELLATLY
The geology of the northern part of the Victoria River Basin, N.T.	C.M. MORGAN, I.P. SWEET, I.R. PONTIFEX, J.R. MENDUM
Revised stratigraphic correlations in the McArthur Group, Carpentaria Proterozoic Province, N.T.	K.A. PLUMB, M.C. BROWN
Stratigraphy and sedimentology of the Barneys Creek Formation, McArthur River, N.T.	M.C. BROWN
Probable carbonatite from the Strangways Range area, central Australia. Part 2 - Petrography	D.C. GELLATLY
The geology of the northern half of the Bowen 1:250,000 Sheet area, Queensland (with additions to the geology of the southern half)	A.G.L. PAINE, D.E. CLARKE[1]
Igneous and metamorphic rocks of the Coen and Cape Weymouth 1:250,000 Sheet areas, Cape York Peninsula, Queensland	D.S. TRAIL, W.F. WILLMOTT, W.D. PALFREYMAN, W.G. WHITAKER[1], R.F. SPARK

Geology of the Kubor Range, New Guinea	J.H.C. BAIN, R.J. RYBURN, D.E. MacKENZIE
Traverse equipment used by New Guinea field parties	J.H.C. BAIN
Geology of Eastern Papua, including Normanby Island and the Louisiade Archipelago	G. CIFALI, I.E. SMITH, H.L. DAVIES
Geology of the Gazelle Peninsula, New Britain	R.P. MACNAB
Catalogue of isotopic age determinations carried out on Australian rocks during 1967	R.W. PAGE, Miss R. BENNETT
Studies in the cold extraction of copper, lead, and zinc from geological samples	J.R. BEEVERS
Solubility of apatite	A.D. HALDANE
Synthesis of hydroxy- and carbonate-apatites	A.D. HALDANE
Current practices in the analysis of geochemical prospecting samples	A.D. HALDANE
Adsorption of trace elements onto iron oxides	J. FERGUSON
Geochemistry of Proterozoic carbonate rocks from the Northern Territory	D.W. BENNETT
Miscellaneous chemical investigations carried out in the Geological Laboratory, 1968	
Application of the direct-reading optical spectrograph to the analysis of geological materials, including studies of element behaviour in the arc and of analytical control of rock standards	K.R. WALKER
A petrological and chemical study of the Hart Dolerite, Kimberley District, Western Australia	K.R. WALKER, D.C. GELLATLY, K.A. PLUMB

An eruptiive cycle - Manam volcano.	G.A.M. TAYLOR
An anomalous vent at Wau, New Guinea	G.A.M. TAYLOR
Volcanic activity near Doma Peaks	G.A.M. TAYLOR
Installation of a telemetered seismic network at Rabaul	G.A.M. TAYLOR
Rabaul crustal study	Geophysicists, G.A.M. TAYLOR
Karkar volcano	G.A.M. TAYLOR

MAPS AND EXPLANATORY NOTES

(1968 progress indicated by underlining)

1:250,000 Sheet area	Map: Field Work	Map: Prelim. Edit.	Map: Coloured Edit.	Explanatory Notes: Authors	Explanatory Notes: Record	Explanatory Notes: Publication
Arnhem Bay-Gove	1962	1964	Issued	Dunnet, D.	1964/62	Issued
Blue Mud Bay - Port Langdon	1962	1964	Issued	Plumb, K.A., Roberts, H.G.	1964/67	Issued
Gordon Downs	1962	1963	Printed	Smith, J.W., Gemuts, I.[2]	1963/120	In press
Dixon Range	1962/63	1964	Printed	Dow, D.B., Gemuts, I.[2]	1964/56	In press
Lissadell	1963	1964	Printed	Dunnet, D., Plumb, K.A.	1964/70	In press
Cambridge Gulf	1963	1966	Being fair drawn	Plumb, K.A., Veevers, J.J.	1965/174	With editor
Lansdowne	1964	1965	Printed	Gellatly, D.C., Derrick, G.M.	1965/210	In press
Mount Ramsay	1964	1966	Printed	Roberts, H.G.,[2] Halligan, R.A.,[2] Playford, P.E.	1965/156	In press
Mount Elizabeth	1965	1967	Being fair drawn	Roberts, H.G., Perry, W.J.	1966/136	With editor
Ashton	1965	1967	Being fair drawn	Derrick, G.M.	1966/81	In press
Drysdale-Londonderry	1965	1966	Being fair drawn	Gellatly, D.C.,[2] Sofoulis, J.	1966/55	In press
Medusa Banks	1965	Being compiled	-	Plumb, K.A., Perry, W.J.	In preparation	-

Montague Sound	1965	1967	Corrections in progress	Allen, A.D.[2]	1966/201	Being compiled
Prince Regent-Camden Sound	1965	1967	With editor	Williams, I.[2]	1967/38	With editor
Charnley	1965/67	Being compiled	-	Gellatly, D.C.,[2] Halligan, R.A.	Being written	-
Lennard River	1965/67	Being compiled	-	Derrick, G.M.,[2] Playford, P.E.	1968/126	-
Yampi	1966/67	Being compiled	-	Sofoulis, J.,[2] Gellatly, D.C.	Being written	-
Townsville	1960-63	1966	Ready for printer	Wyatt, D.H.[1]	1965/159	In press
Hughenden	1963	1964	-	Paine, A.G.L., Vine, R.R.	1965/93	-
Charters Towers	1963-64	1966	With editor	Clarke, D.E.[1]	1967/104	With editor
Ayr	1964	1966	Printed	Gregory, C.M.	1966/68	In press
Bowen	1961 and 1964/65	1967	-	Paine, A.G.L.	Being written	-
Proserpine	1962 and 1965	1968	Being corrected	Paine, A.G.L.	1968/22	Being compiled
Walsh (part)	1966	1968	-	Trail, D.S., et al.	1968/26	Not planned at this stage
Hann River (part)	1966	1968				
Ebagoola (part)	1966	1968				
Coen (part)	1967	Being corrected		Trail, D.S., et al.	Being edited	
Cape Weymouth (part)	1967	Being corrected				

Torres Strait (part)	1968					
Daru-Maer Island	1968					
Auvergne, N.T.	1967	Being corrected		Pontifex, I.R., et al.	1968/117	
Port Keats	1967-68	Being compiled				
Fergusson River (2nd Ed.)	1957, 1968					
Cape Scott	1968					
Delamere	1968					
Bougainville, N.G.	1965	1966	Issued	Blake, D.H., Miezitis, Y.	1966/62	Issued
Ambunti, N.G.	1966-67	1968				
May River, N.G. (part)	1967	1968				
Wabag, N.G. (part)	1963, 1966	With printer				
Ramu, N.G.	1956, 1962, 1967, 1968	Being compiled				
Karamui, N.G.	1968					

OTHER MAPS

1:500,000 Scale

Katherine - Darwin	Issued 1968
East Kimberley	Issued 1968
Kimberley Basin West Kimberley Burdekin River Region Cape York Peninsula	To be ready by December, 1969
Papuan Ultramafic Belt	To await author's return from overseas

1 inch to 1 mile

Herberton Mount Garnet	Preliminary edition issued 1968
Ravenswood	Preliminary edition almost complete

GEOLOGICAL SERVICES SECTION

GEOLOGICAL SERVICES SECTION

CONTENTS

SUB-SECTION FOR ENGINEERING GEOLOGY AND MISCELLANEOUS INVESTIGATIONS; MAP EDITING AND COMPILATION; INDEXING

STAFF AS AT 1st JANUARY, 1968

E.K. Carter, Geologist, Class IV, Geologist-in-charge of sub-section

D.E. Gardner, Geologist, Class III, Engineering Geology

G.M. Burton, Geologist, Class III, Map editing, map compilation and A.C.T. hydrology

Mrs F.I. Townsend, Geologist, Class II, Technical files

Miss B.K. Graham, Geologist, Class II, Map compilation (main duties with another Section)

I.R. McLeod, Geologist, Class II, Map compilation (main duties with another Sub-section)

E.J. Best, Geologist, Class II, Project Geologist, Corin Dam (under construction)

H.F. Doutch, Geologist, Class II, Map editing, map compilation and A.C.T. Hydrology

Miss L. Yendall (now Mrs Gerdes), Geologist, Class I, Stratigraphic indexing

G.A.M. Henderson, Geologist, Class I, Engineering geology

Miss R.G. Warren, Geologist, Class I, Map compilation and catalogue of A.C.T. building stones

Mrs C.E. May, Geologist, Class I, Petrography and testing of building stones

Mrs L.E. Walraven, Geologist, Class I, Stratigraphic indexing

D.A. Buchhorn, Geologist, Class I, Engineering geology

J.R. Mendum, Geologist, Class I, Engineering geology

5 field hands

The following University vacation students were employed during the 1967-68 summer vacation, for various periods: D.N. Carter, N. Christiansen, G.E. Holt, I.D. Loiterton, G.H. McNally, P.R. Murphy, R.C. Price, Miss P.L. Bockenson and N. Williams.

I.S. Cumming, who was Project Geologist during construction of Port Moresby No. 2 power station, was appointed to the engineering geology staff of the Resident Geological Section, Port Moresby, with effect from 1st January 1968.

Changes during the year

Miss P.L. Vockenson was appointed Geologist, Class I, on 1st February and has since worked on map editing and A.C.T. hydrology.

J.R. Mendum returned to the Metalliferous Section on 26th April.

Mrs F.I. Townsend retired on 30th April. Since then Mrs Walraven has worked on both technical files and stratigraphic indexing.

E.J. Best was on recreation leave and leave without pay from 20th May to 19th July.

G.M. Burton was on an Overseas Study Tour from 18th June to 16th August.

D.A. Buchhorn resigned on 12th July.

Mrs L. Gerdes was on leave from 17th July to 21st October.

A. Schuett, field hand, was appointed Technical Assistant, Grade 2, on 1st August.

Mrs C.E. May resigned on 9th October.

D.E. Gardner was on recreation leave from 30th September to 8th November.

In the first five months of the year assistance was given by M.A. Randal and T. Quinlan in coping with the large increase in demand for hydrological services brought about by the drought in the A.C.T. and surrounding districts.

ACTIVITIES AND PROGRAMME FULFILMENT

A general account of the functions and activities of the sub-section is given in the Summary of Activities for 1967 (Record 1967/134, pp 72-73) and need not be repeated, at least so far as functions are concerned.

In the area of engineering geology no field activities, apart from those of the supervising geologist, were undertaken away from the A.C.T. & environs; this situation reflects, particularly, the growth of the Port Moresby engineering geology group. Services programmed for the Northern Territory were not performed because confirmatory advice was not received from the Water Resources Branch, N.T.A. In any event, lack of staff would have prevented a systematic investigation of Nancar damsite, Daly River. With the completion of Corin Dam, A.C.T., and Port Moresby No. 2 hydro-electric station, P.N.G., the group's participation in active construction work ceased; the specially-created construction position for the Rouna (Port Moresby) project lapsed on 31st December 1967. The geological construction completion report on Corin Dam should be finished by 25th November. The year saw a continued growth in the use of the seismic timers for foundation investigations, and reinforced the need for technical staff positions in the group.

Investigations of materials resources and quality occupied less of the group's time than in previous years. All major investigations were completed on schedule but some projects have taken longer than expected, owing to other commitments or additional work needed. The North Molonglo outfall sewer investigation has been planned, but not started, as funds have not yet been made available for drilling; some detailed geological work has been done.

The A.C.T. Hydrology group's work was substantially increased by the drought that affected the A.C.T. and environs in the early part of the year but services required were provided by temporary assistance from other sections.

With the addition of Miss Vockenson to the map editing staff that group has been able to handle maps submitted to it without recourse to contract map editing.

As generally happens, partly due to reliance on other organizations and partly due to the amount of trial and error involved, most of the map compilation projects have extended beyond the programmed date. However, substantial progress was made during the year, as shown by the drafts of several maps displayed at meetings in Australia and Overseas.

Staff vacancies in the indexing positions were such that little could be achieved beyond maintaining routine work. Improvements were made in the services provided by the stratigraphic index but little progress was made with Fascicule 5H of the International Stratigraphic Lexicon.

As in other years, serious delays have occurred in the editing of Records by the supervising geologist; attempts are being made to overcome these delays.

RESUME OF ACTIVITIES NOVEMBER-DECEMBER 1967

Engineering geology services and investigations continued as required and, in the A.C.T., several new investigations were started. By the end of the year the embankment of Corin Dam was virtually complete, and construction of the spillway water-deflector, the spillway lining, the plug for the diversion tunnel and the bridge to the valve tower was in progress. The project geologist, during the two months, mapped spillway foundations, analysed grout consumption and started the completion report. The reservoir area for Coree damsite, Cotter River, was mapped, and mapping of the proposed damsite was begun.

Plane tabling of the proposed damsite and mapping of the reservoir area for Tuggeranong damsite, on the Murrumbidgee River, were started. A report on the geology of the route of the Bendora water main was almost finished.

Urban development area mapping included further work in the Weston Creek area and in the Belconnen District where two map sheets were finished and vacation students started six others.

Building investigations included the site of a proposed Conference Centre near the Albert Hall, Yarralumla, the Woden Town Centre, and inspections of several other building sites or excavations.

Work on construction materials included the inspection of a building stone quarry near Mount Stromlo, inspection of a brick shale quarry near Sutton, N.S.W., where the presence of lime was causing trouble, and further work on two reports - the testing of slate and a catalogue of building stones used in Canberra. Petrographic work included a study of slides of crystal tuff from the Belconnen area and specimens from Tuggeranong damsite.

Routine hydrological observations were maintained. In addition, 3 bores were sited and 3 other sites inspected, 8 enquiries on groundwater were handled; technical advice was given to the Departments of the Interior and Supply on a water supply problem, possibly involving litagation, at Honeysuckle Tracking Station. Two talks were given by Mr Burton on the ABC Rural programme. Further work was done on drainage problems in the Weston Creek and Woden areas and at Forrest School.

In Papua-New Guinea most of the civil construction work for the No. 2 underground Port Moresby Hydro-electric Power Station, at Rouna, had been completed and No. 1 generator had been commissioned by the end of the year. Remaining civil work included work associated with the installation of two additional generator sets, the left-hand cut-off walls for the diversion weir, and general site development. I.S. Cumming provided the necessary geological services and also logged the drill core and supervised the water pressure testing for the stage two design investigation for Sirinumu Dam, on the Laloki River.

During November and December the map editing and compilation group completed the edit of five 1:250,000 map sheets for the standard series and did work on three others. Compilation work continued on the metallogenic map of Australia, scale 1:5,000,000; geological map of the World: Sheet 15 - Australia and Oceania, scale 1:10,000,000; tectonic map of Australia, scale 1:5,000,000 (for the Geological Society of Australia); and further assistance was given with the compilation of the morpholithological map of Australia (by Land Research Division, C.S.I.R.O. for the Australian Water Resources Council).

Stratigraphic indexing and technical files were maintained as resources permitted.

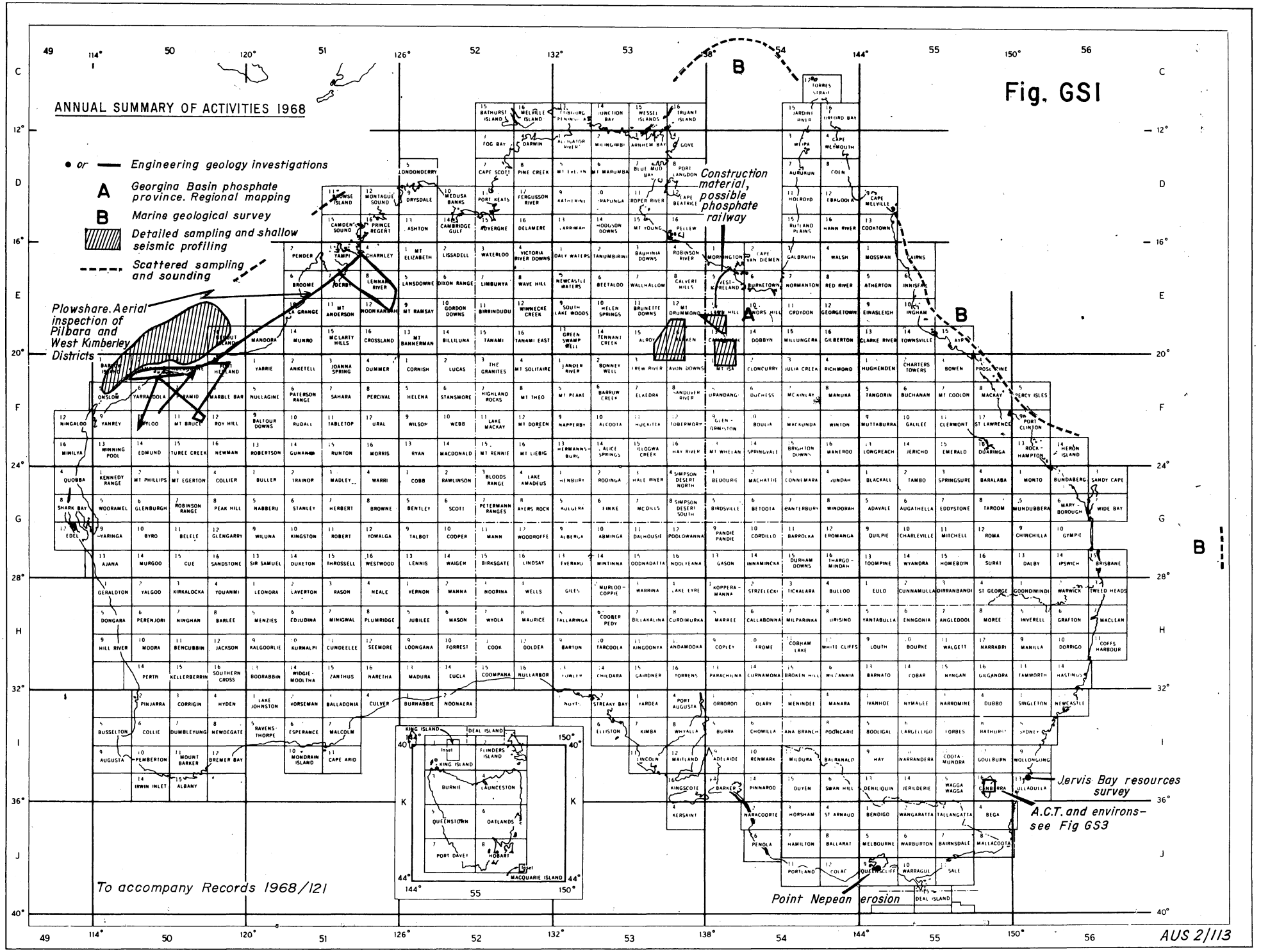
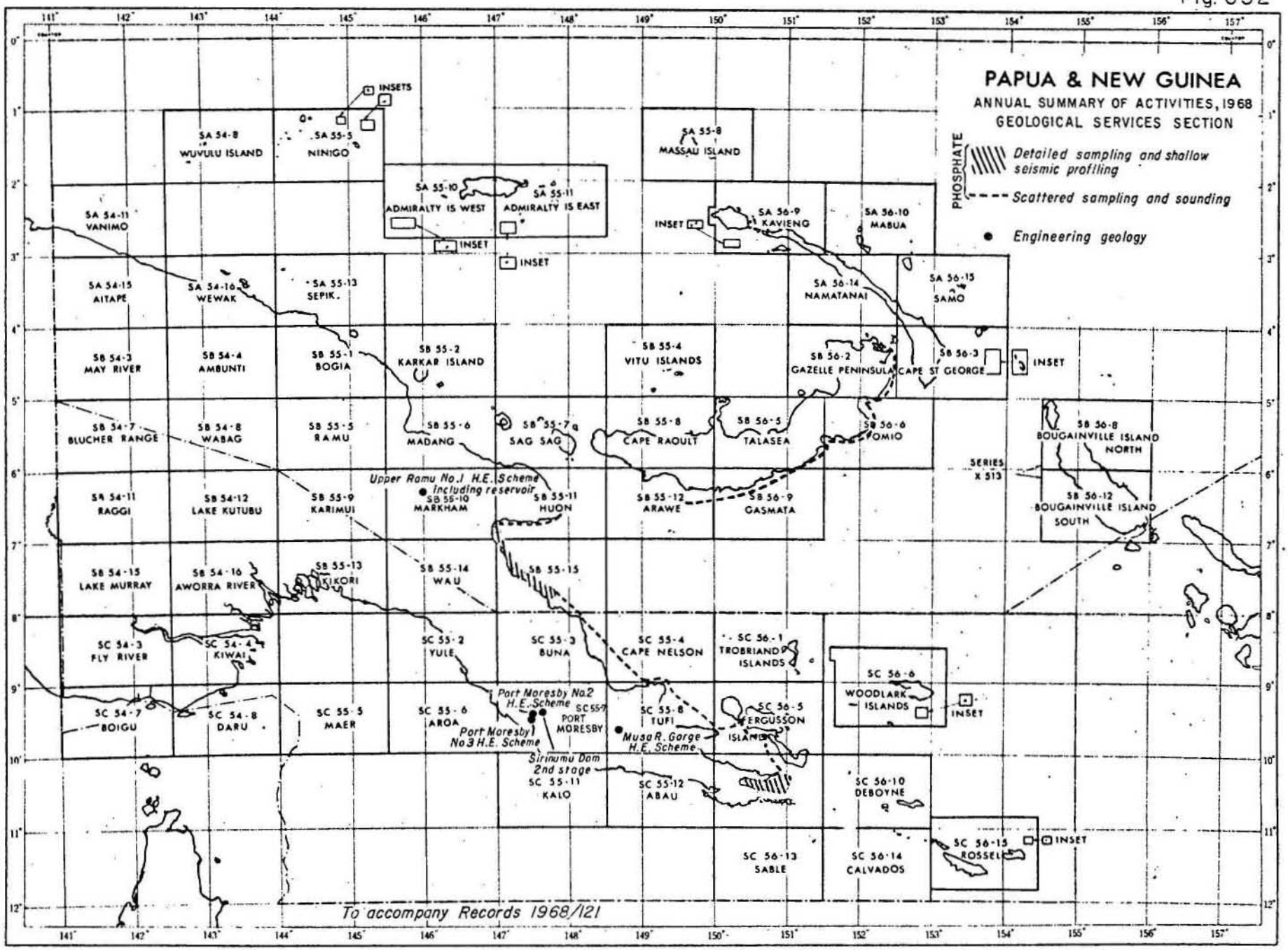


Fig. GSI
ANNUAL SUMMARY OF ACTIVITIES 1968
• or — Engineering geology investigations
A Georgina Basin phosphate province. Regional mapping
B Marine geological survey
Detailed sampling and shallow seismic profiling
Scattered sampling and sounding
Plowshare. Aerial inspection of Pilbara and West Kimberley Districts
Construction material, possible phosphate railway
Jervis Bay resources survey
A.C.T. and environs – see Fig GS3
Point Nepean erosion
To accompany Records 1968/121
AUS 2/113

Fig. GS2



Engineering geology investigations. Essentially by Port Moresby Resident Staff with supervision from Canberra Projects handled entirely by Port Moresby staff not shown

ENGINEERING GEOLOGY

(See Figs GS1 & GS2)

AUSTRALIAN CAPITAL TERRITORY (See Fig. GS3)

Engineering Projects

Corin Dam, Upper Cotter River: (E.J. Best - Fig. GS3, locality 1)

The construction of Corin Dam, apart from clean up and landscaping, was completed in March, 1968, and the inlet end of the diversion tunnel was plugged in April to start filling the reservoir - 5 months ahead of schedule. In mid-October the water was at RL 3072.5, 64.5 feet below full supply level. Provision of geological services continued until the dam and associated structures were completed. Regular readings of water table levels have been taken in three observation boreholes during filling of the reservoir. Two of the holes, on the west abutment, give an indication of the water table gradient near the Cotter Fault zone; this is important because the grout curtain below the dam was not extended across the fault zone, and excessive leakage from the reservoir could possibly occur along the Cotter Fault. The third observation hole is located on the east abutment in an area of possible leakage from the Kangaroo Creek arm of the reservoir.

When the reservoir level reached a point half way up the dam, water started leaking from beneath a large spoil heap immediately downstream of the toe of the dam. Although it is likely that the source of water is spring action beneath the spoil and downstream rockfill zone, caused by the reservoir increasing the head on the groundwater, the possibility of leakage through the dam cannot be ruled out. The flow in October 1968 was about half a cusec. An investigation is at present being carried out to determine the leakage path of the water; so far, hydrological, chemical and geophysical methods have been used to provide data for an evaluation of the problem.

Since construction was completed, the contractor has claimed substantial additional payments because, in part, of variations from predicted conditions. An analysis of support requirements in the diversion tunnel has been supplied to the Department of Works to assist in answering the contractor's claim.

A geological report giving full details of the investigation and construction of Corin Dam has been written. Much of the engineering geological information obtained at the site is presented in a series of detailed plans and sections to accompany the report; these form a concise "as constructed" record of the foundation conditions exposed immediately before dam and concrete placement.

Tennent Damsite, Gudgenby River: (D.A. Buchhorn and others - Fig. GS3, locality 2)

Of the three damsites investigated in the A.C.T. in 1967 and 1968 for the next Canberra water supply storage, Tennent damsite is considered, on technical and planning grounds, the most suitable. However, Googong damsite, on the Queanbeyan River (investigated by the Bureau several years ago), has economic and technical advantages over Tennent damsite, and other schemes outside the A.C.T., investigated by the Snowy Mountains Hydro-Electric Authority, may also be economically more attractive.

During the year, the main geological activity was the logging of core from the three diamond drill holes, supervision of water pressure tests and computation of results, check geological mapping, assistance to the Department of Works in the location and evaluation of earth construction materials, and production of the preliminary geological feasibility report (Record 1968/88).

Investigations have shown that the site is suitable for a fill dam 220 feet high, with a spillway to the west of the dam, but considerably more information is needed to assess accurately foundation levels, particularly in the left abutment and for the spillway chute. The whole site is in Tharwa Adamellite which is fresh, tight and strong at river levels but is deeply and irregularly weathered at higher levels, and is extensively faulted in the left abutment. Adequate earth materials for an earth-cored rock-fill dam have yet to be located.

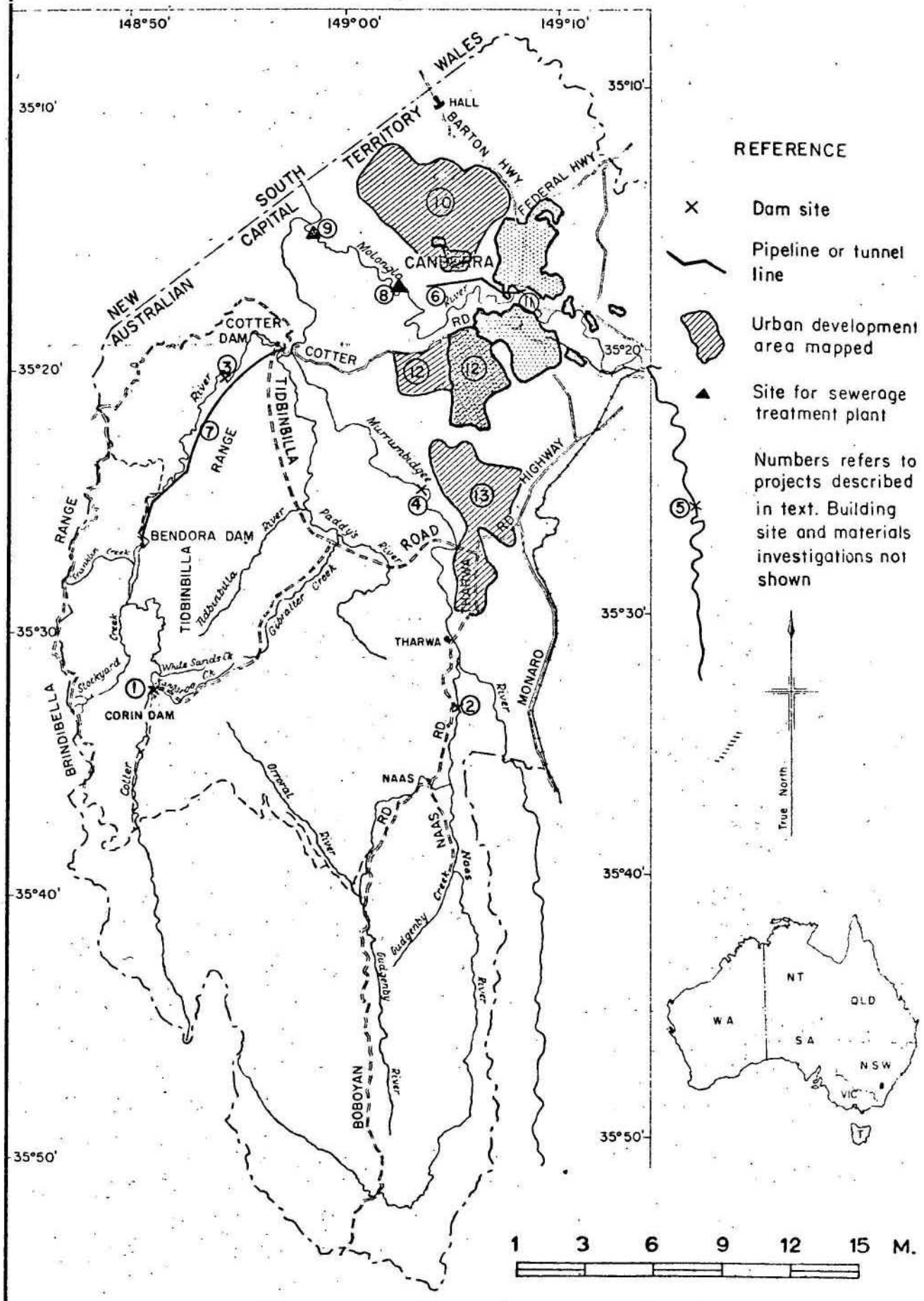
Coree Damsite, Cotter River: (D.A. Buchhorn and others - Fig. GS3, locality 3)

The damsite and two saddles were geologically mapped during the year, five diamond drillholes were drilled and water-pressure-tested, seismic investigations were carried out by C.D.W., and further work was done on possible sources of construction materials.

The dam site and saddles are in Upper Silurian Urriara Volcanics; the rocks are massive dellenitic crystal tuff. Fresh rock is strong and provides both good foundations and sound construction materials. The damsite has fresh, tight rock in the river bed but the upper abutments have sparse to moderate exposures of slightly weathered rock, with moderately to strongly weathered rock between, along joints. Drilling revealed weaknesses in the left abutment caused by weathering and faulting, but the site appears suitable for a variety of dam designs up to 250 feet high. The left hand saddle requires an embankment about 80 feet high; it is deeply and irregularly weathered and appears to be suitable only for an earth or earth-cored rock dam. The right hand saddle, 1400 feet south of the damsite, is suitable for a spillway but extensive excavation would be needed.

Figure GS 3

A.C.T. ENGINEERING GEOLOGY INVESTIGATIONS, 1968



155 A16 507 J.W.C.

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

To accompany Record 1968/121

Most types of construction material should be available within reasonable distance of the site, but suitability and quantities remain to be proved.

The site is less attractive than Tennent damsite on grounds of storage capacity and availability of water. The investigation is reported in Record 1968/98.

Tuggeranong Damsite, Murrumbidgee River: (J.R. Mendum and others; Fig. GS3 locality 4)

The site was geologically mapped between December 1967 and March 1968. No diamond drilling was done as the site is not compatible with urban development plans for Canberra. The investigation was designed to determine the suitability of the site for a dam, roughly 6600 feet long, most of which would be less than 50 feet high but which would be up to 230 feet high in the gorge.

The rock throughout is well-jointed Lower Devonian rhyolite tuff. It is fresh in the gorge but is completely weathered to depths of up to at least 42 feet at other points along the proposed dam axis, for example in the saddles, one of which could serve as a spillway. A report has been written on the investigation but has not yet been processed as a Record.

Googong Damsite, Queanbeyan River: (G.M. Burton; Fig. GS3 locality 5)

Some testing of possible earth core material was carried out by C.D.W., with advice from the Bureau. Testing so far has failed to reveal adequate resources of suitable material.

North Molonglo Outfall Sewer Tunnel: (G.A.M. Henderson; Fig. GS3 locality 6)

Trenches near Commonwealth Avenue were mapped, and mapping was done to locate several major faults accurately. A report on the preliminary investigation was written and is being processed as a Record; the design investigation, to be started shortly, was planned.

Bendora Water Main: (G.A.M. Henderson; Fig. GS3 locality 7)

A report on the geology of the line of the main, as revealed during construction, was prepared for issue in the Record Series.

Building Foundations and Sites for Buildings: (D.E. Gardner, E.J. Best, G.A.M. Henderson)

The following sites were investigated, generally by surface mapping and seismic timer work, and drilling as indicated:

(a) Secretariat Building, Blocks C, D. & E. Construction drillholes were logged. The holes indicated cavernous limestone to depths of up to 120 feet. A report on the pre-construction investigation has been processed as a Record (1968/111).

(b) C.S.I.R.O. Head Office Site, Campbell. The site, in well-jointed Devonian Ainslie Volcanics, was plane-tabled, and a joint analysis was made. Seismic exploration was carried out by the Engineering Geology Group and the Geophysical Branch to determine subsurface conditions for site planning and general building design purposes. A report was written.

(c) Camp Hill area, Parkes, was mapped, seismic surveys were carried out by the Geophysical Branch, and five drill holes were planned and logged to determine general foundation conditions, as an aid to site development. The site is underlain by Lower Silurian State Circle Shale and Camp Hill Sandstone which is extensively weathered to depths of at least 70 feet. A report was written on the investigation.

(d) The Geophysical Branch carried out a seismic survey of the proposed High Court site, Parkes, with assistance from the Engineering Geology Group. A report is in preparation.

(e) Other buildings. More than a dozen other building sites were inspected, generally in the course of construction; rock exposures were mapped in many cases and advice was given as required. Sites examined were in Lyneham, Braddon, Civic, Acton, Parkes, Russell, Reid, Barton, and Phillip.

As a result of site investigations over the last two years, limestone (mainly in the Lower Silurian Riverside Formation) has been detected in the foundations of the Lyneham office blocks, Civic Telephone Exchange extensions, Secretariat building, Ward Bridge, A.N.U., and John XXIII College, A.N.U.

Sewerage Treatment Plants: (D.E. Gardner & others; Fig. GS3 localities 8 & 9)

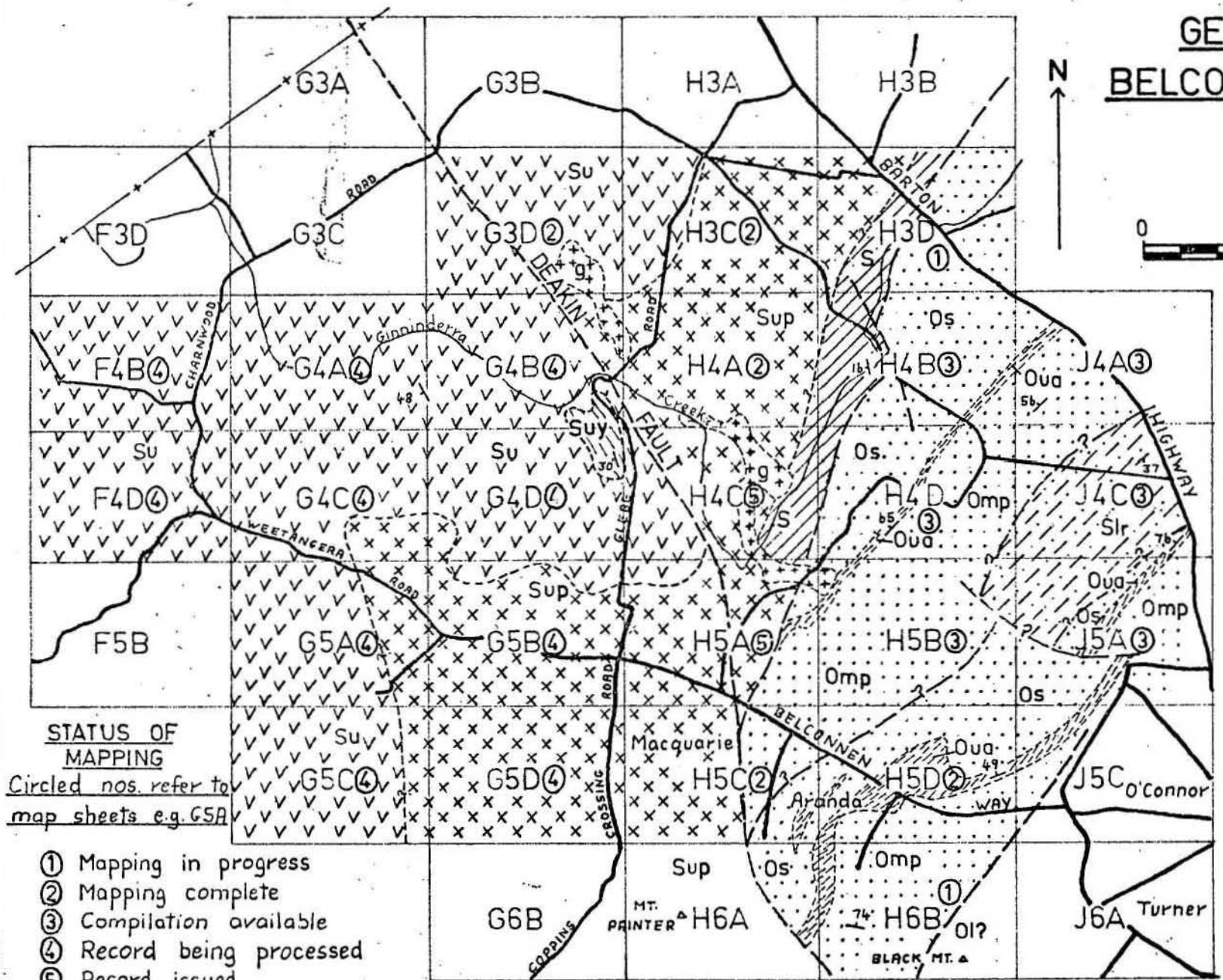
Foundation conditions and amenability to excavation were investigated by seismic timer surveys and geological mapping at two sites near the lower Molonglo River - near Coppins Crossing and at the junction of the Molonglo and Murrumbidgee Rivers. Reports on each investigation were written.

Other Engineering Projects: The core of holes drilled to test foundations for a bridge over Yarralumla Creek was logged, and a seismic survey was made to determine excavation conditions for a pipeline in the Belconnen area.

In addition many exposures in roadworks, including over-passes, were mapped.

Figure GS4

GEOLOGY OF BELCONNEN AREA



Granodiorite
Painter Porphyry
Volcanics
Yarralumla Formation
Riverside Formation
Sediments & volcanics
Sediments
Acton Shale
Pittman Formation
Black Mountain Sandstone
Geological Boundary
Fault, position accurate
Fault, position approximate
Fault, position inferred
Dip & Strike of Bedding

STATUS OF MAPPING

Circled nos. refer to map sheets e.g. G5A

① Mapping in progress
② Mapping complete
③ Compilation available
④ Record being processed
⑤ Record issued

To accompany Record 1968/121

I55/A16/226

Mapping of Development Areas

Belconnen: (G.A.M. Henderson, H.F. Doutch & Vacation Students; Fig. GS3 locality 10)

Substantial progress was made during the year in the mapping of the Belconnen urban district, helped greatly by mapping by students in the 1967-68 summer. The present status of mapping, and the stratigraphy of the area mapped, is shown in Figure GS4. Mapping consisted of both outcrop mapping, on sheets at scale 1 inch to 200 feet, prior to development, and mapping of selected trenches during development. Only marginal areas remain to be mapped and present mapping is being extended south from the development area towards the Molonglo River. Reports have been written on all completed sheets, or groups of sheets, and are being, or have been, issued as Records.

Most of the area mapped is underlain by Upper Silurian Volcanics (generally acid crystal tuffs) or high-level intrusive equivalents. Generally the only reliable distinction between intrusives and volcanics lies in field relationships, which are rarely clear; consequently detailed stratigraphy and structural relationships cannot be deciphered. Lower Silurian and Ordovician strata lie to the east of the Deakin Fault, mainly in areas mapped in previous years.

Canberra District: (D.E. Gardner; Fig. GS3 locality 11)

Considerable time was spent compiling all available information on the Central Area of Canberra (bounded by Commonwealth and Kings Avenues, Lake Burley Griffin and Capitol Hill) to provide information for planning authorities on foundation conditions within the area. The bedrock of the area is of Lower Silurian Formations - mainly shale and sandstone, but extensive, and commonly cavernous, limestone lenses are known to occur in the western part of the area. The compilation of the map of the area is complete and the report is well-advanced.

Some trenches in the Deakin-Yarralumla area, and outcrops in the western part of Deakin, were mapped.

Woden (including Weston Creek): (D.E. Gardner and students; Fig. GS3 locality 12)

Mapping of the Weston Creek area was extended beyond the Kambah Road and north to join with the Woden area. During the year considerable progress was made with the compilation and interpretation of the geology of the Woden Valley, based on field and trench mapping in past years; some supplementary mapping was done.

The Woden-Weston Creek area consists essentially of Upper Silurian Volcanics, with some recognizable sedimentary and other sequences which should enable the stratigraphy and structure to be interpreted broadly.

Tuggeranong; (D.E. Gardner; Fig. GS3 locality 13)

Reconnaissance mapping was undertaken and a general geological map, largely based on existing maps, was prepared for this proposed development area. The map and report on the engineering geology of the area was issued as Record 1968/75.

Most of the area is underlain by Devonian and Silurian Volcanics; granite occurs a short distance to the south-east.

Materials

The demand for services was noticeably less this year than in past years; enquiries about building stones, from both official and private sources, provided most of the work. A systematic investigation of the materials and groundwater resources of the Commonwealth Territory at Jervis Bay was started in November.

Building Stones: (Mrs C.E. May & Miss R.G. Warren)

A Record (1967/145), on the testing of slate, was distributed. Field inspections were made of a quarry near Mount Stromlo and the northern extension of the Honeysuckle deposit of sandstone. Stone from New Zealand and from Harden was petrologically examined or tested. Numerous enquiries about the suitability of local stone were dealt with and advice was given to C.D.W. architects on the use of stone for extensions to the War Memorial.

Miss Warren examined a collection of building stones held by the University of New South Wales. Progress was made in the preparation of a pamphlet on building stones used in Canberra buildings.

Clay and Shale: (D.E. Gardner; Fig. GS1)

Information on possible useful resources of clay and shale, particularly for brick-making purposes, in the Canberra area was supplied to enquirers. A deposit of kaolin in the Jervis Bay area was investigated; it appears to be a moderate-sized deposit formed by the weathering of a basic dyke.

Aggregate: Advice was given on the suitability of various occurrences of limestone in the Canberra region for use as road and concrete aggregate.

Further discussions were held with C.D.W. and company representatives on the problem at ABM's Federal Highway quarry (see Report for 1967, p. 78).

Sand: Further information was given to the Department of the Interior regarding resources of "red sand". Private enquiries were dealt with.

Drainage: (G.M. Burton, H.F. Doutch, A. Schuett)

A drainage problem in Section 45, Pearce was investigated and reported on, and further work was done on the problem in the Weston Creek area (Sections 2 & 3), at Red Hill Primary School and the Canberra Grammar School. Advice was given to N.C.D.C., about drainage problems in the Belconnen district, and assistance was given to authors of notes on the engineering geology of parts of the Belconnen area.

Petrography: (Mrs. C.E. May)

In addition to petrographic work on building stones, rock specimens from the following areas were identified and, where appropriate, advice was given on their engineering properties: Belconnen, Tuggeranong, Weston Creek, Coree damsite, Mount Painter (all in A.C.T.); Lake George drillhole cores and cuttings; and Musa River Gorge (Papua). An attempt was made to make a systematic study of the extrusive/intrusive and igneous rocks of the Tuggeranong-Weston Creek-Mount Painter-Belconnen area, of Silurian age, but owing to petrological uniformity (most are dellenitic in composition) and lack of close stratigraphic control little progress was made.

Miscellaneous: (E.K. Carter, D.E. Gardner and D.S. Strusz)

Many minor enquiries about the geology and materials of the A.C.T. and environs, and elsewhere, were dealt with. The sections on geology in the Department of the Interior's publication "Lands of the Australian Capital Territory" are being revised and enlarged.

PAPUA-NEW GUINEA (Fig. GS 2)

In 1968 all engineering geological field work was done by staff of the Geological and Volcanological Branch, Department of Lands, Surveys and Mines, Port Moresby. E.K. Carter, in Canberra, provided technical supervision and maintained liaison with the head office of the Commonwealth Department of Works, Melbourne. Activities for the year are described in the report of the Senior Resident Geologist, Port Moresby; further, an outline of all but one of the schemes referred to below has been given in previous Annual Summaries of Activities. Only brief accounts are therefore given below.

Port Moresby No. 2 Hydro-Electric Power Station Laloki River (I.S. Cumming)

By the end of March all major civil engineering works were complete and geological services were no longer required. The geological completion report on the construction of the power station and ancilliary structures is now complete, subject to editing, except for a few minor sections.

Sirinumu Dam, Laloki River, 2nd Stage (I.S. Cumming)

Design investigations for the dam and spillway are complete, drilling having been done by February and exploratory costeans by August. Further field work may possibly be needed on the problem of leakage in the saddle areas on the reservoir perimeter. The geological report on the design investigations is being prepared.

Upper Ramu Hydro-Electric Scheme (J.C. Braybrooke, R.J. Tingey)

The detailed feasibility and design report on the geology of the No. 1 power station, weir and tunnel was issued as Record 1968/144, J.P. MacGregor, in January.

Bedrock exposures in and around the proposed No. 1 reservoir were mapped in April, to define more accurately the distribution of marble which could provide a leakage path from the reservoir. Geophysical work is at present in progress by C.D.W.'s Central Testing and Research Laboratory to give further information. A report on possible leakage from the reservoir will then be written and issued as a Record.

Government approval has not yet been given for the design and construction of any part of the Upper Ramu scheme but construction is not expected to start, in any event, before June 1971.

Musa River Gorge Hydro-Electric Scheme (I.S. Cumming and P.E. Pieters)

In April, inspection was made by helicopter of possible leakage points from the proposed reservoir - particularly Wowo Gap, which was found not to present a problem. Preliminary mapping of the proposed damsite is programmed for later in the year.

Port Moresby No. 3 Hydro-Electric Scheme, Laloki River (E.K. Carter)

The existing No. 1 Scheme, penstock and station were inspected as a preliminary step in a possible investigation directed towards a parallel scheme to the No. 1 scheme, and possible sites for the No. 3 station, just downstream of the No. 1 station, were examined.

Issue of Records

Four reports on engineering geology investigations were received from staff of the Geological and Volcanological Branch for processing as Records. Three of the reports were processed, in whole or part, and three other Records, to which numbers had been allotted in 1967, were issued.

NORTHERN TERRITORY

None of the investigations programmed for 1969 were carried as it was not possible to make the necessary arrangements with the Water Resources Branch of the Northern Territory Administration (now Mines and Water Resources Branch).

Several minor investigations were done by the Resident Geological Section, Darwin.

OTHER PLACES AND GENERAL (E.K. Carter - Fig. GS1)

Standard Code of Practice for Site Investigations

One meeting of special sub-committee No. 3 of the committee of the Standards Association of Australia responsible for preparation of the Standard Code of Practice for Site Investigations was attended in Adelaide, and further contributions were made to the chapter on engineering geology.

Plowshare

E.K. Carter took part in an aerial tour of the Pilbara and West Kimberley districts of Western Australia, in the company of officers of U.S. Atomic Energy Commission, Lawrence Radiation Laboratories and the AAEC. The purpose of the tour was to acquaint the overseas visitors, Mr. J. Kelly and Dr. G. Worth, with conditions and development prospects as they relate to possible uses of nuclear explosives.

Erosion Problem, Point Nepean, Victoria

An inspection of the Point Nepean area was made at the request, and in the company, of C.D.W. engineers to advise on the geology of the area and its influence on the progress of active coastal erosion and on possible remedial action. A report was written.

Construction Materials, N.W. Queensland

Advice was given to a company representative on the availability, quality and distribution of materials suitable for railway construction, in connection with the possible development of phosphate deposits in north-western Queensland.

Conference

A Record by E.J. Best and E.J. Polak was issued on the 5th Australian and New Zealand Conference on Soil Mechanics and Foundation Engineering held in Auckland, N.Z. in February 1967.

HYDROLOGY

AUSTRALIAN CAPITAL TERRITORY & ENVIRONS (G.M. Burton, H.F. Doutch, Miss P. Vockenson, A. Schuett; M.A. Randal and T. Quinlan part time).

The first four months of 1968 were a period of severe drought in the A.C.T. and surrounding districts, with below-average rainfall continuing the pattern of the previous winter and spring. Despite good rains in May the outlook for the pastoral industry is only fair as summer is likely to start with groundwater levels and soil moisture still well below normal. Figure GS5 shows the groundwater behaviour recorded in representative observation bores. The dry conditions imposed a substantial additional load on the A.C.T. Groundwater Party, as evidenced by the number of bores sited. To help cope with the extra work, M.A. Randal and T. Quinlan sited a number of bores during the drought period.

A total of 38 bores were sited (compared with 11 for the same period in 1967); of these at least 22 were drilled and satisfactory supplies were obtained in all cases. Several pumping tests were carried out, and systematic water sampling was continued. Samples were determined by use of a conductivity meter; selected samples were submitted for chemical analysis. A great many enquiries about farm water supplies were dealt with as they were received, and several drainage problems investigated (see under "Engineering Geology").

The drought has also brought to the attention of both the expert and the general public the importance of groundwater as a resource in the Southern Tablelands region. Mr. Burton supplied systematic information on groundwater to the Department of Works (C.D.W.), the Department of the Interior, and the National Capital Development Commission, to assist in policy decisions regarding town water restrictions. He also supplied information to the Australian Broadcasting Commission and the Press on several occasions and gave two radio talks over Radio Station 2CY.

An important development during the year has been the first wide-scale use of a down-the-hole air hammer for drilling hard rock. The use of this tool has permitted the exploitation of water stored in fractures in certain zones of fresh hard crystalline rock, and has led to very substantial increases in yield; the commercial rigs previously available were not able to penetrate thick sections of fresh hard rock. Air hammer drilling was first used in the A.C.T. by the Bureau's Petroleum Technology Section (Mineral Resources Branch).

Three additional observation bores were sited - in the Kowen District and south of Lake George; they were drilled by the Petroleum Technology Section. The holes were logged and equipped with instruments by the A.C.T. Groundwater Party; bores sited for the Honeysuckle and Orroral Tracking Stations and the C.S.I.R.O. experimental farm and drilled by the Petroleum Technology Section were also logged and tested.

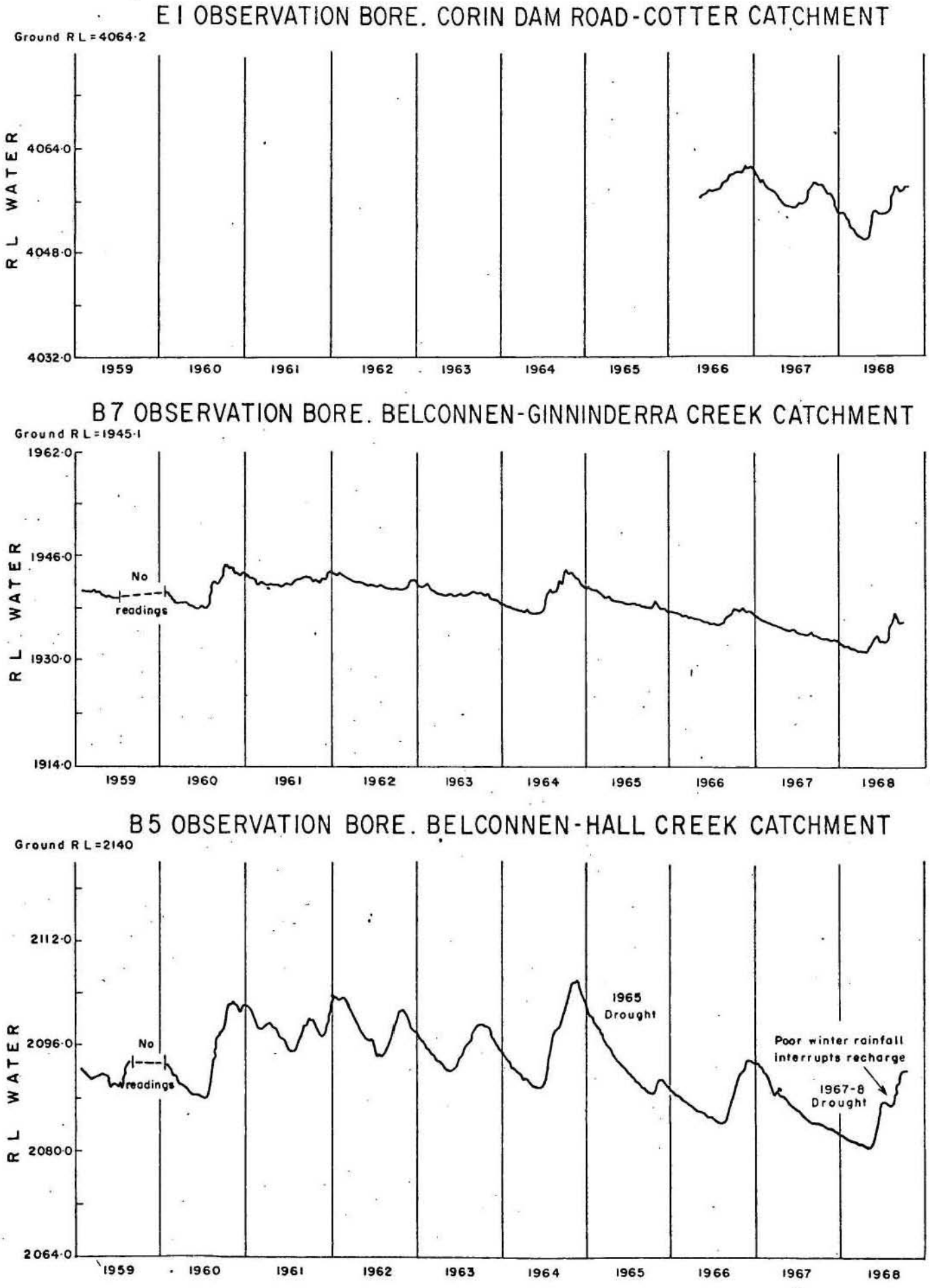


Figure GS 5-A.C.T. Groundwater levels, showing records of three representative observation bores.

To accompany Record 1968/121.

I55/A16/506

Further work was done on the development of a punch card system (for automatic processing) for storage, retrieval and analysis of water quality data (CHEMAN programme).

The group's advice and assistance was also sought in connection with legal difficulties which arose over the use of water from Honeysuckle Creek by the Honeysuckle Tracking Station. As a result an additional drillhole was sited, drilled by the Petroleum Technology Section, tested and equipped.

Lake George has reflected the severe dry conditions. By April it had declined to a depth of 5.58 feet (about 22% of its volume in October 1963); it was at a level of 6.21 at the beginning of October and will probably fall, given a normal summer, to between 2 and 4 feet depth in late February 1969. Routine measurements of lake level and salinity were maintained throughout the year and a warning was issued that the salinity along the western margin in late summer was becoming dangerous for stock. Supplementary measurements were made from time to time and studies of salinity and temperature stratification, seiches and drift of water in the lake were also attempted. The A.C.T. Groundwater Party collaborated with the Airborne Group of the Geophysical Branch in arranging photography of the shores of the lake in May to provide accurate information on shore features and volume of the lake. It is planned to repeat the photography when the lake is at other levels and then estimate deposition of the sediment in the lake since 1902.

A submission has been prepared in support of an intensive study of the rapidly declining lake, which was agreed to in principle at the last Heads of Branches programme meeting in February. The submission is still under consideration.

PAPUA-NEW GUINEA AND NORTHERN TERRITORY

The only activity in groundwater by the sub-section was the processing by the Supervising Geologist of reports for issue as Records. For the Northern Territory, 2 Records (to which numbers were allocated last year) were issued, one was processed and issued, and two are being processed.

Two water supply reports were received from Papua-New Guinea but have yet to be processed.

Opinions on bore sites were placed on the appropriate technical file as they were received from the Senior Resident Geologist, Darwin.

Work by other sub-sections is reported elsewhere.

GENERAL

G.M. Burton was a member of a working group appointed by the Water Research and Education Sub-Committee (for the Australian Water Resources Council) to formulate recommendations on the selection of Representative Drainage Basins for study as an aid to determining the run-off rainfall relation and Australia's water resources.

Relevant sections of the A.W.R.C.'s publication "Australian Activities in Hydrology" were revised for a new issue.

MAP EDITING (G.M. Burton, H.F. Doutch, and Miss P. Vockenson)

The Map Editing Group, which also is involved in map compilation, provides a link between authors, on the one hand, and draftsmen, colour designers and staff responsible for publication, on the other. The group edits all coloured geological and specialist maps for publication by or in co-operation with, the Geological Branch. Most of the maps edited are standard 1:250,000 scale map sheets; preliminary editions of these are not checked by the Map Editing Group. Maps generally receive a first and a final edit.

The Group also co-ordinates and maintains records of the map production programme. By issuing reminders to authors and supervisors it attempts to ensure that programme and contract commitments for fair drawing and printing are met. An important function of the group is the training of junior geologists in techniques of map production and field draftsmen in Bureau requirements in presentation of geological data. Miss Vockenson is preparing a Record on map editing. Mr. Burton acted as organizer and recorder for the Map Committee.

All map editing requirements were met during the year without recourse to contract editing. The table below summarizes the editing performed:

Sheets	First Edit		Final Edit	
	Completed	In progress 31/10/68	Completed	In progress 31/10/68
1:250,000 Sheets	26	1 1 (not started)	20	-

MAP COMPILATION

Geological Map of Australia and Oceania, scale 1:5,000,000 (Miss B.K. Graham)

Sheets 8 and 10 of this 13-sheet map were issued during the year, leaving only Sheets, 1, 9 and 13 to be published. Sheets 9 and 13 are being compiled and published by the New Zealand Geological Survey; compilations, which are long overdue, are still awaited (see Annual Summary for 1967, p. 86) but no report of progress has been received. Little can be done on Sheet 1, the title and general reference sheet, until compilations, with colour guides, for Sheets 9 and 13 are received.

A report of progress was presented to the E.C.A.F.E. meeting of Senior Geologists, held in Teheran in August.

International Geological Atlas: Sheet 15 - Australia and Oceania, scale 1:10,000,000 (Miss B.K. Graham)

Progress on this map is noted in the report of the Sedimentary Basins Section, under "Miscellaneous".

Metallogenic Map of Australia and Papua-New Guinea, scale 1:5,000,000 (I.R. McLeod and Miss R.G. Warren)

The map is being compiled and will be published on behalf of the Sub-commission for the Metallogenic Map of the World of the Commission for the Geological Map of the World. It will be published as one sheet.

Extraction of information from the literature for an overall coverage of Australian mineral deposits has been completed.

The topographic base has been scribed. Inserts at 1:2,500,000 have been included to amplify detail in some of the more complex regions.

A trial draft, showing mineral deposits and provinces and tectonofacies of the insert covering Far North Queensland, and a tentative draft of mineral deposits and provinces for all Australia and T.P.N.G. were prepared in the drawing office for presentation at the ECAFE Conference of Senior Geologists in Teheran (July, 1968) and at the International Geological Congress at Prague (August, 1968). The draft of Far North Queensland was also displayed at a symposium held by the Geological Society of Australia and the Australasian Institute of Mining and Metallurgy in Sydney (September, 1968), where it attracted some valuable criticisms.

Compilation of tectonofacies detail is in progress. Close co-operation and interchange of concepts with compilers of the Tectonic Map of Australia has proved invaluable, as did the symposium on the Tectonic Map held at the Australian National University in May.

Careful and detailed re-evaluation of the draft showing mineral deposits and provinces by comparison with the draft showing tectonofacies is being made to produce a composite draft which will be distributed for criticism by interested parties.

Tectonic Map of Australia, scale 1:5,000,000 (H.F. Doutch and K. Plumb)

Compilation of a new Tectonic Map of Australia was started in 1965 by State Committees of the Geological Society of Australia. The Commonwealth Territories Division Tectonic Map Sub-committee has been co-ordinating State contributions; in 1968 K. Plumb and H.F. Doutch (BMR) and Dr. Rickard (ANU) were responsible for producing a hand-coloured draft at a scale of 1:6,000,000 (excluding New Guinea) for exhibition at a symposium at the Australian National University in May, and at the International Geological Congress, in Prague, in August.

During 1968 the Territories sub-committee has worked closely with the compilers of the Metallogenic Map of Australia. The two maps will show only minor differences of tectonic detail in orogenic belts and basement blocks, but platform (craton) cover will be treated differently.

The Geological Society plans to publish the new Tectonic Map of Australia, including the whole of the island of New Guinea, at a scale of 1:5,000,000, in mid-1969.

A report on progress was presented to the E.C.A.F.E. meeting of Senior Geologists, held in Teheran in August.

Litho-morphological Map of Australia, scale 1:5,000,000 (G.M. Burton)

Further assistance was given to the Land Research Division of C.S.I.R.O. early in the year, in the compilation of this map. The map is now being despatched to the printer.

Groundwater Maps of Australia, scale 1:5,000,000 (G.M. Burton)

A series of four groundwater maps of Australia, to present a variety of data, is to be compiled by officers of State and Commonwealth authorities concerned with groundwater. The compilation is under the direction of a working committee appointed by the Technical Committee on Underground Water of A.W.R.C. Mr. G.M. Burton is convener of the working committee. Work is in progress.

Atlas of Australian Resources

Assistance was given by the Bureau to the Geographic Section, Water, Power and Geographic Branch of the Department, in the production and revision of several maps. Most of the assistance by the Map Compilation Group was in the form of comment on maps and texts.

STRATIGRAPHIC INDEXING (Mrs. L. Gerdes, Mrs. L.E. Walraven)

Indexing of current literature was maintained through the year, and a steady stream of proposed names, submitted for checking of availability, was dealt with. Author cards for new literature references indexed are now circulated to the appropriate State and Territory Surveys. Subject cards are also sent to Tasmania and map reference cards to South Australia. Copies of author, subject and map reference cards are supplied to the Bureau Library. A copy of the register of stratigraphic names was sent to the S.A. Department of Mines, and a list of all Papua-New Guinea references held was supplied to the Senior Resident Geologist, Port Moresby.

Lists of variations to proposed and published stratigraphic names were distributed to interested organizations every second month. It is apparent from the response to these lists that they are serving a useful purpose both in informing workers in geology of changes and proposed new uses of stratigraphic names, and in reducing the use of names without prior clearance or careless use of names.

Little progress was made with Fascicule 5H - Australia, General - of the International Stratigraphic Lexicon owing to lack of staff.

TECHNICAL FILES (Mrs. F.I. Townsend, Mrs. L.E. Walraven)

Recording of unpublished data in the technical file system, which is based on 1:240,000 Sheets, continued as resources permitted. Before the retirement of Mrs. Townsend much of the backlog of work was overcome. Publications on Australian geology for the period 1962-1967 were also indexed.

An average of 2 or 3 people use the technical files each week.

RECORDS OF INVESTIGATION

A total of 17 Records was processed, in whole or part, in the sub-section in the period 1/11/1967 to 31/10/1968. In addition 8 Records which had been processed last year were issued and 8 reports are held for editing and processing. Twelve of the reports processed, or being processed, were written by members of the sub-section, 4 were received from the Port Moresby Resident Staff engineering geology group and one from Darwin. Other minor reports have been received from Resident offices and are being held until grouped into a composite report by the Resident staff concerned, or until a further stage of investigation, e.g. drilling, is completed.

The following Records produced within the sub-section were issued, or allotted numbers, during the last twelve months. Records numbered 1967/135, 1967/145 and 1967/146 were allotted numbers before 1st November 1967 but not issued until after that date. Those marked with an asterisk had been allotted numbers at 31st October 1968 but were not issued by that date.

Rec. No.	Author	Title
1967/135	D.E. Gardner, J.L. McCawley	Unconsolidated sediments of the Pialligo refuse disposal area, A.C.T.
1967/145	C.E. Newbigin	Testing of slate for suitability as natural building stone.
1967/146	L. Yendall, L.E. Walraven, H.F. Doutch	Geological investigations, Belconnen Sheets H4C and H5A, Australian Capital Territory, 1967.
1967/163	E.J. Best & E.J. Polak	Report on the Fifth Australia-New Zealand Conference on soil mechanics and foundation engineering, Auckland, February 1967.
1968/75	D.E. Gardner	Preliminary notes on the geology of the Tuggeranong Urban Development area, A.C.T.
1968/98	D.A. Buchhorn	Geological investigation of Coree Damsite, Cotter River, A.C.T. 1967-1968.
1968/88	D.A. Buchhorn	Geological investigation of Tennent Damsite, Gudgenby River, A.C.T. 1966-1967.
*1968/108	H.F. Doutch	The Ninth International Congress of Soil Science, Adelaide, August 1968.
*1968/110	G.A.M. Henderson	Preliminary geological report on proposed North Molonglo outfall sewer A.C.T. 1967.
*1968/111	E.J. Best & G.A.M. Henderson	Geology and foundation conditions at the Secretariat building site, Canberra.

CONFERENCES AND OVERSEAS VISITS

G.M. Burton was in the United States of America and Canada, on a study tour, from 18th June to 16th August. The purpose of the visit was to study groundwater investigation and map compilation methods, to examine the geological environment of groundwater, to meet experts in hydrology and map compilation and to study the organization adopted by various bodies to handle their work. Organizations visited included the U.S. Geological Survey, California Department of Water Resources, Geological Survey of Canada and Canadian Inland Waters Branch.

A report on the visit is being written.

D.E. Gardner attended a two-day conference and field demonstration on soil testing, held in Melbourne in August.

H.F. Doutch attended the 9th International Soil Science Congress in Adelaide, in August, and took part in the post-sessional excursion from Adelaide to Darwin. He has reported on the conference and excursion in Record 1968/108.

PHOSPHATE SUB-SECTION

STAFF AS AT 1st JANUARY 1968 - professional staff comprised :-

H.A. Jones, Geologist Class IV, in charge of sub-section

F. de Keyser, Geologist Class III, continental phosphate search and leader of Georgina Basin phosphate field party

R. Thieme, Geologist Class I, Georgina Basin field party

R. Geyskes, Geologist Class I, Marine Geology (Recent foraminifera)

F. Walraven, Geologist Class I, Marine Geology (sediments)

One of the Geologist Class III positions in Marine geology was filled by D.S. Trail during the year. P.J. Cook, Geologist Class II, continental phosphate search, is due to return from overseas in November 1968. D. Jongsma, Cadet geologist, took part in the Solomon Sea marine geology cruise and is expected to join the group at the end of the year.

MARINE GEOLOGY

Solomon Sea

The second half of the 1967-68 marine geology survey using the chartered vessel Kos II was carried out from January to March in the south-western, western, and northern margins of the Solomon Sea. Dr. C.C. von der Borch, of the Horace Lamb Centre for Oceanographical Research Flinders University, acted as cruise leader for the first 6 weeks of the survey and he was replaced by Dr. Tj. H. van Andel of Scripps Institution of Oceanography for the last 3 weeks.

The cruise track is shown in Figure GS2 . Four areas were sampled during the survey and each area forms a separate study. The areas were as follows:-

1. The narrow continental shelf between Lae and Morobe on the north-eastern New Guinea coast. (Sediment sampling and shallow seismic profiling).

2. Milne Bay, eastern Papua (Sediment sampling and shallow seismic profiling).

3. Gomwa Bay, Fergusson Island, D'Entrecasteaux Islands (Sediment sampling).

4. Rabaul Harbour, New Britain (Sediment sampling and shallow seismic profiling).

The Lae-Morobe continental shelf is 3 to 5 miles wide and is floored mainly by green argillaceous sediments whose texture and composition can be related to the rivers draining the bordering highlands. The banks near the outer edge of the shelf represent a submerged barrier of mainly dead coral and no traces of phosphatization, were seen.

The sparker survey indicated the presence of deltaic wedges of sediment opposite the mouths of the major rivers exhibiting classical deltaic foreset structures. A thick sequence of bedded sediments of probable Pliocene-Pleistocene age overlies a rugged basement topography and is unconformably overlain by Recent sediments deposited since the late Pleistocene transgression. A submarine canyon off the mouth of the Waria River is entrenched up to 900 feet at its head, in the horizontally bedded Plio-Pliostocene sequence. Another canyon off the Markham River shows indications of large scale slumping near its head.

Milne Bay is a structural depression with a water depth of about 550 metres; it has a relatively flat floor and steep side slopes. The sill separating the basin from the open ocean to the east consists of reef structures. The bottom sediments mainly consist of green muds, and coarse-grained material in the centre of the basin suggests turbidite deposition is active. There is evidence of delta formation by the river system discharging into the western end of the basin.

Gomwa Bay is another steep-sided basin with fumarole activity nearby. Argillaceous bottom sediments include much coarse material, chiefly pumice and glass.

Rabaul Harbour A sparker traverse from the head of Matufi Harbour indicated that it is a volcanic caldera with several hundred feet of horizontally bedded sediments on its floor. Further seaward, towards the main harbour, a sill with the form and internal structure of a volcanic rim was crossed. Bottom samples in Matufi Harbour consisted of blue-green muds and samples with red argillaceous material in the surface layers were also recovered.

N.W. Australian Continental shelf

A continuation of the survey of the sediments, form, and superficial structure of the continental shelf off north-western Australia began on 3rd October and will terminate in mid-December. The motor vessel Espirito Santo was chartered for this work. Terrigenous muds predominate in the near-shore zone in depths of less than 40 metres and calcareous oozes occur on the continental slope to the greatest depths in which sampling was attempted (about 500 metres). The continental shelf itself, from the inshore terrigenous mud zone to the break in slope at about 150 metres depth, is floored almost exclusively by carbonate material although authigenic clays, particularly glauconite, occur with the carbonate locally and traces of phosphatization were also recorded. Non-depositional areas floored by a limestone pavement or partially cemented agglomerations of coral and shell, representing drowned littoral deposits, are widespread.

There is a contrast between the somewhat irregular surface of the outer continental shelf and the fault and slump structures on the continental slope displayed by the northern part of the area surveyed, and the more subdued relief of the area inshore from the Rowley Shoals and southwards. A gentle rise is commonly present close to the outer margin of the shelf.

Torres Strait A sampling and shallow seismic profiling survey was carried out during September in Torres Strait in connection with an investigation being undertaken by the Department of Shipping and Transport on the feasibility of deepening the shipping channel through the Strait to allow the passage of deep-draught ore carriers and tankers. The work was concentrated in Gannet Passage and close to Herald Patches. Both areas are floored by dominantly sandy sediments; in Gannet Passage these sediments are more or less argillaceous and in the Herald Patches area the sand is interspersed with areas of cemented coral and shell debris. No sediments which could be cored by gravity corers were found.

Sparker records indicate that in both areas bedrock lies at 20 to 35 feet below the sea bed along the recommended track for vessels navigating the channels.

Lord Howe Rise Dredging was carried out during September on a sea mount 300 miles east of Brisbane, at approximately 26° 45' S; 159° 30' E, where the Scripps Institution of Oceanography Research Vessel Argo recovered phosphatic material during her 1967 cruise. Only carbonate sediments were recovered and it seems likely that the phosphate dredged up by the Argo is of local occurrence and that no widespread deposit occurs in less than 1000 feet of water. Dredging was also carried out on the slopes of the Capel Bank, a little to the north, and again only carbonate material was brought up.

Gulf of Carpentaria and Great Barrier Reef A series of 17 bottom samples were collected north of the line from Torres Strait to Cape Wessel to supplement the Gulf of Carpentaria collection being studied by Dr Phipps of Sydney University. Nineteen bottom samples were also taken between Capricorn Channel and Torres Strait inside the Great Barrier Reef in connection with a study of Recent foraminifera being undertaken by Dr Palmieri of the Queensland Geological Survey.

GEORGINA BASIN PHOSPHATE PROVINCE

The study of the phosphate province of the Georgina Basin, which had been initiated in 1967 in the Burke River outlier (Duchess), was continued in 1968 with field work in the various phosphatic areas between Mount Isa and the Alexandria region (N.T.). Fossils collected were sent to Canberra for identification. Drilling and coring started on 24th September in the Alexandria-Wonarah-Ranken area, and is expected to be completed by the end of November.

Part of the time of field hands and the Technical Assistant was taken up with the collecting of bore water samples for M. Randal's Hydrological Survey of the Georgina Basin, and with field duties for G. Derrick who visited the Mount Isa - Cloncurry area for one month while making use of the facilities of the Georgina Phosphate Party's base camp.

Personnel: F. de Keyser, R. Thieme; K.J. Armstrong (T.A.); 1 cook, 1 mechanic, 2-3 field hands.

Locality: Base camp at Camooweal, N.W. Queensland.

Scope: The biostratigraphic mapping of the phosphatic units of the Cambrian outcrop areas. The main areas of interest (see Fig. Gs6) were: (a) the Thorntonia-Yelvertoft region (covered by International Minerals Corporation's,Authority to Prospect No. 315M and Continental's,Authority to Prospect No. 375M);

(b) the Border Water Hole - Lawn Hill belt (covered by Broken Hill South, Authority to Prospect areas Nos. 415M, 427M, 469M, 474M);

(c) the Lady Annie - Lady Jane areas (covered by Broken Hill South Authority to Prospect area No. 415M);

(d) the Burton Beds (International Minerals Corporation areas Nos. 303, 364, 366)

(e) the Wonarah Beds (ground held by International Minerals Corporation and Continental Oil).

The last two regions are in the Northern Territory, and are very poorly exposed, and are being drilled to a maximum depth of 750'.

Geology: The geological framework of the phosphogenic areas is shown in Figure GS7. Basically, the lithological succession from the bottom upwards is as follows:

(a) basic volcanics, with some quartzite beds near the top. Local occurrence only.

(b) an irregular layer (not everywhere present) of sandstone, grit, conglomeratic sandstone, basal breccia and conglomerate. Thickness 0'-35'.

(c) dolomite and dolomitic limestone with and without nodules and layers of chert. Overlain by, and interfingering with, beds of unit d).

(d) uneven-bedded chert, nodular chert, siliceous siltshale, limestone with chert layers and nodules. Units (c) and (d) together are more than 500 feet thick where in optimum development.

(e) bedded or flaggy siltstone and fine sandstone with some thin-bedded chert.

(f) grey bedded limestone, silty limestone, marl, and some chert.

(g) sandstone (Split Rock Sandstone) or dolomite (Camooweal Dolomite).

In the Thorntonia-Yelvertoft area, short and local time breaks are indicated by manganiferous and iron-stained phosphatic breccia zones, in which the breccia fragments may be coated and cemented by collophane. A significant time-break appears to be present, on fossil evidence, about 4 miles west of Thorntonia Homestead, where Thorntonia Limestone may be overlain directly by siltstone, chert, and dolomitic limestone of Split Rock Sandstone age.

The geological conditions in the Lady Annie area are very similar to those in the Thorntonia-Yelvertoft area, but units younger than Inca Formation are missing. The contours of the Thorntonia Limestone show abrupt peaks and troughs, the latter filled with earthy phosphorite or phosphatic siltstone with altered chert fragments; this may be a result of solution-and-replacement processes.

The stratigraphy in the Border Water Hole - Lawn Hill belt is essentially the same as in the Thorntonia - Yelvertoft area, though different formation names have been used. The area is of interest stratigraphically as it very clearly shows the relationships between the various facies units (see Fig. GS7). Field observations confirmed beyond doubt that the Camooweal Dolomite west of the head of Ridgepole Creek is younger than Atavus-time; that the dolomites east and south-east of the same creek are lower Middle Cambrian and can be equated with the Thorntonia Limestone; and that the Border Water Hole Formation and Thorntonia Limestone are intertonguing units. Where the Border Water Hole Formation and Currant Bush Limestone pinch out, the Camooweal Dolomite and the Thorntonia Limestone merge together, and cannot be distinguished lithologically.

The Wonarah Beds and Burton Beds are poorly exposed in rubbly outcrops of lateritized and silicified rocks, mostly represented by siltstone and chert (including silicified limestone) at the surface; limestone and dolomite are very commonly present in drill hiles. Because of the poor exposures no meaningful sections could be constructed, and no new data came to light additional to what was already known.

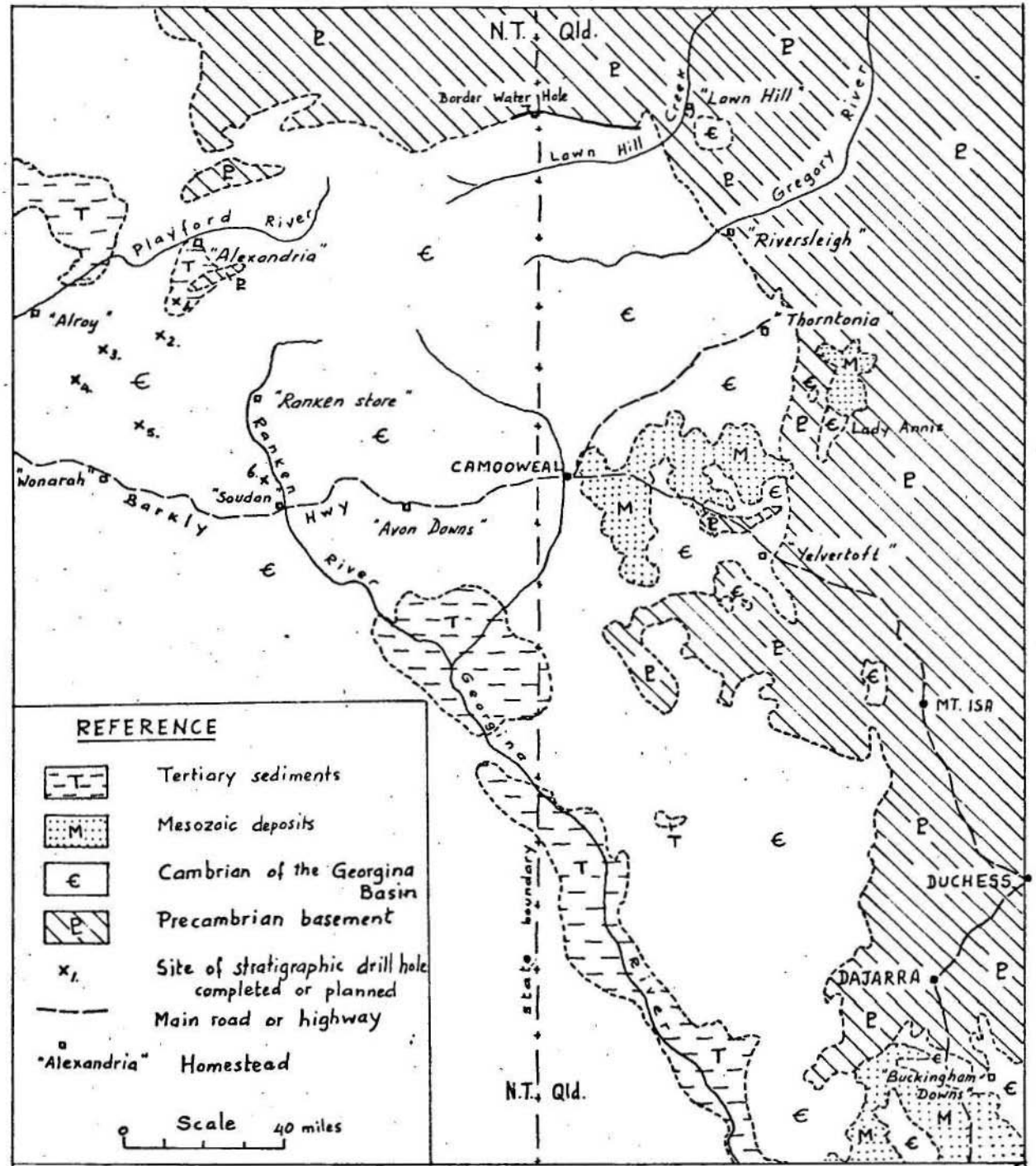


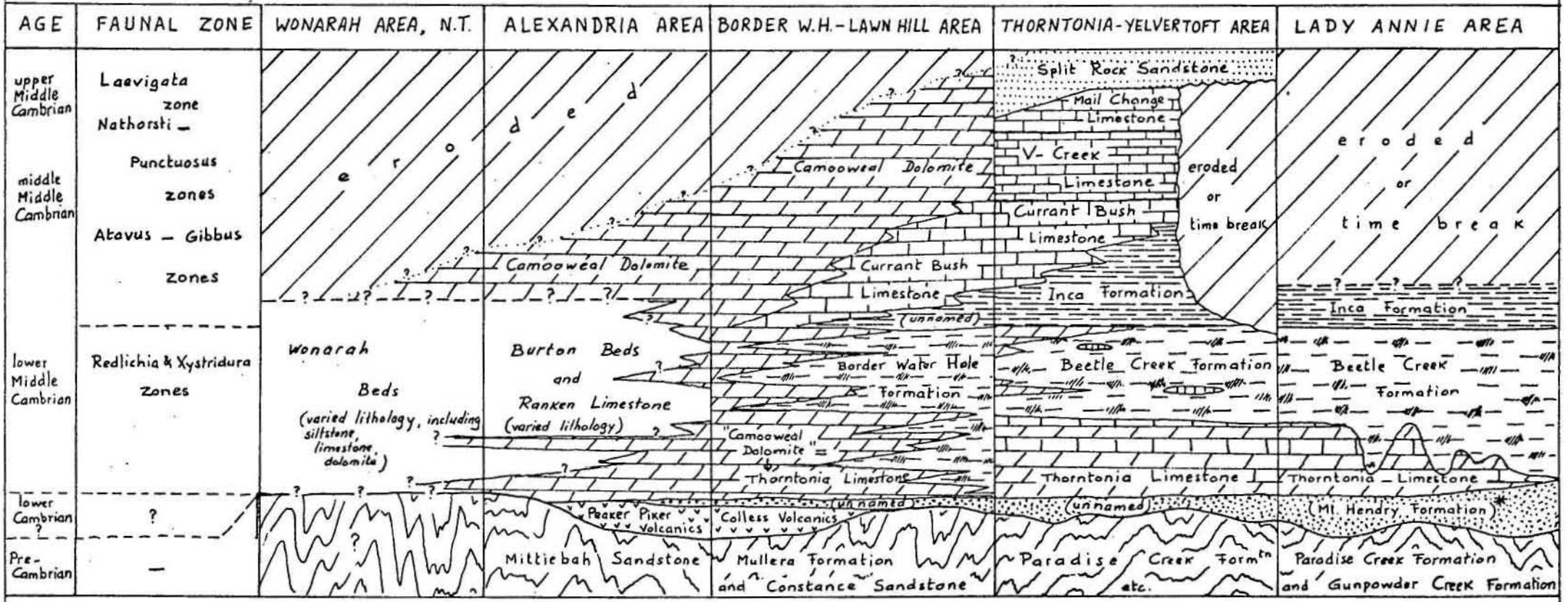
FIGURE GS.6 – LOCALITY MAP, AND DRILL HOLE SITES

To accompany Record 1968/121

Annual Summary of Activities, 1968 - Continental Phosphate

AUS 3/76

FIGURE GS.7 – SUMMARY OF STRATIGRAPHIC RELATIONSHIPS, NORTHEAST GEORGINA BASIN PHOSPHATE AREA



REFERENCE

- sandstone
- limestone, marl, silty limestone, etc.
- dolomite, dolomitic limestone
- siltstone, fine sandstone, thin-bedded chert
- chert, siltstone, siliceous shale
- coarse sandstone, grit, basal conglomerate and breccia
- vesicular and non-vesicular basic volcanics
- Precambrian rocks
- erosional gap or non-depositional break

* Name used by company geologists, but not yet published.

N.B. With the exception of the Cambrian/Precambrian boundary, time lines are represented by horizontal lines. Formation thicknesses not to scale

To accompany Record 1968/121

Annual Summary of Activities, 1968, Continental Phosphate

M(S) 71

In all phosphogenic areas, the phosphorite is accumulated in lower Middle Cambrian formations (Beetle Creek Formation, Border Water Hole Formation, Burton Beds, Wonarah Beds) and in tongues in Thorntonia Limestone that are the lateral equivalents of those formations. The Inca Formation, also, contains small lenses of (detrital?) phosphorite locally near its base, and the dolomites of Thorntonia Limestone and Camooweal Dolomite are commonly slightly phosphatic. The formations younger than Inca, however, are totally devoid of phosphate.

The distribution of the phosphogenic Cambrian outcrops with respect to the Precambrian ridges and "highs", and the type of sediments and fossils, show that the depositional environment favourable for the genesis of the phosphorite was characterized by:

generally more restricted seas than during the succeeding transgressions;
irregular coast line with embayments, lagoons, estuaries; shallow, probably clear water over a shelf area;
slow sedimentation of fine-grained detrital and chemical deposits (chert, silt-shale, limestone), interrupted by short and local time breaks;
copious supply of nutrients, giving rise to an abundance of life.

It appears that the richest phosphorite deposits were formed close to the old shore lines; towards the open sea the grades drop off, the thickness of the stratigraphic section increases considerably, and the depth of burial of the phosphorite beds becomes prohibitive. The phosphorites are predominantly earthy, fine-grained deposits, and the pelletal phosphorites that are so common in the Duchess district are rare in the localities visited in 1968.

Drilling programme

The stratigraphic drilling programme, much delayed, started on 24th September. Five to seven holes are being drilled in the Alexandria - Wonarah - Ranken area (see Fig. GS6) to basement or to a maximum depth of 750 feet, whichever is the lesser. Total footage planned is from 2500 to 3200 feet. Cores are being obtained at suitable intervals.

Contractors: Drilling Services Pty. Ltd., (Darwin-based).
Sub-contractor: Thompson Drilling Pty. Ltd., (Brisbane-based).
Rig: Mayhew 1000.

The hammer-drill technique used produces good-quality, coarse cuttings, which relieves some of the need for drill cores.

TABLE

Bore hole	Location	Formation	T.D.	Generalized log	Cored
Ranken (BMR) No. 1	Lat. 19°16' Long.136°39'	Burton Beds	287'	0 - 20 clay 20'-124' fossiliferous 1st, sandy 1st, dolomitic 1st, some chert.	27' - 29' 6" 65' - 68' 4" 125' - 126' 6" 257' - 262'
		"Camooweal Dolomite"?		124'-284' dolomite	
		Mittiebah Sandstone		284'-287' precambrian quartzite	
Ranken (BMR) No. 2	Lat. 19°25' Long.136°36'	Burton Beds or Wonarah Beds		0 - 30' clayey soil 30 - 50' chert or siliceous siltstone	59'6"-64'6" 197' - 203' 2" 255' - 260' 2"
		Ranken 1st?		50 -295' oobiopelsparite 295'-358' clay-filled cavity	358' - 367'
				358'-480' oobiopelsparite with dolomite stringers	440' - 441'
				480'-580' dolomites	510' - 517' 3"
				580 -593' medium-grained dolomite	593' - 603'
				593 -603' (no recovery)	

RECORDS The following BMR Records were prepared during the year.

1968/43 "Recommendations for future activities in marine geology in the BMR" by Tj H van Andel (restricted)

1968/44 "BMR marine geology cruise in the Solomon Sea" by C.C. von der Borch (restricted)

1968/52 "Cretaceous phosphorites of the Darwin region" by K.J. Kemezys

1968/67 "The Cambrian of the Burke River outlier" by F.de Keyser

1968/84 " A preliminary account of the sediments and morphology of part of the north-west Australian continental shelf and upper continental slope" by H.A. Jones

1968/95 "Recent marine sedimentation on the continental shelf south of Lae, New Guinea", by F. Walraven.

RESIDENT GEOLOGISTS - NORTHERN TERRITORY

The Resident Geologists, Northern Territory, are officers of the Bureau of Mineral Resources seconded to the Northern Territory Administration to provide geological advice and services to Government Departments, the mining industry and the general public. Offices are normally maintained at Darwin, Alice Springs, and Tennant Creek. Due to shortage of staff during the current year, the office at Tennant Creek was closed until the position can be filled. After closure of the office, services from Tennant Creek were provided by the Darwin based staff as the Alice Springs staff remained under strength for the entire period.

STAFF

On 31st December the Resident Geologists consisted of the following professional staff:

Darwin	
R.G. Dodson	Senior Resident Geologist
A.T. Laws	Geologist Class I
M.R. Daly	Geologist Class I
J. Watts	Geologist Class I
Tennant Creek	
Position Vacant	
Alice Springs	
I.G. Faulks	Geologist Class II
D. Grainger	Geologist Class I
R. Shaw	Geologist Class I

A clerical assistant and typist at the Darwin office and a clerical assistant at the Alice Springs office are provided by the Northern Territory Administration.

WATER SUPPLY INVESTIGATIONS

Water supply investigations make up a considerable proportion of the work done by the Resident Geologists. The investigations include the selection of bore sites and hydrological surveys of sedimentary basins. During the year investigations were made for domestic water supplies at Katherine, Alice Springs, Pine Creek, Finke Township, Frances Creek Iron Ore Mine, Maningrida Settlement, Gove, Hatches Creek Wolfram Field, Warrabri Settlement, Elcho Island, Nobles Nob Mine, and Emerald Hill mineral prospect.

Water supply investigations are undertaken at the request of the Assistant Director (Water Resources), Mines and Water Resources Branch, Northern Territory Administration.

SELECTION OF BORE SITES

One hundred and forty-four pastoral bore sites were selected. Advice against six proposed sites was made as they were considered unlikely to yield the required quantities of water. The bore sites are described in minor reports which are made available to the Director, Mines and Water Resources Branch, for use in the issue of bore construction advices to pastoral and agricultural lease holders, and the planning of Government bore holes. The reports include a brief description of hydrological and geological data and a summary of information on the past history of drilling in the location investigated.

The following is a list of localities for which bore sites were selected:

Pastoral Bores

Manbillo	1
Mount Bundey	5
Moroak	4
Benmarra	5
Roper River Mouth	2
Tipperary	1
Kallala	1
Elliot Creek	1
Western Creek	5
Section 349 Hundred of Strangways	1
Dneiper	3
Mount Dennison	4
Lucy Creek	3
Narwietooma	2
Glen Helen Reserve	1
Mount Allan	2
Temple Bar	1
Ooratippra	1
MacDonald Downs	1
Marqua	5
Alice Springs Farm area	2
Bond Springs	2
Henbury	1
Deep Well	3
Haasts Bluff	2
Elkedra	1
Philip Creek	1
Maryvale	6
Wave Hill Station	20
Block 292, Hundred of Bagot	1
Kirkimbie Station	2

Humbert River	9
Killarney	7
Auvergne	5
Willeroo Timber Creek Beef Road	5
Kildurk Station	2
Newcastle Waters Station	12
Cresswell Downs Station	1
Munmalary Station	1
Muckitty	2

Samples from 263 bores were logged. Rock cuttings and soils collected at 5-foot intervals down each borehole are supplied by the Mines and Water Resources Branch drilling section. The specimens are microscopically examined and qualitatively tested for phosphate. Where samples are considered to warrant further investigation, they are submitted for detailed chemical analysis. Data obtained from examination and tests of the borehole cuttings are recorded, indexed and made available to the Bureau of Mineral Resources, Canberra, the Water Resources Section, N.T.A., other Government Departments and to mining companies holding authority to prospect or leases over the areas in which boreholes were put down.

Routine additions were made to the bore data filing system at the Alice Springs office as new information became available.

TOWN WATER SUPPLY INVESTIGATIONS

Katherine

An investigation was made of the Katherine River Valley to establish the feasibility of using infiltration wells near the river as an additional source of water for the town supply. As the area considered is liable to flooding, the scheme was considered unlikely to produce a secure additional source to the town water supply.

A bore site was chosen to provide additional water for the Katherine township. As choice of the site was governed by the necessity for situation close to the Works Department Yard, it could not be chosen in the most favourable site. A yield in excess of 25,000 g.p.h. is required for the additional supply.

Pine Creek

A bore intended to provide additional water supplies to Pine Creek township was sited. The bore will be drilled during the next year.

Francis Creek Mine

Two bores were sited at the Francis Creek Mining township to augment the domestic water supply. In addition a brief survey was made of water supplies available for mining purposes. Approximately 50,000 g.p.h. are required for beneficiation of fine residue ores. Initially a series of pump tests will be made to establish the quantity of water available from existing bores. If the amount falls short of this figure, additional sites for bores will be selected to provide the balance of the required water.

Gove

As part of a plan to provide an adequate water supply for mining and domestic purposes at Gove, production bore 'B' was sited and after completed pump tested to a yield of 18,000 g.p.h. with a 25-foot drawdown. Preliminary analyses indicate a transmissivity of 40-45,000 g.p.d./ft and a storage coefficient of 0.35. Calculations on a distance drawdown plot indicate a theoretical drawdown of about 5 feet. The remaining 20 feet of actual drawdown is attributed to well loss and well inefficiency. It is concluded that the aquifer is unconfined and recharge is from direct infiltration.

In conjunction with the bore pump testing a survey of the Gove area was made to assess the danger of saline infiltration if the aquifer is over developed.

McArthur River

An appraisal of the water supply of the McArthur River area was prepared during the year. No bore data from previous drilling in the area is available but the changes of obtaining a supply of underground water are considered good.

Maningrida Settlement

To augment domestic water supplies, a brief hydro-geological survey was made of the Maningrida Settlement area. Two bore sites were selected.

Hatches Creek Wolfram Field

A report was completed on the availability of groundwater in the Hatches Creek Wolfram Field. It was concluded that a survey of suitable drill sites should be made as prospects of obtaining adequate supplies of groundwater within 25 miles of the mines are small.

Warrabri Settlement

A report on groundwater in the Warrabri area was commenced, but had not been completed by the end of the year.

An analysis of bore data suggests that the groundwater potential is dependent on the extent and degree of interconnection between travertinous limestone aquifers as well as the interconnection between lensoid gravel and sand aquifers. Analysis of pump test data indicates that there is a partial interconnection of the aquifers. The groundwater is of marginal quality for irrigation purposes as the total salt content is high (1200-1400ppm) and there is a medium sodium horizon.

Pine Valley

The water supply investigation at Pine Valley, started the previous year, was completed. Two production bores were completed by February; one at a depth of 480 feet was tested at 12,000 g.p.h. for 10 feet 6 inches drawdown, the second at a depth of 558 feet at 15,000 g.p.h. for a 6 feet drawdown.

Nobles Nob Mine

To determine the feasibility of using groundwater as a water supply source for Nobles Nob Mine, a brief survey was made of the mine area. Initially, a series of bores are planned to test the availability of water along a roughly east-west lineament west of Nobles Nob. Additional bore sites may be chosen after evaluation of yields from the first bores.

Elcho Island

Two bore sites were chosen to provide a domestic, pastoral and irrigation water supply for Elcho Island. A third alternative site was selected for convenience of situation if either of the two sites proves unsuitable.

The first of the bores has been completed, the yield being in excess of 7,000 g.p.h.

Emerald Hill Mineral Prospect

A single bore was selected to provide a water supply for a proposed tin mining project at Emerald Hill. The bore has yielded 7,000 g.p.h., a quantity considered adequate for the initial phase of mining.

MINOR INVESTIGATIONS

Coburg Peninsula

As part of a feasibility study to assess the possible establishment of a woodchip industry in the Northern Territory, an appraisal was made of the available water supplies in the Coburg Peninsula area.

Salt Pans, Roper River Area

An aerial reconnaissance was made of the mouth of the Roper River area to examine a series of salt pans of possible use for extraction of salt from seawater by evaporation. The salt pans in the area were considered unsuitable as they are liable to tidal flooding. Although climatic conditions in the Roper River area are not ideal for the evaporation of seawater, if necessary, a suitable site could be found for use as an evaporation pond to produce salt locally.

IRRIGATION PROJECTS

Daly Basin

Work on the Daly Basin hydrogeological survey was interrupted by heavy and unusually prolonged seasonal rains during the year. By 31st December, six investigation bores had been completed by the drilling section, Mines and Water Resources Branch.

Bore DB 5 was completed at a depth of 450 feet to yield approximately 12,000 g.p.h. Bore DB 6 in highly cavernous limestone has not been fully tested.

Huckitta 1:250,000 Sheet area

A compilation was made of maps illustrating bore data for the area covered by the Huckitta 1:250,000 Sheet. A report on the availability of groundwater in the area is in preparation.

South West Davenport Ranges

Bore data and water samples for conductivity measurements were collected from McLaren Creek, Singleton and Murray Downs Stations.

Lilla Creek and Horseshoe Bend Stations

Work commenced on an appraisal of the availability of groundwater on Horseshoe Bend and Lilla Stations. A preliminary groundwater map of the area covered by the Finke 1:250,000 Sheet was completed but further work has been deferred until the forthcoming year.

Terowie Investigation

An investigation of the groundwater potential of the Mereenie Sandstone was originally planned for the northern side of the Levi Range. A reconnaissance survey proved the inaccessibility of this region to drilling equipment. Accordingly the survey was replanned to investigate the Mereenie Sandstone in the Terowie area, about 3 miles south-east of the Tempe Downs homestead. A total of 14 bores was completed, as production, observation and investigation boreholes.

Wycliffe Well

A preliminary report on the availability of groundwater in the Wycliffe Well area was completed. A drilling programme consisting of 9 bores is recommended, four bores to be put down initially, the remainder to be sited after assessment of data obtained from the first phase of drilling.

Burt Plain

Investigation of the groundwater potential of the Burt Plain area continued as time permitted. During the year, water bore information was collected for bores at Milton Park, Yambah, Narwietooma and Bond Springs Stations for conductivity tests. The investigation will continue during the forthcoming year.

ENGINEERING GEOLOGY

TELEVISION MAST FOUNDATION INVESTIGATION

At the request of the Postmaster General, a geological investigation was made of a site considered for future erection of a television mast. A detailed geological map was prepared and recommendations made for the drilling of a series of shallow test drill holes.

DARWIN ROAD FOUNDATIONS

Following the collapse of sections of bituminised road in Darwin, an investigation was made of the underlying foundations. The collapse was apparently caused by erosional effects of substantial groundwater movement beneath the road surface. The groundwater movement is mainly along joint and fault planes but also along horizons of softer rock particularly susceptible to erosion.

WINNELLIE TANK FOUNDATIONS

A brief investigation was made of the foundation conditions at a site chosen for the erection of a 1,000,000 gallon water tank in the Winnellie area, Darwin. Cores from three shallow drill holes put down to test the underlying rock confirmed the predicted succession to be a capping of Mullaman Beds, overlying blue/grey phyllite of the Noltenius Formation.

The Mullaman Beds at this locality consist of silicified kaolinitic siltstones, generally suitable as a foundation medium.

MINES AND MINERAL PROSPECTS

During the year interest in mineral exploration in the Northern Territory has again increased as geological staffs of companies have been significantly enlarged. Geological and geophysical surveys in areas for which authority to prospect are held have continued from previous years and new work has commenced. Considerable assistance in the form of technical advice and mineral identification was given to company officials and individual prospectors. Further exploratory and proving work has continued at the Tennant Creek field, the manganese deposits of Groote Eylandt, the bauxite deposits of Gove Peninsula, the lead/zinc mineralization in the McArthur River area, and the iron ore at Francis Creek and Mount Bundey. Work by company personnel and Bureau of Mineral Resources Geologists continues in the Rum Jungle area. At the close of the year reappraisals were being made of heavy mineral beach sands, materials for cement manufacture and certain mineral fields which have been neglected for some years. After some years of investigation of clays in the Darwin area by the Resident Geologists, fire brick making has commenced.

Several aboriginal prospectors have been given advice and other assistance during the past year.

IRON ORE

Mount Bundey

A helicopter survey of the Mount Bundey area was made by geologists of the Darwin Resident Staff. Three medium grade iron ore deposits were discovered in the area east of the Mary River but detailed surveys are required before an assessment can be made of the economic significance of this ore.

Daly River Turnoff

A helicopter survey was made of low grade layered iron ore in the Cretaceous sediments west of the junction of the Daly River road with the Stuart Highway. The ore apparently forms a zone in the lower part of the sedimentary succession, and ranges in composition from low to medium grade.

Millers Iron/Manganese Prospect

Preliminary investigation of iron and iron/manganese ore in the Francis Creek area was completed. Following a series of diamond drillholes to test the content and shape of the orebody a programme of wagon drilling was completed. Ore reserves are in excess of 1.4 million tons but further work is required to ascertain the marketability of such ore.

Acacia Gap Iron Ore

A brief survey was made of a reported iron ore prospect in the Acacia Gap area, south of Darwin. The prospect consists of two small outcrops of lateritic iron ore, locally with surface enrichment. No detailed proving work is considered necessary.

COPPER AND GOLD

Tennant Creek Field

'Anomaly No. 4' Burnt Shirt Area

Test drilling of the Anomaly No. 4 continued during the year. Drillhole No. 3 was completed at a depth of 914 feet after intersections of quartz-hematite lodes of 70 feet and 12 feet respectively. Drillhole No. 4 sited vertically to test the lode extension, intersected three quartz-hematite-magnetite lodes of 25 feet, 34 feet and 62 feet respectively. Small amounts of chalcopyrite and bornite and identifiable in core sections. Assay results were still outstanding by the close of the year.

Valuable information about the extent and shape of the lodes was obtained from the results of sixty-one wagon drillholes put down on a surveyed grid over Anomaly 4.

'Anomaly No. 13' Comet East Reserve

A magnetic anomaly to the east of the Comet Prospect was tested by a single diamond drillhole put down to a depth of 940 feet. No quartz-hematite lode was intersected; the anomalous magnetism is thought to have been caused by disseminated magnetite identified in the core. Between down hole depths of 600 and 940 feet, small grains of pyrite and rhodochrosite were identified in cleavage planes. Clusters of fine flecks of a copper coloured mineral in the core from a down the hole depth of 492 feet were identified as phlogopite.

Lone Star Prospect

The Lone Star prospect was surveyed and data from previous geological mapping and four previously drilled holes were compiled.

Nineteen wagon drillholes were sited to obtain information about the subsurface extensions of outcropping lode rock. Drillhole D.D.H. 5 was sited on a magnetic anomaly and by the close of the year was at a depth of 430 feet. A lamprophyre dyke intersected at 344 feet is considered a likely source of anomalous magnetism. Further preparatory work is planned before a following diamond drillhole is sited.

New Hope Prospect

Under agreement with Australian Development N.L. Mines Branch put down a drillhole at the New Hope prospect. The first drillhole was completed at a depth of 1003 feet, having passed through a succession of greywacke and shale without intersecting massive quartz hematite. In the lower part of the succession intersected, the sediments exhibit a progressive degree of metasomatism, suggesting proximity to granite.

Magnetite contained in the greywacke and intrusive lamprophyres are considered to be likely sources of the magnetic anomaly over the prospect.

Jubilee No. 2 (Res. 306)

A diamond drillhole was put down to test anomaly C13, located by a Bureau of Mineral Resources geophysical party. Quartz-hematite lode with sparse copper mineralization was intersected in the 450-475 feet interval. At a depth of 426 feet approximately two feet of core contains native copper.

Further drilling is planned to test the mineralization.

Diamond drilling to test the anomaly C12 had just started by the close of the year.

Anomaly 11 was tested by a series of wagon drillholes put down on a surveyed grid. Quartz-hematite lode was intersected at between 10 and 15 feet below the surface, in four of the holes. The lode appears to be linear with an easterly trend. Further wagon drilling and confirmatory diamond drilling is planned for next year.

Katherine-Darwin Area

Yam Creek Gold Mine

A brief survey was made of the Yam Creek Gold Mine. In the past the prospect was extensively mined. Further work is not recommended.

Katherine Copper Prospect

A copper prospect near Katherine Township was investigated and briefly described. The mineralization is included in rocks of the Burrell Creek Formation, near the contact with rocks of the Antrim Plateau Volcanics. The copper is present as patchy disconnected seams of malachite. Further work is not recommended.

Francis Creek Goldmine

Following a request for assistance by the leaseholder, a report on proposed diamond drilling at the Francis Creek Goldmine was prepared. Four diamond drillholes, each 250 feet in length, are proposed to test the mineral content and thickness of the lode about 300 feet below the collar.

Golden Dyke Mine

A visit was made to the Golden Dyke Mine to examine reported nickel mineralization. The gold-bearing lode does not contain visible mineralization but fine flakes of leached chlorite are believed to have been mistakenly identified as the nickel silicate, garnierite. Slightly anomalous nickel values are present in contiguous amphibolite bodies but the area does not warrant further search for nickel.

Bridge Creek Goldmine

A brief survey was made of the Bridge Creek Goldmine, Howley Siding area. The gold is apparently contained in quartz veins within slates of the Golden Dyke Formation. Much of the area is blanketed by superficial deposits which, judging from efforts of early gougers, contain patchily distributed gold mineralization. Recommendations were made for deep pitting and trenching to expose the solid geology.

Douglas River Copper Prospect

A brief survey was made of a copper prospect near the Douglas River, about five miles west of the Stuart Highway. The mineralization is contained in a calcareous quartz breccia infilling a shear within the Pine Creek granite. The prospect is only patchily exposed and has been somewhat obscured by past gouging operations. The lode is estimated to be over 600 feet long and 3-5 feet wide.

A detailed investigation of the prospect is planned for next year.

Central Australia

Silver King and Clark Mines

The Silver King and Clark Mines were located accurately and briefly investigated. In the past, the Silver King was worked for copper and lead/silver, the Clark mine for copper. Mineralization at both mines is contained in quartz veins believed to be infillings of quartz mica schist.

A mining reserve of ten square miles has been placed around the Clark Mine and a detailed investigation of the prospect has commenced. A survey of the prospect will be made to assess the feasibility of small scale mining by aboriginal prospectors who are already engaged in mining at Mount Hardy. As part of the investigation a series of diamond drillholes are planned to test the mineralization at depth.

White Point, Yuendumu

Two diamond drillholes were put down to test a geophysical anomaly at White Point, near Yuendumu. The first drillhole, sited to intersect an Induced Polarization anomaly established by Australian Geophysical Pty Ltd, reached a depth of 803 feet. The second hole was sited to intersect a zone of weak sulphide mineralization identified in the core of the first drillhole, was stopped at a depth of 301 feet. The drillholes intersected a succession of siltstone, silty dolomite and dolomite with minor intercalations of sandstone and mudstone. Minor concentrations of disseminated pyrite are restricted to the silty dolomite and dolomite. While assay results are incomplete, the highest values for copper and zinc are less than one quarter percent, the highest value for lead is just over two percent.

Glen Helen Copper Prospects

Two small copper prospects were examined a few miles southeast of Glen Helen Homestead. The copper prospects occur in and adjacent to small quartz veins.

Mount Skinner Prospect

A detailed investigation was made of the copper mineralization contained in the Mount Stuart sediments forming the Mount Skinner plateau. Three drillholes were completed, to depths of 231 feet, 250 feet and 1200 feet respectively. The copper mineralization is contained in horizons of fine to medium grained grey-green sandstone and siltstone with rare mineralized quartzose partings. The quartz stringers contain disseminated pyrite and chalcopyrite but analyses values seldom exceed .2% copper for the mineralized intervals.

TIN

Katherine-Darwin Area

Burrundie-Spring Hill Prospects

Three small tin prospects in the Burrundie Spring Hill area were examined. Cassiterite occurs in lenses of quartz about 6 inches wide. The lenses are conformable with the country rock, slates of the Golden Dyke Formation.

Central Australia

Mount Allan Tin Prospect

A preliminary report on a tin mine near Mount Allan was completed. Aboriginal prospectors are obtaining the cassiterite from a highly weathered pegmatite and overlying eluvium. Further work on the prospect is recommended.

TANTALUM

Mount Skinner Tantalite Prospect

The Mount Skinner tantalite prospect, also known as the Utopia Prospect, was investigated. Tantalite is a rare constituent of zoned tourmaline muscovite-felspar-quartz pegmatite veins which cut muscovite biotite gneiss. Future prospecting is recommended in eluvial and alluvial deposits, immediately east of known tantalite bearing pegmatite veins. Further work on the pegmatite is not recommended.

GYPSUM

Titra Well

To investigate gypsum deposits of the Titra Well area, Alice Springs district, five diamond drillholes totalling 317 feet were put down by Mines Branch. Because of the soft earthy composition of the gypsum, recovery was poor, ranging from 5% to 70% of core.

Seed gypsum up to 30 feet thick forms a roughly horseshoe shaped dune at Titra, approximately 1½ miles across. The gypsum accounts for between 65 and 95% of the dune, iron stained quartz grains forming the remaining mineral constituents of the unconsolidated sediments. Kope (earthy gypsum) occurs as a thin discontinuous layer over the dune to a maximum depth of about three feet. In the low lying area inside the dune, kope overlies a highly porous zone of interlocking crystals of gypsum. A report on the gypsum is in preparation.

LIGNITE

Santa Theresa

Three holes totalling 1211 feet were drilled near the Santa Theresa mission, Alice Springs district, by Mines and Water Resources Branch drilling section to investigate the occurrence of lignite first recognized in cuttings from water bores in the area. The drillholes penetrated a succession of grey sandy clay, fine sand, black clay and thin beds of lignite. Due to the friable condition of the sediments, core recovery was not good, with an average of about 40%. The deepest hole (D.D.H. 2, total depth 535 feet) intersected numerous thin seams of lignite up to ½ inch thick. The most important horizons of lignite in each hole were as follows:

Drillhole No.	Total Depth	Most important Intersection Interval	Total thickness of lignite in Interval
1	275	90 - 100 feet	7 feet
2	535	90 feet 190 feet	4 inches 18 inches
3	401	138 - 145 feet	1½ inches

A report is in preparation.

MATERIALS FOR THE MANUFACTURE OF CEMENT

In response to three separate enquiries during the year, company officials were conducted to deposits of clay and limestone which may be suitable for cement manufacture. A detailed investigation of limestone available in the Darwin area is planned.

Limestone outcropping near the Daly River road in intersection with the Stuart Highway was briefly investigated but in view of the high (8%) magnesia content proved by analysis, no further work at this locality is recommended.

GRAVELS AND SANDS

Throughout the year assistance was given to local authorities and Government Departments in locating sands, gravels, and rock ballast, suitable for use in road making, minor dam construction and bridge-making.

GEOCHEMICAL SURVEYS

MARY RIVER RESERVE

Analysis results of samples collected by auger drilling on a surveyed grid in the Mary River Reserve revealed anomalous mineralization both along a gossan and to the north and south of the gossan. The anomalies coincide with self potential anomalies established by a geophysical survey conducted by a Bureau of Mineral Resources geophysicist. Neither the geochemical nor the self potential anomalies are closed. Further detailed surveys are recommended to establish the extent and shape of the anomalies before confirmatory diamond drilling is attempted.

BISHOP'S CREEK RESERVE

Results of a geochemical survey of the Bishop's Creek Reserve revealed the presence of low grade copper anomalies coincident with linear outcrops of ironstone extending across the reserve in a south-

easterly alignment. Locally anomalous lead values were recorded but no pattern of lead mineralization could be identified. Samples collected from a limited programme of wagon drilling did not yield anomalous mineralization.

Further detailed work is recommended.

MARY LANE SHEAR ZONE

A geochemical survey was planned for an area of 6 x 1½ miles in extent in the western part of the Mary Lane Shear Zone. The survey covered the aeromagnetic survey area No. 2 (B.M.R. Record 1967/35). By the close of the year approximately one half of the area had been auger drilled. Results of chemical analyses received by then did not indicate a pattern of mineralization but certain peak values may require further investigation. Samples from weathered lamprophyre intrusives in the area consistently yielded higher values for base metals than those from the country rock.

BLACK EYE RESERVE

Following a ground magnetic survey of the Black Eye Reserve, an area of approximately 6000 feet x 6000 feet was surveyed. The grid surveyed was auger drilled at 400 feet spaced centres. No anomalous mineralization was revealed by the assay results of the auger drill cuttings. Four wagon drillholes sited around the disused Black Eye shaft failed to intersect ore.

GREAT WESTERN RESERVE

Analyses of auger drill cuttings from the Great Western Reserve grid indicated the presence of a low order north-west trending base metal anomaly. Deeper holes by wagon drill are recommended to test the anomaly at depth.

SEARCH FOR OIL

Close liaison was maintained with company officials engaged in the search for oil in the Northern Territory. During the year a well was put down off Ashmore Reef, some five hundred miles west of Darwin. No hydrocarbons were detected but considerable stratigraphic information was obtained from the core and cuttings.

MISCELLANEOUS

Numerous visitors called at the Resident Geological Offices seeking general information, identification of rock and mineral specimens, and requesting advice on prospecting and exploration matters. The visitors include company staff, officers from other Government Departments, and individuals. Several aboriginals have sought advice about prospecting and mineral identification.

MEETINGS AND CONFERENCES

The Senior Resident Geologist attended the meeting of the Technical Committee on Underground Water held this year at Canberra.

The Senior Resident Geologist attended the 1968 conference of the Australian Petroleum Exploration Association held in Sydney.

The Senior Resident Geologist attended the Government Geologist's conference held at Adelaide.

REPORTS

The more important reports prepared by officers of the Resident Geological Section during the year are as follows:

Elsey Copper Prospect	M. Daly
Drilling Programme Appraisal - Jervois Range Copper and Lead Deposits - Northern Territory	R. Dodson, D. Grainger
Interim Report : 1967 Geochemical Survey of the Bishop Creek Area, Tennant Creek, N.T.	A. Taube
An Evaluation of Groundwater Prospects - McArthur River Area	A. Laws
Salt Pans at Roper River	A. Laws
Copper Mineralization in the Mount Skinner Area, N.T.	D. Grainger
Interim Report : 1967 Geochemical Survey of the Great Western Area, Tennant Creek, N.T.	A. Taube
The Mount Hardy Copper Mine, Northern Territory	D.J. Grainger
Frances Creek Gold Mine, Proposals for Diamond Drilling	J.W. Shields
Tommy's Gap Copper Prospect, Northern Territory	R.D. Shaw
Selenium Geochemical Traverses, Tennant Creek, 1967	A. Taube
Katherine Water Supply - A Discussion of Two Proposed Bore Sites	A.T. Laws
Geological Investigations of Foundations for Television Mast, Blake Street, Darwin, N.T.	B.A. Tapp
Umbakumba Bauxite Deposit, N.T.	J.W. Shields
Investigation of Road Subsidence - Mitchell Street West, Darwin	B.A. Tapp

Preliminary Report on the Clark Copper Mine, Mt Doreen, N.T.	D. Grainger
Preliminary Report on the Mt Allan Tin Mine, N.T.	D. Grainger
Preliminary Investigation - Mauretania Goldmine, Tennant Creek, N.T.	B.A. Tapp
Report on the Utopia Tantalite Prospect, N.T.	R.D. Shaw
Preliminary Geological Survey, Peter Pan Goldmine, Tennant Creek, N.T.	B.A. Tapp
Preliminary Survey - Acacia Gap Iron Ore Prospect	B.A. Tapp
An Outline of the Availability of Groundwater on Dneiper Station, N.T.	R.D. Shaw
Wagon Drilling at Millers Iron/Manganese Prospect, Frances Creek North, N.T. 1967	J.W. Shields
Summary of Investigations Carried out at the Gigantic Goldmine, Tennant Creek, N.T.	B.A. Tapp
The Geology of the Princess Louise Goldmine, Grove Hill Area, N.T.	J.W. Shields, M.R. Daly
Investigations made in the Red Bluff Area, Tennant Creek, N.T.	B.A. Tapp
Barite Deposit Pony Pocket, Dorisvale, N.T.	J.W. Shields
Bauxite Deposits - Groote Eylandt Area	R.G. Dodson

RESIDENT GEOLOGISTS

TERRITORY OF PAPUA AND NEW GUINEA

As in previous years, some revision of programmes and objectives has been necessitated because of unforeseen ad hoc commitments and the shortage of essential ancillary services. Some investigations were suspended owing to a shortage of funds.

On the whole, programming was more realistic than in previous years and the tendency towards over-ambitious programming, noted in previous years, has at last been curbed.

Recruitment has been restricted and the filling of all the positions created in 1967 will take a further two to three years to complete at the present rate. On the other hand, space has become critically short at Port Moresby and Rabaul, and until the current building proposals are implemented there will not be room to accommodate the entire establishment.

However, the structure of the Branch is now becoming apparent, and the three Sections are approaching a reasonable manpower balance. Nevertheless, while the pressure of work increases, and there is no indication that it will in the future be reduced, there is a serious need to accelerate both recruitment and building programmes.

Progress is, for the most part, described in terms of Projects and Investigations begun, continued or completed during the period of the review. Some imbalance in presentation results from the fact that many projects or investigations have reached a stage where they have been, or are being, written up. Others, which have not yet reached this stage, have been described in greater detail.

Because fieldwork in the Territory of Papua and New Guinea is not confined to a single season, and because seismic and volcanic activity are largely unpredictable, the Summary, prepared in October, must rely on projection for some of the activities scheduled for the last quarter of the year and must, equally, omit any reference to those unforeseen events which may, nevertheless, occur and possibly even disrupt the scheduled programme.

HEADQUARTERS AND ADMINISTRATION

The Senior Resident Geologist (A. Renwick) was able to visit a number of activities in the field during the early part of the year, but in the last quarter of the financial year he was unable to make any outstanding visits owing to temporary restriction on expenditure at the beginning of the quarter. In the first quarter of the year he visited a number of centres. He spent a week in Canberra, visiting the Bureau of Mineral Resources for liaison purposes in connexion with the work of Canberra-based field parties and other matters before visiting Adelaide to attend the biennial conference of Government Geologists in March.

Proposals for extending the buildings at Port Moresby and Rabaul were translated into preliminary drawings by the Commonwealth Department of Works and the extensions to the Central Volcanological Observatory at Rabaul were included in the detailed design list for the financial year 1968-69. Submissions for the inclusion of extensions to the Headquarters building in Port Moresby were reviewed and vigorously supported for inclusion in a secondary list for the same period.

The Wau office was officially closed on 31st March 1968, the staff being transferred to Port Moresby.

Work programmes for the current financial year have been seriously affected by the meagre allocation of helicopter support. It is hoped that a further allocation will be made to facilitate the second half of the 1968-69 programme.

Shortage of clerical and other supporting staff is still adversely affecting the full employment of professional and technical staff. The current year's recruitment provides for two professional officers, (1 Engineering Geologist and 1 Volcanologist) together with 2 overseas and 8 local supporting staff. It is expected that all these positions will be filled during the financial year.

Other activities of the Senior Resident Geologist included many consultations with representatives of mining and petroleum exploration companies; the editing of results of investigations and projects; the supervision of Branch activities; and advisory functions in connexion with Bureau of Mineral Resources activities and other individual research projects in the Territory. At the same time, a close liaison was maintained with the University of Papua and New Guinea and also with other Government Departments. Preparations for the proposed meeting of ANZAAS in 1970 have also been undertaken.

Distinguished visitors during the year included Dr S.H. Shaw, C.M.G., O.B.E., Adviser in Geology to the Minister for Overseas Development, London, and Professor G. Newstead, Department of Engineering Physics, A.N.U., Canberra, consultant in equipment

for the Rabaul Volcanological Warning Network and related volcanological installations.

The Senior Resident Geologist served throughout the year as a member of the Mining Advisory Board, the Petroleum Advisory Board, the Science Faculty of the University of Papua and New Guinea, the Council of the Scientific Society of Papua and New Guinea, and as Chairman of the Advisory Committee on Seismology and Earthquake Engineering.

REGIONAL MAPPING AND MINERAL INVESTIGATION UNIT

INTRODUCTION

STAFF AND MOVEMENTS: J.A.J. Smit, R.P. Macnab, R.J. Tingey, P.D. Hohnen (from 11th March, 1968)

R.P. Macnab left Moresby on 9th November, 1967, for a duty tour in Canberra, commencing recreation leave 15th December and resuming duty in Canberra 5th February, 1968, returning to Port Moresby on 12th February.

R.J. Tingey was absent on recreation leave from 12th December, 1967, to 8th January, 1968, and goes on leave in November 1968 until early in 1969.

J.A.J. Smit was absent on a duty tour in Canberra from 21st April to 12th May, 1968.

P.D. Hohnen commenced duty in Port Moresby on 11th March, 1968.

R.G. Horne transferred to Canberra at the completion of his recreation leave, 3rd April, 1968.

The Wau Office (J.A.J. Smit) was transferred to Port Moresby, officially closing on 31st March, 1968.

REGIONAL MAPPING

PROJECTS AND INVESTIGATIONS

B.M.R. Sepik Party 1967

Macnab and Smit were actively involved in the writing of the Record during duty tour to Canberra in November - December 1967 and April - May 1968 respectively.

As part of the Sepik party programme Smit made a traverse in the Telefomin Area. The geology, which consists of Mesozoic Lagaip Beds overlain by Eocene and Lower Miocene limestones, has been described in a Note on Investigation.

B.M.R. East Papua Party

Hohnen took part in the field work of the B.M.R. South East Papua party during two field seasons, in March and September 1968.

B.M.R. Kubor Range Party

Tingey worked with the B.M.R. Kubor Range Party from July 31st until August 19th. In that time he traversed from near Lufa to Karimui, south from Minj across the Kubor Range and from there to Gumine, the party base camp. The Kubor Range Party was engaged in mapping and compiling the geology of the Karimui 1:250,000 sheet SB.55-NG (21NG) and in particular reviewing the work done by Rickwood in 1953.

Wau 1:250,000 Sheet (No. 65104)

Smit, assisted by Tingey, finished the mapping of the Wau 1:250,000 sheet during January 1968. Three traverses were carried out in the Menyamya Area (Investigation Note 68301). The relationships between the Lower Miocene Menyamya Beds, overlying basic volcanics and unconformable overlying late Lower Miocene Langimar Beds were mapped in more detail. Within the Menyamya Beds outcrops of Eocene limestone were found to occur.

Compilation of the geological map of the Wau 1:250,000 sheet, together with Explanatory Notes, is in progress.

Central District Reconnaissance Mapping Project (68101)

This project was revived in April 1968 to provide a reconnaissance geological map of the area east of that mapped by oil companies in the Gulf region of Papua and by officers of the Wau office (Wau 1:250,000 sheet), south of the Papuan Ultramafic Belt mapped by H.L. Davies, and west of the area mapped by Davies et al in Eastern Papua. It falls largely within the Central District of Papua in an area where little systematic geological mapping has been carried out in the past except in the vicinity of Port Moresby. Progress is summarised in Preliminary Note on Investigations Nos. 68201 and 68202).

Gazelle Peninsula Reconnaissance Mapping Project (Macnab: Project 67101)

Late in 1967 a preliminary draft report was prepared detailing the results of fieldwork in the Gazelle Peninsula in 1967. In March-April 1968 several weeks were spent in the Wide Bay-Open Bay area with a Department of Forests helicopter survey; the examination by D.J. Belford of microfossil material collected has resulted in his preparation of a record (Records 1968/82). In August-September four weeks were spent in the North Baining Mountains, sectioning the lower Miocene limestones (2,500 feet), which blankets these mountains and much of the rest of New Britain, examining relationships along the Baining Fault and mapping inland from Ataliklikun Bay. Bad weather and lack of boats have prevented mapping on the south-east coast of the Peninsula which would have completed the fieldwork programme. It is hoped to make use of the B.M.R. New Britain party helicopter in late January 1969 to complete fieldwork and collect material for age determination and chemical analysis.

Wide Bay - Open Bay Area

The soft massive volcanics (Sinewit Volcanics) of the Mount Sinewit area dip gently into the Wide Bay - Open Bay area, with a lateral facies change to tuffaceous marine sediments with some limestone. The age has been determined as ranging from upper Miocene to Pliocene, possibly to Pleistocene. They are underlain in the Bera River headwaters by indurated Eocene Baining Volcanics, and to the south by less indurated, similar-looking marine volcanics of lower Miocene ("e" to lowermost "f" stage) age which correlate with the Merai Volcanics. These volcanics extend westward along the north side of the Sai River to Matanakunei; in this area they are overlain by soft Pliocene-Pleistocene limestones. South of the Sai River indurated Baining Volcanics are intruded by basic dioritic plutonic rocks, with wedges of lower Miocene limestone (capping the Kol-Mengen mountain block) downfaulted along the edge of the valley.

North Baining Mountains

In the north Baining Mountains about 2,500 feet of ? lower Miocene limestone overlies deformed indurated Eocene Volcanics (Baining Volcanics). These limestones are thick-bedded shoal limestones, chalky limestones and ?lime mudstones, generally with no included terrestrial material. They show little vertical or lateral variation. On the north coast the Baining Volcanics are overlain by similar-looking limestones of possible Pliocene age (?correlated with those of the Rembarr Range east of Ataliklikun Bay) - these limestones are being drilled by Titan New Guinea (B.H.P.) on Kilinwata Plantation. Inland from Ataliklikun Bay the plutonic rocks along the Baining Fault extend further east than previously mapped, and Baining Volcanics mapped as a "window" in the upper Toriu River were found to crop out continuously to the north. Soft terrestrial and marine sediments of the Sinewit Volcanics crop out northwards into the Kerevat and Vudal area, where they are overlain by ash of the Rabaul Volcanics. It is possible that the age of the Sinewit Volcanics in this area ranges up to Recent.

MINERAL INVESTIGATIONS

PROJECTS AND INVESTIGATIONS

Kathnel Goldmine, Kainantu, 65309

Smit and Tingey have visited the Kathnel Goldmine several times during the last year, mainly in connection with the diamond drilling programme. Two inclined drill holes, of respectively 155' and 290' depth, succeeded in locating the mineralized contact zone between prophyry and schists. The oxidised ore zone along the contact continues at least to a depth of 100 feet. Both cores revealed a sharp porphyry-schist contact with mineralization mainly within the schists.

PARTICIPATION IN FIELDWORK OF MINERAL EXPLORATION COMPANIES

Helicopter Survey - Carpentaria Exploration Co.

Smit participated in a helicopter survey by Carpentaria Exploration Co., which worked in three separate areas in New Guinea during February, 1968.

The area between Porgera and the Strickland River has been broadly mapped during a programme of large scale geochemical sampling. The geology consists of folded Mesozoic Lagaip Beds overlain by Lower Miocene limestone, shale and sandstone. Near the Strickland River, Lower Miocene massive limestone beds occur, forming a large east-west trending synclinorium, which apparently continues to Telefomin. Remnants of Eocene and Oligocene limestone occur at the base of the Lower Miocene limestone.

In the Sepik Area the Frieda River prospect was visited and some more detailed mapping was carried out.

In the Torricelli Mountains to the south-west of Aitape a more detailed geochemical sampling programme was carried out over a complex of gabbro and granodiorite intruding schist and metavolcanics. The area is surrounded and partly overlain by Miocene sediments with extensive basal conglomerates locally.

Helicopter Survey - Kennecott Exploration Australia

In September, 1968, Smit visited a Kennecott Exploration party, which operated with a helicopter in the area to the west of Olsobip.

In the area, folded and faulted Mesozoic Lagaip Beds continue to the border with West Irian with a regional west-north-west trend. The Lagaip Beds are unconformably overlain by a massive limestone sequence of probably Lower Miocene age. To the south, the Lower Miocene sequence covers the Lagaip Beds completely, striking east-west with a slightly southerly dip. Here the sequence consists partly of siltstone and sandstone and another unconformity was noted between the Lower Miocene sediments and subhorizontal Upper Miocene or Pliocene beds.

In the ranges, the Lower Miocene massive limestone covers the Lagaip beds only partly and occurs as islands with huge cliff faces on top of the Lagaip Beds. Towards the Papua-New Guinea border outcrop of the limestone is again continued, occurring in an east-west striking synclinorium forming the main divide.

A Record describing the present knowledge of the Mesozoic Lagaip Beds and the overlying Tertiary sequences of mainly limestone is in preparation.

MISCELLANEOUS INVESTIGATIONS

Geology of the Koranga Creek, Wau

Emission of gas in the Koranga Creek area near Wau initiated a more detailed geological study of the area.

A close mineralogical relationship appears to exist between the agglomerates of the Otibanda Formation and the flows and breccia of the Koranga Rhyolite. Evidence was found to assume a fair sized crater in the Koranga area, which could have been the source of most of the pyroclastics throughout the area. Volcanism with related earth movements started during late Pliocene, damming the rivers, which originated the Wau Valley Lake. Agglomerates and tuffs interbedded with lake sediments in the Wau area suggest more than one volcanic outburst. Some rhyolite flows are of Recent age and were extruded from the crater during the deposition of fanglomerates, which followed the draining of the lake and erosion of part of the lake deposits.

ENGINEERING GEOLOGY SECTION

INTRODUCTION

STAFF AND MOVEMENTS

Staff changes during the year were as follows:

I.S. Cumming joined the Section from the Rouna No. 2 Project on 31st December 1967 and was appointed to the position previously held by J.P. MacGregor.

J.R.L. Read resigned from the Commonwealth Public Service on 5th January.

P.E. Pieters joined the Section on 11th December in the newly created position of Engineering Geologist, Hydrology.

J.C. Braybrooke has been with the Section throughout the year.

Officers of the Section were engaged on 25 projects and investigations during the year and several enquiries were answered. Eleven of the investigations were unscheduled in the year's programme. Four Bureau of Mineral Resources Records and nine Resident Geological Notes of Investigation were issued.

Apart from 3 weeks spent by Mr. Pieters with the Bureau of Mineral Resources Field Party in south-east Papua the section's working time was divided equally among the three main groups: - hydro-electric schemes, water supplies and miscellaneous engineering investigations.

HYDRO-ELECTRIC SCHEMES

Upper Ramu Hydro-electric Scheme (65403)

The design report by J.P. MacGregor was issued as Bureau Record No. 1967/144.

Upper Ramu Hydro-electric Scheme, Stage 2 Development (67409)

The preliminary report by J.R.L. Read on geological mapping of the Ramu Gorge was issued as Bureau Record 1967/142.

Upper Ramu No. 1 Reservoir (68404)

J.C. Braybrooke and R.J. Tingey mapped certain localities in the reservoir area where possible leakage could occur through limestone. A note on Investigation was issued.

Lower Warangoi Hydro-electric Scheme (65409)

The investigation report by J.R.L. Read was issued as Bureau Record 1968/59.

Rouna No. 2 Hydro-electric Scheme (65410)

The first generator was commissioned in December. I.S. Cumming continued geological inspections as necessary during the year. The completion report is to be issued as a Bureau Record.

Raising of Sirinumu Dam (67410)

Fieldwork at the main dam and spillway sites was completed in August. Additional soil investigation by C.D.W. is in progress at the saddle dams. The Investigation Report is to be issued as a Bureau Record.

Lauis River Hydro-electric Scheme, Manus Island (67416)

J.C. Braybrooke and P.E. Pieters mapped the geology of a possible dam site in January. The site, seven miles south of Lorengau, proved to be too costly to develop.

Vanapa River Hydro-electric Scheme (68401)

Geological information was provided for the feasibility study by C.D.W. Port Moresby. J.C. Braybrooke traversed the river banks between the Bridge and Farisa Creek in July and inspected the sites proposed for the power house.

Nebilyer River Hydro-electric Scheme (68402)

It is proposed to construct a hydro-electric scheme of 5 Megawatts capacity to supply Mount Hagen, on the Nebilyer River 8 miles west of Mount Hagen. The scheme comprises a "Fabridam" inflatable weir, 2½ miles of raceline and a surface power house. I.S. Cumming inspected the geology of the scheme in May.

Musa Gorge Hydro-electric Scheme (68405)

Several localities on the proposed reservoir rim were inspected, using a helicopter, by I.S. Cumming and P.E. Pieters in April to ascertain the occurrence of unconsolidated sediments.

Angabunga Hydro-electric Scheme (68408)

Geological information was provided for the feasibility study by C.D.W., Port Moresby.

WATER SUPPLIES

Village Water Supply - Gulf District (67402)

The Investigation Note was distributed in February.

Village Water Supply - Western District (67413)

The Investigation Note was distributed in March .

Water Supply - Port Moresby (67414)

The drilling and testing programme to determine groundwater resources and the collection of information continues.

Village Water Supply - N.E. part of Gazelle Peninsula, New Britain (67417A)

J.C. Braybrooke and P.E. Pieters visited 160 villages in June-July and made recommendations for improving supplies. The Investigation Note is in preparation.

Village Water Supply - N. coast of West New Britain (67417B)

P.E. Pieters visited 32 villages in July and made recommendations for improving supplies. The Investigation Note is in preparation.

Water Supply - Laloki Mental Hospital, Port Moresby

Testing the yield of boreholes has been vitiated by the crude methods employed. Improvements are being made with limited material resources.

Water Supplies - Miscellaneous

Advice on groundwater resources and the siting of boreholes has been given on many occasions in many localities including the Pore Moresby area, the Markham Valley, Marshall Lagoon and the Milne Bay District.

MISCELLANEOUS ENGINEERING INVESTIGATIONS

Minj-Wahgi River Road (67406)

The investigation note by J.R.L. Read was re-issued as Bureau Record 1967/143.

Togoba-Kaupena Road (67415)

In March and June I.S. Cumming and P.E. Pieters inspected the new alignment of the road which is to become part of the new trunk-road from Mount Hagen to Mendi. The terrain north of the Kaugel River is mainly tuff of the Hagen Volcanics with inliers of Chim Shale and mudstone along the divides. South of the Kaugel River, the terrain is lava apparently from the Ialibu and Giluwe volcanic centres. The Investigation Note is in preparation.

Mount Hagen - Baiyer River Road (68403)

J.C. Braybrooke and P.E. Pieters inspected the proposed new alignment with the consultant engineers in March. The upper part of the road is on Hagen Volcanics. Where the road descends the Baiyer River gorge, Maril shales dip towards the river. The Investigation Note, advising on slope stability and construction materials, has been issued.

Mount Hagen-Togoba Road, (68409)

I.S. Cumming inspected the proposed new alignment with engineers of the Department of Public Works in August.

Wabag - Wapenamanda Road (68410)

I.S. Cumming inspected the proposed new alignments with engineers of the Department of Public Works in August. The road is almost entirely on volcanics resembling the Hagen Volcanics. Near Irelya Mission 1¼ miles from Wabag, shaly mudstone crops out in the cutting of the existing road. An Investigation Note is in preparation.

Crest Hotel Site, Port Moresby (68406)

The promoters of a hotel to be built at the west end of Ela Beach had exploratory drilling done by the Department of Lands, Surveys and Mines. The site and drillhole cores were examined and an interim report was drafted. The site investigation is unfinished.

Construction Materials, Gigo, West New Britain (68407)

Following a request from the District Commissioner, J.C. Braybrooke located extensive deposits of gravel on the Ru River and possible quarry sites in basalt in Lupoi Creek. An investigation Note was issued.

Cement Industry, Port Moresby (68412)

There is a continuing interest to set up a cement industry at Port Moresby. Existing information on limestone resources is widely scattered and much has been lost. Examinations of the larger limestone outcrops around Port Moresby, as at Barune and Bautama is in progress.

Advisory Committee on Seismology and Earthquake Engineering

Three ordinary meetings and two special meetings were held by the committee. The sub-committee on earthquake engineering had seven meetings to discuss the draft of the new building regulations for the Territory.

SCHEDULED PROGRAMME 1st OCTOBER - 31st DECEMBER 1968

In addition to completing the work already in hand, the Section is to carry out the following work in the last quarter of 1968.

Village Water Supply - S. Coast of West New Britain (67417C)

P.E. Pieters is to take part in this Survey which will commence in the November. Fieldwork will occupy two weeks.

Middle Watut Road - Morobe District (68413)

J.C. Braybrooke is to inspect sections of the new road at the request of C.D.W.

Yalu-Boana Road - Morobe District (68414)

J.C. Braybrooke is to inspect sections of the new road at the request of C.D.W.

Ru River Gravels, Gigo - West New Britain (68415)

J.C. Braybrooke will make a further study of the gravel deposits for construction material at the request of Messrs. Harrison & Crosfield Ltd.

Landslides - Waringe and Misuam Rivers - East Sepik District (68416)

I.S. Cumming and J.C. Braybrooke are to inspect landslides caused by recent earthquakes.

Mendi - Ialibu Road, Southern Highlands District (68417)

J.C. Braybrooke is to study slope stability in the Anga River gorge at the request of Department of Public Works.

Lake Hargy Hydro-electric Scheme - West New Britain (68418)

At the request of C.D.W. the area of the proposed scheme is to be studied by J.C. Braybrooke.

Rouna No. 3 Power Station and Sogeri Regulating Pond - Central District (68419)

C.D.W. Melbourne require geological information on these by March, 1969. As January and February are the rainy months, field work must be carried out during November - December, 1968.

VULCANOLOGICAL SECTION

INTRODUCTION

STAFF AND MOVEMENTS

The professional staff comprised Volcanologists G.W. D'Addario and R.F. Heming, Seismologist M. Mancini, (since 15th July): and the senior technical staff consisted of N.O. Myers and R.J. Conway.

G.W. D'Addario carried out several aerial and ground inspections of the volcanoes in the central portion of the New Guinea Volcanic Arc from New Britain to Long Island.

R.F. Heming joined the South-east Papua Geological party from 3rd to 27th March to obtain experience in the utilization of helicopters. He accompanied G.A.M. Taylor to investigate the Doma Peaks volcanoes in May 1968. He investigated, in July, a reported new thermal area near Siribia Village, Bougainville Island and extended the inspection to include the summit of the Balbi Volcanic Complex. In September he carried out investigations in the East Sepik District following a major earthquake in the region.

Mr. Mancini assumed duty at the Central Observatory on the 15th July and after familiarisation with routine seismic interpretation methods commenced the analysis of microseismic activity both long and short duration series. In August he inspected the proposed site for the C.R.A. Bougainville seismic station at Kieta.

SPECIAL PROJECTS AND INVESTIGATIONS

Mechanism of Epicentral Location Using Only Rabaul Seismological Data, (66501)

2211 shocks covering the period January to September 1968 have been entered on the Rabaul Index Cards.

Epicentres located by the U.S.C.G.S. for the period January to December 1967 and January to June 1968 have been plotted on maps showing a semestral and monthly distribution according to date, depth and magnitude.

Revision of New Guinea Earthquake Epicentres (66502)

Teleseisms and large regional earthquakes from 1st May to 3rd August 1966 have been revised and 581 Mark Sense Cards despatched to the International Seismological Research Centre, Edinburgh, for final processing.

Direct and Indirect Methods of Recording Central Observatory Time Signals (66508)

This investigation deals with the installations at the Keravat station and the Esa'Ala Observatory of coils and crystal for reception of time signals through 9RA. Additional equipment will be installed to record radio signals on the chronograph channel of the film recorders. A programmer will be added to the Broadcasting Timing Unit (inv. 68504).

Structure and Geology of Blanche Bay and Adjacent Areas (66509)

Mapping and sampling of the caldera formation including ash deposits to the east of Rabaul, the North Daughter sequence, and a pyroclastic sequence near Mount Varzin, continued.

Analysis of Seismogram Records from Rabaul Observatory in conjunction with the Preliminary Geophysical Survey of Blanche Bay (66510)

Analysis of Rabaul records has been completed and compared with results obtained from the main structure project.

Rabaul Crustal Study Project (67101)

Analysis of Rabaul records from the Rabaul Crustal Study, 1967, continued. Velocities and intercepts, thickness of crustal layers have been calculated and a theoretical structure model has been constructed independently from results produced by the Geophysical Branch, Bureau of Mineral Resources, Canberra.

New Guinea Lavas (67501)

Samples from various volcanic centres were regularly submitted for chemical analysis and results plotted on various diagrams.

Langila Activity 1967 - 1968 (58501)

The field seismic station at Cape Gloucester was operational intermittently until 6th March, 1968. Samples were collected and temperatures taken near Malauri Crater. Results of chemical analysis have been received from A.M.D.L.

Long Island Eruption 1968 (68503)

Aerial inspections have been carried out on various occasions and sketch maps produced of superficial structure development. The notes will be completed as soon as samples are analysed.

A Field Seismograph System (68505)

A prototype package for auxiliary equipment has been constructed and is presently being used in the field.

A design for a filter and converter unit has been completed but construction is delayed because of a shortage of material.

Completed Investigations and Projects.

The draft of the Overseas Study Tour Report has been prepared by G.W. D'Addario, and the Kokopo, New Britain Earthquake Note on Investigation (67503) has been produced by R.F. Heming.

N.O. Meyers, Senior Technical Officer, completed the Investigation 68504 "Broadcast Timing System".

ROUTINE ACTIVITIES

SEISMOLOGICAL

Seismograms, exceeding twentyfive a day, obtained from the stations in and around Rabaul, Esa'Ala and Tabele Observatories, Agenahambo station, and temporary emergency field stations, have been interpreted at the Central Observatory and results entered in the weekly Preliminary Earthquake Analysis. Magnitude from all groups of waves has been calculated for main regional and distant earthquakes. Daily telegrams with main information from the World Wide Standard System have been regularly forwarded to the Washington centre.

The U.S.G.S. Data Centre was re-opened in March 1968 and the supply of components, chemicals and photographic paper to all network stations has been resumed. A backlog of records from July to December 1967 has been despatched to Washington.

581 Mark Sense Cards of revised earthquake phases up to 31st August, 1966, have been despatched to the International Seismological Research Centre, Edinburgh.

Seismic Activity During 1968

2211 earthquakes were recorded at Rabaul between January and September 1968.

Local magnitude calculated at Rabaul for shocks with clear S-P intervals revealed that between January and September 1968, 897 earthquakes had magnitude from 3 to 5.9 and 23 had a magnitude greater than 6.

Regional seismicity was high until April 1968 with peaks of 18, 23 and 24 earthquakes per day in February, March and April, and on a few occasions main earthquakes have been followed by a swarm type of activity.

On the 12th February, 1968, a large earthquake was widely felt with intensity VI - VII in New Britain and Bougainville Islands. Its epicentre was located about 100 miles east south east of Rabaul. Local magnitude $5\frac{1}{2}$ - $5\frac{3}{4}$. This earthquake had the same signature as the one which occurred on Christmas Day 1967. If it is accepted that block tectonic movements have previously occurred between east New Britain and the southern tip of New Ireland, then this event may suggest an extension of the movements to the region between New Ireland and Buka Island.

Harmonic tremors which appeared on the Rabaul network records from the 22nd April 1968 decreased rapidly in number and practically disappeared during May. A noticeable feature was that these volcanic tremors appeared on the Sulphur Creek (SUL), Wanliss Street (WAN), and Rabaulanakaia (RAL), stations and only sporadically at Taviliu (VUL).

On the 14th June 1968 the Obura Patrol Post reported very minor tremors felt in the Suwaira area, near Elandora Mountain, "Once every two days over the past two weeks....".

An earthwuake with local magnitude 6.0 was recorded at Rabaul on the 18th at 0351 hours (L.T) and felt report intensities received from Saidor (IV MM), Lae (IV MM), Siassi (III - IV MM), Kerema (III MM). The epicentre appeared to be located between Saidor and Long Island under the Vitiaz Strait at a depth of about 150 km.

In July, swarm type activity recorded on the W.W.S.S. occurred regularly over a period of several days and was eventually found to be caused by a heavy roller belonging to the Commonwealth Department of Works operating on the shore line east of Shell Beach, Rabaul.

On 9th September at 0114 hours (L.T) a main earthquake (M_L = 6.4, M_B = 5.6) was felt widely over the Sepik District and followed by a swarm of felt after shocks of lesser intensity in the Kaboibus-Maprik-Yangóru area and accompanied by explosive sounds. Maximum felt intensity of VI on the Mercalli Modified Scale was reported from Wewak, Maprik and Yangoru, and intensity VII from Kaboibus.

Another main earthquake (M_L = 6.3) on the 28th at 0508 hours (L.T.) was felt at Wewak with intensity VII and at Yangoru with intensity IV - V where, again, continual minor tremors were felt after the main shock. The main earthquake was followed by a large number of after shocks, some of considerable magnitude, felt at Wewak with intensities ranging up to VI MM.

On 16th September at 1155 hours (L.T) an earthquake was widely felt in New Britain, New Guinea and Papua. The epicentre was located in the Solomon Sea with approximate co-ordinates 148°17'E 6°11'S (320 miles west south west of Rabaul). Slight damage to buildings and extensive damage to water tanks was reported from Kandrian (VI MM) and extensive damage to the wharf occurred at Silavuti S.D.A. Mission, 31 miles south west from Talasea. The O.T.C. submarine cable between Madang and Cairns was broken in the epicentral area. This earthquake was erroneously reported through the A.B.C. to have been located by an American Seismological station as being very near Rabaul.

OBSERVATORIES

Rabaul Harbour Network.

Professor G. Newstead, honorary consultant in Engineering Physics, visited Rabaul between 27th April and 3rd May and carried out a comprehensive study of the network. He subsequently made a detailed report on the present state of the network, measures necessary for its completion and maintenance, and on its extension and future improvement. Professor Newstead has been intimately concerned in the design, planning and implementation of the network and this, together with his continued interest in its improvement and expansion represents a very great contribution to the development of an efficient surveillance system in this, the most economically and socially important volcanic centre in the Territory.

Tavurvur "B" station was fully commissioned on 28th June. This was the last of the Warning Network stations to be completed.

Thermo-hygrographs were installed at Wanliss Street, Sulphur Creek and Rabaulanakaia stations.

In April, an M02 Accelograph was installed at Sulphur Creek station on behalf of the Commonwealth Geophysical Observatory at Port Moresby.

Keravat Station

The permanent site for the Keravat Outer Network station has been selected in the Lowlands Agriculture Experimental Station. It is hoped that funds for the civil works for the building will be allocated from the District Funds.

Ulamona Field Station. (The Father)

Regular tiltmeter readings and observation of the volcano were carried out regularly except for a brief interruption between June and August, owing to the mission part-time observer going overseas. A replacement has been provided by the local mission since 11th August.

Piva Field Station (Mt. Bagana)

Regular tiltmeter readings were received throughout the year from the part-time observer.

Tabele Observatory (Manam Volcano)

The permanent installation has been operating without failure for the entire year. Daily information was received regularly.

Waris Station (Manam Volcano)

Telegrams with information on main vent activity and tiltmeter readings were received regularly.

Agenahambo Station (Mt. Lamington)

The station was inoperative from the end of June until the 14th August. The overhauled seismograph then installed by the Technical Officer is working satisfactorily. An alternative site to the existing one has been investigated near the Sasembata Mission and tests carried out with a Willmore Seismograph in August.

Esa'Ala Observatory

In February a dehumidifier was installed in the vault to reduce damage to equipment during the prolonged repeated failure of the air conditioning plant.

General damage to the optical system of the short period seismograph was caused by the high humidity, therefore the short period recorder has been returned to Rabaul and a vertical Willmore and crystal clock were installed in March. A type 673 chronometer and 20 watt inverter were installed in August.

The power generation facilities were damaged in June during an electrical storm and were restored in July.

Tiltmeter readings were maintained and temperature readings at thermal areas on Oiau Peninsula, Ferguson Island and Dobu Island were carried out regularly.

VULCANOLOGICAL ACTIVITY

Very little activity has occurred this year in the Territory volcanoes. Bagana, Langila and the Father Volcanoes confined their activity to emission of vapour. At Manam, activity this year was mainly centred in the main vent with emission of ash laden vapour. Ash fall was reported in August and this marked a slight increase of activity. A few explosions at long intervals were heard on 18th, 23rd and 24th September. Emission has increased in volume since 25th September.

Long Island Eruption

This volcano erupted in March 1968 and the activity ceased abruptly on 12th May.

Previous eruptive periods were in 1953-1955 and 1961.

The teacher at Matafuma Village reported that activity started in Lake Wisdom with rumbling noises and slight ground tremors on Saturday 16th March. This report reached Rabaul on the 19th March. An aerial inspection was carried out on the afternoon of the same day directly from Rabaul and repeated the following morning. Photographs were taken and the position of the new crater plotted on the one inch to the mile map, B55/6 and 7, according to the following magnetic bearings; from Cerisy Peak bearing 5^{o} from the southern-most tip of the north-western peninsula bearing 130^{o}; from the eastern wall, following the stream which is situated four miles south of Cape Reamur bearing 233^{o}. The plotted position is about one kilometre east north-east from the active crater marked on the war-time map. A horseshoe shaped crater just above sea-level has been formed. Relicts of the volcanic structure developed during 1953-1955 were an old spine about 60 feet high and the southern portion of the western crater. The new crater developed where fumaroles were reported active in 1961. Sketch maps of the new crater in relation to the old structure were prepared. Activity was mild and consisted of ejection of ash, lapili and a few small boulders.

Blanche Bay Caldera

A routine temperature run on Tavurvur revealed a sudden increase at point 16 (104°CO 2 and 3 (100°C) located in the gully and on the inner wall of the main crater on 12th April. G.W. D'Addario visited the area on the 17th when the temperatures at the same points were recorded at 101°C and 102°C respectively. Gas emission was normal but nevertheless, an additional weekly temperature run was established. From the beginning of May temperature readings were above the normal level being 99½°C (N.L. 99°C) at point 16: 100°C (N.L. 99°C) at point 2 and 99°C at point 3.

TECHNICAL DEVELOPMENTS

The Rabaul network cable link was damaged in February by earth-moving equipment operated by Commonwealth Department of Works at Vester Street. This caused some damage to resistors in power circuits. All power circuits have been suitably fused to prevent a recurrence of this trouble.

Much time was spent investigating and recording faults on the Taviliu - Observatory VHF link.

A new timing system, which generates high accuracy time marks suitable for radio broadcasting, came into operation on 26th April at the Central Observatory, Rabaul.

The Labtronic type 303 chronoscope has been modified according to suggestions made by the manufacturer and ourselves and a very much improved model resulted.

Two Labtronic type 671 chronometers have been modified for use in permanent installations.

To allow an analysis of the short frequency range on the Harbour Network records, filter capacitors have been removed in August. Magnification was reduced by half and peak magnification from T=0.5 sec. was shifted to T=0.2 sec.

The Labtronic type 673 chronometer was installed at Keravat station in July and is operating satisfactorily.

The chronometer failures at the Esa'Ala observatory were found to be caused by a faulty batch of capacitors.

EDITING AND PUBLICATIONS

Staff: K.A. Townley
R.R.E. Jacobson

The flow of publications, extrapolated to 31/12/68, is summarized in Table 1.

TABLE 1: Throughput of MSS, Geological Branch, 1968

	In press 1.1.68	In hand 1.1.68	Issued 1968	Sent to press 1968	In press 31.12.68	MSS Received 1968	In hand 1.1.69
Bulletins	8	12	9	11	13	10	8
Reports	13	5	7	4	11	3	3
Maps, 1:250,000	11	10	27	26	-	22	10
Maps, other (coloured)	4	1	5	-	-	-	2
Maps, preliminary	-	-	20	-	-	-	-

As compared with 1967, the throughput has diminished considerably, as was forecast in the 1967 Annual Summary. 1967 was an exceptional year, and the figures presented in Table 1 are much closer to the normal throughput.

Again, Explanatory Notes have not been enumerated separately, since each 1:250,000 map is accompanied by a printed booklet of notes. Each booklet takes at least a week to process.

PUBLICATIONS ISSUED DURING 1968

Items marked with an asterisk are extrapolations to end of year.

Bulletins

Condon, M.A. - Geology of the Carnarvon Basin, Western Australia
Bull. 77. Pt 2: Permian stratigraphy
Pt 3: Post Permian stratigraphy, structure, and economic geology.

*Jones, P.J., - Devonian Ostracoda and Eridostraca from the Bonaparte Gulf Basin. Bull. 99

*Öpik, A.A., - Ordian (Cambrian) Crustacea Bradoriida of Australia. Bull. 103

*Quinlan, T., and Woolley, D., - Geology and hydrology of the Alice Springs town and inner farm basins. Bull. 89

Runnegar, B.M., - Desmodont bivalves from the Permian of eastern Australia. Bull. 96.

Walpole, B.P., Dunn, P.R., Randal, M.A., and Crohn, P.W., - Geology of Katherine-Darwin Region, N.T. Bull. 82

*Palaeontological Papers, 1965. Bull. 80

Palaeontological Papers, 1966. Bull. 92.

Reports

Beevers, J.R., - A chemical investigation into the role of sorption in ore genesis. Rep. 106

Branch, C.D., - Short papers on vulcanology from the Rabaul Observatory. Rep. 107.

*Cook, P.J., - The Ngalia Basin, N.T. Rep. 125

Forman, D.J., - Geology of the southern margin of the Amadeus Basin, N.T. Rep. 87.

Forman, D.J., Milligan, E.N., and McCarthy, W.R. - Structure of the north-eastern margin of the Amadeus Basin, N.T. Rep. 103.

*Shields, J.W., White, D.A., and Ivanac, J.F., - Geology and gold prospects of Union Reef, N.T. Rep. 45.

*Wells, A.T., and others - Geology of the northeastern Amadeus Basin, N.T. Rep. 113

Maps: 1:250,000: Manuka, Charters Towers, Ayr, Westmoreland, Dobbyn, Urandangi, Mt. Isa, Blue Mud Bay, Arnhem Bay, Mt. Rennie, Mt. Liebig, Lake Amadeus, Kulgera, *Henbury, Hale River, *Hermannsburg, MacDills, *Rodinga, Mt. Ramsay, Lansdowne, Lissadell, Macdonald, Pyramid (for GSWA), Yarraloola (for GSWA), Turee Creek (for GSWA), *Edmund (for GSWA), Robertson (for GSWA).
Others: Bonaparte Gulf, Katherine-Darwin, Oceania 8 & 10, Wau.

PUBLICATIONS IN PRESS AT END OF 1968

Bulletins

Conybeare, C.E.B., and Crook, K.A.W., - Manual of sedimentary structures. Bull. 102

*Dow, D.B., and Gemuts, I., - Geology of the Kimberley region, W.A.: the east Kimberleys. Bull. 106

Druce, E.C., - Devonian and Carboniferous conodonts from the Bonaparte Gulf Basin, northern Australia, and their use in international correlation.

*Druce, E.C., and Jones, P.J., - Cambro-Ordovician conodonts from the Burke River Structural belt, Queensland. Bull. 110

de Keyser F,, and Lucas, K.G., - Geology and mineral deposits of the Hodgkinson and Laura Basins, north Queensland. Bull. 84

" Öpik, A.A., - Nepeid trilobites of the Middle Cambrian of northern Australia. Bull. 113.

" Öpik, A.A., - Redlichia of the Ordian (Cambrian) of Northern Australia and New South Wales. Bull. 114.

Shergold, J.H., - Oryctocephaildae (Trilobita:Middle Cambrian) of Australia Bull. 104.

*Thomas, G.A., - Carboniferous and early Permian brachiopods from western and northern Australia. Bull. 56.

*Veevers, J.J., - Sedimentology of the Upper Devonian and Carboniferous platform sequence of the Bonaparte Gulf Basin. Bull.109

Veevers, J.J., and Roberts, J., - Upper Palaeozoic of the Bonaparte Gulf Basin. Bull. 97.

Wass, R.E., - Permian Polyzoa from the Bowen Basin. Bull. 90

Palaeontological Papers, 1967 - Bull. 108.

Reports

Dunnet, D., and Harding, R.R., - Geology of the Mount Woodcock 1-mile Sheet, N.T. Rep. 114.

Harding, R.R., - Catalogue of isotopic age determinations on Australian rocks. Rep. 117.

Kaulback, J., and Veevers, J.J., - Lower Palaeozoic rocks of the Bonaparte Gulf Basin. Rep. 109.

Malone, E.J., and others - Geology of the Duaringa and St. Lawrence 1:250,000 Sheet areas, Queensland. Rep. 121

Mollan, R.G., and others - Geology of the Springsure 1:250,000 Sheet area, Queensland. Rep. 123

Paine, A.G.L., and others - Geology of the Ayr 1:250,000 Sheet area, Queensland. Rep. 128.

Smith, K.G., and others - Stratigraphic drilling in the Georgina Basin, N.T. Rep. 124.

Trail, D.S., and others - Geological work in Australia, 1965. Rep. 118

*Trail, D.S. - ANARE 1961 geological traverses on the MacRobertson Land and Kemp Land Coast. Rep. 135

*Wyatt, D.H., and others - Geology of the Townsville 1:250,000 Sheet area, Qld. Rep. 127.

Yates, K., and de Ferranti, R., - The Astrolabe Mineral Field, Papua. Rep. 105

MAJOR PUBLICATIONS IN HAND AT END OF 1968

Bulletins on: Amadeus Basin, Georgina Basin, Arnhem Land, Bonaparte Gulf Basin; 4 palaeontological Bulletins.

Reports on: Charters Towers, Tambo, Eddystone Sheet areas.

MINERAL RESOURCES - REPORT FOR 1968

Staff: I.R. McLeod, Mrs. L. Walraven, Miss G. Warren.

Numerous enquiries about Australian Mineral Resources were received during the year; not all could be satisfactorily dealt with for lack of a suitable information retrieval system. A simple index to literature on Australian mineral deposits was maintained, so that material in Bulletin 72 can be readily brought up to date when necessary. Notes incorporating revisions of the chapter on bentonite were compiled. Several accounts on resources or reserves of particular minerals were prepared.

Assistance was given to the Water, Power, and Geographic Branch of the Department, mainly connected the Mineral Deposits map of the Fitzroy Region and proposals for minor revision of the Mineral Deposits map of the Atlas of Australian Resources.

Supervision of compilation of the Metallogenic Map of Australia was continued.

Records:

de KEYSER, F., and McLEOD, I.R., 1967 - Geological environments of Australian deposits of phosphate and gypsum. Bur. Miner. Resour. Aust. Rec., 1967/148

McLEOD, I.R., 1967 - Availability of primary fertilizer materials in Australia, Bur. Miner. Resour. Aust. Rec. 1967/149.

McLEOD, I.R., 1967 - A summary of thermal and mineral waters in Australia. Ibid. 1967/167.

COMPUTER APPLICATIONS

Staff: T. Quinlan,
F. Kousal (Technical officer)

Development and adaptation of computer programs to assist in the analysis and interpretation of geological data were continued. In addition to those reported in the 1967 Summary of Activities, the following are now available.

Name	Purpose
EMx1 EMx2	to provide fluorescence and absorption corrections to data collected with the Electron Microprobe.
ANOV	to provide an analysis of variance of up to 10 levels on a set of data, which may contain missing values.
FACTOR	to provide a facility for factor analysis, with specified options for a Variman, Proman, or a specific factor pattern rotations.

In addition a considerable amount of time was spent on the maintenance and revision of enlisting programs.

The set of geochemical and mineralogical data which was obtained from samples collected from the Fountain Formation was used to gain experience in the use of these computer programs. Particular attention was paid to Factor Analysis methods and the ways in which Numerical Taxonomy methods could be used to improve the interpretation.

Work was commenced on a facility for the storage and manipulation of silicate analyses, and the analyses of the age determination samples were prepared for use as a set of test data. The use of the CDC software package INFOL for the storage and retrieval of bibliographic data was investigated on behalf of the Palaeontological Sub-section, and a trial to test its suitability was commenced.

ANTARCTICA - ANNUAL REPORT, 1968

Preparation of reports on earlier work continued as opportunity allowed. Rb/Sr age determinations on several specimens were completed, but a written report was not prepared because of the resignation of the officer who did the work.

A start was made on planning for geological work in the northern Prince Charles Mountains, part of an intensive combined survey-geological operation.

I.R. McLeod, Australian representative on the SCAR Working Group on Geology, attended the meetings of SCAR and the Working Group in Tokyo, and spent additional time examining specimens collected by Japanese expeditions.

Liaison with other departments, organisations, and individuals interested in Antarctica was continued.

Publications:

McLEOD, I.R., and GREGORY, C.M., 1967 - Geological investigations along the Antarctic coast between longitudes 108°E and 166°E. Bur. Miner. Resour. Aust. Rep. 78

DALLWITZ, W.B., 1968 - Co-existing sapphirine and quartz in granulite from Enderby Land, Antarctica. Nature, 219 (5153), 476-477.

In press:

TRAIL, D.S., McLEOD, I.R., COOK, P.J., and WALLIS, G.R., Geological investigations by the Australian National Antarctic Research Expeditions, 1965. Bur. Miner. Resour. Aust. Rep. 118

TRAIL, D.S., ANARE 1961 geological traverses on the MacRobertson Land and Kemp Land coast. Ibid. 135.