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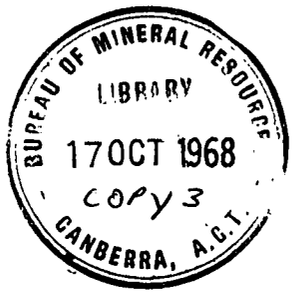


GEOPHYSICAL BRANCH
SUMMARY OF ACTIVITIES
1967

CONTENTS

ILLUSTRATIONS

1. OIL SEARCH

Airborne surveys

Great Artesian Basin survey (VH-MIN). This survey, which was intended to cover parts of the Longreach, Jundah, and Blackall 1:250,000 areas, could not be carried out in 1967 because of insufficient time. These areas are now programmed for inclusion in the 1968 Great Artesian Basin survey by VH-MIN.

Victoria River Basin (Western) survey, N.T. A contract for an aeromagnetic survey of four 1:250,000 areas (Auvergne, Waterloo, Limbunya, and Birrindudu), totalling 28,500 flight-line miles, was let to Adastra-Hunting Geophysics Pty Ltd in 1966. Owing to equipment failures and adverse weather conditions this survey was not completed early in 1967 as was expected, and at 31st October a balance of 1900 line miles remained to be flown. The results of the survey will therefore not be available before 1968.

Victoria River Basin (Eastern) survey, N.T. A contract for an aeromagnetic survey of three 1:250,000 areas (Delamere, Victoria River Downs, and Wave Hill), totalling 22,050 flight-line miles, was let to Geophysical Resources Development Co. in May 1967. At 21 October, a balance of 9194 line miles remained to be flown; consequently the results of the survey will not be available before 1968.

Papuan Basin, Basic Belt, and Astrolabe aeromagnetic survey, TPNG. The contract for this survey was let to Compagnie Générale de Géophysique, and airborne operations commenced in June 1967.

The coverage of the Basic Belt and Astrolabe regions is now completed. The coverage of the Papuan Basin is well advanced; the north-western corner of the survey area was found to be constantly covered by clouds, and permission has been given for the company to omit this corner from the present coverage with B17 aircraft providing an attempt is made to obtain coverage of the area with a lighter aircraft.

The remainder of the survey flying is expected to be completed early in November. A preliminary report and interpretation has been forwarded by C.G.G., and the final report and maps are expected in February 1968.

The preliminary interpretation of the aeromagnetic data over the Papuan Basin shows that the magnetic basement deepens progressively eastward from the basement outcrops on the western side of the Gulf, reaching a depth of approximately 15,000 feet along longitude 144° E. A prominent basement platform develops between longitudes 144° E and 145° E. Magnetic basement is 25,000+ feet in the central part of the Gulf. On the eastern side, shallow volcanics have a marked effect on the magnetic pattern.

Gravity surveys

Introduction. During 1967 two major projects began and a third was completed. In August a marine gravity, seismic, and magnetic survey began; this is expected to finish in December. A contract helicopter gravity survey began in February and finished in November. The helicopter gravity survey that began in 1966 was completed in August 1967. Plate 1 shows the locations of all 1967 gravity surveys.

In Arnhem Land and the Kimberleys, regional traverses were established along Department of the Interior levelled traverses. A detailed survey was made near Cootamundra, and semi-detailed surveys were made in the North Eromanga Basin and the Ngalia Basin.

During August and September the USCGS vessel "Oceanographer" made gravity, magnetic, and seismic measurements in Australian waters.

Additions to the gravity map of Australia, and collation of density determinations on cores, continued throughout the year.

North Queensland helicopter gravity contract survey, 1966. The initial grid flying was completed in November 1966, but the onset of the wet season delayed the follow-up phase of the survey until 1967. The follow-up was commenced by the contractor in April and finished in August; it involved about 1000 new readings, including 99 readings by ground transport. The results are shown in Plate 3.

Ten gravity provinces have been delineated; these include four which continue into neighbouring areas and have been described by other authors. The area is dominated by complex Bouguer anomalies associated with the Tasman Geosyncline, and it appears from the preliminary interpretation that many of the sedimentary basins (the Clarke River, Bundock, and Star Basins) are not gravimetrically defined. There is no clear delineation of the Hodgkinson and Laura Basins because of the effect of the edge of the continental shelf and because of the sparse gravity data. In the Carpentaria Basin also the gravity pattern did not delineate the major structural elements.

Two sedimentary basins, the Peninsula Trough and the Archer River Basin, were delineated. The former is an offshore basin whose existence was known from previous seismic and aeromagnetic surveys. The gravity results indicate that the Mesozoic Archer River Basin has a greater extent than was previously known.

The structural relation between continental Australia and Papua is not clear as there are unavoidable gaps in the gravity coverage.

In the west of the area the Bouguer anomalies indicate a northerly extension of the Cloncurry Fold Belt north of the outcropping Precambrian rocks.

NT and WA helicopter gravity contract survey. The survey began at Katherine on 28 February after some delay because of bad weather, and finished at Yuendumu NT on 21 August. The number of stations occupied per half-month has varied from 396 to 969, the variation being caused by difficulty of access, helicopter breakdowns, field breaks, and other minor factors. A total of 7706 stations were read during the 25-week survey: an average of 308 stations or roughly 1.7 map-sheets per week.

Data checks by the contractor during thefirst half of the survey were inadequate and made necessary a considerable number of check flights and error station occupations in Arnhem Land during follow-up. The general quality of work was higher in the Kimberleys, and few follow-up stations were required. However, some results were suspect in the area, and the contractor agreed to check these free of charge. Follow-up commenced on 6 September after delays due to non-availability of data, and it is expected to finish in early November.

Plate 4 is a preliminary Bouguer anomaly map of the survey area. Most of the geological units can be traced on the gravity map. However, some points of interest may be discerned. The edges of the off-shore basins are marked by considerable gravity "highs", for no reason obvious at present. The Halls Creek Complex exhibits a much simpler gravity pattern than the King Leopold and Pine Creek Complexes, and seems to be split into two parts which may or may not be connected. The Kimberley and McArthur Blocks have gravity patterns which can be correlated with the exposed geology, but the Victoria River Block shows Bouguer anomalies of much shorter wavelength. The Ord Basin has a gravity feature of large dimensions associated with it, stretching from LIMBUNYA to CROSSLAND. As a result, the Tanami Complex does not appear to be coextensive with the King Leopold Complex. The Daly River Basin is on the northern flank of a large gravity feature having the same general trend. The Ngalia Basin also occurs on the flanks of a large negative Bouguer anomaly feature. The basin could therefore be the surface expression of deep-seated structural movements, or of considerable thrust-faulting from the north. The Arunta Complex may be involved with Palaeozoic sediments due to late or post-Palaeozoic movements. Two roughly circular positive anomalies occur on ARNHEM BAY and PELLEW respectively. Their origin is uncertain at this stage of the interpretation.

Cootamundra detailed gravity survey, NSW. An intense gravity "high" discovered during the 1966 helicopter survey was investigated in greater detail. The results are shown in Plate 4; 832 station were read in seven east-west lines. The geology is known only in outline; a north-south belt of basic metamorphics coincides approximately with the gravity anomaly, and is flanked on each side by granite bodies. There are a number of small serpentine bodies, with which are assocated small chromite deposits. A large porphyry body, of unknown structural relation, occurs within the metamorphic belt; close to its edge are small gold deposits that were worked sporadically until 1950.

Detailed interpretation of the gravity anomaly is hindered by lack of adequate geological information. However, comparison with aeromagnetic data shows a close relation between the gravity "highW and a zone of intense magnetic disturbance. Tipper interpreted this zone

as due to many separate shallow ribbon-like bodies with northerly trends and steep dips. The resolution of the gravity method only permits less detailed interpretation. There may be two dense bodies, dipping very steeply to the east and probably cropping out. Further detailed gravity work would be required to elucidate this problem.

North Eromanga Basin semi-detailed gravity survey. During June and July nearly 3000 gravity readings were made at seismic shot-points in the North Eromanga Basin (Plate 1). Results are only in the preliminary stage of computation, but they seem to add little to the pattern of low gradients established by the helicopter surveys. The gravity anomalies do not appear to be related to structures in the sediments.

Ngalia Basin semi-detailed gravity survey. The four north-south traverse lines (Plate 1) for this survey have now been surveyed. One line is in NAPPERBY, two in MOUNT DOREEN, and one in LAKE MACKAY. Station spacing is about one-quarter mile. Gravity readings are due to start in early November and should finish within one month.

Dept of the Interior traverses. In September two BMR gravity parties started to read gravity at Dept of the Interior benchmarks along the levelled traverses for the 1967 helicopter gravity survey. The plan proposed was to include over 4000 miles of traverse in Arnhem Land, the Kimberleys, and in the Lake Mackay area, NT. Owing to rough travelling conditions, however, only about three-quarters of the plan will be completed during 1967. Results will be integrated with the results of the helicopter survey.

(Gravity Surveys continues next page)

USCGS Vessel "Oceanographer". During 1967 the "Oceanographer" made a global expedition from Jacksonville, Florida to Seattle, Oregon. She was in Australian waters for five weeks in August and September 1967. The Fremantle-Sydney leg of the voyage took three weeks, and a BMR geophysicist was aboard for this period. The track followed is shown in Plate 1.

Continuous gravity and magnetic readings were taken while the ship was in Australian waters. Also about 600 miles of seismic air-gun profiling was done. Results will be available for study before the end of 1967.

Formation density project. The compilation and interpretation of Bouguer anomaly maps require an accurate knowledge of the subsurface density distribution. A start has been made to compile all existing data into an accessible form. As outcropping rocks are subject to uncertain weathering effects, only borehole data have been used.

This project takes two forms: direct density determinations on rock samples and density data from down-hole geophysical measurements. During January and February, direct density measurements from all subsidised boreholes were plotted against the stratigraphy. The only geophysical method that gives acceptable results that can be interpreted in terms of density is the gamma-gamma log; unfortuately this is only rarely used at present. The task of converting gamma-gamma data into mean formation densities has now been started.

An investigation into borehole gravity meters was made. These instruments are capable of giving very useful results, but they are not yet available in Australia.

Gravity map of Australia. The 2nd edition of the gravity map of Australia was issued in January 1967, and a Record was prepared detailing how the compilation of the map had been done. Preparation for a 3rd edition of the map was continued, and it is expected to be issued in mid-1968 when the results of the 1966 and 1967 helicopter gravity surveys are available.

Gamma-ray logging

Great Artesian Basin contract logging. A contract has been let to Down Under Well Services Pty Ltd to continue the programme of logging water bores in the Great Artesian Basin, Queensland, for stratigraphic information. Flow-meter and electric logs are also taken where useful and practicable; this information assists the Irrigation and Water Supply Commission of Queensland to improve some water supplies.

Seismic Playback Centre

Seismic data from current and 1963-66 BMR surveys and from a subsidised survey were processed during 1967. An average of 37 cross-sections per month were processed by two two operators. Playback centre technical personnel supervised the preparation of the field seismic recording equipment before the 1967 surveys began. Visits were made to

the field to check equipment performance.

Eleven sonic logs from wells in the Roma Shelf area have been digitised using a CSIRO chart follower, prior to preparation of synthetic seismograms. Two seismic traces from the Roma Shelf 1967 survey were digitised for input to an autocorrelation programme using CSIRO's CDC 3600 computer. Several programmes for processing seismic data with the CDC3600 were revised, and preparation of more programmes was started.

Seismic cross-sections from the East Otway Basin 1967 survey and a test section from the Joseph Bonaparte Gulf "spark array" survey were processed optically using the Shell Development Corporation Laser-scan equipment.

Cross-sections and/or test playback of magnetic tapes have been produced, mainly in variable area/wiggle trace form, for the surveys listed below.

Roma Shelf 1967. Test sections and records were produced with various filters, AGC, gains etc. for use in the field and progress report enclosures, for the current experimental survey.

Roma area (AAO). Magnetic tapes recorded by the company on whose leases the current Roma Shelf survey is being made were played onto cross-sections for comparison with results of the current survey.

East Otway Basin 1967. Tests were made with various filters, AGC, and mixing. Preliminary cross-sections were produced for field use and progress report enclosures etc.

Flinders River 1966. Cross-sections were produced for inclusion in a Record.

Southern Georgina Basin 1965. Noise test tapes were played back in an attempt at true amplitude recovery.

Joseph Bonaparte Gulf marine "spark array" survey 1965. Seven test sections were made for study of the effect of filters, AGC etc.

SE Georgina Basin 1964. The multiple coverage work in Traverse F was reviewed. Static and dynamic corrections were revised, and particular stacking techniques aimed at discriminating against multiple reflections were attempted.

Vibroseis survey 1964. Comparison records showing the effect of changes in the Vibroseis recording parameters were put into section form. Noise test sections were produced with various filter settings and AGC. These sections are to be included in a report on the experimental survey.

Southern Carnarvon Basin 1963. Cross-sections were produced for inclusion in a Record.

SE Georgina Basin 1963. Attempts were made, using delay-line filtering, to eliminate reverberations from a seismic cross-section.

Mount Schank subsidised seismic survey 1967. The multiple coverage work was reviewed for study by the Subsidy Group.

General. Further processing to be done in 1967 will include Roma Shelf 1967, Ngalia Trough 1967, and East Otway Basin 1967 cross-sections.

Seismic surveys

East Otway Basin seismic survey, Victoria. From February to June, Seismic Party No. 1 was engaged on a four-months seismic survey in the Geelong area with the object of improving knowledge of structure and sedimentation in the northern and eastern parts of the Otway Basin. It was originally planned that the survey should extend into the Colac-Winchelsea area, but lack of time prevented this. The work was mainly confined to the Geelong-Anglesea-Cape Schanck area on land.

The survey commenced with Reflection Traverse A, surveyed in a more or less east-west direction on the Bellarine Peninsula north of Lake Connewarre (Plate 5). The best reflections recorded were from shallow depths and for this reason comparatively short split spreads, 900 feet long, were employed throughout the survey. On Traverse A, correlatable events were recorded down to about 0.5 second, particularly on the western half of the traverse, but some of the deeper of these events are probably multiples. The seven-mile-long reflection traverse crossed a fault evident at the surface about half way along its length. Reflection quality was generally better west of the fault than east of it, but along the whole of the traverse the shallower events indicated gentle dips to the east or no dip at all. Many of the poorer quality events recorded later than 0.5 second were probably diffractions, reflected refractions, or multiples, but it is possible that some more or less horizontal reflections were recorded up to about 3 seconds.

Reflection Traverse C, about 3 miles long, was surveyed at right angles to Traverse A, about half way along it and just west of the fault. As on Traverse A, the most reliable, correlatable reflections were recorded at less than 0.5 second. On the southern half of the traverse these reflections indicated northerly components of dip, but on the northern half little dip was indicated. Beyond 0.5 second many other events were recorded, but it is thought that, as on Traverse A, many of these were diffractions, reflected refractions, or multiples.

The highest refraction velocity recorded west of the fault on Traverse A in the course of a refraction probe was about 14,500 ft/s. The depth to this refractor was indicated to be about 2000 feet. A north-south refraction probe, Traverse D, was surveyed east of the fault on Traverse A. A refractor with true velocity of 17,000 ft/s and depth about3500 ft was recorded on this traverse.

A reflection traverse was surveyed westwards from near Queenscliff for about seven miles to cross a gravity gradient on the western side of a gravity "low" in Port Phillip Bay. Correlatable reflections were recorded from depths of up to about 1300 ft near Queenscliff. These reflections were evidently from Tertiary sediments which become thinner to the west. A small amount of reflection shooting was done in

the Portsea-Sorrento area south of the gravity "11w". In this area reflections were recorded from depths up to about 3000 ft. These reflections were probably also from Tertiary sediments.

A refraction probe was made parallel to the coast near Anglesea. The principal refractor recorded had a velocity of 15,700 ft/s and occurred at a depth of about 1900 ft near Anglesea; this is about the depth to the top of the Lower Cretaceous Otway Group as indicated in Anglesea No. 1 bore. The refractor dips south-west.

Ngalia Basin joint project, NT. Seismic party No. 1 commenced two months of preliminary seismic work in the Ngalia Basin in September. This is part of a joint study of the Basin by the Geological and Geophysical Branches. A reflection traverse about 20 miles long was surveyed in a north-south direction near the northern margin of the Basin about 20 miles east of Vaughan Springs homestead (Plate 6). Because of hard drilling it was possible to use only one shot-hole per shot. Eighteen hundred foot split spreads were employed with 24 geophones per trace in two rows of 12 parallel to the traverse. Reflection quality varied from poor to fair. A number of reflections were ontained at times up to1.5 seconds, which corresponds to a depth of about 10,000 ft. Over most of the traverse indications were that sediments dip fairly gently north. In the vicinity of the Vaughan Springs to Yuendumu road there were indications of major faulting, possible with some associated folding.

An east-west refraction probe 12 miles long was surveyed at right angles to Traverse A. Three miles of reflection profiling near the centre of this traverse (Traverse B) indicated that the sediments have little east-west dip. Refractors with average velocities of about 12,400, 14,500, and 20,500 ft/s were recorded, with average depths of about 300, 1400, and 8000 ft respectively. The depth to the deepest refractor corresponds well with the maximum depth of reflections on this traverse. It is probable that this refractor represents igneous or metamorphic basement.

Roma Shelf seismic survey. In June 1967, Seismic Party No. 2 began an experimental seismic survey in the Roma area. This will continue into 1968. It is an attempt to use the seismic method to study stratigraphic problems associated with the accumulation and trapping of oil and gas in this part of the Surat Basin. The three general problems were:

(a) Porosity and permeability changes in the Precipice Sandstone, and their effect on oil and gas accumulation.

(b) Thickening of the Boxvale Sandstone west of the Roma Shelf.

(c) The wedge-out of Permian sands on the eastern flank of the Shelf.

These problems are being tackled by the use of synthetic seismograms (made from sonic logs of local wells) to define the stratigraphic changes in seismic terms, by careful seismic shooting at these wells to attempt to duplicate the synthetic records, and by continuation of this careful shooting between wells to trace the stratigraphic changes. Field data are being processed by the latest techniques, including digital processing.

The survey began in the Richmond Oil and Gas Field. Here there are many wells; some produced oil, some gas, and some were dry. The controlling factor appears to be rapid changes in permeability in the Precipice Sandstone. Synthetic seismograms were made for Richmond Nos. 1, 2, 3, and 4 and Applegrove No. 1. Up-hole tests and noise spreads were made at various places to study the critical seismic parameters of the area, and these suggested the design of shooting techniques to be tried first. The up-hole shooting soon revealed that ghost reflections were a problem, so all the shooting done to date has been duplicated at two depths to enable ghosting to be removed later in the processing stage.

An initial test traverse (Traverse A, Plate 7) was run from Richmond No. 3-No. 1-No. 2, using two different geophone and shot patterns and shooting at both 140 ft and 100 ft. The pattern considered slightly superior uses unusually short pattern lengths; it retains more high frequencies and thus improves the resolution and character of records.

Multiple interference has been suspected and for this reason a trial Common Depth Point line (Traverse C) was shot using six-fold coverage. No significant improvement was noted, however, so subsequent shooting has used only single coverage.

Further shooting has been done from Richmond No. 1 westward through Richmond No. 4 and Applegrove No. 1, and some test shots at Duarran No. 2. Another line has been shot from Ingle No. 1 through the Richmond field to Blythewood No. 1.

Timor Sea marine geophysical survey. The 1967 marine geophysical contract was awarded to United Geophysical Corporation. The amount involved is $508,000, and the survey is expected to cover 16,000 line miles of seismic sparker, gravity, and magnetic traverses in the Timor See (Plate 1).

Instrument systems on the survey vessel "Wyrallah" were tried out on the voyage from Brisbane to Darwin. Most of September was spent in Darwin or on two short cruises. During this period there was some trouble with the VLF navigation system, mostly due to interference from North West Cape VLF signals and to operator inexperience. Also there were teething troubles with the new 6-channel Chesapeake seismic streamer, mostly due to water leaks at connexions.

During the first long cruise the ship covered about 5000 line miles. However, the 6-channel streamer was lost, and a Chesapeake "Towflex" single-channel streamer has since been used in its place. The Askania gravity meter, the magnetometer, and the seismic apparatus all performed well on this cruise. The VLF navigation system gave acceptable position control, but velocity information, critical for gravity reductions, was of marginal accuracy; the sonar doppler system was not functioning properly and the VLF fixes were not accurate enough for this purpose. The underwater gravity meter used to check drift control had a large tare in its readings, and did not recover by the end of the cruise; thus it did not serve its purpose.

After a period in Darwin for crew rest and instrument checks the ship began a 28-day second cruise at the beginning on November. It is believed that the sonar doppler system has now been improved so as to operate from deep water back-scatter, and improved procedures with VLF reductions should increase their value for velocity information. These procedures include correction for standing waves due to long-path VLF interference. The survey is expected to finish in December.

2. METALS

Ground surveys

Dobbyn-Kamileroi, Qld (copper). The 1967 Dobbyn-Kamileroi geophysical survey was planned to investigate three main areas: Area 1, near Kamileroi, where pronounced gravity and magnetic anomalies were to be investigated with the induced polarisation (IP) method; Area 2, north of Dobbyn, where several traverses selected as a result of the 1963-64 gravity survey were to be investigated with IP; and Area 3, at Dobbyn, where a Turam anomaly detected ny Gardener in 1963-64 was to be further investigated by Turam using large loops in a variety of sizes and configurations.

Work commenced in Area 3 where eleven traverses 1600 ft long and 400 ft apart were pegged at 50-ft intervals. The eleven traverses were surveyed with Turam using two large primary loops, one east and one west of the north-south anomaly. Three traverses were selected and re-surveyed from an additional five loops and three grounded cables. The results with various primary sources all detected the anomaly, and variations in size and shape of the anomaly were studied as an aid to interpretation.

The work in Area 2 consisted of three main east-west traverses about five miles long surveyed with IP and gravity. Some IP anomalies were detected, and additional traverses were added to outline them. One traverse was surveyed magnetically. A preliminary interpretation of the results indicates several areas of possible copper mineralisation, and drilling may be recommended.

The party shifted camp to Kamileroi on 9 October to commence the work in Area 1in which Eastern Prospectors are interested. A large gravity anomaly flanked by two magnetic anomalies has been detected, and one drill hole has been put down on the centre of the gravity anomaly. IP was attempted over the gravity anomaly and the neighbouring magnetic anomalies but the low resistivity (about 10 ohm-metres) of sedimentary material overlying the crystalline bedrock prevented adequate depth penetration. Excessive coupling effects were present and made the use of frequency domain equipment unlikely to be effective. The gravity and magnetic work were extended to completely cover the larger magnetic anomaly, and some resistivity depth probes, using expanding Wenner arrays, were carried out to sample the thickness of low-resistivity material.

Some Afmag tests were made in various places during the survey. These were generally not very successful but provided useful experience in the operation of the instrument.

Chewton-Castlemaine, Victoria (gold). During February and March 1967 a geophysical survey was conducted in the Chewton Goldfield near Castlemaine, Victoria, to assess the applicability of geophysical methods in the search for auriferous reefs. This survey was a follow-up of a previous test survey (Williams, 1965) which revealed a significant IP anomaly near the Mona workings. It was hoped that the anomaly was indicative of mineralisation associated with the Mona reef.

A grid was laid out over the old Mona surface workings and the area was surveyed with the Turam electromagnetic and IP methods. The magnetic and S-P methods were also tried but were discontinued because they gave no information on geological structure or location of mineralisation. Several reconnaissance IP traverses were also read outside the Mona area to test the response of other known auriferous reefs.

The Turam results obtained were characterised by numerous anomalies aligned along the general strike direction. They were indicative of shallow poorly conducting zones unrelated to the Mona reef. It is unlikely that the Turam anomalies indicate mineralisation.

The IP anomaly associated with the Mona reef as outlined in the 1965 survey was relocated during the present survey. The extend of the anomalous zone was investigated over a total length of 2700 ft. The apparent resistivities were strongly influenced by near-surface effects, and the resistivity pattern had an undue influence on the metal factor anomalies. Frequency effect anomalies, however, were well defined and the interpretation was largely based on them. The IP results indicated a zone of mineralisation at depth in the western limb of the Mona anticline apparently unrelated to the original Mona reef.

It is impossible to determine from geophysical results whether such mineralisation is auriferous, but the presence of pyrite is indicated and suggests the possibility of a gold reef. Such occurrences are known in the Wattle Gully mine. Two drill holes were recommended to test the geophysical results.

Three reconnaissance traverses surveyed with the IP method outside the Mona area showed numerous anomalies, many of which occurred over known gold-bearing reefs. These could provide additional drilling targets if the drilling tests confirm the usefulness of the method.

Strangways Range, NT (copper). A metalliferous geophysical survey was made in the Strangways Range area (Plate 8) from May to August. Its aim was to investigate minerals in an area of several hundred square miles in which many copper prospects are located. IP, Turam electromagnetic, S-P, and magnetic methods were used.

Geophysical reconnaissance work extending over about one square mile near the Pinnacles workings did not reveal anomalies worthy of further examination. There was no geophysical anomaly associated with two outcrops mapped as gossans, and there were only minor anomalies associated with known occurrences of near-surface mineralisation (Ciccones, Pinnacles workings).

A detailed survey of the New Folly mine gave reasonable Turam results but no S-P and only very weak IP response. At this mine, secondary copper mineralisation in a 2½ foot wide quartz vein has been exploited to a depth of 35 ft. Although the vein appears to widen with depth, the geophysical results suggest that mineralisation will cut out at a depth less than 100 ft. Drilling recommendations were made in this area mainly to help with the interpretation of the Turam results.

Interesting magnetic, S-P, IP, and Turam anomalies were obtained over the Peko grid on Johnnie's Reward prospect. In 1965 this area was surveyed by Geopeko Ltd, using magnetic and S-P methods.

A hole drilled by Geopeko at 60° inclination to a depth of 463 ft intersected patchy chalcopyrite between 146 and 261½ ft. Geopeko's drilling appears to have aimed for a target at 340 ft vertical depth. The present investigations suggest the existence of a shallow boss-like body. The IP results obtained over Johnnie's Reward prospect are the best results recorded during the current survey. Frequency effects of 4% to 5% in a well defined anomalous zone contrast with a background of less then 2%. High apparent resistivities cause low metal factors.

At least three separate anomalies have been found in the area north of Johnnie's Reward. Some of these are accompanied by S-P and Turam anomalies. Drilling recommendations were made to test a promising anomaly on Traverse 4800N. This anomaly appears to be associated with a quartzite which shows ferruginous staining and many small holes similar to boxwork, but in which no copper mineralisation is apparent. Although the individual anomalies are small the total length of the anomalous zone north of Johnnie's Reward together with the Johnnie's Reward prospect itself could make this area quite attractive.

Tennant Creek, NT (gold & copper). From August to October a ground follow-up survey of low-level aeromagnetic anomalies was carried out in the Tennant Creek area (Plate 9). Anomalies delineated by the 1966 and 1967 airborne surveys were investigated. The survey was done using the McPhar model M700 fluxgate magnetometer. Location of anomalies on the ground was difficult because of lack of suitable topographic features near them. Usually the shape and position of anomalies were delineated by a group of widely spaced traverses at the estimated location; then a traverse was surveyed on the maximum of the anomaly. Traverses over selected anomalies were read also with the gravity meter, and anomalies coincident with the magnetic anomalies were obtained.

Work commenced in areas 2, 3, and 6 (Finney's 1966 survey) where several drilling targets have been delineated. Anomalies C5, C6, C7, C11, C13, A1, A2, and A5 (Shelley's 1967 survey) were also investigated.

Eight traverses were observed in the Burnt Shirt area where two holes drilled by NT Administration failed to find magnetic material. A new target 600 ft deep was recommended and is being drilled at present. An area 6000 ft square was surveyed in the Great Western area, where a geochemical grid exists.

The Parker Gay curve fitting method of interpretation appears to give reasonable fits to most magnetic anomalies. This method was used in preference to the Daly method. Drilling targets in areas C11, C12, and C13, and area 3 have been recommended. Further targets may possibly be recommended after final interpretation of work in areas 6, C5, C6, and A5.

Mount Hardy, NT (copper). During late October and early November a short geophysical survey was made over mining lease 367H (Mount Hardy area) held by aborigine prospectors from the Yuendumu Native Settlement. The lease is outside the boundary of the Aboriginal Reserve and is accessible by a 20-mile track from the settlement.

The aim of the leases is to mine oxidised zone material by opencut method and to use the leaching process to extract copper. The NT Administration would welcome such a scheme employing native labour as part of its policy of rehabilitation of aborigines from the Yuendumu Native Settlement.

The Mount Hardy mineralisation is located in Precambrian mica-gneiss formations. The metamorphic rocks in the area have been intruded by several igneous bodies. Quartz and pegmatite veins up to 600 ft long and 10-15 ft wide have been mapped over the mining lease. Two distinct intrusions were observed, of which the earlier is mineralised.

The purpose of the geophysical work was to assist the Resident Geologist's Office, Alice Springs, to select targets in areas where outcrops are scarce and the geology unknown. Eighteen traverses were surveyed with the Turam and S-P methods. The results are being analysed.

Turam model tests. The 1967 Turam model tests were planned to complete the series commenced in Melbourne. Difficulties were experienced in finding a suitable testing ground, and the tests at Kowen Forest, near Queanbeyan, were not started until March. The present series was completed in June. The instrument used in 1967 differed from that of previous years, but the rest of the setup was unchanged. The modelling scale of 100:1 was maintained for the sake of continuity.

The tests have shown the practicability of surveying to the ends of the primary loop. The effects of changes in distance from transmitting source and changes of dip of the models were studied. Some modelling of fences was done also.

Several models surveyed with the old equipment were repeated, and the results obtained differed considerably from the earlier results. A check of equipment revealed that the ratio calibration of the older equipment was at fault. The new equipment showed a linear increase of resistance for an increase of ratio throughout the whole range of the ratio potentiometer, whereas the old equipment showed erratic resistance values for ratios from 0 to 0.5 and then a linear increase to a ratio of 2.0 for a maximum resistance value of 14.77 ohms. Conversion curves were drawn to correct all Turam ratios read with the old equipment.

The only available publication on Turam model tests is by Bosschart (1964). The results of this work are presented only as real and imaginary components, and hence a close comparison with the BMR tests is not possible at present. However, computing programmes were prepared to enable Turam results to be presented as real and imaginary components. These will enable a more realistic comparison of results with Bosschart's work and will also be useful for calculations of current concentration. The model tests conducted by BMR do not duplicate the work done by Bosschart but give detailed information on certain aspects of the tests which were only generally treated by Bosschart.

Airborne surveys

Herberton, Qld (VH-MIN). Preparations have been made to fly this survey during the latter half of November.

Western Victoria detailed aeromagnetic survey (VH-GEO). This survey was made at the request of the Geological Survey of Victoria, for the purpose of mapping the boundaries of Tertiary lava flows and locating "windows" within flows, which might be exploited for the mining of brown coal deposits in the underlying sedimentary sequence. It is a follow-up of an experimental survey made in 1966, which established that basalt boundaries could be positioned to within half a mile by the aeromagnetic method.

The survey covered the 1:63,360 sheet areas of Skipton, Lismore, and Rokewood (Plate10). The east-west flight-lines were 0.2 miles apart and the aircraft flew at a constant ground clearance of 400 feet. In accordance with the findings of the 1966 survey the data will not be contoured, because basalt boundaries are best delineated by the magnetic profiles.

As this survey did not commence until September, the results of the interpretative analysis of the magnetic profiles are not yet available. A preliminary examination of the data suggests, however, that the northern part of the Rokewood demonstrates a good correlation between the magnetic profiles and the known basalt boundaries. This correlation is less marked in the southern part of Rokewood.

SE Musgrave Block aeromagnetic & radiometric survey (VH-MIN). At the request of the SA Dept of Mines an aeromagnetic and radiometric survey of the eastern portions of the South-east Musgrave Block was made from July to October 1967. This survey covered 1:250,000 map area ALBERGA, and parts of WOODROFFE, ABMINGA, LINDSAY, EVERARD, and WINTINNA in north-western South Australia(Plate 11).

The Musgrave Block comprises a stable Precambrian platform flanked to the north by the Amadeus Basin, to the south by the Officer Basin, and to the east by the Great Artesian Basin.

(continues next page)

The stratigraphic succession consists of crystalline basement probably of Lower Proterozoic to early Carpentarian age, overlain unconformably by (?) late Carpentarian, Adelaidean, Ordovician, Mesozoic, and Tertiary sediments. The only known post-basement igneous rocks in the survey area are Adelaidean (Sturtian) basalts. Adelaidean and younger sediments are apparently not regionally metamorphosed. The major magnetic rocks occur in the crystalline basement and include basic dykes, minor iron formations, granitoid rocks, and the mafic and ultramafic intrusive Giles Complex. The latter frequently includes norite, which has been found to contain magnetite and is therefore expected to give rise to strong magnetic anomalies.

The magnetic interpretation indicated on the Plate correlates closely with the mapped geology over much of the region; the association of strong magnetic anomalies and trends with the Giles Complex is, however, not as obvious as was expected. Closer correlation is observed between the mapped dolerite dykes and both positive and negative trends. The latter are believed to be due to remanent magnetisation, and their extent and east-west trend make them similar to the negative features observed in the Goldfields region of Western Australia.

At several points correlation of positive trends with mapped faults is good, but little magnetic evidence was found for the postulated positions of the Mann Fault shown in the centre of the region. A more northerly position for this fault is compatible with the magnetic results.

In the east of the region many trends were found to cross the mapped Musgrave Block/Great Artesian Basin boundary with little change in magnetic amplitude or character. This is believed to indicate that the rocks of the Musgrave Block are only covered by a thin layer of basin sediments at the eastern boundary of the survey area.

Radiometric interpretation yielded approximately 60 point sources, and contouring showed some correlation with the geology. In particular, radiometric "lows" were recorded over the Mount Chandler Sandstone; "highs" over the Musgrave Ranges are of doubtful significance.

Sir Samuel and Duketon aeromagnetic and radiometric survey, WA (VH-MIN). At the request of the Western Australian Geological Survey, an airborne magnetic and radiometric survey was flown in the SIR SAMUEL and DUKETON 1:250,000 areas during the period May to mid-July, 1967. The area is situated in the eastern goldfields region and is part of the Archaean Yilgarn Block of the Western Australian Shield. The aims of the survey were to assist geological mapping and the prospecting for metals, particularly of nickel, which is associated with ultrabasic intrusions.

The magnetic pattern is almost entirely due to variations in the magnetic properties of near-surface rocks. To assist geological mapping, magnetic trends have been delineated and the area has been divided into a series of zones which are defined by the dominant anomaly amplitude range and by the degree of anomaly continuity between flight-lines (Plates 12 and 13).

Listed below are the zone types and a description of their geological significance.

Zone type	Anomaly range	Magnetic linearity
1	less than 50 gammas	poor
2	50 to 100 gammas	Poor
3	100 to 250 gammas	poor
4	greater than 250 gammas	poor
5	less than 100 gammas	good
6	100 to 250 gammas	good
7	250 to 500 gammas	good
8	greater than 500 gammas	good

Type 1 zones - Non-magnetic sedimentary rocks, homogeneous acid igneous masses.

Type 2 zones - Mainly normal granite.

Type 3 zones - Granodiorite, syenite, and other more basic forms of granite.

Type 4 zones - Basic and ultrabasic intrusions.

Type 5 zones - Sequences of alternating sedimentary and basic igneous rocks, basic pegmatites, and dykes.

Type 6 zones - Rock types similar to type 5 but with increased width and/or basicity of the magnetic strata.

Type 7 zones - Bedded lavas, basic intrusives, and banded iron formations.

Type 8 zones - Banded iron formations, basic and ultrabasic intrusives.

Within regions mapped as interbedded basic and sedimenatry rocks, the correlation between the magnetic data and geology is generally good. However, these regions appear to be more extensive than originally thought. In north-east DUKETON zones of types 6, 7, and 8 occur in a region mapped as Cambrian sediments. This region has been interpreted as containing basic rocks and banded iron formations.

Twenty-seven strike fold axes, four cross-fold axes, and one fault have been interpreted in the area. One of the cross folds and the fault have several mines located near them and so they are recommended for further investigation. Geologists have suggested that cross folding may have been an important factor in localising gold mineralisation.

The radiometric data revealed numerous 'highs' which were mainly correlated with granite outcrops. Sixty-two radiometric anomalies from localised sources were detected, thirty-nine of which are recommended for ground investigations.

Rum Jungle detailed aeromagnetic survey (VH-GEO). A detailed aeromagnetic survey of an area of about 200 square miles approximating to the Hundred of Goyder was completed from May to July 1967. The study of the magnetic data in relation to geological and drilling information and to the results of ground geophysical surveys by other methods is not yet complete, and only a preliminary assessment of the survey can be given at present.

Plate 4 shows the aeromagnetic contours at 50-gamma intervals superimposed on the geological map (Rum Jungle District, Special, 1960) and the preliminary structural interpretation.

The broad pattern of magnetic anomalies correlates fairly well with the known geology. The disposition of the anomalous zones over the sediments follows the trend of the sediments around the Rum Jungle Complex. The Mount Fitch Fault is clearly delineated by the abrupt change from the undisturbed area on the west to the strongly disturbed area on the east. The Giant's Reef Fault is less evident in the magnetic contours, although in places it is reflected by the termination of anomalies or changes in strike of the magnetic contours.

A possible east-striking fault is interpreted from the steep magnetic gradient along the southern edge of the anomalies in the Rum Jungle Triangle area. Other possible faults are suggested north and west of the Waterhouse Granite and in the Golden Dyke Formation four miles east of Batchelor Airfield.

In the north-eastern part of the survey area, strong anomalies (6 and 7) occur over the Acacia Gap Tongue and are flanked on the east by a zone of less intense anomalies occurring over the Golden Dyke Formation. The latter anomalies can probably be accounted for by amphibolite, which has been mapped at a few places within this zone. East of the Stuart Highway another anomalous area coincides with outcrops of Acacia Gap Tongue. The Woodcutters area shows little magnetic relief, and this may be related to a thinner section of the Golden Dyke Formation over the anticlinal structure. The anomalous areas to the west and east of Woodcutters are synclinal.

The anomalous zone east of the Stuart Highway extends south and swings west and continues through Area 65. Strong anomalies are associated with both the Golden Dyke and Acacia Gap and it does not appear to be possible to distinguish between these two formations on the basis of the magnetic results.

The intense anomalies in the Embayment Area south-west of Browns and in Area 55 are ascribed to the amphibolite revealed by the drilling in these areas. The source of the anomalies between Dolerite Ridge and Mount Fitch has been established by drilling as amphibolite mineralised with pyrrhotite and magnetite. The amphibolite in the Rum Jungle Creek South and Castlemaine Hill areas, however, appears to produce little or no magnetic effect.

The Coomalie Dolomite is shown in general to be non-magnetic, and this appears to apply also to the Celia Dolomite, except for the two anomalies (21 and 22) situated immediately north of Crater Hill.

The Crater Formation, east of the Rum Jungle Complex and north-west of Batchelor, has no associated magnetic anomalies, but elsewhere the magnetic contours follow the trend of the Formation, and several well-defined anomalies occur over the Crater Formation outcrop. These are anomalies in line to the west which apparently coincide with the contact of the Crater Formation and the Complex, and anomalies 20, 35, and 18 north of the Waterhouse Granite.

There appears to be little correlation between the magnetic results over the Rum Jungle Complex and the major rock units into which the Complex has been subdivided (Rhodes, 1965). The arcuate trend of the contours in the northern part of the survey area corresponds approximately to the southern boundary of the zone of granite gneiss, and this unit is possibly characterised by lower magnetic disturbance than other units of the Complex. The small isolated anomalies may be due to the amphibolite veins which intrude the Complex or to small outcrops of banded ironstone reported in a few places.

Tennant Creek detailed aeromagnetic survey, N.T. (VH-GEO)

During March and April 1967 a detailed aeromagnetic survey was made over three areas in the Tennant Creek mineral field. The areas, totalling 115 square miles, were chosen in collaboration with the Geological Branch and were of particular interest because of their location in favourable geological environments or interesting magnetic features detected in previous surveys in 1956 and 1960.

In Area A (Plate 15) the survey delineated a magnetic 'ridge' striking WNW. This is thought to be a belt of sediments of the Warramunga Group. Areas of low magnetic relief to the west and north of this 'ridge' were interpreted as representing granite and Cambrian rocks respectively.

In Area B(Plate 16), the magnetic contours have a general westerly trend which is intersected by a southerly trend in the western half. Several prominent positive and negative lineations have been interpreted, and a line of porphyry intrusives is thought to be reflected in the contour pattern, particularly in the eastern half. An anomaly of 910 gammas was recorded over the Warrego mine. A depth of 1450 ft was calculated for the centre of the body, and this compares favourably with the known depth of the orebody.

The southern part of Area C (Plate 17) is thought to be underlain by a porphyry mass, and several small circular anomalies near the margins of this mass have been interpreted as being due to ironstone bodies. The average depth to the centres of these bodies is 850 feet. A westerly striking magnetic 'ridge' was delineated in the north of the area, and the magnetic data suggest that the source of the 'ridge' is faulted twice within the survey area. An anomaly of 100 gammas occurs over the Jubilee mine, and a depth of 250 feet to the top of the body was calculated.

Twenty-six individual anomalies were analysed to obtain estimates of the depth and, where possible, the dip and susceptibility of the magnetic bodies. Several anomalies were recommended for further investigation, and those in Area A and C were investigated by a BMR ground magnetic party later in the year.

Experimental colour photography, N.T. (VH-GEO). At the request of the Geological Branch, photographic surveys were made at Rum Jungle, Tennant Creek and in the Ngalia Basin, NT. One of the recently acquired Vinten 70-mm aerial cameras was installed in Cessna aircraft VH-GEO for this work.

At Rum Jungle eleven traverses using colour film were flown at a ground clearance of 5000 ft followed by four traverses at 10,000 ft. At Tennant Creek eight similar traverses were flown at 3000 ft and one at 9000 ft. In the Ngalia Basin three traverses were made at 9000 ft ground clearance and four at 3150 ft, after which one of the traverses was reflown using panchromatic film.

Generally the results of this work were satisfactory, and 9" x 9" enlargements made from some of the colour negatives are quite impressive. A preliminary examination of the prints indicates that those taken with the 3" lens are suitable for stereoscopic analysis, but the wide-angle ($1\frac{3}{4}$") lens introduces too much distortion for stereoscopy. Either lens is capable of providing photographs of sufficient clarity for ground recognition control of aerial geophysical surveys, which is the purpose for which these cameras were acquired.

The detailed interpretation of these photographs is being undertaken by the Geological Branch.

Darwin Uranium Group

Introduction. Geophysical surveys were made in a number of areas in the Rum Jungle area as described below and shown in Plate 17A; this plate also summarises the main geophysical results.

Unless otherwise stated, traverses are 400 ft apart and stations are 50 ft apart. In the Slingram surveys, coil spacing was 200 ft and frequency was 1760 c/s. In the Turam survey, coil spacing was 50 ft and frequencies were 220 and 660 c/s. In the induced polarisation surveys, measurements were made in the frequency domain. Dipole-dipole electrode geometry was used. Dipole length was 100 ft and frequencies used were 0.3 and 3.0 c/s.

A method of depth sounding was developed in the laboratory using Slingram equipment. The method is currently being tested in the field over selected conductors in the Rum Jungle area.

Woodcutters area, Rum Jungle East. A Turam survey was made over the L5 geochemical anomaly in the Woodcutters area. The primary field was produced by a rectangular loop east of the area surveyed. The Turam results show no correlation with the L5 lode. The results are related to pyritic carbonaceous slate; variations in the Turam profiles are probably related to variations in composition of the slate and in depth of weathering.

A self-potential survey was made in the Woodcutters area over the L1, L2, L3, L5, and L6 geochemical anomalies and the areas between them. Self-potential anomalies were found coinciding in position with the L5 geochemical anomaly but offset from the sulphides intersected by diamond drilling. The relation of the self-potential anomalies to the lode is being studied.

Minor self-potential anomalies were found in the general area of the L6 geochemical anomaly. A self-potential anomaly was found on the western part of the L3 grid. The anomaly is associated with Turam and induced polarisation anomalies found in 1966. The anomalies were drilled (DDH 67-11) but no mineralisation was found.

The interpretation of geophysical data in the Woodcutters area is under review continuously during the current diamond drilling programme.

Area 44 Extended, Rum Jungle East. Detailed Slingram, self-potential, radiometric, and induced polarisation surveys were made in the Area 44 Extended to investigate radiometric, geochemical, and electromagnetic anomalies found in the 1964 reconnaissance surveys.

A number of strong Slingram anomalies associated with localised self-potential anomalies were found in the area shown in the plate. These anomalies are due to strong conductors within 100 ft of the surface. An IP survey was made over some of these conductors. The frequency effects were found to be remarkably large, and the apparent resistivities extremely low. This probably indicates a high carbon content in the conductors. No detailed interpretation has been done as yet.

In the western part of Area 44 Extended the boundary between conducting slate of the Golden Dyke Formation and poorly conducting Coomalie Dolomite is reflected in the Slingram results. A zone of Slingram and S-P anomalies was found in the northern part of the area. A surface radiometric anomaly was found in the Crater Formation in the western part of the area, and radiometric anomalies were found in the area of the 1962 Area 44 survey.

Coomalie Gap West area, Rum Jungle East. Detailed geophysical surveys were made in the northern and southern sections of the Coomalie Gap West area. The northern part was known to contain electromagnetic and radiometric anomalies, and the southern part was known to contain geochemical anomalies; these anomalies were found in the 1964 reconnaissance surveys.

Slingram, S-P, and radiometric surveys were made in the northern part. Much of this had been covered by the 1964 Slingram and radiometric surveys, and the 1967 Slingram and radiometric surveys were extensions of the 1964 surveys.

A strong S-P anomaly was found localised on part of one strong Slingram anomaly. Other Slingram anomalies have no S-P anomalies associated with them. The S-P anomaly may be due to mineralisation. An IP survey was made over the S-P anomaly, and frequency effect and apparent resistivity anomalies were found associated with the Slingram and S-P anomalies. A radiometric anomaly was found in the eastern part of the area surveyed.

Slingram and radiometric surveys were made in the southern part of the Coomalie Gap West area. Most of the area is Coomalie Dolomite, but Golden Dyke Formation occurs in the south-eastern corner of the area surveyed. No significant Slingram or radiometric anomalies were found. The stations in the Slingram survey were 100 ft apart on Coomalie Dolomite.

Acacia area. Reconnaissance Slingram and radiometric surveys were made in the Acacia area. Traverses were 2400 ft apart and stations were 100 ft apart. The area was selected because of favourable geological environment for mineralisation. No significant Slingram anomalies were found. The Slingram results can be correlated with geology and are useful in geological mapping of soil-covered areas. Plate 17A shows the boundary between Coomalie Dolomite and the Golden Dyke Formation as indicated in the preliminary interpretation of the Slingram results. Detailed interpretation may modify this boundary and should indicate further boundaries. Two radiometric anomalies were found; both are being investigated.

Mount Minza. The Mount Minza area is within the Gould area, south of Rum Jungle. A self-potential survey was made here over strong electromagnetic anomalies found in the 1965 survey. S-P anomalies were found localised along the axes of the electromagnetic anomalies. The reason for this localisation is not yet known; it may be mineralisation or an increase in carbon content of the conductors.

Gravity survey. A gravity survey was started in mid-August with the primary object of determining the behaviour of the eastern boundary of the Rum Jungle Complex. Traverses extend from within the Rum Jungle East grid westwards until they are in the Rum Jungle Complex. Stations are 100 ft apart in most cases. Preliminary reductions have been made using a density of 2.3 g/cm^3. Results indicate that the Rum Jungle Complex may be at shallow depth beneath the sediments east of the outcrop. The traverses are 2400 ft and 4800 ft apart. Selected intermediate traverses were surveyed to fill gaps in the gravity results, and one closure is to be followed up by auger drilling.

Mary River area. A geophysical survey of one week's duration was made in the Mary River area at the request of the Senior Resident Geologist, Darwin. A conductor was found under soil cover. The conductor extends for about 800 ft under the soil and appears to be an extension of a gossan that crops out north of the traverses surveyed. A magnetic and an S-P anomaly appear to be associated with the conductor. The final interpretation of the results is not yet available.

Radiometric Laboratory. During the field season a continuous programme of maintenance and repairs was carried out on equipment of the Rum Jungle geophysical and geochemical field parties and of various head office field parties. Maintenance and repairs were also done from time to time on the Darwin seismic observatory equipment, the radiometric assay equipment, and the drill-hole logging equipment.

Electric and radiometric logs were made of thirteen diamond-drill holes completed in 1967 in the Woodcutters area.

Slingram model experiments were continued during the wet season. Investigations were made of high-susceptibility models. Anomalies were produced similar to those obtained over magnetic amphibolites in the Rum Jungle area. It was shown that field results in areas containing high-susceptibility conductors require different interpretation from results in other areas. Depth sounding experiments using variable coil separations were made with the Slingram equipment. The Slingram equipment was subsequently modified to enable depth soundings to be made in

the field. A number of these have been made over selected conductors in the Rum Jungle area. Results appear reliable, but the method and equipment are still being tested. The interpretation of the depth sounding data requires the model experiment curves previously obtained.

3. ENGINEERING AND HYDROLOGY

Coastal erosion survey, Queensland

A marine geophysical survey was carried out off the south coast of Queensland between Coolangatta and Southport. The object of the survey was to provide some basic data for the feasibility study of a major coastal engineering project. The methods used comprised seaborne seismic reflection (using Sonar Boomer equipment), some land and sea seismic refraction, and shipborne temperature recordings. The seismic methods gave information about sub-bottom structures and the temperature survey provided some data about currents.

Infra-red photography

A series of infra-red and panchromatic aerial photographs was taken over North Stradbroke Island and Crib Island, Qld. The results suggest that infra-red aerial photographs can be used to indicate areas where excessive salt-water flooding exists. Further tests are suggested using different types of infra-red films.

Rabaul Crustal Investigation

The geophysical survey commenced during October 1967. Seismic Refraction and magnetic methods are being used. The field work is expected to finish by the end of November 1967.

Flow Through Porous Media - A.A.E.C. Lucas Heights

Forty-two model experiments were performed, investigating eleven types of porous materials. The relation between average water flow velocities and volume flow rates was investigated using radioactive travers, mainly bromine-82. The results obtained showed significant deviation from the commonly accepted Dupuit-Forcheimer assumption. A technique was developed using copper-64 and iron gauzes, to study the lateral dispersion of a tracer injected at a point.

Tidbinbilla Tracking Station seismic refraction survey

A seismic refraction survey was done to determine the depth to bedrock at the proposed site of a new dish antenna. The bedrock was found to be deeper than any excavation required for the cellar of the dish.

Miscellaneous

Mr E.J. Polak attended the 5th Australia-New Zealand Conference on Soil Mechanics and Foundation Engineering in Auckland, where he read a paper on the effect of geological environment on the properties of foundation rock. Tests were carried out at St John's Church in Reid, Canberra, to observe the effect of bell-ringing and organ-playing as possible causes of structural damage. Technical advice was given to the British Phosphate Commission about magnetic surveying at Christmas Island. One member of their staff was trained in the use of magnetometers. No opportunity occurred during the year to make tests on the effect of grouting of damsites or to experiment with the use of the induced polarisation method in hydrology.

4. REGIONAL SURVEYS

Regional Gravity Group

Visitors from overseas. Lieutenant-Colonels Pachimkul and Niamloy of the Royal Thai Survey Corps made gravity meter observations at Sydney, Canberra, and Melbourne in March. Mr H. Ishii of Geographical Survey Institute, Japan, made gravity observations in Sydney and Canberra in the course of ties to Tokyo from March to May. BMR co-operated in this, and the BMR pendulums were swung simultaneously throughout these observations.

Mr and Mrs B.C. Browne from Cambridge University also made pendulum observations in May at the National Gravity Base Station in Melbourne, as part of a programme of measurements along the Western Pacific Calibration Line. Mr Browne would also have made an accurate pendulum tie between Melbourne and Teddington, England, during a return visit to Melbourne in July. He became ill in Singapore, however, and had to cancel this visit.

Professor Grushinsky of the Sternberg Institute, Moscow University, visited the group frequently during January and February. He was on a five months' visit to ANU, mainly to study gravity data from Australia and Antarctica.

Mr Takao Seto, a pendulum specialist of Geographical Survey Institute, Japan, worked with the group from March to October, primarily on the pendulum programme. He held an Australian Overseas Award of the Dept of External Affairs. During his stay he made several visits to gravity field parties and studied the Isogal, helicopter, and marine projects.

BMR pendulums. The quartz pendulums and swinging chamber were returned to Australia in March after repairs and adjustments by the makers in Japan. The equipment was in use almost continuously for the rest of the year, mainly in laboratory testing. It was also used to investigate peculiar behaviour first observed during a tie between Sydney and Canberra. A tie from Canberra to Darwin was made between July and September. Some further planning was done for the modified electronics and recording unit.

Isogal surveys. The remaining airborne gravity ties for the Australian Isogal Project begun in 1964 were completed between July and September (see Plate 18). A ground party had prepared airstrips, established excentres, and prepared station descriptions for the remoter areas between April and July. Unusually heavy rain in the W.A. desert reduced the number of airstrips that could be prepared, and the plans had to be modified accordingly.

An Isogal survey of TPNG was made in June and July, including a tie to Homiara in the BSIP (see Plate 19). Final reports and network data for all Isogal surveys should be available early in 1968.

Control network analysis. Further progress was made towards the integration of all control measurements made in Australia by both local and overseas organisations.

Equipment. A new La Coste and Romberg gravity meter was received, but had to be returned to the maker for attention to a faulty heating circuit. It is again in service. All other gravity meters were serviced and evacuated as required.

Gravity meter performance investigations. A vacation student investigated long-term drift of La Coste and Romberg Meters Nos. G20 and G101. Both drifts were positive but that of G101 was at first outside the claimed limits. During the year, however, there was evidence of a turning point in the curve for G101, with negative drift during most of the year. Several unexplained jumps or tares appeared in the drift curves of both meters. Several of the jumps for G20 exceeded one milligal.

G101 was subjected to a brief cold test; the reading change due to a temperature differential of 60 centigrade degrees was almost negligible.

Two multi-meter, multi-observer calibrations were made in Canberra using three Worden and two La Coste meters. Between-observer scatter both in readings and in intervals was larger than expected. Further multi-meter data arose from a sub-base survey made in the Cootamundra area for the Sedimentary Gravity Group.

The group began a major analysis of meter performance as revealed in multi-meter data. This relies heavily on data from the three Isogal surveys and data from the establishment of calibration ranges in Australia. The analysis should be completed in 1968.

Eastern Papua regional gravity survey. This helicopter-borne survey was made between February and May. Some follow-up work was done for the adjacent 1966 Ultramafic Belt survey and some preparation was made for the following Isogal survey of TPNG. About 700 new stations were read. The Bouguer anomaly pattern shows marked gravity "lows" coinciding with solfataric activity. Marine gravity work would be valuable in helping to delineate the complex gravity pattern among the islands.

Automatic computing and mapping. The major programmes GRAVHTS and FIXSAF were rewritten during the year to conform with changes to the CSIRO CDC3600 computer. Minor programmes CREATE and ADDN were prepared as substitutes for FIXSAF during its rewriting. A new programme LOCATE was brought into use.

Preparation and computing of current and old surveys continued. About 15,000 old and 10,000 new stations were processed automatically. Rewriting of data and specialised punching of old surveys continued.

Regional Magnetic Group

A third-order regional magnetic survey was carried out in the southern half of Queensland during May-November. An area of 150,000 square miles was covered with a station density of one per 120 square miles. Several offshore stations were read by making use of a light-house vessel travelling between Brisbane and Townsville.

Minor surveys were made to meet requests by QANTAS Airways (Sydney) and the Royal Australian Navy (Nowra).

Development of the three-component fluxgate variograph intended for the first-order survey of Australia proceeded slowly. Determinations of temperature coefficients gave inconsistent results, but tests at Toolangi late in the year suggested that heavy insulation could reduce temperature effects to tolerable amounts.

The theoretical investigation of electromagnetic induction in the earth was pursued. A method was developed and refined for the plane case solution. The effect of lattice spacing on errors was investigated next, to determine the feasibility of extending the method to a realistic spherical model.

Magnetic data reduction proceeded satisfactorily. The policy of producing current data from the mainland observatories was introduced and proved practicable. At the beginning of the year the backlog was 29 observatory years; this had been reduced to 14 by the end of October.

5. OBSERVATORIES

Regular observatory programmes in geomagnetism and seismology were continued at Mundaring (W A), Port Moresby (T P N G), Toolangi (Victoria), Macquarie Island, and Nawson (Antarctica). Ionospheric data were also produced at the first two. Single-component seismic recording continued at Darwin, where time-control was improved by providing a receiver allowing direct recording of time marks. The magnetic and seismic observatories at Wilkes, Antarctica were closed down in January.

A seismic outstation at Kalgoorlie was maintained in full-time operation, and another established at Meekatharra in October. In TPNG, long-period seismographs of the crustal study project were operated at Tapini, Lae, and Kerema until June when they were replaced by short-period recorders at Lae and, later, at Goroka.

At Macquarie Island a Willmore seismograph was provided to try to discover a less noisy site close to the isthmus station, in an effort to improve this station's capability.

In Western Australia, refraction recordings were continued throughout the year, as the occasions arose, using large quarry blasts and undersea explosions. The formal experiment FRUMP was carried out in February in co-operation with the RAN. Seventeen depth charge explosions in the sea off Fremantle and Albany were recorded by the permanent seismographs and three field seismographs which occupied a total of thirty-three stations. Over 90 percent of first arrivals were recorded, and P-type phases were detected at more than 400 km.

During October-November the group assisted the Rabaul Crustal Project by providing three recording crews - one from Mundaring and two from Port Moresby.

Data or recordings for the 1966 seismic experiment CRUMP were received from most participants. First-arrival data were analysed by the time-term method to give estimates of refractor depths and P-wave velocities.

6. LABORATORIES

Design and Development Group

The Design and Development Group completed a useful number of projects during 1967. Output could have been considerably improved if more sub-professional staff had been available to assist the three professional officers.

Development work on proton magnetometers continued. Further minor improvements to the airborne magnetometer MNS1 were effected between surveys, particularly improvements to performance at high temperature. The ground station magnetometer MNS1 was also upgraded, and handbooks were written for both these instruments. Further improvements to the MNS1 are not considered worthwhile.

A new general purpose magnetometer, the MNS2, is now being developed. Although based on the MNS1 it incorporates many design improvements and makes use of integrated circuits to reduce size and weight and to improve reliability. The prototype should be ready for testing early in 1968. Some work was done on a "down-cable" polarising and amplifying circuit, but development has been postponed until the performance of the MNS2 can be assessed.

No new development work was done on fluxgate magnetometers, but two MFD3 units used by the Airborne Section were upgraded. This was made possible by previous development of the observatory 3-component magnetometer. It is planned to construct a new airborne fluxgate detector channel before the end of 1967. This too will incorporate the later developments, and will be more reliable than the MFS5 unit now in use.

Two calibrating sources for fluxgate magnetometers were completed during the year. These are the MCR1, which can be used to calibrate all BMR ground station magnetometers (MFR1 and MFO4), and the MCS1, designed specifically for the airborne magnetometer. The MCR1 handbook was written.

Five time signal units STA3 were designed, to provide time marks from radio signals; these were required for projects SWUMP and RUMP. The group also assisted in the specifying, testing, and installing of radio and timing equipment for these projects.

A high-reliability fail-safe voltage regulator PUR1 was designed and built for the Vulcanological Group of the Geological Branch. Two units were provided and a handbook was written.

A search coil and amplifier unit was designed and built to measure low-amplitude 50-c/s magnetic fields. It was used to determine the "noise" produced by a mains transformer similar to the one that is to be installed at the Kowen Forest test site. It was also used to measure the field amplitude in the Baas Becking Laboratory.

A magnetograph calibrator, the MC01, was designed for use at Macquarie Island. After the prototype had been demonstrated, the Observatory Section requested further units for installation at all BMR observatories; these units are to be made by sub-contractors.

The TMU1 observatory programming unit originally designed in 1964 for use at Wilkes was equipped with additional output circuits. The design of new programmers (TMU2) for all BMR observatories was commenced.

A control system for the Branch's 70-mm airborne cameras was designed and built. This permits remote operation of the camera from a timing system, and remote setting of the lens aperture.

Many instruments designed by the group require multiple d.c. power supplies. The d.c. converter can be used for these supplies. Investigation began, therefore, into the design of d.c. converters in the range 5 watts to 100 watts. Aspects investigated included the best type of transformer core; the optimum operating frequency; filtering components; and general circuit configuration. The results of this investigation were applied to the design of a converter for the VH-MIN digital scanner.

Design of equipment to permit automatic operation and print-out from microbarometers was commenced for the gravity group. This project is held up until a suitable printer is obtained.

Minor design modifications were performed on the Geoscience induced polarisation receiver to improve its stability and the repeatability of its readings.

The group completed the design, construction, and bench testing of a complete digital recording system for BMR's survey aircraft. The design broadly follows that of a prototype unit first built in 1959-60 but has several additional features. These include parity generation and checking, and provision for additional data such as navigation or scintillation counters. The new design incorporates the latest developments in integrated circuits and high-frequency d.c. to d.c. converters. Field testing of the equipment continues, and there are still a few minor faults to be removed.

A systems review was made for the seismic group, which is becoming increasingly concerned with marine seismic and gravity work. The aim was to investigate the use of common depth stacking, and of 24-hour operation to improve economy. Feasibility studies and some equipment modification and construction were undertaken. These included:

1. Feasibility studies of the use of common depth point with Spark Array techniques.

2. Investigation and recommendation of equipment required.

3. Detailed specification of data processing equipment required.

4. Investigation of navigation methods suitable for 24-hour operation.

5. Design and construction of a crystal clock and programming unit.

6. Modification of the C.G.G. Model 254 recorder for start-stop operation.

The group continued its functions of assessing the merits of new types and makes of electronic components and of standardising components used in BMR equipment. Several types of resistors, capacitors, switches, connectors etc. were assessed, but the main concern was with the various types of integrated micro-circuits now commonly used in BMR equipment.

As many equipment malfunctions are caused by dirty equipment and use of the wrong cleaning solvent, a survey of suitable solvents and cleaning equipment was commenced.

A 1000-c/s signal source was installed for accurate calibration of frequency measuring equipment. The signal is brought by PMG land line from the frequency standard at Mount Stromlo observatory and is amplified in a tuned amplifier designed and constructed for this purpose.

A vibration table and bump machine were set up in the environmental test laboratory in the basement. Their purpose is to simulate the mechanical environments found in mobile installations. By the end of the year the associated measuring equipment should be installed.

Maintenance and Testing Group

The repair and testing of geophysical field and laboratory equipment, which is this group's primary function, consumed most of the manpower available during the year.

The group also assisted in the assembling and testing of equipment for the marine seismic contract survey and the Rabaul seismic crustal project (RUMP).

Other branches of the Bureau, mainly the Geological Branch, were assisted with various equipment problems from time to time.

The rock testing laboratory carried out measurements of certain physical properties of rocks as requested throughout the year.

7. WORKSHOPS

New equipment was constructed and existing equipment modified and repaired as necessary by the Geophysical Workshops. Some of the major jobs were: refitting of a well-logging truck; construction of equipment for the modification and installation of marine spark array seismic profiling system on board ship; construction of a cable-handling winch; and construction of a third wide-angle camera for light aircraft. The construction of a second strip camera for VH-MIN was commenced and about half finished.

Further loss of staff occurred during the year in spite of repeated advertisements, and only two of the eight Instrument Makers' positions are occupied at present.

Many small requests from other Branches of BMR were handled.

8. MISCELLANEOUS INVESTIGATIONS

Airborne reductions

A computer programme for the reduction of aeromagnetic data on the CDC 3600 is being written under contract by CDC. Delivery was taken of the first of three stages of the programme, and this is currently being used on data from the S.E. Musgrave Range Survey for the production of reduced-scale magnetic profiles.

In the Amadeus Basin, reduction by standard methods was completed for Petermann Ranges, Ayers Rock, Kulgera, Bloods Range, Lake Amadeus, Henbury, Rodinga, and Alice Springs areas. Three sheets, Mount Rennie, Mount Leibig, and Hermannsburg, will be finalised within two weeks to complete reduction of this survey.

In the Goulburn Survey, the initial reduction and analysis were completed and the area may be finalised before 1968.

An area of Tennant Creek previously contoured at a 50-gamma interval was reworked at a 10-gamma interval to provide more information.

Regional gradient figures were prepared for the marine seismic and magnetic survey being undertaken north and west of Australia.

Surveys which are being flown and reduced under contract were supervised during the year. These are:

East Victoria River	-	Hunting-Adastra
West Victoria River	-	G.R.D.
Great Artesian Basin	-	A.M.E.G.

Palaeomagnetism

Astatic magnetometer. The construction and calibration of the astatic magnetometer were completed in March. Its sensitivity is 1×10^{-7} gauss/mm deflection; this lies conveniently between the sensitivities of ANU's igneous (2×10^{-6}) and sedimentary (2×10^{-8}) magnetometers.

New Guinea Recent basalts. The initial draft of a paper on this subject was completed in February and after several revisions is awaiting approval from Dr. Chamalaun. The paper is concerned mainly with the secular variation pattern shown by the directions measured.

Older New Guinea formations. The latest measurements on these rocks were compelted in May. The report of the results (which are mainly negative, due probably to surface sampling of weathered outcrops) is being written.

Bowen Basin study. The drilling of specimens from hand samples, and measurement of their natural remanent magnetisation, were commenced in March and are almost completed.

Rock magnetism

Rock samples were collected from a number of aeromagnetic survey localities for measurement of magnetic susceptibility and remanence. These measurements will assist in the interpretation of the aeromagnetic data. R. Gerdes received training from E.Manwaring in the use of the astatic magnetometer for measurements of remanence.

Gamma-ray spectrometer investigation

During the year a study of radiometric techniques was made and specifications drawn up for an airborne gamma-ray spectrometer. Tenders for this equipment were called in October, and delivery may be expected in 1968. When available it will be installed in BMR's new twin-engine Aero Commander aircraft which is being purchased to replace the Cessna-180 VH-GEO.

Flight testing of the gamma-ray spectrometer and the development of a system of data analysis and presentation have been programmed for the latter half of 1968.

Power spectral analysis of aeromagnetic anomalies

A power spectral analysis programme was written for the CDC 3600 computer at CSIRO. This was tested and corrected, and a special sub-routine was written to check the paper tape for errors.

A 340 mile long traverse across Tasmania at 10,000 ft was analysed. The covariance curve showed a peaking at a wavelength of 50 miles. This probably corresponds to a horizon at a depth of 45,000 feet below ground level.

No further work on spectral analysis has been done pending results from D.B. Johnson at the University of Tasmania, who is engaged in similar research. Current efforts are being directed towards the smoothing and filtering of aeromagnetic data in profile form.

Aeromagnetic maps of Australia

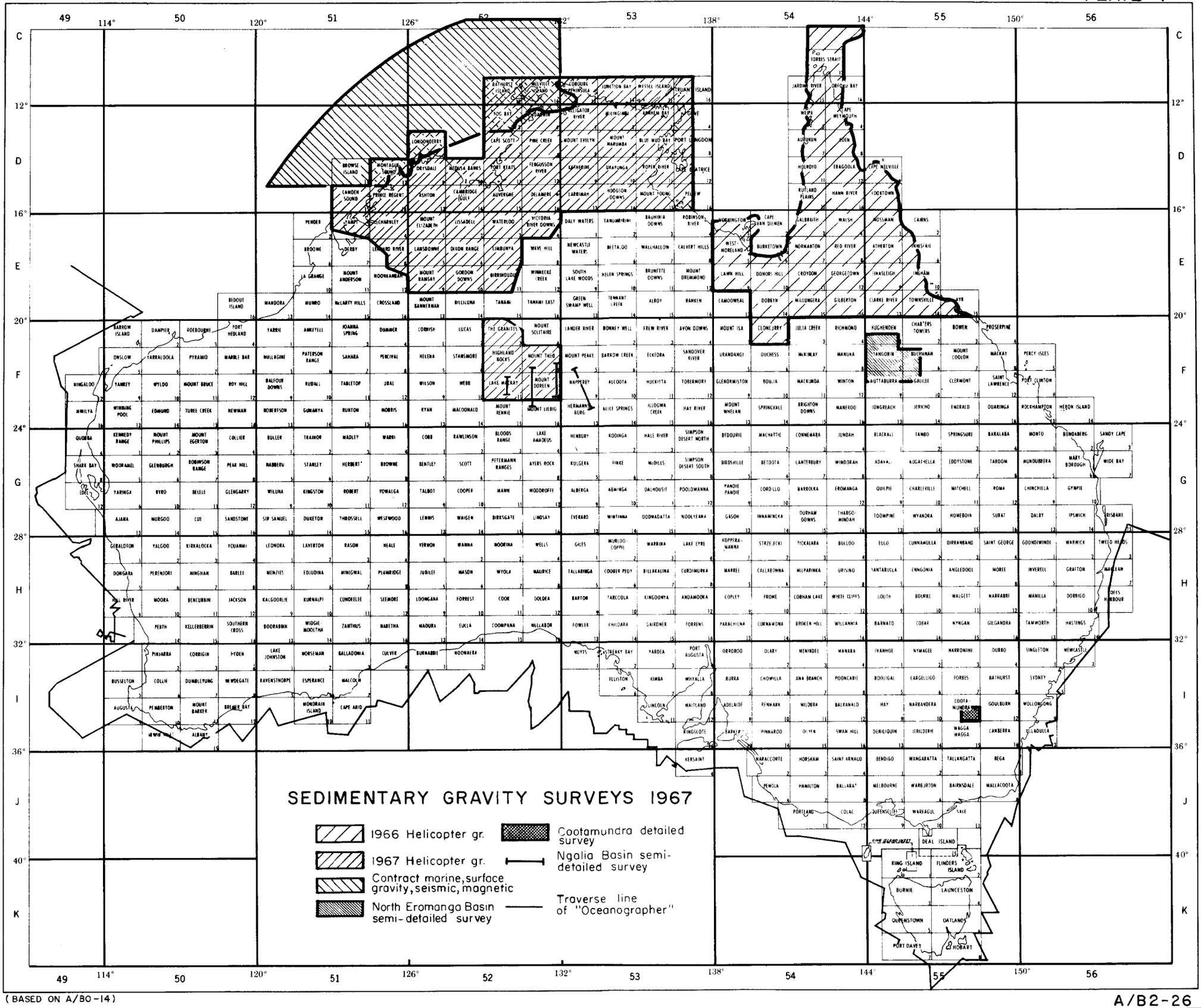
An aeromagnetic contour map and a magnetic basement contour map of Australia were compiled at a scale of 1 inch = 40 miles by the Geophysical Drafting Office under the guidance of D.B. Tipper. Work on this project was temporarily suspended following Tipper's resignation in June. Explanatory notes to accompany the publication of these maps have yet to be written.

Interpretation of contract aeromagnetic surveys

Northern Great Artesian Basin. The results of this contract survey are not yet available from the contractor. No interpretation has been started. The survey covered the 1:250,000 sheet areas of Julia Creek, Richmond, McKinlay, Boulia, Springvale, Hughenden, and parts of Mackunda, Manuka, Tangorin, and Muttaburra.

Western Victoria River Basin . The results of this survey are expected to be delivered to BMR in early 1968. No interpretation has been commenced. The survey covered the 1:250,000 sheet areas of Auvergne, Waterloo, Limbunya, and Birrindudu.

PLATE 1



(BASED ON A/80-14)

A/B2-26

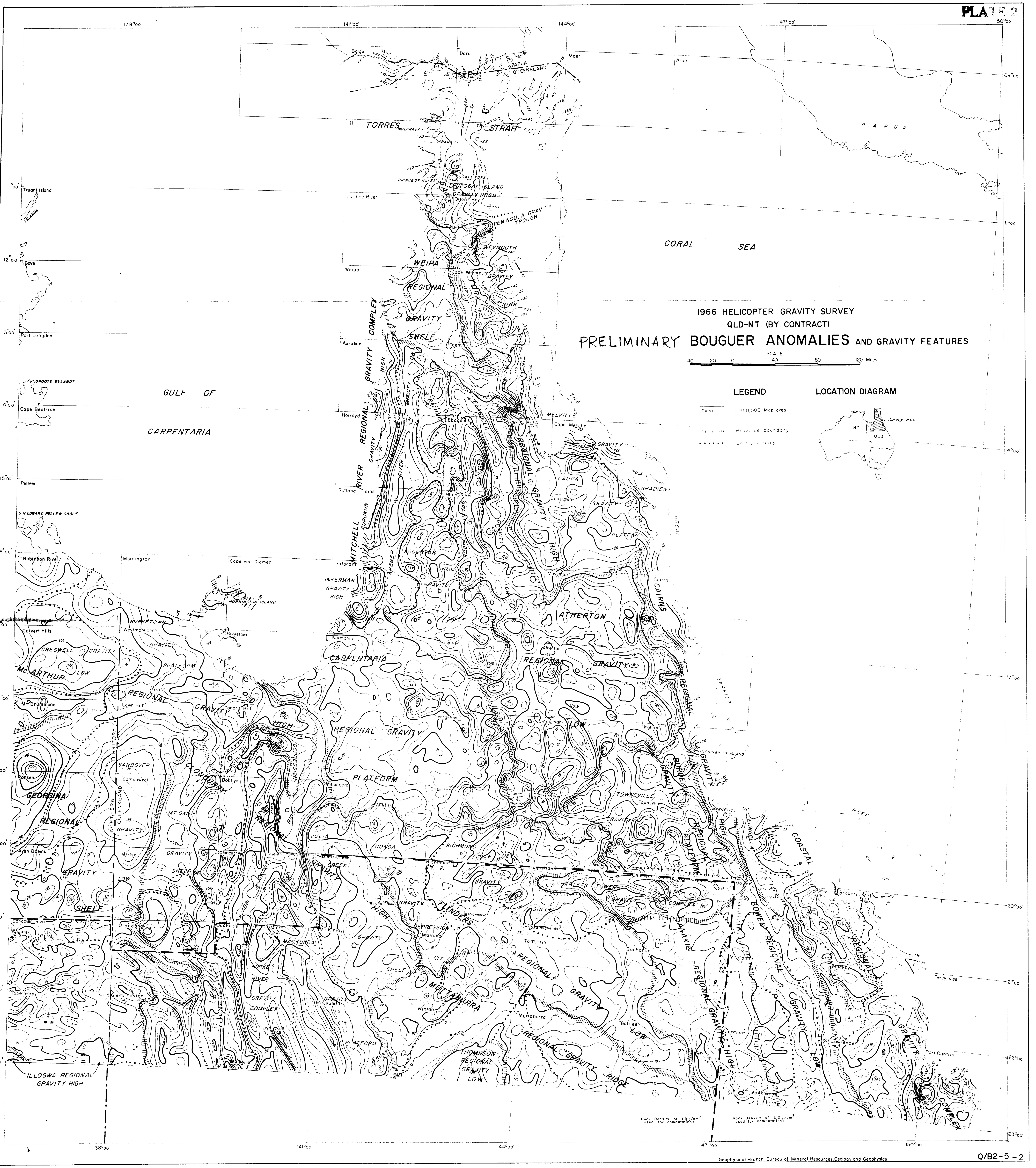


PLATE 2
1966 HELICOPTER GRAVITY SURVEY
QLD-NT (BY CONTRACT)
PRELIMINARY BOUGUER ANOMALIES AND GRAVITY FEATURES
SCALE
40 20 0 40 80 120 Miles
LEGEND
Coen 1:250,000 Map area
Province boundary
Unit boundary
LOCATION DIAGRAM
Survey area
NT
QLD
PAPUA
QUEENSLAND
TORRES STRAIT
CORAL SEA
GULF OF CARPENTARIA
THURSDAY ISLAND GRAVITY HIGH
PENINSULA GRAVITY TROUGH
WEIPA REGIONAL GRAVITY SHELF
YORK GRAVITY HIGH
MITCHELL RIVER REGIONAL GRAVITY HIGH
INKERMAN GRAVITY HIGH
ATHERTON REGIONAL GRAVITY LOW
CAIRNS
LAURA
GRAVITY PLATEAU
GRADIENT
CARPENTARIA REGIONAL GRAVITY PLATFORM
CRESWELL GRAVITY LOW
McARTHUR
BURKETOWN GRAVITY PLATFORM
GEORGINA REGIONAL GRAVITY SHELF
NORTHERN QUEENSLAND GRAVITY LOW
CLONCURRY
BURDEKIN GRAVITY HIGH
TOWNSVILLE REGIONAL PLATFORM
CHARTERS TOWERS GRAVITY COMPLEX
FLINDERS DEPRESSION
MUTTABURRA REGIONAL GRAVITY RIDGE
BURKE RIVER GRAVITY COMPLEX
ANAKIE REGIONAL GRAVITY HIGH
BOWEN REGIONAL GRAVITY LOW
COASTAL REGIONAL GRAVITY COMPLEX
THOMPSON REGIONAL GRAVITY LOW
ILLOGWA REGIONAL GRAVITY HIGH
Rock Density of 1·9 g/cm3 used for computations
Rock Density of 2·2 g/cm3 used for computations
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics
Q/B2-5-2

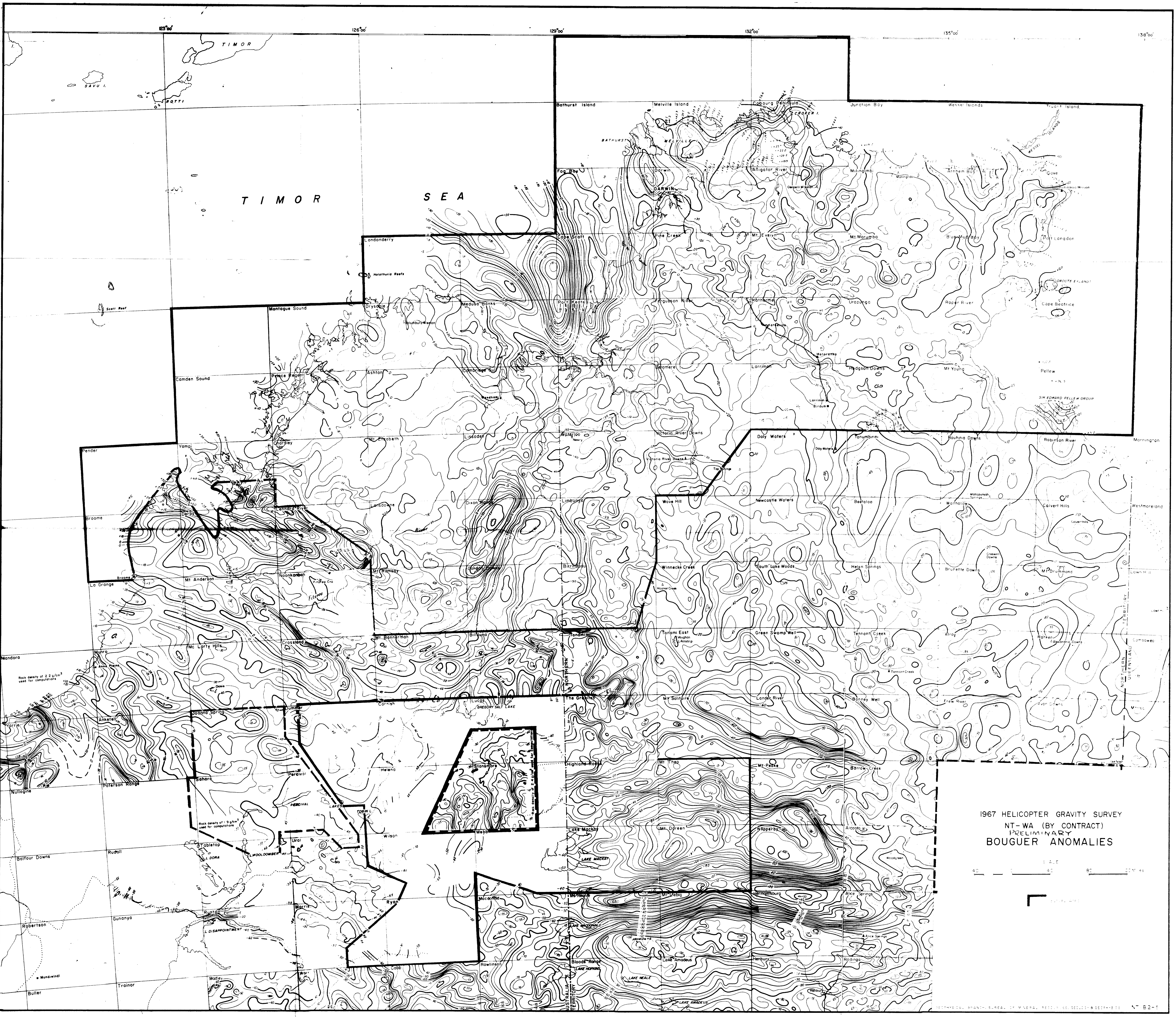

1967 HELICOPTER GRAVITY SURVEY
NT-WA (BY CONTRACT)
PRELIMINARY
BOUGUER ANOMALIES
123°00'
126°00'
129°00'
132°00'
135°00'
138°00'
TIMOR
SAVU I.
ROTTI
TIMOR SEA
Scott Reef
Bathurst Island
Melville Island
Cobourg Peninsula
Junction Bay
Wessel Islands
Truant Island
Fog Bay
Darwin
DARWIN
Alligator River
Milingimbi
Arnhem Bay
Gove
Cape Scott
Pine Creek
Mt Evelyn
Mt Marumba
Blue Mud Bay
Port Langdon
Londonderry
Holothuria Reefs
Port Keats
Fergusson River
Katherine
Urapunga
Roper River
Groote Eylandt
Cape Beatrice
Montague Sound
Drysdale
Medusa Banks
Camden Sound
Prince Regent
Ashton
Cambridge Gulf
Auvergne
Delamere
Larrimah
Hodgson Downs
Mt Young
Pellew
Sir Edward Pellew Group
Pender
Yampi
Charnley
Mt Elizabeth
Lissadell
Waterloo
Victoria River Downs
Daly Waters
Tanumbirini
Bauhinia Downs
Robinson River
Mornington
Derby
Lennard River
Broome
Lansdowne
Dixon Range
Limbunya
Wave Hill
Newcastle Waters
Beetaloo
Calvert Hills
Westmoreland
La Grange
Mt Anderson
Noonkanbah
Mt Ramsay
Gordon Downs
Birrindudu
Winnecke Creek
South Lake Woods
Helen Springs
Brunette Downs
Mt Drummond
Mandora
Munro
McLarty Hills
Crossland
Mt Bannerman
Billiluna
Tanami
Tanami East
Green Swamp Well
Tennant Creek
Alroy
Ranken
Camooweal
Rock density of 2.2 g/cm³ used for computations
Yarrie
Anketell
Joanna Spring
Dummer
Cornish
Lucas
GREGORY SALT LAKE
The Granites
Mt Solitaire
Lander River
Bonney Well
Frew River
NORTHERN TERRITORY
QUEENSLAND
Stansmore
Highland Rocks
Mt Theo
Mt Peake
Barrow Creek
Nullagine
Paterson Range
Sahara
Percival
Helena
Rock density of 1.9 g/cm³ used for computations
Wilson
Webb
Lake Mackay
Mt Doreen
Napperby
Alcoota
Tabletop
Urol
Balfour Downs
Rudall
LAKE MACKAY
Ryan
Macdonald
Mt Rennie
Mt Liebig
Hermannsburg
Alice Springs
Runton
Robertson
Gunanya
L. DISAPPOINTMENT
Morris
Bloods Range
Lake Amadeus
Henbury
Rodinga
Cobb
Rawlinson
Mundiwindi
Buller
Trainor
Madley
LAKE HOPKINS
LAKE NEALE
LAKE AMADEUS
WESTERN AUSTRALIA

PLATE 4

WALLENDBEEN

MURRUMBURRAH

HARDEN

COOTAMUNDRA

JUGIONG

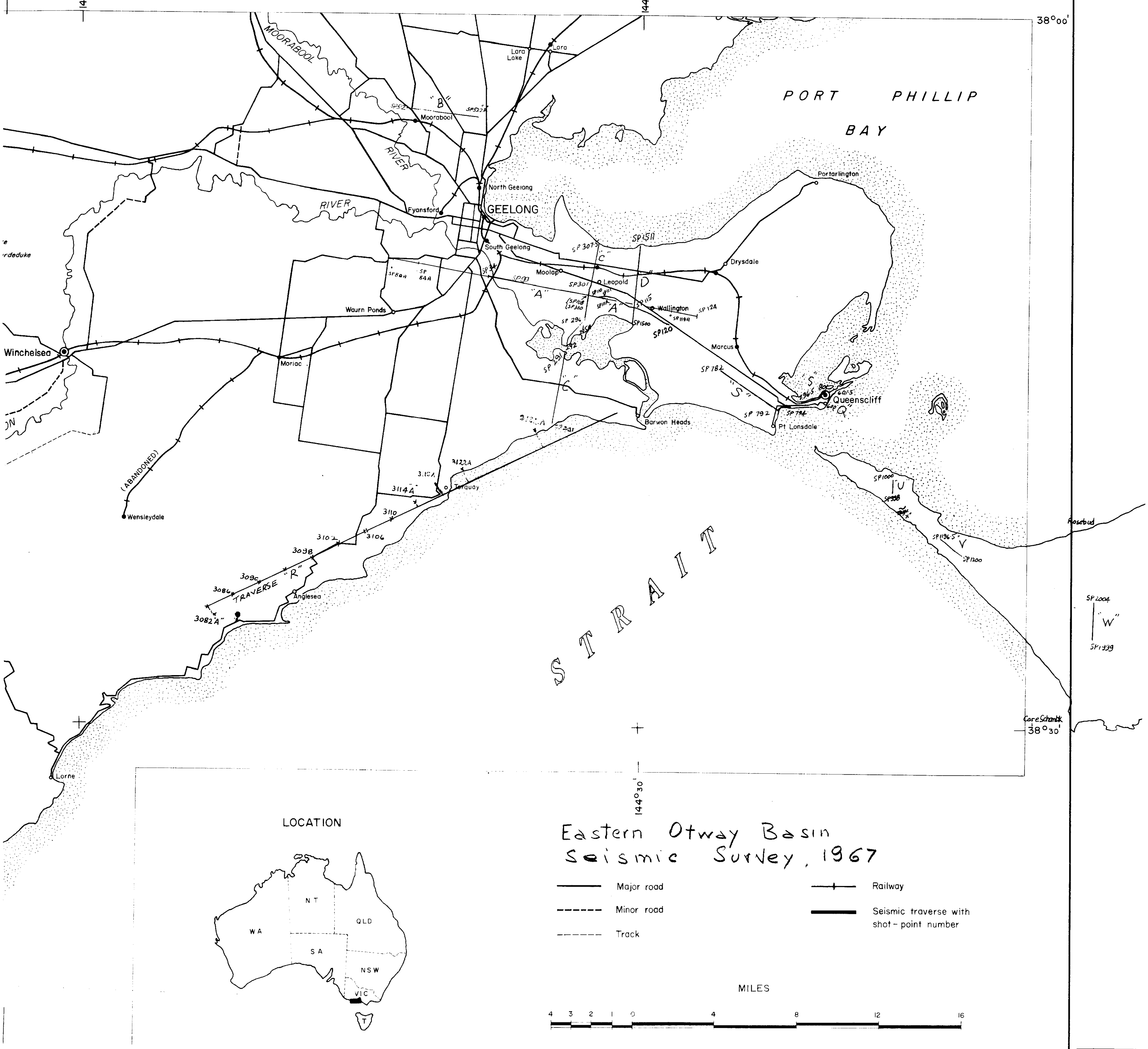
DETAILED GRAVITY SURVEY
COOTAMUNDRA AREA N.S.W

SCALE

MILES 0 1 2 3 4 MILE

I55/B2-29

PLATE 5



144°00'
144°30'
38°00'
38°30'
PORT PHILLIP BAY
STRAIT
MOORABOOL RIVER
RIVER
Lara Lake
Lara
Moorabool
North Geelong
GEELONG
Fyansford
South Geelong
Moolap
Leopold
Drysdale
Portarlington
Wallington
Waurn Ponds
Winchelsea
Moriac
Marcus
Queenscliff
Pt Lonsdale
Barwon Heads
Torquay
Anglesea
Lorne
Wensleydale
(ABANDONED)
Rosebud
Cape Schanck
TRAVERSE "R"
"B"
"A"
"C"
"D"
"S"
"Q"
"U"
"V"
"W"
SP 1511
SP 1500
SP 120
SP 124
SP 782
SP 792
SP 794
SP 1000
SP 1196.5
SP 1200
SP 2004
SP 1999
3122A
3114"A"
3110
3106
3102
3098
3094
3086
3082"A"
LOCATION
NT
QLD
WA
SA
NSW
VIC
T
Eastern Otway Basin Seismic Survey, 1967
Major road
Minor road
Track
Railway
Seismic traverse with shot-point number
MILES
4 3 2 1 0 4 8 12 16

22°00' 130°30' 45' 131°00' 15' 30' 45' 132°00' 22°00'

"MT DOREEN"

Mt Doreen △ NM/G/51

2758' △ Mt Hardy NM/G/50

Yaboogarrie Creek

Alice Creek

Keridi Creek

Gum Creek

Saltbush Bore

Palmungala Creek

Devonian SS. outcrops

SP1617

"VAUGHAN SPRINGS"

Ethel Creek

SP1601

TRAVERSE A

SP1585

TRAVERSE B

SP2032 SP2050 SP1579 SP2068

SP1558

△ Mt Davenport NM/G/126

Waite Creek

YUENDUMU

△ Mt Allan

B.M.R. 1967 SEISMIC TRAVERSES

Line 6 Line 4 Line 3 Line 1 Line 2 Line 5

PACIFIC AMERICAN OIL COMPANY SEISMIC TRAVERSES

"GURNER" "NEWHAVEN"

△ Mt Cockburn NM/G/124

LAKE EATON

Numerous Salt Lakes

23°00' 130°30' 45' 131°00' 15' 30' 45' 132°00' 23°00'

LOCATION DIAGRAM

REFERENCE TO AUSTRALIA STANDARD 1:250,000 MAP SERIES : MT DOREEN

LEGEND

Mission
Homestead
River or creek } Intermittent
Lake }
Track
Previous seismic survey

5 0 5 10 15 20 MILES

5 0 5 10 15 20 25 30 KILOMETRES

NGALIA BASIN

SEISMIC SURVEY 1967

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS ~~F52/B3-1~~

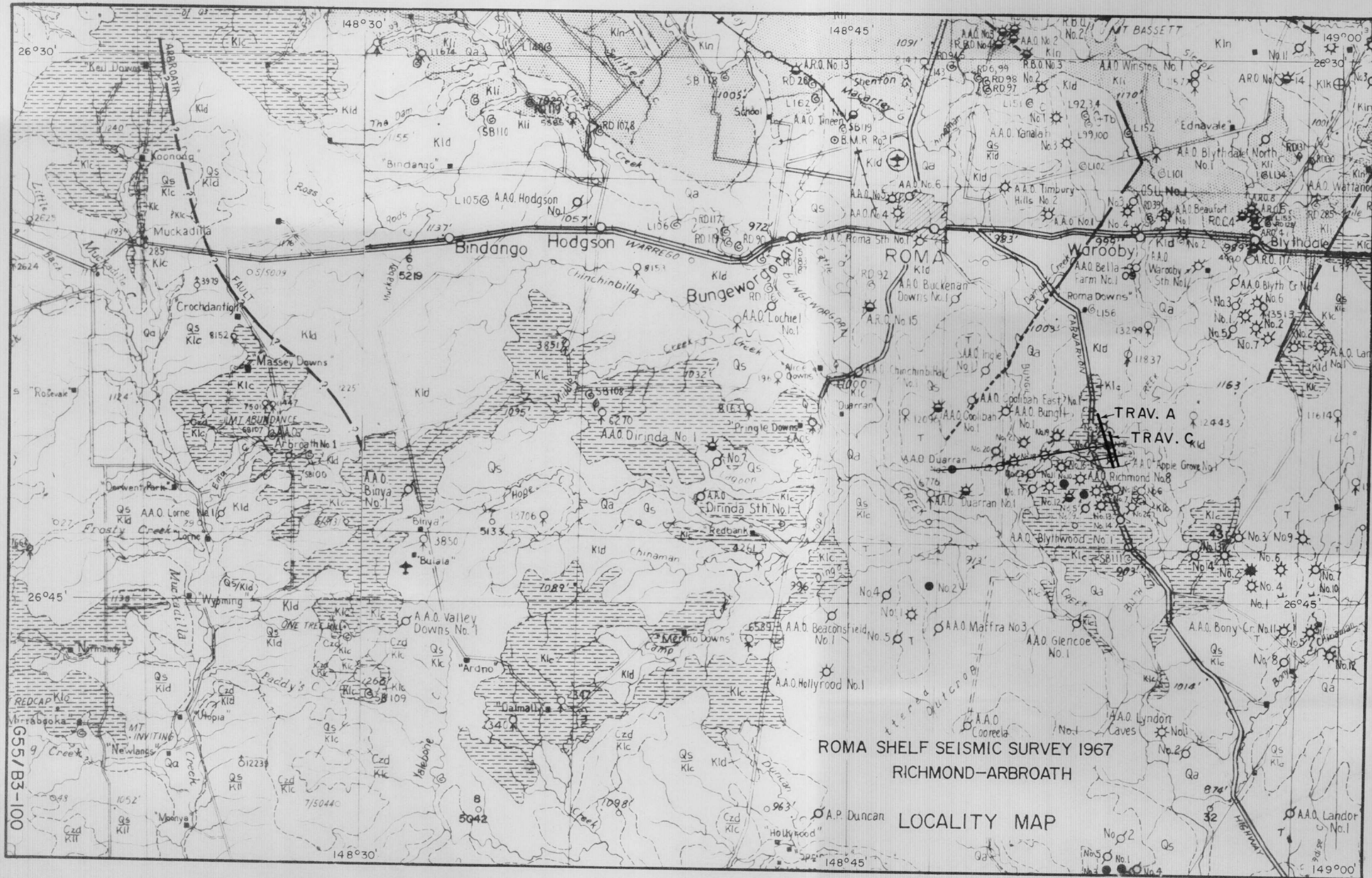
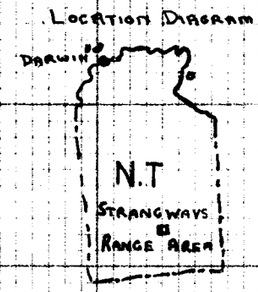


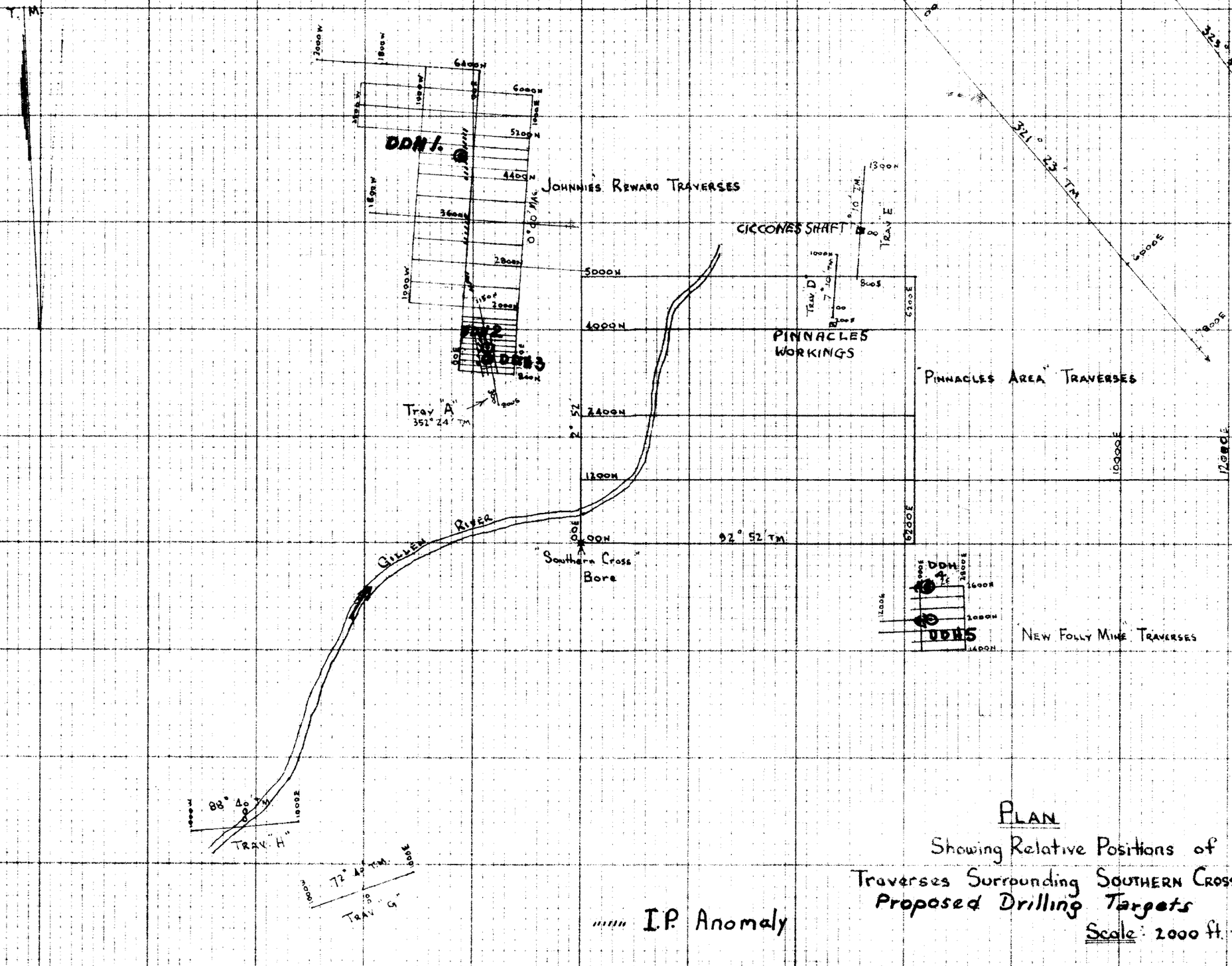
PLATE 7

G55/B3-100

PLATE 8

Location Diagram





PLAN

Showing Relative Positions of

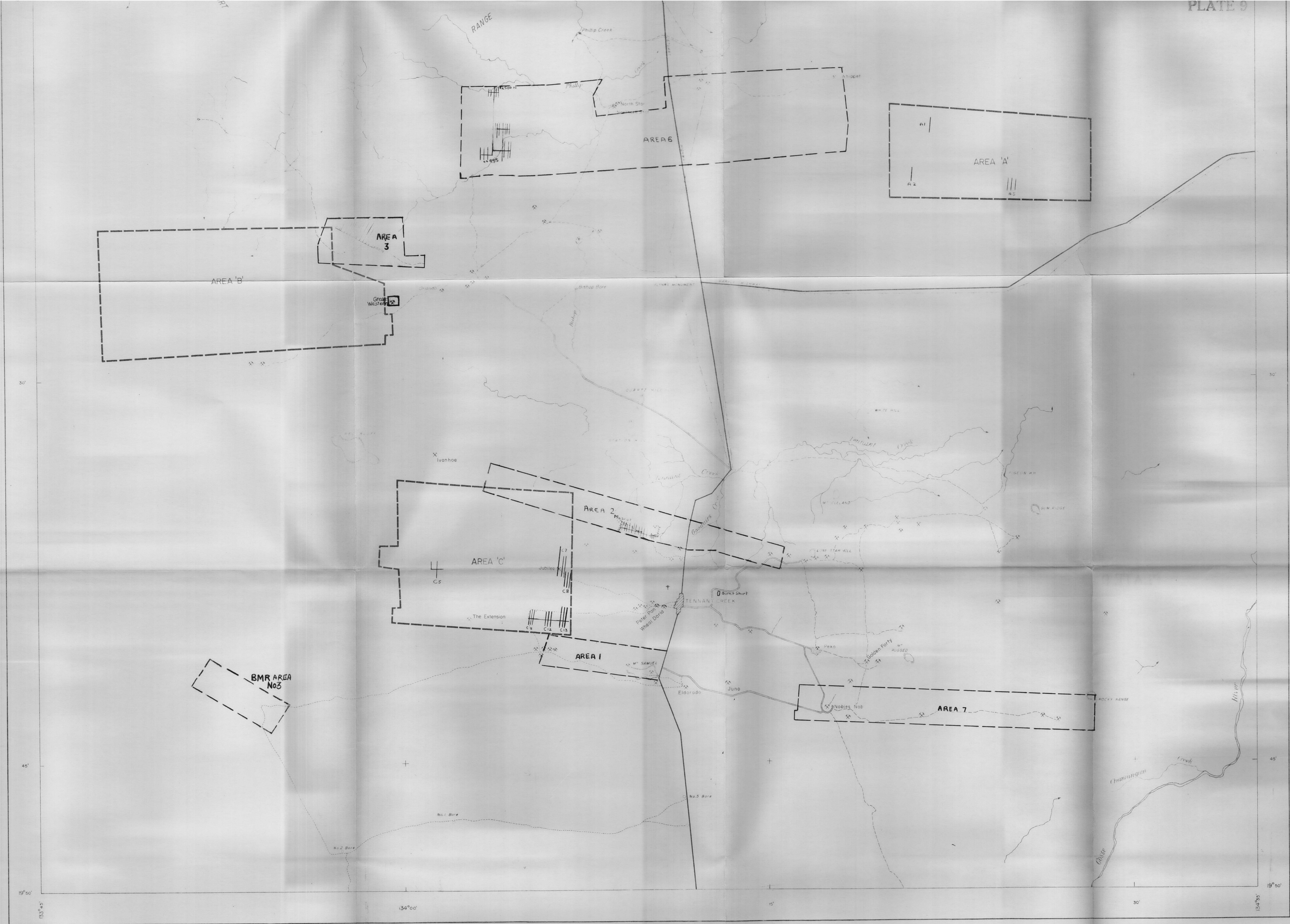
Traverses Surrounding SOUTHERN CROSS BORE ~ STRANGWAYS RANGE

Proposed Drilling Targets

Scale: 2000 ft. to an Inch.

I.P. Anomaly

Sept 1967



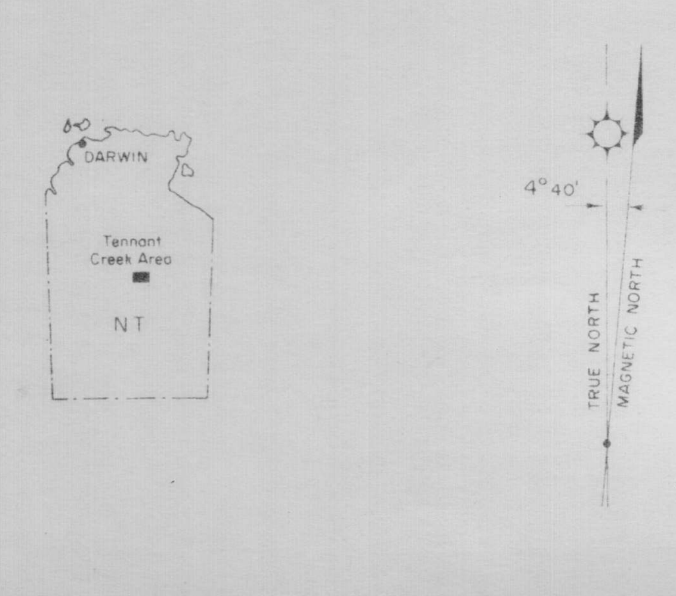
BASED ON G237/11-14, E53/80-46

DETAILED MAGNETIC SURVEY, TENNANT CREEK NT, 1967

PROGRESS REPORT FOR OCTOBER, 1967

LOCALITY MAP

LOCATION DIAGRAM



TOPOGRAPHICAL LEGEND

- River or creek
- Highway or main road
- Secondary road
- Road or track
- Bore
- Mine
- Aerodrome or landing ground
- Soil feature
- Approximate boundary of survey area

MILES 2 1 0 2 4 6 8 10 12 14 16 18 20 22 MILES

KILOMETRES 2 1 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 KILOMETRES

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

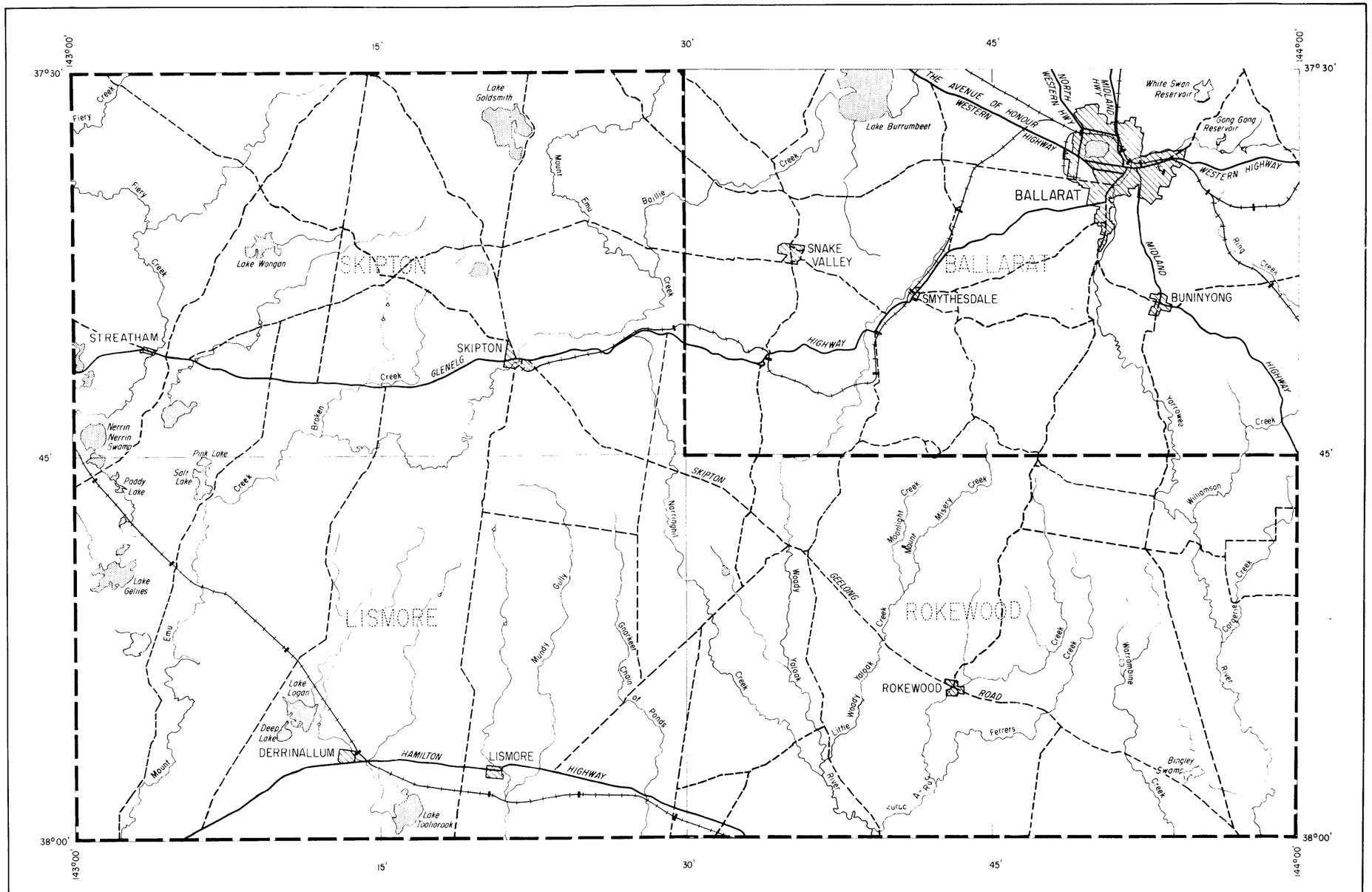
E53/B1-35

TO ACCOMPANY RECORD No

PLATE 10

DETAILED AEROMAGNETIC SURVEY WESTERN VICTORIA, 1967

LOCALITY MAP

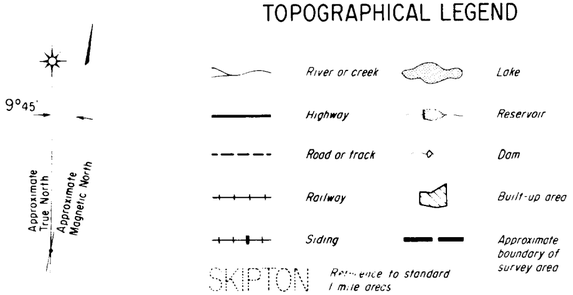


MILES 5 0 5 10 MILES

KILOMETRES 5 0 5 10 15 K LOMETRES

LOCATION DIAGRAM

TOPOGRAPHICAL LEGEND



Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. 054/B1-25

PLATE 11

NORTHERN TERRITORY
SOUTH AUSTRALIA

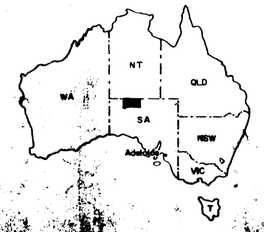
GEOLOGY

GEOPHYSICAL LEGEND

- —·— POSITIVE TREND
- ..... NEGATIVE TREND
- — — POSSIBLE FAULT

(BASED ON G53/50-9)

LOCATION DIAGRAM



INDEX TO ADJOINING SHEETS

AYERS ROCK	KULSERA	FINKE
WOODROFFE	ALBERGA	ABMINGA
LINDSAY	EVERARD	WINTINNA

MILES 10 0 10 20 30 40 MILES

KILOMETRES 10 0 10 20 30 40 50 60 KILOMETRES

TOPOGRAPHICAL LEGEND

- Road or track
- River or creek
- Homestead
- Hill feature
- Aerodrome

GEOLOGICAL LEGEND

AFTER GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

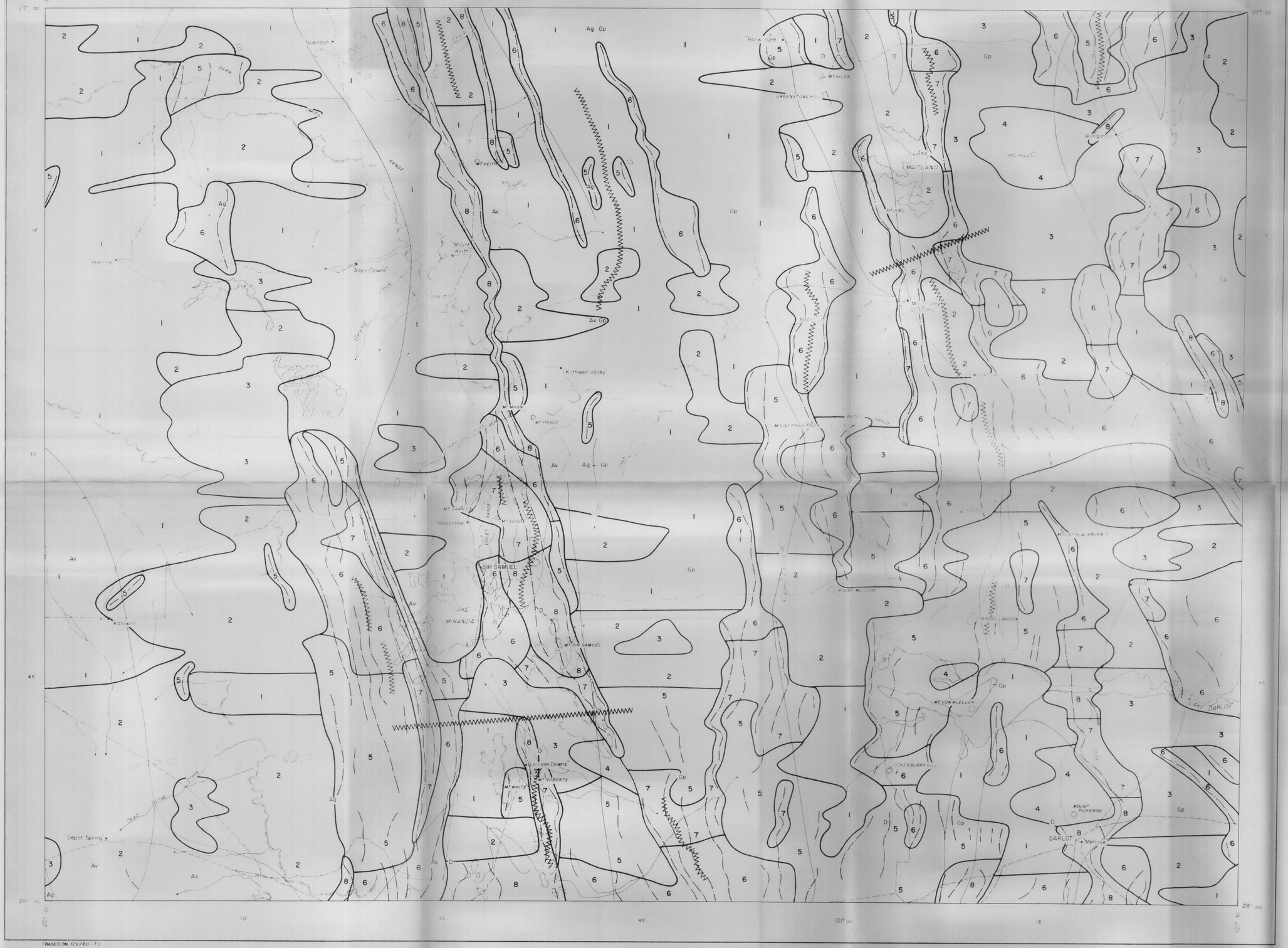
- Geological boundary
- Fault
- Fault, strike and direction of dip
- Thrust or major shear zone, strike and direction of dip
- Foliation
- Shear zone
- Tectonic breccia

POST PALAEOZOIC		T-K	Tertiary (?) and Mesozoic(K)
PALAEOZOIC	ORDOVICIAN	PO	Mt Chandler Sandstone
PROTEROZOIC	ADELAIDEAN	Pa	Mainly slates shales and tillites Basalt and/or Iron formation
	CARPENTARIAN	Pc	Levenger arkose and Moorilyanna conglomerate
OLDER PRECAMBRIAN	CRYSTALLINE BASEMENT ROCKS OF MUSGRAVE BLOCK	A	Undifferentiated crystalline basement rocks
			Dolerite dykes
		GC	Basic and ultra basic intrusives of Giles Complex
		MG	Microadamellite, and microgranite
		HG	Biotite adamellite and hornblende adamellite
		CG	Hypersthene adamellite
		AP	Aplite of Indulkana shear zone
		Peg	Undifferentiated granite rocks

AUSTRALIA 1:250,000

SIR SAMUEL
WESTERN AUSTRALIA

PLATE 12



(BASED ON G51/80-7)
(BASED ON G51/81-16)

GEOLOGICAL LEGEND

AFTER GEOLOGICAL MAP OF WESTERN AUSTRALIA (WA DEPT MINES, 1966)

Geological boundary

PRECAMBRIAN UNDIFFERENTIATED — ARCHAEAN

- Av — Sedimentary rocks containing basic igneous rocks
- Ag — Granite
- As — Sedimentary rocks with zones of high grade metamorphism and zones of migmatite and gneiss

AFTER GEOLOGICAL SURVEY OF WESTERN AUSTRALIA BULLETIN 84 (CLARKE, 1925)

Geological boundary

ARCHAEAN

- Gp — Granite with some porphyry and porphyrite dykes
- D — Derivatives of dolerites and gabbros

GEOLOGICAL REFERENCE

A — Geological Map of Western Australia 1966
B — Geological Survey of Western Australia Bulletin 84

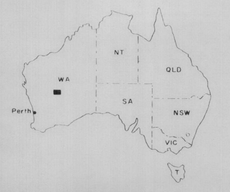
TOPOGRAPHICAL LEGEND

- River or creek
- Road or track
- Homestead
- Hill feature
- Lake
- Mining group
- Named place

INDEX TO ADJOINING SHEETS

GLENGARRY	WILLUNA	KINGSTON
SANDSTONE	SIR SAMUEL	DUKETON
YOUANMI	LEONORA	LAVERTON

LOCATION DIAGRAM



AIRBORNE SURVEY, SIR SAMUEL – DUKETON WA, 1967

MAGNETIC INTERPRETATION AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

GEOPHYSICAL LEGEND

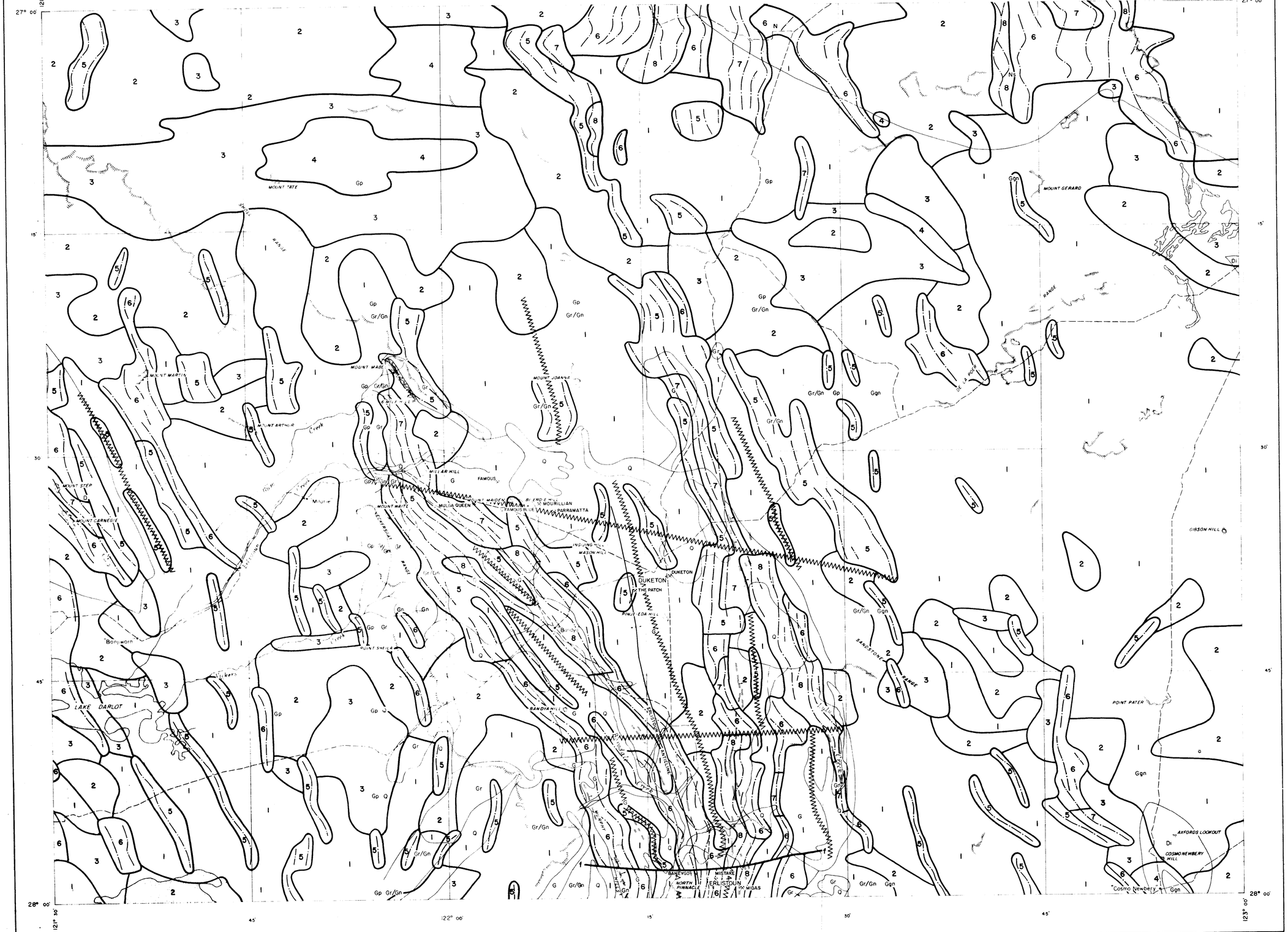
- Magnetic trend
- 3 — Magnetic zone
- Fold axis

TO ACCOMPANY RECORD No. 1967/136 Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G51/81-17

DUKETON

WESTERN AUSTRALIA

AUSTRALIA 1:250,000



(BASED ON G51/80-8)
(BASED ON G51/81-18)

GEOLOGICAL LEGEND

AFTER GEOLOGICAL SURVEY OF WESTERN AUSTRALIA BULLETIN 103 (HOBSON & MILES, 1950)

RECENT
- Q — *Alluvium*

ARCHAEAN
- Gr — *Granite with some granodiorite and syenite*
- Gn — *Gneiss*
- Gr/Gn — *Mainly sandy soil which probably largely overlies granite and/or gneiss*
- G — *Mainly lavas, pyroclastics and sediments with some basic and ultrabasic intrusives. Variable grade of metamorphism*

Axis of major anticlinal fold

Banded iron formation, with dip

Geological boundary

AFTER GEOLOGICAL SURVEY OF WESTERN AUSTRALIA BULLETIN 84 (CLARKE, 1925)

LOWER CAMBRIAN OR UPPER PRECAMBRIAN
- N — *Conglomerates, quartzites, sandstones, shales and limestones*

ARCHAEAN
- Gp — *Granite with some porphyry and porphyrite dykes*
- D — *Derivatives of dolerites and gabbros*

Geological boundary

AFTER GEOLOGICAL SURVEY OF WESTERN AUSTRALIA BULLETIN 87 (TALBOT, 1926)

LOWER CAMBRIAN OR UPPER PRECAMBRIAN
- Ns — *Conglomerates, quartzites, sandstones, shales and limestones*

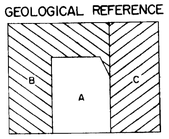
ARCHAEAN
- Di — *Amphibolite, uralitised dolerites etc*
- Ggn — *Granite (in places gneissic)*

Geological boundary

TOPOGRAPHICAL LEGEND

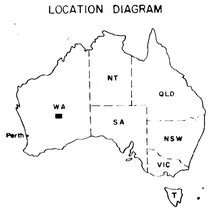
- *River or creek*
- *Road or track*
- *Hill feature*
- *Lake*
- *Named place*
- *Homestead*
- *Mining group*

GEOLOGICAL REFERENCE



A ... Geological Survey of Western Australia Bulletin 103
B ... Geological Survey of Western Australia Bulletin 84
C ... Geological Survey of Western Australia Bulletin 87

LOCATION DIAGRAM



INDEX TO ADJOINING SHEETS

WILUNA	KINGSTON	ROBERT
SIR SAMUEL	DUKETON	THROSSELL
LEONORA	LAVERTON	RASON

AIRBORNE SURVEY, SIR SAMUEL – DUKETON WA, 1967

MAGNETIC INTERPRETATION AND GEOLOGY

MILES 5 0 5 10 15 20 MILES

KILOMETRES 5 0 5 10 15 20 25 30 KILOMETRES

GEOPHYSICAL LEGEND

- *Magnetic trend*
- 3 — *Magnetic zone*
- *Fold axis*
- f——f — *Interpreted fault*

TO ACCOMPANY RECORD No. 1967/136

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G51/81-19

PLATE 14

GEOLOGICAL LEGEND

QUATERNARY

Alluvium

UPPER PROTEROZOIC

TOLMER GROUP
BULDIVA SANDSTONE
DEPOT CREEK SANDSTONE MEMBER
Quartz sandstone, with lenses of boomahite-rich breccia and lenses of quartz pebble conglomerate

LOWER PROTEROZOIC

AGICONDIAN SYSTEM
RUM JUNGLE GRANITE
Biotite granite

WATERHOUSE GRANITE
Pyt — Porphyritic granite, and adamellite

Basic intrusives

FINNISS RIVER GROUP
BURRELL CREEK FORMATION
Siltstone, greywacke siltstone, greywacke, quartz greywacke

GOODPARLA GROUP
GOLDEN DYKE FORMATION
Quartz siltstone and carbonaceous siltstone, in places pyritic

MASSON FORMATION
ACACIA GAP TONGUE
Quartz greywacke, quartz sandstone, pyritic and silicified in places; pyritic, carbonaceous siltstone, siltstone

BATCHELOR GROUP
COOMALIE DOLOMITE
Silicified and metamorphosed dolomite

CRATER FORMATION
Quartz greywacke, greywacke, arkose, fine and pebble conglomerate, siltstone

CELIA DOLOMITE
Algal dolomite, in places silicified and metamorphosed, silicified dolomitic breccia, tremolite schist

BEESTONS FORMATION
Arkose, greywacke, siltstone, conglomerate, arkosic conglomerate, white friable quartz sandstone

Geological boundary
Dip and strike of strata
Trend lines
Established synclinal trough - position accurate
Established synclinal trough - concealed; position approximate
Plunge of syncline
Plunge of anticline
Established fault - position accurate
Established fault - position approximate
Established fault - concealed
Probable fault
Quartz vein
Quartz - tourmaline vein
Fossil locality

GEOLOGY AFTER RUM JUNGLE DISTRICT
SPECIAL SHEET, 1-63,360, 1960 EDITION

TOPOGRAPHICAL LEGEND

Highway
Road or track
River or creek
Railway with station and siding
Mine or prospect
Open cut
Dump
Transmission line
Dam

GEOPHYSICAL LEGEND

750 — Magnetic intensity contours
600 — Magnetic "low"
Positive magnetic trend
Negative magnetic trend
Interpreted fault
23 — Anomaly referred to in text
Granite zone of low magnetic disturbance

THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT

DETAILED AEROMAGNETIC SURVEY, RUM JUNGLE NT, 1967

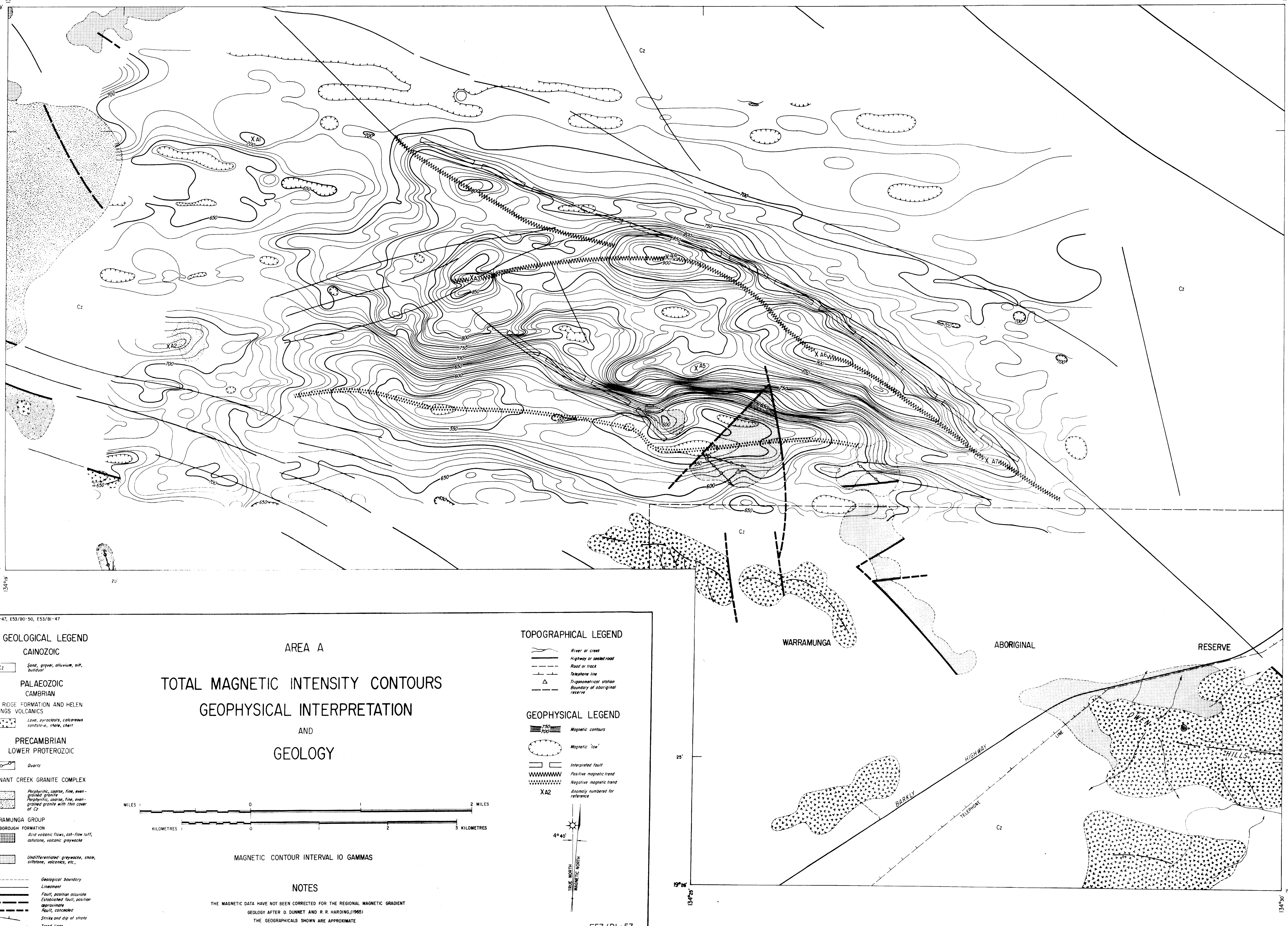
TOTAL MAGNETIC INTENSITY CONTOURS
GEOPHYSICAL INTERPRETATION
AND
GEOLOGY

0 1 2 3 MILES
0 1 2 3 4 KILOMETRES

MAGNETIC CONTOUR INTERVAL 50 GAMMAS

~~052/81-13~~

1. BASED ON 052/8048, 052/8049, 052/81-49, 052/81-51



BASED ON E53/80-47, E53/80-50, E53/81-47

GEOLOGICAL LEGEND

CAINOZOIC

Cz — *Sand, gravel, alluvium, silt, 'bulldust'*

PALAEOZOIC

CAMBRIAN

GUM RIDGE FORMATION AND HELEN SPRINGS VOLCANICS

Lava, pyroclasts, calcareous sandstone, shale, chert

PRECAMBRIAN

LOWER PROTEROZOIC

Quartz

TENNANT CREEK GRANITE COMPLEX

Porphyritic, coarse, fine, even-grained granite

Porphyritic, coarse, fine, even-grained granite with thin cover of Cz

WARRAMUNGA GROUP

BERNBOROUGH FORMATION

Acid volcanic flows, ash-flow tuff, ashstone, volcanic greywacke

Undifferentiated: greywacke, shale, siltstone, volcanics, etc.,

Geological boundary

Lineament

Fault, position accurate

Established fault, position approximate

Fault, concealed

Strike and dip of strata

Trend lines

Macrofossil locality

AREA A

TOTAL MAGNETIC INTENSITY CONTOURS GEOPHYSICAL INTERPRETATION AND GEOLOGY

MILES 1 0 1 2 MILES

KILOMETRES 1 0 1 2 3 KILOMETRES

MAGNETIC CONTOUR INTERVAL 10 GAMMAS

NOTES

THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT

GEOLOGY AFTER D. DUNNET AND R. R. HARDING, (1965)

THE GEOGRAPHICALS SHOWN ARE APPROXIMATE

TOPOGRAPHICAL LEGEND

River or creek

Highway or sealed road

Road or track

Telephone line

Trigonometrical station

Boundary of aboriginal reserve

GEOPHYSICAL LEGEND

750 700 — *Magnetic contours*

Magnetic 'low'

Interpreted fault

Positive magnetic trend

Negative magnetic trend

XA2 — *Anomaly numbered for reference*

4°40'

TRUE NORTH

MAGNETIC NORTH

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. E53/B1-53

BASED ON E53/80-48, E53/80-51, E53/81-48

GEOLOGICAL LEGEND

CAINOZOIC

Cz — *Sand, gravel, silt, alluvium, 'bulldust'*

PRECAMBRIAN

LOWER PROTEROZOIC

WARRAMUNGA GROUP

- *Quartz*
- *Quartz - felspar - porphyry intrusives*
- *Line of quartz - felspar - porphyry intrusive, exact boundaries unknown*
- *Numerous quartz - haematite - magnetite lenses*
- *Quartz - haematite - magnetite*
- *Undifferentiated greywacke - shale sequences. Minor sandstone, siltstone and volcanics*
- *Undifferentiated greywacke - shale sequences. Minor sandstone, siltstone and volcanics (?)*
- *Ironstone (intrusives)?*

- *Geological boundary*
- *Fault, position accurate*
- *Established fault, position approximate*
- *Inferred fault*
- *Quartz - filled fault*
- *Strike and dip of strata*
- *Generalised strike and dip of undulating strata*
- *Trend of bedding showing direction of dip*
- *Anticline, position accurate, showing plunge*
- *Shear zone*

AREA B

TOTAL MAGNETIC INTENSITY CONTOURS
GEOPHYSICAL INTERPRETATION
AND
GEOLOGY

MILES 1 0 1 2 3 MILES

KILOMETRES 1 0 1 2 3 4 KILOMETRES

MAGNETIC CONTOUR INTERVAL 10 GAMMAS

4°40' TRUE NORTH MAGNETIC NORTH

NOTES

THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT

GEOLOGY AFTER B.A. TAPP, RESIDENT GEOLOGIST'S OFFICE, TENNANT CREEK, 1967

THE GEOGRAPHICALS SHOWN ARE APPROXIMATE

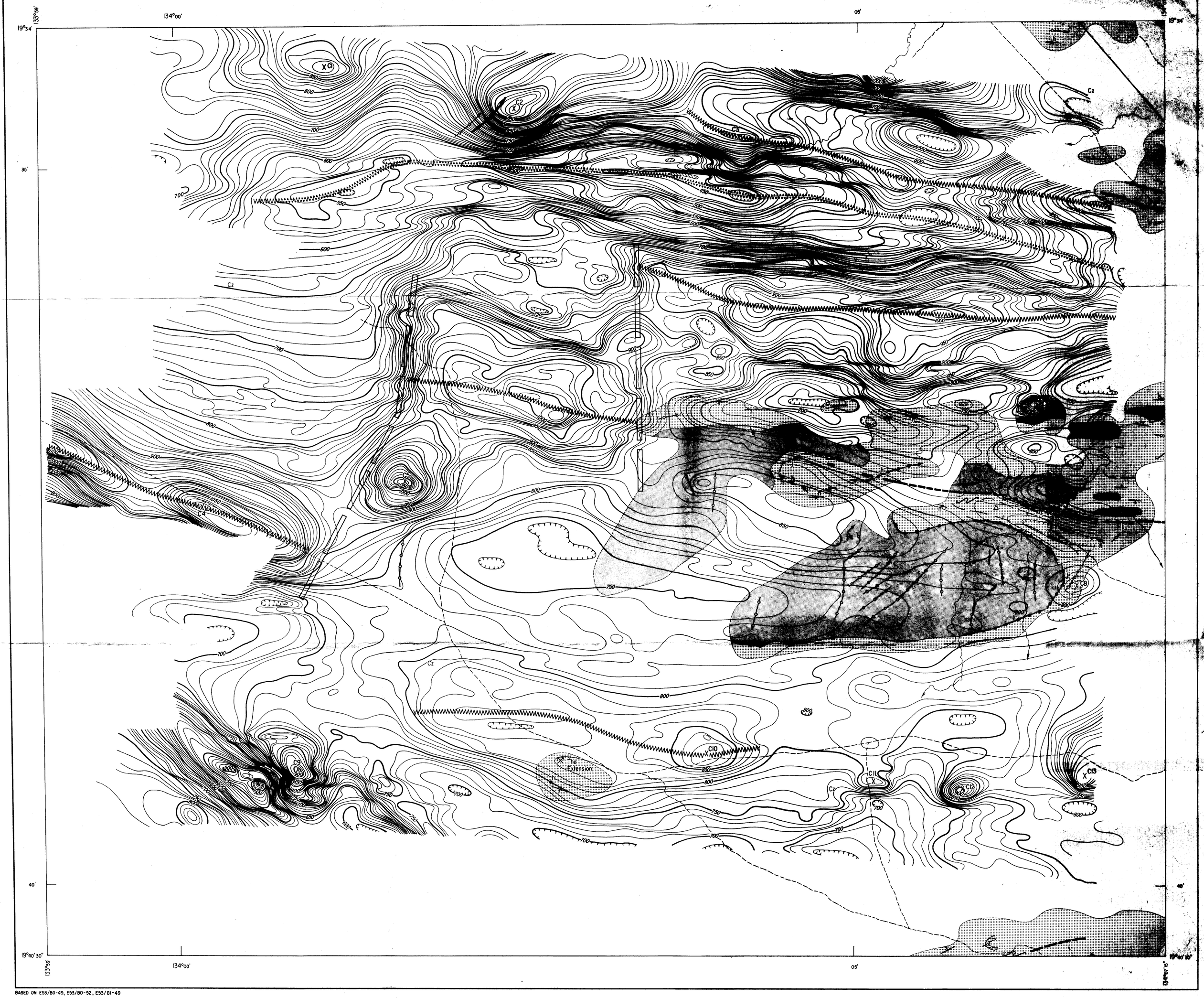
TOPOGRAPHICAL LEGEND

- *River or creek*
- *Road or track*
- *Mine or prospect*

GEOPHYSICAL LEGEND

- 1250 / 1150 — *Magnetic contours*
- *Magnetic 'low'*
- *Positive magnetic trend*
- *Negative magnetic trend*
- XB2 — *Anomaly numbered for reference*

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS E53/81-54
To Accompany Record No. 1967/151



BASED ON E53/80-49, E53/80-52, E53/81-49

GEOLOGICAL LEGEND

CAINOZOIC

Cz — Gravel, sand, silt, clay

PRECAMBRIAN

UPPER AND LOWER PROTEROZOIC

Quartz

LOWER PROTEROZOIC

Quartz - haematite - magnetite

Haematite - jasper

Quartz - feldspar porphyry

Quartz - biotite - feldspar porphyry

WARRAMUNGA GROUP

Greywacke, shale

Metamorphic schist

Geological boundary

Fault, position accurate

Established fault, position approximate

Fault, concealed

Quartz - filled fault

Vertical strata

Strike and dip of strata

Trend of bedding showing direction of dip

Shear zone

AREA C

TOTAL MAGNETIC INTENSITY CONTOURS
GEOPHYSICAL INTERPRETATION
AND
GEOLOGY

MILES 1 0 1 2 MILES

KILOMETRES 0 1 2 3 KILOMETRES

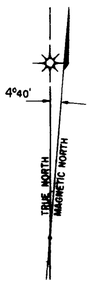
MAGNETIC CONTOUR INTERVAL 10 GAMMAS

NOTES

THE MAGNETIC DATA HAVE NOT BEEN CORRECTED FOR THE REGIONAL MAGNETIC GRADIENT

GEOLOGY AFTER P.W. CROHN AND W. OLDERSHAW, 1963

THE GEOGRAPHICALS SHOWN ARE APPROXIMATE



TOPOGRAPHICAL LEGEND

Highway or sealed road

Road or track

River or creek

Mine or prospect

Trigonometrical station

GEOPHYSICAL LEGEND

750 / 700 — Magnetic contours

Magnetic 'low'

Interpreted fault

Positive magnetic trend

Negative magnetic trend

XC6 — Anomaly numbered for reference

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS. E53/81-55
To Accompany Record No. 1964/

PLATE 17/4

LOCALITY MAP

GEOPHYSICAL & GEOCHEMICAL SURVEYS

1967

RUM JUNGLE AREA

Geochemical Surveys 1967.
Geophysical Surveys 1967.

Scale: 1 mile to an inch.

Pło Coomalie Dolomite boundary
Slingram anomaly axis
Self-potential anomaly
Self-potential axis
Surface radiometric anomaly
Axis of geochemical anomaly
Area of geochemical anomaly
Gravity traverse

PLATE 1

AUSTRALIA

SCALE

100 0 100 200 300 400 MILES

ISOGAL REGIONAL GRAVITY SURVEY 1967

Perth ▲ Cambridge Pendulum Station

Giles △ Isogal Primary Station

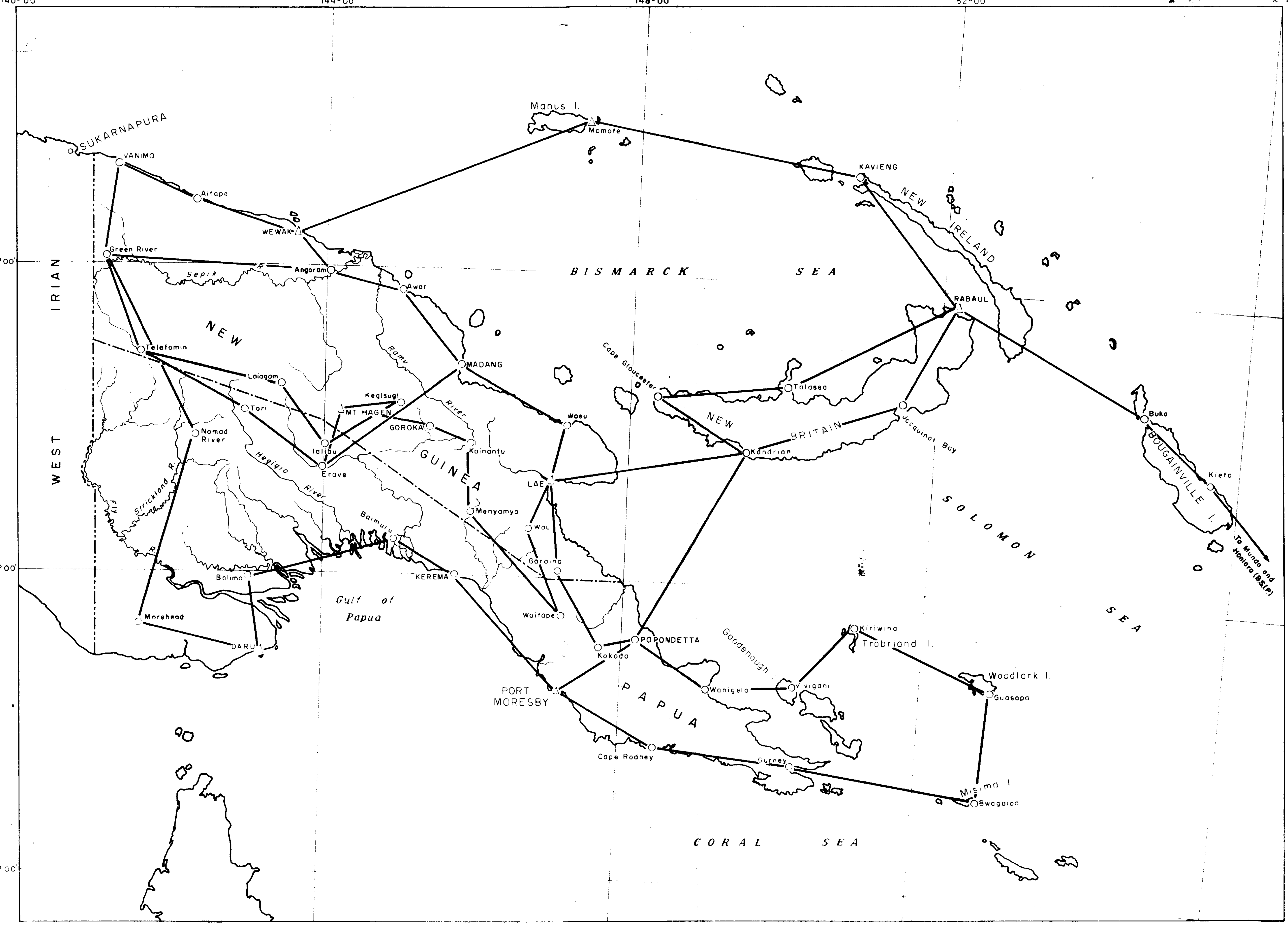
o Isogal Secondary Station

Adelaide (CR) Calibration Range

Restricted area

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS A/B2-19

PLATE 10



Based on PNG/B2-4

SCALE

50 0 50 100 150 Miles

LEGEND

△ Isogal Primary Station
○ Isogal Secondary Station
— Isogal traverse

TERRITORY OF PAPUA AND NEW GUINEA

ISOGAL REGIONAL GRAVITY SURVEY

1967