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Record 1972/117

GEOPHYSICAL BRANCH

SUMMARY OF ACTIVITIES 1972

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SUMMARY

The staff situation improved during the year, but there are still deficiencies in the Metalliferous professional and Airborne sub-professional staffs. Training of new recruits both at Head Office and in the course of the field operations formed an essential part of the year's program. Figure MA1 shows where metalliferous and airborne investigations were made in 1972.

The Metalliferous Subsection extended the work of the previous year at Captains Flat, NSW, into several areas where detailed geochemical and geological information had become available. The surveys provided particularly useful training and experience for new staff and for testing geophysical equipment.

Surveys at Tennant Creek and Mary River, NT, were undertaken in co-operation with the NT Mines Branch. The work at Tennant Creek, comprising 170 km of traversing with magnetometer and gravity meter and measurement of density and magnetic susceptibility of rock samples, was part of a program planned to continue for several years and directed towards the study of the regional structure of the field and its relation to mineralization. In the Mary River area, which lies in the magnetically disturbed zone of the Lower Proterozoic Masson Formation around the Cullen Granite, various geophysical methods were employed; on the basis of the results several drilling targets will be recommended and further work in the area is proposed for 1973.

In the Cloncurry region the geophysical investigations were mainly in areas selected on the basis of BMR's detailed geological mapping. The work is part of a long-term program to evaluate the applicability of geophysical methods in different geological environments and generally to assist in mineral exploration of the region.

The Darwin Uranium Group geophysical staff continued to provide readiometric assaying and logging services as required, and carried out gravity surveys at Mary River and in the Alligator River to determine whether the method could assist in mapping geological structures and units.

The transient electromagnetic method was used for the first time in 1972; BMR took delivery of a set of the Russian built MPP01 equipment early in the year. Initial tests were made in the Canberra area, as a result of which it was found necessary to make some modifications to the circuitry of the equipment. Subsequently test surveys were carried out at several localities in Northern Territory and Queensland.

The Airborne Subsection's field program for the Twin Otter aircraft VH-BMG was delayed by unforeseen problems in the development and installation of new airborne survey equipment, and it was not until August that fully reliable operation of the complete system was achieved. The equipment incorporates a digital acquisition system which records magnetometer, gamma-ray spectrometer, and Doppler navigational data. The survey of the Bendigo, Wangaratta, and Tallangatta 1:250 000 Sheet areas of Victoria, and half of the planned survey of Eucla Basin in South Australia, were completed by the end of the field season. The remainder of the Eucla Basin will be flown early in 1973.

The Aero Commander aircraft VH-BMR was used for regional surveys in the Alligator River region and Alcoota 1:250 000 Sheet area and for detailed surveys over the Artlunga Nappe Complex and Mary River area, all in Northern Territory.

Excluding flights for testing equipment and training personnel, the total survey traverse distances flown by the aircraft during the year were: VH-BMG, 53 000 km; VH-BMR 38 000 km.

In addition to the surveys by BMR aircraft, contractors continued to be employed for aeromagnetic work, which in 1972 was directed towards extending the regional coverage of the West Australian Shield. A contract survey of eight 1:250 000 Sheet areas was completed, and a second contract for survey of four Sheet areas commenced in December. The aeromagnetic data from a previous survey of four Sheet areas by a group of companies were purchased.

The system of computer processing of aeromagnetic data is now well established and is being used for all Twin Otter and contract survey data. The machine-contoured maps serve as a medium for preliminary release of survey results. Further development of software is in progress to improve the efficiency of the system. A digital acquisition system is proposed for the Aero Commander in 1973 to allow digital processing to be applied to the surveys by this aircraft.

A new project, the compilation of a magnetic map of Australia, began in 1972 and will continue for several years. The aim is to produce a map at 1:2 500 000 showing residual magnetic intensity contours derived from BMR's surveys, Commonwealth subsidized airborne surveys, and BMR's marine surveys.

GROUND METALLIFEROUS SUBSECTION

Captains Flat, NSW (N. Sampath, F.N. Michail, I.G. Hone, R.D. Ogilvy, B.R. Spies, E.B. Wronski)

A geophysical survey was carried out in the Captains Flat area between 25 January and 31 March 1972, in co-operation with Electrolytic Zinc Co of Australasia Ltd. The survey was made in the South Keatings, Golf Course, Baldwin, and Grady's areas where E.Z. had been engaged in detailed geochemical and geological investigations. The primary purpose of the survey was to train new staff in various geophysical techniques.

Magnetic and Turam electromagnetic surveys were carried out in the South Keatings area. The magnetic results showed no correlation with structure. The Turam results indicated the probable continuation of the main South Keatings mineralized shear zone and the presence of a cross-fault which appears to mark the termination of the shear zone.

Slingram and VLF electromagnetic, gravity, and induced polarization methods were used in the Golf Course area. The Slingram results showed a weak anomaly coinciding with a known Turam anomaly. The VLF results were affected by telephone wires and fences, and are of little value. Several traverses were surveyed with the gravity method in the Golf Course area to further investigate an anomaly detected during 1960. The results showed that the anomaly could not be attributed to an orebody.

Electromagnetic (Turam, Slingram, and VLF), magnetic, gravity, and self-potential surveys were made in the Baldwin area. The main magnetic anomaly found coincides with a known dolerite dyke. The VLF results show anomalies coinciding with the main magnetic anomaly. Turam results show anomalies probably due to a shear zone; a fault is also indicated. No Slingram or self-potential anomalies were found. The gravity results show a low following the trend of the Turam anomalies.

VLF electromagnetic, self-potential, and induced polarization surveys were carried out at Grady's area. VLF and self-potential anomalies were found over known Turam and geochemical anomalies. Induced polarization surveys were made on two traverses, and a strong anomaly was found on the traverse over the geochemical anomaly. Subsequent drilling of the most favourable geophysical target revealed a substantial intersection of pyritic mineralization at about 100 metres below surface.

Tennant Creek magnetic and gravity survey (I. Hone)

From August to October regional traverses totalling 170 km were surveyed along meridionally trending roads and tracks, with vertical magnetic force and total magnetic force magnetometers and with a gravity meter. One east-west traverse was also surveyed (Fig. MA2). Observations were made at 0.2-km intervals, and the gravity readings were tied into the helicopter gravity base at the airport and also to the 1969 and 1971 ground survey networks. Surface rocks samples were taken and measurements of density, susceptibility, and in some cases remanence will be made on these to help in the interpretation of the geophysical data.

The main aim of the work was to study the relationship of (?)Archaean high-grade metamorphic rocks intersected in drill-holes in BMR Area No. 3 to Lower Proterozoic rocks which crop out to the northeast, and also to study structural problems associated with mineralization of the field.

The lines surveyed in 1972 covered the granites to the north and south of the Tennant Creek township and the sediments of the Warramunga Group containing economic gold and copper mineralization, and extended southward to the northernmost outcrops of the Hatches Creek Group.

The gravity profile across BMR Area No. 3 shows a sudden, 'horst-like' 11-mgal gravity high which coincides with a region of strong magnetic anomalies. By correlating this gravity high with the high-grade metamorphics intersected in drill-holes, the north-south extension of these metamorphics is shown to be rather small, and from the shape and steep sides of the anomaly it appears that a block of (?)Archaean rock has been upfaulted. Farther north, the gravity values decrease and there is a region of low gravity and flat magnetic readings before the gravity values rise and the magnetic field becomes more disturbed as the Red Bluff outcrops are approached.

Preliminary interpretation of geophysical results along the Stuart Highway traverse reveals gravity lows associated with the granites north and south of the Tennant Creek township. The Warramunga outcrops have a magnetic expression suggestive of disseminated magnetite mineralization with local concentrations, contrasting with the flatter profiles over granites. The Aeromagnetic ridge and extension of the Mary Lane magnetic high appear to be superimposed on the regional magnetic profile. On line NN, 13 km east of the Stuart Highway, passing close to the Rising Sun and Golden Forty mines the contrasts in the gravity effects are not as outstanding and the

line is too far east for the Aeromagnetic Ridge and Mary Lane highs to be revealed. The correlation between NN and the Stuart Highway traverse with traverse 96E (surveyed in 1971) is currently being studied.

Cloncurry, Queensland (N. Sampath, R.D. Ogilvy)

From July to October geophysical surveys were made in five areas shown in Figure MA3. The object was to evaluate the usefulness of various geophysical techniques for metalliferous exploration in different geological environments, and to establish methods of mapping the Precambrian buried under younger sediments.

Areas 1 and 2 are in the Marraba Volcanics and are alluvium covered with scattered outcrops of basic rocks and quartz. Copper mineralization occurs mainly in east-trending minor fault zones, and is closely related to basic dykes. The object of the survey in the Marraba Volcanics was to explore the alluvium covered areas and in the process to test various geophysical methods. Electromagnetic, magnetic, self-potential, and induced polarization methods were used. The electromagnetic results show the presence of a number of shear zones in both areas 1 and 2; some of these shear zones coincide with known mines, and some are under alluvium. Induced polarization results show weak anomalies over some of the shear zones, including the ones with mines associated with them. In general these results show a number of shear zones, some of which contain minor, shallow sulphide mineralization. No self-potential anomalies were found. A number of magnetic anomalies were found, and these have been attributed to basic rocks.

Area 3 is in the Marimo Slate; mineralization occurs in carbonaceous slates, mainly at the intersection of faults parallel to local fold axes and minor faults. Electromagnetic, magnetic, self-potential, and induced polarization methods were used to test their response to mineralization in a carbonaceous environment. No magnetic anomalies were found. The carbonaceous beds produced strong, broad self-potential anomalies; they are highly conducting and caused strong electromagnetic and induced polarization anomalies. It was not possible to separate the response to the mineralization (known to occur) from the response to the carbonaceous beds.

Area 4 is in the basal calcareous facies of the Corella Formation. Three traverses were pegged over a strata-bound copper deposit, and magnetic, self-potential, and induced polarization surveys were made. No self-potential anomalies were found. A number of magnetic anomalies were found; one is on the contact of dolomite and quartzite, but the others have no visible geological feature associated with them. None of the magnetic anomalies is associated with the copper deposit. The induced polarization results indicate possible sulphide mineralization. A fourth traverse was pegged over a dolerite dyke to see if this could be detected. Magnetic, self-potential, and induced polarization surveys were made, but no anomalies were found on the dyke. However, magnetic and induced polarization anomalies were found east of the dyke, over dolomite. Two dipole lengths, 30 m and 60 m, were used in the induced polarization survey; the results using 60-m dipoles showed the stronger anomaly, indicating that the mineralization could increase at depth. Further work including drilling is being planned in this area.

Resistivity depth probes were made in Areas 5 and 6 to determine the thicknesses and resistivities of sediments overlying Precambrian rocks east of Cloncurry; this was a preliminary part of a project to establish methods of exploration of buried Precambrian rocks. Initial interpretation

of results indicates about 25 m of low-conductivity sediments in Area 5 and over 200 m of medium- and low-conductivity sediments in Area 6. It appears from the results that Precambrian rocks were not reached in Area 6.

Rock samples were collected from the Cloncurry 1:100 000 Sheet area for laboratory conductivity tests, with the object of obtaining data for a resistivity map of the Sheet. This is the first part of a regional study of the relation between the occurrence of mineralization and the electrical properties of the rocks of the area.

Mary River, NT (F.N. Michail, P.W.B. Bullock, E.B. Wronski)

Geophysical surveys were made in Government Mining Reserve No. 275 in the Mary River area, NT, to locate drilling targets (Fig. MA4). The area is within a mineralized and magnetically disturbed zone of the Lower Proterozoic Masson Formation around the Cullen Granite. Diamond-drilling of a gossan (the Gubberah Gossan) in the Reserve by the Mines Branch in 1970-71 intersected 6.4 m of 19% zinc. Three grids were pegged, one in the area of the Gubberah Gossan and two on aeromagnetic features; electromagnetic, magnetic, self-potential, and gravity methods were used.

No magnetic anomalies were found on the Gubberah Gossan grid. The self-potential and electromagnetic results show anomalous zones corresponding to carbonaceous shale beds east and west of the gossan. The gossan itself produced no recognizable anomalies.

Two areas were selected from aeromagnetic results; the areas, named Minglo 1 and 2, are mainly flat and alluvium-covered with little outcrop. The magnetic results show anomalies with sharp boundaries and steep gradients indicative of faulting. No significant self-potential anomalies were found. The elctromagnetic results show wide elongated conducting zones probably due to carbonaceous shale, with many individual anomalies within the zones. No interpretation has as yet been made of these anomalies.

A gravity survey over the Gubberah Gossan and over selected electromagnetic anomalies in the Minglo 2 grid was started in October.

From the geophysical work carried out by this party together with the transient EM investigations, several targets will be recommended for drilling by the NT Mines Branch.

Transient electromagnetic tests, NT and Qld (B. Spies, J. Williams)

Evaluation tests of the Russian built one loop transient electromagnetic equipment "MPPO-1" were carried out at localities in the Northern Territory and Queensland during the period 4 August to 17 October. In this method a square loop is laid on the ground and current pulses are sent through it. If conductors are present in the vicinity of the loop eddy currents are induced in them. In the off periods the electromagnetic field caused by the decaying of the eddy current in the conductor is measured at delay times ranging from ½ to 15 m sec.

Tennant Creek area, NT. Tests were done using 100 and 200-m loops in areas C6, C11, TC35W, and BMR Area No. 3 (Plate 1). The results were promising, with none of the interference effects experienced in test areas near Canberra. The results are indicative of conducting overburden. Anomalies were obtained over known ironstone bodies of moderate conductivity.

A double-peaked anomaly was found at Area C11, a broad anomaly at BMR Area No. 3, and a localized anomaly at area TC35W. In area C6 a linear zone of higher conductivity was outlined. A traverse using 10-m and 20-m loops was surveyed over the anomaly.

It was found that in areas of highly conductive overburden small negative readings were sometimes obtained on later sample times. This effect was caused by the large initial signal saturating the amplifier, and a modification was made to alleviate this effect. With this modification the first part of the signal is blanked out for reading later sample times (t=4 msec and greater). Accurate readings could thus be obtained under the higher amplification necessary for later sample times.

Mary River Area, NT. Work here was done in the Minglo 2 area, and over the Minglo mine and Gubberah Gossan (Fig. MA4).

In the Minglo No. 2 area, an area of 3 km^2 was covered in a week using 150-m loops, thus proving the effectiveness of the method as a fast reconnaissance tool. Two large anomalies were found, both caused by rocks of high conductivity. One of the anomalies was surveyed in more detail using 60-m loops; the results showed the anomaly to be due to an elongate body about 100 m wide. It is proposed to have this anomaly tested by drilling.

No anomaly was picked up over the Minglo mine, but an anomaly was found to the east (caused by black shales).

The Gubberah Goassan area was surveyed with 60-m loops. An anomaly, corresponding with a Turam anomaly, was caused by a black shale bed.

Rum Jungle Area, NT. Several traverses were surveyed using 60-m loops at the Mount Minza area and the Woodcutters L5 prospect.

In the Mount Minza area an anomaly was found over a conducting shale, corresponding with an S-P and Slingram anomaly reported by earlier workers.

In the Woodcutters area a small north-trending anomaly was found coinciding with a weak Slingram anomaly detected in previous work and estimated to be due to a conductor at about 40 m below the surface. These anomalies are to the west of and not associated with the known orebody.

Cloncurry Area, Qld. Surveys using mainly 60-m loops (and in some places 120-m loops) were conducted in areas 1, 2, 3, and 4 shown in Plate 2.

The best results were found in Area 3, which includes the Red Sierra workings and is an area of very steep topography. Other EM methods such as Slingram and VLF are unsuitable, but the one-loop transient EM method is not affected by topography. A large anomaly was found, which corresponds with a sequence of Carbonaceous shales.

In Areas 1 and 2 only very small anomalies were obtained. One anomaly in Area 2 corresponds with a Turam and IP anomaly over the Dawn mine. A small anomaly in Area 1 occurs over a creek bed. Since there is also a Turam anomaly but no IP anomaly, salt concentrations may be the cause. No significant anomalies were obtained in the Timberu area.

Some interference effects were observed when using the low scales in areas of small signal. The interference is thought to be due to thunderstorm activity.

The MPPO-1 equipment proved to be reliable and fairly fast; most of the time was spent in laying and taking up the loops. Large areas can be covered using 100- or 200-m loops, and follow-up work using smaller loops delineates the anomaly.

The depth penetration of the method is approximately equal to the size of the loop used.

The main advantage of the transient electromagnetic method is that it can be applied in areas of high surface conductivity where most of the other methods fail.

Because the method is basically an EM induction method it cannot distinguish between orebodies and carbonaceous shales of similar conductivity.

Test area

This project was commenced in 1971 and its object is to find an area in or close to the A.C.T. suitable for testing geophysical equipment used in metalliferous exploration. No such area was found within the A.C.T. Several sites outside the A.C.T. were considered, but no field tests were carried out during the year.

Darwin Uranium Group (P.W.B. Bullock, E.B. Wronski)

Routine maintenance and calibration of field and laboratory equipment were carried out. Numerous samples were assayed with the gamma-ray spectrometer for the Alligator River geological party. Methods of assaying mixtures of uranium and thorium with the gamma-ray spectrometer were tested. Geophysical logs were made of nine holes for the Alligator River geological party and of one hole for the Mines Branch. The Manton seismic station became operational in May and the East Point seismic station was dismantled in June. Provisional seismic data were issued.

Darwin Uranium Group staff were seconded to the Mary River survey party from July. In June a brief test survey was made in the Maranboy Tinfield for a private company to see if lodes could be detected beneath alluvium and sediments. Self-potential, Slingram, and magnetic methods were tried; self-potential anomalies were found, and the company was advised to make a detailed self-potential survey.

At the end of September a test gravity survey was started in the Alligator River 1:250 000 Sheet area to determine if detailed gravity can assist in mapping geological units and structures in the area. The survey is being made on the traverses shown in Plate 3, with stations $\frac{1}{2}$ km apart.

AIRBORNE SUBSECTION

Bendigo-Wangaratta-Tallangatta airborne magnetic and radiometric survey (VH-BMG)

This survey covering the BENDIGO, WANGARATTA and TALLANGATTA 1:250 000 map areas was flown between February and October 1972. The survey was divided into two parts, of approximately equal size, at the 146°30' meridian. The eastern part includes the highest terrain in Australia and was flown at 1800 metres above sea level. Only magnetic data were recorded in this area. Radiometric and magnetic data were recorded in the western area at a height of 150 metres above ground level.

This survey was the first undertaken by the Bureau's Twin Otter aircraft VH-BMG and saw several significant advances in the geophysical, data acquisition, and navigation equipment used. The airborne data acquisition system, which includes a small digital computer, records geophysical and navigation data on magnetic tape for subsequent processing in Canberra. Experience has shown the data acquisition system to be virtually trouble free in survey operation. Considerable effort was devoted to the development of techniques that make efficient use of the Doppler navigation system, with the ultimate objective of placing full reliance on Doppler for all future survey work.

The magnetic profiles recorded over the eastern area show a moderate number of well defined, low-amplitude anomalies, forming elongated zones that parallel the regional geological strike. Lower Devonian acid to intermediate intrusives are the major source of the anomalous magnetism. The description of these rocks is quite variable, ranging from granite to diorite, and this is reflected in the variable magnetic response they produce. A well defined magnetic trend follows the metamorphic zone that extends for 100 km SSE from Albury. East of this zone several isolated anomalies correlate with high-grade metamorphic rocks (Fig. MA5).

Over the western region the magnetic field has generally low relief. Two zones of relatively intense magnetic anomalies were recorded over Cambrian basic volcanic rocks near Dookie and over the belt extending from Heathcote north towards Rochester. Other magnetic anomalies were recorded over Tertiary and Quaternary basalts and over areas of subsurface igneous activity.

The radiometric data display low and uniform count rates, in all four channels, over the alluvial plains and sedimentary rock areas. Zones of higher Potassium and Thorium counts correlate with granites, particularly those of Silurian age, and with acid volcanics. Examination of the radiometric data using a long time-constant may reveal changes in count rates that are not apparent in the raw data recorded at an interval of one second.

Southern Eucla Basin airborne survey (VH-BMG), SA (S. Lambourn, E. Olsen)

This survey covering COOMPANA, NULLABOR, FOWLER, and part of NUYTS 1:250 000 Sheet areas was planned to commence in August 1972. Owing to delays experienced in the development of the fluxgate magnetometer for the Twin Otter it was not possible to begin until November, when the survey party established a base at Ceduna. It is expected that the survey flying will be completed late in February 1973.

Such data as have been recorded to date are being processed, but interpretation of the data has not commenced.

Outfitting of Twin Otter aircraft VH-BMG

It was expected that this project would be completed early in the year so that the regional survey of the three 1:250 000 sheets of Bendigo, Wangaratta and Tallangatta could be completed before the winter. Airborne testing of the prototype equipment systems began in February and survey flying based on Canberra commenced in March. Early results were sufficiently encouraging to move the survey party to Albury in April to increase daily coverage. Construction of production standard equipment continued in Canberra.

Surveying in Victoria continued in May but it was becoming apparent that the magnetometer performance was unstable and data were being lost because of erratic baseline drift. Apart from occasional power-supply problems other systems were performing satisfactorily and testing of the Doppler navigation system yielded promising results. Further development of the Doppler digital recorder and associated software enabled Doppler co-ordinates to be included on the digital magnetic tape record.

The survey party returned to Canberra in June so that laboratory staff could investigate the problem of magnetometer instability. Surveying was not resumed until August, but in the ensuing period valuable research of the magnetometer design was completed. This resulted in a much improved warm-up and baseline drift characteristic. These improvements will be incorporated in the production version.

Surveying based on Canberra was resumed in August and the party reoccupied the Albury base in September. All systems operated satisfactorily, and despite the unsuitable weather the survey was completed in October.

The delays experienced in magnetometer development resulted in a late commencement of the southern Eucla Basin survey. The survey party moved to Ceduna for this purpose in November and it is expected that the work will be completed early in 1973. The status of this project may be summarized as follows:

1. We now have a reliable digital acquisition system recording both geophysical and navigational data. The ease with which this complex system was brought into operation says much for the Hewlett-Packard hardware and the quality of the BMR-produced software.

2. The designs of the fluxgate magnetometer, the timer, and associated digital scalers and displays, which were all Geophysical Branch laboratory projects, appear to be complete. However, the installed equipment is all prototype, and satisfactory mean times between failures cannot be expected until production models are installed and supported by spare units.

3. The Marconi Doppler system has proved to be a useful aid to survey navigation over land. The off-track error is of the order of 0.5 km on a 225-km traverse. The performance over water remains to be tested. Digitally recorded Doppler co-ordinates have been used as an aid to flight path recovery in the Victorian survey, but the value of this technique will be fully realized when the relevant computer software is developed by the Airborne Reductions Group.

VH-BMR (Aero Commander) testing and training program (E.P. Shelley)

About 100 hours were flown in the Canberra region during the year, for the purposes of testing geophysical equipment and training new personnel in equipment operation and photo-navigation. In June some 70-mm colour photography was flown over the Mallacoota estuary for the Geological Branch.

Considerable time was spent in maintenance of the geophysical equipment and rewiring of various units. Tests revealed electrical interference between the equipment racks and the airframe, and several new power supply and earthing cables were installed in an attempt to overcome the interference. The new metal containers for the gamma-ray detectors were also found to cause interference, and were insulated. In May, the towed 'bird' became detached from the cable during recovery. This problem has

resulted in a study of an alternative cable system, which, it is hoped, will be implemented at the end of the year. A study of the magnetic field of the aircraft has also been made.

The aircraft now has a VHF navigation system and a second VHF transceiver. It is planned to install further navigation aids, including a new radio altimeter, during the 1972 Christmas lay-up. A new, lighter solid-state inverter has been purchased for installation in the aircraft. Tender specifications for a digital data acquisition system have been prepared. It is hoped that this system will be ready for installation in mid 1973.

Cloncurry detailed magnetic and radiometric survey, Qld, 1970 (S.S. Lambourn, E.P. Shelley)

Interpretation of the geophysical data was completed in January and the draft of the record in March.

Ngalia Basin project (E.P. Shelley)

No progress was made on this project, which is being carried out jointly with the Geological Branch.

Interpretation of Victoria River Basin contract aeromagnetic surveys, NT, 1966-1967 (R.J. Taylor)

This project was resumed in December 1971. Depth estimates were calculated from the magnetic data, and a map showing basement structure and surface magnetic features was completed. The area covered is shown in Figure MA6.

High-frequency magnetic anomalies correlate well with Antrim Plateau Volcanics. The subsurface extent of the volcanics has been delineated. The basement ranges in depth from 100 m below M.S.L. in central LIMBUNYA to 13 000 m below M.S.L. in northern DELAMERE. Many of the features in the magnetic basement can be correlated with gravity features.

The draft of the Record has been completed; relevant parts will make up the section's contribution to the Bulletin, which is a joint project with the Geological Branch.

Interpretation of Glengarry, Wiluna, and Kingston areas contract aeromagnetic survey, WA, 1970 (S.S. Lambourn)

The area covered is shown in Fig. MA7. Geological strikes and the boundaries of major rock units were interpreted by delineating magnetic trends and subdividing the area into zones of specified magnetic character. This interpretation was assessed with reference to mapped geology. Correlation between the magnetic data and the geology is good, especially in regions of greenstone and whitestone rocks. A further region of these rock types has been interpreted in the southeast of the KINGSTON area.

Four cross-fold axes were interpreted, one of which has several mines located along it. All four are recommended for further investigation. The Record on the interpretation was completed.

Airborne Remote Sensing survey, WA, 1970 (E.P. Shelley)

This project was continued in co-operation with C.J. Simpson of the Photogeology Group.

Combined photogeological and geophysical interpretations were made for both areas (Fig. MA8). Some reinterpretation was then done and final combined interpretations were prepared that were compatible with the initial data. Some published geology was available for the area near Laverton, and this was incorporated into the results. Finally, interpreted Archaean geological maps were produced.

The project showed that combined photogeological and geophysical interpretations produce more information than either method independently. It was recommended that this technique should be made an integral part of most detailed mapping projects.

Deaf Adder Creek and Jim Jim Creek airborne geophysical surveys, NT, 1971 (K.R. Horsfall)

This survey (Fig. MA9) was carried out in November 1971 with Aero Commander aircraft VH-BMR.

The radiometric data revealed five weak anomalies in the Jim Jim Creek area which were attributed to thorium. The magnetic results disclosed a trend which is possibly due to the basic rocks of the Zamu Complex, and anomalies associated with volcanics in the Kombolgie Formation.

The results of the survey were issued as Record 1972/58 (Restricted).

Tottenham detailed aeromagnetic survey, NSW, 1971 (J.E. Rees)

Digital processing of the magnetic data and the geophysical interpretation were continued in January and February. A draft Record of the survey was completed.

Alcoota regional and Arltunga detailed airborne geophysical survey, NT, 1972 (B. Wyatt, R. Taylor)

The survey party assembled in Alice Springs on 2 October and test flights were commenced. Routine surveying began on 9 October.

The Alcoota 1:250 000 Sheet area is being flown as an aid to geological mapping, and selected areas within the Arltunga Nappe Complex are being flown to help solve some problems regarding geological structure and metamorphic facies changes. These areas are shown in Fig. MA10.

Mary River detailed aeromagnetic survey, NT, 1972 (K.R. Horsfall)

A detailed aeromagnetic survey was flown in the area over and around Mary River Mining Reserve 275 in June. This was to provide further information for the planning of the ground geophysical survey, which commenced in August. It was flown at an altitude of 150 m and a line spacing of 150 m.

A number of offsets of the prevailing regional strike have been interpreted from the magnetic data. These are currently being investigated.

Northern Eromanga Basin project (H.D. Hsu)

This project consists of a detailed study of the aeromagnetic data in the Northern Eromanga Basin and the Drummond Basin in Central Queensland. A locality map with indication of the data coverage is shown in Fig. MA11.

Detailed study of the aeromagnetic data can be divided into two parts. The first part is quantitative interpretation which included depth determination of magnetic basement units and separation of upper and lower magnetic basement depth estimates with the aid of borehole information. Contours of the upper magnetic basement which should be representative of the crystalline basement are displayed in Plate 11. The second part, qualitative interpretation, involved delineation of the magnetic basement into a number of magnetic provinces on the basis of magnetic expression and intensity. A reasonably good correlation was noted between the gravity and magnetic provinces. The observed magnetic response from each province was explained in terms of a simple magnetic model. This may stimulate further discussion on the understanding of the magnetic basement.

Preparation of a Record on this project will be completed at the beginning of 1973.

Development of a magnetic interpretation program (H.D. Hsu)

A magnetic interpretation technique making use of the available computer facilities has been investigated, designed, and developed. The scheme of magnetic interpretation is:

- Removal of first-order regional effect
- Computation of the power spectrum for the given anomaly
- Spectral analysis from which the burial depth and the width of the magnetic source are determined.

The program (AMIBSH) which carried out the above operations is in working order. It can handle a number of separately digitized anomalies in each run, and gives depth and width estimates of magnetic units which can be approximated to 2-dimensional prismatic bodies with an infinite depth extent. With further development, the program will be extended to cover bodies resembling a vertical cylinder with infinite depth extent.

Documentation of the new interpretation program is expected to be completed in mid-1973, but the program is ready for all users.

Aeromagnetic Map of Australia project (H.D. Hsu)

The aim of this project is to produce by digital techniques a magnetic map of Australia at 1:2 500 000 scale from all the workable aeromagnetic data from various surveys. The map will show 'true residual magnetic intensity contours' without discontinuity at the boundaries of adjoining surveys.

It was decided that the bulk of the routine work involved in this project will be let out on contract. However, a substantial amount of preparation work has been carried out:

- An inspection of all available aeromagnetic contours maps in terms of their suitability for digital reduction;
- Compilation of a coverage map (Fig. MA13);
- Examination of some ground magnetic control information;
- Preparation of a pilot run for this project;
- Arrangement with the Drawing Office for the reproduction of company contour maps;
- Preparation of a Preliminary Operational Report;
- Investigation of the suitability of the I.G.R.F. as a basis for regional correlation (with J. van der Linden);
- Preparation of tender specifications.

The pilot run designed as a feasibility study of the scheme of digital reduction of contour maps has been successfully completed by E.C.S. and T.C.G. The results indicate that the digital technique is a feasible means of reducing contour maps. The tender specifications are being prepared and will be finalized in the near future.

Cobourg Peninsula, Alligator River, and Mount Evelyn (part) airborne magnetic and radiometric survey, 1971-72 (K. Horsfall, B. Wyatt and P. Wilkes)

The survey of these three 1:250 000 Sheet areas commenced in September 1971 and was resumed in June 1972. Surveying was completed in September 1972.

Data were collected along east-west flight-lines spaced 1.5 km apart, with an altitude of 150 m above ground level. It was obtained in analogue chart form for both magnetic and radiometric information.

Ultimately a 1:250 000 magnetic contour map will be drawn. At present, contouring is proceeding at 1:50 000 scale. Stacked profiles, at 1:250 000 scale, are completed to assist magnetic interpretation.

Radiometric data are still in the raw state but will be drawn as stacked profiles at 1:100 000 scale. This scale is proposed because geological mapping will be finally presented at 1:100 000.

Magnetic interpretation is based on the magnetic stacked profiles except for the portion of the Mount Evelyn sheet for which a magnetic contour map was drawn during the 1971 survey.

The Mount Evelyn sheet is dominated by the Kombolgie Sandstone. This is reflected in the magnetics as a relatively flat field interrupted by the effect of a conjugate system of vertical tension joints with major components north and northeast. These give a distinctive type of anomaly and can be traced for many kilometres (Fig. MA14). Volcanics occurring in the sandstone may be responsible for these features. These volcanics may belong to two different ages, as some give a positive anomaly whilst others are associated with a negative anomaly. This may indicate that there was a reversal of the magnetic field between the times they were formed.

The Cullen Granite, in the southwest of the area, is surrounded by a moderately disturbed field due to metamorphism of the pyritic siltstone sediments of the Masson Formation.

The Mount Partridge Formation, consisting of arkose, conglomerate and hematite-rich siltstone, is evident from the profiles. It extends from the Mount Evelyn area north to the mouth of the East Alligator River. Trends also indicate its presence west of the West Alligator River.

Dolerites found east and southeast of Oenpelli Mission give anomalies of several hundred gammas. That which is mapped as striking southeast from Nabarlek has a positive anomaly associated with it. The other limb is characterized by a negative anomaly. Dolerites occurring in the Nimbuwah Granite (northeast of Oenpelli) also give a negative anomaly. This suggests that the mapped exposures of dolerite could be parts of a continuous sheet.

A very disturbed magnetic pattern in the south of the Cobourg Peninsula sheet extends to the Arafura Sea.

Large magnetic anomalies, of 1200 gammas, occur in the Mount Roe region of Cobourg Peninsula, and larger anomalies, up to 2700 gammas, occur in the Port Bremer area. The reason for these anomalies is not obvious at present.

Radiometric anomalies were detected over all known deposits. Count rates over the sandstone were very low except for the Cretaceous sandstone in the southeast of the Mount Evelyn sheet. Some uranium anomalies were detected here. Additional uranium anomalies, other than those associated with deposits, were detected along the South Alligator River.

Owing to the extensive soil cover in the west of Alligator River sheet and Cobourg Peninsula sheet, few anomalies were detected.

More correlations with geology will be made when the total radioactivity channel and three spectrometric channels are reduced to map scale.

AIRBORNE REDUCTIONS AND CONTRACTS GROUP

(C. Leary, J. Rees, B. Wyatt, R. Taylor)

Data Processing

Victoria 1972. Field data for the BENDIGO, WANGARATTA, and TALLANGATTA 1:250 000 map areas were edited, stored, profiled and the flight paths digitised. The magnetic data will have levelling adjustment applied during November and December.

Western Australia (Data Purchase). Magnetic field data for the RASON, MINIGWAL, CUNDEELEE, and PLUMRIDGE 1:250 000 Sheet areas were edited and profiled for quality assessment. The data were found to be unsatisfactory and were returned to the vendor (Ausminex) for upgrading. These data are being assessed again after upgrading.

Data mapping

New South Wales 1971. The magnetics for four maps at 1:31 680 scale forming part of the NARROMINE 1:250 000 Sheet area were contoured at a 10-gamma contour interval by computer program and plotted in Sydney.

Western Australia 1969. The magnetics for sixteen maps at 1:100 000 in MURGOO, CUE, YALGOO and KIRKALOCKA were contoured at a 50-gamma contour interval by computer program and plotted in Sydney.

Preliminary mapping released

Western Australia 1969. The preliminary contours for the magnetics for 24 maps at 1:100 000 in the 1:250 000 Sheet areas of BYRO, BELELE, MURGOO, CUE, YALGOO, and KIRKALOCKA were made available for release.

Queensland 1969. The preliminary contours for the magnetics for the three maps at 1:250 000 for WALSH, MOSSMAN, and CAIRNS were made available for release.

Program development

Two programs were designed to determine the datum adjustments necessary for the total integration of the magnetic data of a survey area. One employs successive least-squares adjustments minimizing the misclosures in the crossover grid, which is required to be regular in the space domain. The other analyses the misclosures in the crossover grid defined in the time domain and minimizes the misclosures by determining the systematic error patterns. A general plotting subroutine has been developed with options for scaling, origin, location, and plot annotation.

Three programs handling flight path recovery have been integrated to cut down the turn-around time from 3 days to 1 day.

A program to integrate flight path photo control points with the digitally recorded Doppler data is nearing completion.

Documentation of the bank of user programs continued throughout the year.

Contracts

Western Australia 1972 (1). The contractor, Aeroservice (Aust.) Pty Ltd, completed the field operations, and the magnetic and navigational data for PERENJORI, NINGHAN, MOORA, and BENCUBBIN 1:250 000 Sheet areas will be delivered by mid-November. The data for ROBINSON RANGE, PEAK HILL, NABBERU, STANLEY, and GLENBURGH are expected to be ready at the beginning of December.

Western Australia 1972 (2). A tender has been recommended to Contracts Board for contractual acquisition of airborne magnetic data in KELLERBERRIN, CORRIGIN, PERTH and PINJARRA 1:250 000 Sheet areas.

Western Australia (Data Purchase). The analogue data have been assessed and accepted. The digital records of the magnetic data are being assessed, and the contract with Ausminex to purchase these data should be finalized by the end of November.

FIGURE MA1

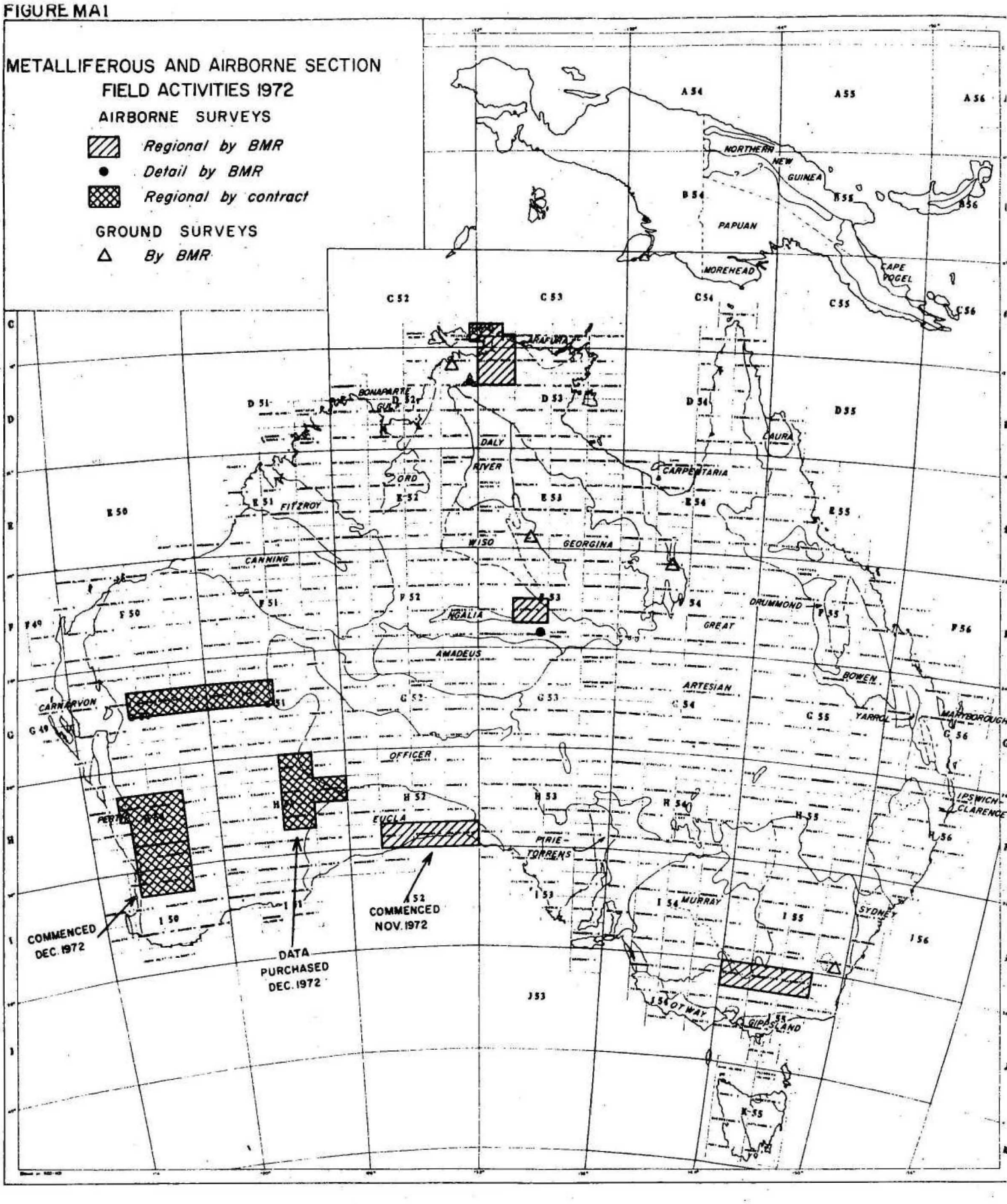
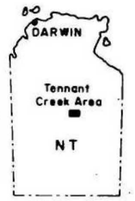

METALLIFEROUS AND AIRBORNE SECTION
FIELD ACTIVITIES 1972
AIRBORNE SURVEYS
Regional by BMR
Detail by BMR
Regional by contract
GROUND SURVEYS
By BMR
NORTHERN
NEW
GUINEA
PAPUAN
MOREHEAD
CAPE
VOGEL
BONAPARTE
GULF
DALY
RIVER
ORD
FITZROY
CANNING
WISO
GEORGINA
CARPENTARIA
LAURA
DRUMMOND
GREAT
ARTESIAN
BOWEN
YARROL
MARYBOROUGH
IPSWICH
CLARENCE
SYDNEY
MURRAY
GIPPSLAND
OTWAY
AMADEUS
NGALIA
OFFICER
EUCLA
PIRIE-
TORRENS
CARNARVON
COMMENCED
DEC. 1972
DATA
PURCHASED
DEC. 1972
COMMENCED
NOV. 1972

Figure MA 2

LEGEND

- River or creek
- Highway or main road
- Secondary road
- Road or track
- Bore
- Mine
- Aerodrome or landing ground
- Boundary of 1964 BMR airborne survey
- " " 1966 " " "
- " " 1967 " " "
- " " AGGSNA ground magnetic survey
- " " BMR " " "
- 1967 BMR traverse layouts
- 1969 BMR traverse layouts
- 1971 BMR survey area
- Telephone line
- Builtup area
- 1972 Traverse layouts
- 1972 Survey Area

LOCATION DIAGRAM



LOCALITY MAP SHOWING SURVEY AREAS IN RELATION TO PREVIOUS SURVEYS

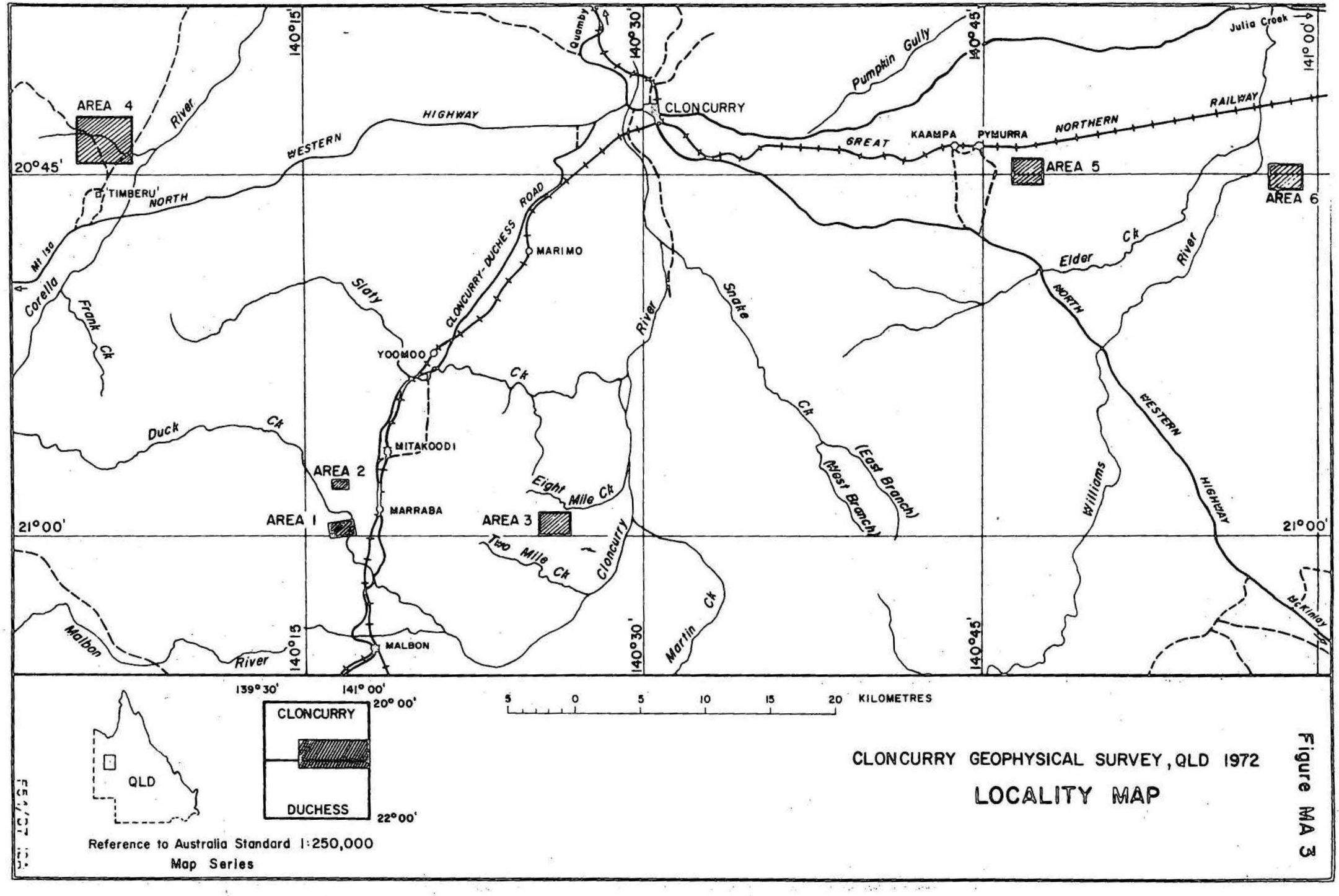
TENNANT CREEK
GEOPHYSICAL SURVEY, 1972

MILES
4 2 0 4 8

(Based on F53/B7-77)

To accompany Record No.

F53/B7-112

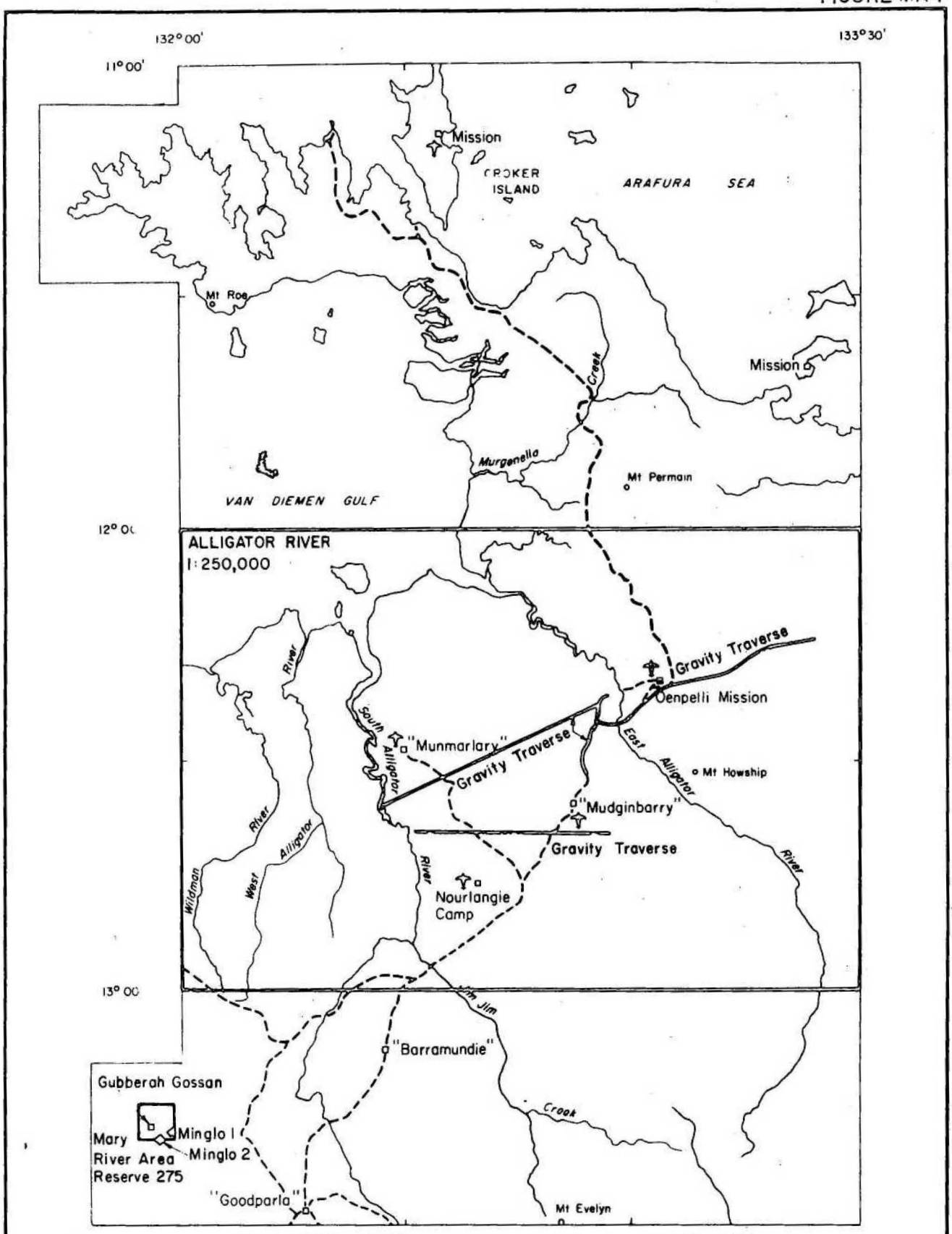


CLONCURRY GEOPHYSICAL SURVEY, QLD 1972

LOCALITY MAP

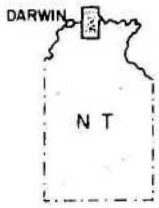
Figure MA 3

FIGURE MA4



MARY RIVER GEOPHYSICAL SURVEY AREA NT AND ALLIGATOR RIVER GRAVITY SURVEY AREA NT 1972

LOCALITY MAP

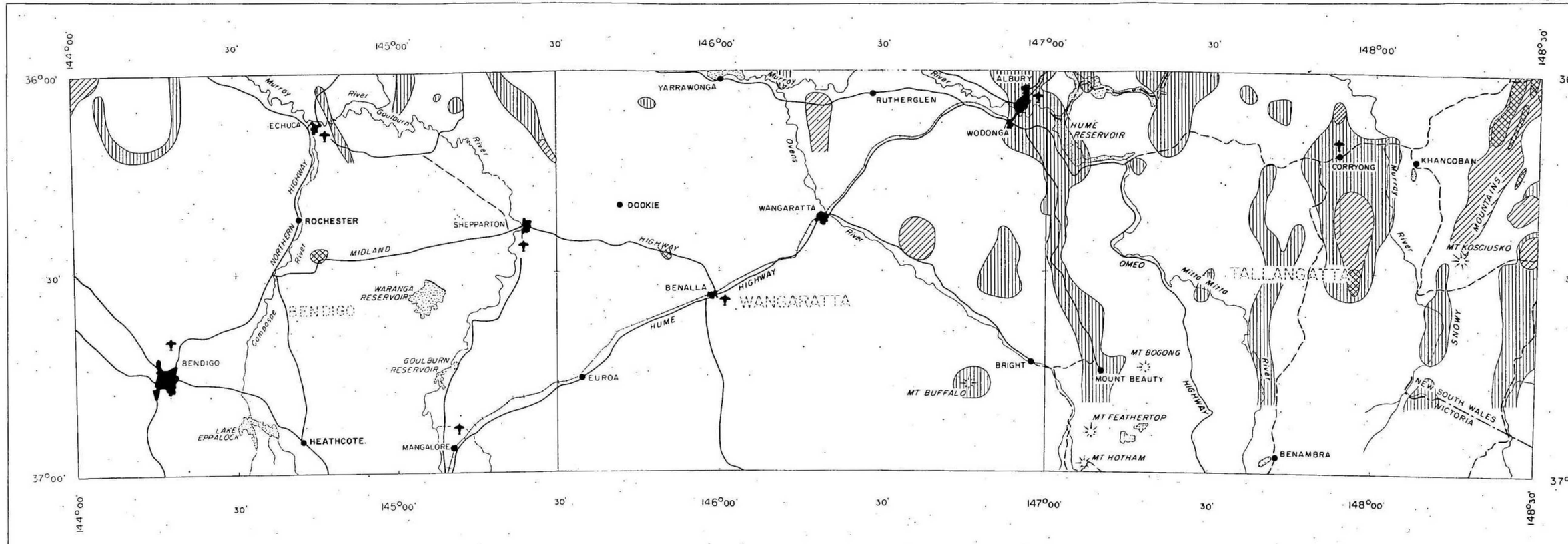


20 0 20 40 60 80 KILOMETRES

10 0 10 20 30 40 MILES

D53/B1-4

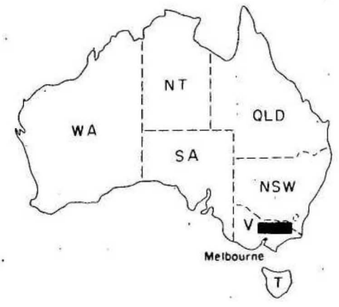
FIGURE MA5



AIRBORNE SURVEY, BENDIGO, WANGARATTA, TALLANGATTA, VICTORIA 1972

SUMMARY OF ACTIVITIES 1972

LOCATION DIAGRAM



Magnetic anomalies up to 100γ

200-500γ

over 500γ

10 0 10 20 30 40 50 60 70 80 90 KILOMETRES

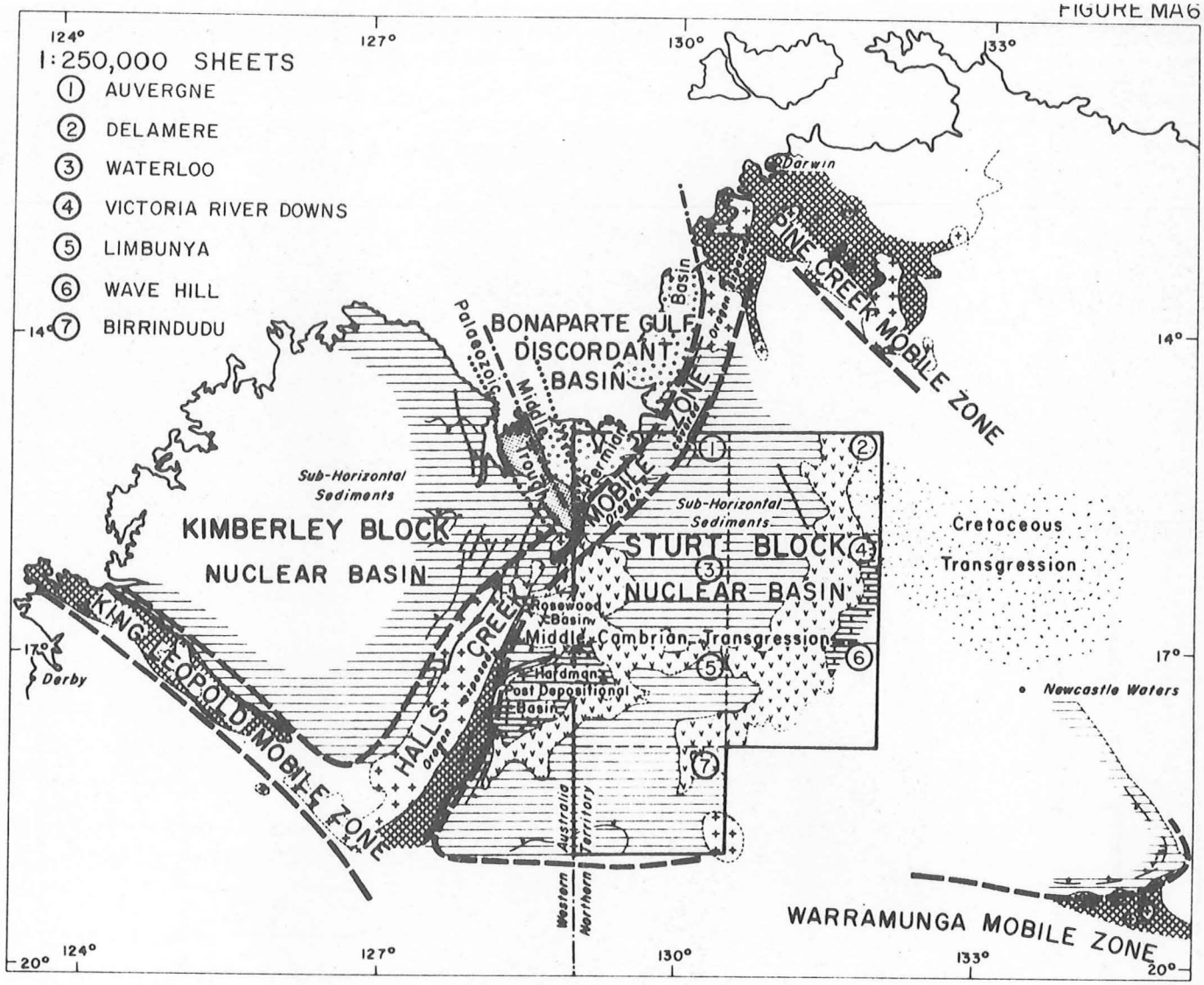
10 0 10 20 30 40 50 MILES

REFERENCE TO 1:250,000 MAP SERIES

SWAN HILL	DENILIQUIN	JERILDERIE	WAGGA WAGGA	CANBERRA
SAINT ARNAUD	BENDIGO	WANGARATTA	TALLANGATTA	BEGA
BALLARAT	MELBOURNE	WARBURTON	BAIRNSDALE	MALLACOOTA

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

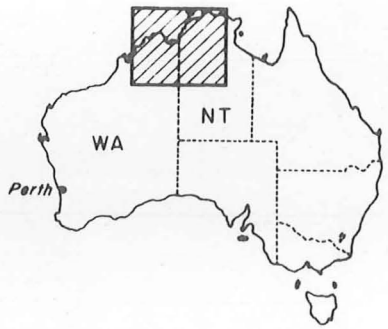
~~J55/B1-5~~



LEGEND

- Cretaceous Sediments
- Permian Sediments
- Middle Palaeozoic Sediments
- Middle Cambrian Sediments
- Lower Cambrian Volcanics
- Upper Proterozoic Sediments
- Lower Proterozoic Granite
- Lower Proterozoic Metamorphics
- Fault
- Trend Line
- Approx. Boundary of Mobile Zone
- Approx. Boundary of Middle Palaeozoic Trough
- Approx. Boundary of Permian Basin
- Approx. Geological Boundary
- Survey Boundary

LOCALITY DIAGRAM



AEROMAGNETIC SURVEYS 1966-68

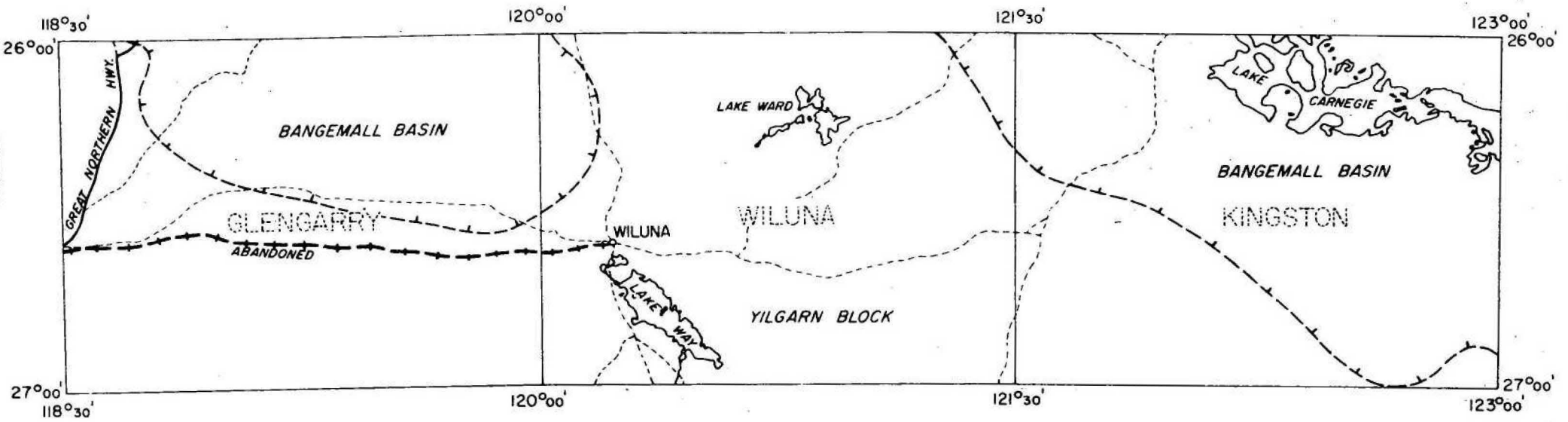
VICTORIA RIVER BASIN, NT

LOCALITY MAP AND TECTONIC GEOLOGY

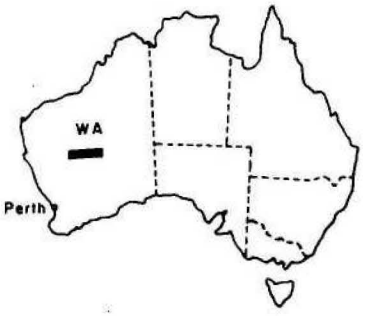
100 0 100 200 300 400 KILOMETRES

50 0 50 100 150 200 250 MILES

To accompany Record No. 1972/120



LOCATION DIAGRAM



AIRBORNE SURVEY, WESTERN AUSTRALIA 1970

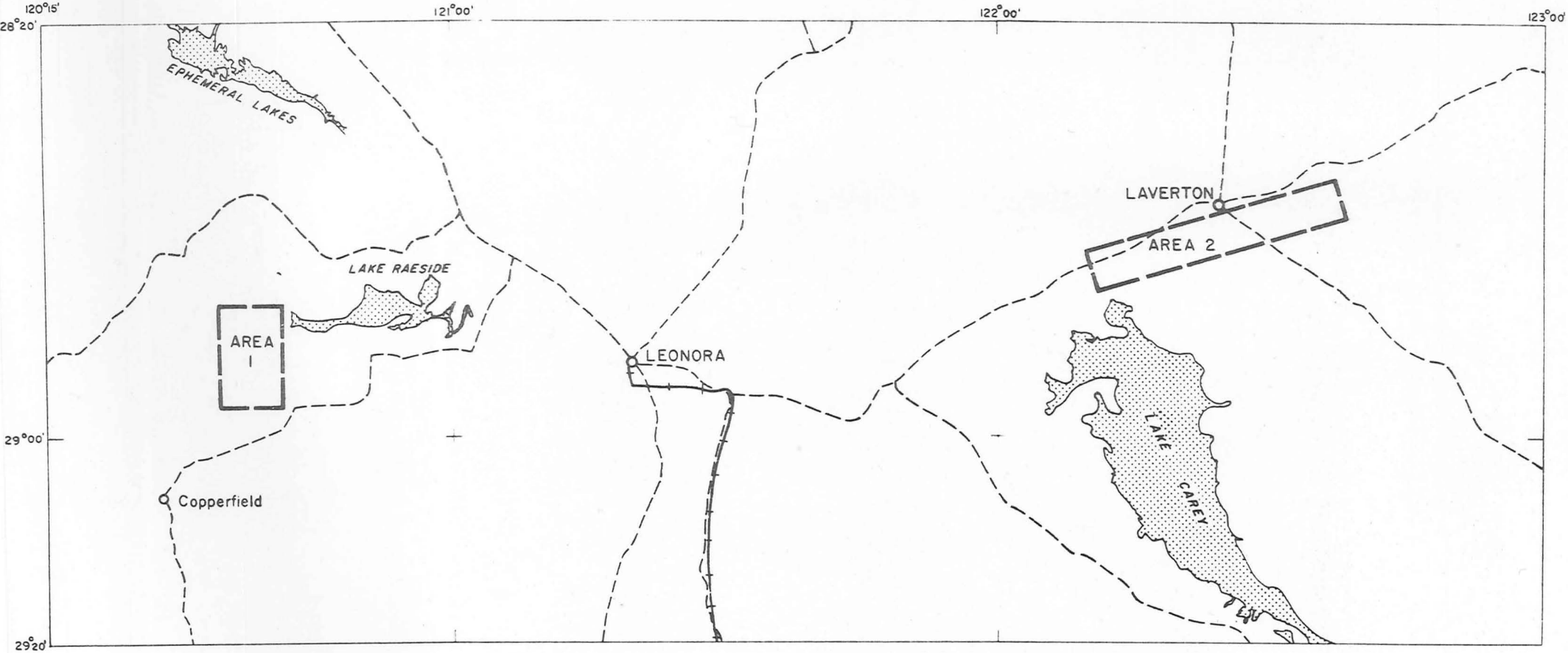
(CONTRACT)

LOCALITY MAP

KILOMETRES 20 0 20 40 60 80 100 120 140 160 KILOMETRES

MILES 20 0 20 40 60 80 MILES

FIGURE MA7



AIRBORNE REMOTE SENSING SURVEY, WESTERN AUSTRALIA, 1970

LOCALITY MAP

Survey boundary

10 0 10 20 30 40 50 60 70 80 KILOMETRES

5 0 10 20 30 40 MILES

To Accompany Record No. 1972/131

FIGURE MA8

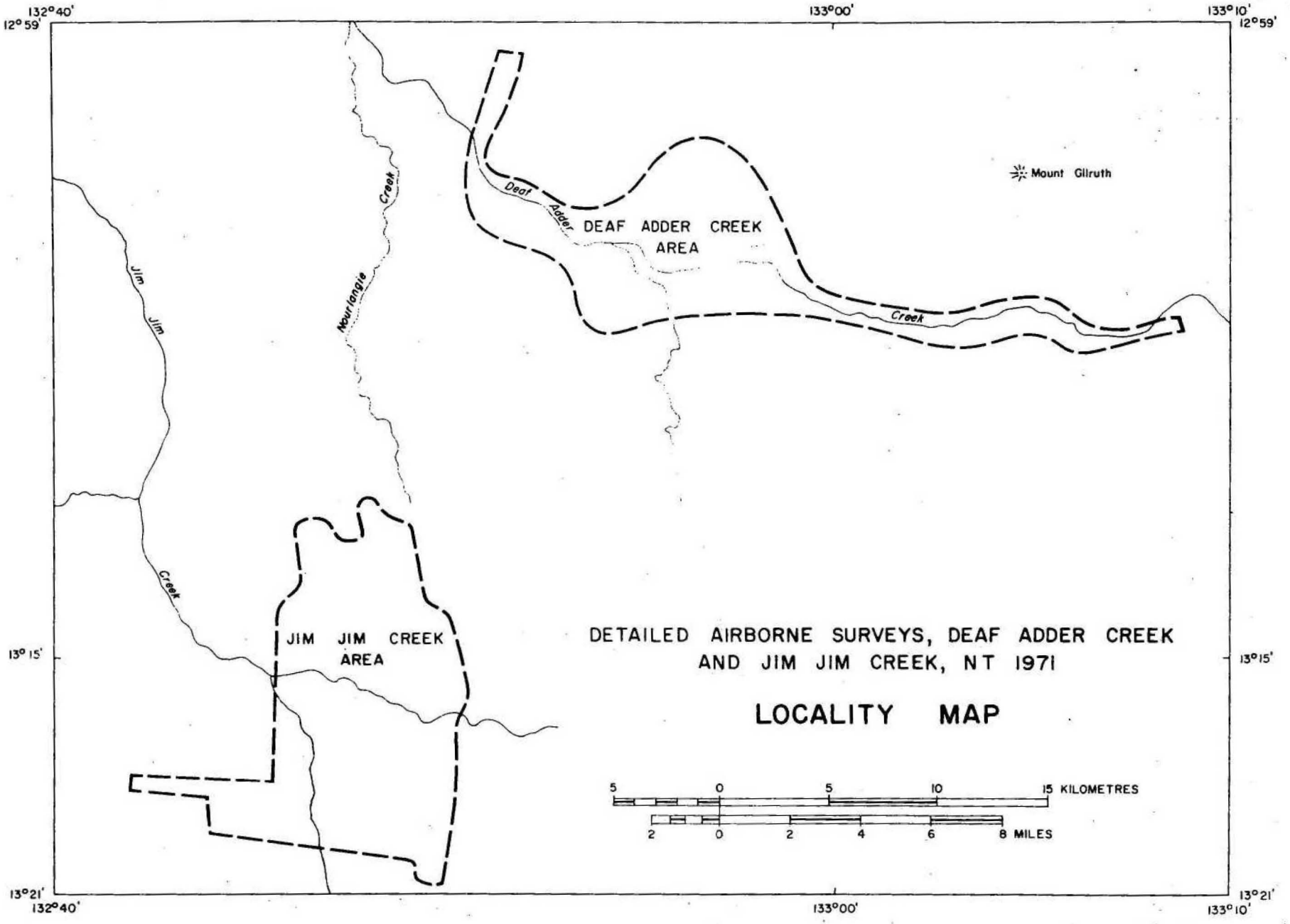
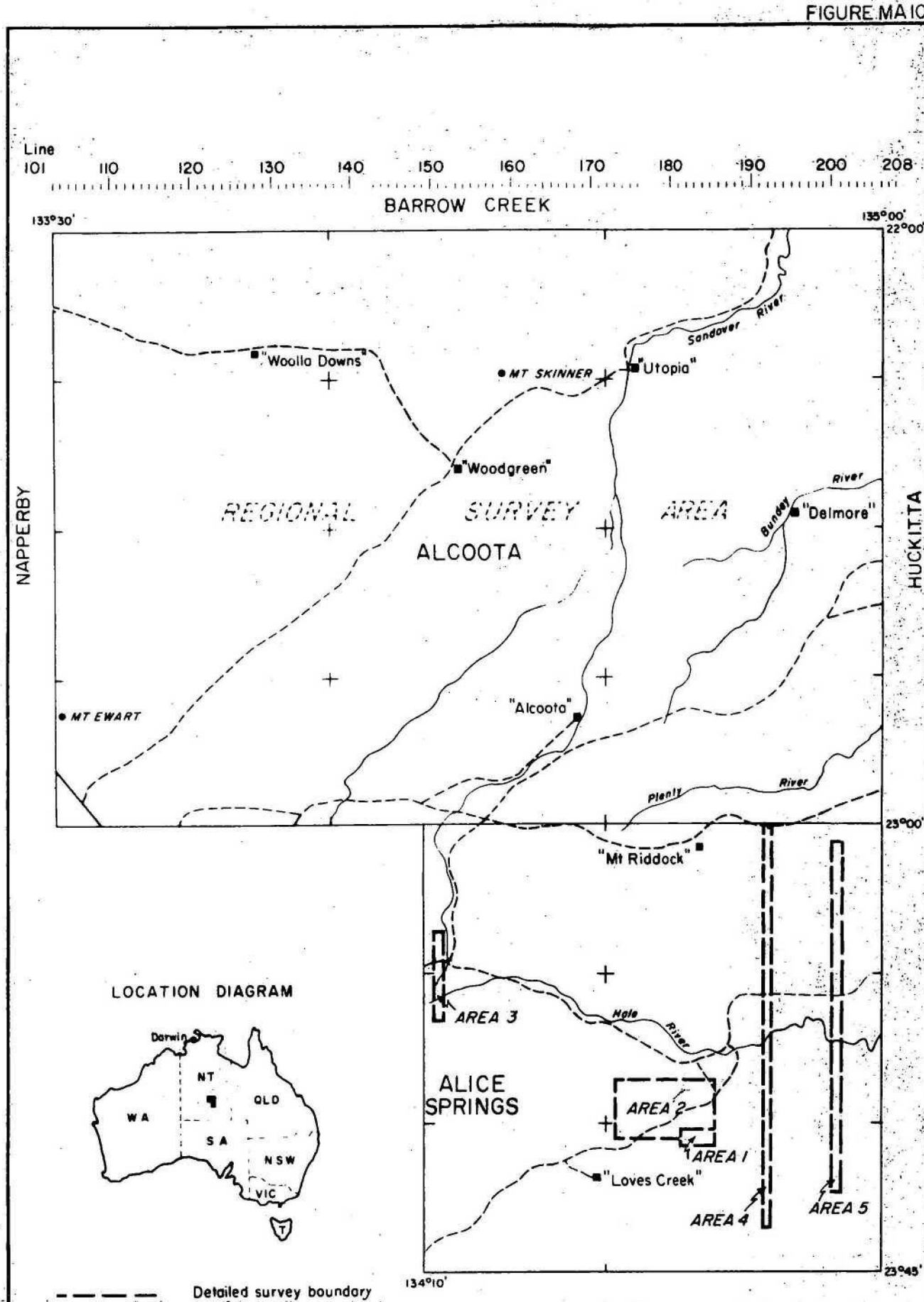

132°40'
133°00'
133°10'
12°59'
13°15'
13°21'
Mount Gilruth
Deaf Adder Creek
DEAF ADDER CREEK AREA
Nourlangie Creek
Jim Jim Creek
JIM JIM CREEK AREA
DETAILED AIRBORNE SURVEYS, DEAF ADDER CREEK AND JIM JIM CREEK, NT 1971
LOCALITY MAP
5 0 5 10 15 KILOMETRES
2 0 2 4 6 8 MILES

FIGURE MA9

FIGURE MA10



AIRBORNE SURVEY, ALCOOTA, NT 1972

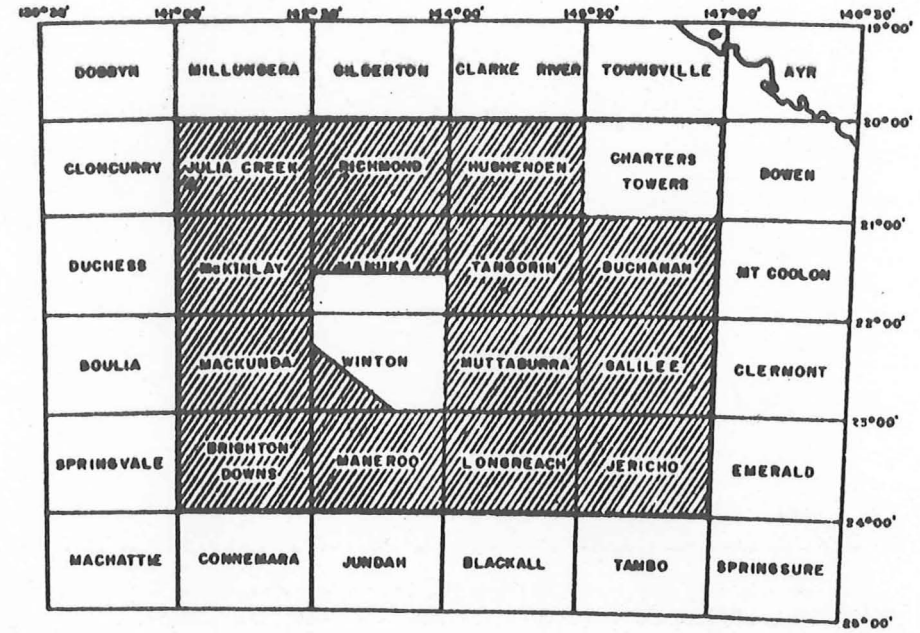
LOCALITY MAP

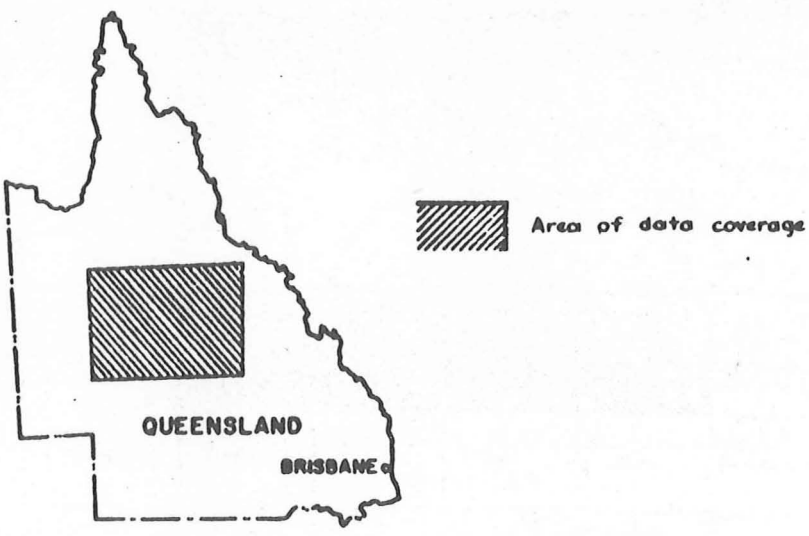
20 0 20 40 60 KILOMETRES

10 0 10 20 30 MILES

F53/B1-##A

FIGURE MAII

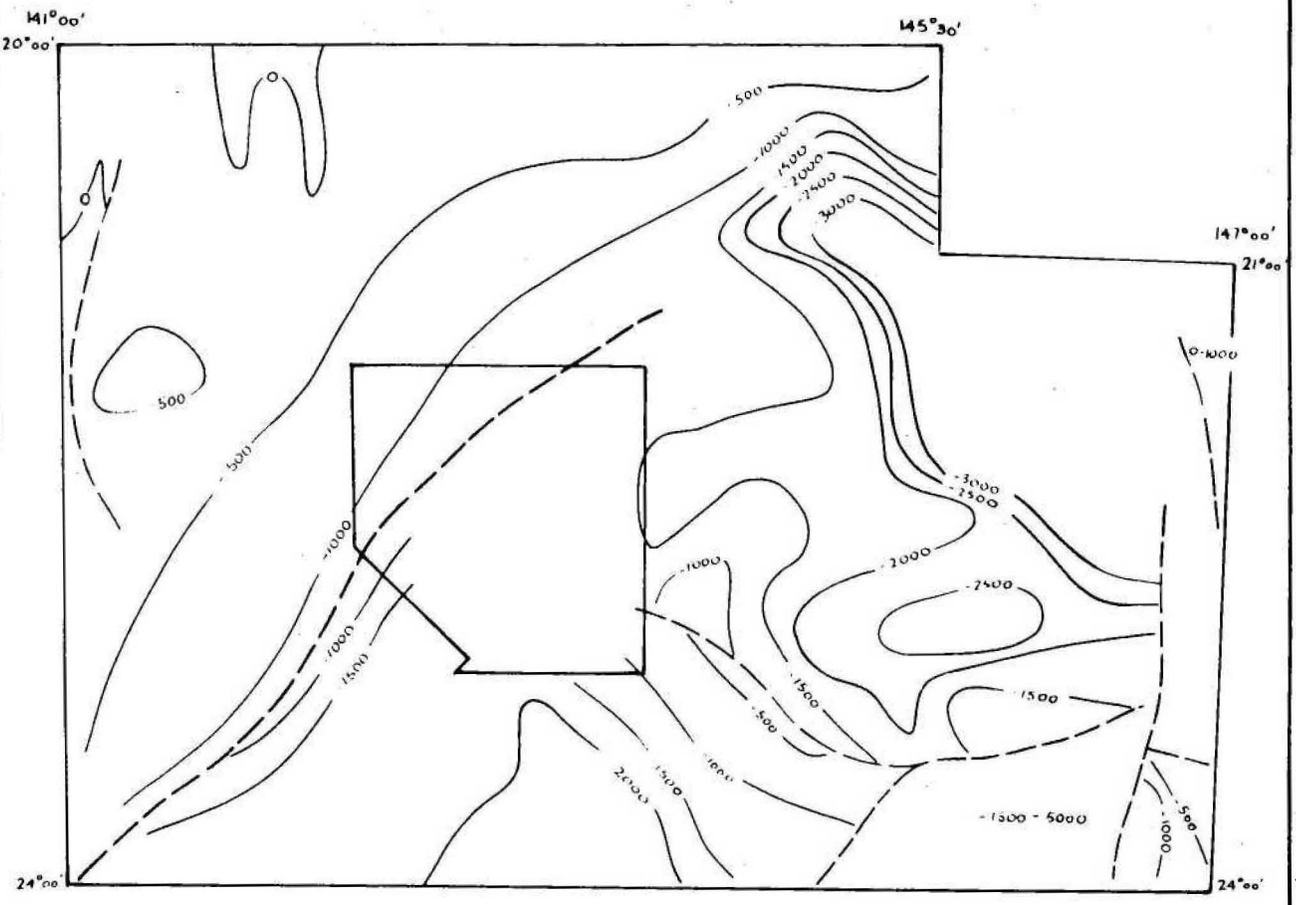




AEROMAGNETIC STUDY AREAS

NORTH EROMANGA AND DRUMMOND BASINS

FIGURE MA12



NORTHERN EROMANGA BASIN

GENERALISED CONTOUR MAP OF THE UPPER MAGNETIC BASEMENT

SCALE 1:4,000,000

--500— Basement Depth in metres below mean sea level

— — — Upper magnetic basement discontinuity

FIGURE MA13

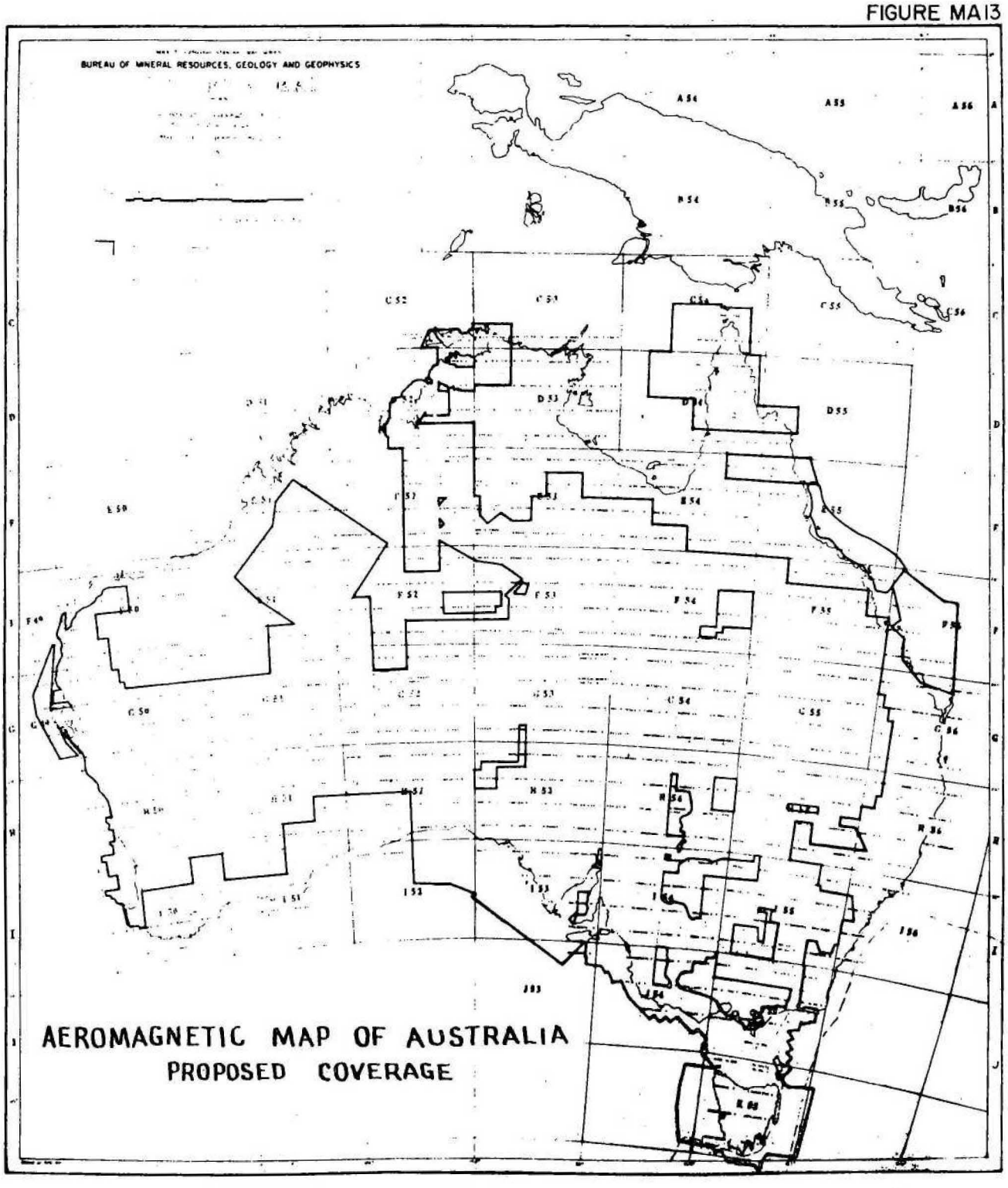
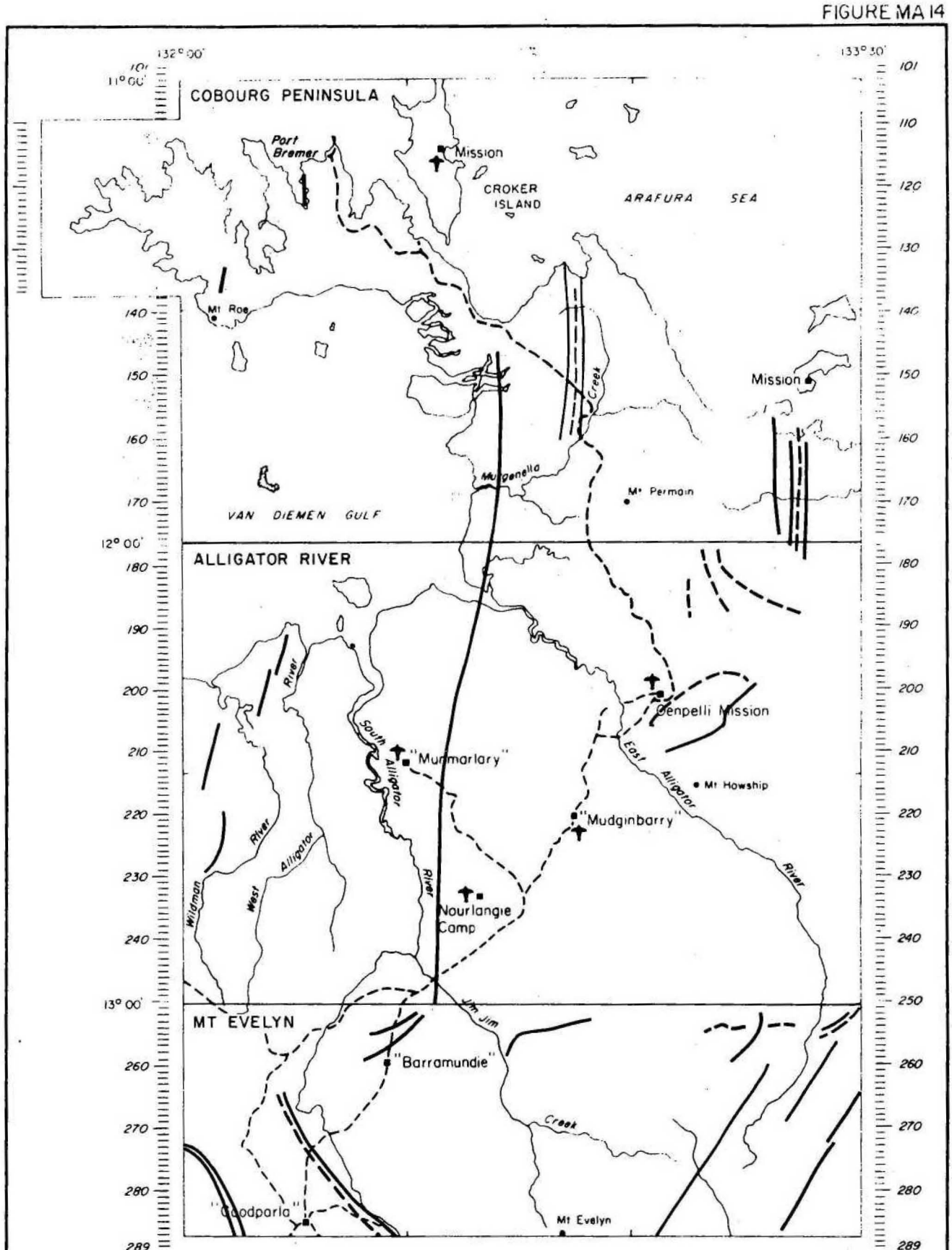
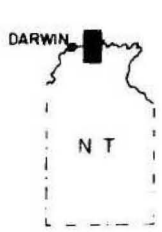

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
AEROMAGNETIC MAP OF AUSTRALIA
PROPOSED COVERAGE

FIGURE MA 14



AIRBORNE SURVEY, ALLIGATOR RIVER, NT 1971

FLIGHT – LINE SYSTEM



POSITIVE MAGNETIC ANOMALIES

NEGATIVE MAGNETIC ANOMALIES

20 0 20 40 60 80 KILOMETRES

10 0 10 20 30 40 MILES

D53/B1 12A

2. OBSERVATORIES AND REGIONAL SECTION

Contents

Figures

SUMMARY

This summary of the work of the Observatories and Regional Section covers the interval November 1971 to December 1972 inclusive. The reports issued and addresses delivered during the year are listed at the end of the Record.

The main activities of the Observatories sub-section were the operation of, and processing and analysis of data from, 5 geophysical observatories, 15 seismological stations, and 21 accelerograph stations. Figure OR1 shows the positions of all recorders at November 1972.

Four new seismograph stations were opened (Marble Bar, WA; Manton, NT; Bellfield, Vic; Talasea, PNG). Temporary stations were closed at: Karratha, WA; Darwin, NT; and Pomio, PNG.

Seismological data processing and analysis were improved by the introduction of the computerized 'Earthquake Data File' - a storage, retrieval, and plotting system for regional earthquakes; it functions through the co-operation of other seismological agencies in the region.

Two third-order regional magnetic surveys were made, in northwest Western Australia and in South Australia. Partial (total intensity) resurveys were made in selected areas of eastern Australia to help in the standardization of airborne magnetic results. Figure OR2 shows the survey areas.

Among the main activities of the Regional Gravity Group were planning and preparation for the joint BMR-Soviet pendulum and gravity meter ties, maintenance of horizontal pendulum tilt-meters at Cooney Observatory near Armidale NSW (see Fig. OR1), calculation of crustal models which are consistent with the regional gravity field, recomputation to modern standards of central Australian helicopter gravity surveys, and completion of a suite of computer programs for manipulating gravity data.

Maintenance of manual and computerized data files takes up most of the group's time. The huge influx of gravity data over the last 10 years is illustrated in Figure OR3. Such a volume of data can be handled effectively only by computer, and so the data are being recomputed and placed on magnetic tape. Figure OR4 indicates the areas for which at least some preliminary gravity data are currently held on magnetic tape.

The Australian Calibration Line, which controls the Australian gravity network, was further strengthened by a run using LaCoste & Romberg gravity meter G104 (see Fig. OR5).

The main efforts of the Regional Structural Surveys group during 1972 were in the interpretation of the results of crustal structure surveys in the New Britain/New Ireland/Bismarck Sea area of Papua New Guinea, and in the development of recording systems for future seismic refraction surveys.

The Papua New Guinean data (seismic, gravity, and magnetic) were obtained during 1967, 1969, and 1970 and have led to a number of concurrent analyses resulting in interpretations which highlight different aspects of the work.

The development of an unattended tape recording seismograph system has been high on the equipment priority list of the Geophysical Branch. The system is planned for use in deep seismic refraction surveys for determining crustal and upper mantle structure, and has now been field tested at Googong damsite, in the Galilee Basin, and on the Trans-Australia survey.

OBSERVATORIES SUBSECTION

Headquarters Observatory Group

Geomagnetism. About 79 observatory-months of magnetograms were reduced to mean hourly values, i.e. the backlog was reduced by only 19 months. As 17 years remain, priority must be given to (a) restoring the digitizer to reliable operation, and (b) the introduction of digital recording equipment. Partly to increase the output, manual scaling of magnetograms at the Antarctic Observatories was reintroduced (from 1973).

The monthly 'Geophysical Observatory Report' was prepared and distributed. About mid-year, printing of the Report was transferred from Melbourne to Canberra; after some initial problems, this resulted in a more rapid production.

A two-component (X and Y) fluxgate variograph was run after March as a contribution to the Australia-USSR conjugate point project. Strip chart records are produced at a sensitivity of about 1.2 mm/gamma and a rate of 150 mm/hr.

It was decided to abandon development of the BMR digital variograph based on conventional variometers, and instead to develop fluxgate variographs to observatory standards. One of the fluxgate systems will be compared with an Elsec digital system and a commercial fluxgate system in 1973-74, to determine future replacement systems.

The Forests Branch Department of Interior was opposed to the development of the Kowen Test Site for a permanent observatory, but offered another area farther east. This was tested and shown to be suitable but it is not readily accessible and would be costly to develop. Therefore negotiations were begun with ANU to examine the Mount Stromlo area.

Seismology. The long-planned Earthquake Data File finally came into operation. This is a computerized storage and retrieval system for all recorded earthquakes in the region 0-90°S, 75-165°E. ISC phase data (from 1 January 1971) from all institutions within Australia, PNG, and Honiara are now processed in Canberra, and collated into a 'time sorted' catalogue; unfortunately many network data are not included, but network results will eventually be added to the file.

The strong-motion data centre was maintained, and twelve accelerograms from PNG were digitized and processed. Detailed studies were made of the Lake Mackay series of earthquakes (with Mundaring and Port Moresby officers), and of the Simpson Desert series of August 1972 (with University of Adelaide personnel); results of the Ord River explosions (1970 and 1971) were published.

A telemetered seismograph system was installed in May near Manton Dam about 70 km by road southeast of Darwin; the seismograph which had operated at East Point since 1961 was then shut down. The new seismograph has a peak magnification (at 0.4 s) of about 300 000, and should detect minor regional events within a radius of several hundred kilometres.

The Giles Meteorological Station was visited to determine its suitability for a seismograph station (planned for 1973). Ground noise tests showed that the seismometer will have to be placed about 1 km from the station to avoid vibrations from the power plant; otherwise there should be no great difficulty in establishing a high-gain station there.

Crustal Studies. Assistance was given in the 'Trans Australia Seismic Project' in October when three field parties made recordings at Mill Ridge, Mount Cavenagh, Granite Downs, and Mount Fitton.

Crustal movements project, Papua New Guinea. Six survey pillars were constructed in the Markham Valley, by the Commonwealth Department of Works, in connection with the Papua New Guinea crustal movement surveys. The sites for the survey of the St George's channel region were selected and it is proposed to proceed with this part of the program , provided suitable land tenure agreements can be negotiated. An intradepartmental committee of Aronsen, Denham, Dow (BMR), Cook (NAT MAP) and Williams (MIN EN) are currently managing the project.

Mundaring Observatory Group

Standard Programs. Standard observatory programs in geomagnetism, seismology, and ionospheric recording were continued, and preliminary results were distributed. There were no significant record losses, nor changes in instruments. Instead of listing ISC phase data in manuscript form, the data were produced on punch cards for processing in Head Office; otherwise there were no changes in data production.

Ground tests over the Mundaring Weir site showed that it would be possible to operate a digital magnetograph there, but the urgency for utilizing the site decreased when the W.A. Government disapproved the construction of an alumina plant near Gnangara.

Regional Seismology. Seismographs were run at Kalgoorlie, Meekatharra, Kununurra (with PWD), Karratha (to August), and Marble Bar (from October). The new visible writing-amplifier system at Marble Bar is the first stage in the establishment of a high-sensitivity seismograph in the northwest; the seismometer will be moved to an optimum site near the airstrip when telemetry components are available. Installation of a seismograph in the Swan View tunnel (near Mundaring) was held up because an APO telemetry line was not erected.

Accelerographs near Meckering were not triggered during the year, although several small earthquakes were felt there. No microtremor or other short-term recordings were made because the transportable cabin had to be air-conditioned.

A contribution was made to the study of the Lake Mackay series of earthquakes, and a Record was written which showed that the rises in water bore levels at Gnangara were caused by rainfall and not local earthquakes.

Crustal Studies. Observatory personnel manned three field stations (one at the Kununalling shot-point) during the 'Trans Australia Seismic Project' in October.

Port Moresby Observatory Group

Standard Programs. There were no changes in the observatory programs of geomagnetic, seismological, and ionospheric recording and distribution of results.

Regional Seismology. Seismographs were operated at Lae, Goroka, Wabag, Momote, Kavieng, Pomio (to June), Talasea (from August), and Kobuan. The station at Pomio had been installed temporarily in 1971 to record aftershocks from two large earthquakes in the Solomon Sea; it was maintained until facilities at the Talasea regional station were completed; then the equipment was transferred. The station at Kobuan (which has been running for several years) is owned by the CRA Company, and recordings were previously analysed by the Rabaul volcanological group. The establishment of a regional station at Vanimo was deferred because of lack of equipment; testing of a site in the Star Mountains was deferred for the same reason.

Accelerographs, largely owned by other institutions, were maintained at Lae, Wewak, the Ramu damsite, Star Mountains, Frieda River, Rabaul, and the Musa damsite. Recordings were sent to Canberra for processing. A new type of accelerograph - the Kinemetrics SMA-1, bought by Department of Works - was put into use late in the year; it appears to have some advantages over the MO-2 used so far.

Studies and reports were made on PNG tsunamis, PNG seismicity, focal mechanisms, Australian seismicity, and the Lake Mackay series.

Toolangi Observatory Group

Geomagnetic and seismological observatories were operated at Toolangi, and preliminary data were distributed. ISC phase data were produced on punch cards before being sent to Head Office (as for Mundaring).

Operation of the seismograph at Norfolk Island continued and routine analyses were made. A new high-gain single-component station was established at Bellfield Reservoir (Western Victoria) in October; it is designed to complete the magnitude 3.5 coverage in southeastern Australia by filling the gap between Toolangi and Adelaide.

Antarctic Observatories

At Macquarie Island and Mawson geomagnetic and seismological recording and analyses continued. A telemetered seismograph system at Macquarie Island was established; the seismometer is positioned on the plateau, where earlier tests had indicated a significant reduction in ground noise. At Mawson an underground vault became available and its preparation for the seismometers was begun.

A tide-gauge and a micropulsations recorder at Macquarie Island were attended to for other organizations.

REGIONAL SURVEYS SUBSECTION

Regional Magnetic Surveys

Third-order surveys were completed in southwestern and northwestern WA and SA. Over the areas accessible to a 2-wheel-drive vehicle, observations of D, H, and F were made at nominal 15-km intervals. Altogether about 1500 stations were occupied and 70 000 km of road traversed; the average station density was about one per 1400 km^2.

A few opportunity observations were made in the Prince Charles Mountains (Antarctica) during the 1971-72 summer expedition.

Third-order repeat measurements of F were made in seven areas in eastern Australia where difficulties were encountered in reconciling ground and airborne data.

There was no call for tests of compass-swinging bases.

Regional Gravity Group

Gravity Map of Australia. A coloured contour map of Bouguer anomalies over Australia is to be published in 1976. The map will be printed in four sheets at a scale of 1:2 500 000 and the density to be used in calculating the anomaly is 2.67 g/cm^3. Discussions between the Drawing Office and Regional Gravity Group involved data availability, colour scheme, scale, and projection. Initial compilation will be made from computer contoured maps at a scale of 1:250 000 and Transverse Mercator projection.

The new map will provide an opportunity to introduce Australian Height Datum (AHD) elevations and the new International Gravity Standard Network (IGSN71) gravity values.

Recomputation of gravity surveys. In order to prepare data for the Gravity Map of Australia the accuracy and availability of data for all surveys indexed in the group's filing system was investigated. A special form was prepared for listing the quantitative information and an assessment of the recomputation for each survey. These forms were filled in for all known surveys and the totals of station numbers and surveys were calculated under several headings such as total number of surveys by BMR, total number of stations read by private companies in 1970. Graphs showing the progressive totals of surveys and number of stations are shown in Figure OR3. The total number of gravity stations was estimated at 540 000.

Recomputation of the surveys in Central Australia was commenced and the control network of road surveys was computed. Recomputation of several Commonwealth subsidized surveys were also finalized. The 1962 helicopter survey by BMR has been recomputed but some follow-up work was found to be necessary. About 100 additional stations have been read by Wongela and the data for these are ready for computing. New flight diagrams were drawn, drift control was checked, and the new Australian Height Datum (AHD) elevations were used.

Other recomputation work was done on the East Victorian road surveys and the Eildon survey, and computation continued on the 1971 Western Highlands survey in Papua New Guinea.

Tender specifications for the trial contract for recomputation of gravity data were drafted and tenders have been called. This pilot contract is a forerunner to the full-scale recomputation proposed for the next three years.

Computing and calculating. The format of the magnetic tape files was changed during the year and a new suite of programs to handle the data reduction, storage, retrieval, and mapping was completed. The new system compresses the data into multi-station records on the tape and enables much more data to be held on each tape, as well as increasing the efficiency of data access by a factor of ten. A tape datum has been introduced which

uniquely defines the units and datum of data on each tape and thus allows automatic conversion of data on input or output by specifying the required datum. At present there are 32 ways in which the data may be read or presented, by a combination of options such as decimal degrees or degrees and minutes for co-ordinates. The format of the print-out changes automatically depending on the units being used. The flexibility of the system is greatly improved and data in any format can be read off cards and internally converted to the standard desired. The system is also able to perform functional transformations on the data for each station. A new, smoother contouring routine developed by I. Briggs of the Marine Group has been incorporated into the gravity data contouring program. The earth tidal gravity value program now has the option of a histogram representation of the tidal corrections. The program for locating data has been generalized and allows up to six tapes to be searched under several criteria.

Submissions were made for the purchase of a Hewlett Packard Model 20 calculator and plotter. The HP9100B programs have been catalogued and documented.

Australian National Gravity Filing System. Major improvements were made to both manual and computer files. A card index covering all survey numbers allotted, inclusion of photocopies of subsidy reports, and the redrawing of key maps was completed. A lecture was given on the use of the manual filing system to officers who are using or may need to use the files.

The magnetic tape files were rationalized by reorganizing the random areas on the 19 old tapes to a set of 10 regional tapes covering 8 segments of Australia, Papua New Guinea, and marine data. The new area blocks have been assigned a file number and a logical name to permit quick location of data.

The area of coverage of gravity data (both final and preliminary) on the magnetic tape files is shown in Figure OR4.

Interpretation of data. A spectral analysis of mean altitudes and free-air anomalies over two-degree squares along two continental traverses indicated crustal isostasy for wavelengths greater than 200 km and a significant decrease of horizontal density variation below 60 km. An Australian crustal model consistent with isostatic equilbrium, deep seismic results, and gravity fields of wavelength between 4 and 20 degrees was constructed.

Further work on Gosses Bluff involved the construction of a new residual gravity map, and several gravity profiles were matched against cylindrical density models.

Joint BMR-Soviet exercises. Preparation for the joint BMR-Soviet gravity measurements along the Australian Calibration Line (ACL) and the pendulum tie Moscow-Sydney-Moscow proceeded for most of the year. The ACL work has been deferred until 1973.

Six scientists from the Soviet Academy of Sciences arrived in December and made measurements with five sets of Soviet pendulum equipment in the basement of the National Standards Laboratory. The measurements will provide a comparison between the absolute gravity determinations at Sydney and Moscow and will strengthen the ties between Europe and Australia in the world gravity network.

Horizontal pendulums and earth tides. The first long-term continuous records of five weeks' duration were obtained and spectral analysis was commenced to determine the components of the earth tides.

Since these records were obtained the record quality has been badly affected by condensation on the pendulums and optics. Several attempts at overcoming this problem have been made. The niche in the rock wall which contains the pendulums has been sealed off by a plate glass door and concrete with a waterproof covering of epoxy-resin has been spread over the floor. Silica-gel is being placed in the niche, and cool dry air is ducted in and made to impinge on the glass door where the light beams pass through.

Australian Calibration Line survey. The LaCoste & Romberg gravity meter G104 belonging to the Antarctic Division, Department of Supply, was taken on a run along the ACL in December. It had been hoped that this meter could have participated in the joint BMR-Soviet exercise but its commitments in Antarctica necessitated a special run. The results were satisfactory apart from trouble with the power lead on the first three readings, which were repeated later. Two new stations have been established on the ACL at Tullamarine Airport in Melbourne and at Brisbane Airport. A diagram of the calibration run is shown in Figure OR5.

Antarctic gravity survey. The regional gravity survey of the Mawson-Davis area of Antarctica was extended by fifty gravity readings in the Mawson area and the southern Prince Charles Mountains during the summer field season. The establishment of an Antarctic network with ties to Australia and the rest of the world is part of an international program.

A draft Bouguer anomaly map of gravity data in the Mawson-Davis area of Antarctica was prepared.

West Sepik gravity survey. The gravity coverage in the Western Highlands of Papua New Guinea was extended in co-operation with the West Sepik geological party. The helicopter was used for gravity work when it was not needed by the geologists.

Equipment. Construction and testing of the timing equipment for the BMR relative pendulums was completed. With the new electronic circuit, laser light source, and rubidium time standard, the required accuracy in timing can be achieved, and direct read-out of the period greatly facilitates analysis of results. However, the results with the National Standards Laboratory low-profile knife-edge pendulums, tested in Canberra, have not been satisfactory and the pendulums were returned to NSL for alterations.

The long-term drift characteristics of the tidal recording gravity meter were tested and found to be satisfactory, but no further progress was made with the construction of the ancillary electronics.

BMR's four LaCoste & Romberg gravity meters were sent to the manufacturers in the United States for overhaul and were thoroughly tested on their return. The drift and calibration factors were measured to ensure the stability of the meter readings.

General. No progress was made with the Isogal reporting, or the review of the East Papua gravity surveys. The proposed Lake George gravity survey was cancelled owing to a lack of vacation students.

Regional Structural Surveys Group

Interpretation of the 1967-69 New Britain/New Ireland seismic refraction data (W.A. Wiebenga, D.M. Finlayson, J.P. Cull, B. Drummond). The interpretation of the data from these surveys has been substantially completed although there are aspects which still warrant further investigation as special projects. The writing of reports on the interpretation will continue into 1973.

Interpretation was undertaken using two methods: the delay-time method and the time-term method. The two methods highlight different aspects of structure, but both identified four refractors: (a) the near-surface refractor in the Rabaul Caldera area; (b) basement refractor in some detail in the Gazelle Peninsula/southern New Ireland area and in general terms in other areas; (c) the intracrustal refractor detected over the whole survey region; and (d) the Moho refractor over the whole of the survey region. These refractors are illustrated in the plot of reduced time-distance data given in Figure OR6. Figure OR7 shows crustal sections in six areas within the whole survey region. These results are taken from the initial interpretation of the data.

Googong Damsite seismicity study (J.P. Cull). During the second half of 1971, observations were made of seismic activity in the region of the proposed Googong water storage area near Queanbeyan. The data were analysed during 1972. Figure OR8 shows the disposition of the five-station seismic array, and the areas from which seismic events were recorded. These areas are all known quarries. Figure OR9 illustrates the instruments used during the survey. No earthquakes were detected from the Queanbeyan Fault, which lies at the eastern edge of the storage area, and none occurred in any part of the catchment area during the period of recording.

The results of the seismicity study were thus unable to give any positive indication of the level of seismicity in the catchment area. It was recommended that the design criteria for the dam wall should be the same as those used in the Snowy Mountains Scheme.

Galilee Basin deep crustal investigation (J.P. Cull, E.J. Riesz). The interpretation of deep seismic refraction and relfection data collected during November 1971 in the Galilee Basin of north Queensland (Fig. OR10) was completed. The north-south crustal section interpreted for the area is illustrated in Figure OR11.

Bismarck Sea magnetic interpretation (J.B. Connelly). The interpretation of a number of marine magnetic profiles across the Bismarck Sea has been completed using two-dimensional computer modelling techniques. The interpretation indicates that the Bismarck Sea is divided into two main provinces and that the boundary between them roughly coincides with a line joining Manus Island and the Willaumez Peninsula of New Britain. An area of apparently nonmagnetic basement about 10 km wide coincides with a well defined band of shallow earthquakes which runs east-west across the entire sea. A major boundary occurs at the eastern end of the Bismarck Sea along the west coast of the Gazelle Peninsula of New Britain, and continues along an offset in the band of earthquakes to New Hanover.

Trans-Australia seismic survey (TASS) (D.M. Finlayson, J.P. Cull, J.B. Connelly, B. Drummond). In association with State Departments of Mines of WA and SA, and with contractors, BMR organized the detonation in the last three months of 1972 of two 80-tonne land explosions and one 10-tonne marine explosion in order to determine the structure of the upper mantle at depth down to 300 km. The locations of the shots and recording stations are shown in Figure OR12. The 80-tonne land shots were fired on 25 October in an old gold mine at Kunanulling (near Kalgoorlie, WA) and in an old copper mine at Mount Fitton (north Flinders Range, SA). These shots were made possible by WAPET having donated 270 tonnes of surplus explosives to BMR. The 10-tonne marine shot was fired on 19 December in 250 m of water in eastern Bass Strait. The shot was deployed from the oil rig supply vessel 'Smit-Lloyd 33'.

About 45 recording stations throughout Australia were expected to record at least one of the shots. These stations included fixed observatories and mobile field stations set up at selected sites by BMR and the Universities of Adelaide, Melbourne, Queensland, and Tasmania and the Australian National University. The 10-tonne marine shot was also designed to test the possibility of recording such shots at much greater distances (Japan, India, Hawaii, Antarctica) and thus give information on structure deep within the Earth's mantle (3000 km). This forms part of an investigation recommended by a committee of the International Union of Geodesy and Geophysics.

The collection and checking of data will not be completed until the end of 1973. Unfortunately the 10-tonne marine shot had to be fired at an unscheduled time at short notice when the float supporting the explosive began to sink. For this reason a number of the local mobile field stations did not have the opportunity to record the blast. Reports from overseas are not yet available, but the shot was recorded as far away as Darwin.

East Papua crustal survey planning (D.M. Finlayson). Planning continued for the deep seismic refraction survey proposed for Eastern Papua during 1973. Information was gathered on all proposed recording sites, and possible logistic facilities were appraised. Contract specifications were drawn up for the shooting ship, ship navigation, and recording station positioning. The general pattern of proposed shots and recording stations is illustrated in Figure OR13. Because of difficulties which have arisen in the development of seismic tape recording equipment by BMR, the survey has been postponed until the second half of 1973.

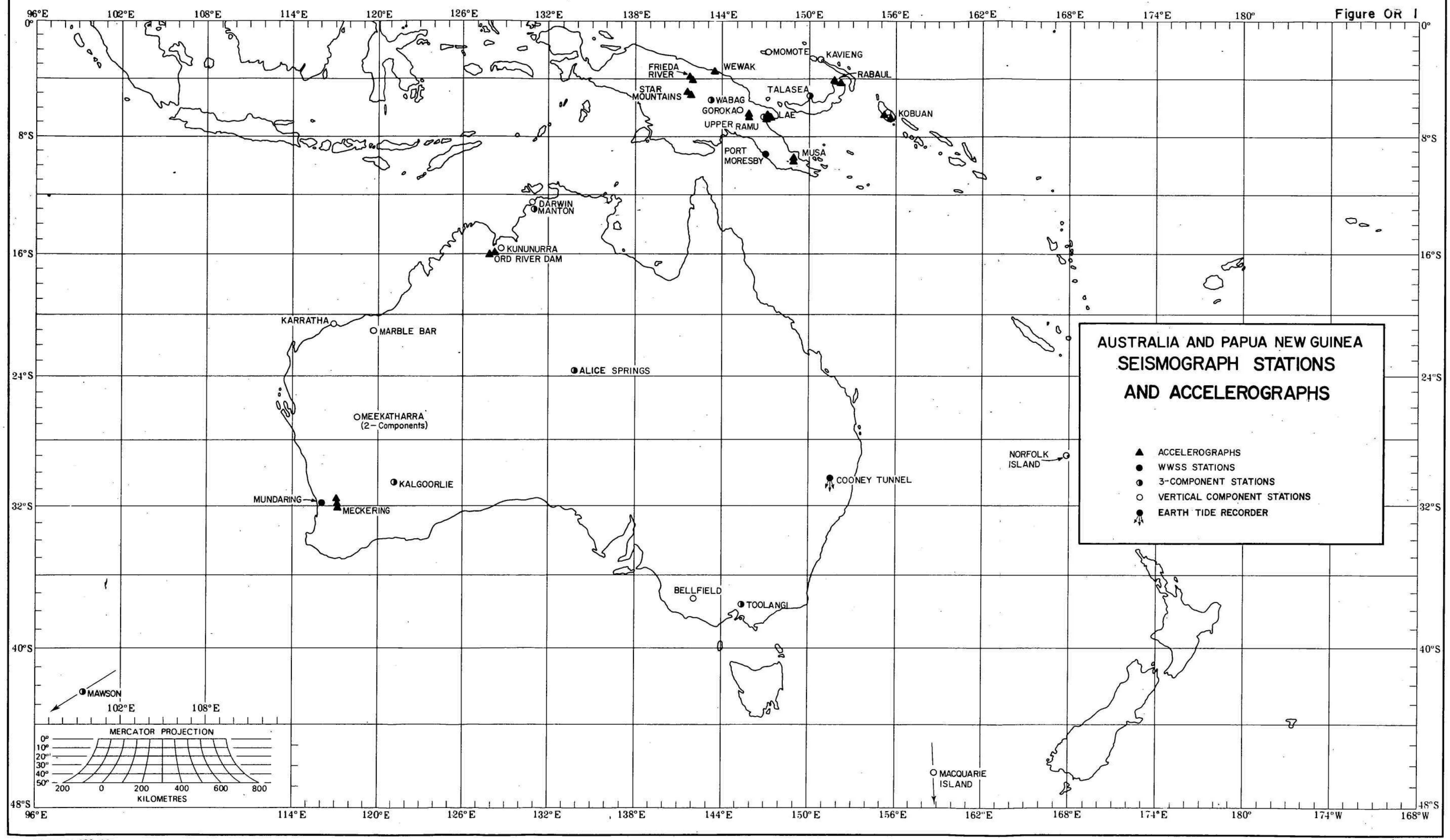
Equipment development. The Regional Structural Surveys Group has been co-operating with BMR's Design and Development Section to produce workable seismic tape recording systems for seismic refraction surveys. There have been a number of delays in the supply of components, but prototypes were ready for field testing shortly before the Trans-Australian Seismic Survey in October. Field use highlighted a number of shortcomings, and the equipment will require further development before being used on the East Papua crustal survey.

Further developments to reduce the power consumption of the system will be considered after the equipment has been used in PNG.

Seismic model ray tracing by computer (J.P. Cull). Various methods have been tried to develop a seismic ray tracing computer program to enable structural interpretations to be tested. The programs are still in the preliminary stage and will be developed further during 1973.

JOIDES drilling proposals (D.M. Finlayson, J.B. Connelly). Submissions were prepared for inclusion in BMR proposals for deep sea drilling by the U.S. JOIDES organization since it was known that Leg 30 of the cruise plan of the drilling ship 'Glomar Challenger' would pass near PNG. These submissions were prepared in co-operation with BMR Observatory and Marine Groups and included the Regional Structural Group proposals for drilling in the Bismarck Sea, Solomon Sea, and Woodlark Basin areas of Melanesia. However, it is feared that the JOIDES organization has already picked drilling sites for the area and there is, as yet, no indication that BMR submissions will be successful.

Figure OR I



(Based on G20 14)

A/BO CO

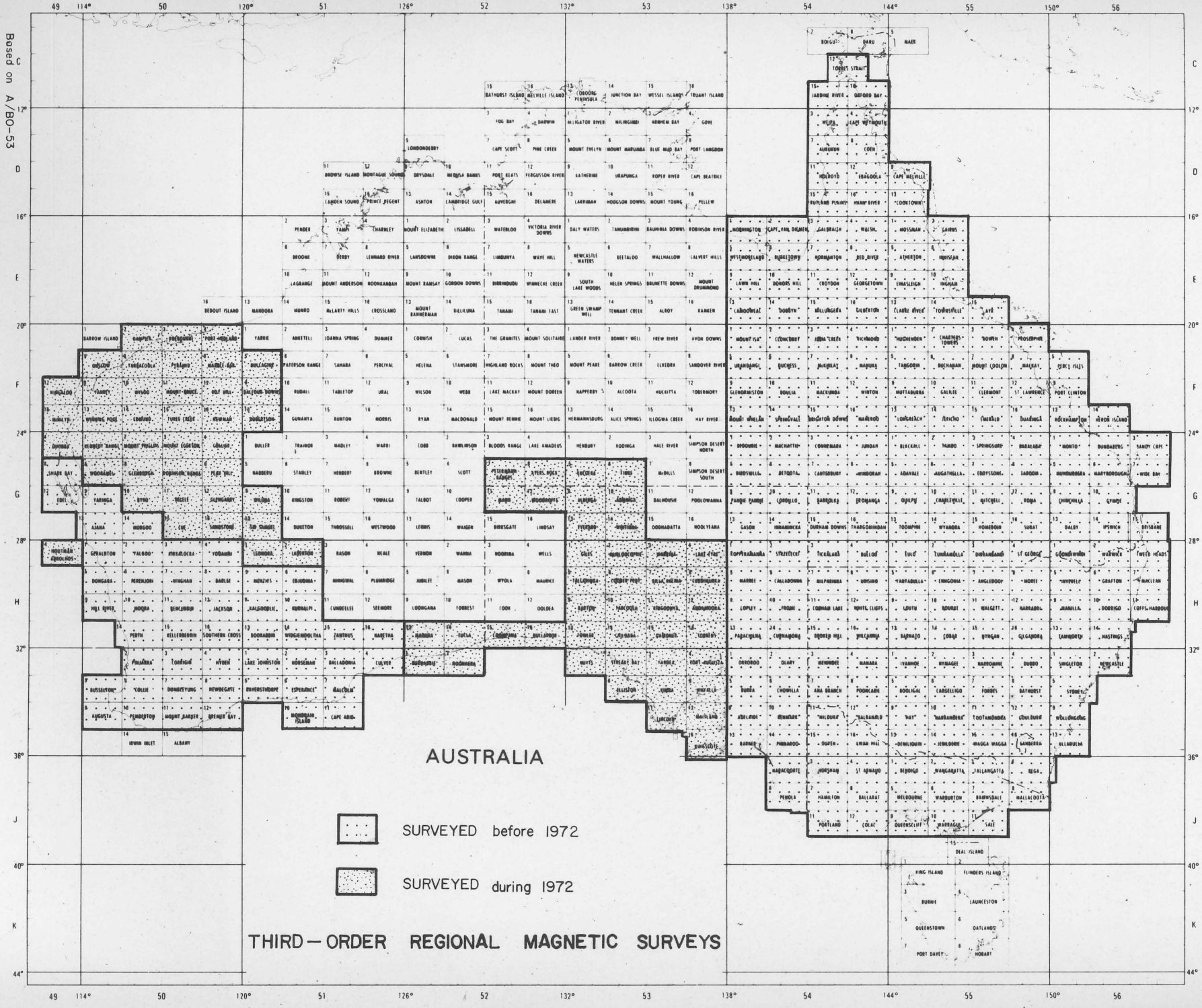
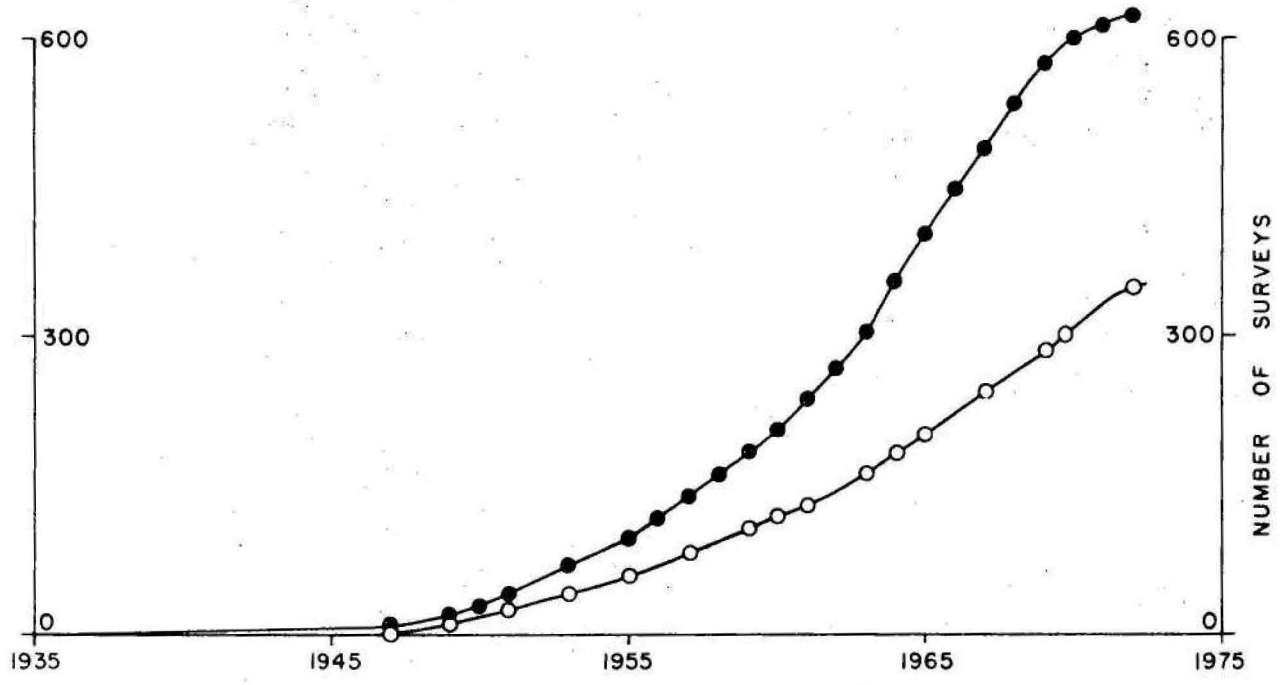


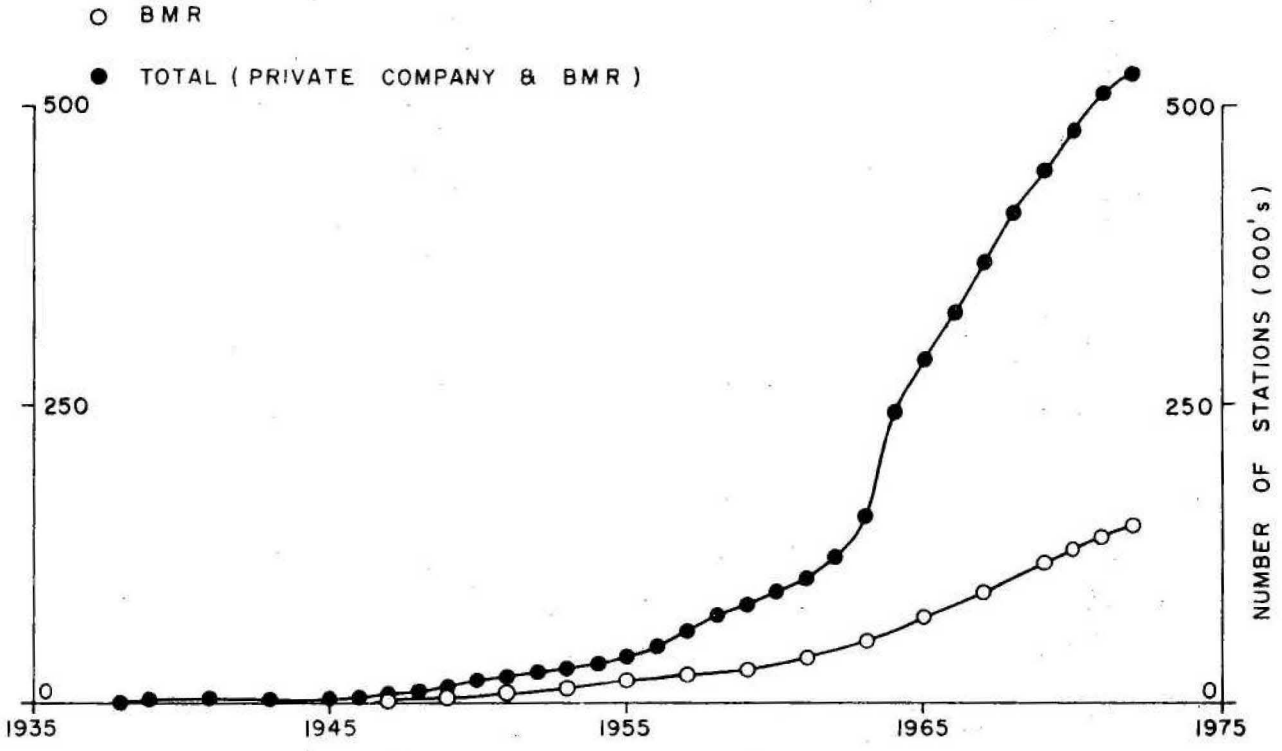
Figure OR 2

A/BO-67A

Figure OR 3



CUMULATIVE TOTALS OF GRAVITY SURVEYS
IN THE AUSTRALIAN REGION

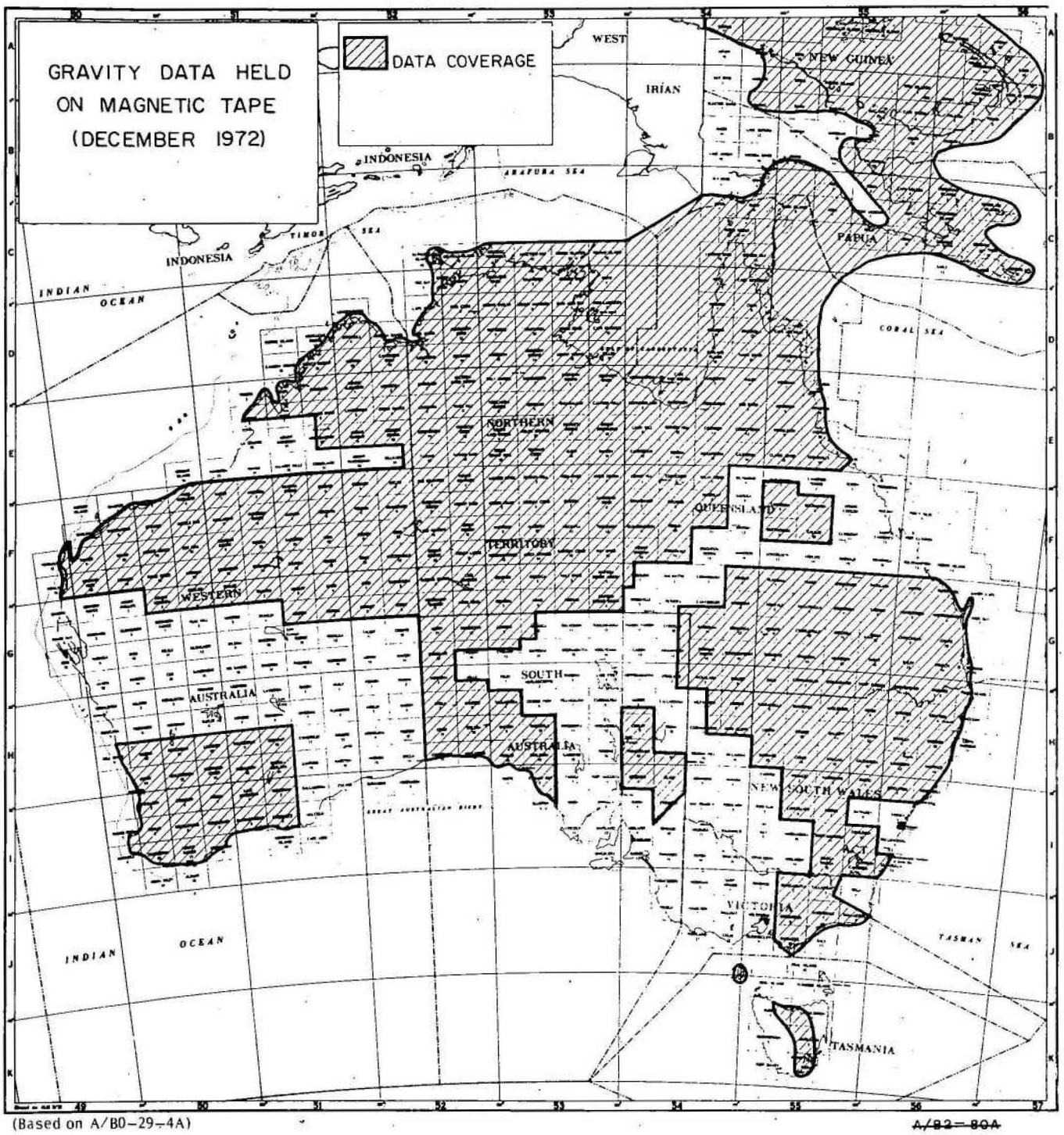


CUMULATIVE TOTALS OF GRAVITY STATIONS
READ IN THE AUSTRALIAN REGION

Fig. OR3

~~A/B2-81A~~

Figure OR 4



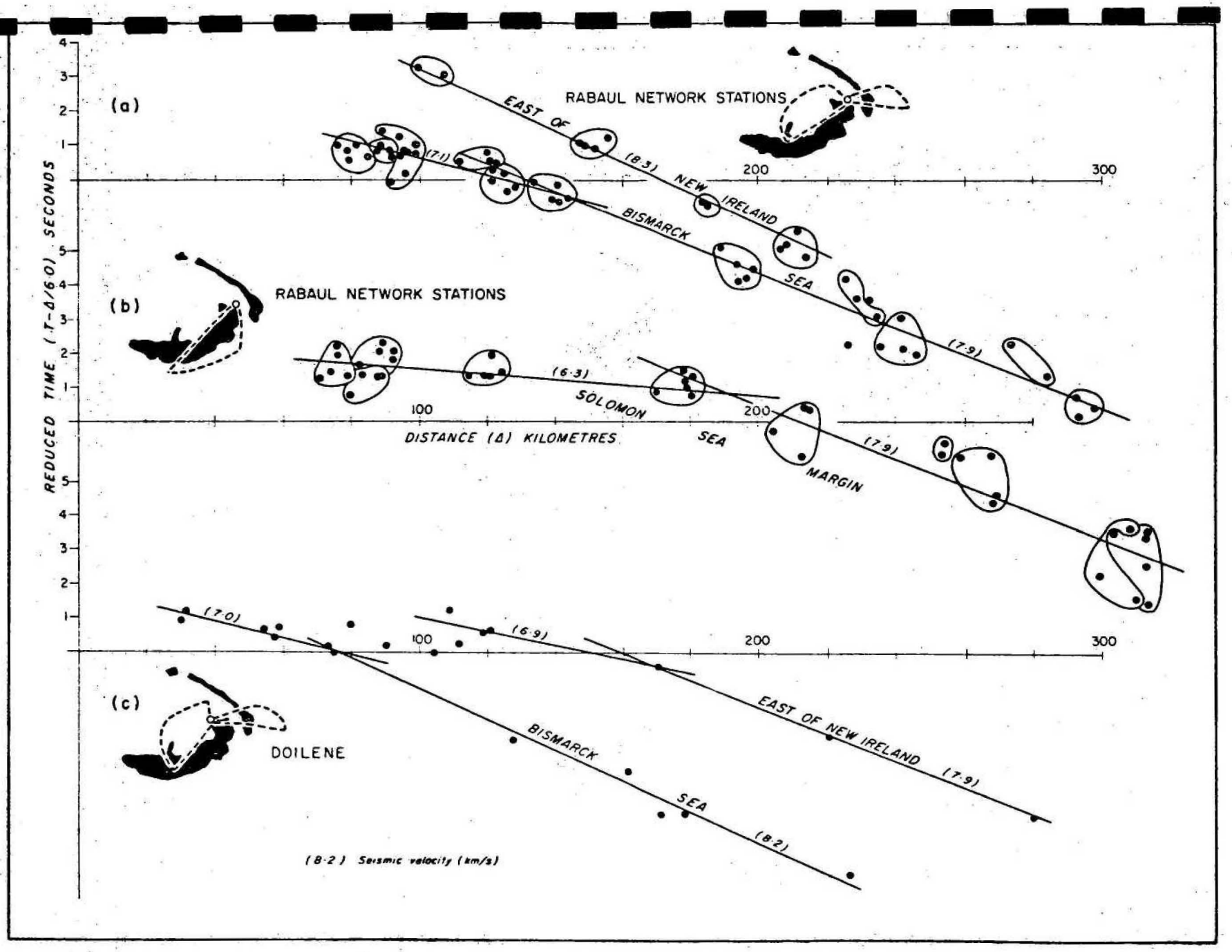
(Based on A/B0-29-4A)

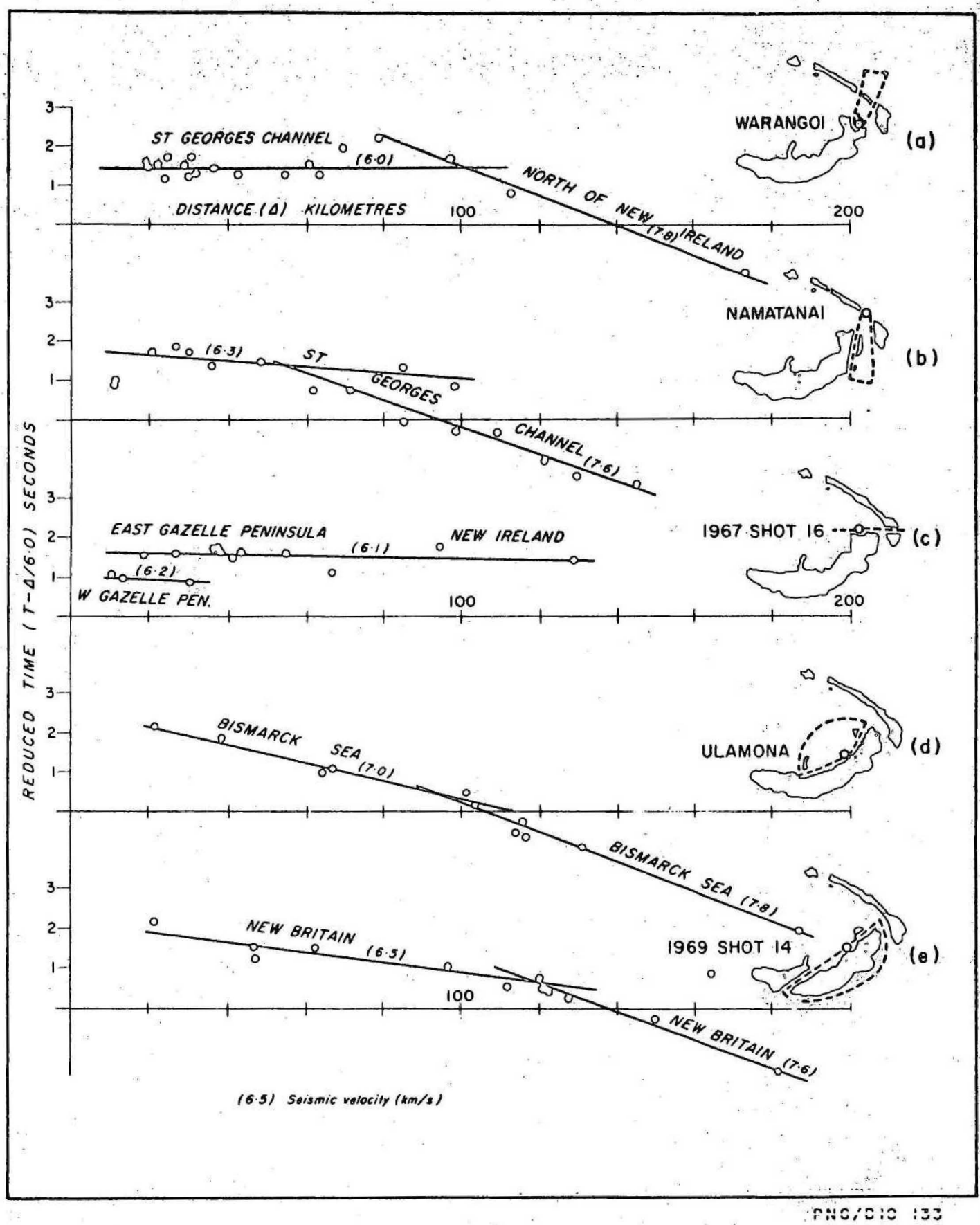
~~A/B2-80A~~

Fig. OR 4

Figure OR 5

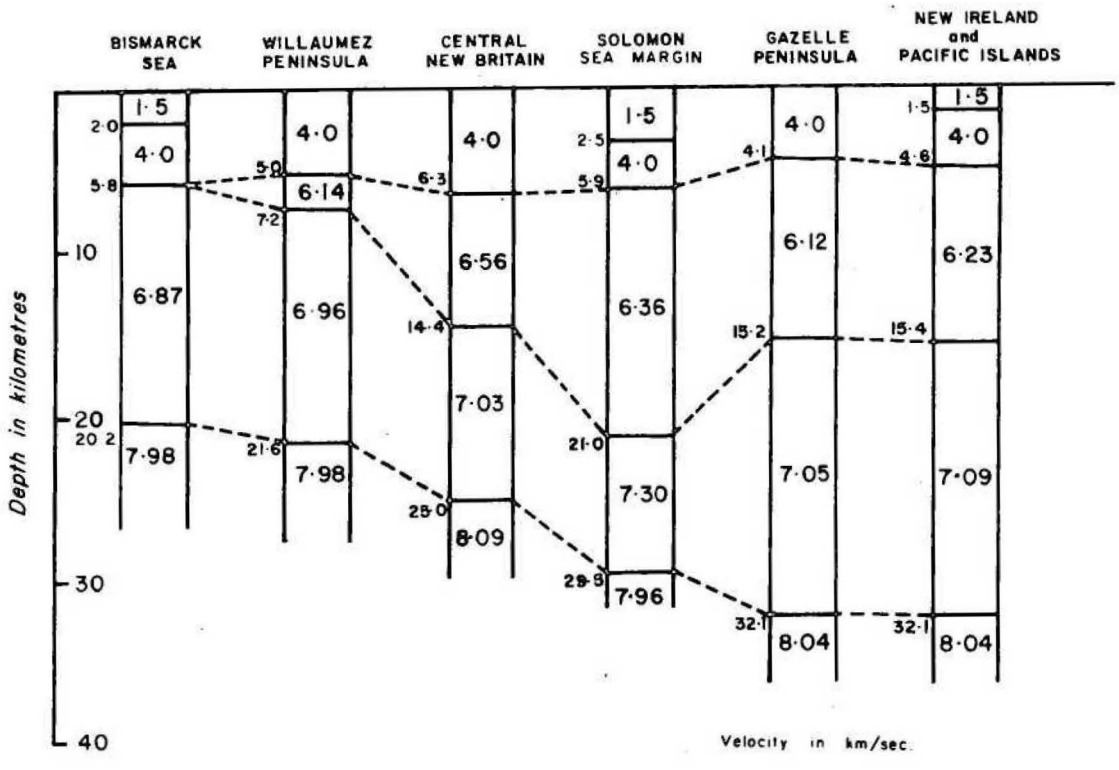
Fig. OR 5


(a)
RABAUL NETWORK STATIONS
EAST OF NEW IRELAND
BISMARCK SEA
(7·1)
(8·3)
(7·9)
(b)
RABAUL NETWORK STATIONS
SOLOMON SEA
(6·3)
(7·9)
MARGIN
(c)
DOILENE
(7·0)
(6·9)
EAST OF NEW IRELAND (7·9)
BISMARCK SEA
(8·2)
100
200
300
DISTANCE (Δ) KILOMETRES
REDUCED TIME (-T-Δ/6·0) SECONDS
(8·2) Seismic velocity (km/s)


REDUCED TIME (T-Δ/6·0) SECONDS
DISTANCE (Δ) KILOMETRES
ST GEORGES CHANNEL
(6·0)
NORTH OF NEW IRELAND (7·8)
WARANGOI
(a)
(6·3)
ST GEORGES CHANNEL (7·6)
NAMATANAI
(b)
EAST GAZELLE PENINSULA
(6·1)
NEW IRELAND
(6·2)
W GAZELLE PEN.
1967 SHOT 16
(c)
BISMARCK SEA (7·0)
BISMARCK SEA (7·8)
ULAMONA
(d)
NEW BRITAIN (6·5)
NEW BRITAIN (7·6)
1969 SHOT 14
(e)
(6·5) Seismic velocity (km/s)

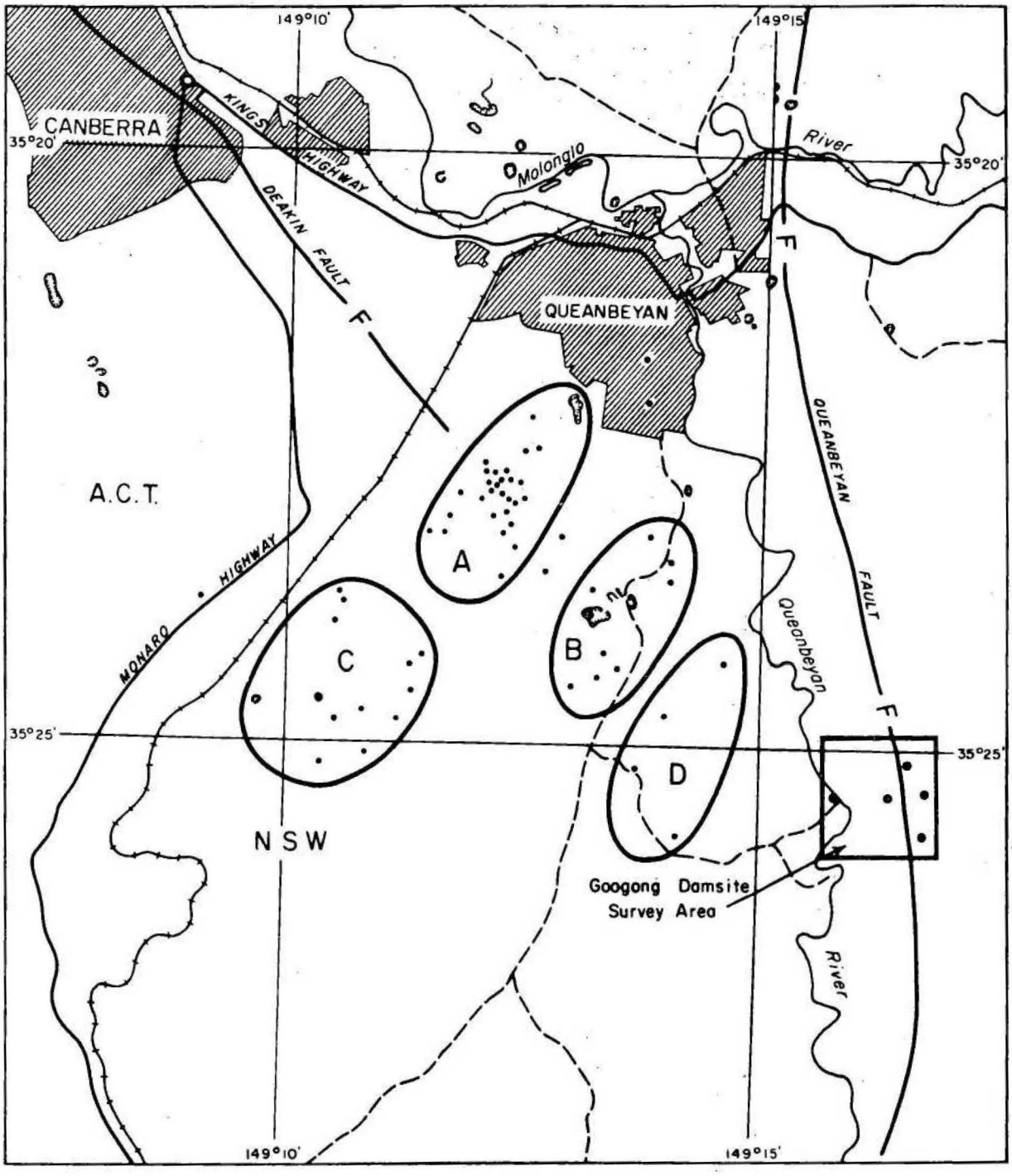
PNG/DIC 133

Figure OR 7



CRUSTAL SECTIONS IN THE
NEW BRITAIN – NEW IRELAND REGION

Figure OR 8

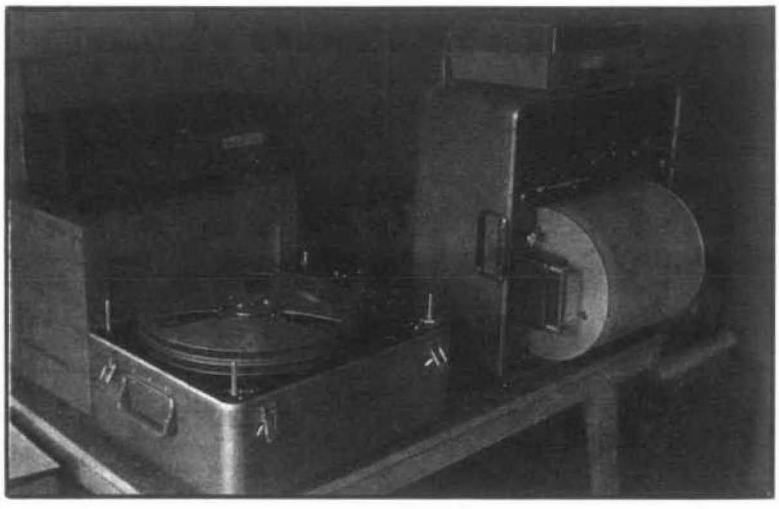


GOOGONG DAMSITE

LOCATIONS OF SELECTED EVENTS RECORDED AT ARRAY

I55/B5 140A

VAULT CONTAINING SEISMOMETER
AND VOLTAGE AMPLIFIER

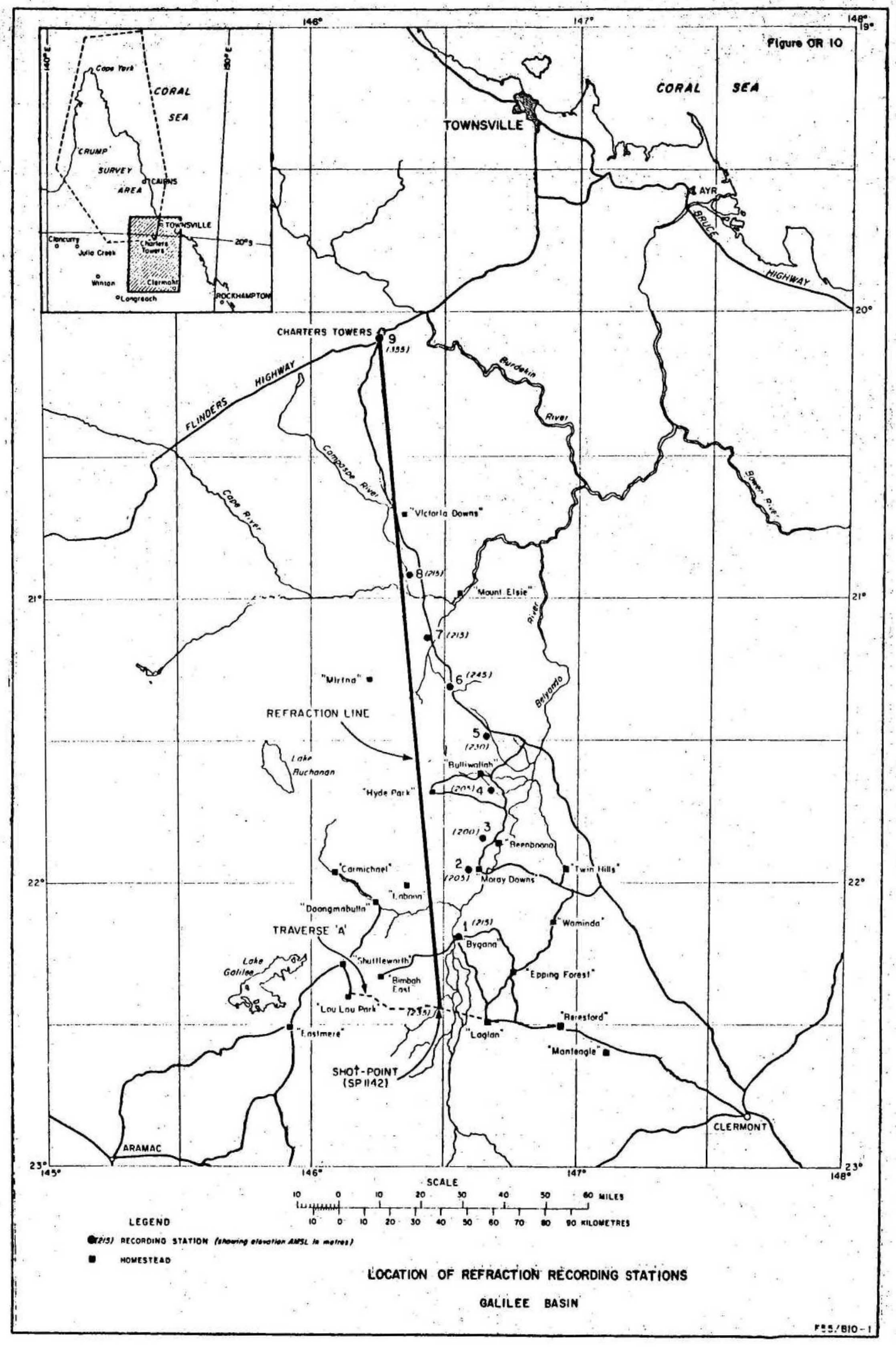


P.I. 5107 TAPE RECORDER
AND GEOTECH HELICORDER

SIGNAL CABLE SPANNING RIVER

INSTRUMENTATION

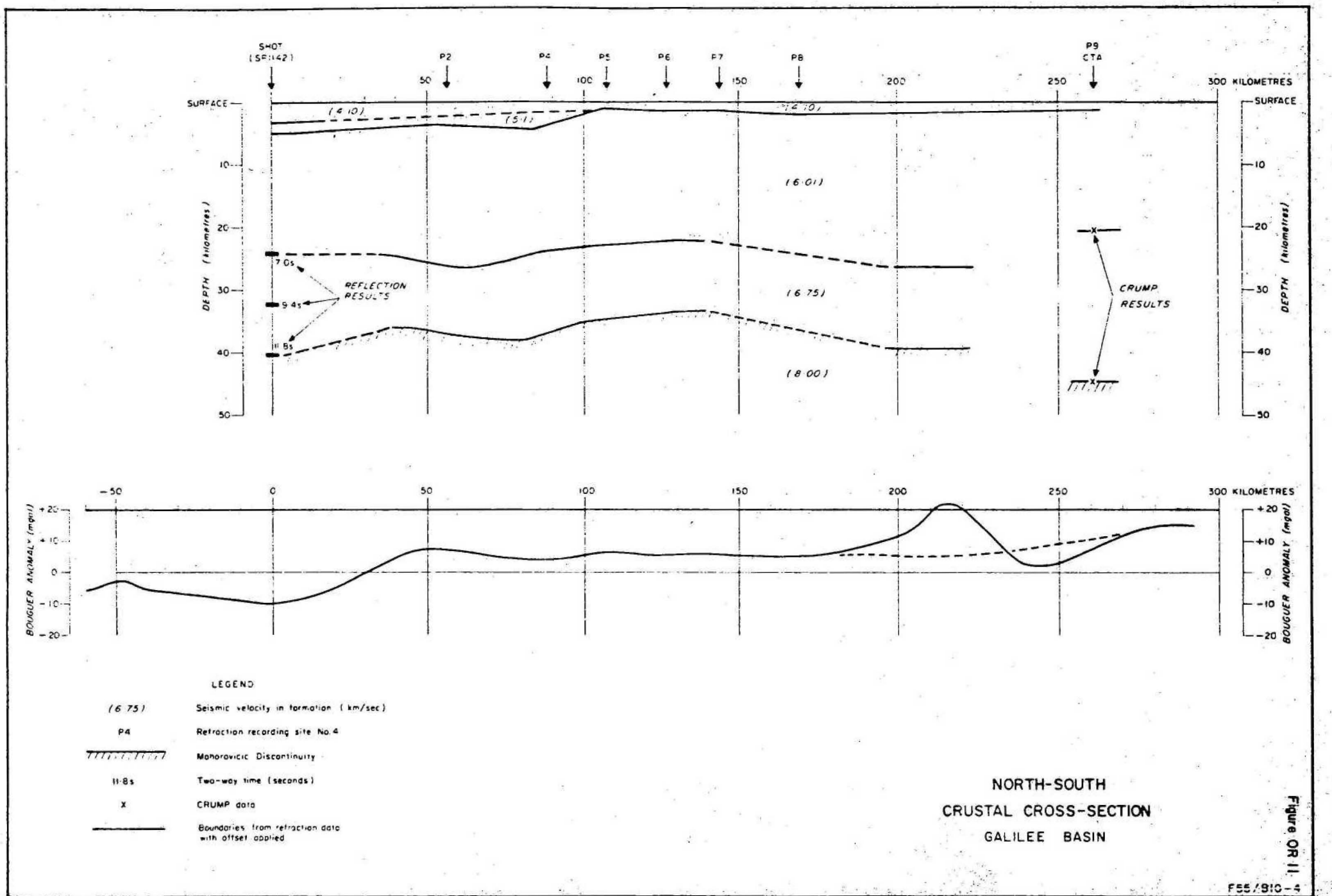
Figure OR 10



LOCATION OF REFRACTION RECORDING STATIONS

GALILEE BASIN

F55/810-1


SHOT (SP:1142)
P2
P4
P5
P6
P7
P8
P9 CTA
50
100
150
200
250
300 KILOMETRES
SURFACE
(4·10)
(5·1)
(6·01)
(6·75)
(8·00)
7·0s
9·4s
11·8s
REFLECTION RESULTS
CRUMP RESULTS
DEPTH (kilometres)
10
20
30
40
50
-50
0
BOUGUER ANOMALY (mgal)
+20
+10
0
-10
-20
LEGEND
(6·75) Seismic velocity in formation (km/sec)
P4 Refraction recording site No. 4
Mohorovicic Discontinuity
11·8s Two-way time (seconds)
X CRUMP data
Boundaries from refraction data with offset applied
NORTH-SOUTH
CRUSTAL CROSS-SECTION
GALILEE BASIN
Figure OR 11
F55/810-4

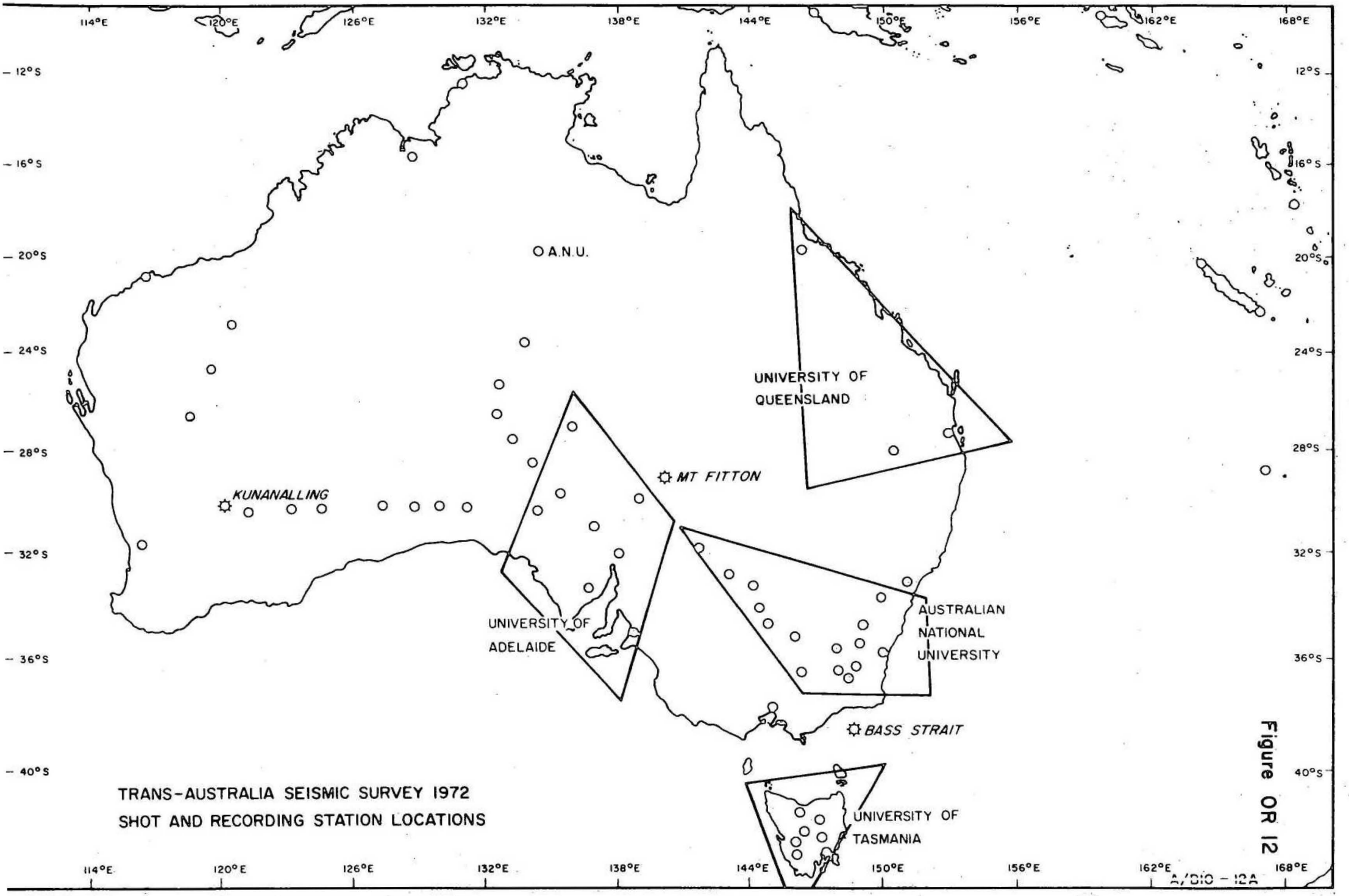

114°E
120°E
126°E
132°E
138°E
144°E
150°E
156°E
162°E
168°E
12°S
16°S
20°S
24°S
28°S
32°S
36°S
40°S
A.N.U.
UNIVERSITY OF QUEENSLAND
MT FITTON
KUNANALLING
UNIVERSITY OF ADELAIDE
AUSTRALIAN NATIONAL UNIVERSITY
BASS STRAIT
UNIVERSITY OF TASMANIA
TRANS-AUSTRALIA SEISMIC SURVEY 1972
SHOT AND RECORDING STATION LOCATIONS

Figure OR 12

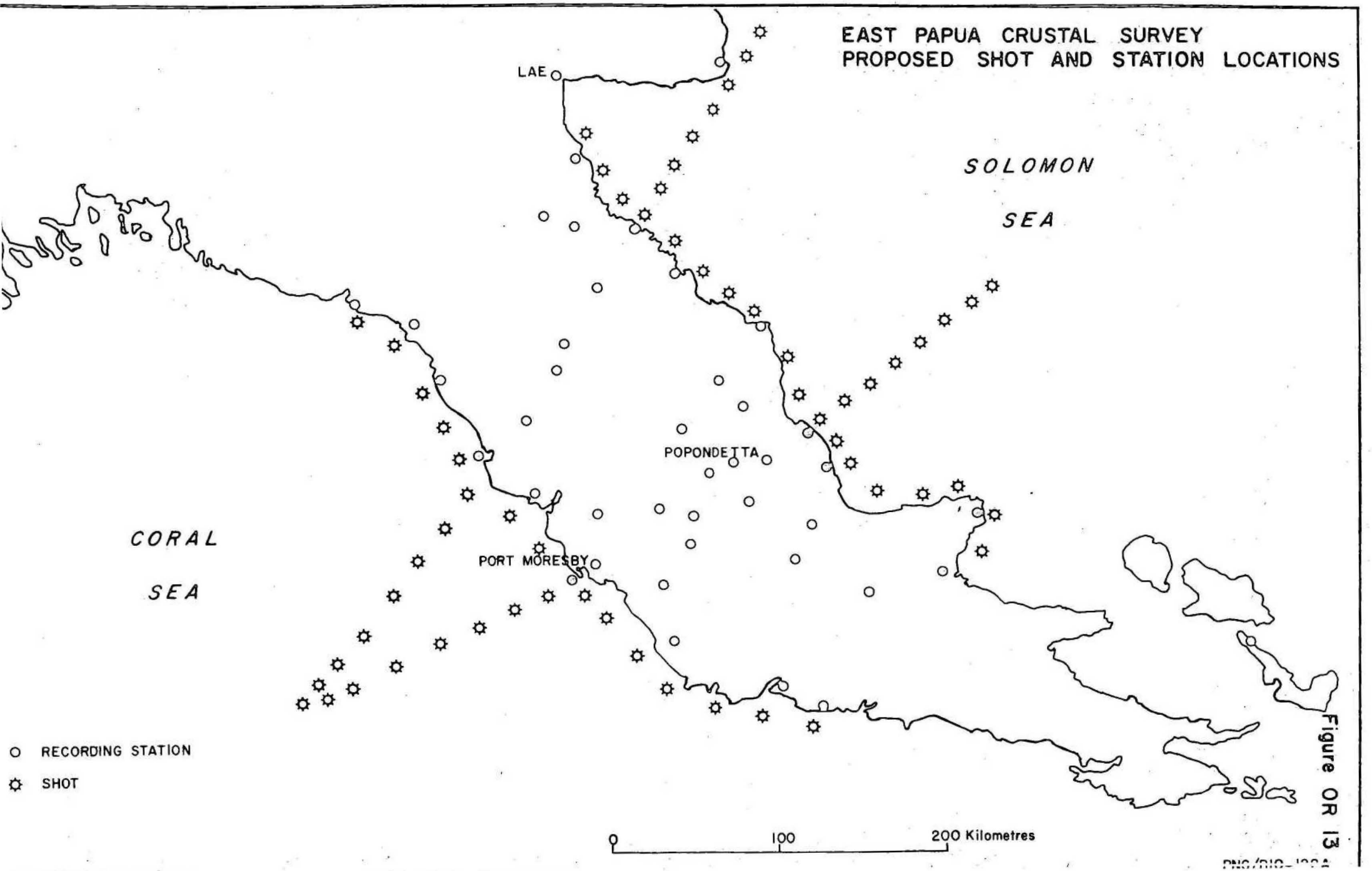

EAST PAPUA CRUSTAL SURVEY
PROPOSED SHOT AND STATION LOCATIONS
LAE
SOLOMON
SEA
POPONDETTA
CORAL
SEA
PORT MORESBY
RECORDING STATION
SHOT
100
200 Kilometres

Figure OR 13

3. SEISMIC, GRAVITY AND MARINE SECTION

Contents

Figures

SUMMARY

The main field activity in the Seismic, Gravity and Marine Section during 1972 was the Continental Margin Survey. The continuous nature and magnitude of this contract survey was demanding of both professional and technical staff. Operations covered the southern and western coasts and some resurveying was done in the Tasman Sea. In 143 operational days to 1 October, 29 000 nautical miles were surveyed. Bathymetric, seismic, gravity, and magnetic data were recorded on traverses 20 to 30 miles apart. It will be some time before the data are ready for release because of lengthy processing. Methods of marine data acquisition and processing have been developed and introduced.

Staffing for the high level of marine activity was again maintained at the expense of land seismic and gravity activities. However, a seismic survey and associated detailed gravity survey of about four months' duration were carried out in the Officer Basin, WA, on a co-operative project with BMR's Geological Branch, which is mapping the area. Geological and geophysical information was reviewed, and objectives for the seismic and gravity survey were defined. In the field, reflection and refraction probes were surveyed at intervals along the Laverton to Warburton Mission road, and gravity, magnetic, and radiometric readings were taken along and to each side of the traverse, and along the road from Cosmo Newbury to Lake Yeo. The seismic results indicate that the Officer Basin is deeper than was previously thought, and add substantially to knowledge of its southwestern margin. The gravity, magnetic, and radiometric results all show anomalies of shorter wavelength than were previously discernible in the regional gravity results, and these anomalies are probably associated with sedimentary features. The results of the gravity survey will be used where possible to extend the seismic interpretation.

The results of deep crustal reflection studies in eastern Australia during 1968-69 were reinterpreted and reports were written. The crustal structure of the Precambrian shield in the southern part of Western Australia was derived from an integrated study of the seismic reflection, seismic refraction, and gravity data. The seismic and gravity results from a traverse across the Galilee Basin in 1971 were interpreted and a structural model was derived for the eastern margin of the basin.

The reconnaissance helicopter gravity survey in Western Australia, which had been commenced in 1971, was completed in mid-year. This completes the regional reconnaissance gravity coverage of Western Australia at a station grid spacing of about 11 km.

Preliminary studies and preparations were carried out for gravity surveys planned for 1973. These comprise the reconnaissance helicopter gravity survey of New South Wales, Victoria, and Tasmania which will complete the reconnaissance gravity coverage of Australia, and a detailed helicopter gravity survey in central Australia.

SEISMIC SURVEYS

Deep crustal reflection studies, eastern Australia, 1968-69

A reinterpretation was made of the data from experimental seismic reflection surveys, at Mildura, Victoria, and Broken Hill, N.S.W., in 1968 and at Tidbinbilla, A.C.T., and Braidwood, N.S.W., in 1969. These surveys had been carried out mainly to develop techniques for recording deep crustal reflections. Fair-quality events believed to be primary reflections from an intermediate crustal layer, the Mohorovicic discontinuity, and an upper mantle discontinuity have been recorded at times between 5 and 15 seconds. Models of the crust and upper mantle have been calculated; depths to the reflectors are based on velocity information obtained from expanded spread data in the Mildura and Broken Hill areas and from previous refraction work at Tidbinbilla and Braidwood.

The crust appears to thicken from about 31 km at Mildura to about 37 km at Broken Hill. An intermediate layer at a depth of about 24 and 15 km in the two areas respectively has an interval velocity of about 7.0 km/s. In the crust above the intermediate layer, the average vertical velocity varies from about 6.1 at Mildura to 5.9 km/s at Broken Hill. A sub-Moho discontinuity is indicated at 49 and 50 km respectively in the two areas. The difference in gravity effect obtained from a comparison of crustal and upper mantle columns down to the level of sub-Moho discontinuity, based on the seismic model, is calculated to be in agreement with the difference in the observed free-air anomalies in the two areas.

In the Tidbinbilla and Braidwood areas, an intermediate layer is estimated, on the basis of refraction velocities, to be at a depth of about 16 km. The crust at Tidbinbilla is estimated to be about 33 km thick, 5 to 7km thinner than estimated previously from refraction results and about 6 km greater than the 27 km estimated at Sydney from previous refraction work. A comparison of Bouguer anomalies also indicates the thickness of the crust at Tidbinbilla to be about 6 km greater than at Sydney.

Records on these surveys have been prepared.

Geotraverse Project, W.A., 1969

In addition to the interpretation of the seismic and gravity data along two traverses, namely, offshore Perth to Jubilee Mine and offshore Perth to Offshore Albany, previously described in the 1971 Summary of Activities, the data along the NW-SE part of the Geotraverse, between Coolgardie and Point Culver, were analyzed. The final results of the integrated study of all seismic reflection, refraction, and gravity data in the southern part of the Western Australian shield are summarized in Figure SGM1 which shows three sections across the shield in a fence diagram.

The crust is of normal continental type in the east but is abnormal towards the Perth Basin in the west. It consists of two layers and is 34 km thick near Kalgoorlie, whereas close to the continental margin, near Perth, it is 44 km thick and consists largely of a high-velocity basal layer, which thins out towards the east and southeast. The upper two layers in the crust, on the other hand thicken in these directions. In the Perth Basin, about 7.5 km of sediments overlie a block of the shield crust thrown down to the west along the Darling Fault. Southeast of Coolgardie, the high-velocity basal layer is estimated to be thin and the southeastern part of the crustal block has been upthrust to the northwest along the Fraser Fault. The velocity in the mantle underneath the abnormal crust is measured to be 8.4 km/s in E-W direction and 8.1 km/s in NW-SE direction.

This model of the crust is consistent with the observed Bouguer gravity field in the south of Western Australia. Due to the constraints imposed by the geometry of the crustal structure along the Geotraverse, a value of 3.45 g/cm^3 for the density of the upper mantle can be estimated with reference to a thickness of 31 km for the standard column and a density of 2.78 g/cm^3 for the uppermost layer of the crust. Crustal root calculations based on Airy's concept indicate that the shield crust in general is in isostatic equilibrium, and the high positive free-air anomalies in the southwest corner of the shield therefore reflect the excess mass of the basal layer in the crust.

A Record on the seismic field work and a Report on the interpretation of seismic and gravity data are in preparation.

Galilee Basin seismic survey, Qld 1971

Seismic reflection, refraction, and detailed gravity data recorded in 1971 were analysed to define the structure of the eastern margin of the Galilee Basin and its relation to the western margin of the Drummond Basin. Figure SGM3 shows a model based on an integrated interpretation of the geophysical data.

The eastern margin of the Galilee Basin is a seismically complex zone which has been moderately disturbed tectonically. Thinning of sediments in the pre-Triassic Galilee Basin sequence occurs from about 20 km west of the Belyando River to the eastern margin of the basin. Drummond Basin sediments do not appear to extend farther than 20 km west of the Belyando River. A sequence of about 1800 m of probable Middle to Upper Devonian sediments, which may be a northerly continuation of the Adavale Basin sediments, underlies the Galilee and Drummond Basin sequences. Further exploration for petroleum in the area appears to be justified, particularly since similar sediments in the Adavale Basin are petroliferous.

Upper Permian coal measures appear to subcrop at relatively shallow depths below Quaternary sediments west of the Belyando River.

A Report on the seismic and gravity surveys is being prepared.

Officer Basin seismic survey, WA, 1972

During the period from mid-July to the end of November, a seismic survey consisting of reflection and refraction probes along the Laverton to Warburton Mission road was carried out in the Officer Basin, W.A., to determine thickness and structure of sediments in the basin and to define the south-western margin of the basin. The reflection recording consisted of single as well as multiple (6 and 12 fold) coverage and the refraction comprised reversed profiles up to 33 km long. Figure SGM4 shows the location of the seismic traverses.

Refraction data indicate (1) the presence of two high-velocity good refractors (velocities 5400 and 6200 m/s and depths 650 and 6900 metres respectively with dips of about 1.5° to the northwest) in the central part of the basin and (2) a high-velocity (6100 m/s) refractor at shallow depths (c. 1000 m) in probes up to a distance of 200 km northeast of the shield outcrops near Lake Throssel.

The reflection data show fair to good reflectors at depths corresponding to record times of 0.5, 0.8, 1.5, 1.9, 2.1, and 2.9 seconds in the central part of the basin, at times of 0.5, 2.2, 2.4, and 3.2 seconds in the area about 100 km to the southwest and poor to fair reflections at 0.2, 1.9, 2.2, and 2.9 seconds about 90 km northeast of the edge (shield outcrop) of the basin. A fair reflection at about 3.3 seconds has also been detected at the above locations. However, no reflections deeper than 0.3 second have been recorded at 55 km northeast of the edge of the basin.

An integrated interpretation of the seismic and gravity data along the traverse is being made. A review of the earlier geological and geophysical information in the area has been made in the Presurvey Report.

Seismic data processing

As in 1971, the work involved the use of analogue playback equipment, the Laser-Scan optical equipment, contract digital processing, and CSIRO's CDC 3600 computer.

165 seismic cross-sections have been produced, mainly from BMR's Officer Basin Survey (1972), Exoil's Lake Galilee Survey (1962), BMR's Galilee Basin Survey (1971), BMR's East Otway Basin Survey (1967), Emerald-Duaringa Survey (1961) and Hay Equipment Tests (1971).

Data from the Galilee Basin Survey (1971) were digitized and computer processed by Western Geophysical Co.

Modifications and overhaul were carried out on the MS-42 analogue equipment and associated Omnitape equipment.

East Otway Basin seismic survey, Vic, 1967

A reinterpretation of seismic data recorded in 1967 is under way to try to obtain a better correlation between the refraction and reflection results.

GRAVITY SURVEYS

Two field operations were conducted. A contract helicopter operation completed the reconnaissance gravity coverage of Western Australia and a BMR field party made a detailed ground survey in association with the concurrent seismic survey over parts of the Officer Basin in Western Australia.

In the Canberra office, the staff of the gravity group were concerned in large measure with interpretation and preparation of reports on past surveys and with studies related to surveys planned for 1973 and 1974.

In addition, recomputation of earlier survey data proceeded. A suite of computer programs for reduction of helicopter gravity survey data was finalized and converted for use on the CDC 6600 computer in Sydney through a Canberra terminal, initially at CSIRO but later a separate installation in the BMR building.

Contract reconnaissance helicopter gravity survey, WA, 1971-72

The work commenced in 1971 and continued through most of 1972. About 8000 new readings were made at a spacing of 11 km over all or parts of 60 1:250 000 Sheet areas. The survey area is shown in Figure SGM5 with preliminary Bouguer anomaly contours, at a scale of 40 miles to one inch. At the end of the survey a small amount of follow-up observations were made in an adjacent area covered previously in 1962.

The contour pattern is noteworthy in the regional sense in depicting the Yilgarn Block as an area of relatively low gravity bounded on the west by a band of higher gravity and in the southeast by a large area of higher gravity extending from the Fraser Range granulites to the Great Australian Bight. In greater detail there is a large variety of trends and anomalies which will provide much opportunity for interpretation and correlation with other data.

Computation and contouring will require another month. Preliminary maps should then be available at a scale of 1:250 000 showing each gravity station with its survey number, height, and Bouguer anomaly value and contours at 5-milligal intervals. An operational Record is in preparation, and interpretational Records will follow.

Detailed gravity survey, Officer Basin, WA, 1972

A party, including two surveyors and their chainmen, spent 4 months establishing about 1000 points with gravity, magnetic, and radiometric observations along two strips in the southwest part of the Officer Basin, covering several lines of seismic observations and tying between them. Optical levelling provided greater accuracy in elevation control for the gravity than the helicopter reconnaissance gravity survey can achieve, and closely spaced stations permitted a more detailed definition of anomalies. Both gravity and magnetic results show characteristic anomalies which will be used in the interpretation. The radiometric results show two levels of background, apparently related to the type of surface. Calcrete is reported to show a higher level in some places, but this was not observed by the party. An operational Record is in preparation; it will be followed by an interpretational record covering both gravity and seismic results.

Galilee Basin survey, 1971

Data reduction was completed early in the year, and co-ordinated interpretation was undertaken with geophysicists of the Seismic Subsection, who were interpreting the concurrent seismic survey, and geologists interested in the local geology and structure. The main feature of the gravity field is a Bouguer gravity maximum. It corresponds with an area of outcropping Lower Carboniferous clastic sediments which form a complex anticlinorium exposing the complete suite of Lower Carboniferous sediments down to the acid Silver Hills Volcanics of Devonian-Carboniferous age. The anomaly cannot be explained satisfactorily by the structure revealed at the surface, but requires a large dense underlying body.

The seismic interpretation of the sedimentary section west of the anticline was used to control the form of structural models in which the dense body is represented by either an intrasedimentary body or a basement high. Aeromagnetic interpretation indicates deep basement under the anticline, supporting the first alternative. A Record is in preparation.

Reconnaissance helicopter gravity survey, New Guinea Highlands, 1970

This survey had been carried out by the Regional Gravity Group as an opportunity survey to extend the regular reconnaissance gravity survey of New Guinea during a geological mapping operation in the highlands. A contour plan shows the location of gravity stations (Fig. SGM6). Parts of the area could not be covered during the time available. Three extensive gravity anomalies in the central and eastern part of the area - the Kubor Gravity High and the Wahgi and Bismarck Gravity Lows - were correlated readily with exposed geological features. These are, respectively, the Omung Metamorphics in the core of the Kubor Anticline, the Yaveufa Syncline, and part of the Bismarck intrusive complex. The gravity provides insight on the form of the syncline and the distribution of acid and basic phases in the complex.

A strong, extensive gradient in the west, the Hagen Gravity Gradient, cannot be correlated with surface features but apparently reflects a large, dense intrusive body, possibly composed of deep crustal material. Several models were tested and these indicate that a density contrast of 0.5 g/cm^3 is required, suggesting a rock density of 3.2 g/cm^3 for the intrusive body. A depth of about 5 km to its upper surface is postulated.

A Record has been prepared.

Reconnaissance helicopter gravity survey, SA, 1970

During September-October 1970 a reconnaissance helicopter gravity survey was made by BMR in the Flinders Ranges area of South Australia. A general interpretation of the data was carried out during 1972. The geology comprises predominantly Adelaidean sediments occupying a tightly folded geosyncline aligned northwards, with a branch eastwards, between the Gawler Craton on the west and a basement complex represented by the Willyama Block on the east.

The Bouguer anomaly field, broadly speaking, is slightly negative but shows three large areas, on the west, northwest, and east of the geosyncline which are prominently negative. That on the east may correlate with outcropping granite. The north end of the geosyncline is slightly positive.

The interpretation indicates that the depth of the geosyncline reaches 16.5 km but seems to lie more generally at 10 km. This is in contrast to aeromagnetic interpretation which suggests a maximum thickness of 8 km. A noteworthy feature of the gravity field is the northwest alignment of at least five large, strong minima along the eastern side of the area (Fig. SGM7), at least three of which can be correlated with outcropping granite. However, a reasonable assumed density contrast (0.1 g/cm^3) for granite enclosed in Adelaidean rocks leads in two cases to unreasonable computed depth to the base of the granite (23-26 km). Therefore some further complication seems probable, presumably involving a stronger density contrast of a larger rock mass incorporating the granite.

A Record has been prepared.

Kalgoorlie detailed gravity survey, WA 1970

One of the main objectives of this survey was to investigate the subsurface dimensions of greenstone bodies in the Yilgarn Block. The data were drawn up in profiles and interpreted as two-dimensional features. The interpretation generally indicates that the greenstones are tabular masses whose roots reach a depth of at least 4 km in the Kalgoorlie area but a lesser depth to the east in the Southern Cross area.

A strong positive anomaly over the Fraser Range was interpreted as the effect of a granulite body elevated by reverse thrusting between the Fraser Fault and a parallel fault 35 km to the southeast. The roots of this body reach a depth of 8 km, assuming a density contrast of 0.3 g/cm^3.

The detailed gravity on three profiles near the south coast at Albany, Bremer Bay, and Ravensthorpe was interpreted in the broader setting of the reconnaissance gravity as revealing an arcuate Albany/Esperance block of denser rocks parallel to the coastline and trending towards the Fraser Range granulite at its northeast extremity.

A Record is in preparation.

Reconnaissance helicopter gravity survey, WA, 1969

Preparation of the interpretative records on Area A and Area B was resumed on the return from overseas study of the author, A.R. Fraser, who is also preparing a paper on the gravity field on the Western Australian shield.

Recomputation of reconnaissance gravity survey data

Before 1966, the BMR reconnaissance helicopter gravity surveys were computed using paper tape data input to a Sirius computer and obtaining printed output. Since that time the data input has been on punched cards and, in addition to printed output, a permanent file has been created on magnetic tape, suitable for automatic accessing and further data processing.

One activity of the Group has been the conversion of the older data to the present system of permanent magnetic tape files. The degree of reworking required depends on the age of the survey; the older ones which used less consistent observing, booking, and computing routines generally require more work to achieve a satisfactory magnetic data tape.

During 1972, the survey data for the 1964 helicopter gravity reconnaissance survey were completely rewritten and recomputed, using the modern format for preparation of new field sheets and the computer program GRAVHT05 for adjustment of closed loops. The final data were written on a magnetic tape in standard BMR format.

A magnetic tape of final data for the 1965 helicopter gravity reconnaissance survey was completed.

The data from the 1963 survey were examined, sorted, and annotated in preparation for recomputation.

A Record is in preparation, dealing with the recomputation of the 1964 data.

Gravity data reduction program

A comprehensive program was completed for use in automatically reducing helicopter gravity survey data to final observed gravity values by computer. It incorporates a high degree of error analysis with messages to permit more rapid and reliable correction of data, and editing routines permit the incorporation of corrections at various stages as the data from a complete survey are built up on magnetic tape.

The program was converted for use on the CDC6600 computer in Sydney, using a Canberra terminal initially at CSIRO and then in the BMR building. This permits more rapid turn-around of individual runs and greater flexibility in handling large blocks of data.

Documentation of every subroutine and auxiliary program was commenced, beginning with draft driving instructions.

Density project

Rock density was measured for a selection of specimens collected in recent field seasons by officers of the Geological Branch during mapping surveys in the nappe country of the Northern Territory. These data were punched on cards along with standard geological field data and written on magnetic tape using the computer programs prepared previously for the purpose. They will be particularly relevant to gravity work planned for the area in 1973.

The density file on magnetic tape now holds density and geological data for about 3200 specimens collected by the Geological Branch, mainly in Cape York Peninsula and the Northern Territory.

Preparations for future surveys

Central Australia and Arltunga Nappe detailed gravity surveys

A study of operational methods suited to this project was made, particularly regarding methods of radio positioning which would permit choice of station position independent of its photo-identification. A specification for contract helicopter hire was prepared. Initial study of rock densities in the areas was undertaken.

The Survey Branch of the Department of the Interior undertook an aerial photographic project to provide more detailed photography in strips about 16 km wide along the line of both project areas. The intention is to use navigation by aerial photographs as a back-up to and as a means of assessing the radio method.

Reconnaissance helicopter gravity survey, NSW, Vic, and Tasmania, 1973

In preparation for the final stage of the helicopter reconnaissance gravity survey of Australia, benchmark lines for elevation control were agreed with the Survey Branch of the Department of the Interior. A visit was paid to the Tasmanian Department of Lands, to obtain photography and photo-centre maps or computed photo-centres, and orders for corresponding material were completed by the Victorian and NSW Lands Departments. A preliminary list of existing geophysical surveys of regional importance was compiled and their locations plotted at a scale of 1 inch to 40 miles.

MARINE SURVEYS

Introduction

During 1972 Compagnie Generale de Geophysique continued the contract bathymetric, gravity, seismic, and magnetic survey covering the Australian margin between the 20- and the 4000-metre isobaths. A total of 29 000 nautical miles was surveyed in 143 operational days up to 7 October (Fig. SGM8). The Marine Group devoted a large effort to supervising the survey, that is to planning, supervising, inspecting data, and reporting.

Interpretation of the 1970 Gulf of Papua and Bismarck Sea survey, and of the segments of the 1971 program in the Coral Sea, Tasman Sea, and south of Tasmania continued as operational requirements permitted. Magnetic data acquired during the marine survey of the northwest continental shelf in 1968 were digitally processed.

Continental margin survey operations

Most of the 1972 operations were conducted around the southern and western coasts of Australia, but some resurveying was done in the Tasman Sea. The regular progression westwards along the southern margin of Australia was halted by bad weather during July at a point near Esperance in Western Australia, and work recommenced up the west coast of Western Australia. Missing traverses were left until the summer of 1972-73.

Traverses omitted during 1971 south of Victoria and along the east coast of Tasmania were completed in January. Resurveying between 24° and 28°S was carried out to improve the quality of seismic data in the Tasman Sea in February.

East-west traverses were recorded in April up the west coast of Tasmania and as far west as the Victorian and South Australian border. No work was carried out in Bass Strait between King Island and Flinders Island.

The main traverse direction was changed to north-south for the South Australian coast and Bight between May and July. The work included surveying inside Spencer and St Vincent Gulfs. Traverse spacing was increased from 20 to 25 nautical miles along the Western Australian coast between the border and Esperance.

North of Perth an increase in spacing was made to 30 nautical miles, and lines were oriented east-west. From Perth to North West Cape lines varied from 60 to 420 nautical miles long. North of the cape the survey covers the areas outside those surveyed by BMR in 1968 and 1967, extending east-west across the slope from the edge of the north west shelf and as at 7 October 1972 it is planned to extend existing coverage of the Timor Sea to the boundaries of Indonesian and Portugese territorial waters as far as 132°E. Proposed sites off the W.A. coast and in the Timor Sea intended for drilling on Leg 27 of the Deep Sea Drilling Project were intersected to provide additional site survey information.

Instrumentation and recording techniques were substantially the same as in 1971. A new data acquisition program was implemented, and this continued to record samples of data from bathymetry, gravity, magnetics, and several navigation aids at 10-second intervals, using a Hewlett-Packard 2116B computer.

The main bathymetric recording devices were not consistently recorded in digital form on the data acquisition system, and water depths for the first half of 1972 were hand digitized from the seismic and bathymetry charts.

The marine gravity meter was returned to the U.S.A. for testing, repair, and maintenance in January. In May a single-electrode 120-kilojoule sparker replaced the four-electrode system, and in July new seismic amplifiers containing 24 channels replaced the 12-channel system used in 1971. Other seismic equipment remained the same as in 1971.

Refraction profiles were recorded, using sonobuoy receivers and the 120-kilojoule sparker as a source, at locations shown in Figure SGM8.

The continental margin survey program is expected to be completed by the end of 1972.

Access to marine data

It will be some time before copies of sections and profile and contour maps from this survey are ready for formal release, because the lengthy processing task is lagging behind the data acquisition. Meanwhile, visitors may inspect preliminary maps and sections that are available in BMR.

The Tasmanian margin (P.J. Cameron)

During 1971 and 1972, 9100 nautical miles of traverses were surveyed in the areas of eastern and western Victoria, and Tasmania. The survey extended across the continental shelf and slope to approximately the 4500-metre isobath and delineated the northern part of the Tasmania Ridge and the Cascade Plateau to the south and southeast of Tasmania. The survey area, with indications of approximate sediment distribution is shown in Figure SGM9.

On the broad continental slope of the western margin of Tasmania and Bass Strait, basement is not visible on the seismic cross-section but at least 1.5 km of sediment is present. A regional unconformity, probably between Upper Cretaceous and Eocene, can be traced over a large part of this slope.

On the eastern margin a steeper slope has developed with less than 1 km of sediments above an undulating basement. It is characterized by numerous igneous intrusions which form a line, approximately half way down the slope, trending along the margin in a northerly direction. In several places the base of this slope drops abruptly to the abyssal plain and elsewhere oceanic basement can be seen abutting continental basement, indicating the fault controlled origin of this margin.

Evidence for a more abrupt transition from continental to oceanic crust on the eastern margin than on the western margin is shown by a higher Bouguer anomaly gradient in the east.

Sediment cover on the rugged Tasmania Ridge is generally sparse, but some pockets are up to 1 km thick. This contrasts with fairly uniform sediments 1 to 1.5 km thick on the Cascade Plateau. Between these two features a broad channel trending south, then southeast around the Cascade Plateau, is present and contains at least 1 km of sediments. Basement is not apparent in this channel.

Crustal thicknesses of about 17 km beneath the ridge and plateau indicate that they are probably subcontinental blocks. The thicknesses were estimated from free-air gravity anomalies based on a standard model continental crust 34 km thick.

Queensland continental margin, 12-24°S (J.C. Mutter)

Twenty thousand nautical miles of combined seismic, gravity, and magnetic data have been collected over the plateaux, troughs, and rises of the continental margin of Queensland between 12°S and 24°S. Although a detailed interpretation has not yet been made, some features of a tentative structural picture which has emerged from work done so far are shown in Figure SGM10.

The Queensland and Marion Plateaux both appear to be underlain by crust of continental thickness. This interpretation is made entirely from the gravity results of the BMR survey and is consistent with the seismic results of Ewing et al (J. geophys. Res., 75, 1953-72, 1970). The Queensland Plateau is separated from the Queensland coast by the Queensland Trough, which appears to be fault-bounded on both sides, i.e. a graben. It is not possible to postulate a similar character for the Townsville Trough, which forms the southern margin of the Queensland Plateau and separates it from the Marion Plateau. The latter is at a much shallower depth than the Queensland Plateau, is approximately half its size, and has no marginal trough.

Between 500 and 1500 metres of stratified sediment on the plateaux overlies acoustic basement apparent on the sparker monitor sections, but analysis of magnetic anomalies and sonobuoy refractions indicates that basement is more than 1000 metres below sparker penetration. It is suggested that the acoustically observable sediments represent Tertiary, post-subsidence deposits overlying New England Geosyncline sediments. These lower sediments are distributed in a pattern which closely resembles the highs and lows of the New England and Tasman Geosynclines.

Within the ?Tertiary of the Queensland Plateau is an angular unconformity which is believed to represent the regional Oligocene unconformity found by the JOIDES drilling on LEG XXI.

Formation of the plateaux appears to have resulted from a three-stage process: firstly subsidence by downbuckling of the eastern margin following the opening of the Coral Sea; secondly subsidence of the plateau as a whole; and finally formation of the marginal troughs.

East of the Marion Plateau, the Cato Trough was seen to contain more than 1500 metres of sediment. Only the northern end of the Mellish Rise was traversed. It was seen to have a very rugged basement and a thin sediment cover. All features east of the plateaux appear from the gravity data to have oceanic or suboceanic crustal sections.

Figure SGM10 shows the relation of Tasman Geosyncline trends on land with possible structures identified from the BMR survey work.

Tasman Sea area (P.A. Symonds)

The area under consideration extends from the coast to 160°E and lies between latitudes 40° and 24°S. Since the initial summary in 1971 of work in the area, coverage has been increased from about 18500 to about 26500 nautical miles of traverse. The 8000 nautical miles of traversing completed in 1972 consists of rerunning eleven east-west lines between latitudes 34°S and 24°S, one regional traverse across Lord Howe Rise, and five regional traverses in the central Tasman Basin between latitudes 34° and 40°S. About 4500 nautical miles of the new traversing was run without a gravity meter. Due to the good quality of the seismic sections obtained these extra traverses have allowed a more confident interpretation to be made of the Tasman Sea area, and deductions about the regional tectonics of this part of the Southwest Pacific. The traverse plan in the Tasman Sea area is now as shown in Figure SGM8.

A description of the major bathymetric magnetic and gravity features in the area has been given in 1971. Two characteristic sketched seismic sections (Fig. SGM11) across the north and central Tasman Basin are included here as they indicate the general nature of these two distinct areas better than a description. The locations are shown in Figure SGM8.

Most of the major structural features of the Tasman Sea region are shown in Figure SGM12. They are the Tasman Basin, which may be divided into the abyssal plain and abyssal hills provinces, the Dampier Ridge, the Lord Howe Rise, the Middleton and Lord Howe Basins, which lie between the Dampier Ridge and Lord Howe Rise, and Mellish Rise, and a NW-trending, highly disrupted basement ridge, which Ringis (1970) and Hayes & Ringis (1972) suggested may be an extinct spreading centre.

Mutter and Symonds have deduced a tectonic evolution of the Tasman Sea area, which is similar to that proposed by Griffiths & Varne. (Nature, 234, 203-7, 1972). Mutter and Symonds tentatively suggest that the Tasman Basin was formed in two discrete stages. The initial stage was due to the seafloor spreading that occurred from about 80 to 60 m.y. B.P. creating a triangular rift between Australia and the southern part of Lord Howe Rise. The oceanic crust created by this stage now exists as the swale and abyssal hill province of the central and southern Tasman Basin. In response to the spreading a rift developed between Australia and the northern part of Lord Howe Rise, which may have been a marginal plateau at this time. The second stage of formation of the Tasman Basin was the result of the 'differential spreading of Australia and the Campbell Plateau from Antarctica during the Tertiary' leading to 'the establishment of a zone of transcurrent displacement through New Zealand' (Griffiths & Varne), namely the Alpine Fault. This produced further rifting between Australia and Lord Howe Rise, thus forming the 'oceanic' basement beneath the present abyssal plain as the rise moved northeast with respect to Australia. Mutter and Symonds suggest that the Mellish Rise may have been formed as a result of igneous activity in a zone of transcurrent displacement resulting from the northeasterly movement of the northern end of Lord Howe Rise. That is, the Mellish Rise may be the northern equivalent of the Alpine Fault. During the second stage of rifting, the Dampier Ridge, which probably formed as an intrusive complex in the initial rift between Lord Howe Rise and Australia, also moved northeast with respect to Australia in a similar manner to Lord Howe Rise. This movement may have been responsible for some rifting between the Dampier Ridge and the rise.

Three Deep Sea Drilling sites have been proposed in the Tasman Sea area, as shown in Figure SGM11 as BMR 3, 4 and 5. They are designed to provide information on age and biostratigraphy to help elucidate the tectonic evolution of the area.

Marine Development and Standards Group (R. Whitworth, I.C. Briggs, A. Hogan, E. Jacobson)

Much of the group's effort throughout the year has been directed towards analysis of problem areas of the marine contract survey and introduction of improved methods and programs. The group also provided Marine Group with programs for handling hourly data files on the CDC 6600 computer, and created a working accession fiel system and background information and driving instructions for programs.

Programming for the marine contract survey. The major effort during the year has been the conversion of existing programs to the CDC 6600 computer, completion of programs for the later phases (Phases 3 and 4) of the marine data processing system, and programming assistance to the contractor. The rate of progress in this work has improved considerably since the installation of the CDC 6600 terminal within the BMR building.

The remoteness of the CDC 6600 machine has required considerable changes in some of the programs to avoid the several days delay between punching card output and its receipt back in Canberra. All punched cards are saved on disc file and edited as necessary as they are read into the next program.

The much larger areas now covered annually on the Continental Margin Survey, and the non-uniform movement of the vessel around the continent, have necessitated reorganisation of the programs in Phases 3 and 4, as some areas are covered by up to five surveys. All programs will now accept multiple survey data files limited only by the capacity of the disc system on the CDC 6600.

Many problems were encountered in extending the facilities within the plot program used for verification of digital data acquired on the surveys. Sub-plots of about three feet in length are now created as independent plots, allowing restart with minimal loss of information.

New data acquisition program - NEWDAS. In June, 1971 an enlarged memory was acquired for the Hewlett-Packard 2116B computer being used for data acquisition, on board the 'Lady Christine'. This was to allow modification and enlargement of the existing programs. The aim of the changes were to:

(1) Include geophysical calculations currently being done manually

(2) Improve data checking

(3) Simplify the operation overall from the point of view of the user

(4) Improve the navigational part of the system

(5) Allow automatic resynchronization of the program timing with the external clock.

On inspection the old system was found to be unsuitable for the modifications, because:

(a) It was not planned around a central monitor; and

(b) Interrupt routines were too long and used library programs.

A total new system was then designed around a monitor with all input and output buffered. Operator communication was made in the form of question and answer, in order to ease the operator's task. Half-hourly dead-reckoning positions are adjusted to satellite fixes, as fixes are input. These positions are then used for calculating free-air anomalies and the regional magnetic field every half hour.

The system was flow-charted and described in seven weeks to July, when coding began. The monitor and operator input-output was punched and tested in Septmeber 1971, while most of the eight thousand statements were coded and punched by December, 1971.

In March the first system was running, the main difficulty being that only when the ship was in port could the system be tested satisfactorily.

The first test run was in May 1972, when the new system was used to survey the St Vincent and Spencer Gulfs.

A problem occurred at this time because the gravity data input uses a serial interrupt system. After minor changes the system was retested from 4 July, 1972. The gravity data input was again a cause of trouble, and the corresponding interrupt routine was rewritten.

After five weeks of testing and changes a final system was reached on 31 July 1972.

The system has now been running for three months without having to be altered. The output tapes are satisfactory and there are fewer gaps in the data.

Marine seismic system improvements. Operational problems with the Sercel AS 626 amplifiers used on the survey since January 1971 showed that replacement with a more versatile amplifier system was desirable. A study of the return energy levels expected from different depths indicated that individual channel gain control was preferable.

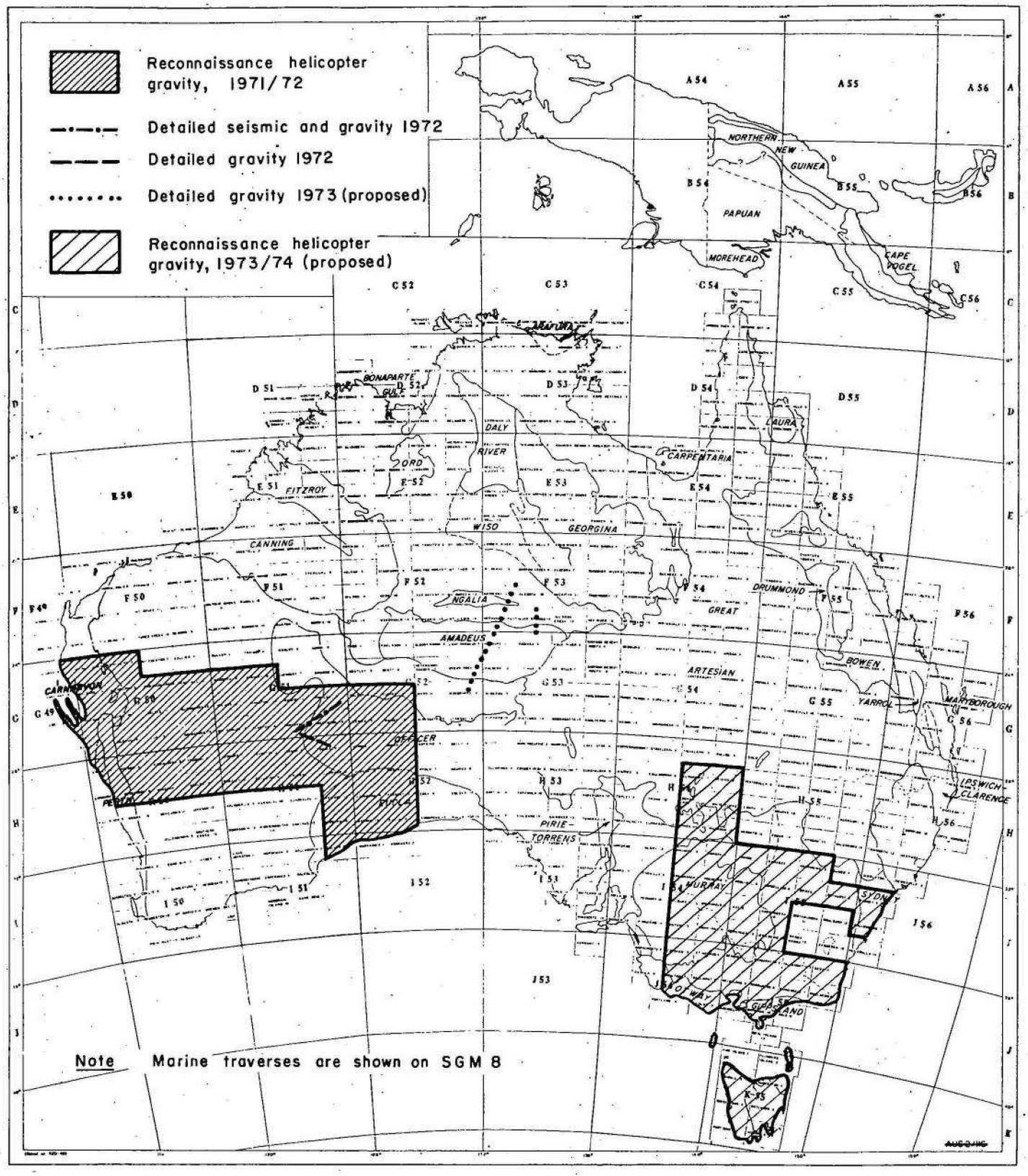
The SIE PT700 system was selected with the addition of a PT100 filter bank. The amplifiers give a maximum output of 10 volt (RMS) for digital purposes, which is suitable for the seismic stacking system, and the filter bank gives a wider and more selective range of filters than the standard PT700 filters.

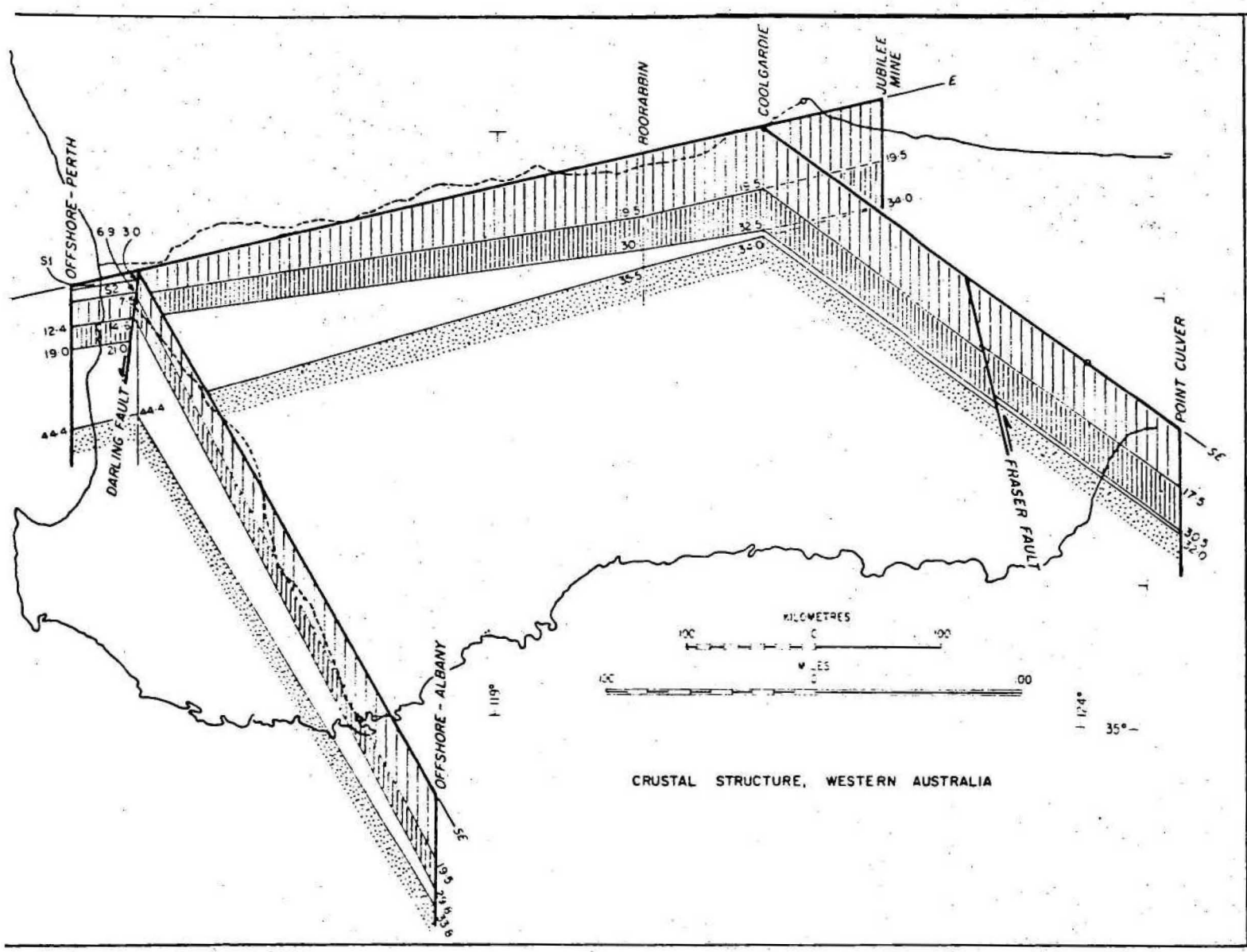
The new amplifier system was installed on the boat in May 1972 during a port call at Adelaide. The increase in the number of amplifiers available has been utilized to provide improved monitor recording and a wider recording band-width on magnetic tape.

The following cruise was used to define the desirable recording characteristics, signal levels at various points in the system, and checks for measuring cable noise and amplifier performance.

Since installation of the new seismic amplifiers, reliability of recorded data has improved. A more consistent quality of monitor recording has also been achieved.

Figure SGM 1


Reconnaissance helicopter gravity, 1971/72
Detailed seismic and gravity 1972
Detailed gravity 1972
Detailed gravity 1973 (proposed)
Reconnaissance helicopter gravity, 1973/74 (proposed)
NORTHERN TERRITORY
NEW GUINEA
PAPUAN
MOREHEAD
CAPE VOGEL
BONAPARTE GULF
DALY RIVER
ORD
FITZROY
CANNING
WISO
GEORGINA
CARPENTARIA
LAURA
DRUMMOND
GREAT ARTESIAN
BOWEN
YARROL
MARYBOROUGH
LOGWICH CLARENCE
NGALIA
AMADEUS
OFFICER
BASIN
PIRIE-TORRENS
MURRAY
SYDNEY
GIPPSLAND
Note Marine traverses are shown on SGM 8



CRUSTAL STRUCTURE, WESTERN AUSTRALIA

		VELOCITY KM/SEC	DENSITY GM/CM^3
S1	SEDIMENTS	2·52	2·38
S2	SEDIMENTS	4·67	2·63
	CRUST LAYER 1	6·12	2·78
	CRUST LAYER 2	6·67	2·94
	CRUST LAYER 3	7·41	3·10
	MANTLE	8·25	3·45

DEPTHS SHOWN ARE IN KILOMETRES

Figure SGM 2

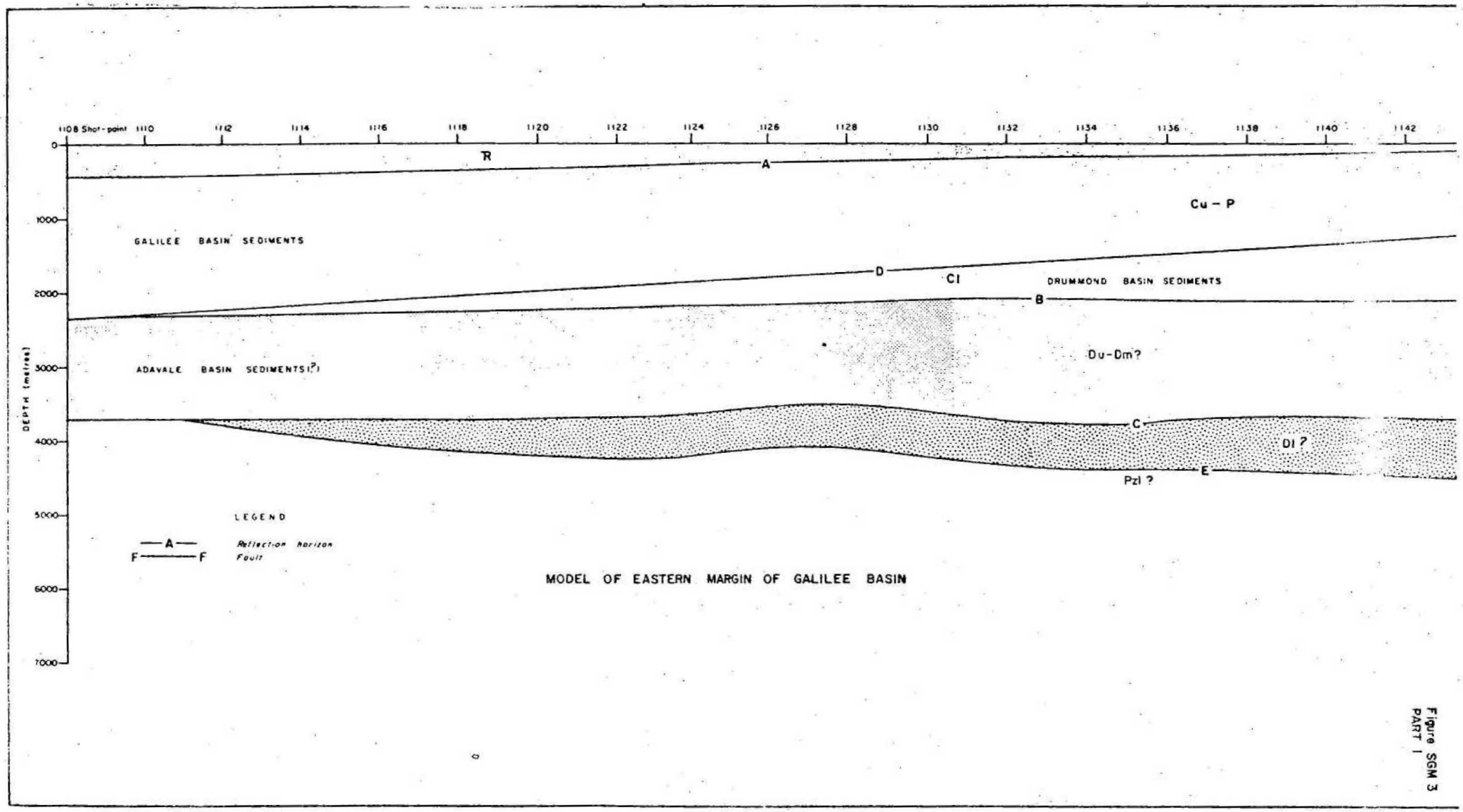
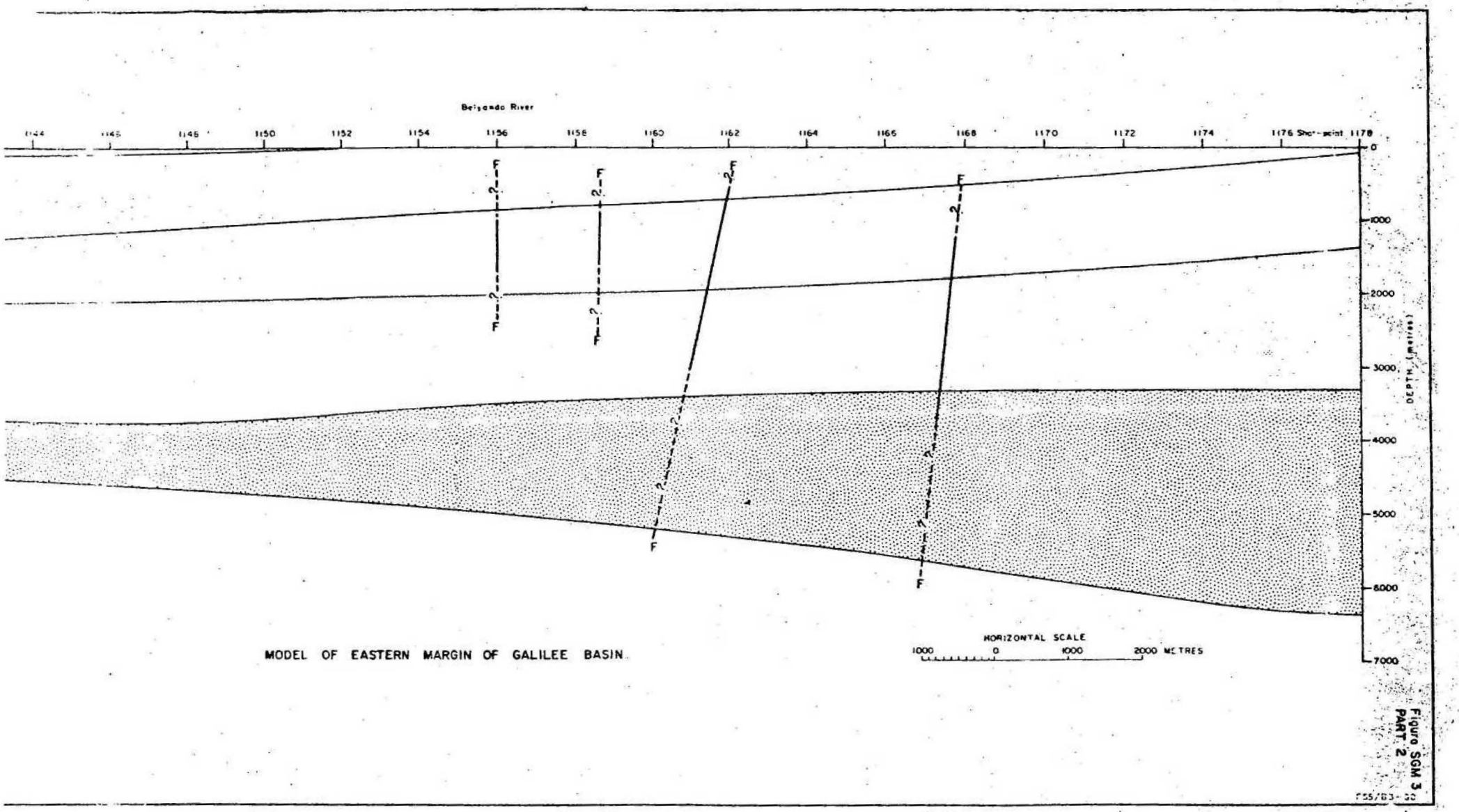
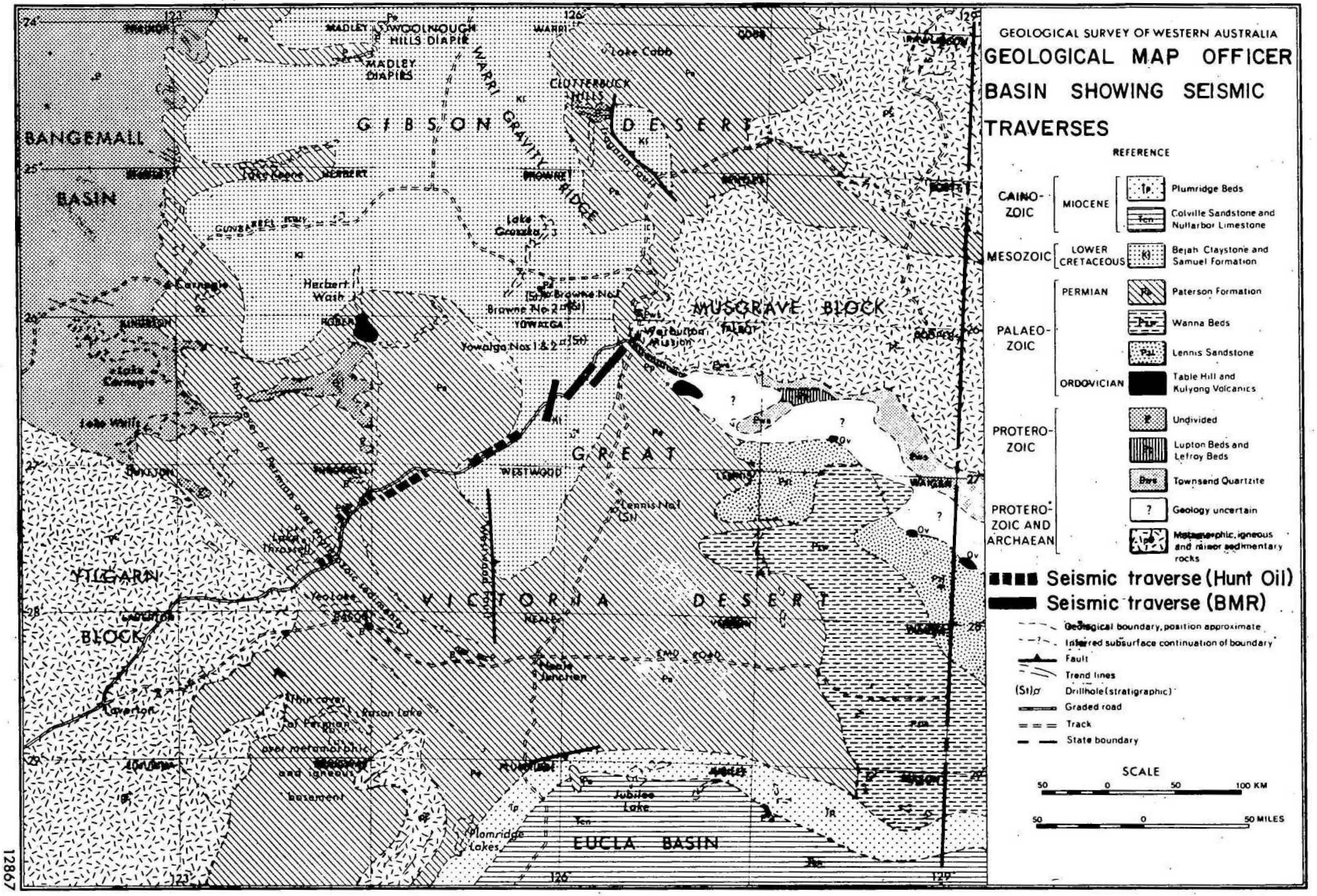


Figure SGM 3
PART 1



MODEL OF EASTERN MARGIN OF GALILEE BASIN.

Figure SGM 3
PART 2



12867

Figure SGM 4

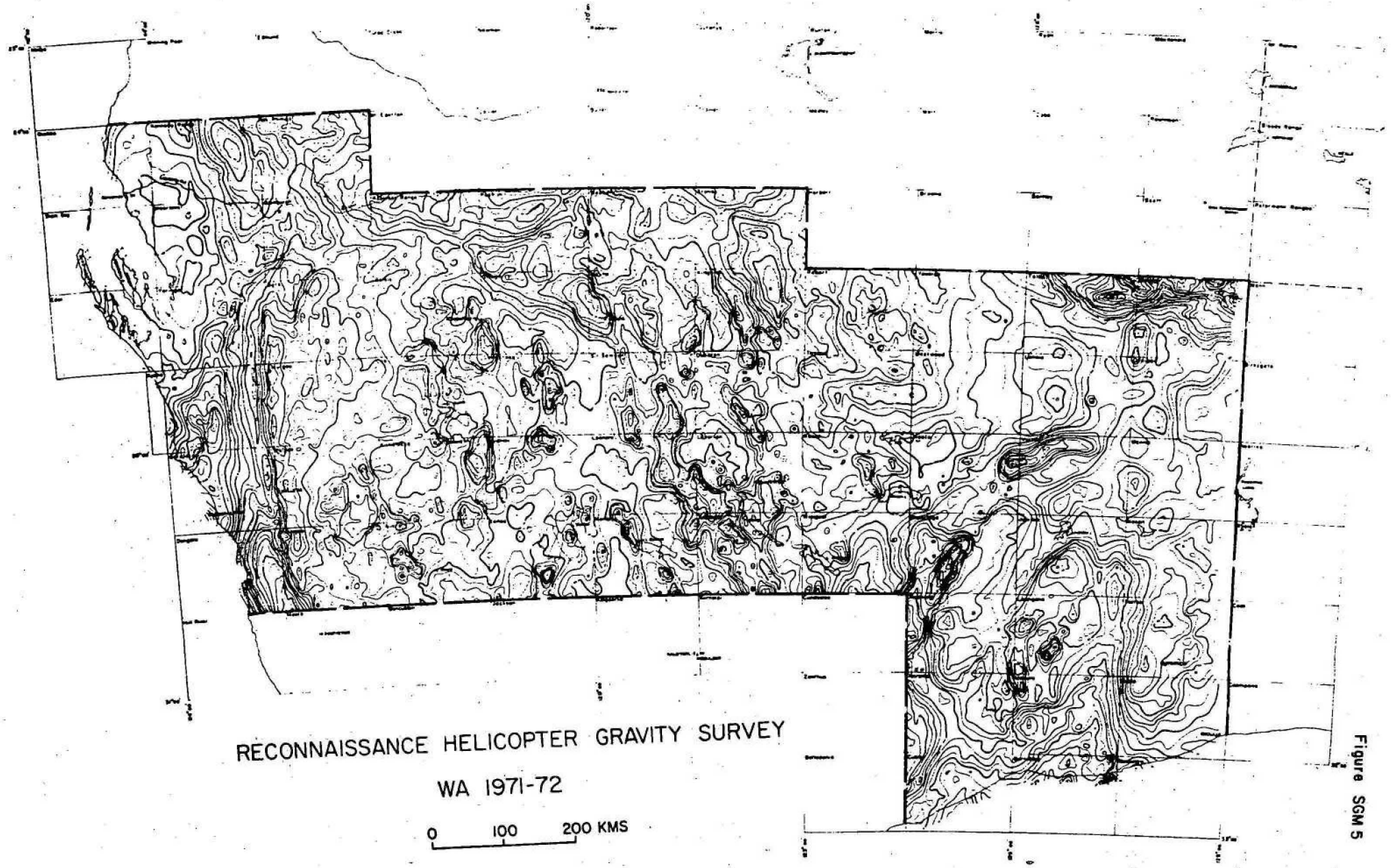
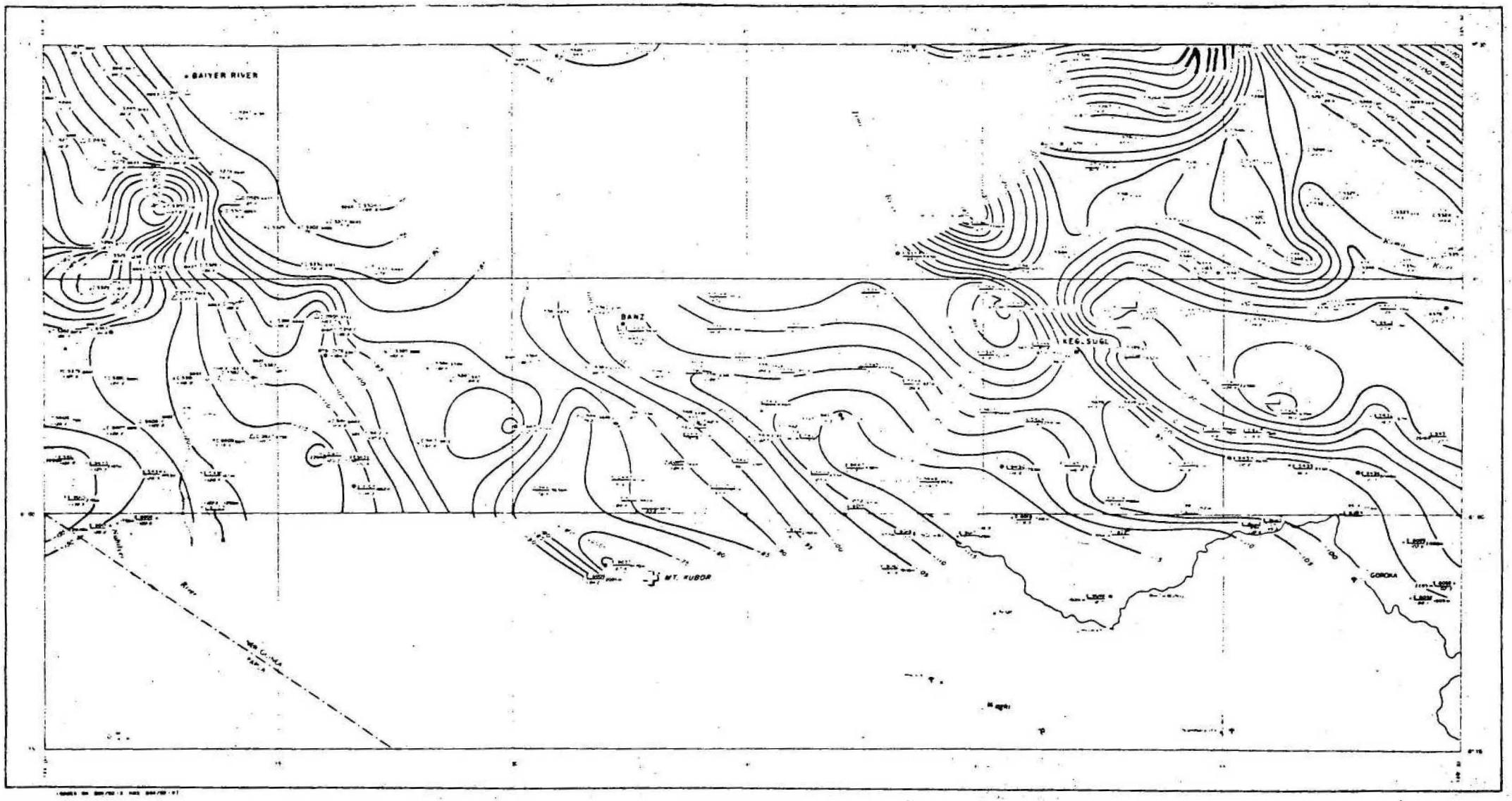

RECONNAISSANCE HELICOPTER GRAVITY SURVEY
WA 1971-72
0 100 200 KMS

Figure SGM 5



NEW GUINEA HIGHLANDS RECONNAISSANCE HELICOPTER GRAVITY SURVEY, 1970

LOCATION DIAGRAM

BOUGUER ANOMALIES

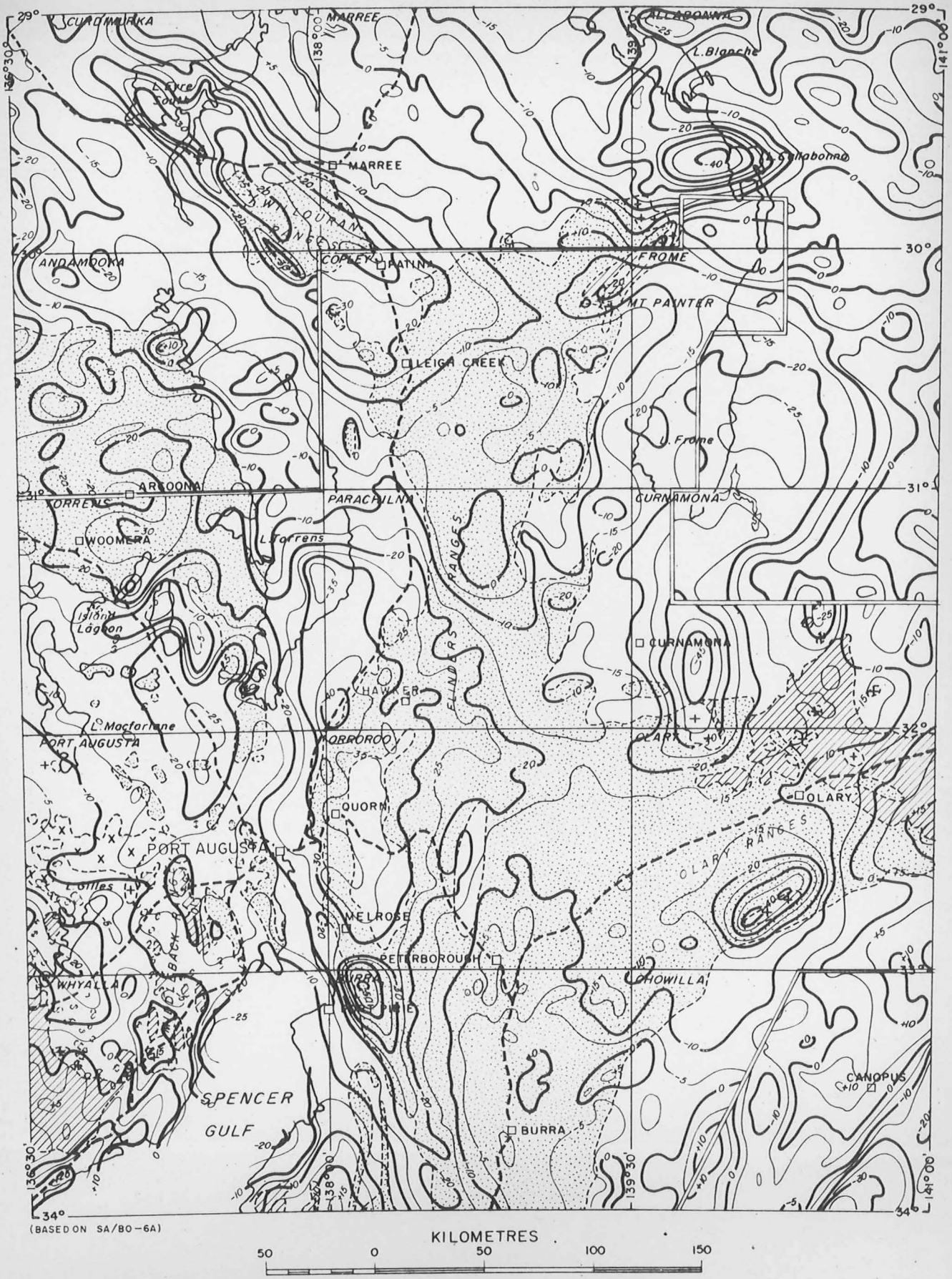
SCALE

KEY TO GRAVITY STATION NUMBERING

TOPOGRAPHY

GRAVITY

Figure SGM 6



SEDIMENTS

CAMBRIAN AND ADELAIDEAN SEDIMENTS

METAMORPHIC COMPLEXES OF THE MT PAINTER AREA, WILLYAMA BLOCK AND GAWLER CRATON

ACID INTRUSIVE AND GRANITOID ROCKS

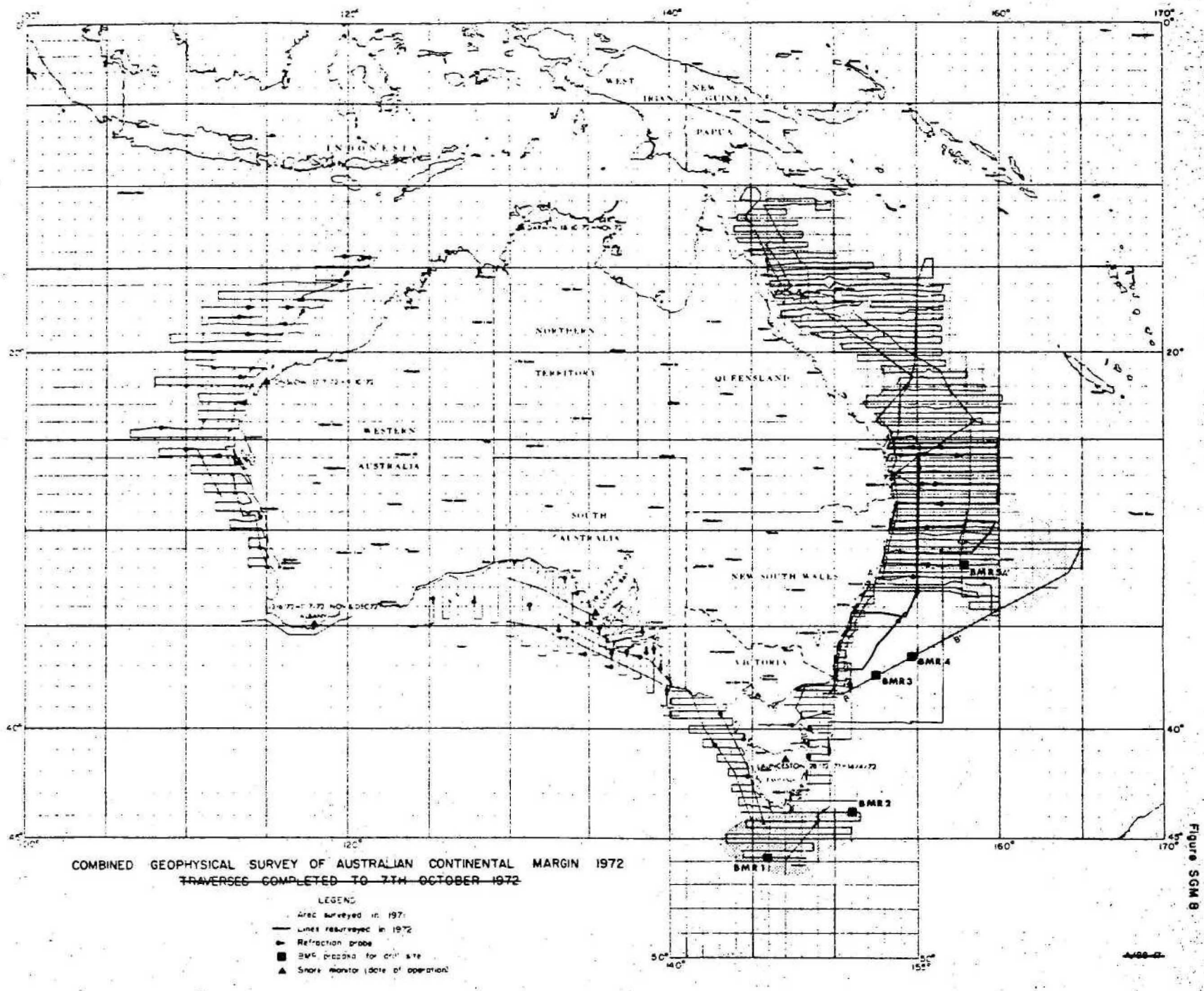
FELDSPAR QUARTZ PORPHYRIES OF THE GAWLER RANGES

BOUGUER ANOMALY CONTOURS

GEOLOGY GENERALIZED AFTER SPRIGG, 1953 (GEOLOGICAL MAP OF S.A. 32M = 1")

GEOLOGY AND BOUGUER ANOMALIES FLINDERS RANGE AREA S.A.

~~SA/B2-33A~~



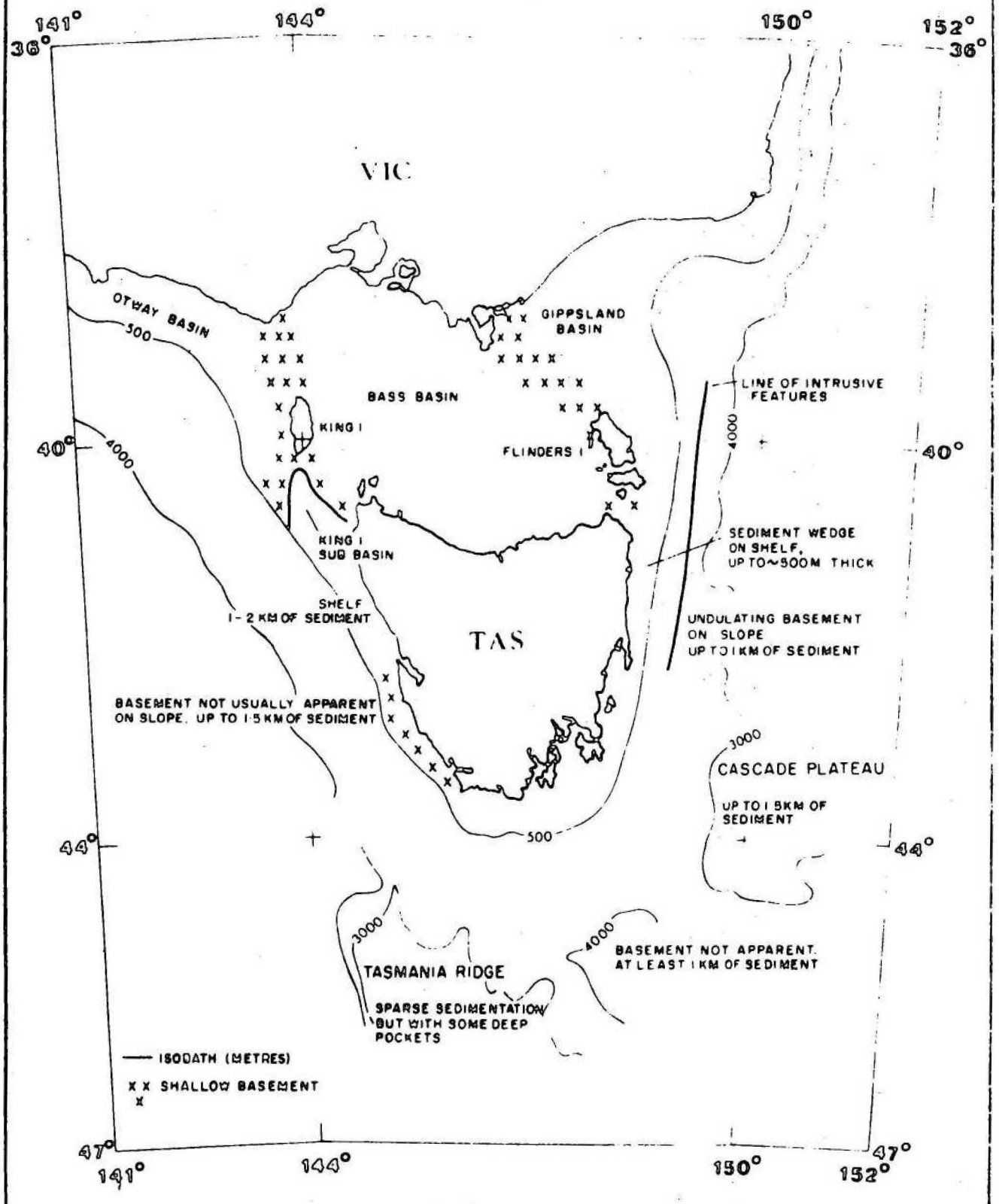
COMBINED GEOPHYSICAL SURVEY OF AUSTRALIAN CONTINENTAL MARGIN 1972

~~TRAVERSES COMPLETED TO 7TH OCTOBER 1972~~

LEGEND

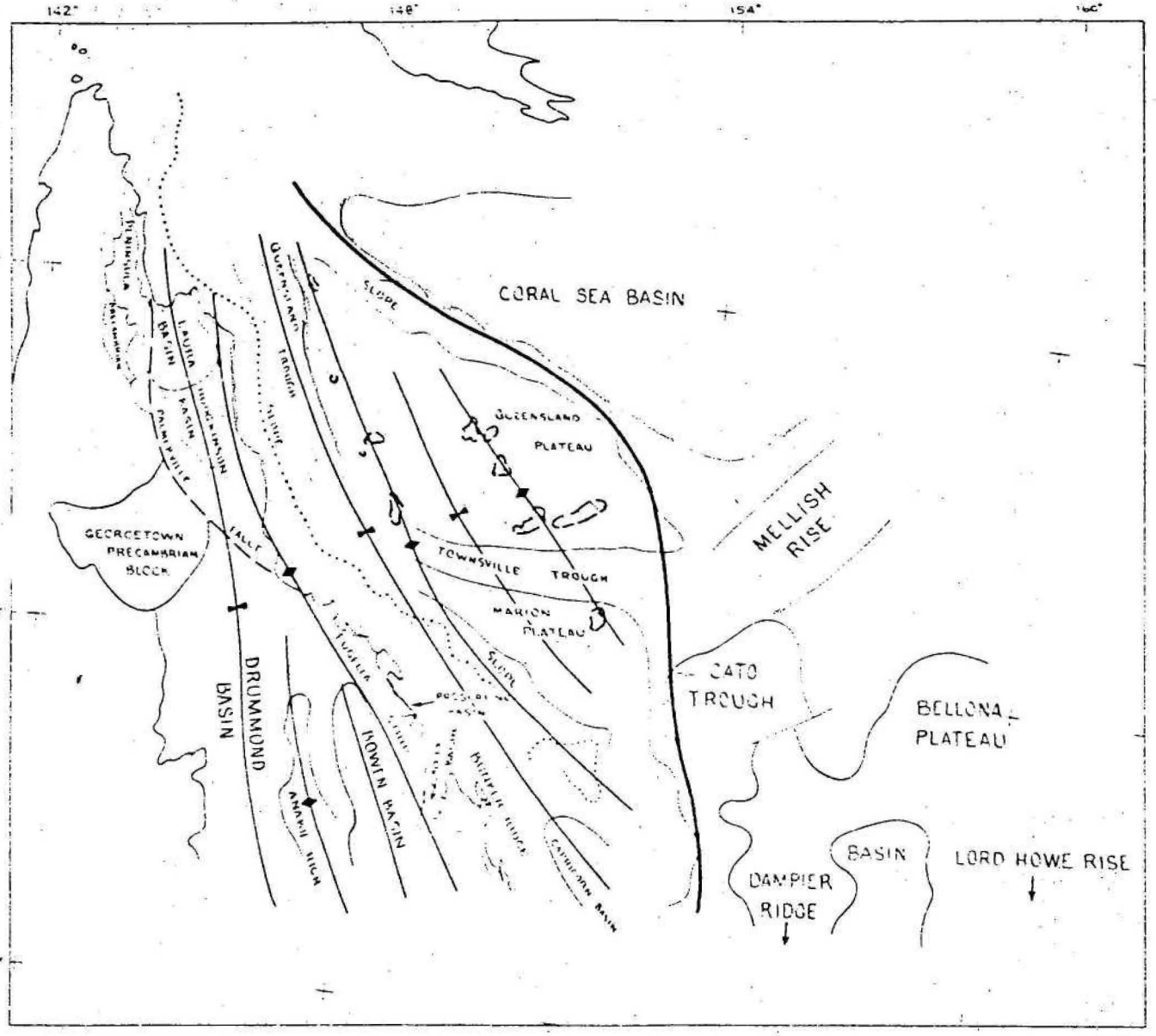
- Area surveyed in 1971
- Lines resurveyed in 1972
- Refraction probe
- BMR program for drill site
- Shore station (date of operation)

Figure SGM 8



SEDIMENT DISTRIBUTION IN THE TASMANIAN AREA

K 55/B8-3-1A



BOUNDARY OF MAJOR STRUCTURAL UNITS

STUCTURAL LINEAMENTS

STUCTURAL HIGH

STUCTURAL LOW

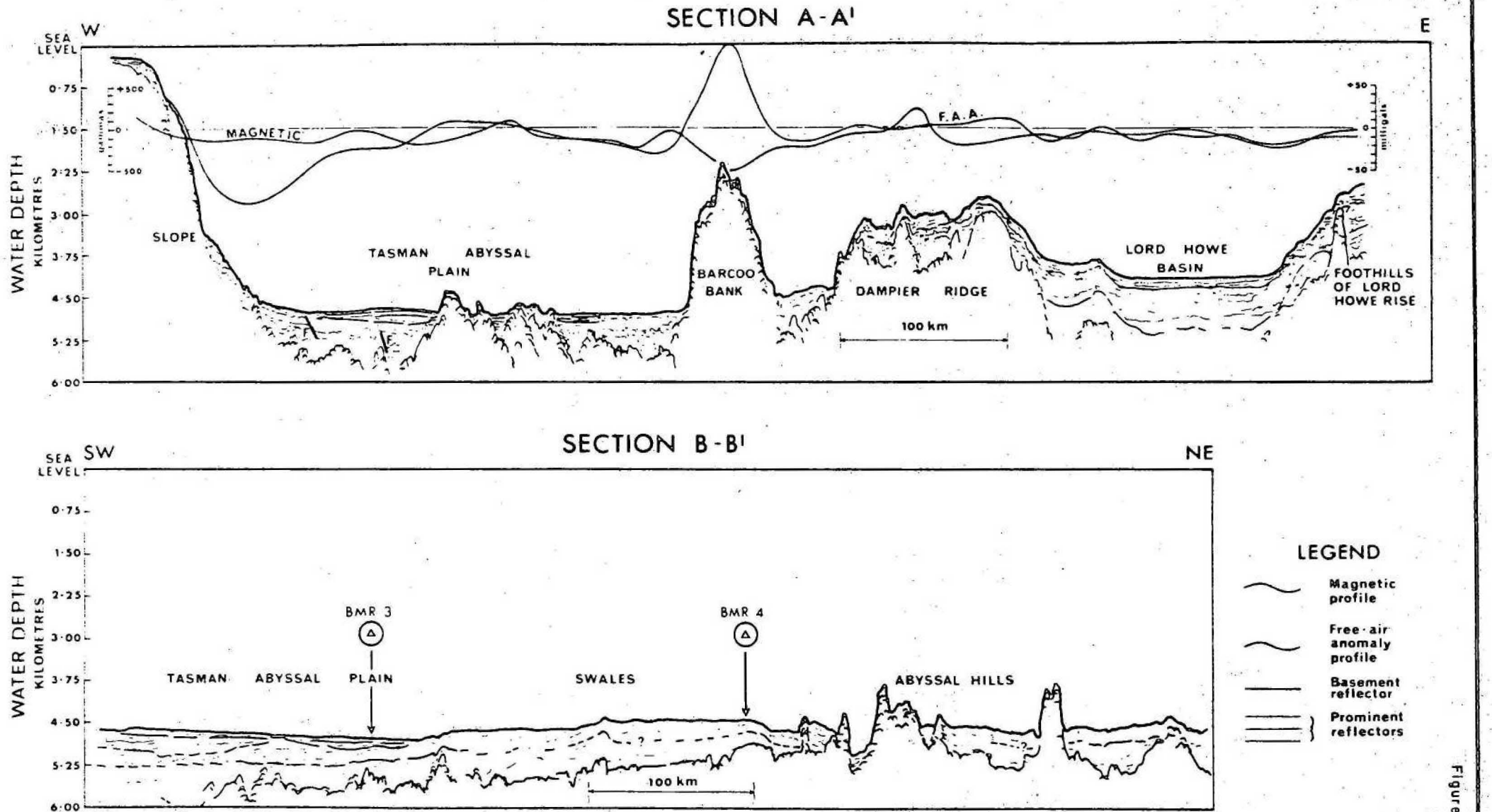
EASTERN LIMIT OF CONTINENTAL CRUST (DETERMINED FROM GRAVITY EVIDENCE)

GREAT BARRIER REEF

OTHER REEFS

GENERALISED STRUCTURAL MAP OF THE WESTERN CORAL SEA

Figure SGM 10

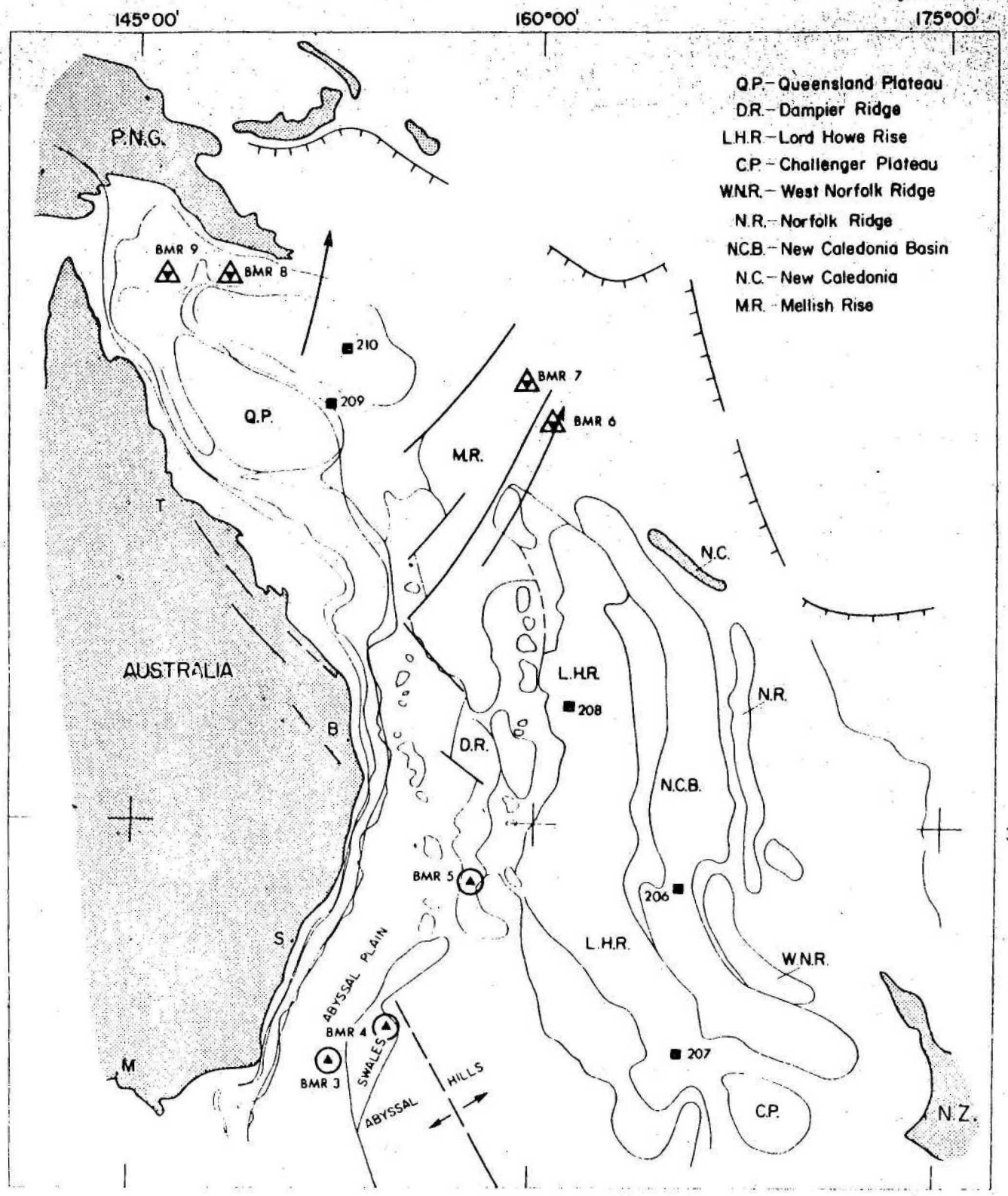


SKETCHED SEISMIC SECTIONS
showing locations of proposed sites BMR 3 and BMR 4

Figure SGM11

G85/3-174

Figure SGM 12



STRUCTURAL MAP
EASTERN AUSTRALIAN MARGIN

■ JOIDES sites completed on Leg XXI

BMR proposal for drill site on Leg XXIX

BMR proposal for drill site on Leg XXX

Ocean Basin

Sub-Continental Crust

Sub-Oceanic Crust (Igneous activity in fracture zone)

Base of Continental Slope

Fracture zone

Trench

Extinct spreading centre

Tasman Geosyncline trends

4. GEOPHYSICAL SERVICES SECTION

Contents

Figures

SUMMARY

The section comprises three Subsections: Electronics, Mechanical, and Services. The Electronics and Mechanical Subsections are concerned primarily with equipment development construction and maintenance, and the Services Subsection covers procurement and utilization of equipment, measurements of physical properties of rocks, engineering geophysics, and geophysical drafting. The activities of the subsections and groups are reported under these headings.

In 1972 the trend toward greater use of digital recording systems and mini-computers continued. The mini-computer based data acquisition system in the Twin Otter survey aircraft became operational and tenders were called for equipment to provide automatic digital recording on magnetic tape in the Aero-Commander survey aircraft. A Calcomp 745 digital flat-bed plotter was acquired and installed and a contract placed for a mini-computer based A/D and D/A conversion system.

The completion of a prototype high performance airborne fluxgate survey magnetometer and partial production of 21 remote automatic recording seismographs were major electronic design tasks. Greater use was made of computers in circuit design and CDC 3600 programs MANYPOLE, MANYPLOT and MERRY were written to assist in prediction of circuit behaviour.

In the Services Sub-section the Engineering Geophysics Group carried out many small surveys in support of engineering geology in the ACT, conducted a major dam-site survey on the Musa River in PNG and hydrological surveys on Daru Island and the Markham Valley in PNG and in the Goulburn Valley in Victoria. Other activities were in shallow seismic profiling, blast and vibration measurements and well logging.

Physical properties were measured on 350 rock specimens in the Rock Measurements Group.

The Geophysical Drafting Office produced approximately 1100 plates or illustrations in support of geophysical survey records and reports. Eleven aeromagnetic maps and over 100 Bouguer anomaly gravity maps were printed and released. Approximately 87,000 dyelines were printed for use in BMR and in production of Records.

ELECTRONIC SUBSECTION

The Subsection is divided into three groups: Instrument Development, Systems Development, and Electronic Maintenance and Testing. As in 1971, Instrument Development projects had to be given priority at the expense of progress in some Systems Development projects. However, much has been accomplished during the year.

Instrument Development Group

Two major projects occupied the group almost continuously this year. These were the MFS7 Airborne Fluxgate Magnetometer with associated installation and the remote recording seismographs for the Regional Crustal Groups. To cope with these projects, sub-professional staff was increased from two to an average of about eight by seconding staff from the Systems Development, Airborne, Regional Crustal, and Workshop groups.

MFS7 fluxgate magnetometer. Following intensive work on the drive channel and power supplies, the MFS7 prototype was installed in VH-BMG and flown on trial surveys in February-March. At this stage the noise level was below one gamma, but the temperature drift was several gammas per degree.

VH-BMG left for Albury in April but had to return twice, owing to various forms of trace shift and noise which had developed. The causes of these effects were numerous and included distortion, pick-up, component noise, inverter noise, and mechanical maladjustment of the orienter gimbals. New circuits, developed to overcome these problems, reduced the basic noise level to below 0.2 gamma and the drift to 4 gammas in 10 minutes at turn-on, then below a gamma for the rest of the flight. An independent 400-Hz inverter to power the MFS7 was also necessary.

Operation has been satisfactory since August apart from occasional minor noise due to malfunction of the original ASQ-10 orienter amplifiers.

Because of the physical difficulties in building the prototype in the ASQ-10 chassis, this system is regarded as temporary and the design of a production model was started in March. Power supplies, detector and drive channels, and magnetic compensator interface filter have been completed. The new orienter system is to be all solid-state, and preliminary designs of servo systems based on a detailed analysis of the ASQ-10 circuits have been bench tested satisfactorily. Empirical stabilizing networks are being used until the mechanical transfer function of the gimbals is determined to permit proper design. It is expected that the production MFS7 will be finished by March 1973.

Investigations were carried out on the bandwidth requirements of the MFS7 fluxgate as a function of aircraft height and speed. These used Fourier transform techniques to show that the present bandwidth is more than 10 times the theoretical requirement for the Bureau's present aircraft and altitudes. The magnetometer noise could be decreased even further with a bandwidth reduction. The findings will have application in all airborne magnetometer design. However, there is still some additional work to be done in these computations.

Regional crustal seismographs. The construction of 12 of 21 remote seismic low-power recording stations was completed for field trials in October, and the remaining 9 stations will be completed in 1972. A complete station is housed in three portable cases having a total weight of 90 kilograms including batteries.

Each station comprises a Willmore seismometer, two TAM5 seismic amplifiers, a TMF1 dual-channel FM modulator, an NCE1 crystal clock with time-code generator and programming facilities, an SSC1 seismometer calibrator, two power supply modules PP1 and PP2 for the clock and amplifiers/modulators, an optional high-voltage monitor amplifier TAM6 with power supply PP3, a modified Labtronics time-signal receiver, and a four-channel Akai tape recorder modified for pre-programmed operation with low-speed multi-pole synchronous motor drive and various monitoring circuits.

Test schedules were drawn up for each module, and a handbook produced. Specifications were compiled for an associated playback system.

Aircraft installations. Installations in both the Bureau's aircraft required modifications during the year. In the Twin-Otter, VH-BMG, design improvements were made to the timer, Doppler display, and chart drive systems. A digitizer was designed for the radio altimeter, and aircraft cabling and power supply configurations were altered to reduce interference to the magnetometer. Design of a production model timer was started.

In the Aero-Commander, VH-BMR, installation noise caused interference to the gamma-ray spectrometer and proton magnetometer. Aircraft wiring was altered and bonding improved to eliminate ground loops and pick-up. An improved line filter was installed to reduce interference from the 50-Hz inverter, and the power distribution box was rewired. Recorder input circuits were modified to make them less sensitive to noise. There is still a problem of magnetic noise, probably from the generator system, interfering with the proton magnetometer.

Proton magnetometers MNS2. Following a break of several months, work resumed on production model MNS2 proton magnetometers. Serial No. 2 had been installed in VH-BMR since May 1971, and construction of Serial Nos 1 and 3, using high-temperature logic, was completed in May 1972. High-temperature logic was installed in Serial No. 2 in June. All three units are now held by the Airborne Section.

Some minor design changes were made to improve operation as ground stations. Three more cylindrical detectors were constructed, and another three were commenced. An experimental toroidal detector is still to be tested.

Construction of serial Nos 4 to 6 was started in September and should be completed by March 1973.

The feasibility of designing future proton magnetometers using CMOS logic, LED read-outs, and improved signal circuits was investigated and the concept was recommended.

Computing. The CDC 3600 terminal was used for computations associated with the design of the MFS7 orienter system and the optimization of the compensator filter. D. Kerr developed three general-purpose programs: MANYPOLE provides a print-out of either frequency- or time-domain performance of a linear, time-invariant system with known poles, zeros, and gain; MANYPLOT provides a plot and print-out of frequency-domain performance; MERRY enables either of the above programs to be used interactively from the console.

The CDC 6600 terminal was used for Fourier analysis of magnetic anomalies.

Miscellaneous. Several training lectures were given to airborne and laboratory staff on the MFS7 and MNS2 magnetometers.

The Instrument Laboratory continued its function of calibrating and maintaining test instruments and was able to assist the Metals Group with modifications to the Russian electromagnetic equipment MPP01. A mathematical model to determine the effects to be expected from a body below a conducting layer was analysed.

The Electronic Drafting Group was fully occupied with the MFS7 and Regional Crustal projects. It operated with only two of its three positions filled for most of the year, and a backlog of lower-priority work has accumulated.

Systems Development Group

For most of this year the two technicians from the group were on loan to Instrument Development, leaving Hillman and Ramsay as the only full-time members of Systems Development.

Tidal gravity. No work was possible on this project, apart from a visit by Hillman to National Standards Laboratory in Sydney to discuss the problems of temperature control and temperature measurement of the North American gravity meter. Both problems will have to use very advanced techniques to obtain the accuracy of 5×10^{-5}°C required for the tidal gravity records.

Semi-Absolute gravity equipment. A project to redesign the measuring electronics for the Japanese GSI pendulums was commenced in 1969. The aim in 1972 was to produce a working system ready for field tests. The prototype equipment was completed, and laboratory tests indicated some outstanding problems.

Two types of photo-detectors were tested using the original GSI pendulums. The system accuracy using a photo-multiplier optical detctor was determined at about 4 parts in 10^7. Using an artificial pulse it was possible to obtain an accuracy of 2 parts in 10^9. Solid-state detectors and a laser light source were then tried, and the system accuracy using the GSI pendulum was improved to somewhat better than 1 part in 10^7.

During the tests the vacuum system in the original pendulum swinging chamber was found to be inadequate mainly as a result of deterioration. An improved system was designed, and this reduced the pressure to 0.01 Torr.

During the year the low-profile knife-edge pendulums designed by National Standards Laboratories, CSIRO, were swung. Tests showed that the period was extremely dependent on amplitude. The pendulums have been returned to CSIRO where it is intended to relap the knife edges to 173° instead of 178°.

Long-period seismometer. The DC to DC inverter card has to be modified slightly to prevent the output transistors from overheating.

Tests carried out at Kowen Forest showed that the boom stabilization system did not introduce any measurable noise into the seismometer output.

Three modified seismometers, with transit cases, and four servo amplifiers have been completed. Cables from the amplifiers to the seismometers have still to be made.

Remote sensing. P.J. Hillman attended meetings of the A.C.E.R.T.S. committee, assisted W.J. Perry (Geological Branch) from time to time, and continued reading relevant literature.

Electronic Maintenance and Testing Group

The Electric Maintenance and Testing Group provides a service of repair and overhaul of electronic equipment used by BMR. A further function is the acceptance testing of new survey and laboratory equipment and the installation of new equipment in aircraft, ships and motor vehicles.

One of the major non-routine jobs this year was the Darwin-to-Manton Dam observatory seismic telemetry project. This involved collaboration with the Observatory Group in assembling and testing a system designed to telemeter data from Manton Dam seismic vault to Darwin. The work involved construction of some equipment, assembly and check-out of the system in Canberra, installing it on site, and carrying out complete operational checks. Other tasks completed for the observatory Group were the repair and installation of a 3-component fluxgate magnetometer (at Kowen Forest), modification to digital clocks, and overhaul of the magnetogram scaler.

Shallow marine seismic profiling trials were carried out on Lake Burley Griffin in collaboration with the Engineering Geophysics Group, and assistance was given to survey parties at Gudgenby River near Tharwa and in Port Phillip Bay. Assistance was also provided to Engineering Geophysics in preparations for the Musa Gorge dam site survey and in experiments on the effect of blasting on electricity transmission line pylons. The well logging group was helped as required with the installation of equipment in their logging vehicle.

A major task was assistance in the construction of remote seismograph recording stations for the Crustal Studies Group. Most of the assembly and wiring was done in Electronic Maintenance and Testing Group.

A marine proton magnetometer was installed on a bathymetric survey vessel operating under contract to Division of National Mapping.

Acceptance testing of new equipment continued. Work commenced on the check-out of a set of Geotronics magnetotelluric equipment in preparation for field work in 1973. Work was also done on software for the system, viz. writing up of a data acquisition program for the Hewlett-Packard computer and some work on a data processing program AVSPEC supplied by Geotronics to make it acceptable on BMR's CDC 6600 terminal.

A series of field tests of single-sideband transceivers was carried out to determine their performance and suitability for BMR purposes.

The supervision and practical training of seven trainee technical officers falls to this group. Six of the trainees have made satisfactory progress in the technical side of their training, and the seventh has spent most of the year on sick leave as a result of a road accident in April.

An increasing volume of ad hoc work is now being done for other Branches. The Marine Geology group has received assistance on various occasions during their survey of the continental margin. Field geological parties have been equipped with radio transceivers and portable loggers. They in turn have issued various complaints about the performance of this equipment, to which we have responded with demonstrations, instructions, and advice. Conductivity and temperature equipment and depth-to-water-table indicators have been repaired for the ACT groundwater group. A number of miscellaneous items, such as stirrer motors, centrifuges, and grainsize counters have been repaired for various geological laboratories.

The Drawing Office, which operates a number of copying machines, has made numerous calls throughout the year for modifications and repairs. A lot of time was spent on their new dyeline printer, which cannot be operated on full power without overheating. The electrical installation and modification of a Barcro process camera was carried out for the photographic laboratory, and the usual run of repairs to items such as timers, driers, and flash equipment continued.

MECHANICAL SUBSECTION

The subsection comprises three groups: Mechanical Design, Mechanical Instrument Construction, and Mechanical Maintenance and Testing. The position of Mechanical Design Engineer Class 2, which has been vacant for several years, was filled in July of this year.

Mechanical Design Group

The Mechanical Design Group designed and drafted detailed plans for the construction of electronic chassis and other components for the Crustal Study Group's remote-recording seismographs. It refitted the 10000-ft well logging vehicle in preparation for the 1972 program of logging 'difficult boreholes', completely rebuilt the logging cab following the 1972 survey and transferred it onto a new Dodge chassis in preparation for the 1973 logging program, and modified bore logging tools to allow Widco and Gearhart-Owen tools to be interchanged. Other work included modifications of a single-electrode sparker frame to accommodate a special BMR-developed sparker with bubble suppression device for use in relatively shallow marine seismic profiling, and an improved tail marker buoy for protection against loss of a Chesapeake marine seismic cable used on deep seismic profiling. Various other minor jobs included a film casette for a 35-mm film processor; a two bar for the Twin Otter aircraft; a housing for the transducer in a Marlin depth recorder; a transit box with vibration isolators for the protection of quartz systems in gravity meters during transport in aircraft; various mechanical assemblies for the gravity pendulum apparatus; and a gear reduction drive for Porta logger shallow logging equipment.

Working drawings were supplied for a decomposition vessel and a teflon-lined stainless steel sediment squeezer for use by the Baas Becking Laboratory, and a float for the suspension of explosives in offshore crustal seismic surveys.

The group carried out experimental determinations of the open loop transfer function of the mechanical orienter system of an ASQ-10 magnetometer detector head assembly. This is required for the design of the orienter electronics for the production model MFS-7 fluxgate magnetometer to be used in the Twin Otter aircraft.

Mechanical Maintenance and Testing Group

The group serviced and calibrated test and field instruments such as rate meters; Esterline-Angus, Moseley, Rustrak, and Rikandenki recorders; Mechanism microbarometers; Worden and LaCoste & Romberg gravity meters; AVO and Philips multimeters; small instrument gearboxes; camera shutters; water-table detector; bore logging flow-meter tool; a gear drive for a Marlin depth recorder; and a strip camera. Unobtainable replacement parts were fabricated for instruments as required. Parts were made for the gravity pendulum equipment, an X-ray spectrometer and a Widco Porta logger. Work continued on the upgrading of a spare airborne strip camera to a proven BMR design. A number of Akai magnetic tape recorders were modified for use in remote recording seismographs for the Crustal Studies Group.

Mechanical Instrument Construction Group

The group, comprising the Machine Shop, the Heavy Workshop, and the Modelmakers Shop, was mainly concerned with the construction of new equipment and instruments. Throughout the year the group contributed heavily to the manufacture of electronic chassis for the Crustal Study Group's remote recording seismographs and to the manufacture of parts and modifications of tools for the refit of the well logging cab and its equipment. The group also constructed chassis for the Darwin-to-Manton Dam telemetry system, 1M7, 2M7, and 10M7 electronic module bins, a decomposition vessel and a teflon-lined sediment squeezer for the Baas Becking Group, two 35-mm film casettes for the Airborne Group's HF985 film processor, parts for a number of Creed paper punches, various transit boxes to hold delicate instruments, a number of transducer and other floats for offshore surveys, a support for an OCE-7 pattern printer in the Drafting Office, lead lined battery boxes, a number of instrument racks to house the MNS-2/NTA1 proton magnetometer and timing unit on an aircraft, and a non-magnetic field housing and support for a storm warning magnetometer detecting head.

The group modified such instruments and equipment as a Thermionic tape playback unit, a number of downhole logging tools, a seismic office caravan, and a fume cabinet. Repairs and overhaul were carried out on an outboard motor, seismic cable winders, JLO, Honda, ABEM, and T200 Lyon Norman motor generators, a core barrel for a Proline auger, and a Wedag rock crusher in which the jaws were refurbished.

SERVICES SUB-SECTION

The Services Subsection comprises four groups: Procurement, Rock Measurements, Engineering Geophysics, and Geophysical Drafting.

Procurement Group

The group drew up specifications to purchase through public tender a wide range of geophysical equipment required for the Branch's program. Tenders were assessed and recommendations made for purchase. One member of the group was engaged full-time arranging purchase of components for the construction of 21 automatic seismic stations for crustal studies.

A considerable time was spent answering queries raised by departmental and inter-departmental groups relating to the purchase of a flat-bed digital plotting table and associated equipment. This equipment has now been installed in the Geophysical Drafting Office.

Rock Measurements Group

Some 350 rock samples were measured during the year, including 70 samples from a co-operative palaeomagnetic project with the Geological Survey of N.S.W. It was hoped to establish that the Kempsey Block in N.S.W. has rotated through a large angle since its formation. The results proved inconclusive because of remagnetization of samples during weathering. A further difficulty encountered was the near-vertical inclination of the Earth's magnetic field in Australia during the Upper Carboniferous, when the Kempsey Block sediments were deposited; steep inclinations necessitate a very high degree of accuracy in sample orientation and remanence measurements to determine rotations. It was concluded from this work that determination of rotation would be feasible in only strongly magnetized, magnetically stable rocks such as fresh, fine-grained, red sediments.

The remainder of the measurements were carried out for various groups in support of field geophysical survey activities. These were mainly magnetic susceptibilities, remnant magnetizations, ultrasonic velocities, and electrical resistivities.

Two sun compasses were manufactured for palaeomagnetic sample orientation.

The characteristics of the Sharpe susceptibility meter were investigated and the meter was adapted for measurement of small samples. An in-situ susceptibility meter built by BMR was given field trials. The in-situ meter may be used successfully in regions of fresh to lightly weathered outcrop.

After various techniques for measuring ultrasonic shear wave velocities directly in rock samples had been examined, types of shear mode transducers were designed and constructed. These will help to determine elastic moduli of rock samples for engineering projects.

Preliminary work was done on measurement of sound absorption in unconsolidated sediments. These measurements would be useful for shallow seismic profiling interpretation where bottom and sub-bottom samples are available.

Engineering Geophysics Group - Engineering Surveys

During the year the group was at full strength.

E.J. Polak went on a study tour of Hong Kong, Japan, USA, and Canada. During the tour he attended the Third Southeast Asia Conference on Soil Engineering, Hong Kong, November 1972 and read a paper "The Application of Geophysics in the Design of Underwater Foundations". F.J. Taylor attended "A Short Course on Rock Mechanics" at the University of NSW. Five geophysicists from the group attended the Institute of Physics Summer School of Geophysics in Canberra.

Two officers from the Department of Shipping and Transport were trained in measuring and interpretation of resistivity depth probes to be used to locate a suitable area for an Omega navigation station in Australia.

Four geophysicists attended the soil mechanics course given in the BMR building by Professor Davis of the School of Civil Engineering of the University of Sydney.

Musa Gorge damsite survey, PNG. Following a reconnaissance seismic survey in 1970 a detailed seismic refraction survey was made at the request of the Commonwealth Department of Works to determine the most suitable of two alternative dam sites for the proposed dam on the Musa River in eastern Papua. The proposed dam will be a rock-fill structure 150 metres high intended for hydro-electric purposes and is located in a rugged gorge in the ultramafic belt of PNG. The investigations included a survey of two alternative dam axes, two possible power station sites, areas for location of spillways and diversion tunnels, and a landslide area which intersected the toe of the downstream dam site.

A total of 13 km of seismic traversing with 5- and 10-metre geophone spacings was done; much of the traversing was on very steep and rugged terrain which necessitated the use of safety rope. Cross-river traverses were also carried out in the area of the dam axes. Bedrock velocities range from 4000-5000 m/s at river level to 2000-3000 m/s in the higher slopes. The results indicate that at river level between 20 to 30 metres of 2000 m/s material overlies fresh bedrock in the area of the dam axes. Preliminary results suggest that both sites have similar foundations conditions and are capable of supporting a rock-fill structure. Drilling is to be done and seismic velocities of cores are to be measured to provide further control for geophysical interpretation.

Up to 70 metres of scree material (1800 m/s) was detected on the slopes above the proposed site of the downstream power site and in the area of a possible spillway for the downstream dam site. On the basis of these geophysical results the upstream dam site would possibly be a more suitable site. Sediments 50 to 60 metres thick were detected on the top of the landslide area; however, the main slide mass and the base of the slide consisted of 4000-5000 m/s fresh rock with little evidence of shearing.

A seismic depth probe in the Musa Valley, which will be eventually flooded to an area of 640 km^2 by the dam waters, showed that the valley is probably a large graben structure. The seismic probe failed to detect ultrabasic basement within the structure, but the results show that sedimentary fill of the trough is at least 1600 metres thick and suggest that there has been a subsidence of at least 800 metres since the Pleistocene.

Molonglo Valley interceptor sewer, ACT. Seismic refraction investigations using 2-m geophone spacings were carried out at seven bridge sites along the sewer line from Weston Creek along the Molonglo River. Basement velocities of 3600-4600 m/s were encountered at depths generally less than 10 m.

Mount Stromlo water distribution, ACT. A seismic refraction survey over the area of excavation for a water storage reservoir indicated that some blasting would be required for the northern part of the excavation. Velocities up to 3800 m/s were measured.

Civic Centre foundation test, ACT. A seismic refraction survey was carried out in the area of a car park near Monaro Mall, Civic Centre. The information was required to determine the conditions for excavation of a multi-level underground car park. Deep weathering was recorded.

King's Avenue overpass, ACT. Seismic refraction work was done to determine the foundation and excavation conditions for an overpass on the intersection of King's Avenue with Parkes Way. The results indicated great depths of weathering and that excavation could be carried out without blasting.

Tuggeranong urban development, ACT. A reconnaissance seismic survey of 13 spreads using geophone spacing of 2 and 4 metres was made to determine the general foundation conditions of the proposed town centre and urban areas. The area of the Town centre was found to be covered by up to 15 metres of highly weathered material (1000-1700 m/s) overlying fresh bedrock (4300-5000 m/s). Detailed seismic refraction investigation of any major multi-storey building within the town centre is recommended. A colluvial fan located south of Point Hut Crossing showed up to 37 metres of colluvium overlying generally deeply weathered bedrock. Bedrock depths up to 50 metres were measured in the Tuggeranong South area.

Molonglo Freeway, ACT. A seismic survey was made on parts of the proposed Molonglo Freeway to be located between Lake Burley Griffin and Black Mountain. Refraction techniques were employed on land and parts of the lake, and shallow reflection techniques using the 'Sonar Boomer' and 'pinger' were employed on the lake.

The deepest refractor encountered on most of the traverses on the slopes of Black Mountain has a seismic velocity of about 2500 m/s. There is a marked contrast across the Deakin Fault; the 'bedrock' velocity changes from 2500 to about 3500 m/s, and the 'bedrock' depth changes from about 2 metres to about 24 metres over the area surveyed.

Tuggeranong Freeway, Stage II, ACT. Additional seismic refraction traverses were shot along the line of the proposed freeway south of Hindmarsh Drive and 18 spreads with 2-metre geophone spacing were completed. The object of the survey was to interpret the measured seismic velocities in terms of rippability of the near-surface layers. The results show that blasting will be required in some proposed cuttings.

Road materials and soil investigation, ACT. Several surveys were done to investigate proposed sites where road construction material may be obtained.

At the Oaks Estate near Sutton Road, Queanbeyan, the seismic refraction method using 3-metre geophone spacing was used to determine the volume of gravel available for road making in the Molonglo River valley. The thickness of gravel proved to be between 2 and 16 metres.

At Tharwa an experimental survey to determine the thickness of sand and gravel in the Murrumbidgee Valley was done for the Department of the Interior, using several sets of equipment. Land refraction seismic traverses indicated 4 to 7 metres of sand over hard bedrock (3000 m/s). Seismic profiling over the river using pinger and sparker did not give conclusive results, and high water noise and other problems limited the usefulness of refraction traversing over water-covered areas.

Four seismic depth probes and two resistivity depth probes were done near Hall to assist CSIRO's Soils Division to evaluate the use of geophysics in soil and landscape studies.

Engineering Geophysics Group - Hydrology

Goulburn Valley, Victoria. As part of a geophysical investigation of the Goulburn-Murray River valley system a gravity survey consisting of 942 stations and covering 3200 square kilometres was made around Shepparton. The survey, done in co-operation with the Mines Department and the State Rivers and Waters Supply Commission of Victoria, was an extension of a geophysical survey done in 1971, and it will be continued in 1973. The area of the gravity survey will be extended westwards, and other geophysical methods will be used to determine the thickness of alluvium, the character of the bedrock, and the presence of sand layers in alluvium.

Daru groundwater survey, Papua New Guinea. Electrical methods were used to investigate whether an aquifer consisting of volcanic tuff can be developed further as a water supply for 7000 inhabitants of Daru Island. The water in the aquifer is highly mineralised and the low resistivity values found on depth probes gave no indications of freshwater lenses. Augering done during the survey disclosed a bed of low-permeability clay overlying the aquifer, and this clay may seriously restrict entry of rain water to the aquifer.

Markham Valley groundwater survey. At the request of the Chief Government Geologist of PNG an investigation has been commenced to find the depth and the shape of the buried valley of the Markham River and aquifers in the alluvium. Four gravity traverses were completed across the valley. A total of 190 gravity stations were measured, spaced from 0.3 to 1.6 km apart. The levelling of stations was done by the Department of Lands. The gravity results show a large gravity gradient across the valley with Bouguer anomaly values ranging from -115 mgal in the south to -160 mgal in the north. The gradient flanks on an extended -160 mgal low located to the north over the Tertiary Finisterre and Saruwaged Ranges. The large gradient masks any local variations in gravity that arise from the bedrock profile in the valley. Further analysis of the results is required. Seismic depth probing and resistivity surveys are planned for 1973.

CSIRO Land Division, Perth. Some assistance was given to CSIRO Land Division, Perth, in the use of geophysics in hydrological studies of several catchment areas. From the results it appears that the most promising approach would be to run a number of detailed refraction seismic traverses.

Engineering Geophysics Group - Shallow Seismic Profiling

The development and testing of shallow-water profiling equipment continued in 1972. An improved time-varied-gain amplifier was tested successfully on Lake Burley Griffin. The acoustic characteristics of a high-power boomer were measured. A magnetic tape recording system, a playback system, and improved transducers are being developed in co-operation with the Electronic and Mechanical Sections.

In February and March assistance was given to the Marine Geology section during their sparker survey off the coast of NSW. Maximum penetration of about 760 metres of sediment was recorded and in shallower water (20 fathoms) a resolution of about 1½ to 3 m was achieved.

Technical advice was given to the Department of Shipping and Transport which is carrying out seismic profiling under contract in the Gannet Passage, Torres Strait. B. Dolan joined the survey vessel in March-April to observe and advise on the standard of the work. Sparker and pinger systems were employed by the contractor. Good 'pinger' results were obtained, showing a good reflector underlying about 1.5 metres of sediment over the area.

A survey of an area offshore at Mordialloc, Victoria was conducted in co-operation with Melbourne and Metropolitan Board of Works using the Boomer, sparker, and pinger. The object of the survey was to determine the thickness of sand about 300 m offshore. Good reflections were recorded at an average depth of about 8 m. A sample record and interpretation are shown in Figure GS1.

Engineering Geophysics Group - Vibration Measurements

A Sprengnether blast and vibration seismograph with provision for recording 3 components of ground motion and air blast intensity was used on all tests. On some tests spreads of 3-component geophones with conventional refraction seismic amplifiers were used to obtain additional data.

Blasting vibrations, ACT. Measurements were made of the ground vibration due to blasting at Latham, Scullin, Weston, and Tuggeranong. The results are summarized in Figure GS2, which shows peak particle velocity as a function of distance and charge size. The objects of the tests were to predict safe charge sizes and distances from structures near blasting, and to monitor the vibration levels at structures when blasting is proceeding. For houses, the Standards Association of Australia Explosives Code, a safe limit of 0.75 in/sec for resultant velocity is specified.

Concorde tests, Alice Springs. Measurements were made of the ground vibration induced by the sonic boom of the Concorde supersonic aircraft. Results showed that the maximum ground vibrations induced were only one hundredth of the maximum safe vibration limit. Numerous measurements of airblast-induced ground waves at several places were recorded.

Electricity pylons, Sydney. An investigation into the effect of blasting near electricity transmission pylons was made in co-operation with the Electricity Commission of NSW. Three pylons due for demolition were selected, and several charges of up to 18 kg of gelignite and at a distance of 6 m were fired. The only observable damage occurred on one pylon located on water-saturated sand and clay. Tests may be continued in 1973 in different geological settings.

RAN practice shells, Jervis Bay. Measurements were made of vibration of structures near a Navy firing range during shelling practice. The co-operating authority was the Department of Supply Defence Standards Laboratories. The ground vibrations were very small; the major effect originates from the sonic boom of the shell rather than from detonation of the practice shell.

Engineering Geophysics Group - Well Logging

The group was responsible for technical supervision of a contract bore logging survey which commenced in late 1971. Neutron logging was introduced on this survey. Seventy-six bores were logged to an average depth of 190 m on the margins of the Great Artesian Basin in the Northern Territory and Queensland.

Forty-nine bores were logged by BMR's logging party, which concentrated on 'difficult' bores omitted by contractors in previous years. Gamma-ray, temperature and differential temperature, and casing collar logs were run. Neutron logging is planned for 1973.

Gamma logs were run on 43 shallow bores in the Weipa area, the deepest being 160 m.

Geophysical Drafting Group

The Ground Surveys Group is responsible for the drafting requirements of five geophysical groups. Work completed during the year comprised:

Seismic surveys. Ngalia Basin, 3 plates; Galilee Basin, 21 plates; Officer Basin, 6 plates; Gosses Bluff, 28 plates; Seismic Playback Examples, 5 plates; APEA Conference, 17 plates; Deep Crustal Braidwood-Mildura, 10 plates; Seismic Methods & Digital Processing, 2 plates.

Engineering Surveys. Mallacoota Inlet, 7 plates; Underwater Foundations, 4 plates; Queensland Coastal, 6 plates; Seismic Velocities, 5 plates; Googong Dam site, 1 plate; Lecture Transparencies, 21 plates; Daru Island Groundwater, 1 plate; Mordialloc Beach, 2 plates; Various Engineering Projects within the A.C.T., 75 plates.

Observatories. Ord River Blasts, 2 plates; Mundaring 1971 Report, 4 plates; Port Moresby 1971 Report, 4 plates; Plate Tectonics, 7 plates; PNG Structural Elements, 2 plates; Manton Seismograph Station, 6 plates; PNG Seismicity 1968, 34 plates; Solomon Sea Earthquake, 7 plates; New Britain/New Ireland, 6 plates; East Canning Earthquake, 3 plates.

Crustal Studies. New Britain, 39 plates; Lake Galilee, 5 plates; Pacific, 4 plates; New Britain/New Ireland, 10 plates; Bismarck/Solomon Marine, 1 plate; Magnetic and Gravity Curve Matching, 52 plates; Rabaul Caldera, 5 plates; Rabaul Shots and Stations, 114 plates.

Metalliferous. Tennant Creek, 42 plates; IP logging tests, 5 plates; Afmag Tests, 7 plates; Hayes Ck-Cove Hill, 6 plates; Maranboy 1972, 2 plates; Slingram Model Tests, 24 plates; Captains Flat, 20 plates; Lecture Slides, 9 plates.

The Petroleum Titles map for December 1971 and June 1972 were prepared for 3-colour printing for the Petroleum Technology Section.

A total of 243 miscellaneous drawings were made for various groups. Final amendments on 949 plates were made for inclusion in the Record series.

The plan-printing service controlled by the group had an output of 86864 prints for the year.

Work of the Airborne Surveys Group consists of pre-survey compilation of programmed areas, plotting, digitizing of flight-line plots, compiling and drawing of plates for Records, and quality control of contract surveys. The following survey areas were processed during the year:

Regional Surveys. Tennant Creek 1960, (completed); Western Australia 1969, (completed); Eucla Basin S.A. 1970, (completed); Eucla Basin S.A. 1972; Western Australia 1970 (contract) (completed); Eastern Papua 1969 (contract), (completed); Alligator River 1971/72; Alcoota 1972;

Eromanga Basin; North Eastern Victoria 1972; Western Australia 1972 (contract); Victoria River Basin 1966/67 (contract); Western Australia Purchased Survey Material; Mary River 1972; Cairns, Mossman and Walsh 1969 (completed); Jim Jim Creek-Deaf Adder Creek 1971 (completed).

Detailed Surveys. Arltunga Nappe Complex 1972 (completed); Western Australia 1970 (BMR) (completed); Tottenham 1971 (completed); Cloncurry 1970 (completed).

Pre-survey Compilation. Canberra 1972; Cootamundra-Wagga 1973; Carpentaria Basin 1973.

Miscellaneous. Goulburn 1965; Tasman Geosyncline; Magnetic Map of Australia; Airborne Surveys - Progress Map (BMR & Subsidy).

In the Cartographic Group maps were prepared to the printing stage or printed for the following areas during 1972:

Victoria River Aeromagnetic Survey N.T. 1966/67; (Limbunya and Birrindudu 1:250 000 Sheet areas) Limbunya, NE, SE, SW, and NW Sheets at 1:126 000 scale, Birrindudu, NE, SE, SW, and NW Sheets at 1:126 000 scale (total 8 maps).

Herberton Aeromagnetic Survey Queensland 1967 - the Herberton 1:63 000 Sheet (1 map).

Sandstone-Youanmi Aeromagnetic and Radiometric Survey W.A. 1968 - the Sandstone and Youanmi 1:250 000 Sheets (2 maps).

Maps for the following surveys are near completion and will be printed early in 1973: Central Great Artesian Basin Qld, 1968; Southern Cape York Peninsula Qld,1969; Western Australia 1969 and 1970; Goulburn 1965 and Eastern Papua 1969-71 (total 32 maps).

In the Gravity Group preparatory work for 1973/74 helicopter gravity survey Victoria/NSW/Tasmania. This involves fifty-one 1:250 000 Sheet areas and is 75% complete.

In the 1:250 000 Bouguer anomaly map series, three sheets from the Queensland 1964 survey area were completed, and 38 maps sheets from the South Australia 1970 survey area were commenced. One hundred and ten Bouguer anomaly maps at 1:500 000 scale were printed. They comprised areas from the 1968 Marine and 1969 W.A. helicopter surveys.

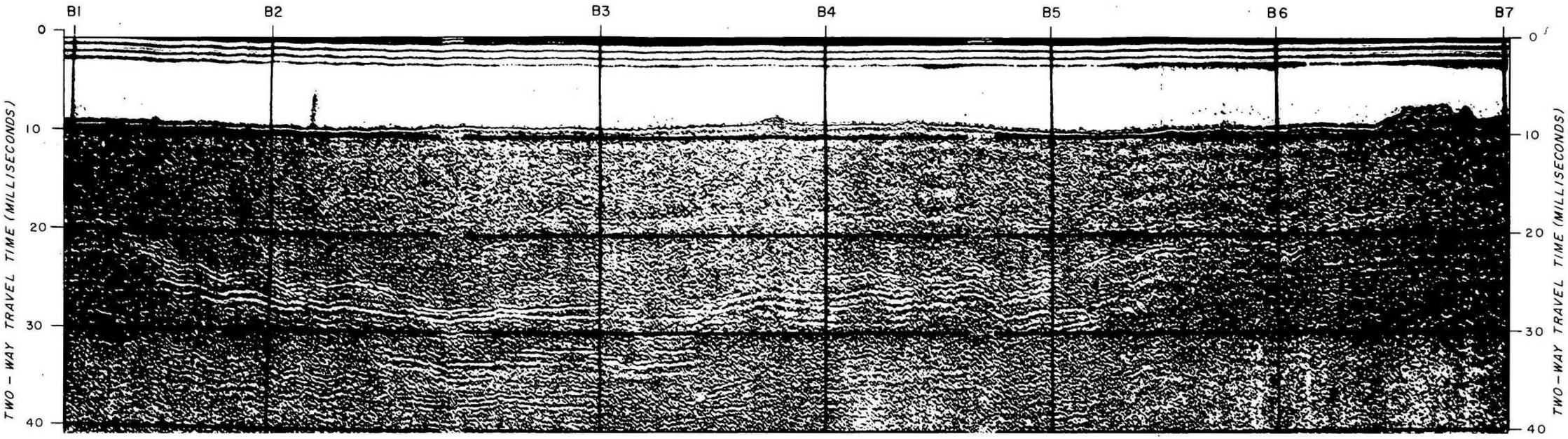
About 200 illustrations for Records were drawn, and the compilation of the new Gravity Map of Australia at 1:2½ million was commenced.

Work for the Continental Margin Marine Survey was carried out, updating the 40 mile to one inch and 1:10 million traverse plans, 1:1 million tenement boundaries, and 1:2½ million proposed traverse plans.

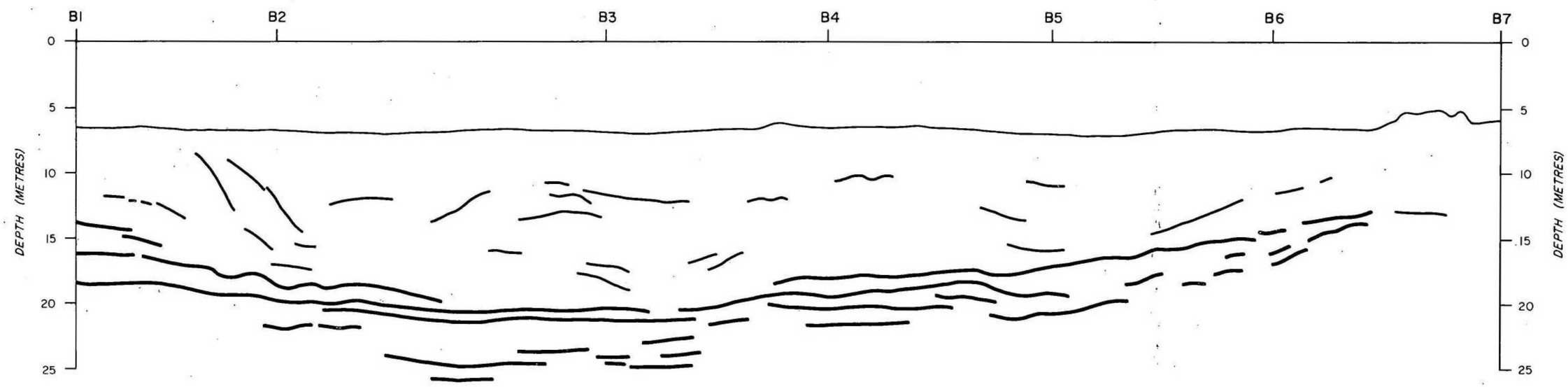
Flat-Bed Plotter. A Calcomp 745 flat-bed digital plotting table was delivered and installed at the end of October along with a Calcomp Model 900 controller and Model 937 magnetic tape unit. The rest of the peripheral equipment will arrive later in the year. Certain test programs have been delivered to allow drawing operations to be executed to demonstrate the ability of the machine. When the machine is fully operative it will greatly facilitate work of the drawing office.

Figure GS 1

RECORD



INTERPRETATION



BOOMER RECORD B

MORDIALLOC BEACH

SAMPLE SHALLOW SEISMIC PROFILING RECORD

100 50 0 100 200 300 METRES

(APPROXIMATE ONLY)

B 5 *Traverse fix number*

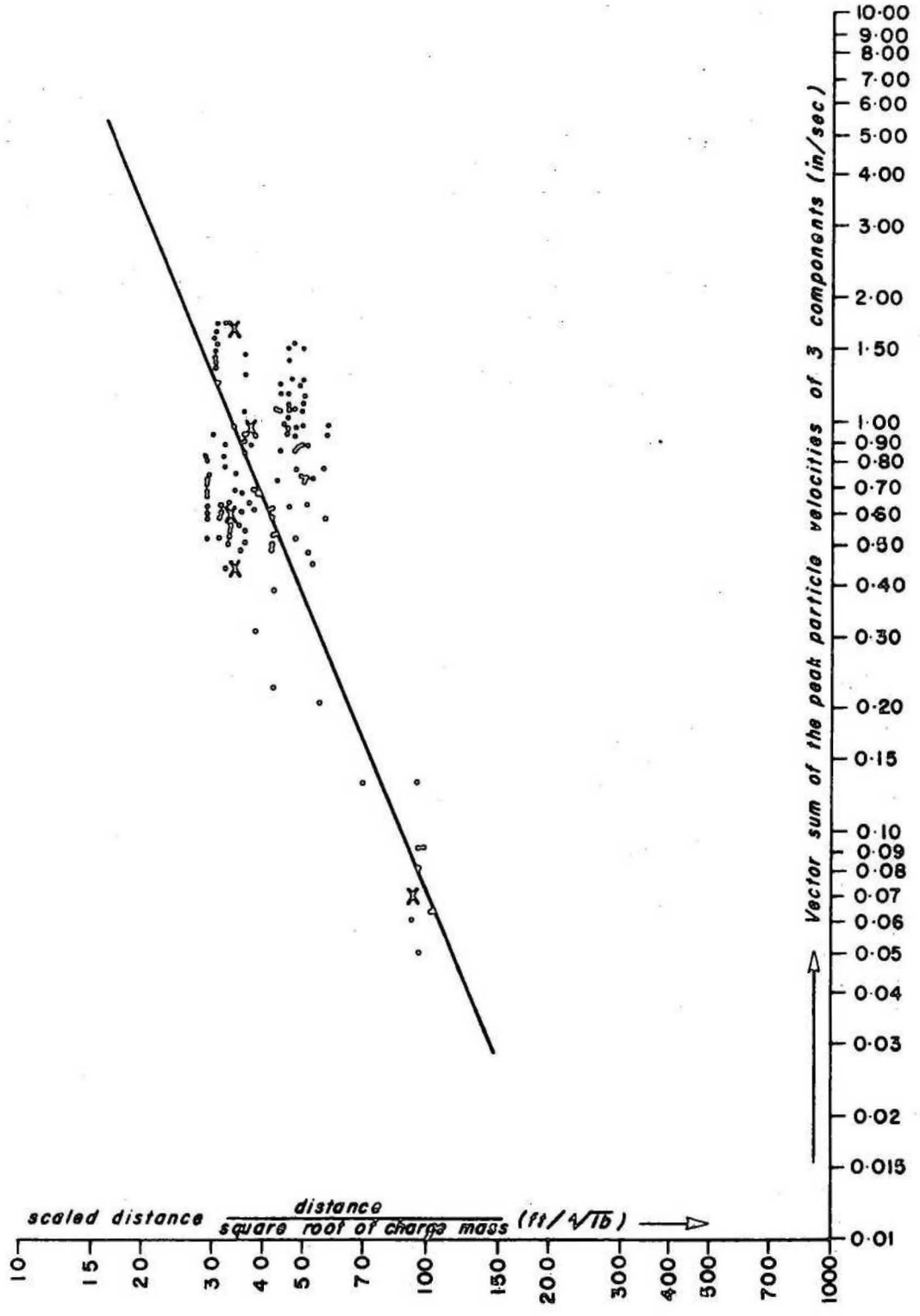
Strong Sub-bottom reflections

Bottom reflections

Weak Sub-bottom reflections

J55/B5--05

Figure GS 2



LEGEND

• *Measurements taken near electricity tower Latham A.C.T.*

x *Measurements taken near electricity tower Scullin A.C.T.*

GRAPH OF THE VIBRATION VELOCITIES DUE TO BLASTING, RECORDED IN A.C.T. IN 1972

I55/85-182A

5. REPORTS, MAPS, LECTURES ETC.

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INTRODUCTION

Listed in the following pages are reports and maps issued during 1972, papers published in outside journals, and addresses delivered at meetings and conferences.

BMR PUBLICATIONS

Bulletin 118	TIPPER, D.B. & GERDES, R.	Laverton-Edjudina airborne magnetic and radiometric survey, Western Australia 1966
Bulletin 119	HAIGH, J.E.	Standard curves for the magnetic anomalies due to spheres

EXTERNAL PUBLICATIONS

DENHAM, D.	Earthquake focal mechanisms and continental drift.	APEA J. 1972, p81
WELLS, A.T., MOSS, F.J., SABITAY, A. (Layton)	The Ngalia Basin, NT - recent geological and geophysical information upgrades petroleum prospects.	APEA J. 1972, p144
DENHAM, D., SIMPSON, D.W. (ANU) GREGSON, P.J., SUTTON D.J., (Adel. Univ)	Travel times and amplitudes from explosions in Northern Australia.	Geophys. J. 28, 1972, p225
FINLAYSON, D.M. CULL, J.P. WIEBENGA, W.A. FURUMOTO, A.S. (H.I.G.) WEBB, J.P. (Qld. Univ)	New Britain/New Ireland crustal seismic refraction investigations, 1967 and 1969.	Geophys. J. 29, p245
MILTON, D.J. (U.S.G.S.) BARLOW, B.C. BRETT, R. (U.S.G.S.) BROWN, A.R. MANWARING, E.A. MOSS, F.J. SEDMIK, E.C.E. VAN SON, J. YOUNG, G.A.	Gosses Bluff impact structure, Australia.	Science, 175 1972, p1199
PARKINSON, W.D. (Tas. Univ, prev. BMR)	An analysis of the geomagnetic diurnal variation during the International Geophysical Year.	Gerlands Beitr. Geophys. Leipzig, 80; 1971, p199

WIEBENGA, W.A. Crustal structure of the New Britain/New Ireland region, in the Western Pacific island arcs, marginal seas, and geochemistry. (Ed. P.J. Coleman) Univ. W.A. Press (in press)

BMR RECORDS (an unpublished series)

1971/12	EVERINGHAM, I.B. GREGSON, P.J.	Mundaring Geophysical Observatory, annual report 1968
1971/19	SHELLEY, E.P. DOWNIE, D.N.	Mann-Woodroffe aeromagnetic survey, South Australia 1969
1971/22	GARDENER, J.E.F.	Rum Jungle area, Hundred of Goyder, geophysical survey, NT 1968
1971/25	FINLAYSON, D.M.	First-order regional magnetic survey, northern and western Australia, 1969
1971/40	EVERINGHAM, I.B. TILBURY, L.	Information on West Australian earthquakes during 1849-1900 and 1923-1960
1971/48	SEERS, K.J.	Three-component Fluxgate Magnetic Variometer MFR I
1971/54	MANWARING, E.A.	Astatic magnetometer designed and built by the Bureau of Mineral Resources
1971/72	GARDENER, J.E.F.	Astrolabe area geophysical survey, Papua 1970
1971/73	BULLOCK, P.W.B.	Stapleton area reconnaissance geophysical survey, NT 1970
1971/74	CULL, J.P.	A Fortran program for calculating the gravity effect of a vertical cylinder
1971/75	GREGSON, P.J. PAULL, E.P.	Refraction recording of Geotraverse explosions, 1969 - operational report
1971/76	GREGSON, P.J. EVERINGHAM, I.B.	Mundaring Geophysical Observatory, annual report 1969
1971/77	GREGSON, P.J.	Mundaring Geophysical Observatory, annual report 1970
1971/78	YOUNG, G.A.	Applications of regional airborne geophysical data to metals search in Western Australia
1971/79	MEATH, J.R.	Selection of a seismometer site, Macquarie Island
1971/80	EVERINGHAM, I.B.	Intensity data, Landor and Calingiri earthquakes, WA

1971/82	RIPPER, I.D. SMITH, R.S.	Port Moresby Geophysical Observatory, annual report 1969
1971/83	GARDENER, J.E.F.	Rum Jungle area radon survey, 1969
1971/84	DOLAN, B.H. WHITELEY, R.J.	Orroral Valley seismic survey, A.C.T. 1970
1971/85	BEATTIE, R.D.	Airborne gamma-ray spectrometer survey Rum Jungle, NT 1969
1971/86	MAJOR, J.A.	Macquarie Island Geophysical Observatory, annual report 1967
1971/87	CONNELLY, J.B.	Macquarie Island Geophysical Observatory, annual report 1968
1971/89	HILL, P.J.	Seismic refraction survey at Belconnen No. 4 reservoir site, A.C.T. 1970
1971/91	DOLAN, B.H.	Belconnen Trunk Sewer seismic refraction survey
1971/92	MAJOR, J.A.	Mawson Geophysical Observatory, annual report 1969
1971/93	DENHAM, D.	Port Moresby Geophysical Observatory, annual report 1968
1971/96	DENHAM, D.	Seismicity of the New Guinea-Solomon Islands region, 1967
1971/97	DENHAM, D.	The thickness of the earth's crust obtained from the spectrum of P-waves at Charters Towers, Honiara, Port Moresby, and Rabaul
1971/102	HILL, P.J.	Hall gravel quarry seismic refraction investigation, A.C.T. 1971
1971/106	MANCINI, M.G.	An investigation of tremors at Bagana volcano using telemetered equipment
1971/119	RIESZ, E.J. MOSS, F.J.	Regional marine geophysical surveys in the Australian area
1971/121	TAYLOR, F.J.	Musa River hydroelectric scheme, eastern Papua, geophysical investigations 1970
1971/122	TAYLOR, F.J.	Geophysical survey Maura coalfield Queensland 1970; Part I - seismic reflection
1971/124	SHELLEY, E.P. DOWNIE, D.N. REES, J.E.	Southern Cape York Peninsula airborne magnetic and radiometric survey, Queensland 1969
1971/125	GARDENER, J.E.F.	Acacia area self-potential survey, NT 1968
1971/126	WILLIAMS, J.P.	Coronation Hill geophysical survey, NT 1970

1971/127	FINLAYSON, D.M. PARKINSON, W.D.	Computer calculation of distances in the range 0°-160° (Program EPICENT)
1971/129	MEATH, J.R.	Macquarie Island Geophysical Observatory, annual report 1970
1971/130	IDNURM, M.	Laboratory measurements on drill cores from the proposed Tuggeranong sewer line, A.C.T.
1971/131	BROOKS, J.A. (ed.)	Investigations of crustal structure in New Britain/New Ireland region 1969, geophysical and geological data
1971/134	WILLIAMS, J.P.	Mary River geophysical survey, NT 1970
1971/135	LANGRON, W.J. HAIGH, J.E.	Tests of the Ronka EM16 VLF prospecting equipment, Western Australia 1969
1971/136	ALMOND, R.A.	Captains Flat geophysical survey, New South Wales 1971
1971/138	HARRISON, P.L. BROWN, A.R.	Galilee Basin seismic survey, Queensland, 1971: Operational Report
1971/141	BROWN, A.R.	A detailed seismic survey of Gosses Bluff
1972/2	TAYLOR, F.J. PETTIFER, G.R.	Googong dam site spillway seismic refraction survey 1971
1972/3	HEMPHILL, L.E. BROWN, A.R.	Overhaul of PT-700/PMR-20 seismic recording equipment June-July 1971
1972/4	DOOLEY, J.C.	Report on attendance at XV General Assembly of IUGG Moscow USSR, 30 July-18 Aug 1971
1972/5	BARLOW, A.J.	Application of electronics to offshore oil exploration
1972/6	TAYLOR, G.A.M. McGREGOR, P.M.	Research in seismology, vulcanology and tsunami occurrence in Australia and Papua New Guinea
1972/7	DOLAN, B.H.	Tennent damsite seismic survey, A.C.T. 1970/71
1972/8	HILL, P.J.	Belconnen refuse disposal area seismic refraction survey, A.C.T. 1971
1972/9	DOLAN, B.H. HILL, P.J. POLAK, E.J.	Ada-La Trobe pumped storage hydroelectric scheme, State Electricity Commission, Victoria 1971
1972/10	DOLAN, B.H. HILL, P.J. POLAK, E.J.	Wilhelmina Falls pumped storage hydroelectric scheme, State Electricity Commission, Victoria 1971
1972/11	ANFILOFF, W.	Galilee Basin detailed gravity survey, Qld 1971: Operational Report

1972/16	TURPIE, A.	Integration, specification testing, adjustment, and repairs of the PT-700 seismic system and associated equipment by Dresser Aust. Pty Ltd, Brisbane May-June 1967
1972/23	ALLEN, M.G. CHAMBERLAIN, N.G. DOOLEY, J.C. SEDMIK, E.C. TURPIE, A.	Recent developments in geophysics in Australia
1972/24	PETTIFER, G.R.	Seismic refraction survey of proposed pipe storage area, Molonglo Valley interceptor sewer, A.C.T. 1971
1972/25	DOLAN, B.H.	Vibration tests during blasting at the proposed Belconnen 54-inch trunk sewer construction site, A.C.T. 1972
1972/28	GILLESPIE, P.J. POLLARD, P.C.	Ormond River area (Kakakaka prospect) geophysical survey, Papua 1970
1972/29	GILLESPIE, P.J.	Down-hole induced polarization tests at Currawang NSW and Kowen Forest A.C.T., 1971
1972/30	GILLESPIE, P.J.	Down-hole induced polarization and electric applied potential survey at Tennant Creek, 1971
1972/42	HILL, P.J.	Tuggeranong sewer tunnel seismic refraction and magnetic survey, A.C.T. 1971
1972/43	PETTIFER, G.R.	Woden trunk sewer extension seismic refraction investigation, A.C.T. 1971
1972/44	ROBERTSON, M.J.M.	Mawson Geophysical Observatory, annual report 1970
1972/48	GREGSON, P.J.	Mundaring Geophysical Observatory, annual report 1971
1972/49	HAIGH, J.E. POLLARD, P.C. WILLIAMS, J.P.	A computer program for calculation of gravity and magnetic curves for two-dimensional bodies of arbitrary cross-section.
1972/51	HILL, P.J.	Oaks Estate river gravel seismic refraction survey, A.C.T. 1972
1972/52	BULLOCK, P.W.B.	Mary River area self-potential survey, NT 1971
1972/58	HORSFALL, K.R.	Deaf Adder Creek and Jim Jim Creek airborne geophysical surveys, NT 1971
1972/60	WALLER, D.R. QUILTY, J.H. LAMBOURN, S.S.	Eucla Basin airborne magnetic and radiometric survey, SA 1970
1972/67	BULLOCK, P.W.B.	Hayes Creek/Grove Hill area geophysical tests, NT 1971

1972/68	DENHAM, D.	Earthquakes, focal mechanisms, and continental drift
1972/75	CULL, J.P.	Googong dam site New South Wales, seismicity investigations 1971
1972/83	PETTIFER, G.R.	Computer program for calculating seismic velocities from expanded and offset reflection spreads
1972/84	HILL, P.J.	Seismic refraction survey along Tuggeranong Freeway stage II and Village Creek Arterial, A.C.T. 1971
1972/85	TAYLOR, F.J.	Seismic and magnetic observations at Mallacoota Inlet 1971
1972/86	BISHOP, I.D.	Seismic refraction survey at bridge sites for Molonglo River interception sewer, A.C.T. 1972
1972/87	ALMOND, R.A.	AFMAG field recording 1968-1971
1972/95	PINCHIN, J. MATHUR, S.P.	Presurvey report on Officer Basin seismic survey, WA 1972
1972/96	WYATT, B.W.	Presurvey report on Alcoota regional and Arltunga detailed airborne geophysical surveys, NT 1972
1972/97	CULL, J.P. RIESZ, E.J.	Deep crustal seismic reflection/refraction survey between Clermont and Charters Towers, Qld 1971
1972/98	SMITH, M.J.	Laboratory tests on cores from the Rum Jungle area, NT
1972/101	GREGSON, P.J.	An explanation of water level changes preceding the Meckering earthquake of 14 October 1968
1972/107	ZADOROZNYJ, I. BROWN, F.W.	Presurvey report on detailed gravity survey, Officer Basin, WA
1972/110	LAMBOURN, S.S. SHELLEY, E.P.	Cloncurry detailed airborne magnetic and radiometric survey, Queensland 1970
1972/111	SYMONDS, P.A. CAMERON, P.J.	BMR proposals for drill sites for Legs XXVIII and XXIX of the Deep Sea Drilling Project
1972/118	BROWN, A.R.	Experiments in controlled directional reception seismic methods and digital processing 1969-70
1972/120	LAMBOURN, S.S.	Aeromagnetic survey of the Glengarry, Wiluna, and Kingston 1:250 000 Sheet areas, WA 1970
1972/126	TAYLOR, F.J. MOSS, F.J. BRANSON, J.C.	Deep crustal reflection seismic test survey, Tidbinbilla A.C.T. and Broken Hill NSW, 1969
1972/127	BRANSON, J.C. MOSS, F.J. TAYLOR, F.J.	Deep crustal reflection seismic test survey, Mildura Victoria and Broken Hill NSW, 1968

ADDRESSES TO MEETINGS AND CONFERENCES

BARLOW, B.C. - Gosses Bluff, Monash University.

BROOKS, J.A. - Some aspects of BMR's current offshore geophysical program. APEA Luncheon, Sydney 14 March 1972.

BROOKS, J.A., MUTTER, J.C. & SYMONDS, P.A. - Marine geophysical reconnaissance of the Australian continental margin. BMR Symposium, Canberra, 16 May 1972.

CAMERON, P.J. - Some marginal features of Bass Strait. Geological Society of Australia (Tasmanian Division), Hobart, 7 September 1972.

DENHAM, D. - Earthquake focal mechanisms and plate tectonics - Melbourne, Latrobe, Sydney, and Newcastle Universities; also to Australian Society of Exploration Geophysics, Sydney.

DENHAM, D. - Results from the Ord River explosions. Queensland and Adelaide Universities, Australian Institute of Physics, Tasmanian Branch.

DENHAM, D. - Earthquake mechanisms and continental drift. APEA Symposium, Sydney (prepared comments).

DENHAM, D. - Earthquake distribution and earthquake risk. Division of Building Research, CSIRO, Melbourne.

DOOLEY, J.C. - (a) 3D seismic refraction interpretation;
(b) The new maths and geophysics.
Australian Institute of Physics, Summer School, Canberra.

GREGSON, P.J. - Earthquakes. Northam community, Western Australia.

GREGSON, P.J. - Work of Mundaring Geophysical Observatory. Western Australia Institute of Technology.

HARRISON, P.L. & VINE, R.R. - 1971 seismic survey across the eastern margin of the Galilee Basin, Qld. BMR Symposium, Canberra, 16 May 1972.

KERR, D.W. - A high performance airborne fluxgate magnetometer. Institute of Radio and Electronic Engineers Conference, 'Electronics in the A.C.T.', Canberra, 1 September 1972.

POLAK, E.J. - The application of geophysics in the design of underwater foundations. South East Asian Conference on Soil Engineering, Hong Kong, 6 November 1972.

WIEBENGA, W.A. - Lithospheric isostasy in the Bismarck Sea, Solomon Sea, and Ontong-Djawa Plateau. International Symposium on the Oceanography of the South Pacific, Wellington, New Zealand.

AEROMAGNETIC AND RADIOMETRIC MAPS

SURVEY	YEAR	TYPE	MAP NAME	SCALE	REMARKS
Astrolabe, PNG	1966	M	Gaile	1:50 000	In press 1971, released 1972
"	"	"	Gea	"	"
"	"	"	Goldie R.	"	"
"	"	"	Kemp Welch R.	"	"
"	"	"	Laloki R.	"	"
"	"	"	Port Moresby	"	"
"	"	"	Round Point	"	"
"	"	"	Sogeri	"	"
"	"	"	Tupuseleia	"	"
"	"	"	Urogolo	"	"
Kalgoorlie WA (Reprint)	1957	M/R	Kalgoorlie NE	1:126 720	"
"	"	"	" SE	"	"
"	"	"	" SW	"	"
"	"	"	" NW	"	"
Amadeus Basin NT	1965	M/R	Mt Rennie	1:250 000	"
"	"	"	Petermann Ranges	"	"
Sydney Basin NSW	1966	M	Sydney	"	"
Victoria River NT	1966/67	M	Waterloo NE	1:126 720	"
"	"	"	" SE	"	"
"	"	"	" SW	"	"
"	"	"	" NW	"	"
"	"	"	Limbunya NE	"	Printed and released 1972
"	"	"	" SE	"	"
"	"	"	" SW	"	"
"	"	"	" NW	"	"
"	"	"	Birrindudu NE	"	"
"	"	"	" SE	"	"
"	"	"	" SW	"	"
"	"	"	" NW	"	"
Herberton Qld	1967	M	Herberton	1:63 360	"
Sandstone-Youanmi, WA	1968	M/R	Sandstone	1:250 000	In press
"	"	"	Youanmi	"	"

SURVEY	YEAR	TYPE	MAP NAME	SCALE	REMARKS
Central Great Artesian Basin Qld	1968	M	Adavale	1:250 000	In press
"	"	"	Blackall	"	"
"	"	"	Brighton Downs	"	"
"	"	"	Eromanga	"	"
"	"	"	Jundah	"	"
"	"	"	Longreach	"	"
"	"	"	Maneroo	"	"
"	"	"	Quilpie	"	"
"	"	"	Thargomindah	"	"
"	"	"	Windorah	"	"
Southern Cape York Qld	1969	M/R	Cairns	"	"
"	"	"	Mossman	"	"
"	"	"	Walsh	"	"
Eastern Papua PNG	1969 & 1971	M	Abau	"	"
"	"	"	Buna	"	"
"	"	"	Cape Nelson	"	"
"	"	"	Fergusson I.	"	"
"	"	"	Kalo	"	"
"	"	"	Port Moresby	"	"
"	"	"	Samarai	"	"
"	"	"	Trobriand Is.	"	"
"	"	"	Tufi	"	"

M = Aeromagnetic results only

M/R = Aeromagnetic and radiometric results

GRAVITY MAPS

1:500,000 Gravity maps printed in 1972

Albany
Balfour Downs
Balladonia
Barnato
Barrow Island
Bathurst Island
Bedout Island
Bencubbin
Boorabbin
Bremer Bay
Broome
Browse Island
Buller
C52-12
Camden Sound
Cape Arid
Collier
Corrigin
Cundeelee
D50-16
D51-1
D51-2
D51-6
D51-7
D51-8
D51-9
D51-10
D51-13
D51-14
Dampier (Offshore)
Dampier (Onshore)
Dumbleyung
E50-4
" -5
" -6
" -7
E50-8
" -10
" -11
" -12
" -13
" -14
" -15
E51-1
" -5
" -9
Eddystone
Edmund
Esperance
F49-3
" -4
Gunanya
Hill River
Hyden
Jackson
Kalgoorlie
Kellerberrin
Kurnalpi
La Grange
Lake Johnston
Louth
Malcolm
Mandora
Marble Bar
Melville Island
Mondrain Island
Montague Sound
Moora
Mount Barker
Mount Bruce
Mount Egerton
Mount Solitaire
Narrabri
Newdegate
Newman
Norseman
Nullagine
Onslow (Offshore)
Onslow (Onshore)
Pender
Port Hedland
Pyramid
Ramu
Ravensthorpe
Roebourne (Offshore)
Roebourne (Onshore)
Robertson
Roy Hill
Southern Cross
Springsure
Tambo
Trainor
Turee Creek
Widgiemooltha
Winning Pool
Wyloo
Urandangi
Yanrey
Yantabulla
Yarraloola
Yarrie
Zanthus