DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1978/97

GEOPHYSICAL BRANCH
SUMMARY OF ACTIVITIES - 1978

Assistant Director, Geophysical Branch
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CONTENTS

SUMMARY

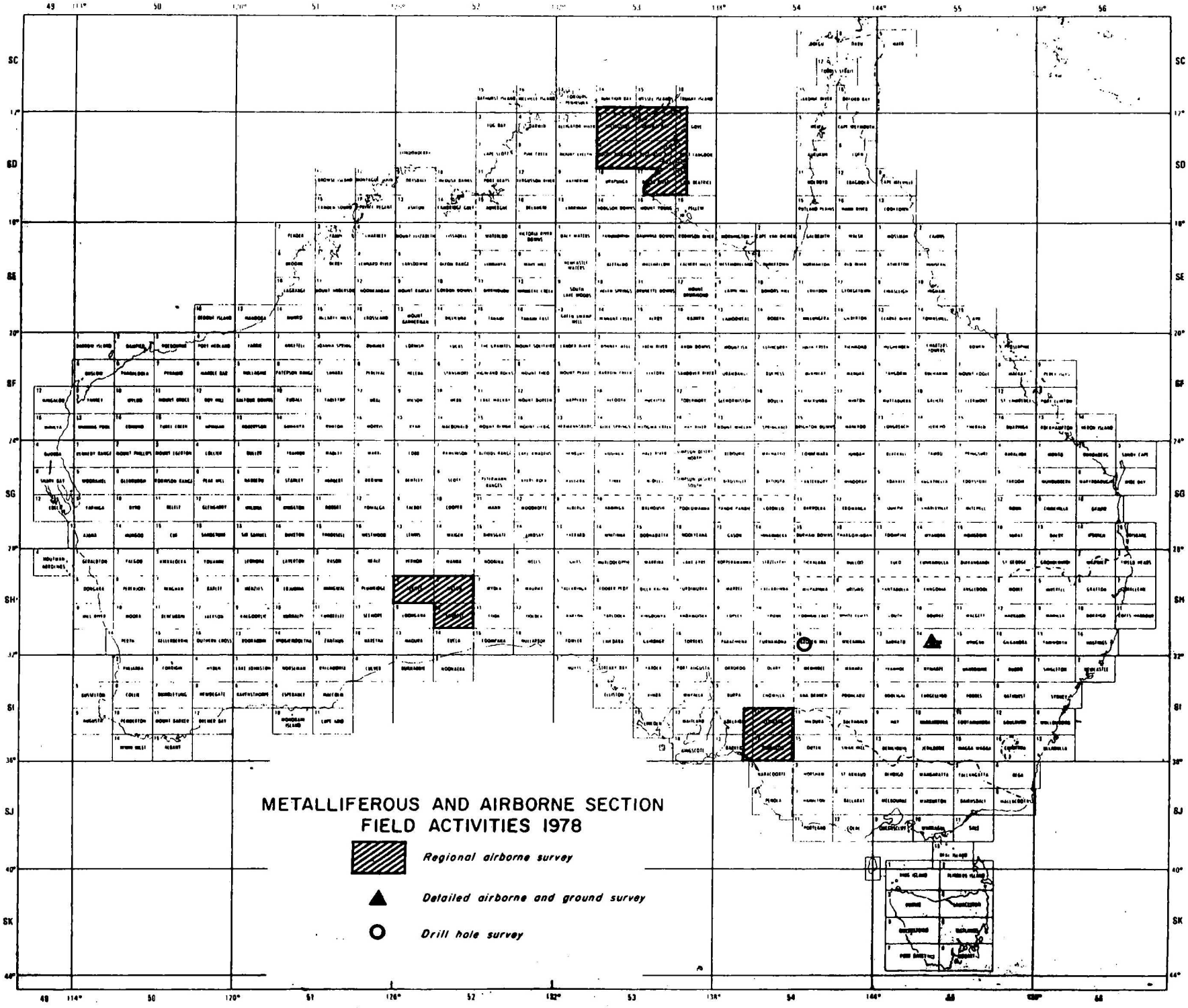
METALLIFEROUS AND AIRBORNE SECTION

Consistent with the trend over the past 2 years, a reduced work program was planned for the Section for 1978 to accommodate increasing staffing and financial problems. In particular projects programmed and undertaken by the Metalliferous Subsection were curtailed when compared to the previous year's program due to staff shortages. The lack of finance resulted in the 1978 airborne survey program being restricted to the period June/November and the removal of the Aero Commander from operations in late August. At that time, this aircraft had completed 3 months field work following a major upgrading of its data acquisition facility. Programmed work cancelled as a result of the enforced aircraft standdown included surveys of NARACOORTE, S.A. and HORSHAM, Vic.

The work undertaken by the Airborne Subsection concentrated on the McArthur Basin province involving further data acquisition, and processing of 1977 survey results to ensure maps were released to the public in 1978. The Metalliferous Subsection concentrated fieldwork and research on the Cobar region. The locations of the field activities of the Section during 1978 are shown in Figure MA1.

Work in the Pine Creek Geosyncline was completed in July 1978. This program commenced in early 1977 and was fully reported in the Geophysical Branch Summary of Activities for 1977. No field work was undertaken this year; instead personnel assigned to this project concentrated on the interpretation of regional magnetic, gravity and radiometric data assisted by field observations of the previous year. Work involved laboratory measurements of rock properties, and computer model studies. Analysis of the gravity data proved to be particularly useful in indicating the thickness of Lower Proterozoic metasediments throughout the Geosyncline. Analysis of the magnetic data was primarily confined to defining the characteristics of rocks. A similar analysis of radiometric data proved to be very difficult due to poor exposure throughout most of the Geosyncline.

Key members of the interpretative team were subsequently assigned to the multidisciplinary study of the Georgina Basin to provide an interpre-



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MA 1

tation of the geometry and composition of the basement rocks in this province as determined from magnetic and gravity data.

A major project was commenced in the Metalliferous Subsection in February to study mineral deposit geophysics in the Cobar region. The application of magnetic, gravity, electrical and electromagnetic methods for mineral exploration and mapping in this region is being researched with the cooperation of a number of companies. This project will continue for much of 1979. One aspect of work at this stage is directed towards physical property studies of rocks, ore and overburden to assist in response modelling and in the analysis of experimental surveys. Such surveys have been concentrated near areas of known mineralisation, such as Elura and Shuttleton, and over selected magnetic anomalies. Drill hole logging complemented by a series of shallow IP/resistivity soundings was used at Elura to assess geoelectric characteristics of the orebody and the gossan. Ground, vehicle and airborne magnetic measurements were made at a number of localities to investigate methods of discrimination between magnetic response associated with mineralisation and response of surficial magnetic sources.

Research continued into the application of electrical methods for mineral exploration. Staff shortages dictated that work on this project be restricted to a part time basis with the fieldwork aspects of studies linked to the Cobar mineral deposits investigations. Experimental surveys included the application of the magnetic-resistivity method around the Elura deposit to investigate the ability of this method to minimise the effects of conductive overburden, investigations of SIROTEM involving a variety of remote detectors, and field tests of the rotating dipole EM method. Laboratory based projects were restricted to TEM numerical modelling in association with CSIRO.

Down hole geophysical studies continued on the same basis as electrical method research. Field work was limited to short surveys at Broken Hill and Elura for which new IP/resistivity and EM probes were constructed.

Planned investigations into nuclear exploration techniques were only able to proceed on a part-time basis, again due to staffing problems. Projects undertaken this year included the development of dynamic calibration ranges for airborne gamma-ray spectrometry in association with the Airborne Subsection, and a study of the application of radon detection methods to uranium exploration.

Personnel of the Metalliferous Subsection were also involved in the development of computer modelling programs to aid the analysis of gravity and magnetic data. They presented 3 papers at the Applied Magnetic Interpretation Symposium held in Sydney in August, and provided major assistance to the McArthur Basin magneto-telluric project. An attempt was made to recommence the heavy mineral sand project in May. Staff losses experienced soon after dictated the termination of this project.

The Bureau's Twin Otter and Aero Commander aircraft were not able to start surveying until June this year due to lack of finance. As a consequence only 67 000 km were flown this year compared to 132 000 km in 1977. During the standdown period, the Aero Commander underwent a major refit of the geophysical data acquisition system to bring it into line with that installed in the Twin Otter. The aircraft also had considerable work done on its airframe.

The 1978 field survey season commenced for both aircraft in the first week of June in what became the major project of the year, namely the final phase of a regional geophysical survey of the McArthur Basin province. 43 000 km were flown to complete the project with all or parts of the following sheets surveyed: JUNCTION BAY, WESSEL ISLANDS, TRUANT ISLAND, MILINGIMBI, ARNHEM BAY, GOVE, MOUNT MARUMBA, BLUE MUD BAY, PORT LANGDON, ROPER RIVER and CAPE BEATRICE. Both aircraft were equipped with magnetometers of 1 nT resolution, gamma-ray spectrometers with 5550 cm^3 NaI detectors, radioaltimeters and digital data recording facilities. Results of this work are expected to become available progressively from December 1979.

From October to December the Twin Otter undertook a magnetic and gamma-ray spectrometer survey of the RENMARK, PINNAROO and eastern thirds of ADELAIDE and BARKER 1:250 000 Sheet areas. Line spacing was 1.5 km in the west and 3.0 km in the east, a total of 24 000 km being surveyed. Processing of survey data will commence early in 1979 and survey results will be released as they become available.

Work is expected to be completed on the contract aeromagnetic survey of the Western Australia portion of the Officer Basin by the end of 1978. Magnetic contours of NEALE, VERNON and WANNA 1:250 000 Sheet areas were released in mid-1978. Magnetic profiles of JUBILEE, MASON and FORREST are expected to be available by the end of the year with contours to follow in 1979.

Most Airborne Subsection personnel contributed to work in the Airborne Reductions and Contract Group for long periods during the year. Processing was undertaken on 54 1:250 000 Sheet areas; this resulted in the production of 191 maps of which 143 were released and 48 were retained for inspection at BMR.

During the year requests from outside organisations were dealt with for the supply of digital geophysical data for 14 1:250 000 Sheet areas. In addition computer programs for processing airborne geophysical data were requested. This request will be met in early 1979 by the publication of the Reduction Group's program listings with an accompanying data structure and processing manual.

Subsection personnel were also involved in the development of computer programs for gamma-ray spectrometer and magnetic data analysis, further development of gamma-spectrometry instrumentation to be brought into service in the Twin Otter in 1979, and participation in an ADAB mission to the Philippines to assess the status, potential and requirements for uranium exploration in that country.

SEISMIC, GRAVITY AND MARINE SECTION

A seismic survey was conducted in the Denison Trough of the Bowen Basin, from July to November in cooperation with the Geological Survey of Queensland; the aims were to improve signal penetration to investigate the deepest Permian formations, basement structures in the Trough, and the structure of its eastern margin. Traverses were designed to tie together exploration wells, previous seismic surveys and stratigraphic holes drilled by GSQ. An appraisal of the quality of information obtained on the deep section to basement must await final processing of the multifold CDP data.

Results from the 1977 seismic survey of the Toko Syncline in the southeastern Georgina Basin are being interpreted by the Georgina Basin Project Team. P.L. Harrison and S.P. Mathur were seconded to the team for this purpose.

The interpretation of the data from the 1976 Galilee Basin Seismic Survey was completed and the results indicate that the possibly prospective Adavale Basin sediments do not extend far northwards under the Galilee Basin. The main petroleum exploration targets should be the Drummond Basin sediments in the Koburra Trough.

Work continued on reviews of sedimentary basins where future seismic work is envisaged, with a view to formulating specific objectives. The review of the Denison Trough was completed before the current survey started, the review of the older basins below the Eromanga Basin continued, and brief reviews were made of both the onshore Bonaparte Gulf Basin and the eastern Otway Basin.

The joint study with Geological Branch of the Ngalia Basin advanced with the writing of a draft Bulletin. An assessment of petroleum reserves is being made.

Gravity measurements were made in the MacArthur Basin as part of the MacArthur Basin Project and in the Agate Creek area in association with the Georgetown geological mapping project.

The Marine Group was much occupied with interpretational and reporting projects. Major studies were made of the Ceduna Terrace, Carnarvon Terrace and Scott Plateau. Papers were prepared on the Petroleum Prospectivity of Australian Marginal Plateaus for presentation at the Second Circum Pacific Energy and Mineral Resources Conference and on the Northeastern Margin for presentation at the Geological Society of Australia special meeting in Townsville.

Members of the Marine Group are presently (October - November) participating in a geophysical survey of the Lord Howe Rise by BGR (Geological Survey of the Federal German Republic) in the R/V Sonne, and other members of the Group will join the Sonne to participate in the immediately ensuing survey in the northeast Coral Sea. These ventures have required a considerable effort for review and planning in association with BGR. Considerable work has resulted during the year from previous cooperative surveys with overseas institutions, in particular interpretation continued of the geophysical data from the cooperative survey of the Scott Plateau with BGR in the R/V Valdivia. C.R. Johnston continued with the reporting of his joint study of the tectonic evolution of the Timor area following his visit to Woods Hole Oceanographic Institution (USA), and G. Karner visited Lamont Doherty Geological Observatory (USA) where he was associated in joint studies of the anomalous gravity fields over continental margins.

Magnetic measurements were again made on the M/V Cape Don in association with Division of National Mapping's bathymetric survey of the continental shelf. The survey lasted for about a month and 10 000 km were surveyed in an area west of Carnarvon. During the survey BMR's digital data acquisition system was extended and improved particularly with regard to on-line navigation.

Processing of data from the Continental Margin Survey continued and is nearing completion. Final maps are now being produced. The data processing system developed for the Continental Margin Survey is being adapted as necessary for processing of navigation bathymetry and magnetic results from the Division of National Mapping Survey.

A small team has been engaged in developing a digital seismic processing system. The initial stage of this system which is nearing completion will be required to provide a "brute-stack" of CDP data from land seismic surveys.

OBSERVATORIES AND REGIONAL SECTION

The work of the Section comprises two main aspects - firstly, the systematic gathering of basic data on geophysical fields and events, to establish and maintain data banks and to provide data in suitable form in response to requests; and secondly, the conduct of research into the significance of these data in understanding geological processes and in relation to applications for the benefit of the community.

In times of restrictions on staff and funds, it is generally considered that the basic data acquisition should take priority over research; this has a more serious effect on the Observatory Sub-section than on the Regional Sub-section for several reasons. Observatories, once set up, produce data relentlessly 24 hours per day throughout the year, and these data need to be processed in order to meet regular international deadlines. In any case if processing rates fail to equal data production, backlogs continue to increase. In contrast the Regional Sub-section can largely plan in terms of definite projects of data acquisition followed by analysis and interpretation. However processing of data from outside sources into data banks and servicing requests still form a significant part of the work-load.

Backlogs in data processing are by no means new to the Section, in particular for the mean hourly values of components of the magnetic field derived from observatory recordings, which form the basis for study of long period variation of the magnetic field. In spite of the introduction of scaling machines and ADP over the years, there remains a back-log of about 90 observatory years to the end of 1977.

Against this background, it is encouraging to note two significant developments. Firstly, the semi-automatic scaling machine has been rebuilt with direct link to a dedicated computer. Consequently with the loan of staff from the ADP group on roster, the backlog of scaling should be overtaken by the end of 1979. Secondly, the Automatic Magnetic Observatory (AMO), now in operation at the new Canberra Magnetic Observatory, records digitally on magnetic tape in a format suitable for direct input to a computer. It is planned to introduce these systems progressively at other observatories over the next few years, depending on availability of plant and equipment funds, thus ultimately eliminating the need for manual scaling of mean hourly values.

Throughout 1978, the normal seismological and magnetic observatory operations continued at Mundaring (WA), Macquarie Island, Mawson (Antarctica), and Toolangi (Vic). The new Canberra Magnetic Observatory in the north-east of ACT became fully operational in June; it will ultimately replace Toolangi Magnetic Observatory after an overlap period. Seismological recording will continue at Toolangi. Toolangi staff have transferred to Canberra, necessitating some rearrangement of duties.

After lengthy negotiations, the Port Moresby Geophysical Observatory was eventually transferred to the PNG Government, together with its associated regional network of seismographs and accelerographs.

Three-component seismological recording was continued at Manton (NT), with single component recording at nine other stations throughout the Australian mainland; Christmas Island and Melbourne seismographs were closed down by the end of 1977. The university seismographs at Hobart, Adelaide, and Charters Towers were supported financially and data were received from these, their associated networks, and from other stations.

Australian Cooperation with the US Air Force in the Joint Geological and Geophysical Station at Alice Springs was announced publicly in March; BMR

has had a seismic recorder operating there for some years. Unveiling of the secrecy will enable freer use by Australian seismologists of data recorded by USAF; BMR and ANU are planning cooperation with the US authorities through the Department of Science.

Mundaring observatory staff continued operation of the Seismic Research Observatory at Narrogin (WA), installed by US Geological Survey in 1976. Further accelerographs were installed in WA, and advice was given to sundry authorities on equipment installation for local seismicity studies.

Three field seismographs were deployed near Meckering to study local seismicity.

The regional Earthquake Data File now contains 24 500 events; during the year about 100 enquiries were serviced. Largest earthquakes in WA were located at 220 km S of Halls Creek (6 May, magnitude 6.2) and 240 km ENE of Carnarvon (1 May, magnitude 5.7). In eastern Australia, an earthquake of magnitude 5 occurred near Bacchus Marsh (Vic) on 3 December 1977.

A first-order regional magnetic survey reoccupying 59 stations throughout Australia was begun and will be substantially completed in 1978. This will enable compilation of magnetic charts for 1980, and further study of secular variation.

Fr P.N. Mayaud from France visited Australia in February on behalf of the International Association of Geomagnetism and Aeronomy, as part of a world trip to improve standards of derivation of indexes of magnetic disturbances.

Another project of overtaking a backlog is nearing completion - the compilation of all available gravity data into a unified data bank. Data recomputed by contract this year added 20 000 stations and BMR recomputations added 6 000 stations, bringing the total number of land gravity stations to 340 000. With a final renewel of the contract during 1979, the data bank is expected to be up to date by early 1980.

Computer programs to manipulate gravity data were further developed. The contouring program was made more accurate and programs were written to manipulate gridded data.

A tidal gravity meter from the International Centre for Earth Tides is giving very good records at Alice Springs; it will record for one year, to determine accurate tidal gravity components from a site least prone to effects of ocean tidal loading.

The larger gravity anomalies within the Australian continent have been interpreted as due to abrupt changes in mean crustal density with regional isostatic compensation of the crust.

The isostatic compensation of topography in eastern Australia was investigated by calculating the isostatic correction for various models, and comparing the calculated and observed anomalies. This method confirms that the mantle is deep under the Eastern Highlands.

A new series of gravity maps at 1:250 000 was initiated; the first to be issued include 32 sheets in each of the Pilbara area and the Lachlan geosyncline. Maps were prepared at 1:10M for the BMR Atlas.

A report on Australian regional gravity 1974-78 was presented at the meeting of the International Gravity Commission in Paris in September by J.B. Connelly. Mr B.C. Barlow was seconded to the Irian Jaya project, and began planning a helicopter gravity survey of the area.

The physical properties and the structure of the earth's crust in the Australian region are not well known compared with many other regions of the world. The broad purpose of the Regional Structural Survey Group program is to apply seismic refraction/reflection methods to interpret the differences in structure within and between the tectonic provinces of continental Australia. During 1978 the principal areas under investigation were the Pilbara-Yilgarn area of Western Australia using data from field work conducted in 1977, and the Lachlan Fold Belt in southeastern Australia using data from field work conducted from 1976 onwards. The benefits of improved recording equipment developed in BMR, and interpretative computer programs adapted from European workers, are shown by the much greater detail in the interpreted structures compared with what could be achieved a few years ago.

Modelling of the gravity and magnetic data in these provinces is proceeding in parallel with the seismic work. These studies can provide valuable information on the lateral extent of near surface features and structures, and also provide a constraint on proposed seismic models.

Heat flow data from borehodes throughout continental Australia are being gathered to determine the thermal regime within the earth's crust and how it might affect seismic models. Areas of high heat flow are investigated to determine the geothermal energy potential. The Otway Basin is one such

area studied in 1978. Measurements were also made in North Queensland, the Pilbara area, and the Canning Basin, and several borehodes were cored for future logging. A study of residual thermal effects of the Recent glaciation in S.E. Australia was begun.

The stress regime in continental Australia is also being investigated in cooperation with CSIRO Division of Applied Geomechanics; stress was measured at five sites in south-eastern N.S.W. this year. This information is designed to improve our understanding of current tectonic processes within and between the tectonic provinces of Australia.

The Rock Measurements Group was transferred to the Regional Subsection late in 1977.

Interpretation of geophysical field measurements can be greatly improved by a knowledge of the physical properties of rocks likely to be found beneath the surface; in addition, study of palaeomagnetic properties reveals much of the past history of geological formations, and measurement of thermal conductivity on bore cores in essential for heat flow calculations.

Cooperative arrangements have been made with ANU for use of a "SQUID" magnetometer, which greatly increases both the sensitivity and the speed of palaeomagnetic measurements. With this facility, stratigraphic correlation of ancient non-fossiliferous sedimentary sequences becomes possible by studying the pattern of magnetic field reversals. During 1978, about 2500 samples were collected for such studies, in the McArthur Basin, Pine Creek Geosyncline, Georgina Basin, and Georgetown region.

In the laboratory, 876 rock samples were measured for one or more of the following properties: sonic velocity, magnetic susceptibility and remanence, density, porosity, and thermal conductivity.

ENGINEERING GEOPHYSICS GROUP

The Engineering Geophysics Group was formerly part of the Geophysical Services Section; when this section was removed from the Geophysical Branch to form the Interim Geophysical Services Section the Engineering Geophysics Group became directly responsible to the Assistant Director (Geophysics).

Engineering studies were conducted in the ACT to determine a suitable location for a new bridge at Tharwa; all six of the nominated sites proved suitable. Seismic studies were extended to locate water sumps to supply the Cuppacumbalong homestead but these were unsuccessful. Sites for the Tuggeranong Gilmore reservoir were investigated and results indicate that blasting will be necessary for excavation stages.

Special purpose electric-field surveys were conducted to locate buried conduits and cables at the site of the National Gallery.

Vibrations were monitored at ANU to facilitate the siting of an electron microscope. Similar measurements were made at Holsworthy army camp to assess the effects of artillery shelling.

Magnetometers and transient electromagnetics were used to ensure that there were no unexploded artillery shells at the site of the ACT Police Driver's Training Centre. A similar search was successfully conducted at Warnbro Sound (WA) where magnetic signal enhancement techniques were tested.

Down hole logging equipment was overhauled and new probes were constructed or modified for IP and EM measurements. Boreholes were logged at Broken Hill, Cobar, and Beaudesert (Qld).

A digital seismic system has been completed and two test surveys were conducted at Lake George and Newcastle. At present a sledge hammer is used as the source of energy; a road compactor was considered in a search for alternatives but the quality of recordings was poor and an application has now been made for a grant to buy a commercial energy source.

A seismic refraction survey was conducted at a proposed tunnel site in Fiji in conjunction with the Australian Development Assistance Bureau. The Group also made computer studies of vertical electrical sounding data from Indonesia as part of a foreign aid project.

1. METALLIFEROUS AND AIRBORNE SECTION

(G.A. Young)

The Section comprises two Sub-sections: Metalliferous and Airborne. The Metalliferous Sub-section is principally concerned with providing geophysical support to multi-disciplinary studies of mineral provinces and research into the development and application of improved ground geophysical methods to assist mineral exploration. The Airborne Sub-section is principally concerned with providing basic airborne geophysical data coverage of the continent at a regional scale. These data, published in the form of maps and interpretation reports are seen as an essential component of background information required to assist mineral exploration and for the assessment of mineral potential.

The role of the Section in the analysis of regional geophysical data as part of multi-disciplinary studies of mineral provinces is expanding with staff outposted to projects where appropriate. Reference should be made to the Georgina Basin study in this Record as this project absorbed the total interpretative strength of the Section for the second half of 1978.

METALLIFEROUS SUB-SECTION (D. Stuart, J. Gardener, D. Tucker)

Regional Study of the Pine Creek Geosyncline, N.T. (D. Tucker, N. Sampath, I. Hone, (G. Ewers - Geological Branch), V. Carberry)

This study commenced in March 1977 and was completed at the end of July 1978. Objectives of the study were to establish the source of geophysical anomalies and assist in the understanding of the geology of the region.

In 1978, the interpretation of regional magnetic, gravity and radiometric data was enhanced by laboratory determination of the physical properties and mineralogy of rock types in the Geosyncline, and the results of computer model studies.

Gravity: A study of regional and detailed gravity data, and the results of rock density measurements from 17 deep drillholes throughout the Geosyncline, indicate that most of the Bouguer anomaly features in the Pine Creek Geosyncline can be explained by the presence of low density granitic complexes within a more dense Lower Proterozoic metasedimentary column.

Density measurements and gravity modelling suggest that the mean density of the Lower Proterozoic metasediments is 2.85 g/cm^3 and the mean density of the granitic complexes is 2.67 g/cm^3.

There appears to be no density or magnetic contrast between the granitic complexes and the basement of the Pine Creek Geosyncline. Gravity modelling indicates that the granitic complexes commonly slope outwards and merge with the basement at a depth generally less than 5000 m. The modelled depth extent of the granitic complexes can be used to map the thickness of Lower Proterozoic sediments and hence the structure of the Geosyncline.

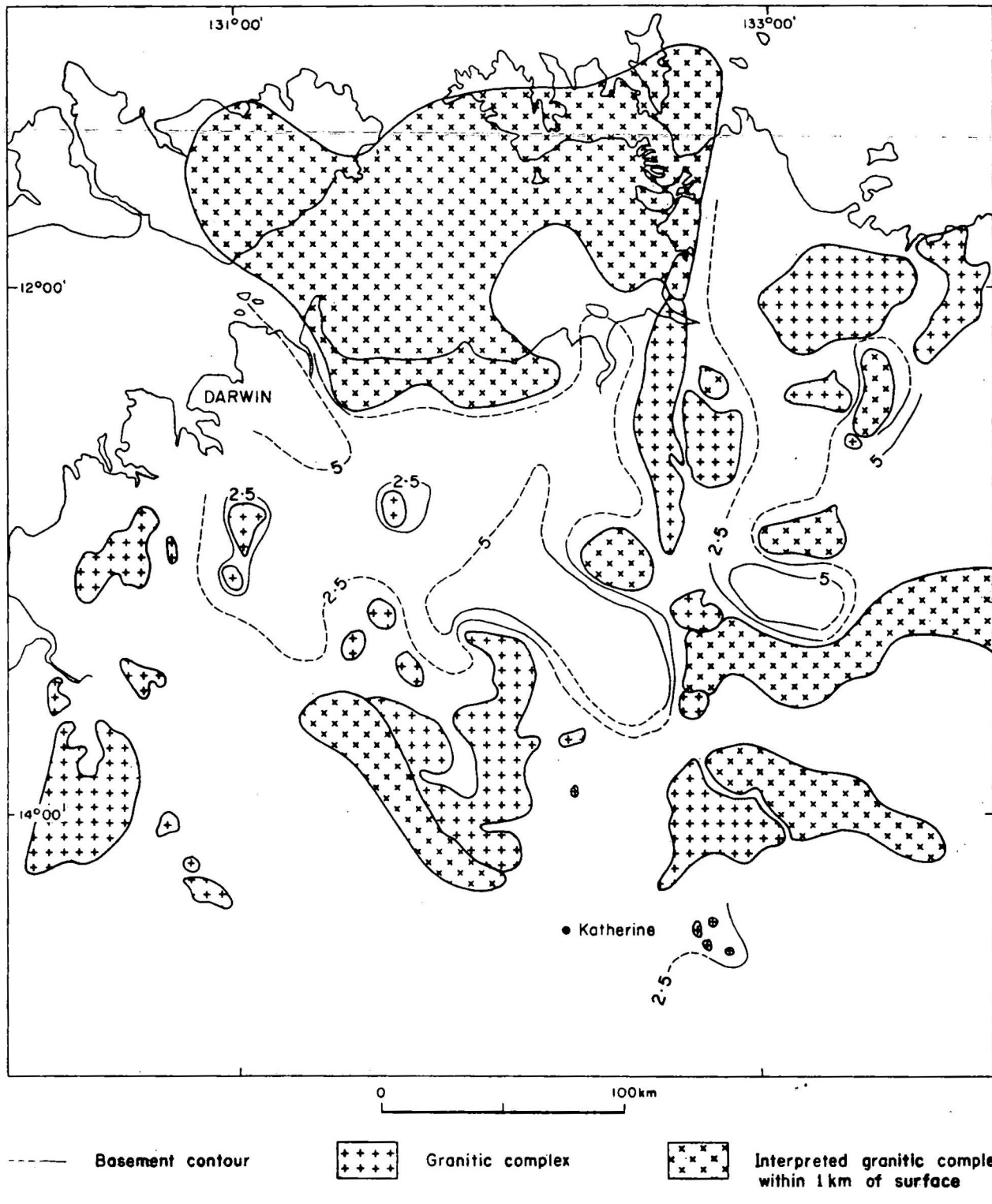
A regional model based on this hypothesis is shown in Figure MA2 and suggests that a basement high runs south from the Alligator Rivers Uranium Field, through the Jim Jim Granite, and then eastwards beneath the Kombolgie Sandstone. Another basement high fringes Van Diemen Gulf. The South Alligator Valley Uranium Field appears to be located on a basement deep.

To assist further interpretation of the Bouguer anomaly data a residual Bouguer anomaly map has been prepared which shows zero anomaly over granitic bodies and positive anomaly over metasediments. This map can also be used to indicate the thickness of Lower Proterozoic metasediments throughout the Geosyncline.

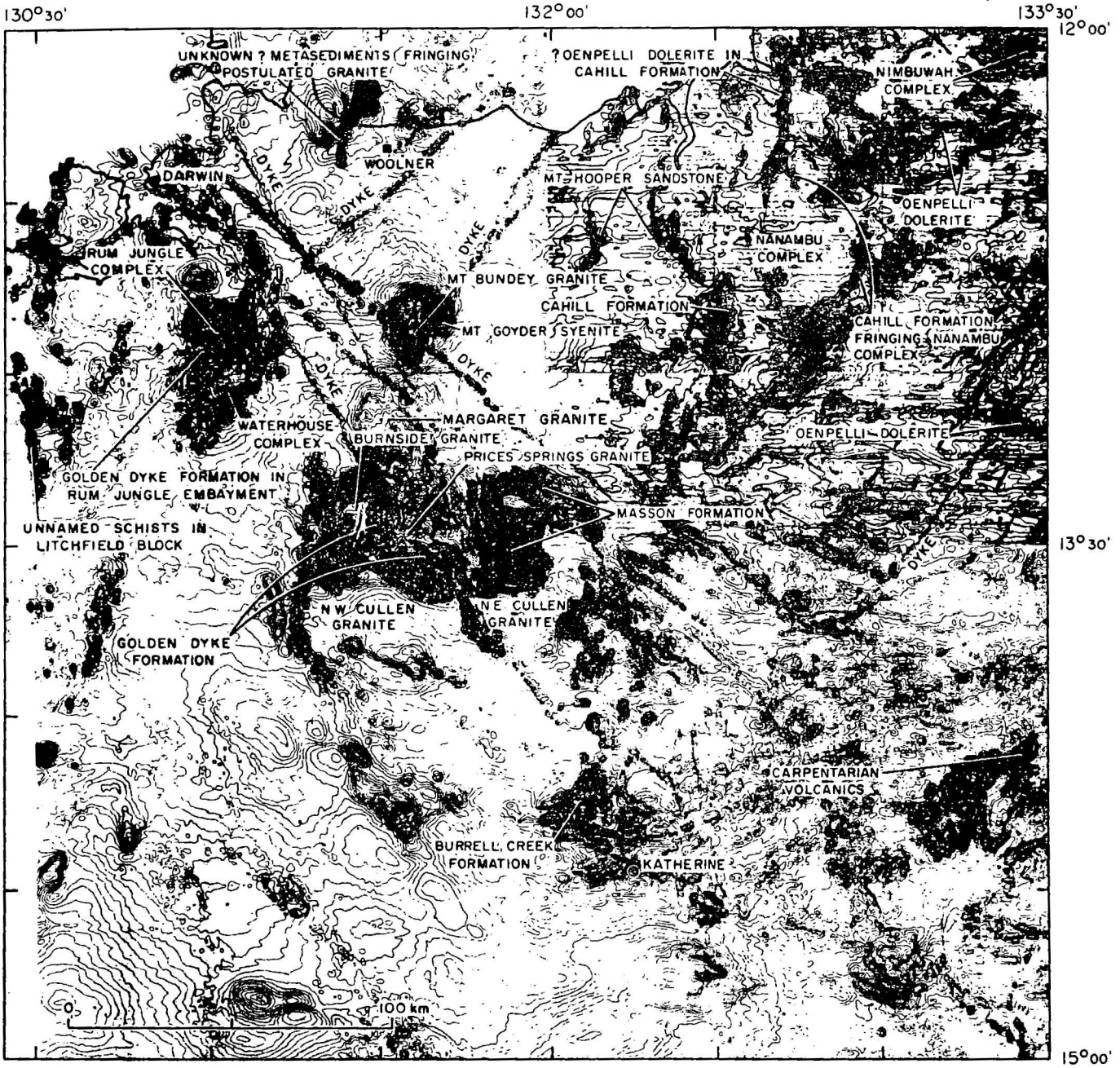
Magnetics: The magnetic characteristics of the Pine Creek Geosyncline are indicated in the results of BMR regional magnetic surveys shown in Figure MA3. The magnetic field can be characterized by four types of magnetic features.

The most common characteristic of the regional magnetic data is large areas of little or no magnetic relief. This type of field is observed over the bulk of the Lower Proterozoic metasediments and most of the Archaean and Carpentarian rocks of the region, including the granitic complexes.

The most prominent characteristic of the regional magnetic data is the broad curvilinear zones of narrow magnetic anomalies which occur throughout the region and contain anomalies with amplitudes from 500 to 1500 nT. The zones of curvilinear anomalies have at least three different sources. The most interesting zones are those which occur over and sub parallel to steeply dipping Lower Proterozoic sediments or intrusives near or surrounding



BASEMENT CONTOURS, PINE CREEK GEOSYNCLINE



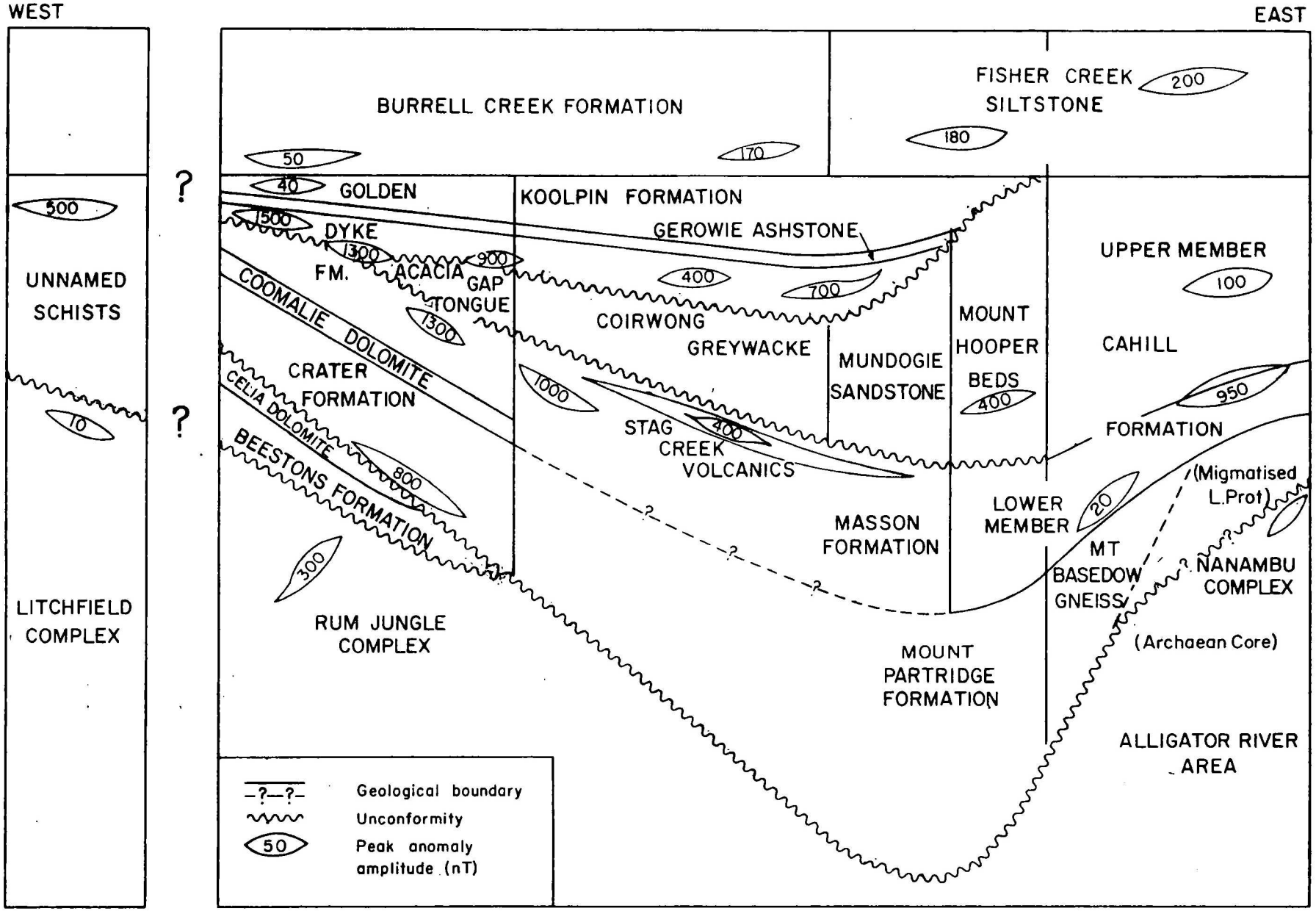
AEROMAGNETIC CONTOURS, PINE CREEK GEOSYNCLINE

granitic and metamorphic complexes. Other sources of curvilinear anomalies appear to be sills of Oenpelli Dolerite and volcanic members of the Carpentarian rocks. The most prominent curvilinear anomalies occurring over Lower Proterozoic rocks are in the Alligator Rivers area, the Rum Jungle area and around the northern part of the Cullen Granite. Other curvilinear zones which may be associated with Lower Proterozoic metasediments are observed in the Litchfield Block to the west, and over black soil plains fringing Van Dieman Gulf.

Curvilinear magnetic anomalies have been observed over most rock units in the Lower Proterozoic section where these rock units are near or adjacent to granitic or metamorphic complexes. The results of detailed ground magnetic surveys show that the sources of individual anomalies appear to be conformable with the metasediments and are repeated by folding or faulting to a greater or lesser extent. The sources are mostly less than 100 m thick and are locally continuous for 10 - 50 km. Similar sources often reappear at approximately the same stratigraphic level throughout the geosyncline. The approximate position and maximum amplitude of anomalies within the Lower Proterozoic section are indicated in Figure MA4. Magnetic units with the highest amplitude anomalies appear to occur in the shalier, or siltier parts of the section; notably in the Golden Dyke Formation, Koolpin Formation, Masson Formation and Lower Cahill Formation.

A study of the magnetic and mineralogical characteristics of Lower Proterozoic rocks from five curvilinear anomaly zones, indicates that the anomalies are frequently caused by metasediments adjacent to amphibolitized sills. In the central part of the Geosyncline, the anomalies appear to result from strongly remanently magnetized iron sulphides in the sedimentary section. In the east, in the Alligator Rivers Uranium Field, and in the west, in the Litchfield Block, the anomalies appear to result from inductively magnetized iron oxides.

Other magnetic features are suites of long, linear anomalies and a few discrete "bulls-eye" anomalies of small area. The linear anomalies have been investigated by ground magnetic surveys, drilling and laboratory studies, which show the source of these anomalies to be post Carpentarian dolerite dykes. The distribution, density and orientation of the linear anomalies might be useful to study the structural history of the Geosyncline.



MAGNETIC SOURCES IN THE LOWER PROTEROZOIC SECTION OF THE PINE CREEK GEOSYNCLINE

The "bulls-eye" anomalies appear to occur near or within granitic complexes and are probably the result of basic intrusions. The most prominent "bulls-eye" anomalies are at Mt Bundy and north of the Rum Jungle Complex.

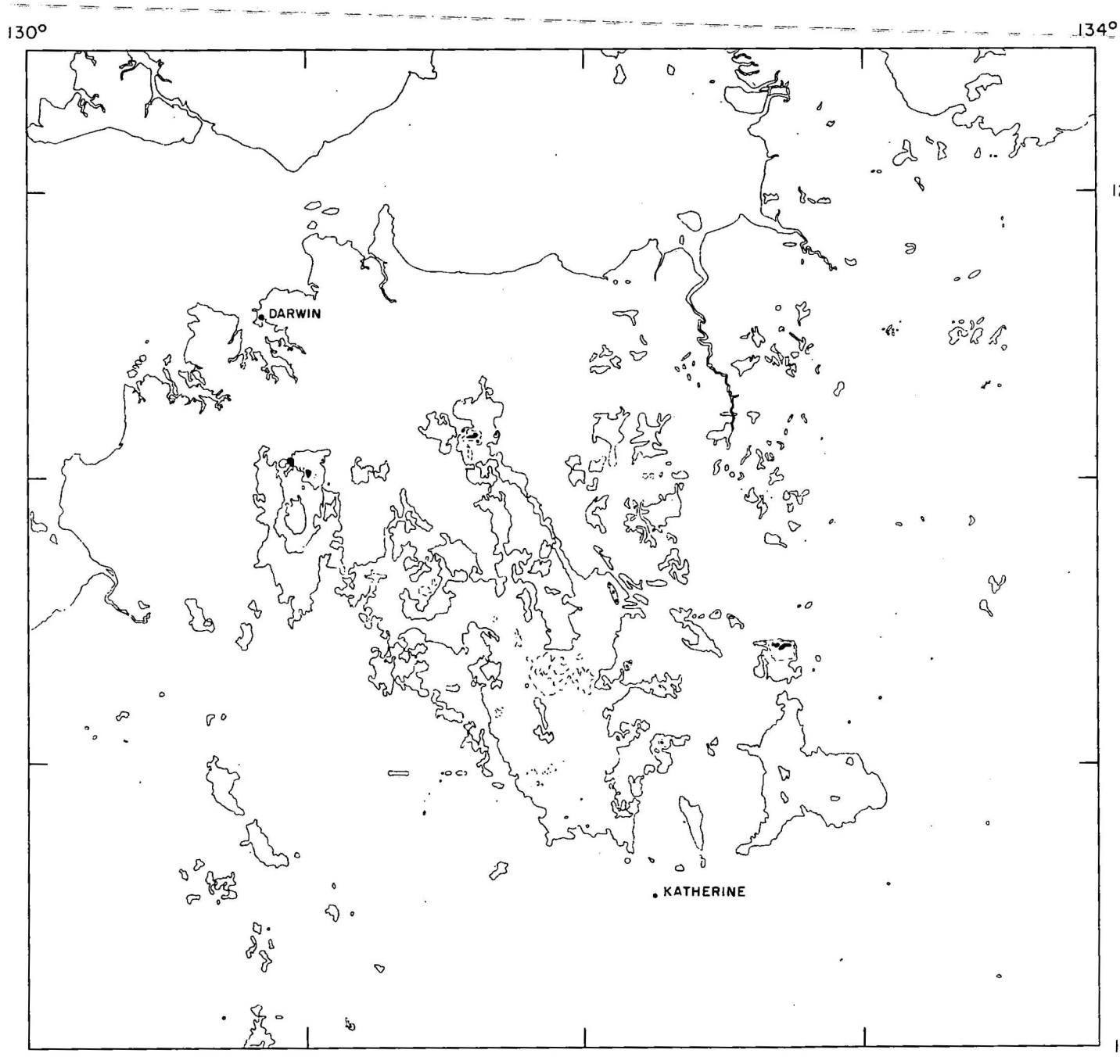
Radiometrics: Determining the radiometric characteristics of the rocks of the Pine Creek Geosyncline has proven to be a difficult task due to the regional nature of BMR's aeroradiometric surveys and the poor rock exposure throughout most of the Geosyncline.

Work on the radiometrics included the preparation of a total count contour map of the region and a study of the radioelement characteristics of broad rock units obtained by averaging spectrometer channel countrates from a number of traverses over good rock exposures. An indication of the characteristics of the total count survey in the region is shown in Figure MA5.

The most striking features of the total count contour pattern are the very low count rates recorded over the Carpentarian and Adelaidean rocks, and the high count rates recorded over outcropping granitic rocks which are from two to three times greater than the count rates observed over Lower Proterozoic sediments.

The total count response over broad areas of the more quartz rich Lower Proterozoic metasediments, such as the Burrell Creek Formation, is usually higher than that recorded over broad areas of shalier metasediments such as the Golden Dyke Formation. This observation is counter to normal expectations and appears to be the result of different weathering effects on arenaceous and argillaceous rocks. Quartz rich rocks have relatively good exposure together with a fairly stable residual soil which is representative of the underlying rock. However, shaley sediments are deeply weathered, have poor exposure and are frequently covered by transported soils or leached profiles. It is interesting to note that small radiometric highs in the Kombolgie Formation occur along northeast trending linear magnetic features.

A study of the spectral signatures of the granitic complexes and metasediments is hampered by the poor counting statistics which result from small samples of the BMR airborne radiometric data. However, the reg-ional spectrometer data do not appear to show any rock types which have a consistly abnormal spectral signature. The spectral characteristics of some of the rock types in the Pine Creek Geosyncline are indicated in Figure MA6.



▲ >375 cps ----- 250 cps —— 100 cps

Note: 7·5 cps is approximately 1 μR/h

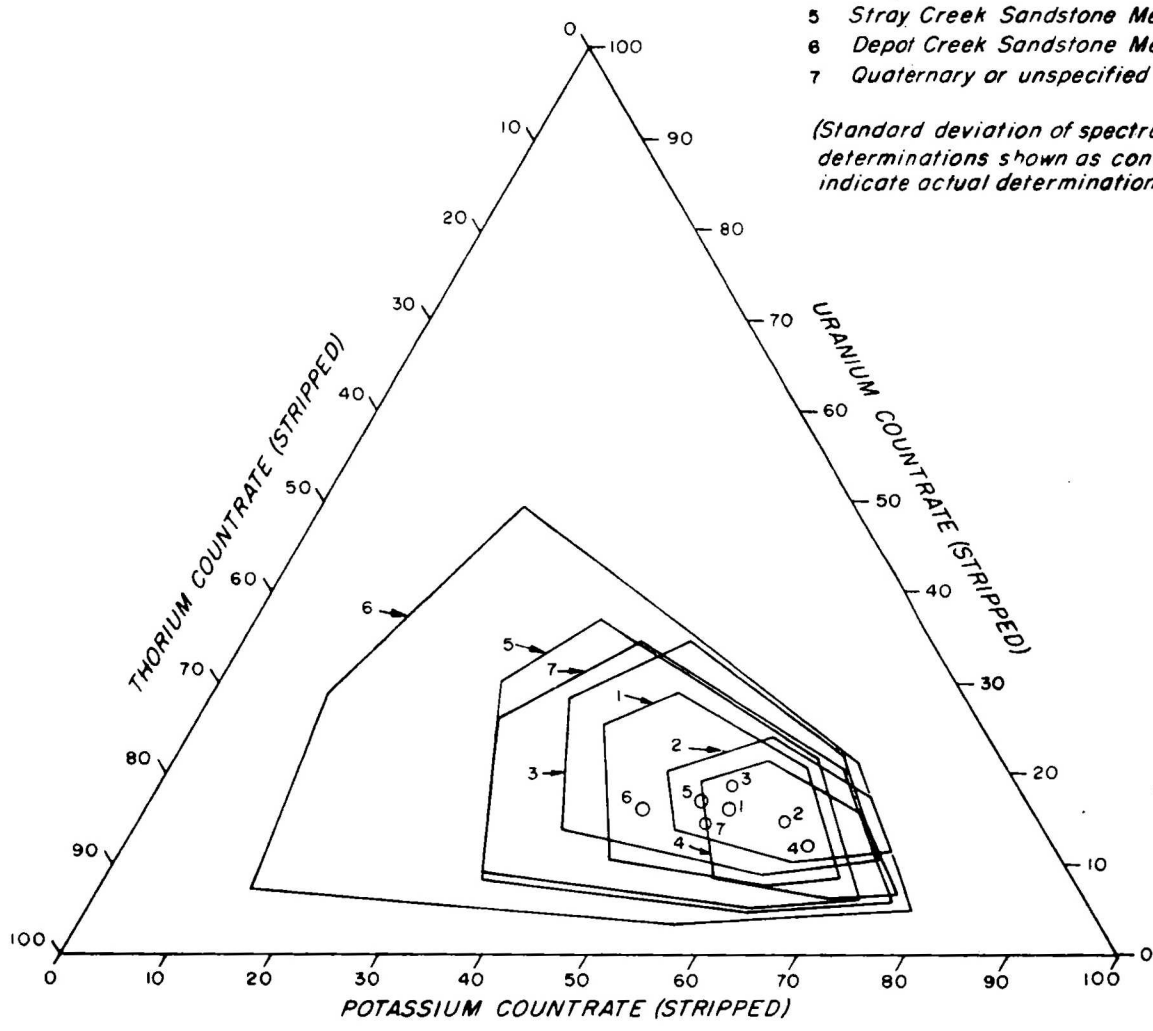
TOTAL COUNT RADIOMETRIC CONTOURS
PINE CREEK GEOSYNCLINE

Record No. 1978/97

D52/B7-693

1 *Quaternary over Cullen Granite*
2 *Burnside Granite*
3 *Quaternary over Golden Dyke Formation*
4 *Burrel Creek Formation*
5 *Stray Creek Sandstone Member*
6 *Depot Creek Sandstone Member*
7 *Quaternary or unspecified*

(Standard deviation of spectral signature determinations shown as contours, circles indicate actual determinations)



PERCENTAGE SUM DIAGRAM SHOWING SOME SPECTRAL SIGNATURES DETERMINED FROM BMR AERORADIOMETRIC SURVEYS, PINE CREEK, NT

Mineral Deposit Geophysics Studies in the Cobar Region (P. Wilkes, N. Sampath, J. Silic, P. Gidley, V. Carberry, H. Reith, R. Curtis-Nuthall)

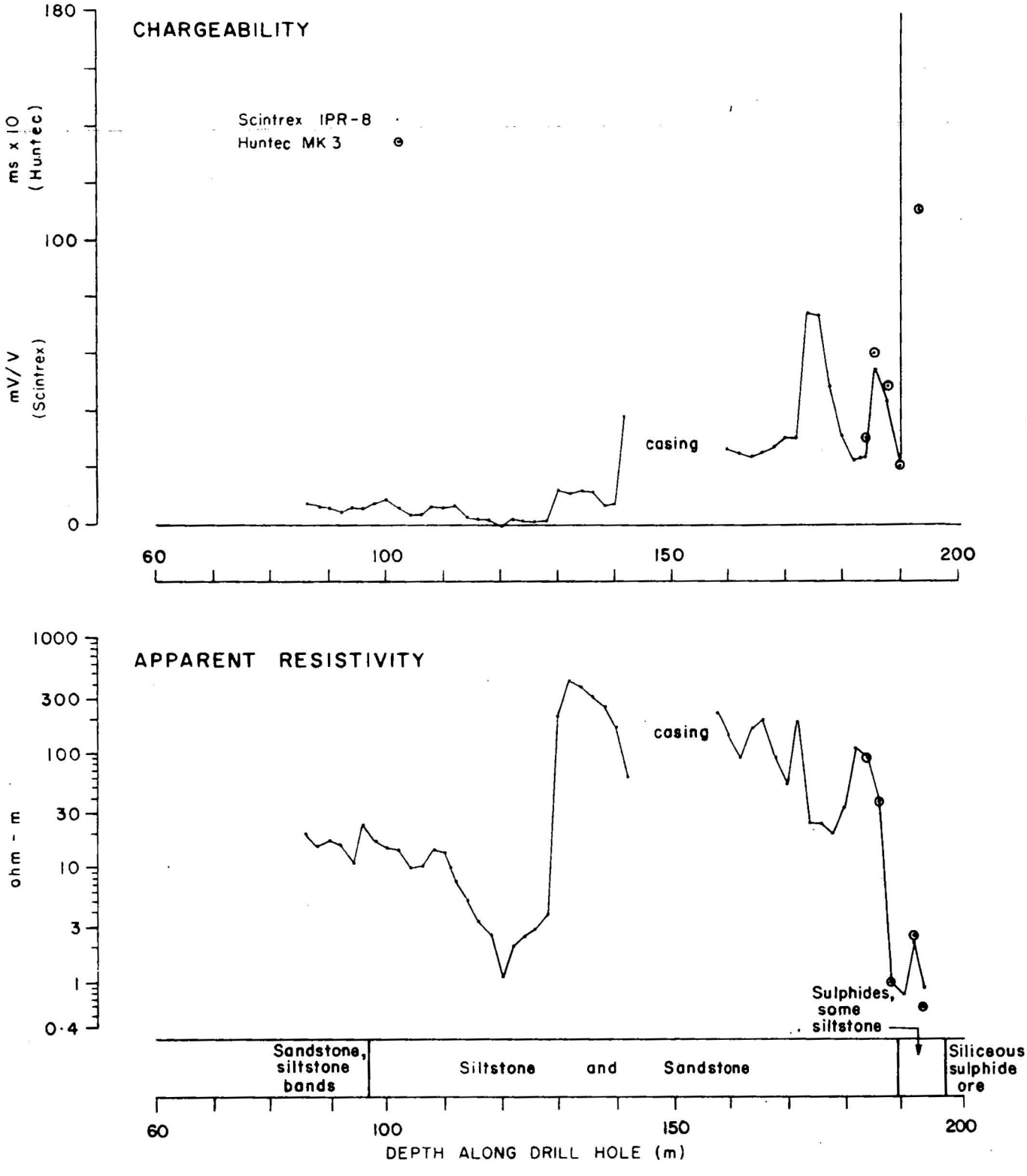
A study of the applications of magnetic, gravity, electrical, and electromagnetic methods for prospecting and mapping in the Cobar area commenced in February 1978 and will conclude in mid-1979. The program has involved 12 weeks of ground surveys in the Cobar area in the May-June and August-September periods. The project was supported by special purpose aeromagnetic surveys flown by BMR aircraft VH-BMG in May. Surveys were undertaken at the Elura deposit with the co-operation of the Electrolytic Zinc Company of Australasia and at the Shuttleton copper prospect with the co-operation of Aberfoyle Ltd. Other surveys over selected magnetic anomalies and zones of mineralisation in the Cobar area were conducted with the co-operation of Conzinc Riotinto of Australia, Samedan of Australia, and the Electrolytic Zinc Company of Australasia. During the project, liaison and co-operation were maintained with the New South Wales Geological Survey.

Physical Property Studies: Samples of rocks, ores and overburden from the Cobar area were collected and subjected to laboratory analyses of magnetic, electrical and density properties. The results of these measurements are being used to assist in response modelling and in analysing the results of field surveys.

At Elura a deep hole which intersected the orebody at a depth of about 180 m was logged using an IP and resistivity probe. The results of this logging are shown in Figure MA7 and indicate the complex geoelectric section of the conductive overburden and the high conductivity of the ore body.

A series of shallrw IP/resistivity soundings was also made over and around the gossan at Elura to investigate the geoelectric characteristics of the weathered part of the mineralised body. The results are still being processed.

Magnetic Studies: Ground, vehicle and airborne magnetic surveys were conducted over Elura, Shuttleton and other anomalies in the Cobar area to investigate methods of discriminating between magnetic ore bodies and surficial magnetic sources. The field investigations were supported by model studies and physical property measurements.



ELURA IP/RESISTIVITY LOG

USING 2-M SPACING, 3-ARRAY PROBE

The characteristics of these two types of magnetic sources were documented by airborne surveys flown at different altitudes and flight directiofns, and by extensive ground magnetic surveys employing various station spacings down to 1 m.

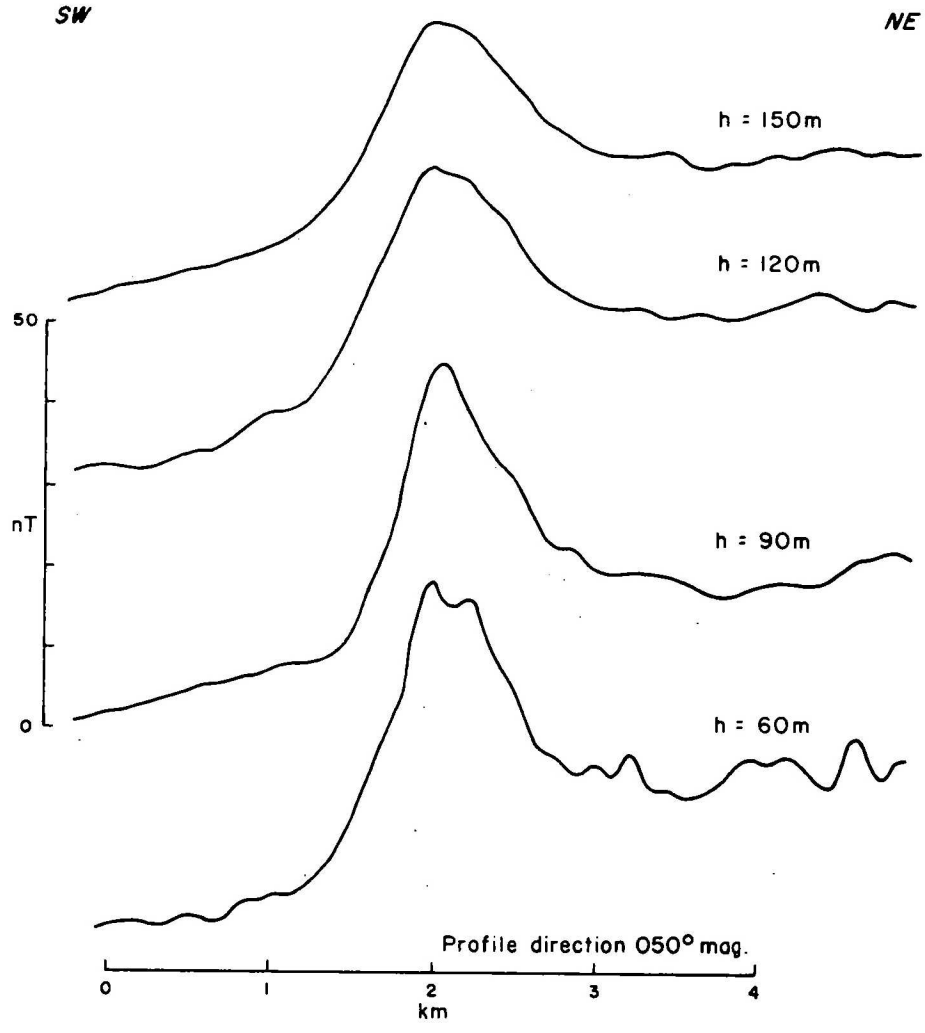
Preliminary investigations indicate the development of thick surficial magnetic material in the Cobar area which can produce significant aeromagnetic anomalies (Figure MA8). However, as indicated in Figure MA9 which shows different rates of anomaly attenuation with altitude for a bedrock source (Elura) and a surficial source, it may be possible to distinguish between bedrock and surficial sources by careful comparison of model results and the results of multiple height, multi-directional airborne surveys. Filtering of close spaced data, with specially designed digital filters, can be used to reduce the magnetic noise from near surface sources and improve the possibility of detecting underlying magnetic orebodies. Possible targets located in this way can be checked with other geophysical methods (e.g. gravity, EM, resistivity/IP) and/or geochemistry before drilling.

EM Methods: The response to EM methods at Elura, Shuttleton and several other minor prospects in the Cobar area was investigated using SIROTEM. The characteristics of the EM response at Elura were investigated by a variety of coincident loop and dual loop configurations. To investigate the direction of the secondary EM fields over and away from the deposit, specially built multiturn coils of 1.2 m and 2.7 m diameter were employed as the receiving loop.

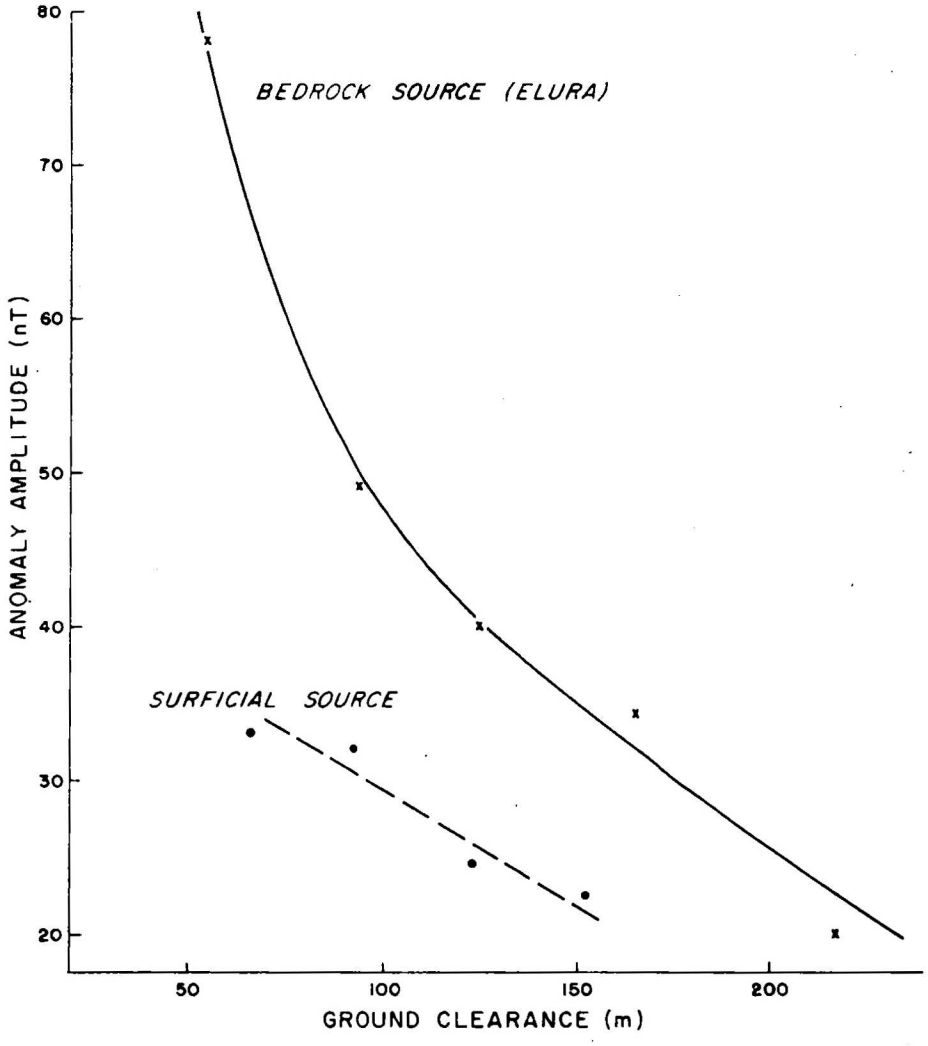
The results of a 50 m coincident loop survey over the South Shuttleton mine are shown in Figure MA10.

Analyses of the EM survey results, including a comparison with analogue model studies are continuing. Preliminary assessment of the field work and physical property studies indicate that the source of the EM anomaly at Elura may be within the zone of weathering.

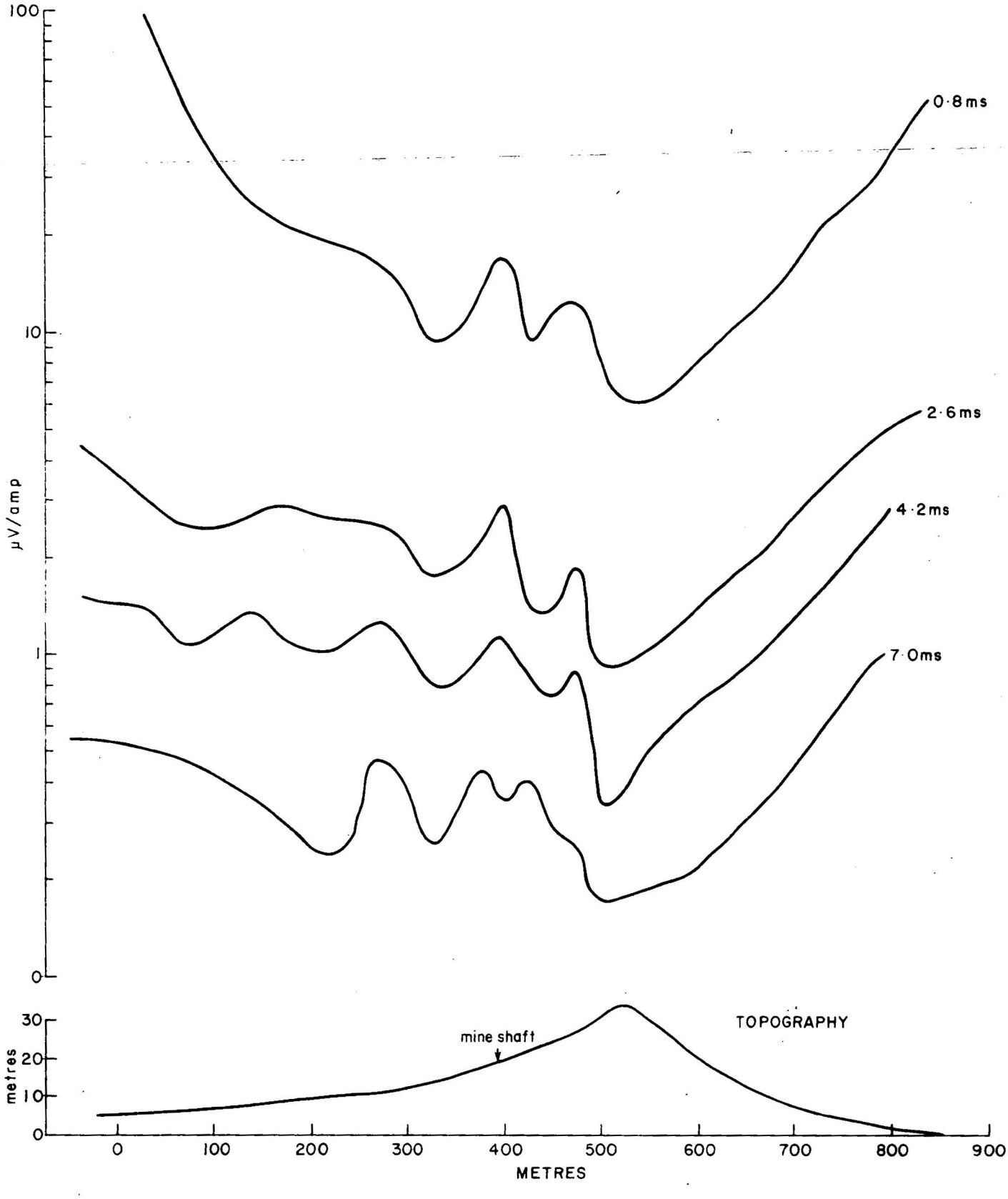
Magnetic Resistivity Method: A magnetic resistivity survey was conducted over and around the Elura deposit to investigate the ability of this method to minimize the effects of a conductive overburden. The survey was designed with an electrode spacing of 1.8 km employing a Geotronics 10 kW IP transmitter and a Scintrex MFM-3 high sensitivity fluxgate magnetometer.



AEROMAGNETIC ANOMALY OVER SURFICIAL SOURCE, COBAR, N.S.W.



ATTENUATION OF MAGNETIC ANOMALIES WITH ALTITUDE, COBAR AREA, N.S.W.



TEM RESULTS SOUTH SHUTTLETON MINE

COBAR AREA

Record No. 1978/97

H55/B7-34A

Survey results show several prominent conductance anomalies which possibly indicate rock boundaries. A small conductance anomaly was recorded over the Elura deposit.

Gravity method: Gravity surveys were made over mineral prospects and other geological features in the Cobar area to document characteristic anomalies. These data together with the results of model studies (Figure MA11) show that the gravity anomalies likely to be produced by sulphide orebodies will be small (0.2 mGal) and of the same order of magnitude as anomalies produced by changes in the thickness of weathering.

Electrical Methods Study (B. Spies, P. Wilkes, J. Silic, R. Curtis-Nuthall)

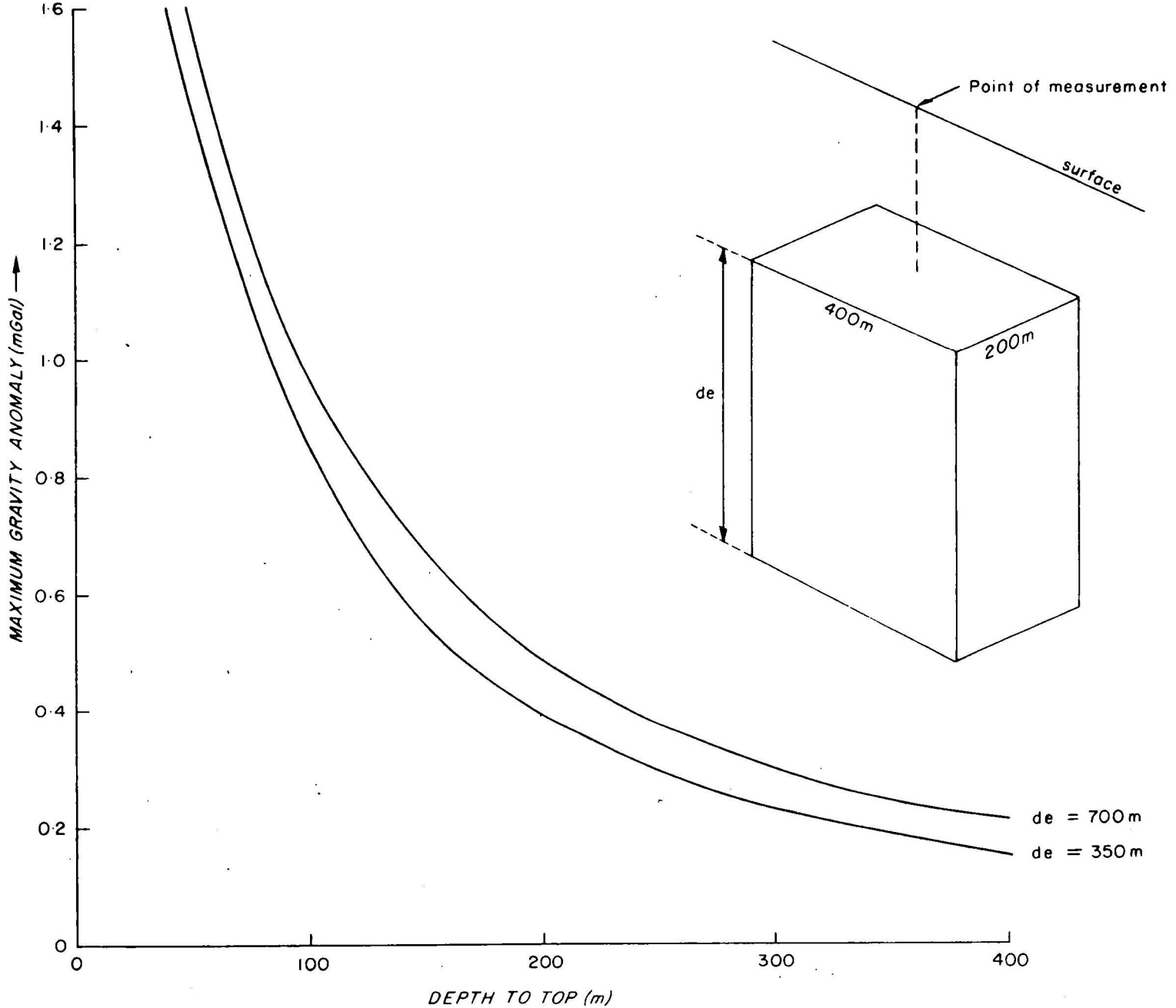
Due to staff shortages, investigations into the application and interpretation of electrical methods was continued on a part-time basis. Field surveys were made concurrent with the mineral deposit geophysics study in the Cobar area.

Rotating Dipole EM Method: Dr S. Hall of the University of Queensland was assisted by BMR in field tests at Elura with his rotating dipole EM technique. Further tests were subsequently made by BMR at the Kowen Forest observatory. The results of this work are still being reduced and interpreted. However, a phase anomaly appears to be located over the body of mineralisation at Elura.

SIROTEM Tests: Field and laboratory tests were made of the response characteristics and performance of the SIROTEM instrument jointly operated by CSIRO and BMR. Particular studies concerned the relationship between measurement precision and sample time, the effect of loop size on response, and the use of the instrument with a variety of remote detectors. Some of the studies were carried out in co-operation with CSIRO.

TEM Modelling: BMR is assisting in a co-operative project with Dr Raiche of CSIRO to formulate numerical models of the TEM response over one dimensional structures. These models will permit a more effective use of TEM as a geoelectric sounding tool.

Magnetic EM and Resistivity: Tests were made at Elura of the applications of a Scintrex MFM-3 magnetic sensor used in conjunction with a Geotronics IP transmitter or SIROTEM. The results of the magnetic resistivity



GRAVITY MODELLING OF COBAR TYPE OREBODY

work are described in the discussion of the mineral deposit geophysics study at Cobar, and indicate the possible use of the method for reconnaissance mapping beneath thick cover. The magnetic EM tests were unsuccessful due to high drift rates in the magnetometer.

Downhole Geophysics Study (I. Hone, R. Cobcroft, G. Jennings, P. Swan)

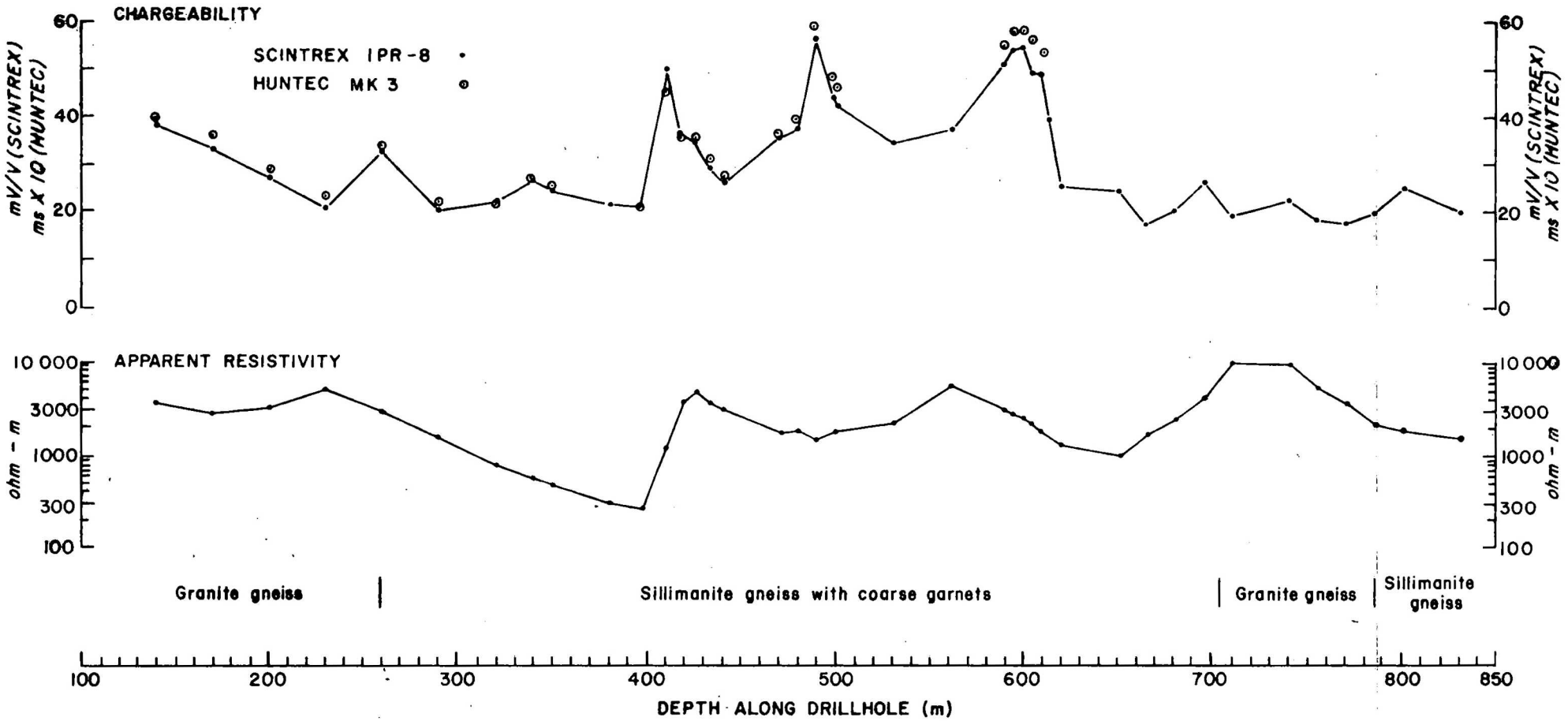
Activities in 1978 included the construction and testing of probes and the logging of holes at Broken Hill and Elura NSW. Completion of a report on the 1977 BMR-CSIRO joint model study of the fixed source DHEM method has been delayed pending the availability of staff.

Construction of Probes: A three component downhole EM probe and ancillary instrumentation were constructed by the Engineering Services Branch and tested at Kowen Forest. Following some additional development work this probe will be used in field surveys to study the response of geological conductors to EM fields and subsequently to assess the capabilities of downhole EM exploration methods.

Three-array IP/resistivity probes with electrode spacings of 2 m, 10 m and 30 m were constructed and adapted by the Engineering Services Branch for use with the BMR logging truck in field tests at Kowen Forest. These probes were then successfully used to log drillholes at Cobar and Broken Hill.

Field Surveys: During August, the BMR logging truck was used to make downhode IP/resistivity logs in deep diamond drillholes at Elura and Broken Hill. The surveys were made to document the electrical properties of rocks in these mineral provinces and to investigate the ability of downhole IP/resistivity methods to detect offhole mineralisation. The results of the survey at Elura are described in the report of the mineral deposit geophysics study at Cobar.

The borehole at Broken Hill passed through 800 m of gneissic rocks above a zone of minor Broken Hill type mineralisation. The log of this hole is shown in Figure MA12. Resistivities of the rocks range from 1000 to 10 000 ohm-m and chargeabilities are in the range 10-50 mV/V. Small, high chargeability-low resistivity zones coincide with weakly disseminated sulphides observed in drill core. Broad zones on the IP and resistivity logs appear to correlate with geological units. Logging of the hole at Broken Hill was carried out with the co-operation of the Zinc Corporation Ltd.



BROKEN HILL AREA N.S.W., IP/RESISTIVITY LOG USING 30-m 3-ARRAY PROBE

Nuclear Methods Study (A. Mutton, D. Robson)

Radon detection methods are being considered for programs of uranium exploration. Current investigations include field and laboratory studies of the operating characteristics of alpha meter devices, monitoring of background alpha and gamma activity at a test site at Kowen Forest, monitoring of radon transport through soils using artificial test sites, and measurements of the radon emanation of rock samples.

A joint project was conducted with the airborne subsection to locate and calibrate test ranges for airborne gamma-ray spectrometry. Further details are given in the airborne subsection report.

Magnetic and Gravity Methods Study (J. Silic)

Computer modelling programs for the Cyber 76 system were written to provide a rapid inverse interpretation method for two dimensional magnetic and three dimensional gravity structures. The programs were developed principally to assist regional geophysical studies. The techniques used in these programs provide information to the user on the sensitivity of the solution to changes in model parameters.

Heavy Mineral Sands Study (I. Hone)

Surveys were planned to document the physical properties of heavy mineral deposits and to investigate methods of marine exploration for heavy mineral sands. However the project was terminated due to staff shortages which developed in other ongoing projects.

Magneto-Tellurics (J. Major)

J. Major was seconded to the McArthur Basin project for most of 1978 to undertake field and model studies on the magneto-telluric responses of the basin. The results are included in chapter 5 of this report detailing multidisciplinary projects.

AIRBORNE SUB-SECTION (J.H. Quilty, R. Wells, C. Leary, J. Rees)

McArthur Basin airborne magnetic and radiometric survey, N.T., 1978 VH-BMG and VH-BMR (T. Zadoroznyj, J. Silic, L. Winters, J. Eurell, S. Wilcox, E. Chudyk)

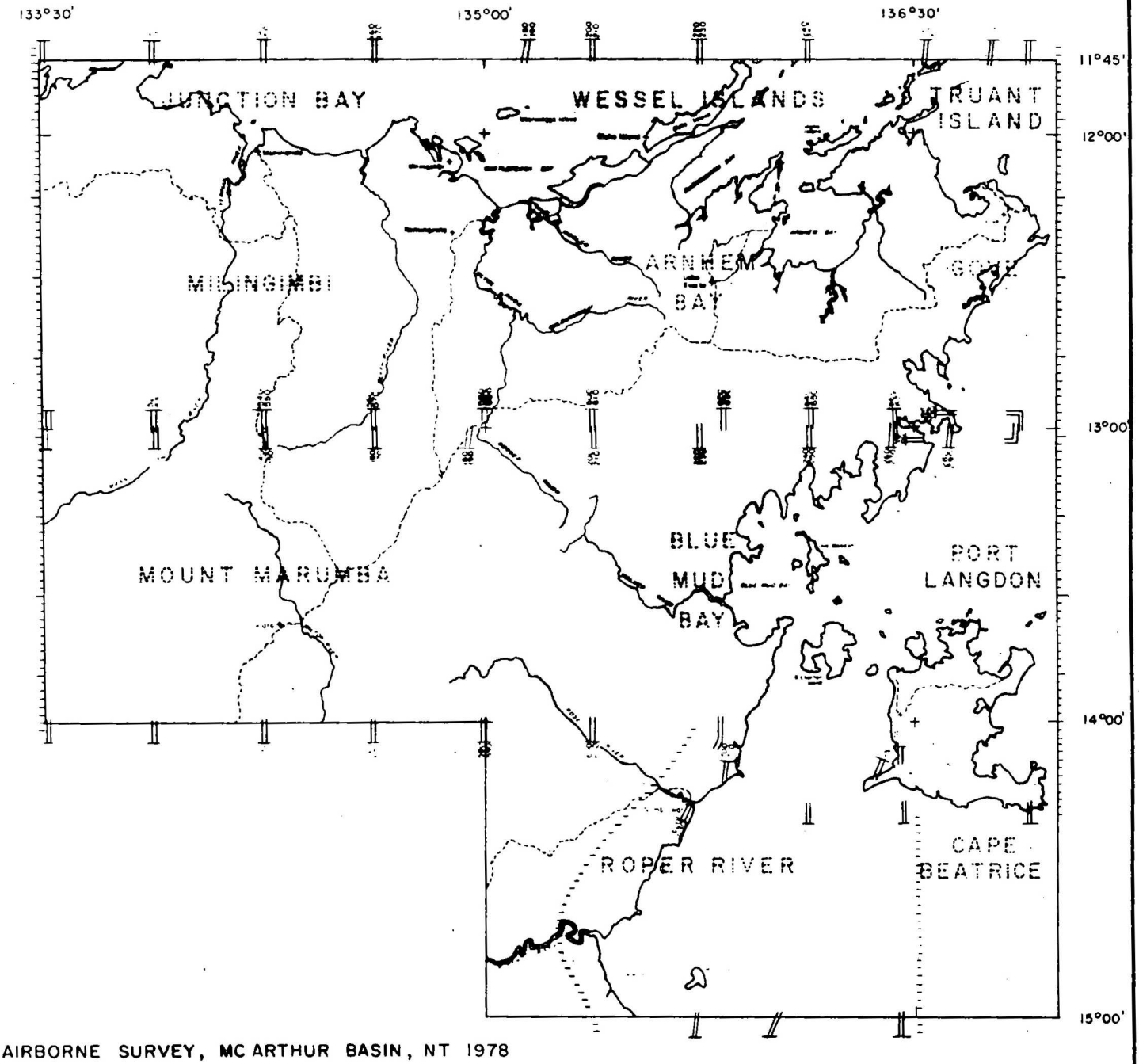
During the period June-September 1978 the BMR made an airborne magnetic and radiometric survey of the northern part of the McArthur Basin, N.T. (Fig. MA13). This survey completed the airborne geophysical mapping of the McArthur Basin which commenced in 1977. The geophysical data obtained will help to outline the main structural features of the Basin and assist in the geological interpretation.

The Twin Otter aircraft (VH-BMG) and Aero Commander (VH-BMR), both operating from Gove (Nhulunbuy) were used on the survey. The Aero Commander was restricted to flying the onshore areas while the Twin Otter, equipped with a Doppler navigation system flew mainly the offshore areas. Limited use was made of Groote Eylandt for refuelling and as survey base for the areas furthest south. All or part of the following sheet areas were covered in approximately 45 000 km of line flying: JUNCTION BAY, WESSEL ISLANDS, TRUANT ISLAND, MILINGIMBI, ARNHEM BAY, GOVE, MOUNT MARUMBA, BLUE MUD BAY, PORT LANGDON, ROPER RIVER and CAPE BEATRICE.

The survey was flown at 150 m above ground level along east-west lines 3 km apart with north-south tie lines about 25 km apart. Both aircraft digitally recorded magnetometer, four channel gamma ray spectrometer and radioaltimeter data. VH-BMG also recorded Doppler navigation data.

Preliminary inspection of the data shows a wide range in magnetic anomaly amplitude over the area. Most of the western third of the survey area and the southern part of the MOUNT MARUMBA sheet are magnetically disturbed with many anomalies ranging from a few tens of nanoteslas (nT) to about 200 nT in amplitude. Many of these anomalies are probably caused by dolerite intrusives and basalts reported in this region. The other prominent magnetic feature is a band approximately coinciding with the Mitchell Range in the ARNHEM BAY sheet, where some anomalies reach an amplitude of about 1000 nT. The anomalies here are probably caused by basic volcanic and igneous rocks associated with the Mirarrmina Complex. Elsewhere, the magnetic relief is generally low, with anomaly amplitudes less than 100 nT.

MA 13



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1978

LOCALITY MAP
AND
FLIGHT-LINE SYSTEM

10 0 20 40 60 80 100 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

COBOURG PENINSULA	JUNCTION BAY	WESSEL ISLANDS	TRUANT ISLAND
ALLIGATOR RIVER	MILINGIMBI	ARNHEM BAY	GOVE
MOUNT EVELYN	MOUNT MARUMBA	BLUE MUD BAY	PORT LANGDON
KATHERINE	URAPUNGA	ROPER RIVER	CAPE BEATRICE
LARRIMAH	HODGSON DOWNS	MOUNT YOUNG	PELLEW

a gradual deepening of the basin to a maximum of 1600 m in the west of the Rutland Plains 1:250 000 Sheet area. In the north-west of the survey area no magnetic anomalies suitable for depth estimation were recorded.

The magnetic data over the exposed parts of the Peninsula Ridge allowed the interpretation to be extended to areas of alluvial cover, under which metamorphic rocks have been delineated.

The radiometric results showed that little of the laterite has a thorium response; thus it would be difficult to map it using radiometric methods. The granites and metamorphic rocks gave a response only in the potassium channel whereas some of the alluvials and clays contained thorium. No uranium anomalies were recorded.

Airborne Gamma Ray Spectrometer System Development (J. Rees)

Detector Assembly: A contract for $40 000 was let for the supply of a detector assembly containing 16 000 cc (1000 cu ins) of thermally stabilised NaI (Tl) crystal. The new slab crystal package will replace the three 6" x 4" cylindrical crystals (5560 cc) which have been used for the past 10 years in VH-BMG. The application of airborne gamma-ray spectrometry to regional geological mapping and uranium search will be significantly enhanced by the improved counting statistics and increased sensitivity of the new equipment. Further upgrading of detector efficiency will be made when funds permit.

Data Acquisition: Feasibility studies on the design of a multi-channel analyser were completed. An extremely simple approach will utilise low cost front-end analogue to digital conversion hardware combined with signal processing in the data acquisition computer. The prototype system to be developed by mid-1979 will use 256 channels and will incorporate window size selection by software, and spectrum analysis facilities. The use of the natural spectrum for "self" calibration and stabilisation is being investigated to permit recording over the entire energy spectrum and allowing removal of the Cs 137 calibrating source.

Calibration and Test Sites: Work continued on the development of procedures to establish dynamic calibration strips for airborne spectrometer systems. Several strips will be established in the Canberra district and elsewhere in Australia for use by airborne contractors.

The gamma-ray spectrometer data showed many zones of potassium rich rocks and a few zones with anomalies in the uranium channel.

Processing of the survey data commenced in October and will continue in 1979. Maps displaying these data will be available late in that year, or early in 1980. Inspection of survey results will not be possible prior to the map releases.

Adelaide Geosyncline airborne magnetic and spectrometer survey, S.A. 1978: VH-BMG (K. Horsfall, G. Green, S.J. Wilcox, E. Chudyk)

At the request of the South Australian Department of Mines a regional airborne magnetic and spectrometer survey totalling approximately 24 000 line km of the RENMARK, PINNAROO; and parts of the ADELAIDE and BARKER 1:250 000 Sheet areas was flown from the airport at Renmark during the period October to early December (Fig. MA14).

The Twin Otter aircraft VH-BMG, which is equipped with a fluxgate magnetometer and a 4-channel spectrometer system, was used on the survey. It was flown at an average height of 150 m above ground level along flight lines bearing east-west. These lines were spread 3 km apart east of longitude 139°30'E and 1.5 km apart west of that line. A Doppler system was used to aid navigation and flight path recovery. All data were digitally recorded.

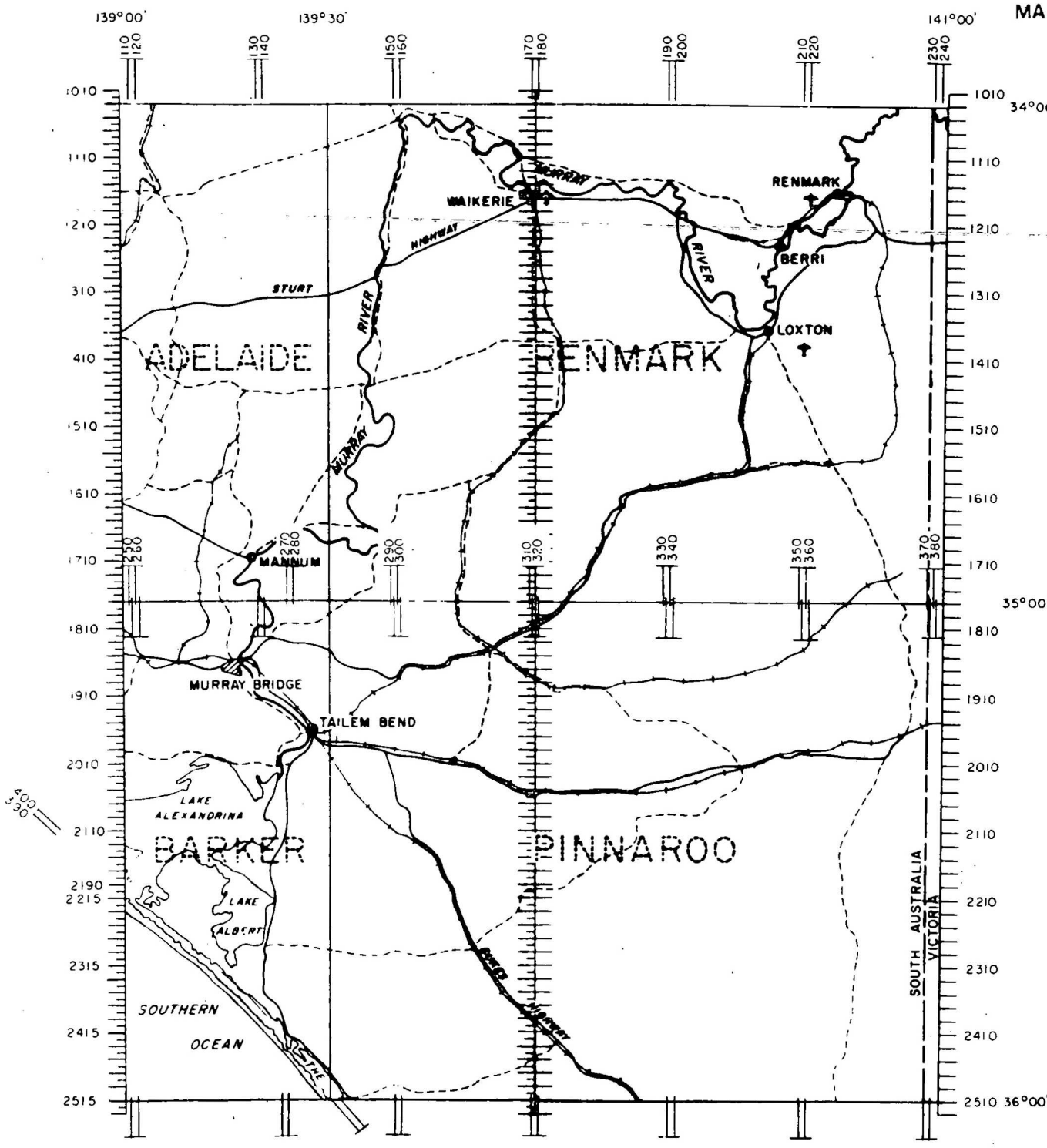
Processing of the survey data will commence in 1979 and preliminary release of survey results will be made as they become available.

Carpentaria Basin Airborne Survey Interpretation (K.R. Horsfall)

The geophysical interpretation of the 1973-74 airborne survey of the Carpentaria Basin, Qld was completed in September. A BMR Record on the results will be issued in 1979.

The main aims of the survey were accomplished in providing a more detailed account of the geological structure of the Laura and Carpentaria Basins. The magnetic depth to basement estimates agreed well with data from drill holes in the Laura Basin, and two basement highs were postulated. The basin sediments are approximately 1100 m thick in the region of Princess Charlotte Bay. Generally the magnetic data in the Carpentaria Basin suggest

MA 14



AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

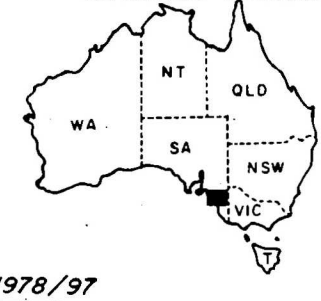
LOCALITY MAP

AND

FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

BURRA	CHOWILLA	ANA BRANCH
ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN

Record No. 1978/97

154/BI-27A

Survey Procedures: Several quality control procedures have been introduced into routine surveying associated with the Australia Wide Magnetic and Radiometric Mapping Project. Programs for improved control of equipment stability, sensitivity, and background monitoring together with the systematic measurement of absorption coefficients have been implemented in preparation for the better performance expected with the introduction of the new crystal and multichannel analyser in 1979.

A.D.P. Applications (J. Rees)

Collation and adaptation of published interpretation procedures for use by Metalliferous and Airborne Section personnel on the HP 2100 system in BMR and the CYBER 76 at CSIRO continued. Programs were developed for special analysis of spectrometer data to support the Pine Creek Project and for magnetic interpretation in the Georgina Basin Project. An interactive graphic modelling program was developed on the HP 2100. Numerous requests were received for the development of advanced analytical and interpretive routines for use by project teams involved in a regional geophysics data interpretation.

Foreign Aid - Philippines (J. Rees)

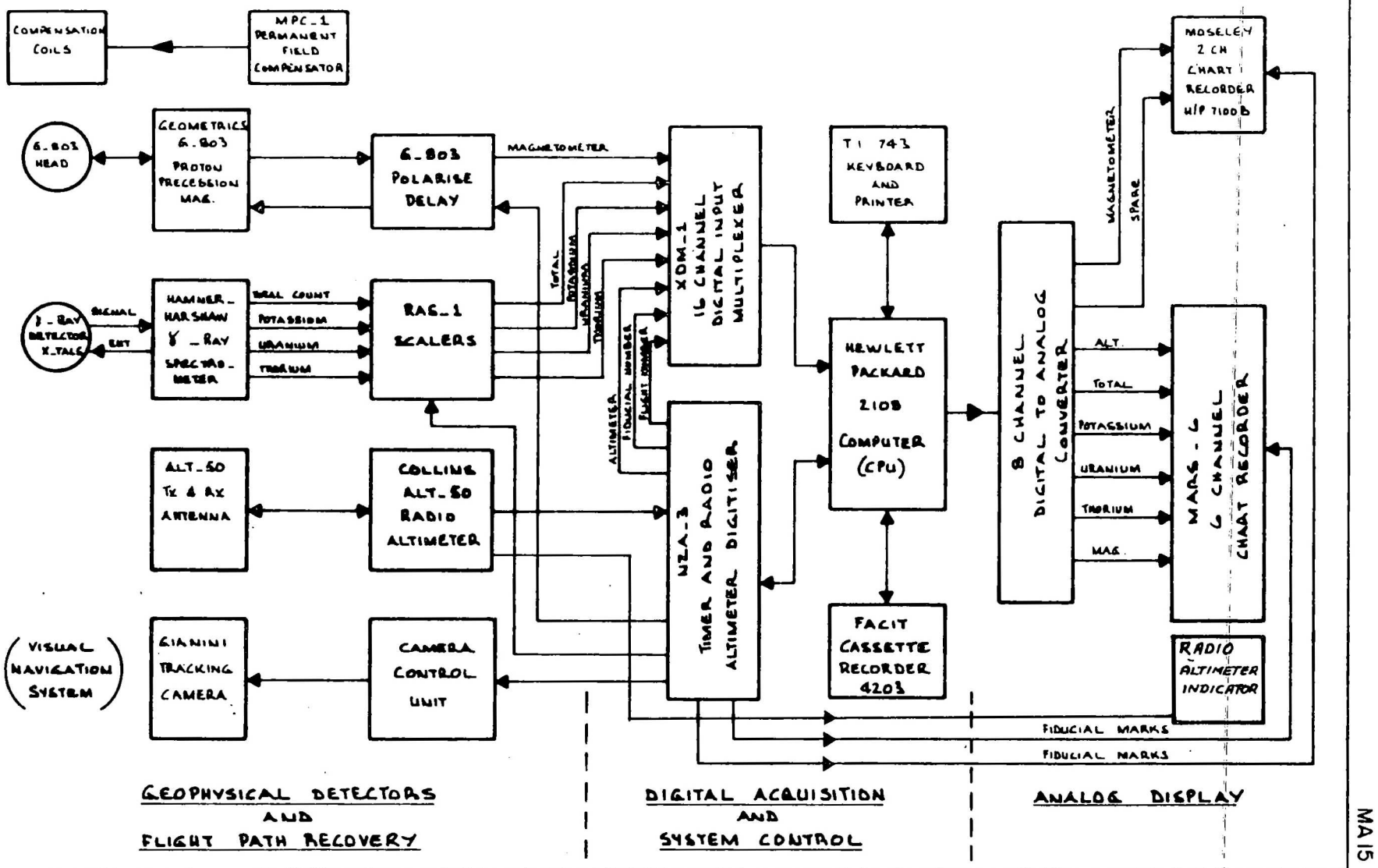
J. Rees was seconded to an ADAB (Foreign Affairs) mission which visited the Philippines during May to assess the status, potential and requirements for uranium exploration in the Philippines. A comprehensive report was submitted to ADAB in October.

Aircraft VH-BMR Refit (J. Rees)

The Aerocommander, VH-BMR, underwent extensive interior refitting and equipment replacement in the first half of the year to bring surveying performance up to the standard of the Twin Otter, VH-BMG. The final data acquisition system is shown in Figure MA15. A doppler navigation system and a multichannel gamma ray spectrometer with increased crystal detector volume (1000 - 2000 cu inch) are proposed to be installed when funds permit.

AERO COMMANDER VH-BMR

AIRBORNE GEOPHYSICAL DATA ACQUISITION SYSTEM OVERVIEW



Decommissioning of Aero Commander Aircraft VH-BMR

Because of cuts in the BMR budget the finance available for airborne operations was reduced to an extent which precluded the use of more than one aircraft for geophysical surveying during most of the 1978/79 financial year. Accordingly the Aero Commander, which lacked the doppler navigating equipment installed in the Twin Otter, was taken out of service on 1 September. The consequent reduction in survey capacity caused the deletion of the NARACOORTE, S.A. and HORSHAM, VIC 1:250 000 Sheet areas from program originally planned for 1978.

AIRBORNE REDUCTIONS AND CONTRACTS GROUP (C. Leary, R. Moore, A. Luyendyk, S. Chee, P. O'Rourke, Part-time - P. Bullock, A. Mutton, K. Horsfall, B. Wyatt, I. Zadoroznyj, O. Terron, P. Black, I. Perkovic) -

Airborne Data Processing: The Table MA 1 shows the status of data processing and mapping at the end of 1978. During the year final processing was commenced on new data for 21 1:250 000 map areas or part map areas and mapping was completed for 15 of these areas. Work was continued or additional work was done and completed on data for a further 33 areas. The total output for 1978 was 193 geophysical maps. At the start of 1979 work will continue on 6 map areas and a backlog of data for 17 areas will wait processing.

Preliminary Maps: Listed in Table MA2 are the magnetic and gamma-ray contour and profile maps made available during 1978 through the Copy Service, Government Printer (Production) and the relevant State Authorities. A total of 143 maps have been released. Figures MA16 - MA31 show reduced scale copies of a selection of these maps.

Listed in Table MA3 are 48 maps displaying spectrometer ratio data which are available for inspection at the BMR in Canberra.

Officer Basin Contract Survey: In mid-October delivery was taken of the magnetic and navigational data for the last 3 map areas (JUBILEE, MASON and FORREST, W.A.) involved in the contract. Data checking will be completed by the end of 1978 and the contract concluded.

TABLE MA1: AIRBORNE DATA PROCESSING AND MAPPING 1978

C = Processing completed P = Processing in Progress S = Data Stockpile

PROJECT	SHEET NAME	SURVEY CONFIGURATION					STATUS		MAPPING			
		MAG.	GAMMA	DOPPLER	SPACING km	ALT. m	MAG	GAMMA ray	No.	SCALE	CONTOURS	PROFILES
LACHLAN G/S	Bega	x	-	x	1.5	1650	C	-	1	1:250 000	magnetic	
									2	"		magnetic
	Mallacoota	x	-	x	1.5	1650	S					
	Warburton	x	-	-	1.5	1650	S	-				
PINE CREEK	Fergusson R.	x	x	x	1.5	150	C	C	3	1:250 000		rad. ratios
	Katherine	x	x	-	1.5	150	C	C	3	"		" "
ARUNTA	Mt Peake	x	x	x	1.5	150	C	C	3	1:250 000		" "
	Napperby	x	x	x	1.5	150	C	C	3	"		" "
	Hermannsburg	x	x	x	1.5	150	C	C	3	"		" "
	Alice Springs	x	x	x	1.5	150	C	C	3	"		" "
OFFICER BASIN	Neale	x	-	-	3.0	500	C	-	1	"	magnetic	" "
									2	"		magnetic
	Vernon	x	-	-	3.0	500	C	-	1	1:250 000	magnetic	
									2	"		magnetic
	Wanna	x	-	-	3.0	500	C	-	1	1:250 000	magnetic	
									2	"		magnetic
	Jubilee	x	-	-	3.0	500	P	-				
	Mason	x	-	-	3 0	500	P	-				
	Forrest	x	-	-	3.0	500	P	-				
GEORGINA BASIN	Glenormiston	x	x	-	1.0	100	C	C	1	1:100 000	magnetic	
									1	"	total count	
									6	"		gamma ray
MACARTHUR BASIN	Urapunga	x	x	x	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Roper River	x	x	x	3.0	150	C	C	1	"	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Hodgson Downs	x	x	x	3.0	150	C	C	1	"	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Mt Young	x	x	x	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios

TABLE MA1: Contd.

PROJECT	SHEET NAME	SURVEY CONFIGURATION					STATUS		MAPPING			
		MAG	GAMMA RAY	DOPPLER	SPACING KM	ALT. M	MAG	GAMMA RAY	NO.	SCALE	CONTOURS	PROFILES
MACARTHUR BASIN	Pellew	x	x	x	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Tamumbirini	x	x	-	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Bauhinia Downs	x	x	-	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad ratios
	Robinson River	x	x	-	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad ratios
	Wallhallow	x	x	-	3.0	150	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Calvert Hills	x	x	-	1.5/ 3.0	100	C	C	1	1:250 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1	"		magnetic
									3	"		rad. ratios
	Junction Bay	x	x	x	3.0	150	S	S				
	Wessel Is.	x	x	x	3.0	150	S	S				
	Truant Is.	x	x	x	3.0	150	S	S				
	Milingimbi	x	x	-	3.0	150	S	S				
	Arnhem Bay	x	x	-	3.0	150	S	S				
	Gove	x	x	x	3.0	150	S	S				
	Mt Marumba	x	x	-	3.0	150	S	S				
	Blue Mud Bay	x	x	x	3.0	150	S	S				
	Pt Langdon	x	x	x	3.0	150	S	S				
	Roper River	x	x	x	3.0	150	S	S				
	Cape Beatrice	x	x	x	3.0	150	S	S				

TABLE MA1: Contd.

PROJECT	SHEET NAME	SURVEY CONFIGURATION					STATUS		MAPPING			
		MAG.	GAMMA	DOPPLER	SPACING	ALT.	MAG	GAMMA	No.	SCALE	CONTOURS	PROFILES
ALBANY-FRASER	Bremer Bay	x	x	x	1.5	150	P	P				
	Mt Barker	x	x	x	1.5	150	P	P				
	Pemberton	x	x	x	1.5	150	P	P				
ARUNTA	Ehrenburg Range	x	x	-	1.5	100	C	C	1	1:100 000	magnetic	
									1	"	total count	
									6	"		gamma ray
									1			magnetic
VICTORIA	Bendigo	x	x	x	1.5	150	C	C	2	1:250 000		magnetic
QUEENSLAND	Cooktown	x	x	x	3.0	150	C	C	1	"	total count	
									1	"		magnetic
	Rutland Plns	x	x	x	3.0	150	C	C	1	"	total count	
									1	"		magnetic
	Hann River	x	x	x	3.0	150	C	C	1	"	total count	
									1	"		magnetic
WEST AUSTRALIA	Bencubbin	x			1.5	150	C	C	2	1:250 000		"
	Moora	x			1.5	150	C	C	2	"		"
	Ningham	x			1.5	150	C	C	2	"		"
	Peremjori	x			1.5	150	C	C	2	"		"
	Glenburg	x			1.5	150	C	C	2	"		"
	Nabberu	x			1.5	150	C	C	2	"		"
	Peake Hill	x			1.5	150	C	C	2	"		"
	Robinson Range	x			1.5	150	C	C	2	"		"
	Stanley	x			1.5	150	C	C	2	"		"
ADELAIDE GEOSYNCLINE	Adelaide	x	x	x	1.5	150	S	S				"
	Renmark	x	x	x	1.5/ 3.0	150	S	S				"
	Barker	x	x	x	1.5	150	S	S				
	Pinnaroo	x	x	x	1.5/ 3.0	150	S	S				
					Toaal No. maps				193			

Supply of Data to Outside Organisations: During 1978 4 external organisations requested copies of digital geophysical data in respect of a total of 14 1:250 000 Sheet areas. These were supplied on magnetic tape at a cost of $250 per sheet area.

Several requests were received for computer programs contained within the Airborne Group's data processing system ARGUS (Airborne Reductions Group Utility System). In order to respond to these requests the manuals describing the data structures and processing philosophy along with program listings are to be published as a microfiche report. Considerable effort was put into updating the manuals to reflect the changes and developments which have occurred since they were first written.

ADP System Development: Major program developments were in the following areas.

1. A complete set of programs were written for the conversion of airborne geophysical data to tape formats suitable for users external to the BMR.
2. Programs which enter field data into the Data Base were modified to reflect changes in the aircraft acquisition systems.
3. The magnetic data levelling programs were considerably upgraded.
4. Doppler flight path recovery programs were extended to provide line printer plots of navigation miss-matches.
5. Photo-navigation flight path recovery programs were extended to provide an extrapolation facility for the start and end points of flight lines.
6. Profile and flight path plotting routines were upgraded to ensure standard map presentation.
7. The major requirements for upgrading the contouring package were specified.

Two ARGUS programs were fully documented at user level for the expenditure of 4 man weeks programmer effort. It is estimated that a further 46 man weeks programmer effort will be required to document the other 65 programs to this level contributing significantly to the programming and documentation backlog of 50 man weeks which will be carried forward into 1979.

TABLE MA2: AIRBORNE PRELIMINARY MAP RELEASES 1978

PROJECT	SHEET NAME	NO. OF MAPS	SCALE	CONTOURS	PROFILES	FIG.
OFFICER BASIN W.A.	Yowalga	1	1:250 000	magnetic		MA16
		2	"		magnetic	
	Westwood	1	"	magnetic		MA17
		2	"		magnetic	
	Lennis	1	"	magnetic		MA18
		2	"		magnetic	
	Waigen	1	"	magnetic		MA19
		2	"		magnetic	
	Neale	1	"	magnetic		MA20
		2	"		magnetic	
	Vernon	1	"	magnetic		MA21
		2	"		magnetic	
	Wanna	1	"	magnetic		MA22
		2	"		magnetic	
LACHLAN GEOSYNCLINE	Bega	1	"	magnetic		MA23
		2	"		magnetic	
MACARTHUR BASIN	Urapunga	1	"	total count		MA24
		1	"	magnetic		MA25
		6	"		gamma-ray	
		1	"		magnetic	
	Hodgson Downs	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
	Mt Young	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
	Pellew	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
	Bauhinia Downs	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
	Wallhallow	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
	Calvert Hills	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	

TABLE MA2: Contd

PROJECT	SHEET NAME	NO. OF MAPS	SCALE	CONTOURS	PROFILES	FIG.
MACARTHUR BASIN (Cont)	Tanumbirini	1	1:250 000	total count		
		1	"	magnetic		
		6	"		gamma ray	
		1	"		magnetic	
	Roper River	1	"	total count		MA26
		1	"	magnetic		MA27
		6	"		gamma-ray	
		1	"		magnetic	
	Robinson River	1	"	total count		
		1	"	magnetic		
		6	"		gamma-ray	
		1	"		magnetic	
N.S.W. (revised)	Canberra	1	"	magnetic		
(revised)	Broken Hill	1	"	magnetic		
		1	"	total count		MA28
VICTORIA	Bendigo	2	"		magnetic	
QUEENSLAND	Cooktown	1	"	total count		MA29
		1	"		magnetic	
	Rutland Plains	1	"	total count		MA30
		1	"		magnetic	
	Hann River	1	"	total count		MA31
		1	"		magnetic	
WEST AUSTRALIA	Bencubbin	2	"		magnetic	
	Moora	2	"		magnetic	
	Ninghan	2	"		magnetic	
	Peremjori	2	"		magnetic	
	Glenburg	2	"		magnetic	
	Nabberu	2	"		magnetic	
	Peake Hill	2	"		magnetic	
	Robinson Range	2	"		magnetic	
	Stanley	2	"		magnetic	

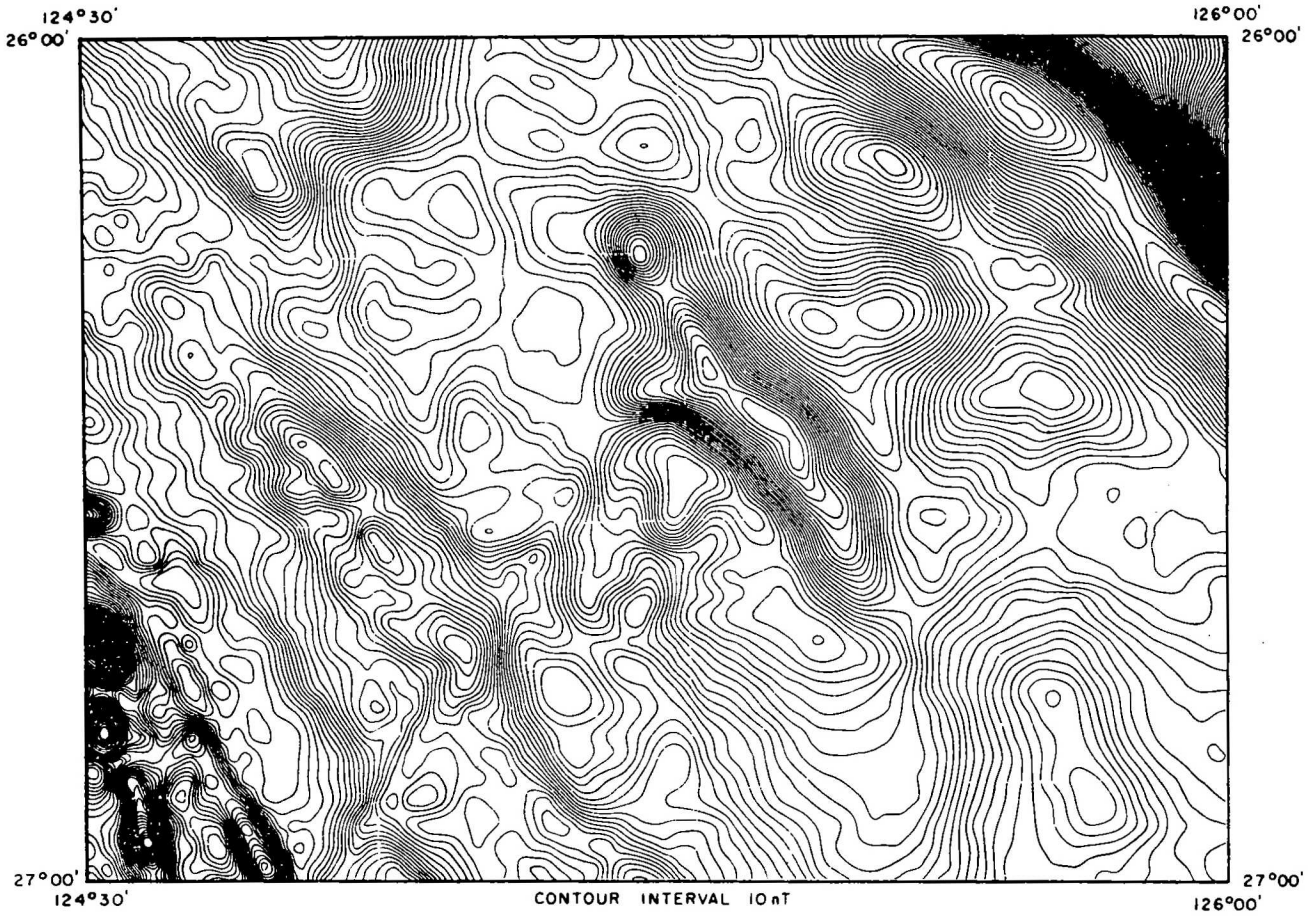
TABLE MA3: AIRBORNE MAPS NOT RELEASED 1978

AVAILABLE FOR INSPECTION AT BMR

PROJECT	SHEET NAME	NO. OF MAPS	SCALE	CONTOURS	PROFILES
PINE CREEK	Fergusson River	3	1:250 000		Rad. Ratios
	Katherine	3	"		" "
ARUNTA	Mt Peake	3	"		" "
	Napperby	3	"		" "
	Hermannsburg	3	"		" "
	Alice Springs	3	"		" "
MACARTHUR BASIN	Urapunga	3	"		" "
	Roper River	3	"		" "
	Hodgson Downs	3	"		" "
	Mt Young	3	"		" "
	Pellew	3	"		" "
	Tanumbirini	3	"		" "
	Bauhinia Downs	3	"		" "
	Robinson River	3	"		" "
	Wallhallow	3	"		" "
	Calvert Hills	3	"		" "
	Total No. Maps	48			

MA 16

YOWALGA



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

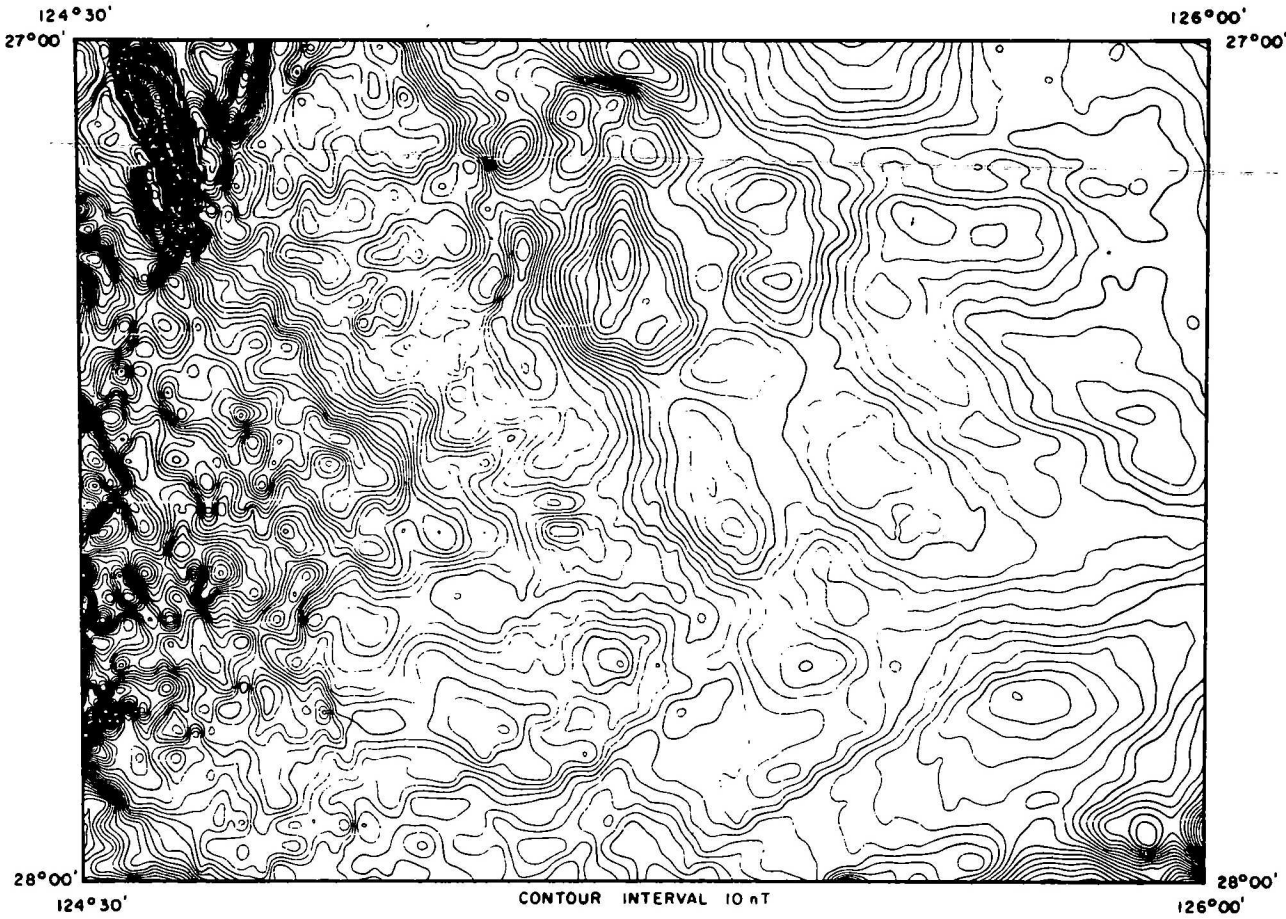
HERBERT	BROWNE	BENTLEY
ROBERT	YOWALGA	TALBOT
THROSSELL	WESTWOOD	LENNIS

Record No. 1978/97

G51/81-78AR

MA17

WESTWOOD



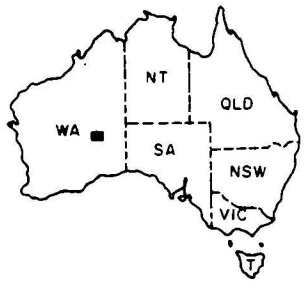
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



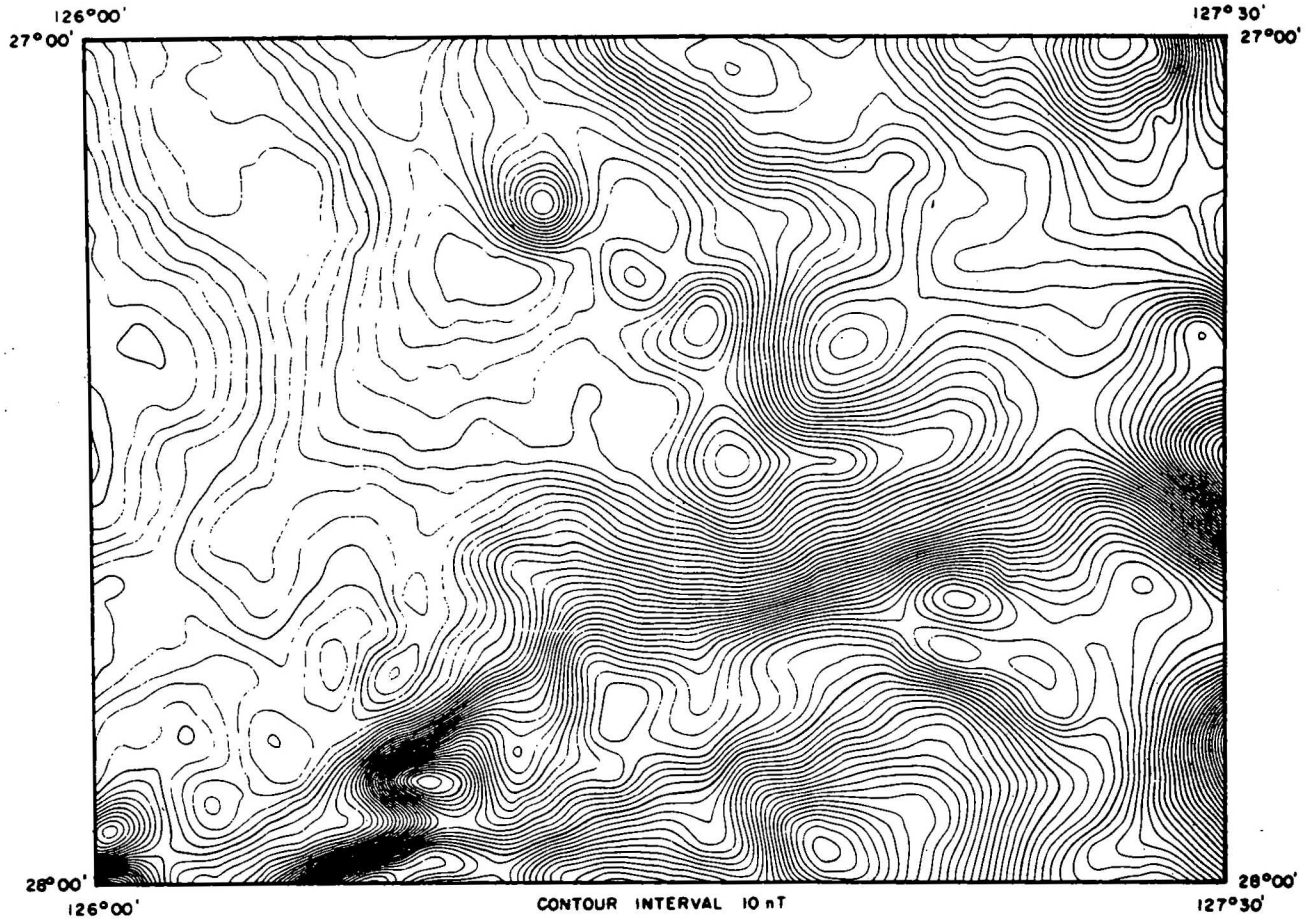
REFERENCE TO 1:250 000 MAP SERIES

ROBERT	YOWALGA	TALBOT
THROSSELL	WESTWOOD	LENNIS
RASON	NEALE	VERNON

Record No. 1978/97

MA18

LENNIS



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

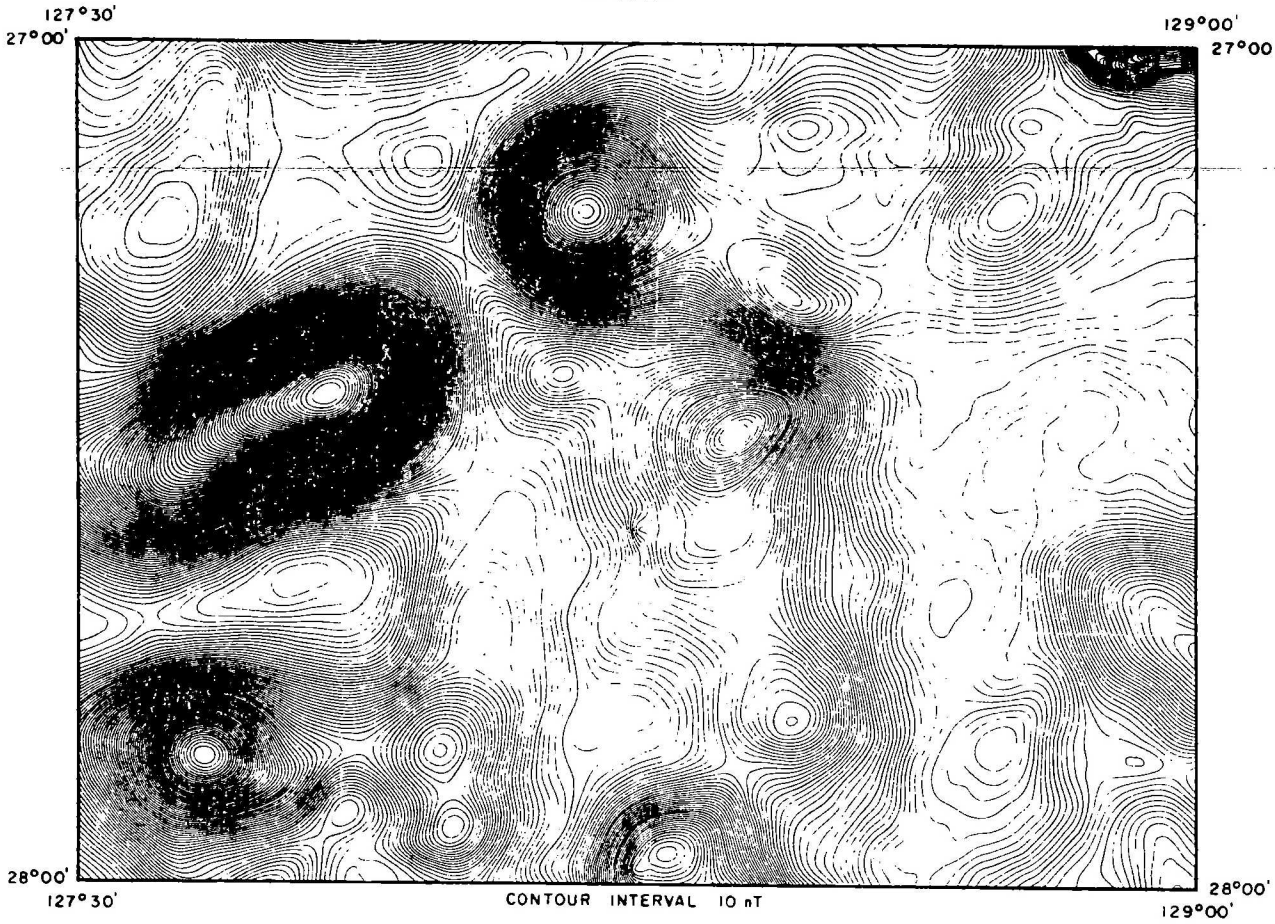
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

YOWALGA	TALBOT	COOPER
WESTWOOD	LENNIS	WAIGEN
NEALE	VERNON	WANNA

MA19

WAIGEN



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 km

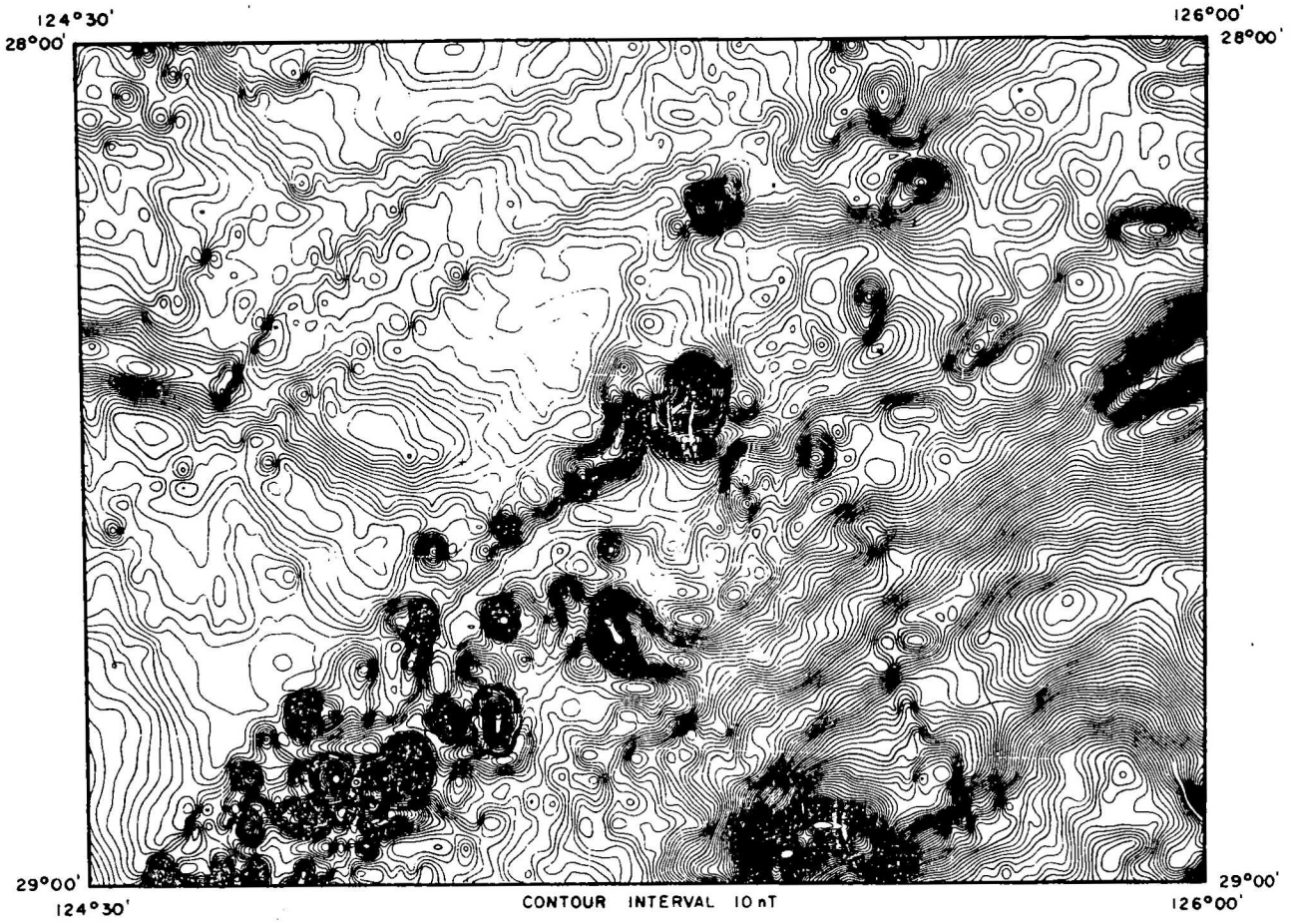
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

TALBOT	COOPER	MANN
LENNIS	WAIGEN	BIRKSGATE
VERNON	WANNA	NOORINA

MA 20

NEALE



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

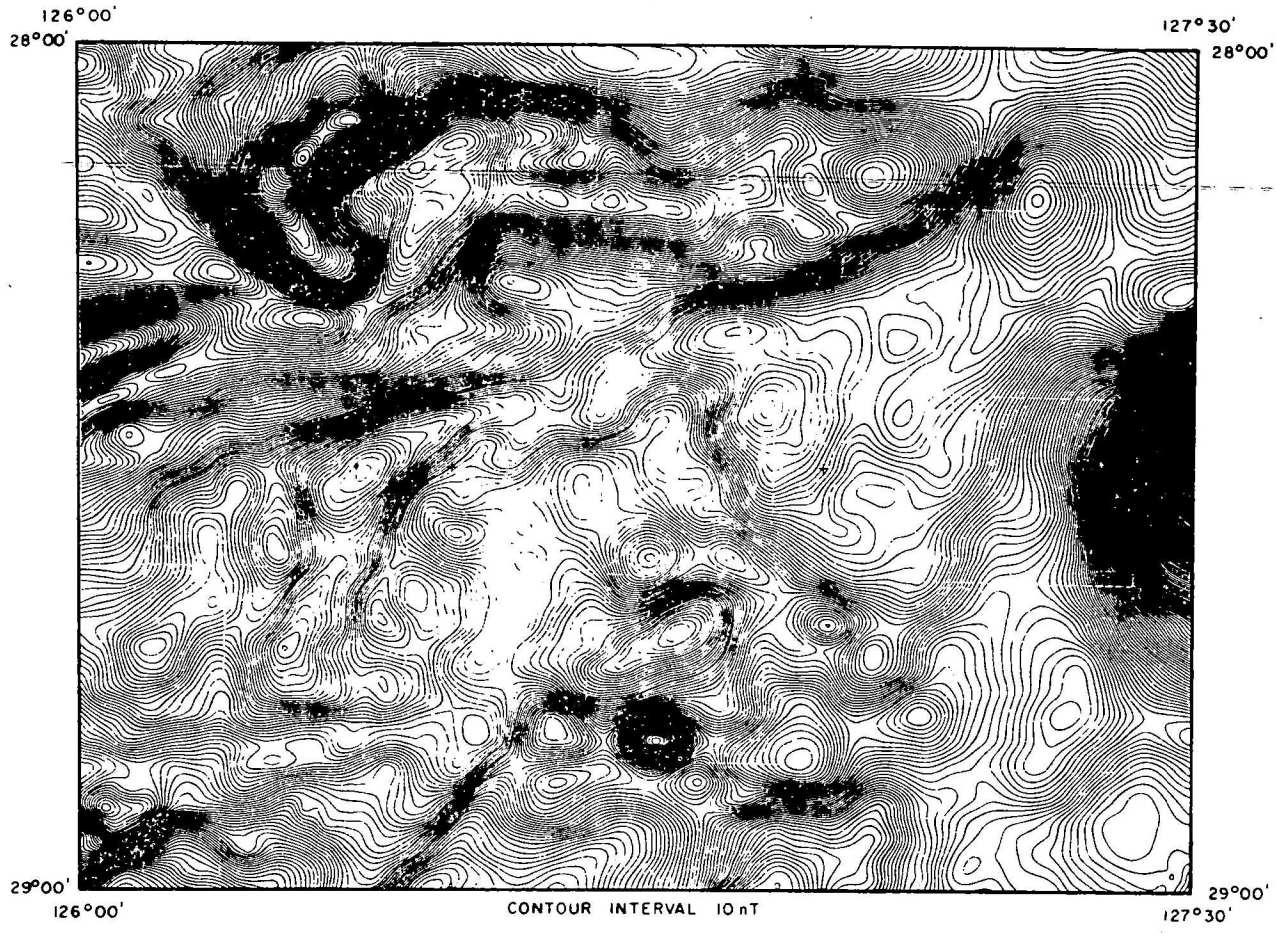
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

THROSSELL	WESTWOOD	LENNIS
RASON	NEALE	VERNON
MINIGWAL	PLUMRIDGE	JUBILEE

MA 21

VERNON



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 km

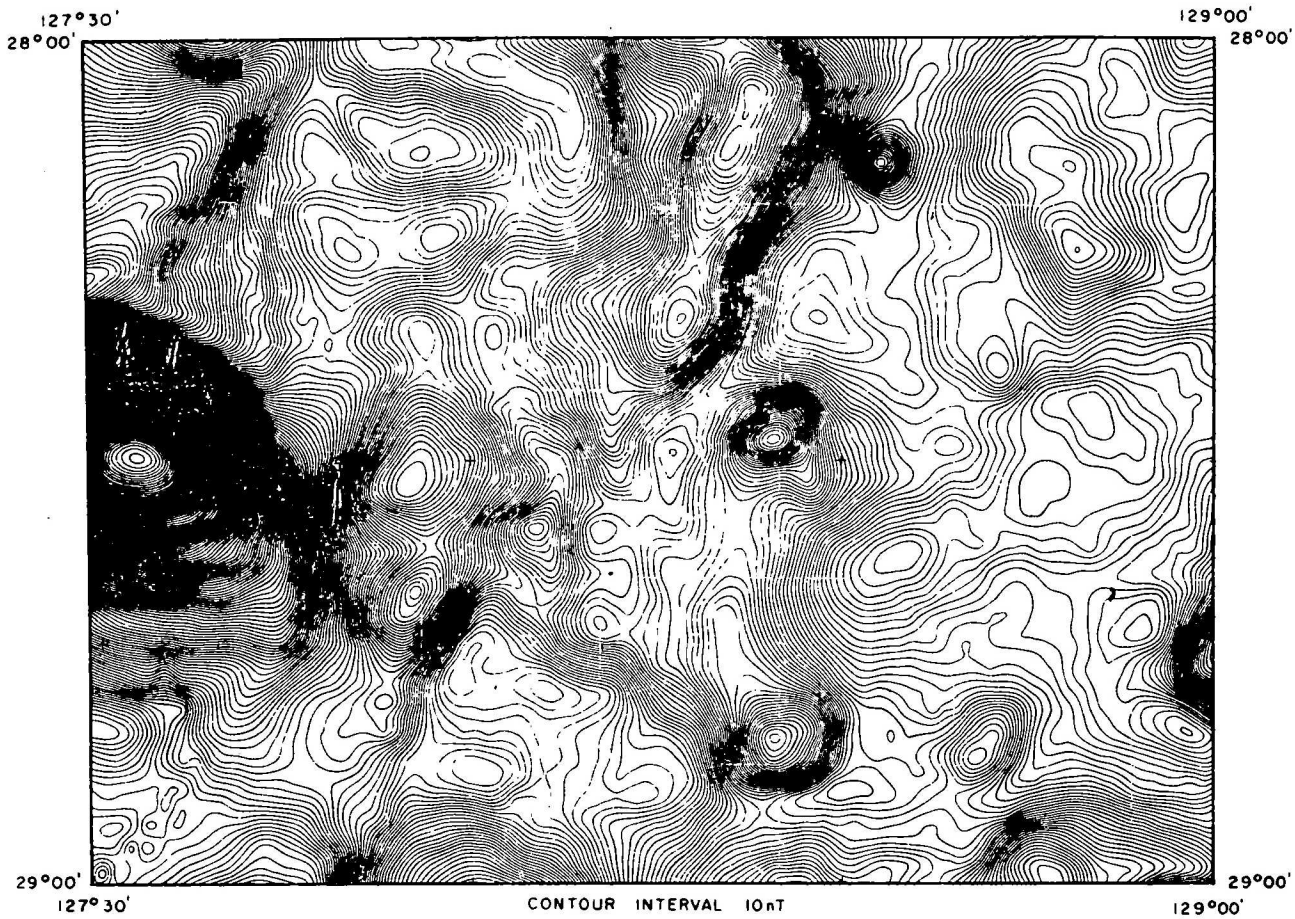
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

WESTWOOD	LENNIS	WAIGEN
NEALE	VERNON	WANNA
PLUMRIDGE	JUBILEE	MASON

MA 22

WANNA



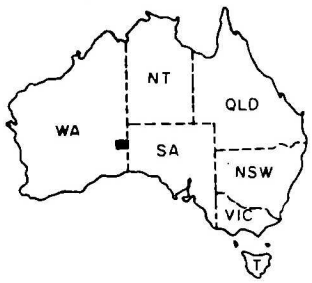
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



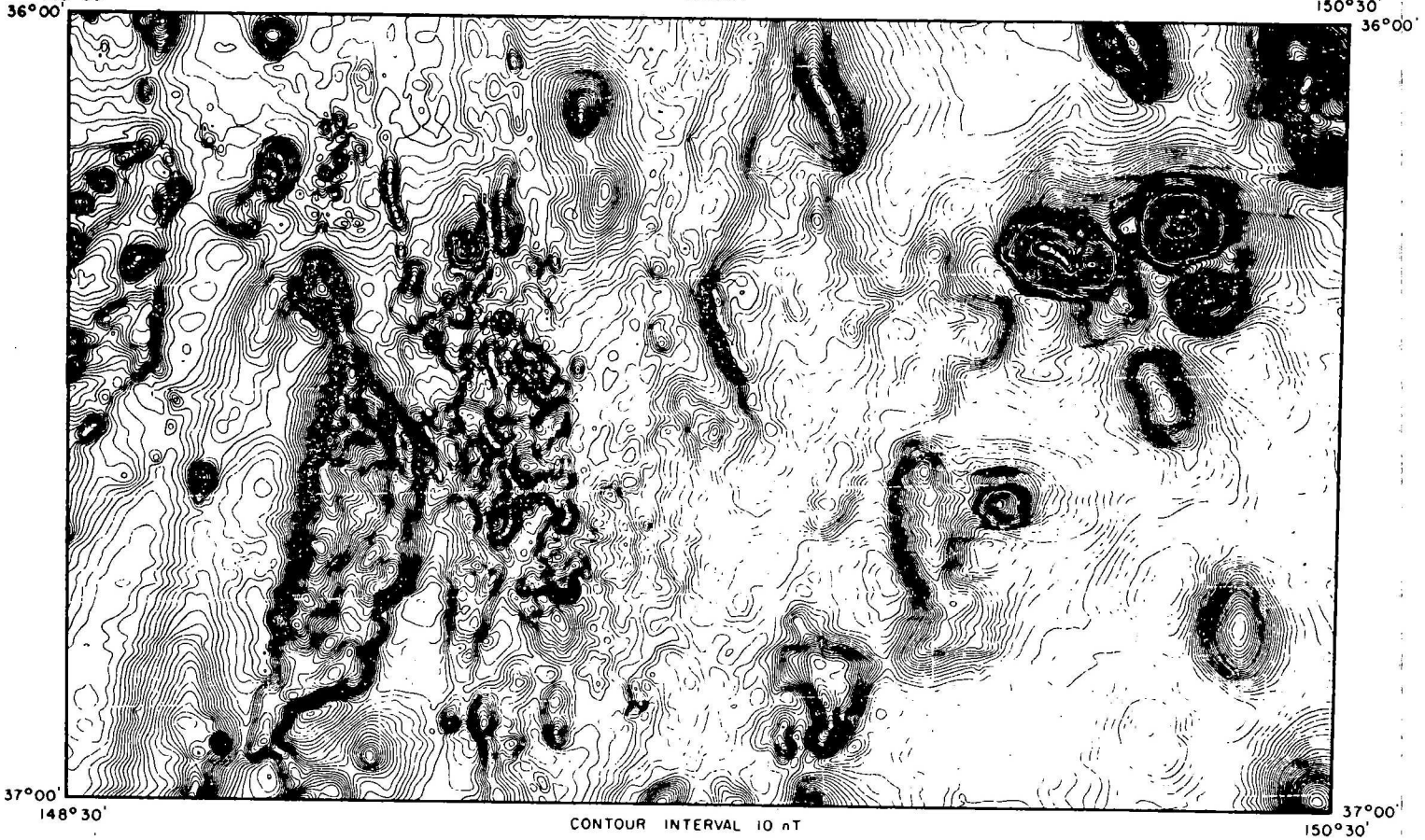
REFERENCE TO 1:250 000 MAP SERIES

LENNIS	WAIGEN	BIRKSGATE
VERNON	WANNA	NOORINA
JUBILEE	MASON	WYOLA

Record No. 1978/97

H52/BI-49AR

BEGA



CONTOUR INTERVAL 10 nT

LOCATION DIAGRAM

AIRBORNE SURVEY, BEGA, NSW 1976

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

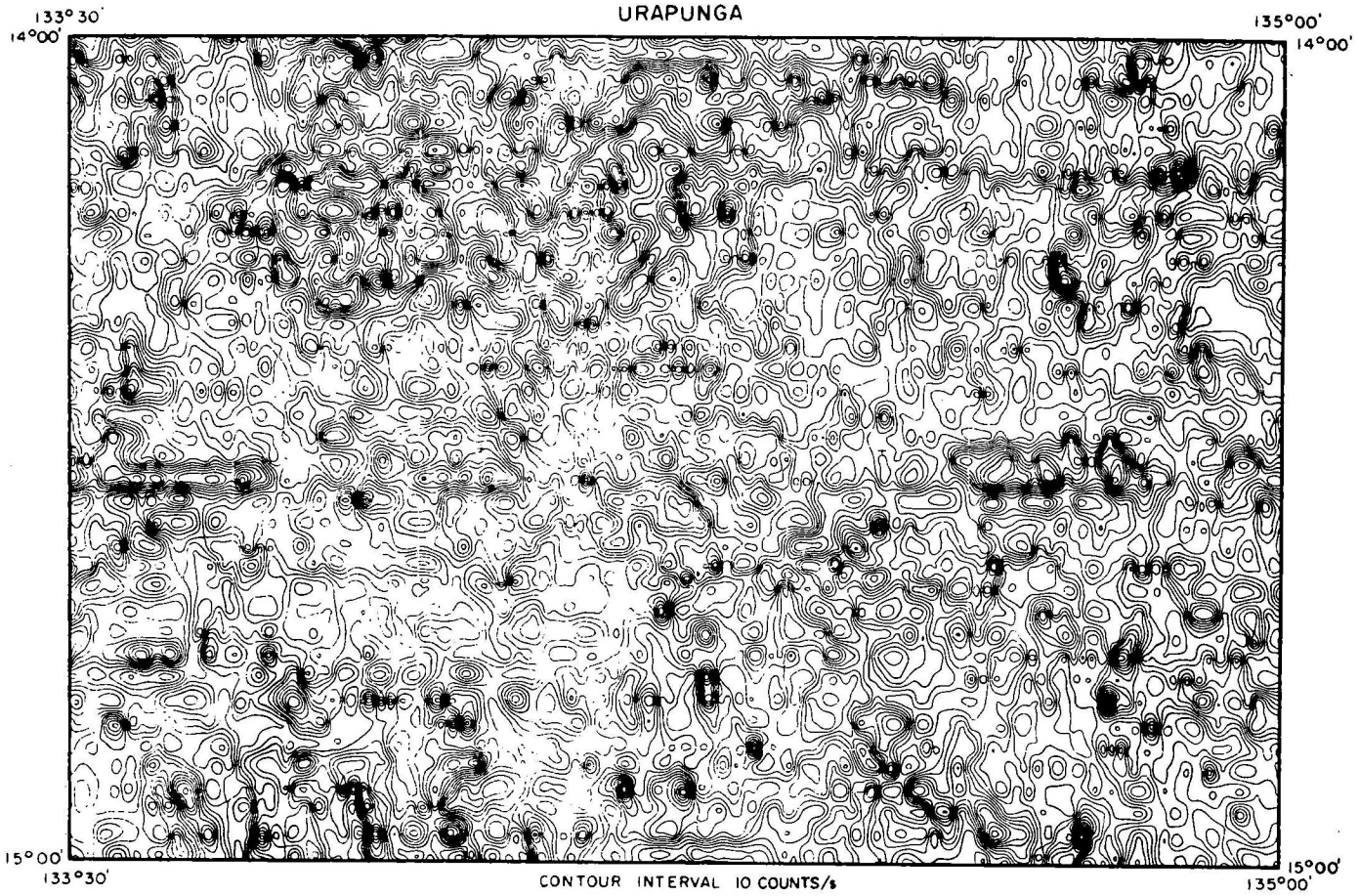
REFERENCE TO 1:250 000 MAP SERIES

WAGGA WAGGA	CANBERRA	ULLADULLA
TALLANGATTA	BEGA	
BAIRNSDALE	MALLACOOTA	

J55/BI-55AR

MA 23

MA24



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000000

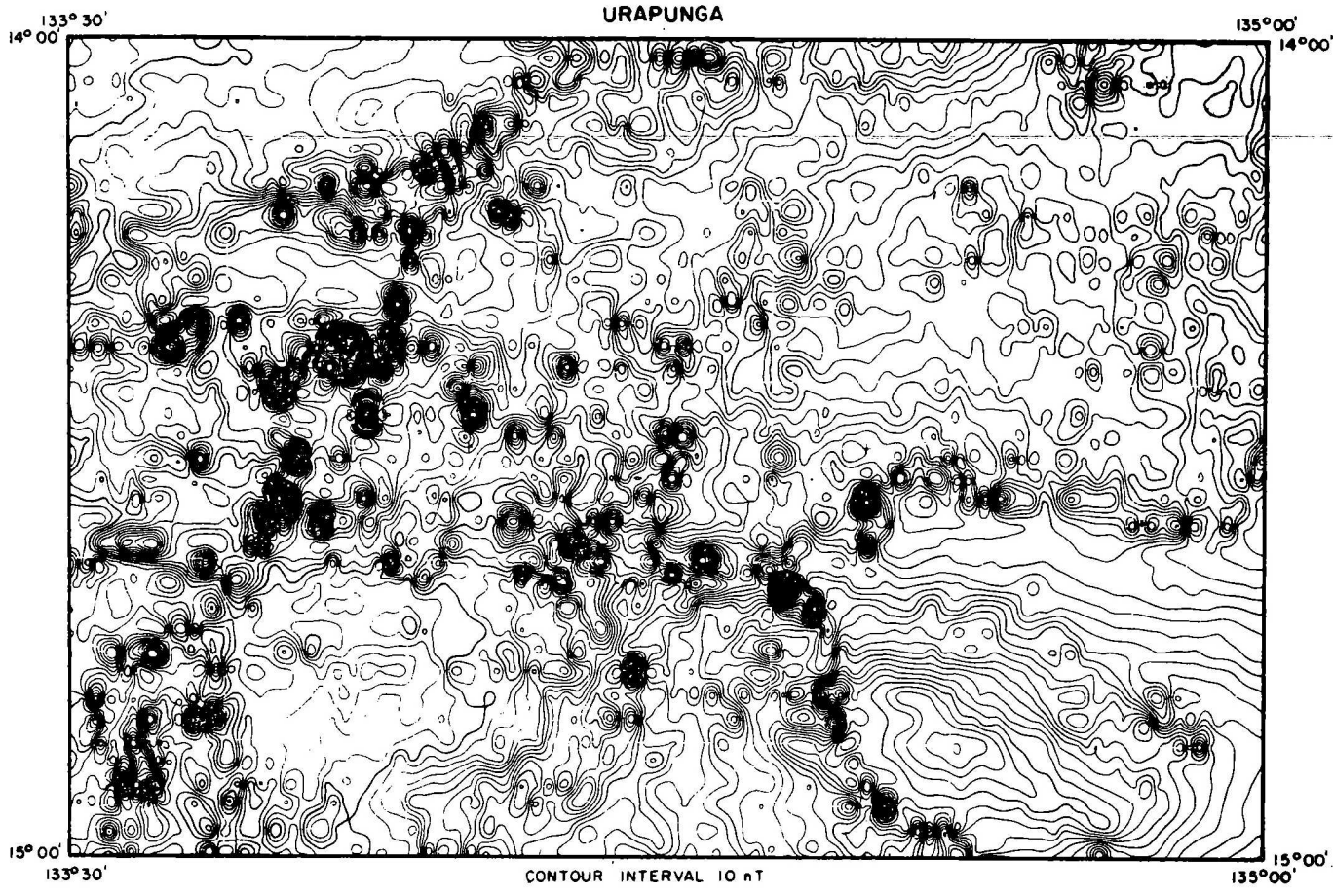
10 0 0 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

MT EVELYN	MT MARUMBA	BLUE MUD BAY
KATHERINE	URAPUNGA	ROPER RIVER
LARRIMAH	HODGSON DOWNS	MT YOUNG

MA25



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

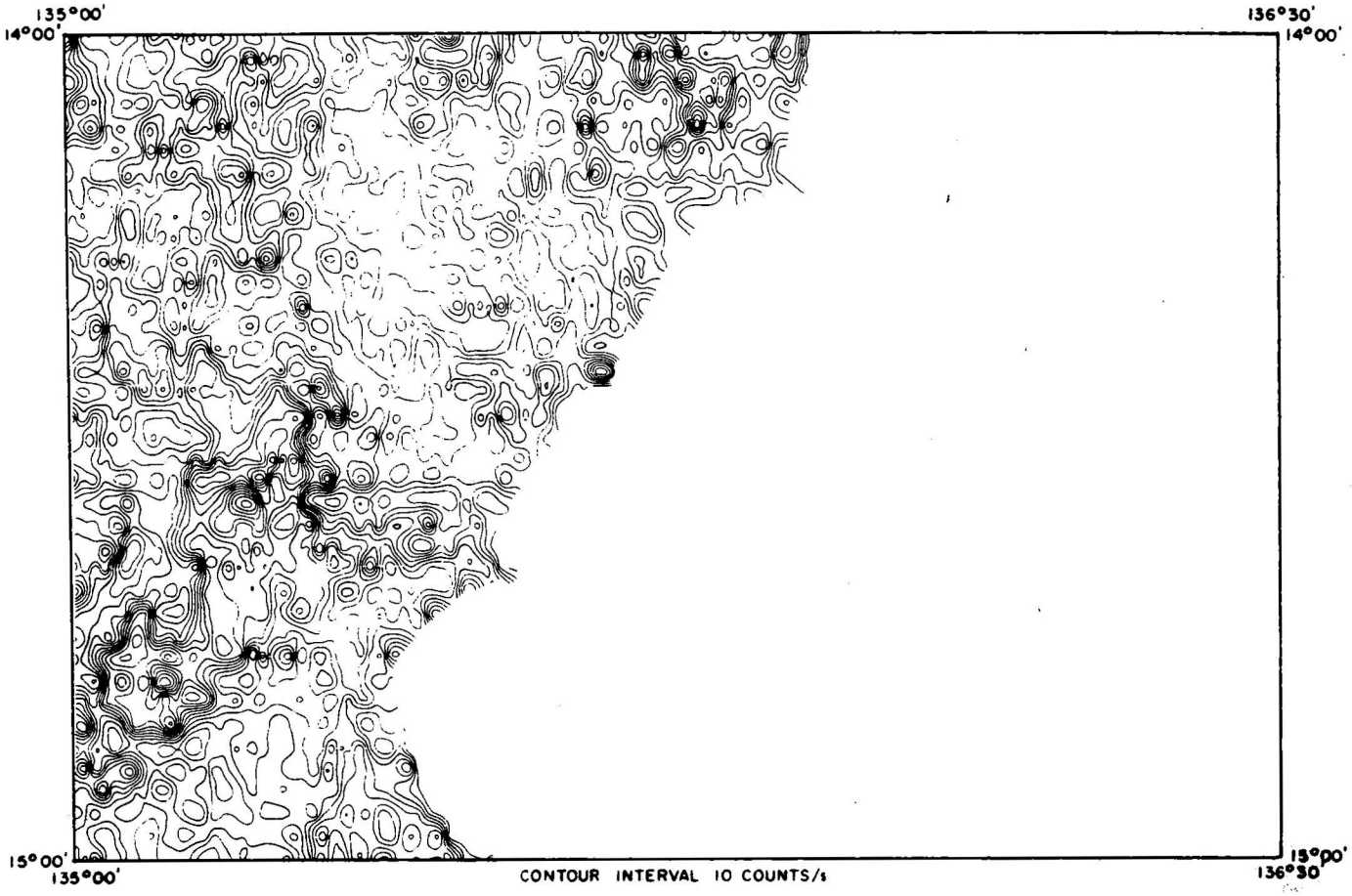
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

MT EVELYN	MT MARUMBA	BLUE MUD BAY
KATHERINE	URAPUNGA	ROPER RIVER
LARRIMAH	HODGSON DOWNS	MT YOUNG

MA 26

ROPER RIVER



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

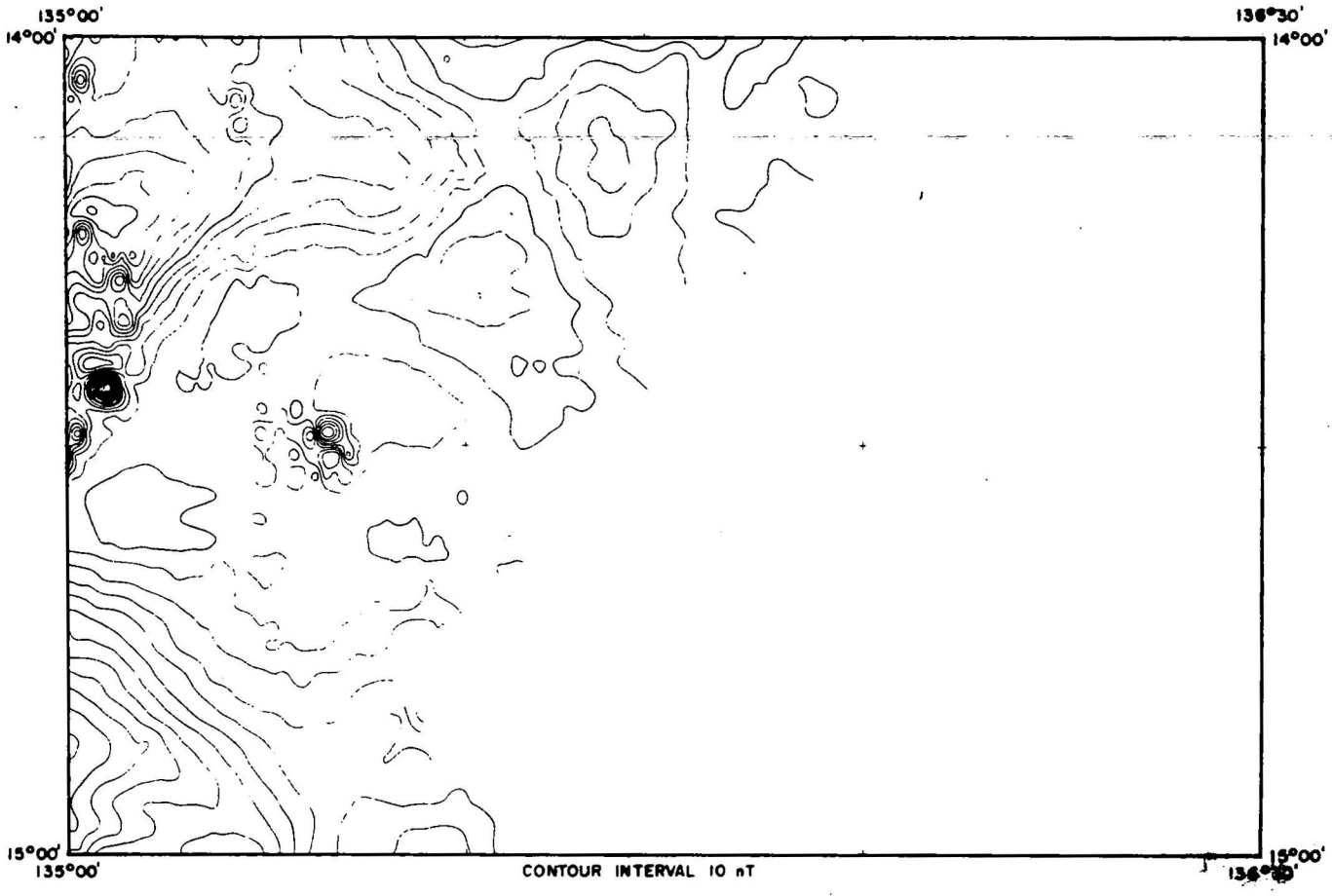
REFERENCE TO 1:250 000 MAP SERIES

MOUNT MARUMBA	BLUE MUD BAY	PORT LANGDON
URAPUNGA	ROPER RIVER	CAPE BEATRICE
HODGSON DOWNS	MOUNT YOUNG	PELLEW

Record No. 1978/97

MA 27

ROPER RIVER



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

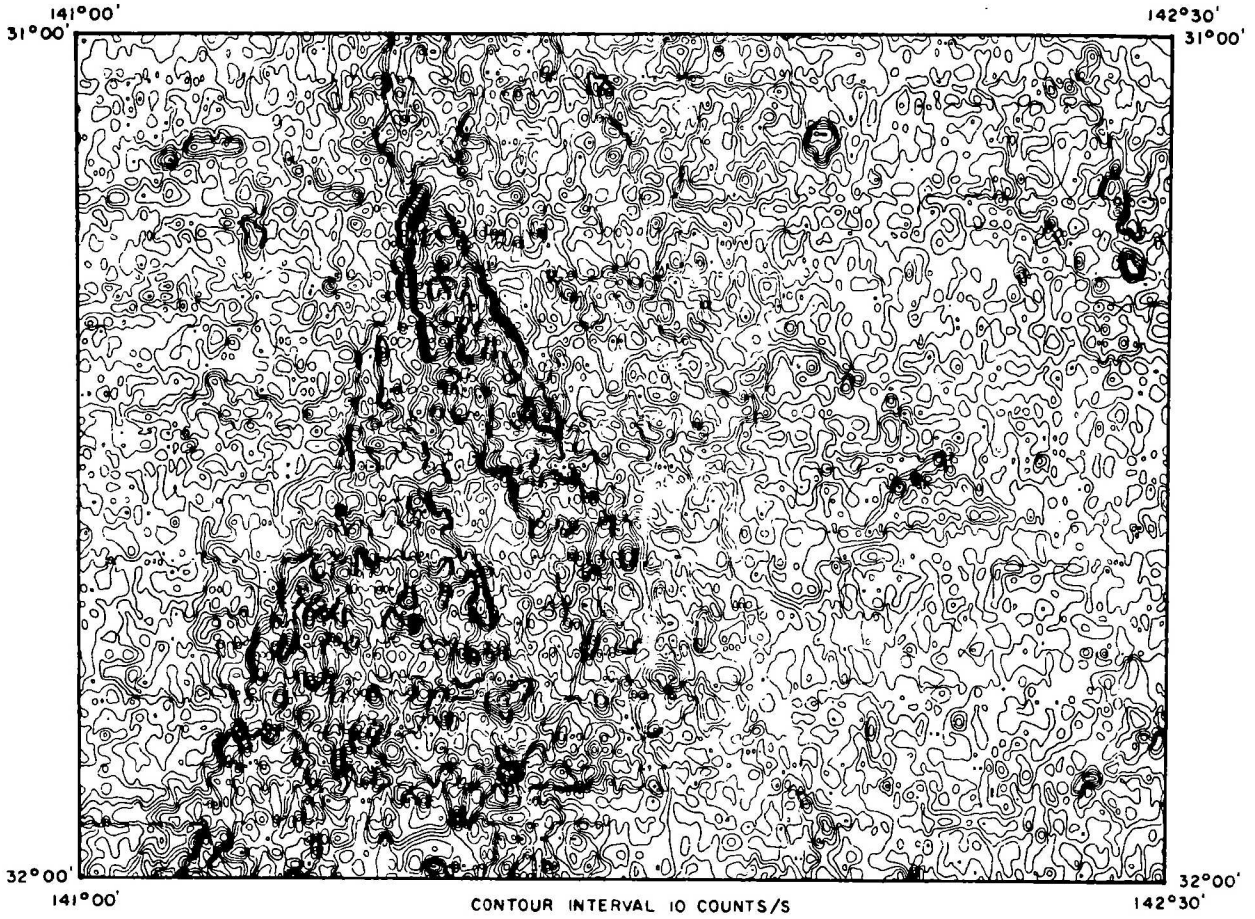
REFERENCE TO 1:250 000 MAP SERIES

MOUNT MARUMBA	BLUE MUD BAY	PORT LANGDON
URAPUNGA	ROPER RIVER	CAPE BEATRICE
HODGSON DOWNS	MOUNT YOUNG	PELLEW

Record No. 1978/97

MA28

BROKEN HILL



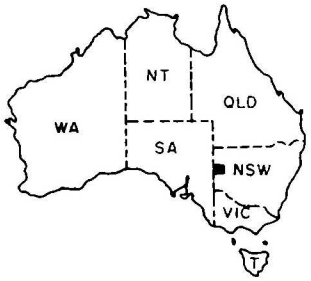
AIRBORNE SURVEY, BROKEN HILL, NSW 1975

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



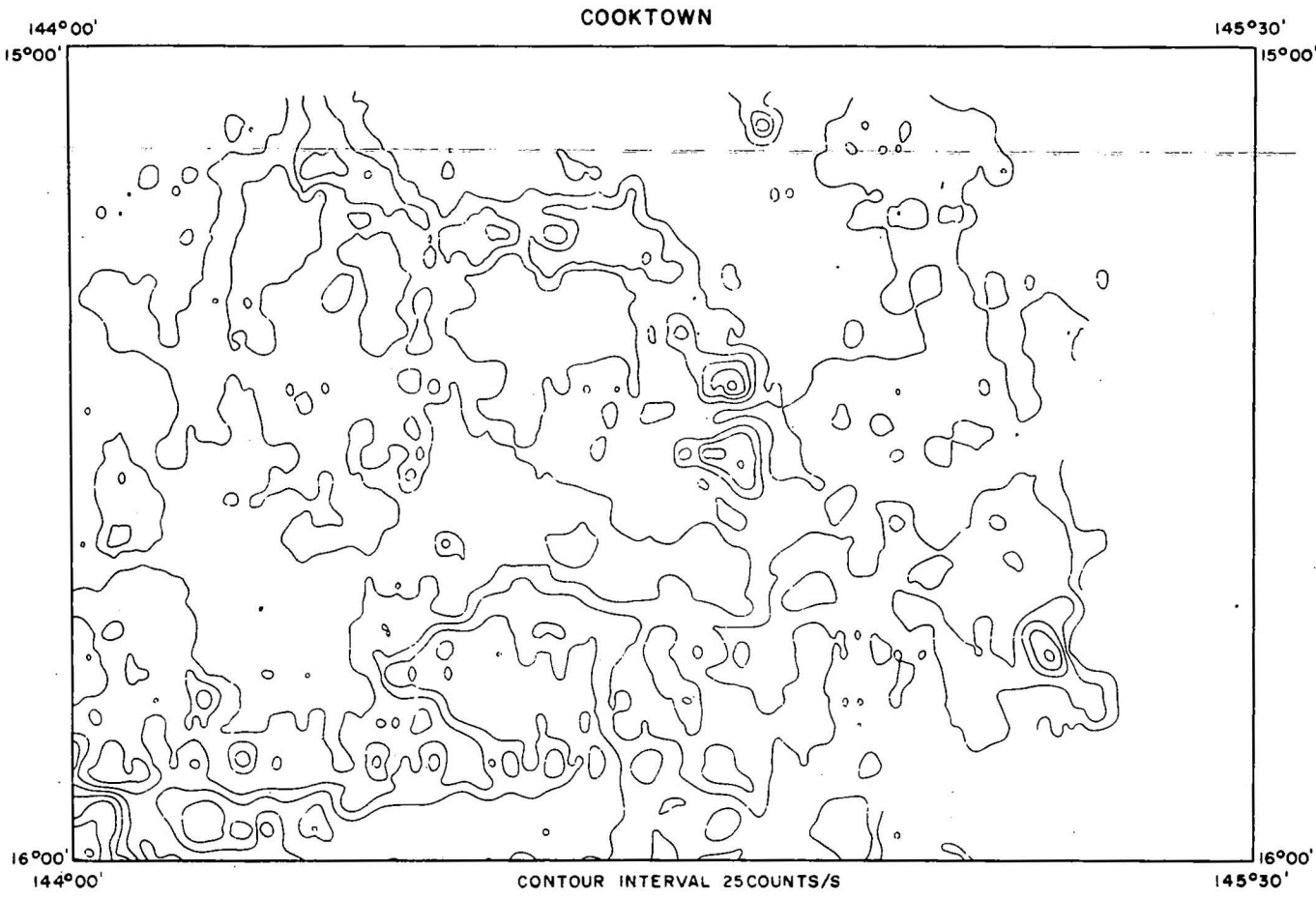
REFERENCE TO 1:250 000 MAP SERIES

FROME	COBHAM LAKE	WHITE CLIFFS
CURNAMONA	BROKEN HILL	WILCANNIA
OLARY	MENINDEE	MANARA

Record No. 1978/97

H54/BI-145A

MA29



AIRBORNE SURVEY, CARPENTARIA BASIN, QLD 1975

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000 000

10 0 10 20 30 40 50 km

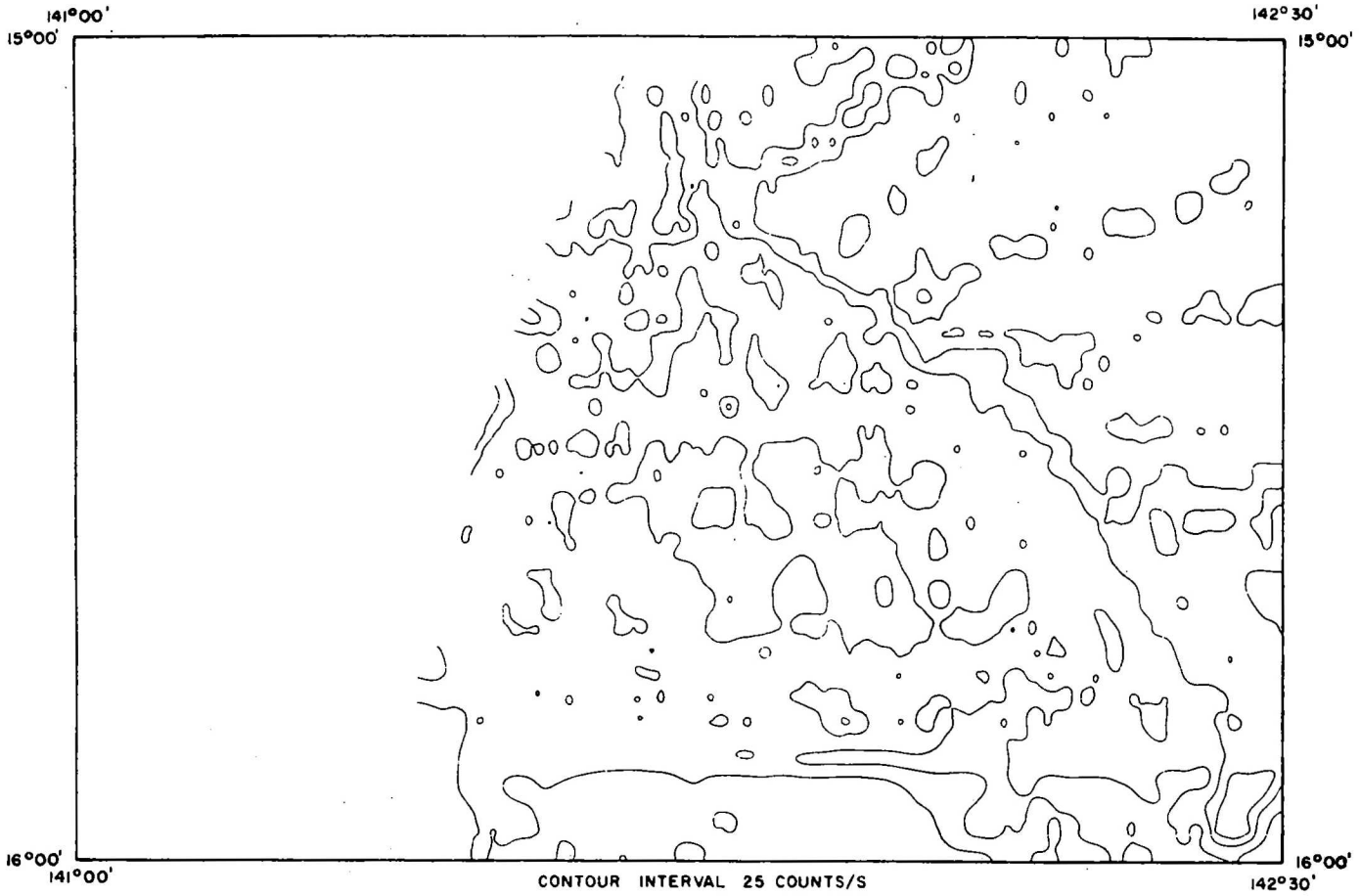
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

EBAGOOLA	CAPE MELVILLE	
HANN RIVER	COOKTOWN	
WALSH	MOSSMAN	CAIRNS

MA30

RUTLAND PLAINS



AIRBORNE SURVEY, CARPENTARIA BASIN, QLD 1975

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

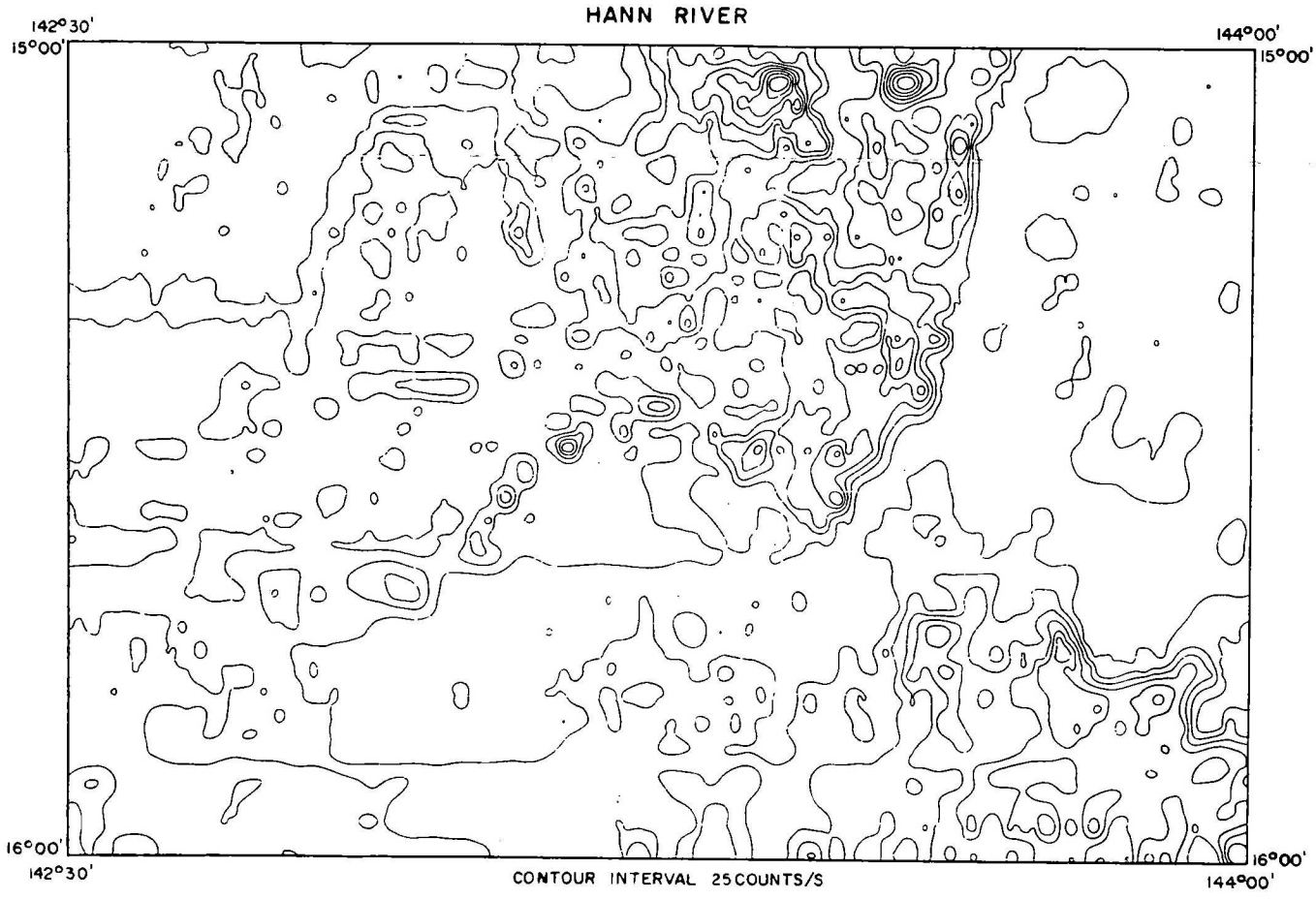
REFERENCE TO 1:250 000 MAP SERIES

	HOLROYD	EBAGOOLA
	RUTLAND PLAINS	HANN RIVER
CAPE VAN DIEMAN	GALBRAITH	WALSH

Record No. 1978/91

D54/BI-55AR

MA31



AIRBORNE SURVEY, CARPENTARIA BASIN, QLD 1975

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

HOLROYD	EBAGOOLA	CAPE MELVILLE
RUTLAND PLAINS	HANN RIVER	COOKTOWN
GALBRAITH	WALSH	MOSSMAN

Record No. 1978/97

D54/BI-56AR

2. SEISMIC, GRAVITY AND MARINE SECTION

(A. Turpie)

SEISMIC AND GRAVITY SURVEYS (F.J. Moss)

The area concerned in the work of the seismic and gravity groups are shown in Figure SGM1.

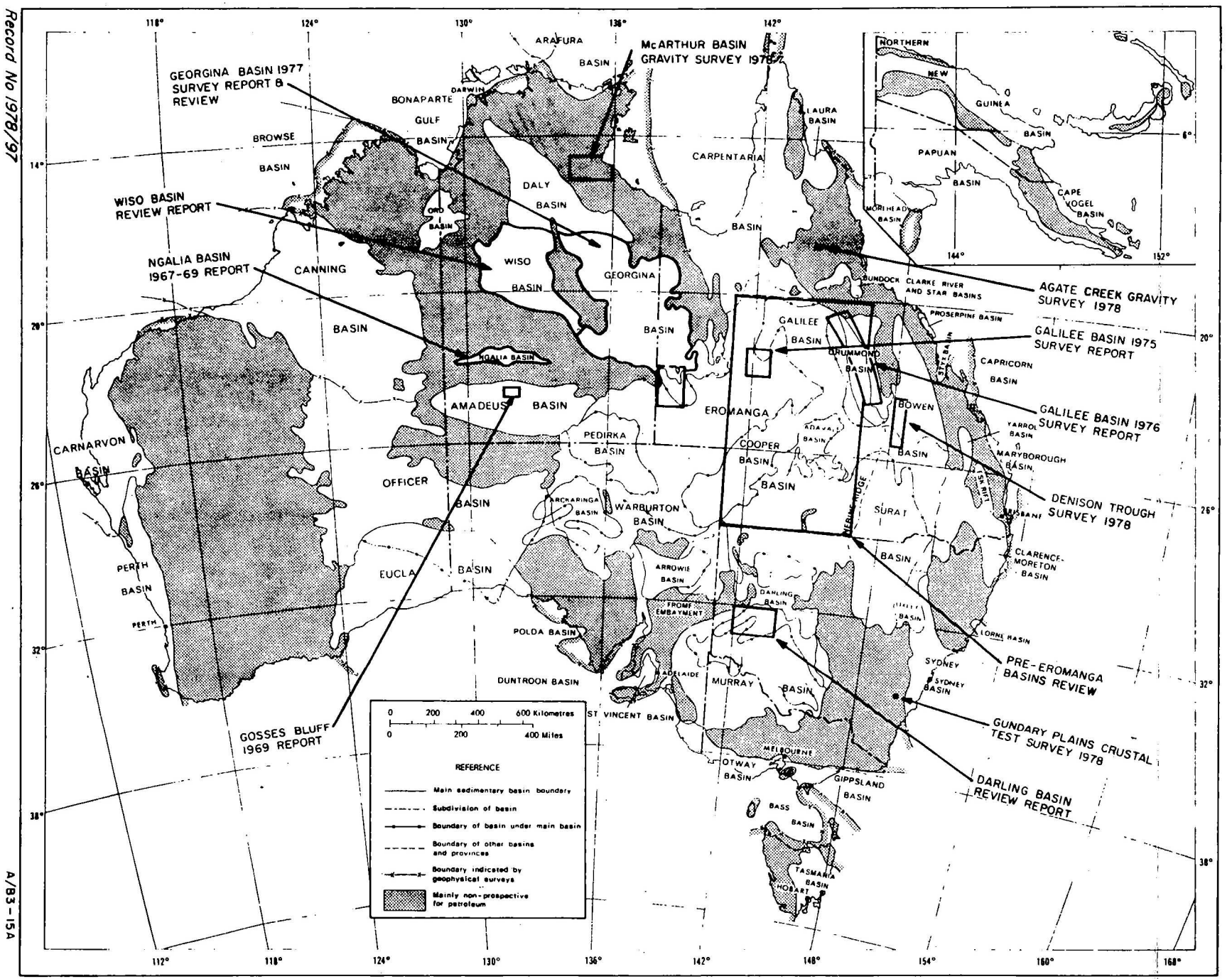
Denison Trough seismic and gravity survey, Bowen Basin Qld, 1978

(J.A. Bauer, W. Anfiloff, F.M. Brassil, A. Nelson (GSQ), O. Dixon (GSQ), J.K.C. Grace, G.S. Jennings, D. Gardner, D. Pfister, T. Hegvold, G. Price, R. Cherry, L. Rickardsson, D.K. McIntyre, A. Takken, P. Flanagan, F.J. Moss, J. Pinchin)

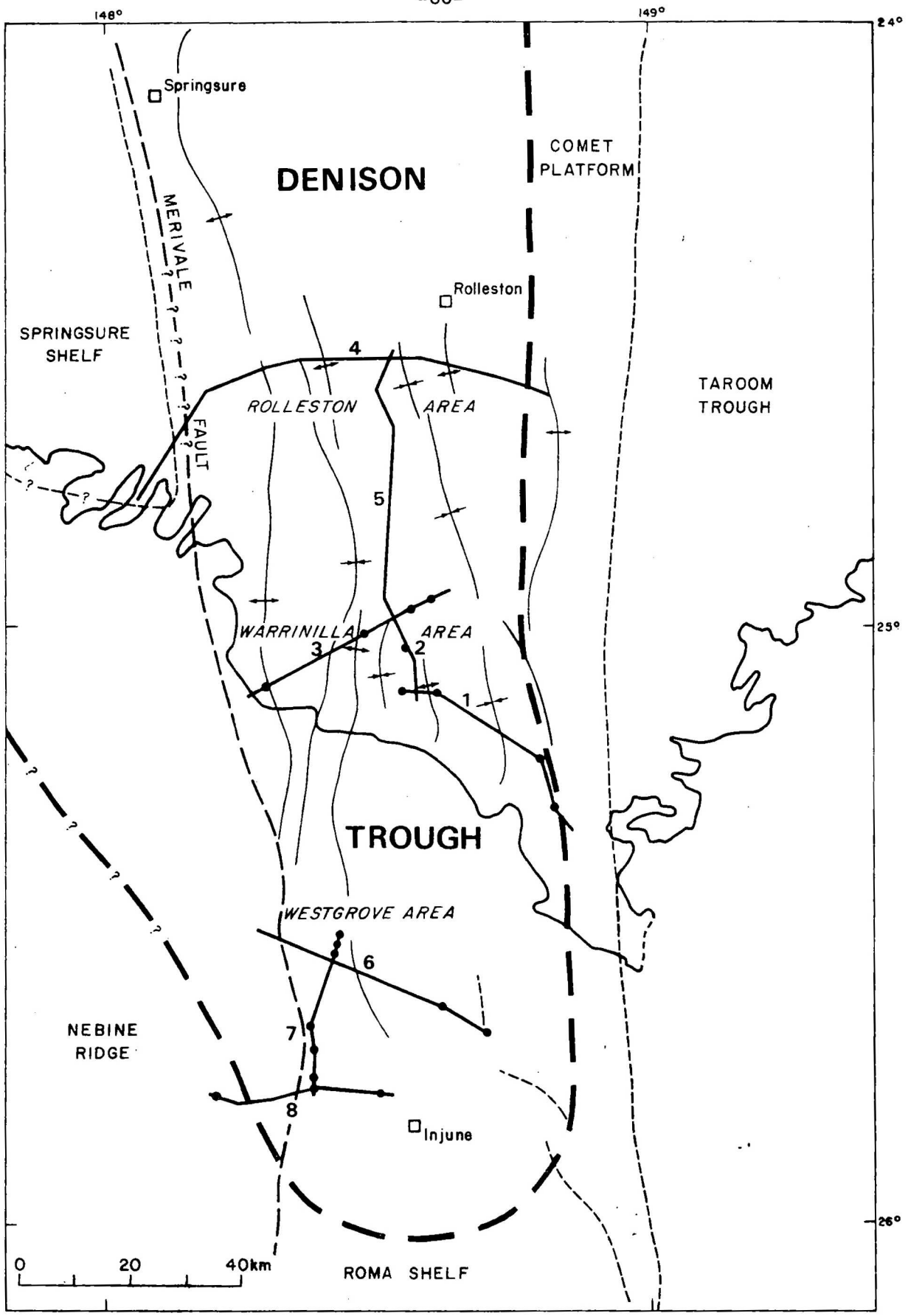
A review of the geological and geophysical information in the Denison Trough was completed and a preview report outlining the objectives and proposed program for a seismic survey was written. The review indicated that previous seismic surveys, using analogue recording equipment and mainly single-coverage techniques, gave poor penetration to the deepest Permian formations and basement because of thick coal seams in the Upper Permian. Little was known of the structure of the western margin of the basin.

Digital recording and processing and C.D.P. coverage were proposed for a seismic program consisting of 3 main east-west traverses across the southern part of the basin with a north-south tie line. This program was formulated in consultation with and was strongly supported by the Geological Survey of Queensland (GSQ) and by Mines Administration Pty Ltd who are the petroleum exploration leaseholders of 119P which covers a substantial part of the Denison Trough. The traverses were located to provide ties between GSQ stratigraphic holes, exploration wells and previous seismic surveys. (Fig. SGM2).

The surveyors and drillers started work in the Warrinilla area in late June, but heavy rain in the black soil terrain stopped operations. The party moved to the southern part of the Trough in the Westgrove area where surface conditions, on the Hutton Sandstone, were drier, and recording there started in late July. The party continued to operate in the Westgrove area,



AREAS COVERED BY SEISMIC AND GRAVITY REVIEWS, REPORTS, AND SURVEYS.



DENISON TROUGH SEISMIC SURVEY, QLD 1978
REGIONAL SETTING AND SEISMIC TRAVERSES

despite occasional further periods of heavy rain. They moved back to the Warrinilla area in mid-October. The party will record on the east-west lines through Warrinilla prior to finishing the survey at the end of November.

Charges of up to 50 kg were fired in holes drilled to about 45 m. Generally 6-fold C.D.P. recordings were made on 48 channel equipment with split-spreads and 1 km maximum shot-to-geophone offsets. Tests with longer offsets showed that information at the long reflection times expected from basement would be seriously affected by coherent shot-generated noise.

Fair to good quality results were obtained on most traverses. The quality of the seismic data was substantially improved by preliminary 'brute-stack' processing at Geophysical Service International (GSI) in Sydney. Preliminary processing parameters were estimated mainly from those applied previously to other data from the area. Final processing parameters will be selected with greater accuracy after velocity, deconvolution, and other filtering tests.

The reflections in the upper part of the preliminary seismic cross-sections are of higher frequency and are more distinct than on reflection cross-sections recorded previously. The reflector can thus be more readily correlated with particular formations in the Permian section above the Reids Dome Beds.

No clear basement reflection event can be seen on the preliminary sections, however these may become more apparent after processing with more accurate velocity control and more appropriate frequency and deconvolution filtering. Some faulting and thinning of section may be seen in the Upper Permian, and the Merivale Fault at the western margin is clearly seen on the east-west sections.

S.E. Georgina Basin seismic and gravity survey, Qld, 1977 (P.L. Harrison, D.L. Schmidt, S.P. Mathur, D. Pfister, W. Anfiloff).

The seismic and detailed gravity survey in the Toko Syncline, was started in June 1977 and completed in November 1977. About 200 km of 6 and 12 fold C.D.P. seismic reflection traversing was recorded digitally and gravity was measured at 500 m intervals along the traverses. The objectives

of the survey were to obtain information on the nature of the Lower Palaeozoic sediments in the Toko Syncline and on the structures within the sediments and at the Toomba Fault, and to provide ties between exploration wells, previous seismic traverses and outcrops.

The seismic data were processed by Geophysical Services International in Sydney. Digital processing included velocity analyses, deconvolution, filtering, autostatics, and migration. These operations improved the quality of the data significantly. Several good quality sections were produced for study of the stratigraphy and structure of the syncline.

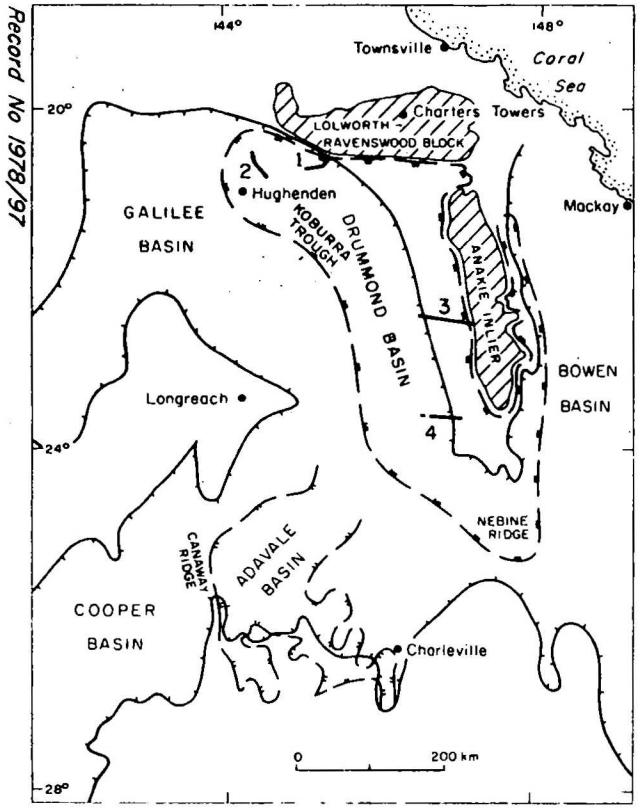
Synthetic seismograms were produced using information from well logging to facilitate stratigraphic correlations in the basin and gravity models were used in studies of the nature of the Toomba Fault.

Interpretative information from the seismic and gravity studies is included in the multidisciplinary report on the Georgina Basin Project which appears in chapter 5 of this record.

Galilee Basin seismic survey, Qld, 1976 (J. Pinchin, W. Anfiloff)

Seismic processing, gravity modelling, and interpretation of all data are now complete for this project. The interpretative seismic cross-sections from the four traverses are shown in Figure SGM3.

The results from Traverse 1 showed that the northeast margin of the Galilee Basin has been affected by faulting as recently as Tertiary times, and a possible fault-bounded anticline probably trending parallel to the basin margin was crossed. Drummond Basin rocks thicken to 800 m at the western end of the traverse, where they are overlain by 2000 m of Galilee Basin sediments. No anomalous structures were apparent on Traverse 2, although a steep basin margin was expected from interpretation of aeromagnetic data; the observed magnetic anomaly is probably caused by intrabasement changes in rock type. The Permian coal measures dip gently from a depth of 750 m at the northwest end of the line to 1000 m at the southeast end. The Galilee Basin sediments are underlain by 600 m of Early Carboniferous Drummond Basin sediments, hence the Drummond Basin is seen to extend further northwest than previously thought.

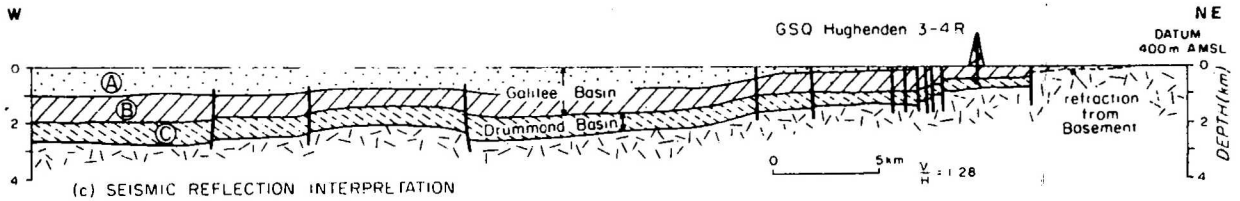


Boundary of Carboniferous - Triassic sedimentary basins

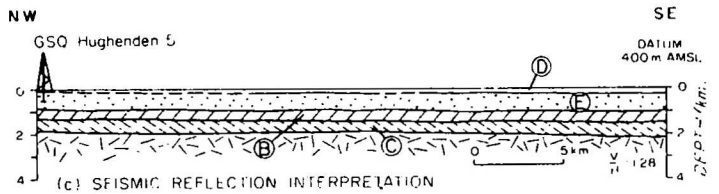
Boundary of Carboniferous - Upper Devonian Drummond Basin

Boundary of Devonian Adavale Basin

2 1976 Seismic traverse



TRAVERSE 1



TRAVERSE 2

Jurassic to Quaternary sediments

Triassic sediments

Permian sediments

Carboniferous sediments

Silver Hills Volcanics (Devono-Carboniferous)

Metamorphics (mainly Lower Palaeozoic)

·00 Seismic velocity (m/s)

Ⓐ Warang Sandstone

Ⓑ Betts Creek and Boonderoo Beds

Ⓒ Natal Formation

Ⓓ Wallumbilla Formation

Ⓔ Gilbert River Formation to Warang Sandstone

Ⓕ Joe Joe Group

Ⓖ Lake Galilee Sandstone

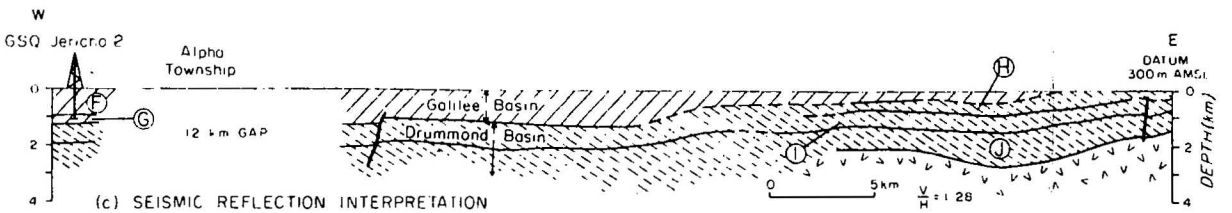
Ⓗ Ducabrook Formation

Ⓘ Star of Hope Formation and Raymond Formation

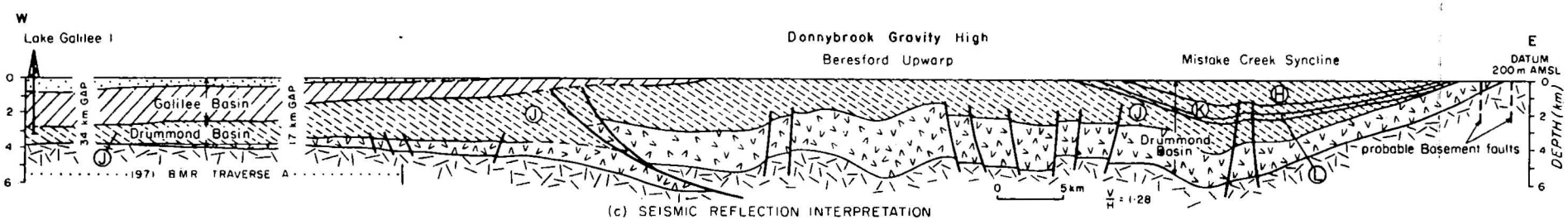
Ⓙ Mt Hall Formation and Telemon Formation

Ⓚ Star of Hope Formation

Ⓛ Raymond Formation



TRAVERSE 4



TRAVERSE 3

INTERPRETIVE CROSS SECTIONS FROM GALILEE BASIN SEISMIC SURVEY, 1976

Traverse 3 extended a 1971 BMR seismic traverse to provide continuous seismic coverage from Lake Galilee 1 well eastwards to the outcrops of the Anakie Metamorphics. Results indicate that sedimentary rocks of the Drummond Basin, in particular the Mount Hall and Telemon Formations, extend westwards below the Galilee Basin; Adavale Basin sediments are not apparent. The traverse crosses a prominent gravity feature, the Donnybrook Gravity High, which is now interpreted to be caused by a dense intra-basement block rather than a basement uplift as thought previously. An alternative explanation for the gravity high, involving a reversed density contrast of dense sediments over less dense volcanics, is being considered. Results from Traverse 4 also show that Drummond Basin sediments extend far westwards beneath the Galilee Basin and that the Adavale Basin, which is the more prospective of the two pre-Galilee basins, does not extend this far north.

The Koburra Trough, along the northeast margin of the Galilee Basin, contains a thick sequence of Permo-carboniferous sediments; results from the 1976 survey indicate that it could be bounded on the east by large anticlinal or monoclinal structures which might provide petroleum traps; it is on this area that exploration should concentrate.

Galilee Basin seismic survey, 1975 (P.L. Harrison, S.P. Mathur, P.J. Hawkins (GSQ))

Amendments were made to the final report on the survey and to a paper which is to be published in the Qld Mining Journal. The paper is titled 'Recent stratigraphic and seismic studies in the Lovelle Depression, Galilee Basin' by P.J. Hawkins & P.L. Harrison.

Gundary Plains deep crustal reflection test survey, NSW, 1978 (J. Pinchin, J.K.C. Grace, L. Richardson, A. Takken, G. Egge, D. Pfister, D.K. McIntyre, J.A. Bauer, P.L. Harrison]

Seismic recording equipment being prepared for the Denison Trough seismic survey was field-tested on a deep crustal reflection test survey in the Gundary Plains during May. The survey area lay south of Goulburn, N.S.W., on the Dartmouth-Marulan deep crustal refraction survey line. Six

shots were recorded in an attempt to obtain seismic reflections from deep crustal and upper mantle layers together with velocity information on expanded spreads.

Recordings were made with shot-to-geophone offsets out to a maximum of 6 km with 16 geophones per station in patterns of length 80 m. Two cross traverses were used each with three shot points. There were approx 20 shot holes per shot point in a square array with 10 m intervals and an average charge size of 370 kg. The reflection recordings were made using the 48 channel DFSIV system with geophone stations at 83 1/3 m interval. Refraction recordings were made along a line extending to 100 km south of the Gundary Plains using automatic remote recorders.

The field records were made with open filters and the quality was only fair. The data are now being processed by Geophysical Service International, Sydney and fairly strong reflections are indicated with reflection times of about 7, 10 and 12 seconds, corresponding to depths of about 20, 30 and 40 km.

Darling Basin review (S.P. Mathur, J.A. Bauer)

Amendments were made to the draft report reviewing the geology and geophysics of the Darling Basin. The review recommended a 3 month seismic survey using CDP digital recording over the flanks of the Blantyre and Menindee Troughs to investigate the possible presence of shallow Lower Devonian sediments which may have petroleum source potential.

Wiso Basin Review (S.P. Mathur)

Details of gravity and seismic investigations in the basin were extracted from a review of geophysical and geological information conducted in 1976 in cooperation with P. Kennewell (Geological Branch) and P. Wilkes (Airborne section). This information has now been incorporated into a Bulletin on the Wiso Basin with P. Kennewell as senior author.

Pre-Eromanga Basins review (S.P. Mathur, F.M. Brassil, D. Pfister]

The review was begun in 1975, with the objective of studying geophysical and geological data in basins underlying the Eromanga Basin and to indicate areas where further seismic surveys were required. Compilation of data, including digitization, checking and storing of seismic shot-points, and indexing petroleum exploration wells and stratigraphic bore locations continued as time permitted. About 700 well and bore locations were plotted at 1 : 1M scale. The nature and depth of the metamorphic basement or the deepest sediments reached were then recorded on the base maps. Basement contours from the Surat Basin, published in Bulletin 166, were transferred to the base maps. These contours are being extended to other parts of the Eromanga Basin using the recorded well and bore information. This project is related to a general review of future seismic programs.

Ngalia Basin, N.T. (F.J. Moss, A.T. Wells]

A draft of a Bulletin on the stratigraphy and structure of the Ngalia Basin was completed. The results of the review of the geological and geophysical information in the basin were also presented in the BMR internal lecture series and in the BMR Symposium. The re-interpretation of all available seismic data in the basin, which has led to a better understanding of its structural history and stratigraphy has been of considerable interest to the petroleum and mineral exploration companies with interests in the basin.

An assessment of the basin's petroleum resources is being made using the 'Prospect-by-Prospect' method. The basin is generally considered to have fair prospectivity, mainly because its geological units and history are similar to the nearby Amadeus Basin, a known hydrocarbon province. Although only one possible anticline is evident in the central zone, a number of fault-bounded structural traps with closure in the possibly prospective Lower Palaeozoic sediments can be seen from the seismic results. The assessment is necessarily preliminary because of lack of deep stratigraphic drilling in this zone.

Future seismic program (F.J. Moss, S.P. Mathur, J. Pinchin)

Work continued intermittently on assessing seismic program proposals in consultation with other BMR officers and with State Government Geological Surveys and industry. In addition, the interpretation and reporting on recent seismic surveys in the Galilee, Georgina and Bowen Basins, and review work on the pre-Eromanga Basins generally, will lead to recommendations for future surveys.

A brief review report was written on the geological framework and the results of previous seismic surveys in the onshore part of the Bonaparte Gulf Basin. A proposal has been made for an experimental and reconnaissance seismic survey of the western margin of the basin. This would involve about a 4 month survey using 12 fold CDP to obtain information on the structure of prospective Upper Devonian - Lower Carboniferous sediments in the area between the Upper Devonian outcrops and the Bonaparte wells.

Proposals have been made by the Geological Survey of Victoria, the Victorian State Electricity Commission, and Beach Petroleum N.L. for the BMR to carry out seismic work to solve basic structural and stratigraphic problems in the Otway Basin. Experimental surveys have been proposed to outline pockets of Tertiary Brown coal north of the Otway Ranges west of Melbourne, to define faults which have controlled the deposition and distribution of sediments prospective for petroleum in the Port Campbell and Torquay areas, and to tie wells to previous seismic surveys in the eastern part of the Otway Basin in order to provide a basis for further review of the petroleum prospects of the area. Further seismic surveys have been proposed to obtain better quality data west of the Portland area, where dunes and cavernous limestone cause problems in obtaining good quality seismic information.

Seismic data processing (J. Pinchin, S.P. Mathur, P.L. Harrison, W. Anfiloff, F.M. Brassil, J.K.C. Grace, D. Pfister)

Geophysical Service International (G.S.I.) continued as contractor to process data from the Bureau's seismic surveys. In general geophysicists supervised the processing of their own survey information from the 1977 Georgina Basin seismic survey, Gundary Plains deep crustal seismic test survey, and the 1978 Denison Trough seismic survey. G.S.I.'s turnaround time

has improved significantly for recent processing with brute stack sections for the Denison Trough being produced within 48 hr after receipt of data in the centre. Data sheets for card punching are written up by BMR staff thereby assisting in speeding up the process.

The quality of results from the Georgina Basin survey were significantly improved by the processing described under that project heading. Gundary Plains data processing is now being finalised. There were some problems with these data, principally in determining good static corrections to apply prior to stacking. Initial results from the Denison Trough survey are excellent. Minor problems in processing have been readily solved and parameters are being selected for final processing after completion of the survey.

A seismic field data processing system has been developed in BMR and tests are proceeding. Work on this system is described in the present Summary of Activities for the Marine Surveys Group.

Seismic shot-point location maps were produced as time permitted, for areas in which reports or reviews were in progress. A long-term aim of this project is to produce seismic shot-point location maps using computer programs on the Cyber 76 for all onshore surveys. These can then be used as a data base in further studies.

A synthetic seismogram program, originally written in the late 1960s for use on the CDC 3200 was coverted for use on the Cyber 76 computer. The program was used to produce synthetic seismograms for the Netting Fence 1 and Ethabuka 1 wells in the Georgina Basin. Minor modifications are necessary before it is extensively used to produce seismograms for wells in the Denison Trough.

Seismic equipment (J. Pinchin, D.L. Schmidt, J.K.C. Grace, D. Gardner, R.D.E. Cherry, L. Rickardsson, G. Egge, A. Takken, D.K. McIntyre)

The DFSIV and associated field seismic equipment continued to function satisfactorily with only minor problems. The system was upgraded in the early part of the year from 24 channel to 48 channel recording. This results in less drilling and less explosives for a given coverage. All

cables, geophones, remote firing units, radios, etc. were overhauled prior to the Denison Trough survey and were field tested on the Gundary Plains survey. Five new 48 channel geophone-cables were purchased. A further 6 of these cables are on order and eventually it is planned to purchase a further 7 for a total of 18, 48 channel cables which will allow C.D.P. recording with 83 1/3 m station intervals. More sets of geophones are being procured to allow at least 16 per station for 48 channel recording.

A new 20 KVA generator is on order for the seismic party. A field processing system described elsewhere, is being developed for use on seismic surveys. It is proposed that parts of the tape transports of the analogue seismic data processing system will be used for A-D conversion to allow old analogue data to be transcribed for digital processing.

Agate Creek gravity survey, 1978 (W. Anfiloff)

Gravity measurements were made at station intervals of 0.25 km along a 20 km traverse across the Agate Creek Volcanics in the Forsayth area. These measurements were made at the request of the Georgetown Mapping Party from the Geological Branch. The objective was to determine the thickness and structure of the volcanic pile. Preliminary results confirmed the steep gravity gradient of about 20 mGal/10 km previously detected in regional surveys over the western edge of the pocket, a region of deeply dissected topography. The Bouguer anomalies increase smoothly to the west with gradients of 5 mGal/10 km over the central part of the pocket. A fairly uniform basement surface is indicated there from the gravity results. Terrain corrections will be applied to the anomalies before proceeding with a final interpretation of structures.

Gravity interpretation methodology (W. Anfiloff, A.J. Flavelle (Layton Geophysical))

A paper dealing with the methodology of gravity interpretation in two dimensions in areas of undulating and steep topography was prepared for presentation at the Society of Exploration Geophysicists meeting in San Francisco, U.S.A. in late October 1978. A standard processing routine was described by means of which principal facts from straight traverses can be

reduced automatically to a set of terrain-corrected Bouguer profiles. The routine is valid for any elongate topography when it is traversed at right-angles to the strike of the geological formation.

Foreign aid projects - Thailand and Bangladesh (F.J. Moss)

Comments were prepared on a report for ADAB on the results of feasibility surveys using seismic and gravity techniques in exploring for lignite in Thailand. The report was prepared by a geophysical consultant Mr L. Ingall after a brief visit to Thailand to carry out the surveys in 1977. The project was successful and Mr Ingall demonstrated that the methods could be used to explore the Tertiary basins at Krabi and Mae Moh for lignite.

Subsequently comments were also prepared on a new proposal by the Electricity Generating Authority of Thailand for ADAB aid in carrying out gravity and seismic surveys to assist in lignite exploration in other Tertiary basins. A recommendation was made for a detailed review of the geology of the proposed survey areas and visits to these areas by an experienced geologist and a geophysicist to draw up objectives and programs for detailed gravity, drilling and follow-up seismic surveys using high resolution seismic techniques. It was proposed that these surveys should be supervised by a consultant who could in turn be advised by BMR.

Comments were also prepared concerning a recommendation by Mr J. Erskine (Mineral Resources Branch) for ADAB assistance to the Geological Survey of Bangladesh. A seismic survey and drilling program were proposed to explore for shallow coal seams at Gaibandha and Madhyapara/Fulbari. It was requested that this work together with stratigraphic drilling be scheduled as soon as possible during the 1978/79 dry season. An alternative proposal has now been made for high resolution seismic surveys in these areas with subsequent selection of drill sites for stratigraphic holes based on the seismic results. All seismic work would be carried out by the Geological Survey of Bangladesh and would be supervised by a consultant geophysicist. Overhaul of the seismic equipment in use by the Survey or purchase of new high resolution equipment will be necessary and a contract technician should be in attendance during the seismic operations.

MARINE SURVEYS (R. Whitworth, F.W. Brown)

Plans and Preparations (R. Whitworth, F.W. Brown, J.C. Branson)

The marine geophysics group was involved during 1978, as in previous years, in the preparation of estimates, proposals and specific plans for surveys at sea. Some of these various endeavours were in association with other groups.

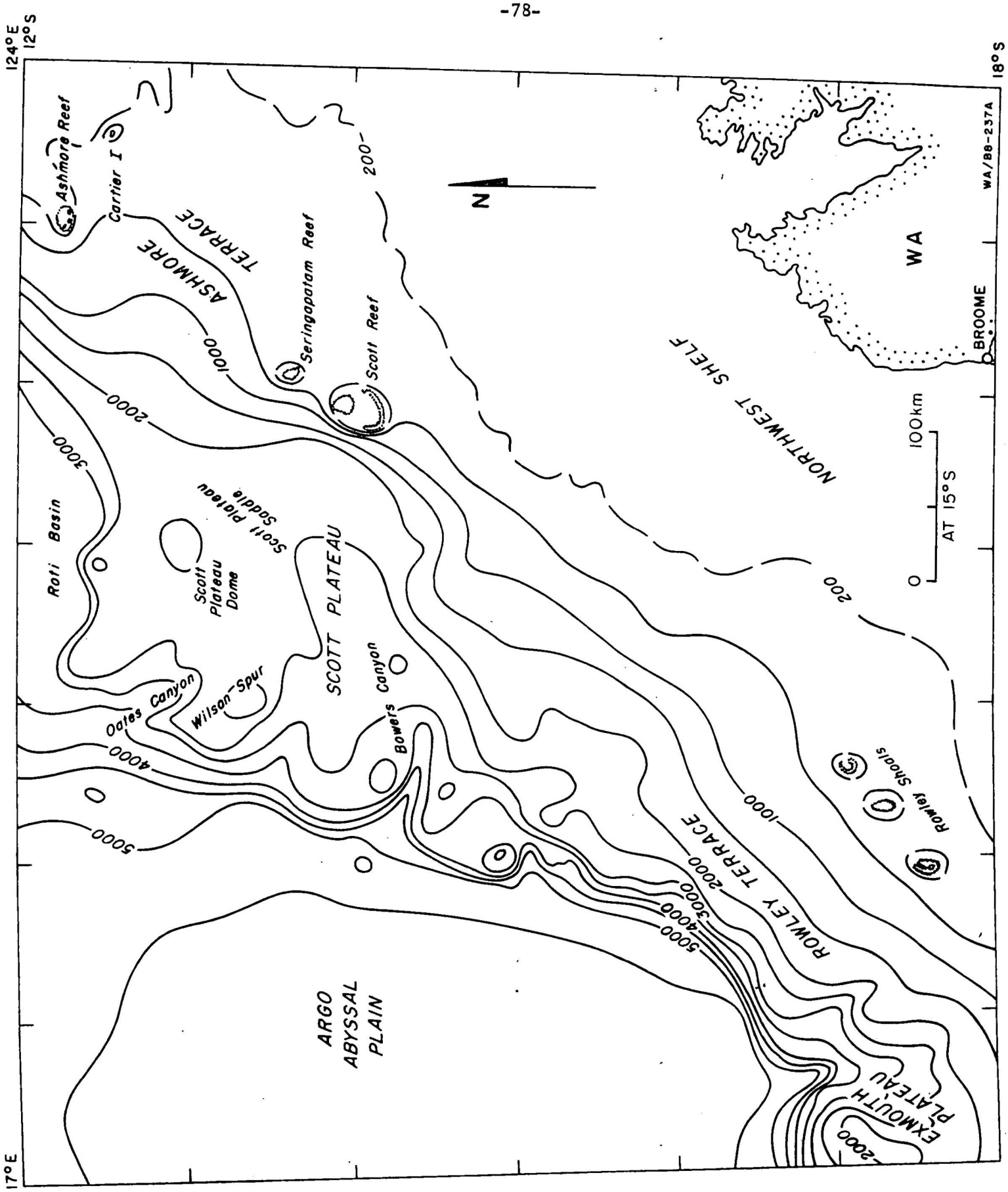
The Antarctic Division of the Department of Science is investigating the feasibility of obtaining a new Antarctic supply vessel that will also be capable of carrying out scientific surveys in Antarctic waters and in the shorter term to have the present supply vessel the M/V NELLA DAN modified so as to be able to carry out scientific surveys on an extended charter. BMR represented the requirements for geoscience surveys and subsequently entered into more detailed discussions of necessary shipboard facilities and equipment, some of which could be provided by BMR.

BMR also associated with the Consortium for Ocean Geosciences (COGS), representing Australian University interests, in the preparation of a submission to Government for a marine geoscience vessel as a national facility.

Scott Plateau Project (H.M.J. Stagg, N.F. Exon)

The Scott Plateau and Rowley Terrace lie oceanward of the Browse and Canning Basins respectively, in water depths ranging from 600 m to 3000 m (Figure SGM4 WA/B8-237A). They are bounded to the west by the Argo Abyssal Plain and to the north by the Roti Basin. The area of the plateau and terrace is about 130 000 km^2.

15 000 km of bathymetric and seismic reflection profiles, and rather less magnetic and gravity data, have been analysed to provide a geological interpretation of this part of Australia's margin. The initial results were presented at the 1978 APEA Conference and published in the APEA Journal by Stagg. During the year work has continued on the illustrations and text of a BMR Bulletin, the first draft of which will be finished by the end of the



BATHYMETRY OF THE SCOTT PLATEAU REGION

Isobaths in metres

Record No 1978/97

WA/88-237A

year. A BMR Record, to accompany the full suite of maps prepared for the area, has been edited but awaits completion of the illustrations.

The nucleus of the Scott Plateau consists of ancient rocks which were emergent during most of the late Palaeozoic and early Mesozoic, and shed debris into the Browse Basin to the east. After Late Jurassic breakup of Gondwanaland the plateau sank, and is overlain by a thin sedimentary sequence consisting of Late Jurassic and Early Cretaceous detrital sediments, and Late Cretaceous and Cainozoic bathyal carbonates and marls. To the south-east the thick Browse Basin sequence pinches out against the basement highs forming the plateau, and these pinch-outs must be regarded as potential petroleum traps.

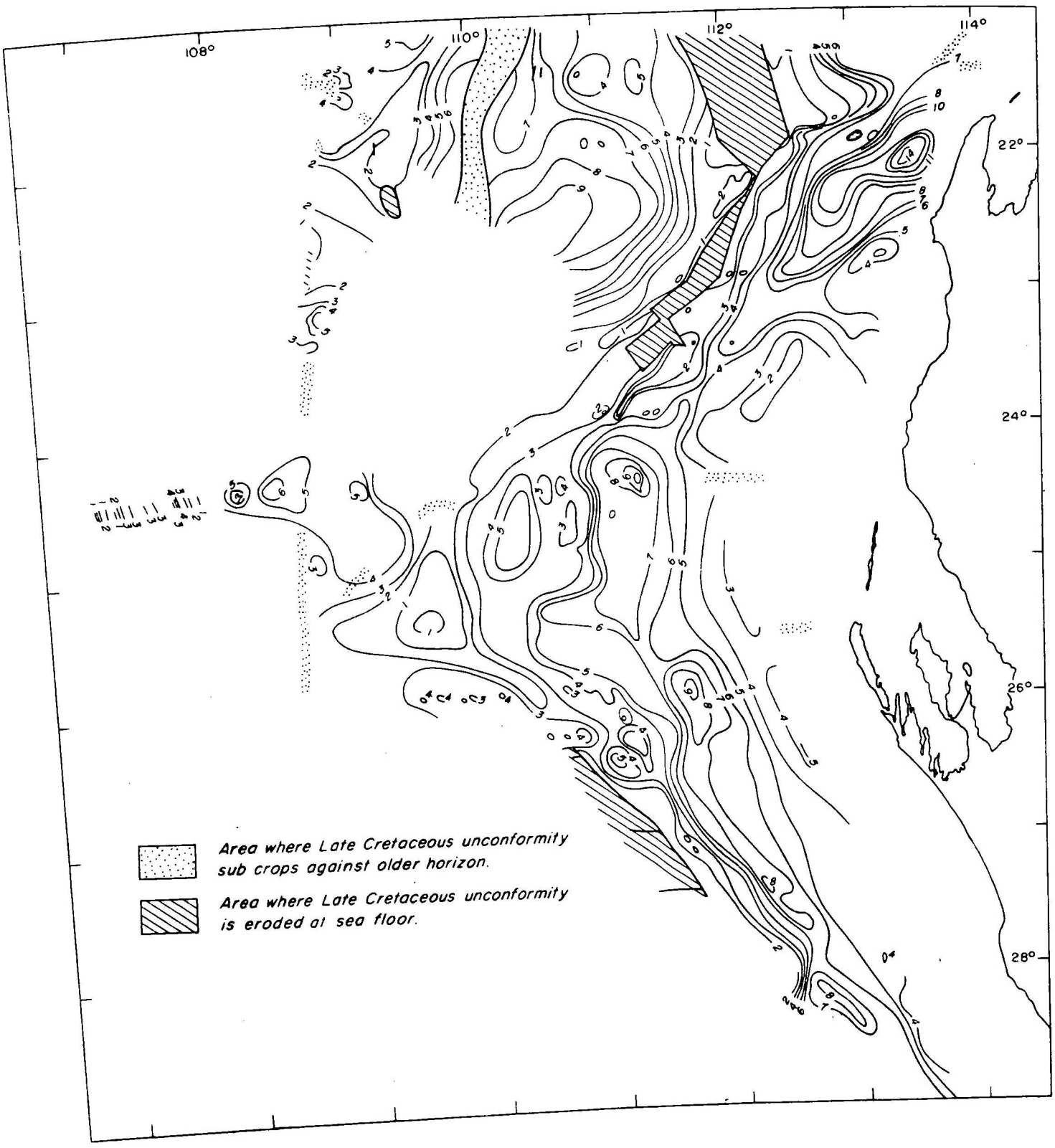
The Rowley Terrace is underlain by 6 km or more of Mesozoic and Cainozoic sediments forming part of the Rowley Sub-basin of the Canning Basin. Despite a lack of major faults or pinch-outs this area must be regarded as having some petroleum potential.

Carnarvon Terrace Project (P.J. Cameron, P.A. Symonds)

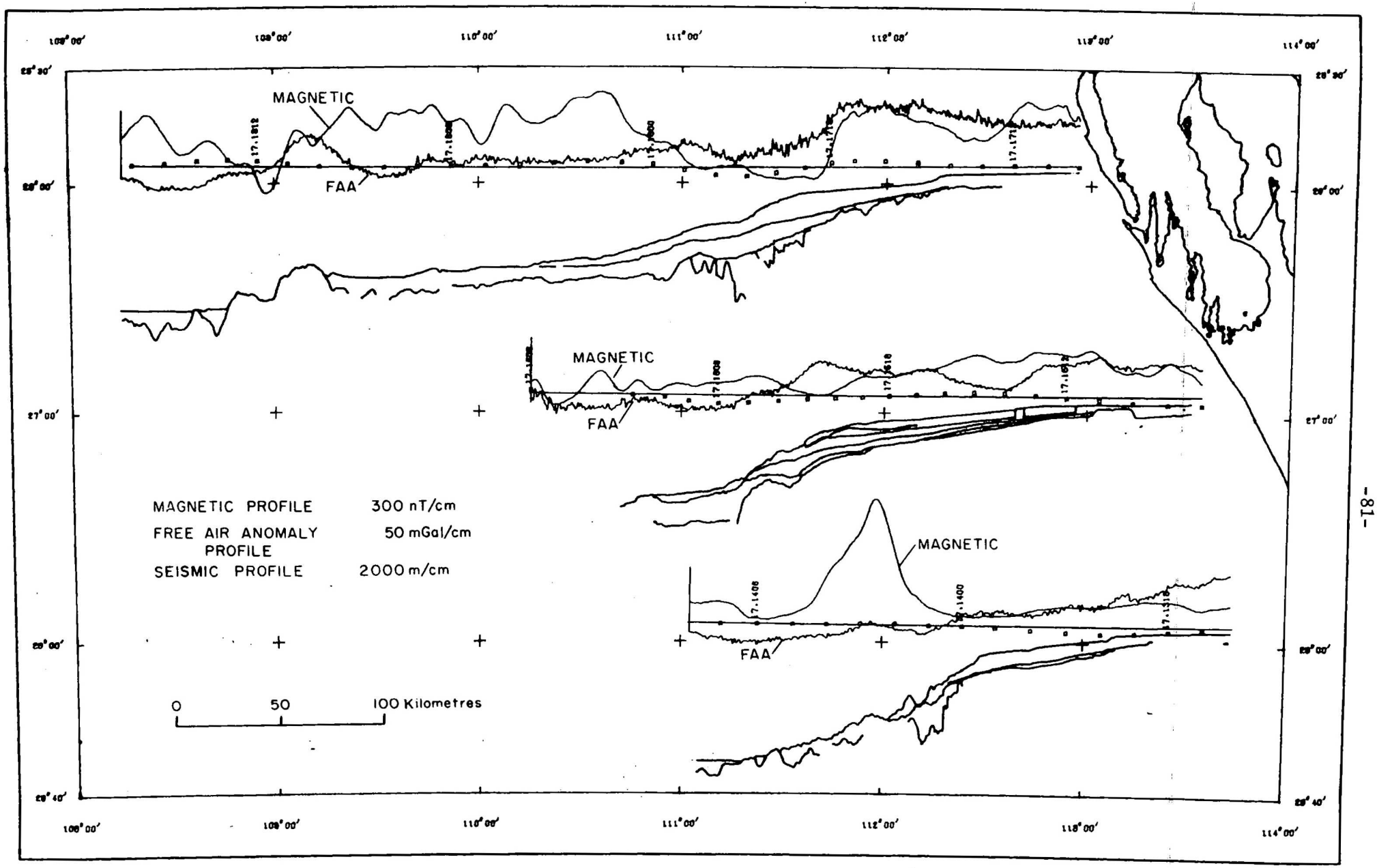
Work on the data from the Continental Margin Survey over the Carnarvon Terrace continued in 1978 and involved finalisation of the seismic data maps and preparation of data for further publication.

Seismic data maps were plotted from the digitised seismic data after modifications to program SEISMAP allowed the location of faults to be automatically indicated. Structure contour and isopach maps were plotted in both two-way reflection time and depth. Velocities used for time to depth conversion were obtained from least square fitting of T^2/X^2 data from wide angle reflections recorded on BMR refraction probes combined with velocities obtained from processing of some BMR seismic lines in the area. An isopach map is shown in Figure SGM5.

A special effort was directed towards modification of program LINEMAP to produce seismic profile maps from the digitised seismic horizons. Program LINEMAP was originally used to produce maps of geophysical profiles stacked in position. It can now be used in addition to display seismic sections in this way, with horizons in depth rather than two way reflection time and with magnetic and/or gravity profiles over the section. An example is given in Figure SGM6.



CARNARVON TERRACE ISOPACHS



AUSTRALIAN NATIONAL SPHEROID
SIMPLE CONICAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 18°00' AND 36°00' SOUTH

EXAMPLE OF STACKED SEISMIC, GRAVITY & MAGNETIC PROFILES

CARNARVON TERRACE

A more detailed bathymetric map was prepared using ocean sounding values in addition to the BMR and Shell data used previously. This map, hand contoured, should aid in structural interpretation of the area.

An investigation of the subsidence history of the area was carried out by examining palaeo-environment data from wells on the continental shelf. It showed the subsidence of this area to be compatible with the normal rate of ocean basin subsidence.

Ceduna Terrace Project (A.R. Fraser, L. Tilbury)

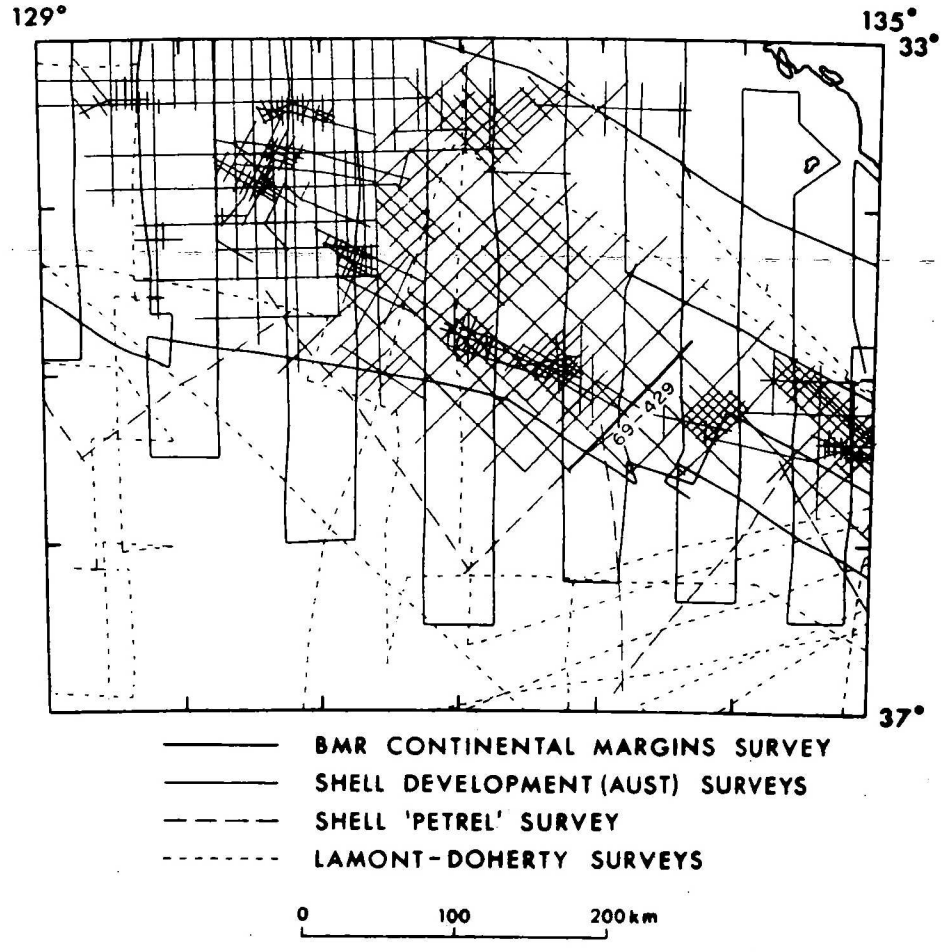
This is a continuation of the project described in the 1977 Summary of Activities. Reductions of track location and bathymetric maps produced late last year are shown in Figures SGM7 and SGM8.

This year work has been directed towards the production of a paper for the 1979 APEA Conference and of a BMR Bulletin. Seismic sections from a regional grid of Shell and BMR lines were marked, and the reflectors on the Shell sections were digitized using the BMR GRADICON table. The digital data so obtained were used to produce line profiles for all the sections, and post maps from which isopach and structure contour maps were hand-drawn. Interval velocities for conversion of reflection times to depths were computed from rms processing velocities on selected Shell lines. An example of a line profile is shown in Figure SGM9.

Gravity and magnetic data extracted from BMR, Lamont, and Shell surveys, were used to produce gravity and magnetic anomaly contour maps (Figures SGM10 and SGM11).

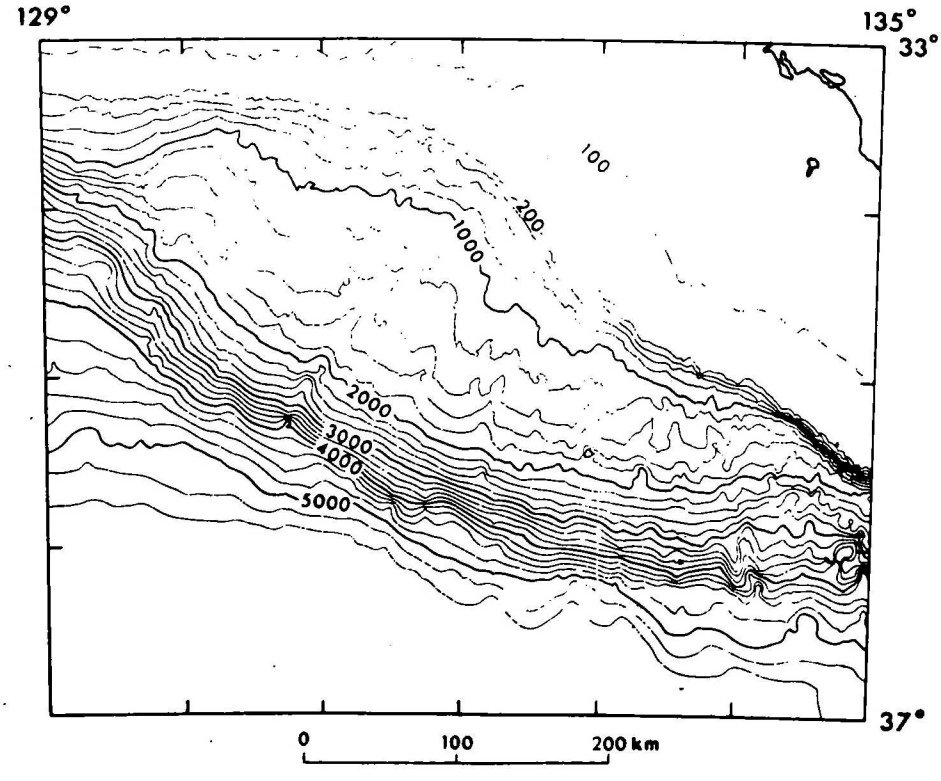
Geophysical data indicate that the basin can be modelled as a sedimentary wedge, up to 10 km thick, extending from the shelf to the continental rise. Three important unconformities were mapped and tied to Potoroo No. 1 well - a basement reflector separating Lower Proterozoic rocks of the Gawler Craton from an overlying, block-faulted sequence of mainly Lower to Mid-Cretaceous sediments; an unconformity at the base of an Upper Cretaceous sequence which includes a major prograded unit in the west; and a break-up unconformity at the base of a Tertiary marine transgressive sequence which in turn is overlain by marine carbonate deposits. Several marker horizons of regional significance can be mapped in both the Lower and Upper Cretaceous sequences.

SGM 7

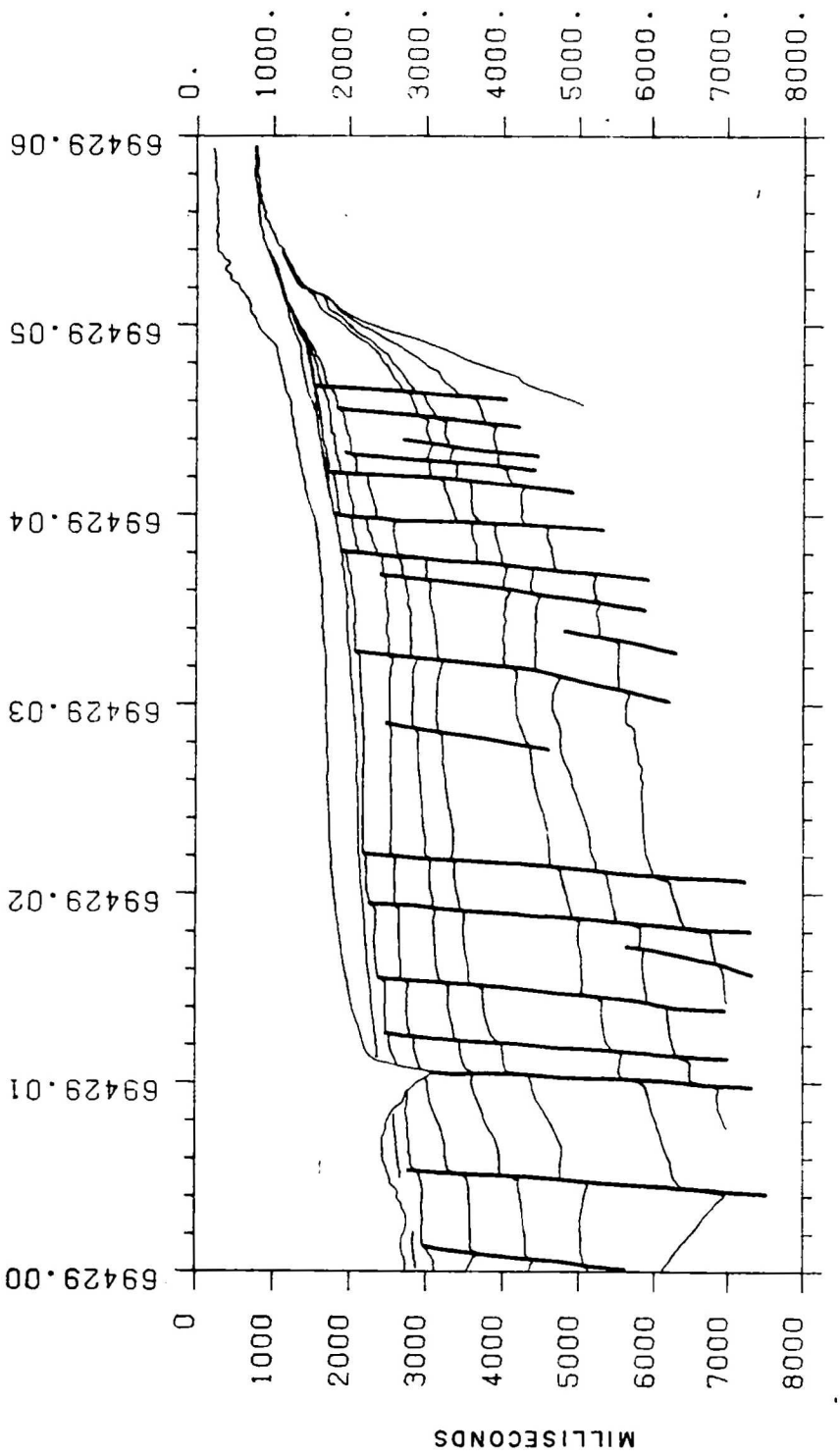


LOCATION OF SURVEY TRAVERSES CEDUNA TERRACE

SGM 8

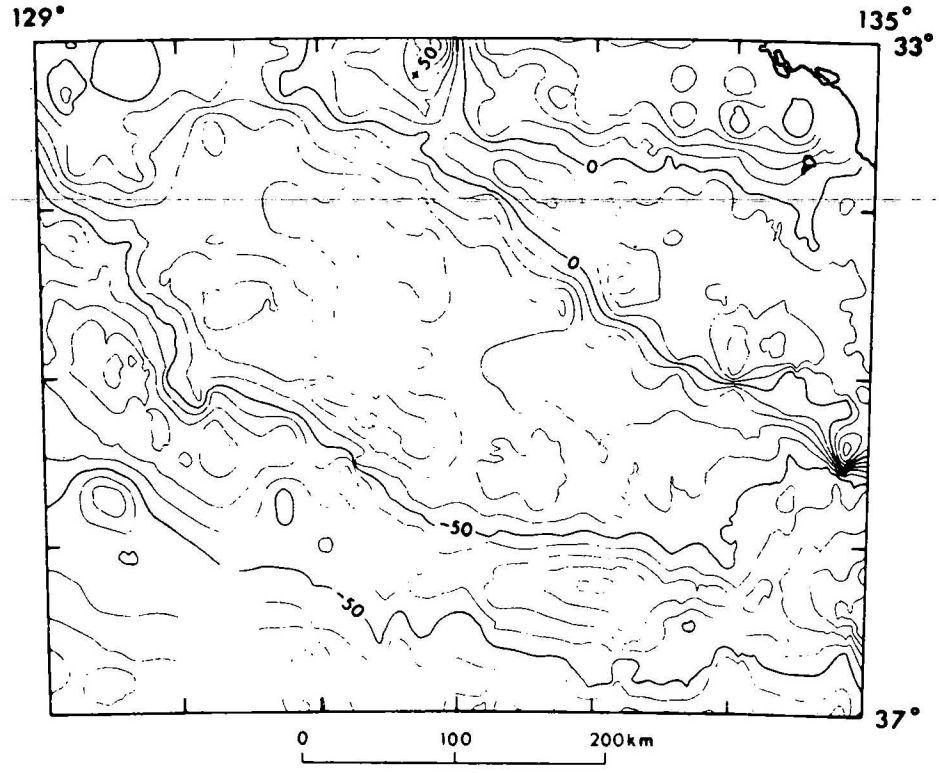


BATHYMETRIC CONTOUR MAP



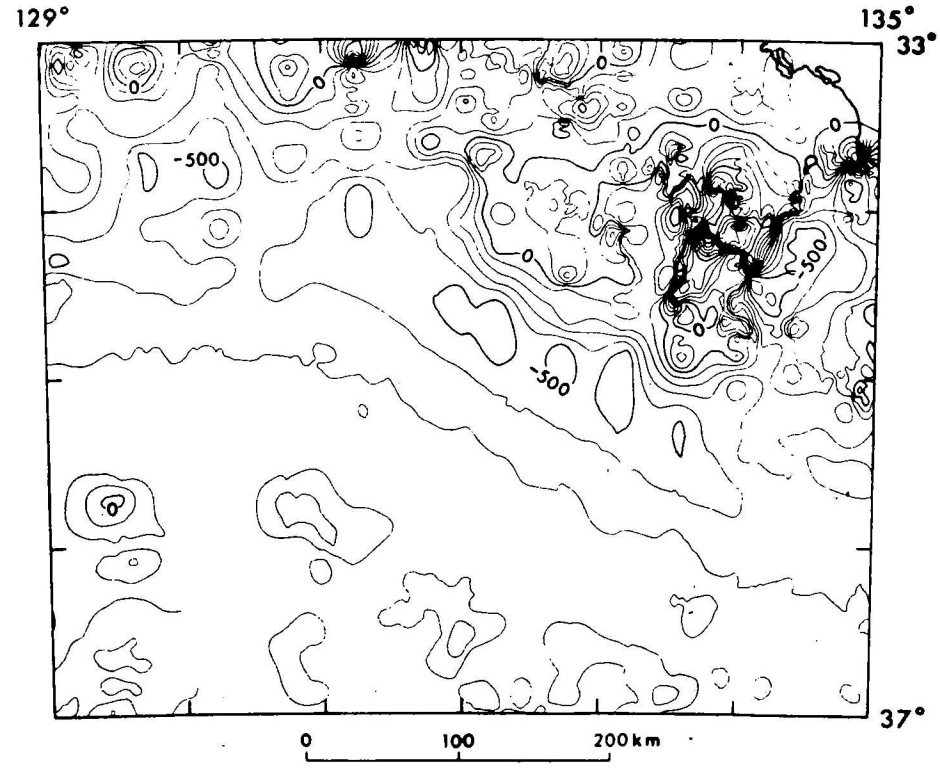
EXAMPLE OF COMPUTER DRAWN PROFILE
FROM SHELL SEISMIC LINE 69-429
CEDUNA TERRACE

SGM 10



FREE-AIR ANOMALIES
CEDUNA TERRACE

SGM 11



MAGNETIC ANOMALY CONTOURS

The tectonic style is of normal, west to northwest trending, down-to-the-south faults. Faulting is most intense along a hinge zone close to the shelf-break which is clearly related to significant downthrow of the basement. Growth faulting to the south has resulted in a marked thickening of both Upper and Lower Cretaceous sequences.

The basin is considered to have fair potential for petroleum even though prospectivity has been down-graded by the results of recent work by Shell. The environment of deposition in the central part of the basin, as yet untested by drilling, appears to be significantly different from that near existing wells on the basin's northern margin. It is possible that marine conditions prevailed in this area for long periods during the Cretaceous, and in this case the prospectivity of known structural traps would be increased. Prospective stratigraphic traps may be present within the Upper Cretaceous deltaic sequence.

Co-operative Survey with BGR (Federal German Republic)

Under the auspices of the Australian-German scientific agreement BMR is now in its second year of co-operation with the Federal German Republic's Geological Survey (BGR). Co-operation in 1977 involved surveying of the Scott Plateau, W.A., on the R.V. Valdivia. In October 1978 co-operation was underway in the first of two cruises of the R.V. Sonne off the Australian east coast.

The first cruise, from Suva (Fiji) to Brisbane aims to study the southern Lord Howe Rise. The second cruise, from Brisbane to Port Moresby will work on the margins of the Coral Sea Basin.

As well as magnetic and gravity systems the Sonne is equipped with a 24 channel digital seismic system. This system will be used on both cruises to attempt penetration of rift and pre-rift sedimentary sequences related to Australia's eastern margin.

These cruises should provide important scientific and economic information in areas hitherto traversed only by widely spaced or inferior seismic surveys. BMR participation involves 4 officers on the first and 5 on the second cruise. It is foreseen that participation will extend into the processing and interpretation of the geophysical data.

Co-operative project with BGR: R.V. Valdivia (H.M.J. Stagg, N.F. Exon)

In 1977 the German research vessel R.V. Valdivia carried out a survey between Scott Plateau and the Java Trench during which 1700 km of 24-channel seismic data, and 2550 km of bathymetric, gravity and magnetic data, were recorded. A paper dealing with the results of this cruise appeared in the December 1978 issue of the BMR Journal. Geological aspects of the cruise are covered in the Geological Branch Annual Summary of Activities. The geophysical results discussed below come from combining Valdivia data with those of earlier cruises.

The Scott Plateau trends NNE and is bounded to the west by the Argo Abyssal Plain and to the north by the Roti Basin. The plateau is a foundered continental block, and lies at an average depth of 2000-3000 m. The western margin probably formed as a series of NE-trending rifts and NW-trending transforms during Late Jurassic breakup. Canyons cut the western margin, and some of these appear to be fault-bounded. The bathymetric depression of the Roti Basin, which lies southeast of the Java Trench, links the trench to the Timor Trough.

The dominant fault direction within the northern Scott Plateau is probably NW or WNW, and hence related to ancient faults on the Australian mainland, rather than the NE or NNE directions related to the Permian to Jurassic phases of rifting, which allowed this part of Gondwanaland to disperse. Structural information indicates that a major transform fault trending northwest forms the northern flank of the Wilson Spur (the southern flank of Oates Canyon). We have named this the North Wilson Transform.

The nature of the basement rock south of the eastern Java Trench changes at about 119°30'E, south of western Sumba. On VALDIVIA traverse VA 16/005 the basement consists of thrust-faulted dipping strata and it may be continental. However, on VA 16/006 further west the basement appears to be typically oceanic. This change corresponds with the trend of the North Wilson Transform, and we suspect that the transform terminates the subducting part of the Java Trench.

The Argo Abyssal Plain slopes gently southward with water depths ranging from 5000 m near the Java Trench to 5730 m in the south. Oceanic basement varies from smooth to hummocky and irregular, and is overlain by

about 400 m of acoustically semi-transparent Late Jurassic and Cretaceous sediments, that is in turn unconformably overlain by 200 m of layered Tertiary sediment. On the Valdivia records, there are features on the plain similar to those described by other authors as possible diapirs, but in this case they mostly appear to be drapes over basement highs.

Cooperation with BGR: Processing of data (H.M.J. Stagg & R. Whitworth)

Processing of the digital data (navigation, bathymetry, gravity, and magnetic) from the Valdivia cruises on the Scott Plateau was severely curtailed during 1978 through lack of available personnel. The original cruise magnetic tapes were copied to standard 9-track tape in Germany and were received at BMR early in the year. Since then, the data have been converted from their original format for 16-bit PDP computers to the 60-bit word format used by CSIRO's CYBER-76 computer. The next stage is to delimit all the problem areas where bits had locked-on or dropped-out in the original recording, giving spurious data. Once these errors have been corrected, all the data will be converted to BMR's standard survey format. The raw satellite data have also been received from BGR, and it is intended to process the navigation data using satellite control to obtain corrected positions.

Cooperative Project with Lamont-Doherty Geological Observatory (G.D. Karner)

From February to August inclusive, Karner was stationed at Lamont-Doherty Geological Observatory. This followed his participation during December 1976/January 1977 in a survey aboard the R/V VEMA investigating the Coral Sea Basin.

Following the survey, Karner was invited to visit LDGO to take part with Dr A. Watts and Dr J. Weissel in interpreting the data collected in the Melanesian region, and in particular the Coral Sea Basin. During this period he was concerned with,

(i) the research of geophysical problems relating to Australia, with an attempt to understand the anomalous gravity field over continental margins and its relationship to the geology. A mechanism for basin

formation has been outlined in terms of general plate tectonic principles.

(ii) familiarisation with and development of geophysical and mathematical techniques for data interpretation.

(iii) the collection of marine geophysical data relevant to Australia.

(iv) obtaining in confidence copies of relevant computer programs for use in BMR.

The interpretational work outlined in (i) is based on previous global observations. The application of Fourier Transform theory to free-air gravity and bathymetry profiles from passive margins around the world demonstrates that the anomalous gravity response at these margins is dominated by the flexure of oceanic and continental crust caused by the weight of deposited sediments on the margin. Three factors appear to control the degree of flexure,

(a) the age of the margin,
(b) the age of the sediment on the margin, and
(c) the thermal history of the margin.

Anomalous gravity observed today at continental margins is really a result of ancient or fossil response to flexure caused by the original rifting/drifting characteristics of the margin and its corresponding oceanic basin.

These results will be summarised in a paper to the Journal of Geophysical Research.

Investigation of tectonic developments resulting from a continent/island arc collision in the Timor region (C.R. Johnston, C.O. Bowin (Woods Hole Oceanographic Institution, USA))

During 1977 Johnston visited Woods Hole as a guest investigator to study the tectonics of the Banda Sea/Banda Arc region of Indonesia. This study included the interpretation of data collected during the 1976 Woods Hole survey. A paper dealing with the results is now with the Woods Hole co-author and will probably be submitted for publication before the end of 1978.

After returning to BMR Johnston continued working on the development of a regional, evolutionary tectonic model encompassing all published geological and geophysical data from the survey area. Some near surface, relative crustal motions in the vicinity of the Timor Trough were estimated using results from DSDP-262 in conjunction with micropalaeontological datums, seismic reflection profiles, surface sediment distributions and local geomorphology. These have been interpreted as convergent motions decreasing from 16 cm/yr, 2 million years ago, to zero at present. Together with major lithospheric plate motions they indicate an evolutionary link between the Java Trench and the Timor Trough. An apparent middle Pliocene date was obtained for the collision between the Australian continental lithosphere and an oceanic subduction zone at the southern edge of the Southeast Asian plate.

A simple development model arising from these determinations was used in conjunction with volumetric and other convergent tectonic constraints in reviewing the published geology of Timor which supports a middle Pliocene collision. However integration of the model with other aspects of the geology leads to a requirement for the continental rocks of northern Timor having been part of the Southeast Asian plate prior to the collision. It is suggested that these rocks were probably rifted from northern Australia during the Upper Jurassic and have become re-united with the Australian lithosphere following the middle Pliocene collision.

Having adopted this tectonic model the velocity of the southeast Asian plate was calculated to be about 6 cm/yr in an easterly direction relative to the Eurasian plate. More detailed models can now be proposed for the Tertiary tectonic regimes in this region.

The results of this work will also be submitted for publication in late 1978.

Petroleum prospectivity of the Australian marginal Plateaus [J.R. Willcox]

A paper entitled 'Petroleum prospectivity of the Australian marginal plateaus', was presented at the Second Circum-Pacific Energy and Mineral Resources Conference in Honolulu, 28th July - 4th August. The paper is to be published in the American Association of Petroleum Geologists Bulletin.

Sixteen deeply submerged plateaus, terraces and rises have been identified on the margins of the continent. These are largely unexplored for petroleum and some are now within range of drilling and well-completion technology. Most of these features are rifted and foundered continental blocks on which sediment thicknesses range from about 500 to 9000 m. However, the marine sequence deposited after continental breakup is generally thin.

The most prospective areas, the Exmouth Plateau, and Carnarvon and Rowley Terraces, are underlain by several thousand metres of mainly fluvial-deltaic rift-stage sediments, which provide reservoirs and gas-prone source beds. A transgressive marine mudstone provides the main source beds and seal. Fair prospects are assigned to the Queensland and Townsville Troughs, and to a depocentre flanking the Marion Plateau. The Ceduna Terrace also warrants further exploration. Rift-basins which may occur in the South Tasmania Rise, Lord Howe Rise, Kenn Plateau, Eastern Fields Plateau and other areas off northeastern Australia require further surveying, as they may provide long term prospects.

Coral Sea Taphrogeny (J. Mutter and G. Karner)

At the 2nd SW Pacific Workshop Symposium held at Sydney University in December 1977, Mutter and Karner presented a paper dealing with the Queensland Plateau, its creation and subsequent modification by taphrogeny, subsidence and sedimentation. Special emphasis was placed on the application and results of the Werner deconvolution computer program outlined in the BMR record 1977/50 by H. Hsu and L. Tilbury. The paper was published in a special issue of the ASEG Bulletin.

Tasman Sea rift systems and break-up (J.C. Mutter & D. Jongsma)

In another paper presented at the 2nd SW Pacific Workshop Symposium Mutter and Jongsma suggested that the present evidence supports asymmetric rifting in the separation of the Lord Howe Rise continental block from the Australian continent. In their view the rift valley system remained attached to the Lord Howe Rise block and now forms its western part. They reviewed

proposed rifting systems which could have resulted in the present distribution of continental blocks and concluded that the Tasman Basin represents a series of ridge-crest/transform segments in the secondary arm of a 3-arm rift configuration; here the primary spreading was in an arm extending southeast while the third arm, through the Gippsland Basin, failed to spread. This paper was also published in the special issue of ASEG Bulletin.

Continental Margin, NE Australia (J. Mutter & G. Karner)

During August, 1978, the Geological Society of Australia held a conference at James Cook University on the theme "Geology and Geophysics of N.E. Australia". Mutter and Karner prepared a paper which summarised the current state of knowledge of the geology and geophysics of the N.E. Australian continental margin, its formation, structure and stratigraphy. It includes a summary of data available from Government Departments, private companies, and from other Institutes. It was presented at the conference by J.C. Dooley on behalf of the authors and will be published in a special issue of the Bulletin of the Geological Society of Australia.

Continental Margin Survey data processing (R. Whitworth, J.C. Branson, J.C. Mutter, P.J. Cameron, W.J. Meyer, T.R. Hegyold, G.B. Price, P.J. Fowler, U. Hammerling).

Substantial progress towards finalisation of this task was made during the year, in spite of interruptions arising from program and system changes, staffing changes and the consequent delays during training and familiarisation of geophysicists and new technical personnel.

Phase 3. Adjustment of the magnetic network is an iterative procedure eliminating those nodes which show an excessive difference between the two values at the intersection of traverses, and then recomputing the network adjustment. The excessive differences arise mainly from errors in computing the ship's track which entail errors in the track intersections and consequently in the magnetic values identified as lying at the intersections. The effect is magnified by higher field gradients. Noisy magnetic records also affect the differences adversely. There are nearly 1200 nodes in the original network. They will be reduced during the adjustment to about 800.

When the network adjustment is complete, all values along the intervening traverse links will be adjusted to correspond with the adjusted node values and the magnetic data will be processed through Phase 4. This should commence before the end of 1978.

Phase 4. The navigation processing was completed in 1977. The plotting phase was delayed while a complete computer file of the Australian coastline was prepared and the elements of a completely automated map title, legend and comments were programmed. The first 30 track maps at 1:1 million scale were then made, entirely automatically. An original transparency of each was provided to the Copy Service of the Australian Government Printer early in 1978. The remaining 20 maps were completed after additional marine topographic features such as reefs, shoals and cays were added to the coastline file. This involved the sheets in the northwest, northeast and around Papua New Guinea.

Fairly high noise levels occurred in some of the gravity data from the Continental Margin survey and consequently these results will be presented initially in profile form. However contour maps (masking noise) will also be produced consistent with the 1:1 million map series detailing water depths and magnetic field values. Profile maps should be completed about the end of 1978.

Water depths have been corrected after assessment of the edit versions of the contour maps and a final check has been made between the last detailed profile plot from Phase 2 and the Phase 4 values on which the contours were based. Preparation of final contour maps of the bathymetry was delayed until a modification was completed to the contouring program.

National Mapping Survey (R. Whitworth, H.M.J. Stagg, R.A. Dulski, G. Price)

As in 1977, the marine group provided equipment, software, and personnel to acquire navigation, bathymetry, and magnetic data in digital form aboard the National Mapping survey vessel, MV Cape Don. Survey 28 commenced in Fremantle on July 8 and was concentrated in the area west and southwest of Carnarvon, i.e. from Bernier Island southwards. During the survey, approximately 10 400 km of bathymetry and navigation data were

recorded at a 10-second sample rate with a line spacing of 3 km. For about 9000 km, fair to good quality magnetic data were also recorded. For the duration of the survey, magnetic diurnal data were recorded at a shore monitor station installed in Carnarvon and operated on behalf of BMR by officers of the Carnarvon station of the Bureau of Meteorology. The survey terminated in Fremantle on August 14.

For this survey the software for digital acquisition was extensively upgraded and rewritten, to accommodate additional inputs. The consequent enlargement of the software required the replacement of the HP 2116B computer with an HP 2108 and I/O extender. Most of the software development was done using the marine group HP 7900 disc which was configured in the system. The primary modifications made to the software were the improvement of on-line navigation aids, the much higher level of data checking particularly in the field of radio navigation, and the option to survey inshore simultaneously with the Cape Don and the small launch, both under way.

National Mapping Processing (R. Whitworth, G. Karner, J. Branson, G. Price, T. Hegvold).

BMR has collaborated with the Division of National Mapping (NATMAP) in three bathymetric surveys of the offshore Carnaryon region and an earlier survey of the Bremer Bay region. The data acquired consist of bathymetry and magnetic information with line spacing of approximately 1500 m. Surveying was conducted from the coast to the shelf break and precise navigation control was provided by Decca Miniranger and Hifix systems. BMR provided a computer based data acquisition system with on-line navigation and 10 second sampling for data and navigation collection.

Subsequently, processing was begun on all four surveys using the marine processing system developed originally for the Continental Margin Survey. The processing is being done primarily by NATMAP staff with BMR supplying the necessary system training and programming expertise.

The processing procedure employed is firstly to sort the time identifiers (the equivalent of a station or shot-point number) into a strictly increasing sequence. The raw data are then plotted as continuous

profiles so that the type of problems that exist in each channel can be identified. The type of filtering, window lengths and thresholds are determined from these plots and applied in Phase 1 processing jobs on the computer. The editing and filtering programs record everything that is done to the data and the printouts are stored in microfiche form.

Phase 1, the detection and removal or rectification of dubious data (spikes, data gaps etc), is nearing completion for surveys 26, 27 and 28 (Carnarvon surveys). Survey 25 (Bremer Bay survey) is entering Phase 2, the calculation of final, definitive latitude and longitude values for each data point based on the best evaluation of all navigation data in the vicinity of the point.

Law of the Sea Project (P.A. Symonds, J.B. Willcox)

During rhe latter part of 1977 and 1978 the Marine Group attended to several requests from Offshore and International Division for background data relating to Law of the Sea negotiations and in particular the delineation of the legal 'continental shelf' around Australia and its territories.

Attendance at 7th Session of CCOP/SOPAC in Wellington (N.F. Exon)

The 7th Session of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) was held in Wellington from 9 to 16 October. N.F. Exon attended the meetings as the Australian Technical Adviser on secondment to the Australian Development Assistance Bureau. During the year a UNDP Technical Review Mission visited the area and thereafter a draft Project Document was prepared, covering a three-year $4 000 000 offshore research program for the territories of Cook Islands, Fiji, Gilbert Islands, New Hebrides, Papua New Guinea, Solomon Islands, Tonga and Samoa. At the meeting the program was finalized and the revised Project Document was signed. The main sources of funding will be UNDP and the participating countries, and the project is due to start in January, 1979.

Compilation of External Data (G. Karner)

The Lamont-Doherty Geological Observatory (LDGO) has recently given over 200 000 nautical miles of digital geophysical data to BMR, primarily as a result of past co-operative ventures. These data complement our own computer data banks in the Southern Ocean and Tasman Sea. The data are held in confidence and any publication or external dissemination is subject to prior written authorisation from LDGO. The data, collected by RV ELTANIN, consists of gravity, magnetic and bathymetry information sampled at 6 minute intervals. The cruises involved were - EL34, EL35, EL36, EL37, EL39, EL40A, EL41, EL41A, EL42, EL44, EL45, EL47, EL47A, EL48, EL49, EL50, EL53, EL54, EL54A, EL54B, EL55 and EL55A.

In addition to the above data, BMR also received as part of a co-operative agreement over 10 000 nautical miles of digital geophysical data from the Coral Sea Basin. Data included gravity, magnetic and bathymetry profiles plus photographed copies of reflection seismic records. These data were collected by RV VEMA, and were also sampled at 6 minute intervals. The cruises concerned were V3313 and V3314. The same terms of confidence apply.

Seismic Field Processing Brute Stack System Development (C.R. Johnson, A.P. Hogan, F.M. Brassil)

After preliminary meetings and investigations late in 1977, work on this project began in January. Major items of equipment to be delivered within six months include a HP2117 F series fast floating point processor, a 22 inch wide 200 dot per inch electrostatic printer/plotter, and an additional magnetic tape transport.

A seismic pre-processing package, SEISY, has been developed with facility for:

(1) Reading SEG-B or SEG-C field records.
(2) Conversion of data samples to HP floating point.
(3) Demultiplexing.
(4) Gain recovery.
(5) Alternative input of SEG-Y data.
(6) Apply true amplitude recovery.

(7) Anti-alias and resample.
(8) Annotate auxiliary data to trace header block.
(9) Edit data traces.
(10) Vertical stack.
(11) Trace mix.
(12) CDP Gather.
(13) Update and edit trace headers.
(14) Produce an SEG-Y tape.

The program has been tested and it has performed satisfactorily.

Further development will include writing of programs to list field and SEG-Y tape headers, and a program to display seismic data with timing lines and annotation on a Zeta plotter. This last program will provide a basis for developing a seismic data display package on the Electro-static plotter when it arrives.

After considering the needs of potential users to input numerous program control parameters, a method of parameter input was set up which consists of a set of standard processing instructions each of which requires a number of parameters values. A default value has been established for each processing instruction. This method of parameter input has been called the Program Control Language (PCL). In essence it gives the user simple and effective control over the processing and allows the program to execute without further user intervention.

Major work remaining includes extension of the plot program to operate on an electrostatic plotter and development of a software package to incorporate normal moveout and stacking, constant velocity gather, constant velocity stack, static correction, band-pass filtering and scaling.

Development of a seismic analogue to digital transcription facility
(C.R. Johnston, F.M. Brassil, J.K. Grace, R.A. Dulski, P.J. Fowler, B. Devenish, P.J. Hillman)

This project was started in 1977 with the development of a system to transcribe marine analogue data into a digital format suitable for input into the Woods Hole Oceanographic Institution seismic processing system.

In order to produce the data in a standardised SEG-Y digital format that can be read by any seismic processing contractor it was necessary to modify the transcription programs. Special hardware was required to provide the digitisation timing and interfacing for computer control of the analogue equipment.

The system has been designed to transcribe marine 6-channel data recorded during BMR's survey of the Australian continental margin. It incorporates facilities enabling automatic start and stop of the analogue tape drive. In addition, the software has been designed to recognise shot times or water delay times, digitise 5 seconds of data at 4 microsecond intervals, demultiplex the data into channel files, determine the time interval between shots, maintain an accumulated time from the commencement of digitisation, detect ten minute pulses on the analogue tape, produce two sets of diagnostic printout (one for operator requirements and the other for retention with the digital data), organise the data into a standard SEG-Y format including headers giving tape and channel information, and output the data onto magnetic tape.

In addition to the transcription system a program was developed for plotting the digital data using a Zeta plotter. This program is used in routine or daily testing of the transcription system and in checking suspected data problems.

The system has been extensively tested in BMR and a tape of transcribed data which was sent to Geophysical Services International, Sydney, was successfully read on their seismic processing system.

It is proposed that this system be extended to perform digitisation of land seismic analogue data which are obtained in various formats.

Program development (R. Whitworth, G.D. Karner, L.A. Tilbury, P.J. Cameron, J.C. Branson, G. Lamberts)

A number of computer programs were written or revised during 1978, mainly in relation to Phases 1, 3 and 4 of the marine data processing system.

Phase 1 data processing routines were further revised and generalised to accommodate navigation methods and data arising for the first time from the co-operative work with Division of National Mapping. In particular

this involved the addition of an extra Miniranger channel and the introduction of HiFix. It entailed the treatment of noise and instrumental behaviour peculiar to these systems.

Phase 3 is the network adjustment phase in which the duplicate values of magnetic or gravity field measurements at the intersection of traverses (nodes) are adjusted by a least squares method to give minimum average closure error throughout the network. There are particular problems in applying this procedure to a network at sea owing to the errors and operational problems in marine navigation. This results in a much higher proportion of node rejection, for adjustment purposes, than in land surveys. Revision of programs in this phase were required to simplify the procedures dealing with this treatment of nodes.

Phase 4 provides the automatic display procedures for presentation in final form of the fully processed data from a marine geophysical survey. The rapid contouring program was thoroughly tested and debugged early in the year while it was in use for contouring detailed bathymetric data obtained by Division of National Mapping over the Northwest Shelf. The result proved highly satisfactory for this purpose. However, the data from the Continental Margin survey, very closely spaced along each traverse but having 20 mile to 40 mile or even greater spacing between traverses, produced a poor result from the same contouring program.

This program begins by relocating data points temporarily at the nearest point of a superimposed regular grid. It thenngenerates a palane surface at each such grid point, representing the value of the parameter to be contoured. These planes are expanded by successive sweeps through the grid until they meet adjacent, expanding planes. Intervening grid points assume the value of the plane which covers them. To minimize directional bias, the sweeps take place alternatively in opposite directions. Two spatial filtering operations follow, to smooth the step boundaries between the planes. First a Laplace function is applied iteratively, producing the effect of stretching an elastic membrane over the fixed values along the traverse line. This is followed by a longer iteration of a Poisson function, giving the much less pronounced effect of deforming a thin metal plate over the Laplace surface.

The difficulty with these filters lies in their inability to respond realistically to the nature of the sea bed, which changes slope in some places

more abruptly than would a simple force field. This is particularly troublesome at the 'break' between continental shelf and continental slope and to a less degree between slope and continental rise. The region between traverse lines of the 'breaks' receives a scalloped effect in the Laplace filtering which no economic amount of Poisson filtering can rectify. Therefore, the data were modified by the temporary addition of artificial shelf break and base of slope digital depth values where these were clearly necessary and readily defined. At the end of the Laplace filtering they were dropped from the data set to permit the Poisson filter to react normally.

The program modifications to achieve this result were prepared during the year and were incorporated in the Phase 4 system.

Other display programs were prepared or amended to provide the means of displaying more comprehensive profile sections and contour plans of seismic sections, in terms of depth as well as time and incorporating fault pdanes as well as truncated and onlapping horizons and unconformities.

DAS Development (H.D. Hsu, H.M.J. Stagg, G.D. Karner, R. Whitworth, L.A. Tilbury)

Development of the marine data acquisition system (DAS) was delayed because of the resignation of Hsu in April. New staff had to be familiarised with the details of the system which Hsu had developed (based on Hewlett-Packard's RTE-C operating system). Furthermore, with the success of the National Mapping DAS (NADAS) on the Cape Don and in the light of a current hardware shortage, it was decided to integrate the relevant parts of the RTE-C based system with a modified NADAS, using a single processor rather than the dual processor system envisaged by Hsu. Principally, this involved adapting the software to cope with user-selected sample rates, the writing of additional plotting software, and the addition of routines to read the multiprogrammer and multiverter, through which most marine data will be gathered.

The restrictions imposed by fitting all the software in a single processor limits the number of data channels which can be recorded. The optimum configuration at present seems to be to record 17 channels of 5-second sampled data on cassette tape every 2 minutes. Development of the new system is progressing well, and it should be ready for user familiarisation early in 1979.

3. OBSERVATORIES AND REGIONAL SECTION

(J.C. Dooley)

OBSERVATORIES SUB-SECTION (P.M. McGregor)

The observatories sub-section deals with basic investigations in geomagnetism and seismology; formerly it was comprised of four groups situated at Canberra, Melbourne, Mundaring (WA), and Port Moresby (PNG). However in December 1977 the Melbourne Group was transferred to Canberra and during 1978 the transfer of the Port Moresby Geophysical Observatory to the PNG Government was completed. Two new groups were subsequently formed in Canberra as follows:

-SURVEYS, DATA AND REDUCTIONS GROUP: G.R. Small, A.J. McEwin and E.H. Smilek.

-CANBERRA OBSERVATORY GROUP: R.S. Smith, M.W. McMullan, G.H. Thomas, S. Schmidt, J. Salib.

In brief, the first group provides data services for the entire Sub-section and attends in particular to magnetic surveys. The second group operates all permanent BMR observatories and seismograph stations outside Western Australia. It is also responsible for BMR personnel engaged in Antarctic observatory operations namely P.M. Davies (Macquarie Is) and J.J. Petkovic (Mawson). Staff from either group can be assigned to any specific project e.g. the periodic magnetic survey.

The MUNDARING GROUP maintains its previous functions with staff comprised of: P.J. Gregson, E.P. Paull, B.A. Gaull, G. Woad, B.J. Page, Y. Moiler and T. Creaser.

I.B. Everingham was attached to the Sub-section in June after transferring from the Port Moresby Observatory. He undertook tasks relating to the handover of the Observatory, provided specialist seismological services, and assisted in the general administration of the Sub-section.

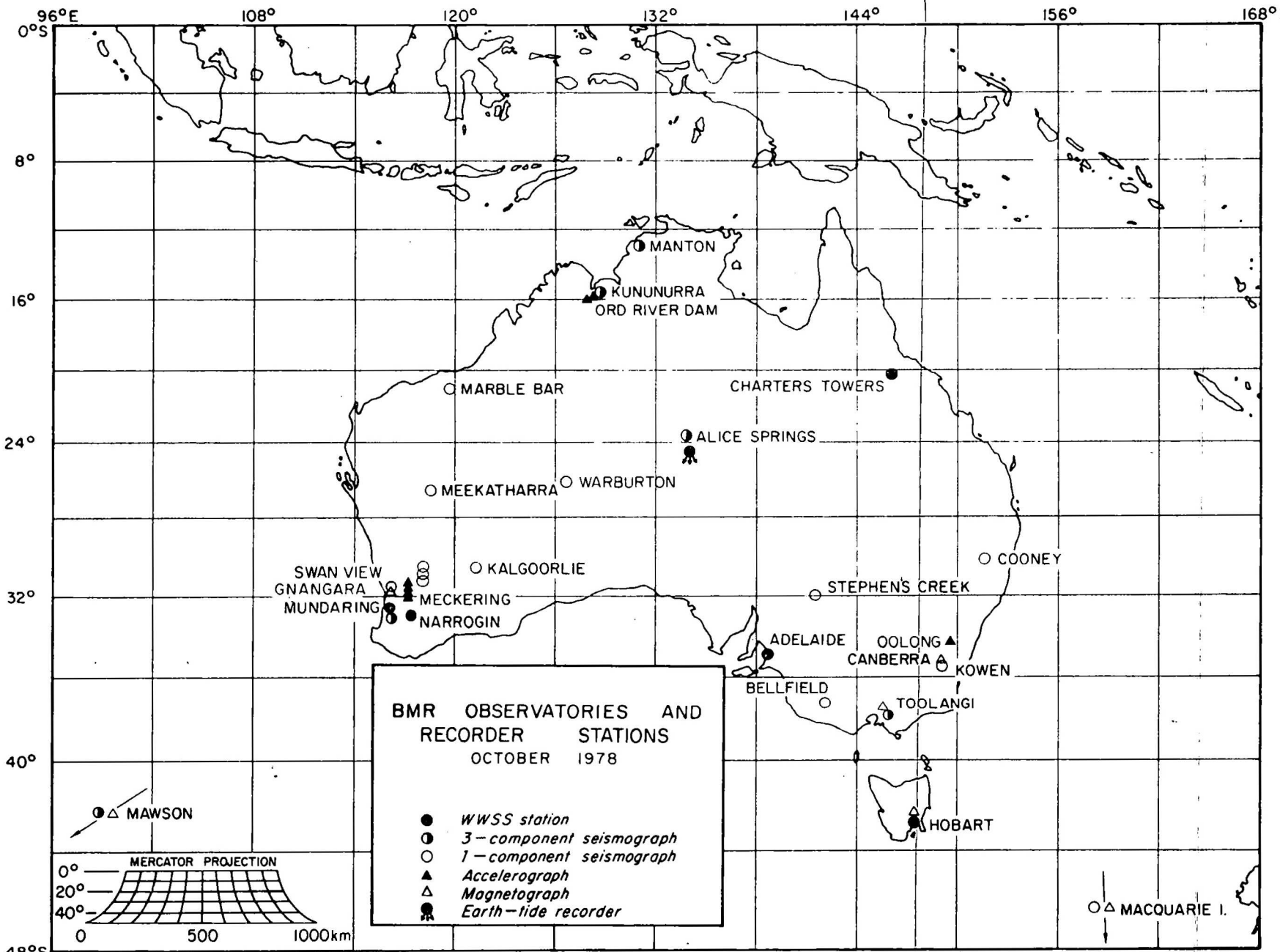
The following summary is presented by discipline rather than by operational group as in the past, and covers the interval October 1977 to September 1978. The locality map Figure OR1 shows the disposition of the magnetographs and seismographs operated solely or jointly by the Sub-section.

Nuclear explosions treaty

P. McGregor continued as Australian representative (for Department of Foreign Affairs) on the UN's Geneva 'Group of Scientific Experts' (GSE) to report on the use of seismological means for verifying a treaty banning underground nuclear explosions. After its final meeting in February the GSE presented a consensus report to the Conference of the Committee on Disarmament (CCD) showing how a global network of stations and a rapid data exchange scheme could serve the purpose. Subsequently the CCD accepted the report and gave the GSE a mandate to make the necessary preliminary plans for establishing the scheme for implementation when a test ban treaty is signed. The re-formed GSE met in July and four working groups were established to prepare operations manuals covering all the procedures from signal-recording to exchange of complex discrimination parameters. Actions relating to these working groups were begun in August.

Security declassification

A significant event for Australian seismology was the security declassification in May of the 'Joint Geological and Geophysical Station' at Alice Springs. This seismic array station is operated jointly by the USAF and the Department of Science. Proposals have been made to improve the station in the next two years and to allow wider participation by Australian seismologists. The declassification has had no immediate effect on BMR's seismological program at JGGS.


96°E
108°
120°
132°
144°
156°
168°E
0°S
8°
16°
24°
32°
40°
48°S
MANTON
KUNUNURRA
ORD RIVER DAM
MARBLE BAR
CHARTERS TOWERS
ALICE SPRINGS
MEEKATHARRA
WARBURTON
SWAN VIEW
GNANGARA
MUNDARING
MECKERING
NARROGIN
KALGOORLIE
COONEY
STEPHENS CREEK
ADELAIDE
OOLONG
CANBERRA
KOWEN
BELLFIELD
TOOLANGI
HOBART
MAWSON
MACQUARIE I.
BMR OBSERVATORIES AND RECORDER STATIONS
OCTOBER 1978
WWSS station
3-component seismograph
1-component seismograph
Accelerograph
Magnetograph
Earth-tide recorder
MERCATOR PROJECTION
0°
20°
40°
0
500
1000km

Geomagnetism

Observatories: Standard magnetic observatories were operated continuously at Gnangara (WA), Macquarie Island, Mawson, Toolangi (Vic). They provided geomagnetic disturbance indices and data on other transient phenomena; preliminary monthly values; and 20 mm/hour analog recordings of the three components declination (D), horizontal intensity (H) and vertical intensity (Z). In addition, monthly values were derived from absolute measurements made at Casey (Antarctica) by an officer of the Antarctic Division; a similar program at Davis was suspended when the observer had to be repatriated through illness. All these results were published by the data group in monthly issues of the 'Geophysical Observatory Report' volume 27.

Buildings for the new Canberra Magnetic Observatory in the ACT were completed in December 1977 and an 'automatic magnetic observatory' (AMO) was brought into operation in June. The AMO produces 1-min digital values of total intensity (F) and changes in D and inclination (I). The AMO uses a proton precession magnetometer (PPM) and bias coils which modify F in a fixed manner to provide the information on D and I. The other standard elements are derived by computer, but the programs for these conversions had not been developed at the end of September.

Because the AMO coils are subject to tilts and changes of direction, the directions of the coil axes have to be measured periodically. This is done by means of absolute measurements of D and I, the latter from H and Z for which the primary standard is the proton vector magnetometer (PVM). Unfortunately the PVM had not been brought into regular use because of delays in modifying the MNS-2 magnetometer required for the system.

Improvements were made to the AMO by immersing the sensor in a water bath (to allow cooling of the water sample and thus preservation of signal levels); by providing a local earth independent of the AC mains earth to reduce noise pick up; and by fitting a digital printer to give visual readings of data for use during absolute calibrations. Levelling of the PVM coils (which is the most critical source of inaccuracy) was improved significantly by lapping the conical bearing (carried out in the mechanical workshop) and by fitting lock-screws to the feet.

Dr P.N. Mayaud, IAGA specialist on geomagnetic indices, visited Canberra and Mundaring in February to standardise the derivation of the global index Km. This is based on the 3-hr range indices (K) measured at 18 well-distributed mid-latitude observatories, including Gnangara and Toolangi. These two BMR observatories are of particular importance because of the wide longitude range they represent.

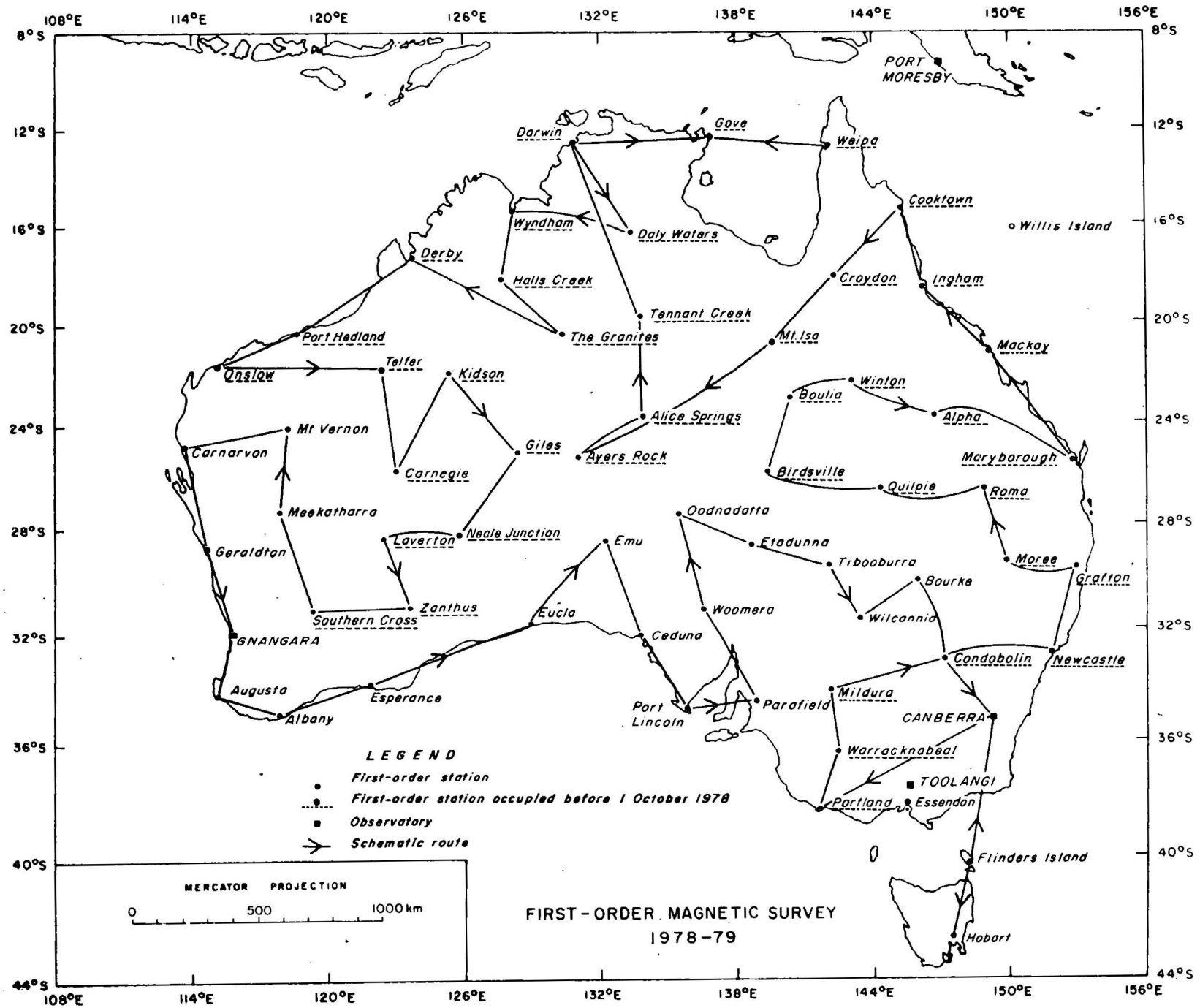
From March absolute observations at Toolangi were made by C.H. van Erkelens under contract to BMR. It is planned to maintain absolute control until mid-1979 and variation recordings until after the next maximum of solar magnetic disturbance in the mid 1980's. However, absolute control will need to be resumed periodically for such projects as MAGSAT - the orbiting 3-component vector magnetometer satellite scheduled to be launched late in 1979.

Data reduction: Magnetograms from the observatories are reduced to absolute mean values (hourly, daily, monthly, annual) by the reductions group. For this purpose a semi-automatic digitiser is used to measure hourly mean ordinates which are merged with the calibration data produced at the observatories. Re-construction of the digitiser around a dedicated mini-computer, and the preparation of basic computer programs was completed, and routine scaling of ordinates began in July. The reduction programs are expected to be available by the end of 1978 and it is aimed to eliminate the backlog of over 20 years' reductions by 1980, with help from the ADP section.

All published magnetic mean hourly values from Watheroo, Toolangi and Macquarie Is were converted to the IAGA format and stored in one computer file for ready access in standard form.

First order survey: Re-occupation of the set of 59 first-order magnetic stations was begun in March, and by September, 39 had been occupied in Victoria, NSW, Queensland, NT and WA (see Figure OR 2). At each, recordings were made for at least 48 hours of D, H and F (and the temperature of the fluxgate sensor); the recordings were calibrated by frequent absolute measurements, and accuracies approaching observatory standards were attained at most. The object is to obtain secular variation results for updating isomagnetic charts to epoch 1980.0; it is planned to complete the survey

(Based on A/BO-59-1A)



(mainland stations) early in 1979 and to produce the charts by the time of the IUGG General Assembly (December 1979). Personnel from all groups took part in this survey as follows: Victoria, NSW, southern Queensland - G.R. Small (part), M.J. Sexton; northern Queensland, NT - A.J. McEwin; northern/eastern WA - M.W. McMullan, B.J. Page (part); field hand D. Morrison assisted throughout.

Seismology

Seismic stations: Seismographs were operated at the following places; some jointly, with the cooperating agencies shown in parentheses:

THREE OR MORE COMPONENTS: Adelaide (University of Adelaide), Alice Springs (USAF), Charters Towers (University of Queensland), Kununurra (WA Public Works Dept), Manton, Mawson, Mundaring, Narrogin, Hobart (University of Tasmania), Toolangi. Stations underlined are part of the 'World Wide Standard Seismograph Network'. Narrogin is a 'Seismo Research Observatory' (SRO) and Charters Towers is an Abbreviated SRO.

SINGLE COMPONENT: Bellfield, Christmas Is (to November 1977), Cooney, Giles (to April), Kalgoorlie, Kowen, Marble Bar, Macquarie Island, Meekatharra, Melbourne (to Dec 1977), Stephens Creek, Swanview, Warburton (from July).

The station on Christmas Island was closed down because it was ineffective for Australian regional purposes, and the equipment was needed more urgently on the mainland. The equipment at Giles was transferred to Warburton Mission which has better access and fewer personnel changes. The Melbourne seismograph was dismantled as a consequence of the transfer of the Toolangi Observatory Group.

The SRO at Narrogin/Mundaring was serviced and modified by maintenance teams from the USGS Albuquerque Seismological Laboratory. The modifications improved the standby power supplies, the short-period event detector and calibrations, and reduced the number of data dropouts. However, they also removed the ability to play back recorded data without interrupting recording.

The vertical component at Kununurra was made more responsive to local earthquakes by changing galvanometer free periods from 0.75 s to 0.25 s - the magnification at 0.25 s increased from 30 K to 100 K.

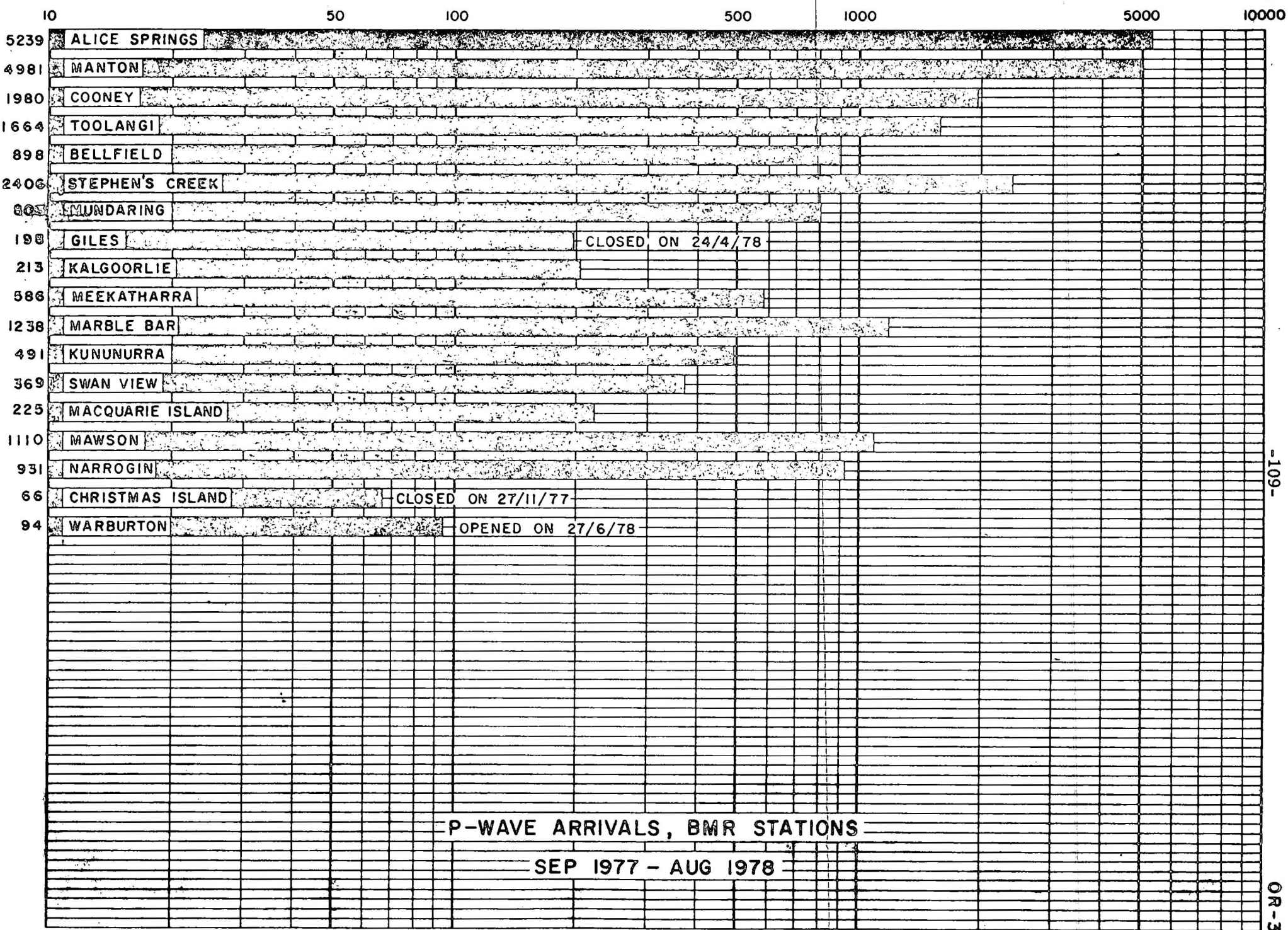
At Manton/Darwin the recording rate was decreased to 30 mm/min to give 2 days' record per chart in order to reduce weekend overtime expenditure. Progress was made at Mawson towards replacing the short-period horizontals by high and low-gain long-period vertical components: these will provide valuable surface-wave data.

Three field seismographs were installed in the Meckering area. Information is being gathered which will enable studies to be made on the depths and locations of earthquakes, attenuation factors and possibly variations in the body-wave velocity ratio Vp/Vs.

Data files: Preliminary phase data from all the 3-component stations and several of the single-component (regional) stations were sent a few times a week to the USGS 'Preliminary Determination of Epicentres' centre. Final phase data (from all agencies in Australia, PNG and the Solomon Islands) for the interval March 1976 to December 1977 were sent to the International Seismological Centre (ISC); data on about 4500 P-phases were sent monthly (Figure OR 3 shows the details for BMR stations). The data were also produced in time-sorted bulletins and distributed to co-operating agencies.

The regional Earthquake Data File (for the area 0-90^{o}S and 75-165^{o}E) was expanded to contain about 25 400 hypocentres from 1873 to December 1977. About 100 calls were made on the file, from within and outside BMR. The calls included requests for: information on felt earthquakes from the public and insurance companies; advice on earthquake engineering from consulting firms; and plots and listings of regional seismicity for numerous purposes. Epicentral data from Australian and Papua New Guinea sources on the file were sent on punched cards to ISC. Listings from the file, and all bulletins are available optionally on microfiche or paper.

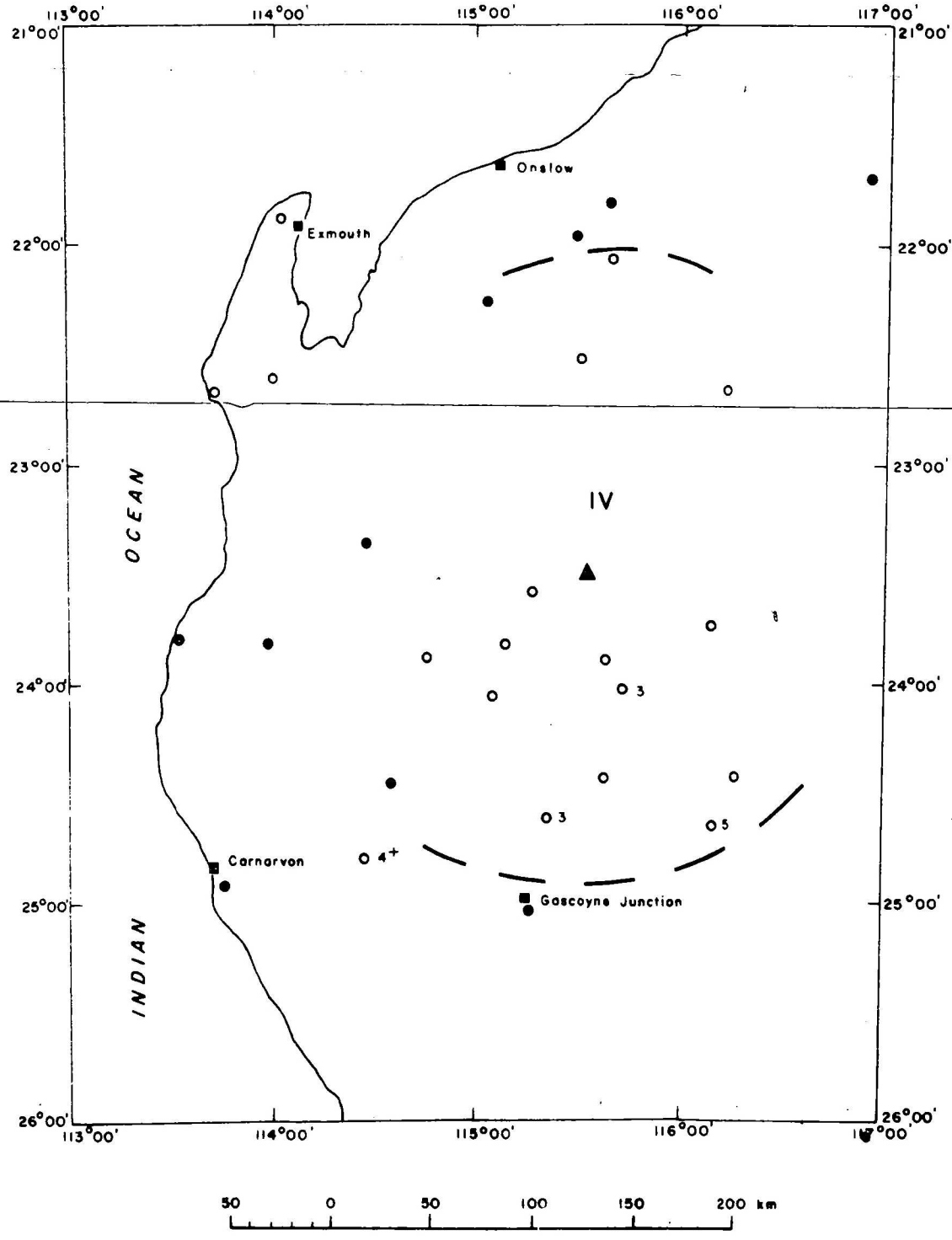
Seismic events: All significant earthquakes that occurred in Western Australia during the report period are listed below:



Date	Locality	Magnitude	Remarks
(1977)		(ML)	
Oct 10	60 km E Katanning	3.2	
24	250 km NE Carnegie	3.6	
Nov 03	Lake McKay	4.0	Area active 1970
07	310 km W Broome	3.7	
12	100 km W Kalbarri	3.8	
17	30 km NE Cundeelee Mission	4.6	felt
22	180 km NE Marble Bar	4.3	felt
Dec 26	30 km NE Cundeelee Mission	3.5	
30	Landor	4.9 & 3.8	felt m 5.7 Event 1969.
(1978)			
Feb 07	250 km W Lake McKay	4.0	
13	84 km S Kununurra	2.5 & 2.0	
Mar 13	100 km NE Gascoyne Junction	3.2	
16	160 km W Kalbarri	2.9	
18	32 km S Kununurra	2.0	
Apr 03	340 km SW Giles	3.1	
05	90 km NNE Geraldton	3.3	
*May 01	240 km ENE Carnarvon	5.7	felt
May 06	220 km S Halls Creek	6.2	felt. Largest in WA since 1968.
31	25 km S Port Dover	3.3	
*Jun 09	12 km E Margaret River	3.0	Located on Dunsborough Fault.
Jul 10	73 km SSE Marble Bar	3.5	felt
27	73 km SE Narrogin	3.5	felt

* Isoseismal maps for these earthquakes are shown in Figures OR 4 and OR 5

ISOSEISMAL MAP OF THE MAROONAH H S EARTHQUAKE W A 1 MAY 1978



DATE : 1 MAY 1978
TIME : 03:42:52·5 UT
MAGNITUDE : 5·7 ML
EPICENTRE 23·51°S 115·54°E
DEPTH : SHALLOW

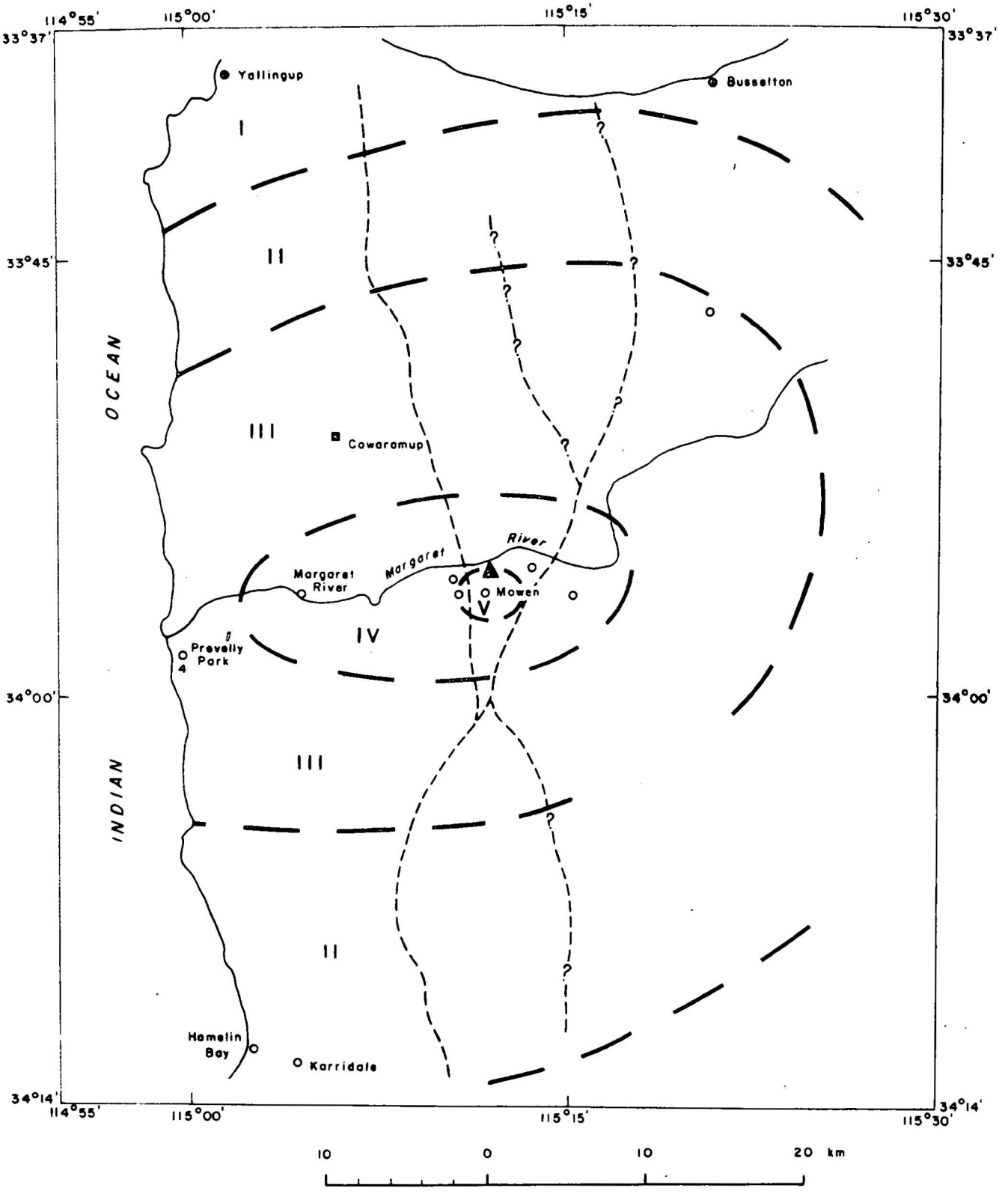
▲ EPICENTRE
o EARTHQUAKE WAS FELT
● EARTHQUAKE WAS NOT FELT
IV ZONE INTENSITY DESIGNATION (MM)
■ NAMED PLACE

Small figure beside open circle indicates intensity is different from zone designation

Record No. 1978/97

F50/B9-7A

ISOSEISMAL MAP OF THE MARGARET RIVER EARTHQUAKE W A 9 JUNE 1978



DATE 9 JUNE 1978
TIME: 12:31:17·8 UT
MAGNITUDE: 3·0 ML
EPICENTRE: 33·93°S 115·20°E
DEPTH SHALLOW

▲ EPICENTRE
o EARTHQUAKE WAS FELT
● EARTHQUAKE WAS NOT FELT
IV ZONE INTENSITY DESIGNATION (MM)
--- FAULT TRACE

Small figure beside open circle indicates intensity is different from zone designation

Record No. 1978/97

I50/89-9A

Elsewhere an earthquake of about magnitude ML 5 occurred on 3 December 1977 at 1232 am (ESST) about 15 km SW of Bacchus Marsh near Balliang. A maximum intensity of MM V caused isolated damage. Although some reports of minor damage were received outside the 20 km radium MM V zone (e.g. from Werribee) these are attributed to a higher density of population.

The earthquake was felt over a radius of 230 km as far as Kerang to the north, Glenorchy to the west, and Warragul to the east. The isoseismal map is shown in Figure OR 6. A number of aftershocks were recorded but no damage from these was reported.

Accelerographs were operated in WA and NSW. Additional units were added near Meckering to bring the total to four. These have modified triggers and the first two accelerograms from the area were obtained within five months after being modified. None were obtained in the previous six years. However the accelerograph at Oolong (NSW) was not triggered. At the Hume Weir the NSW Water Resources Commission was assisted to instal 5 accelerographs on the dam and its abutments.

REGIONAL SUB-SECTION (D. Denham)

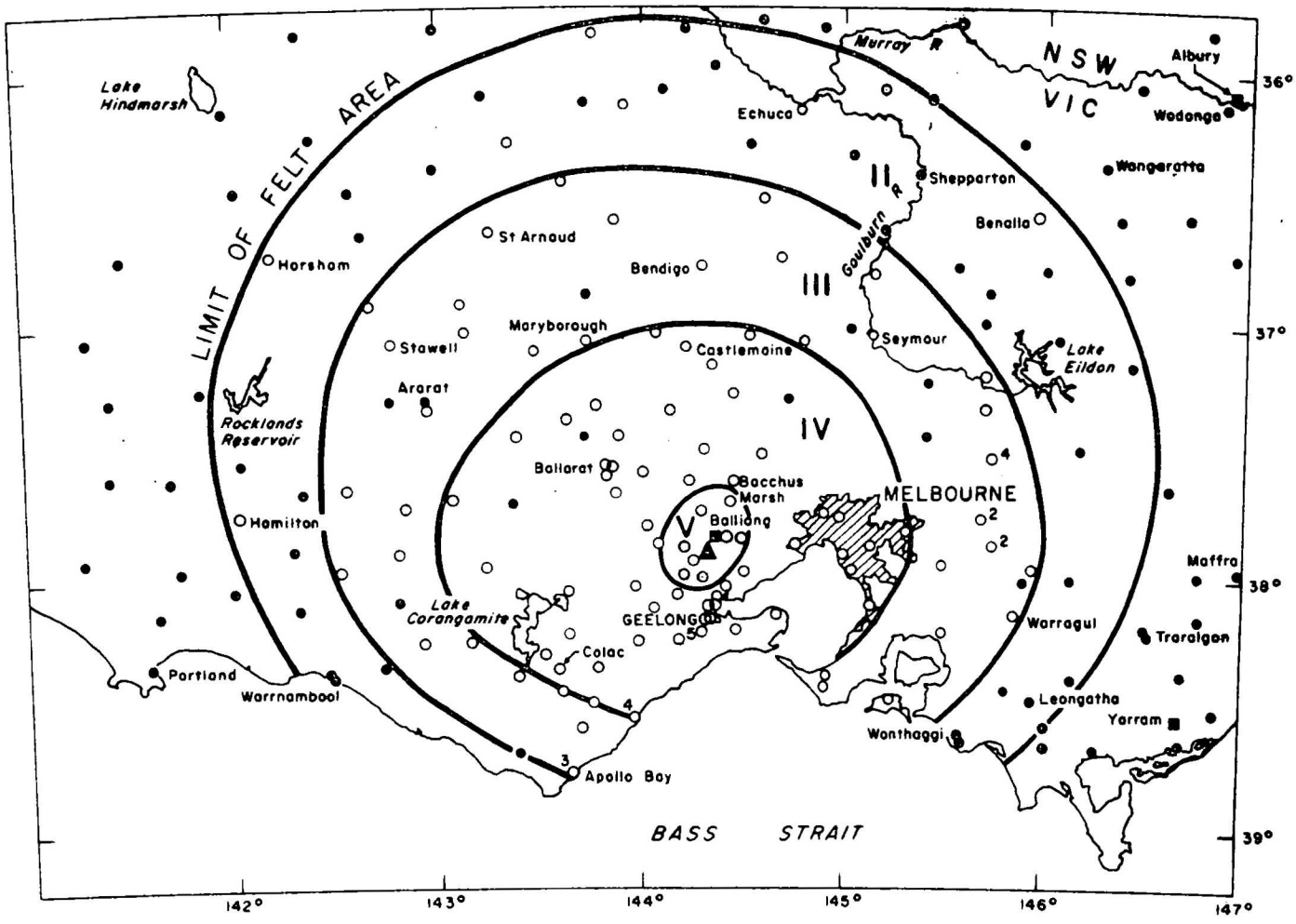
REGIONAL GRAVITY GROUP (P. Wellman)

The regional gravity group is the national authority on all matters relating to the earth's gravity field. The primary service function of the group is to compile all available gravity data in Australia and to distribute those data as required to government and industry. In addition help is provided on instrumentation, gravity standards and interpretation. The research function of the group is to carry out basic research into the Australian gravity field, measuring both its static and dynamic components and to interpret these measurements.

Contract Recomputation of Gravity Data (A.S. Murray)

Late in 1977 a new group of surveys was given to the contractor to be recomputed. Priority was given to those surveys lying in the areas of the Lachlan fold belt and Pilbara crustal investigations. Progress during

ISOSEISMAL MAP OF THE BALLIANG EARTHQUAKE VICTORIA 2 DECEMBER 1977



DATE : 2 DECEMBER 1977

TIME : 13:32:33·7 UTC

MAGNITUDE : 5 ML

EPICENTRE : 37·93° S 144·29° E

DEPTH : 20 km

▲ EPICENTRE

○ EARTHQUAKE WAS FELT

● EARTHQUAKE WAS NOT FELT

IV ZONE INTENSITY (MM)

■ NAMED PLACE

Small figure beside open circle indicates intensity is different from zone designation

the first half of the year was steady but production slowed after July when the smaller more difficult surveys were commenced and the number of the contractors staff working on this project decreased. 50 surveys were assessed, 30 surveys were completed, adding 20 000 stations to the data bank. A contract extension of $26 000 was approved but this money will not be available until 1979/80. This extension will complete the recomputation contract.

Computer Programs (A.S. Murray)

The line-drawing subroutines of program CONTOR were thoroughly analysed and several modifications were tested. These modifications completed the overhaul of the contouring program commenced in 1977. Contour maps can now be reliably produced from large volumes of data covering large areas. Several extra functions were added to the program to permit the saving of gridded data for all maps of a multiple map job, to exclude specified surveys from the data search, and to provide more relevant information on the job listing.

Two new programs which generate and manipulate gridded data tapes were developed. Program FLAGRID generates a gridded data tape in the format accepted by program CONTOR. The grid values and grid flags may be defined with:

(i) direct read from data cards
(ii) polynomial surface, quadratic in latitude and longitude
(iii) inside or outside a specified polygon
(iv) gravity effect of a vertical cylinder
(v) gravity effect of a three dimensional prism

Program REGRID reads the gridded data files generated by CONTOR or FLAGRID and manipulates them to produce new gridded data files in the same format. The main functions of this program are:

(i) Combining several grid files into a composite file with or without mathematical transformation being applied (e.g. subtraction of regional grid)

(ii) Extraction of sub-areas from larger areas

(iii) Sampling gridded data on a larger grid than the original grid

(iv) Windowing the grid so that only specified areas of the map will be contoured.

These programs were extensively tested and debugged in the production of maps for the 1:250 000 gravity map series, and for the Gosses Bluff (Fig. OR 9) and Pine Creek projects. Complementary 3-D body profiling programs were written for the HP9825A calculator and the Cyber 76 computer.

Gravity Maps of Australia

The first sheets of the new 1:250 000 scale Bouguer anomaly maps of Australia were produced. The gravity values are expressed in micrometres/second^2 instead of milligals. The gravity formulas are based on the 1967 ellipsoid and IGSN values. The areas being covered first are the Hamersley Range, Meakathara, Canberra and Melbourne 1:1 million sheet areas.

Gravity maps were produced for the Pine Creek Geosyncline and the Georgina Basin areas for other sections of BMR. Free air and Bouguer anomaly maps were computer drawn for BMR Atlas gravity plates at 1:10 000 000 scale. Detailed explanatory notes for the BMR Atlas maps were written.

Gravity Map of Ghana (A.S. Murray)

The Geological Survey of Ghana was assisted to produce computer contoured gravity maps. Gravity data for 3500 observations were received on punched cards; and after removing numerous punching or coding errors, a 1:1 million Bouguer anomaly map was produced and sent to Dr J. Ako in Ghana.

International Gravity Commission meeting September 1978 (P. Wellman, J. Connelly)

Australian activities during the period 1974 to 1978 were summarized in a National Report that was distributed at the meeting. The meeting was attended by J. Connelly.

Interpretation of large gravity anomalies in central Australia (P. Wellman)

A paper was written attributing the larger gravity anomalies within the Australian continent to abrupt changes in mean crustal density with regional isotatic compensation of the crust. The inferred crustal block boundaries correspond in position with the crustal block boundaries inferred from geology, and approximately with the position of the block boundaries inferred from changes in the gravity trend pattern (Figure OR 7).

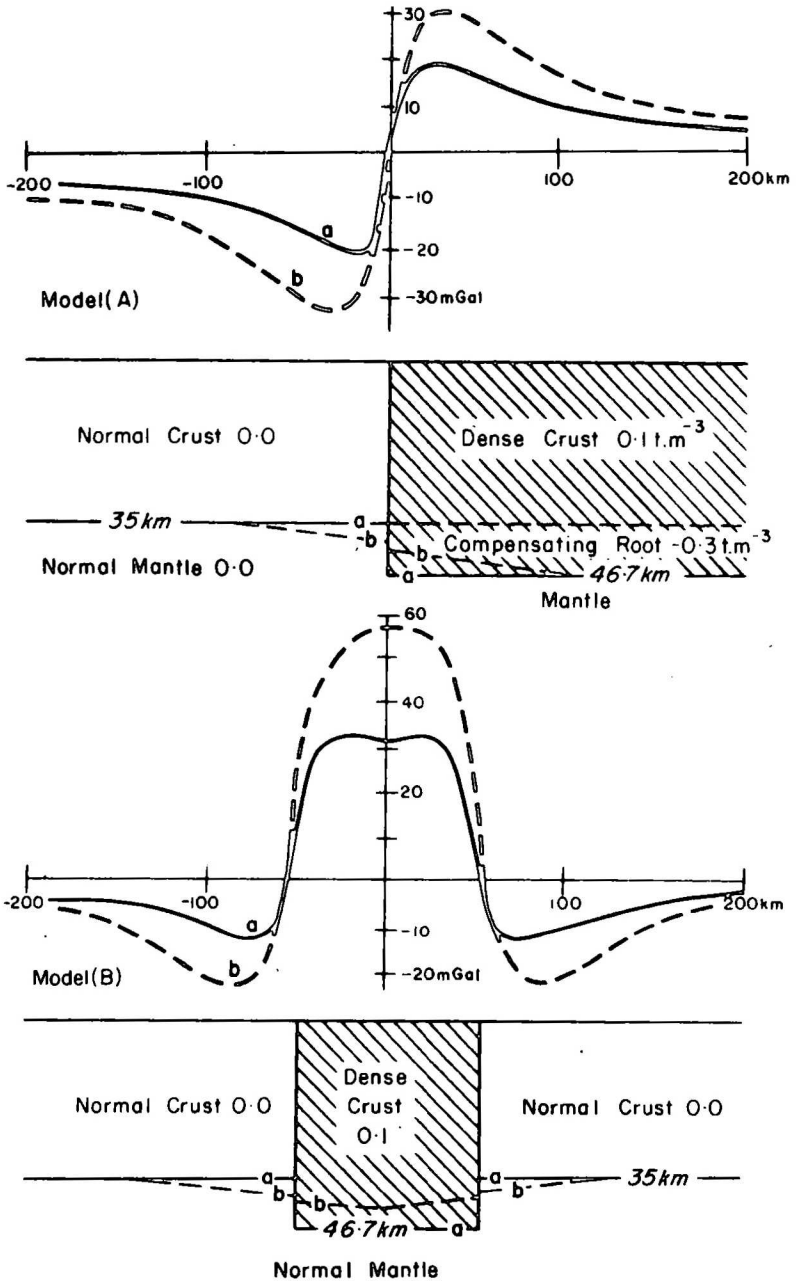
Isostatic corrections and the depth of isostatic compensation in eastern Australia (P. Wellman)

A computer program was written to calculate standard topographic isostatic corrections for gravity anomalies. The program uses gravity station ground heights to define topography of 10 km x 10 km areas, and calculates corrections from 22 km to 900 km from the calculation points. Published maps give the correction outside 900 km. For each calculation point the program evaluates a series of topographic - isostatic corrections; Airy hypothesis corrections for a number of standard crustal thicknesses; and Vening-Meinesz corrections for a number of standard degrees of regionality. The effect of sediment load can also be included in the calculated corrections.

The resultant isostatic corrections have been compared with the mean Bouguer anomalies for 0.5^{o} x 0.5^{o} areas, and the best fitting isostatic compensation model has been determined for most of the major mountain masses in Australia. The steeper mountain masses in southeastern NSW, northeastern NSW, and northeastern Queensland fit most satisfactorially to an Airy compensation model with local compensation and depth to the base of the standard crust of 50 to 60 km. Results from other areas are more equivocal.

Antarctic gravity and magnetic data (P. Wellman)

A start was made in interpreting aeromagnetic data collected in Enderby Land in 1977 and 1978. Using ice radar measurements of basement relief, the apparent susceptibility of the basement can be calculated for each topographic feature (this is about every ten kilometres).



Negative anomalies

GRAVITY ANOMALIES DUE TO ISOSTATICALLY COMPENSATED CHANGES IN MEAN CRUSTAL DENSITY

Gravity data collected by Japanese and Soviet expeditions in west Enderby Land were compiled and a start was made on removing errors and on interpretation.

Earth Tides (B.C. Barlow)

The Alice Springs earth tide station was kept operating throughout 1978 as a co-operative project with the International Centre for Earth Tides, Brussels. Because of the distance from Alice Springs to the nearest ocean, the tide recorded at that site is relatively free of indirect effects caused by ocean tides, and should be close to the pure solid earth tide. Moreover the site is seismically quiet and so the signal to noise ratio is favourably high.

Data collected intermittently during 1976/77 were flawed by inadequate calibration and maintenance of the equipment caused by staff shortages in the Alice Springs Office of the N.T. Geological Survey. The equipment was operated throughout 1978 by Mr C. Braybrook and Mr L. Bell of the Geophysics Section of the Water & Sewerage Branch, N.T. Department of Transport & Works. Their excellent and consistent attention to calibrations and maintenance gave a near-continuous record with very small standard errors.

The data were analysed by Professor P. Melchior and Dr. B. Ducarme of ICET, who supplied the recording gravity meter, Geodynamics 84, and its ancillary equipment. The behaviour of the meter was analysed by B.C. Barlow who adjusted the meter in January and in July.

The long run of reliable tidal data will be used for testing earth models, testing for resonance in the liquid core, ocean tide modelling, and investigation of the elastic parameters of the solid earth. Results will be published during 1979.

Terrain Corrections (B.C. Barlow, D.A. Coutts, G. Fisher).

The effect of terrain corrections on the Bouguer anomaly contours shown on 1:250 000 maps in mountainous areas was investigated in the Canberra map sheet area. General techniques for obtaining approximate values of terrain correction were evaluated for accuracy and for the time involved.

The time required per station varies from one hour to more than 2 hours for a technique which gives terrain corrections accurate to a factor of 2 (e.g. 60 $\mu m.s^{-2}$ estimate for true corrections ranging from 30 to 120 μms^{-2}). More accurate methods take longer and require topographic data which are frequently not available.

Terrain corrections for stations shown on the Canberra sheet range from 2 to 189 μms^{-2}. Simple and terrain corrected Bouguer anomaly contours for the Canberra sheet are compared in Figure OR 8. In general the corrected contours are much smoother.

Terrain corrections were also calculated for a few stations in the Pilbara area. Values of up to 30 μms^{-2} are obtained for traverses through gorges.

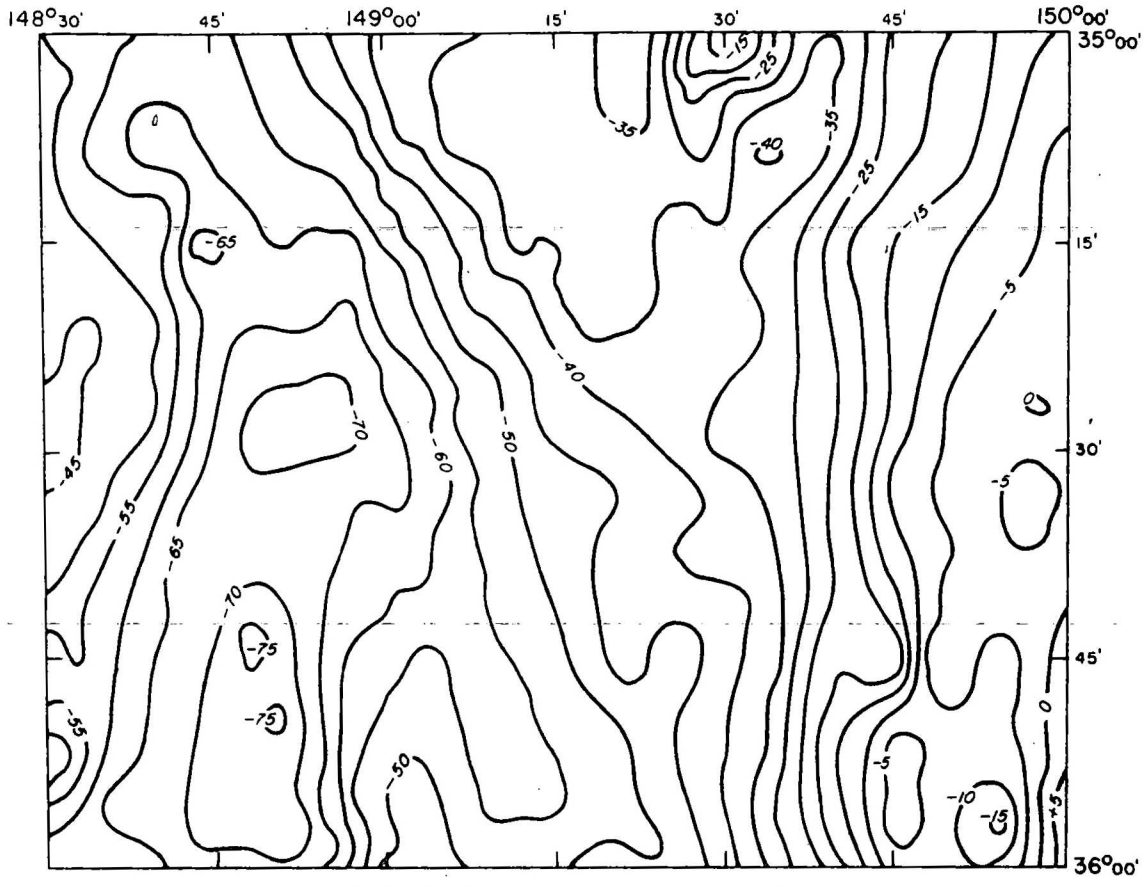
Accurate terrain corrections were calculated for stations on and near the central uplift area of the Gosses Bluff detailed gravity survey. Values range up to 34.7 μms^{-2} in an area where the anomaly to be interpreted is of comparable size.

Gosses Bluff (B.C. Barlow)

In order to finalise the gravity investigation of the Gosses Bluff crypto-explosion structure a major effort was made to remove mapping errors from private company data, calculate terrain corrections and produce final gravity maps at scales of 1:250 000, 1:50 000 and 1: 7 500. Reliable integration of data from all sources has nearly doubled the density of station coverage in the area of interest, has emphasized the symmetry of the gravity feature, and enabled more reliable interpretation by geological modelling. The complexity of the gravity gradients can now be attributed to near surface features with density contrasts of 0.1 Tm^{-3} or larger. Interpretation has been aided by a newly developed ADP facility for removing regional gravity fields enabling ADP production of residual maps (Figure OR 9).

OR-8

CANBERRA



SIMPLE BOUGUER ANOMALIES

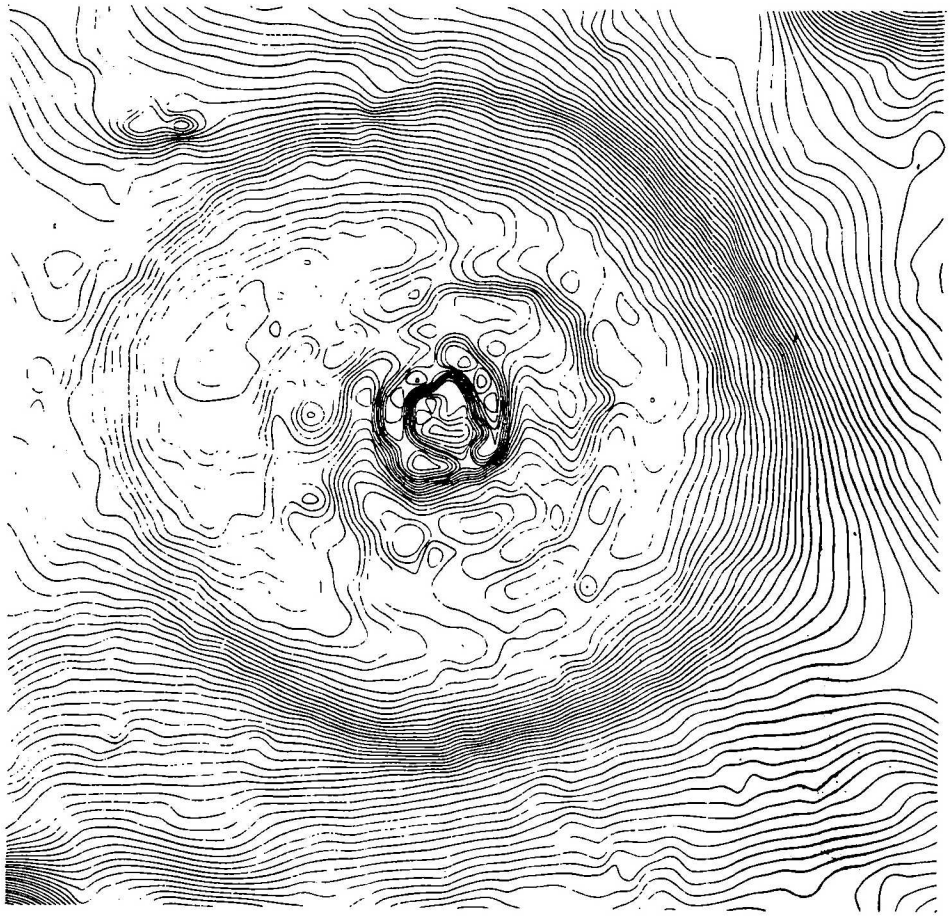
CANBERRA

TERRAIN CORRECTED BOUGUER ANOMALIES

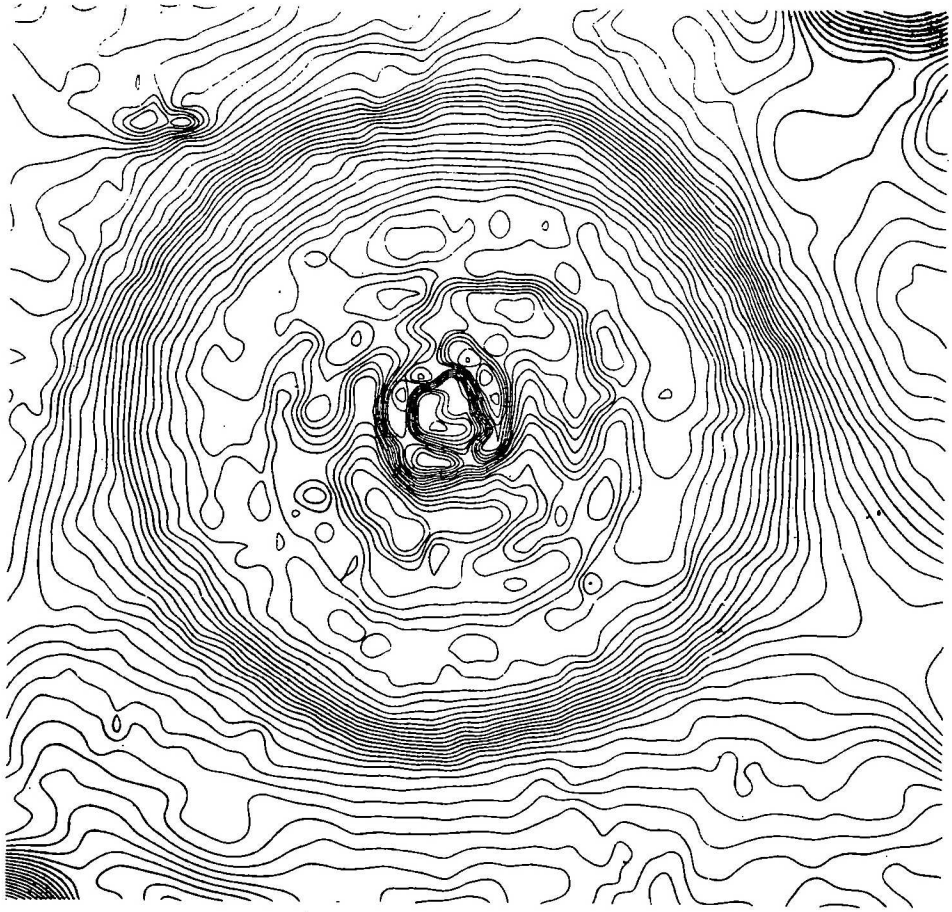
Record No. 1978/97

I55/B2-69A

OR-9



GOSSES BLUFF
OBSERVED GRAVITY



GOSSES BLUFF
RESIDUAL BOUGUER ANOMALIES

Instrumentation (J. van Son, D.A. Coutts)

Routine maintenance of BMR gravity equipment was carried out where necessary and a number of university and industry owned gravity meters were evacuated on request. BMR gravity meters were lent for periods of up to several months to Antarctic Division, University of New England, Australian National University, and Avian Mining Co. Advice was given to companies and universities on gravity equipment.

In 1977 quartz type gravity meters were calibrated on a tilt table on loan from the Soviet Academy of Sciences. The results of this work were reduced using specially written computer programs, and tables of the results were prepared. The operational part of the report was written.

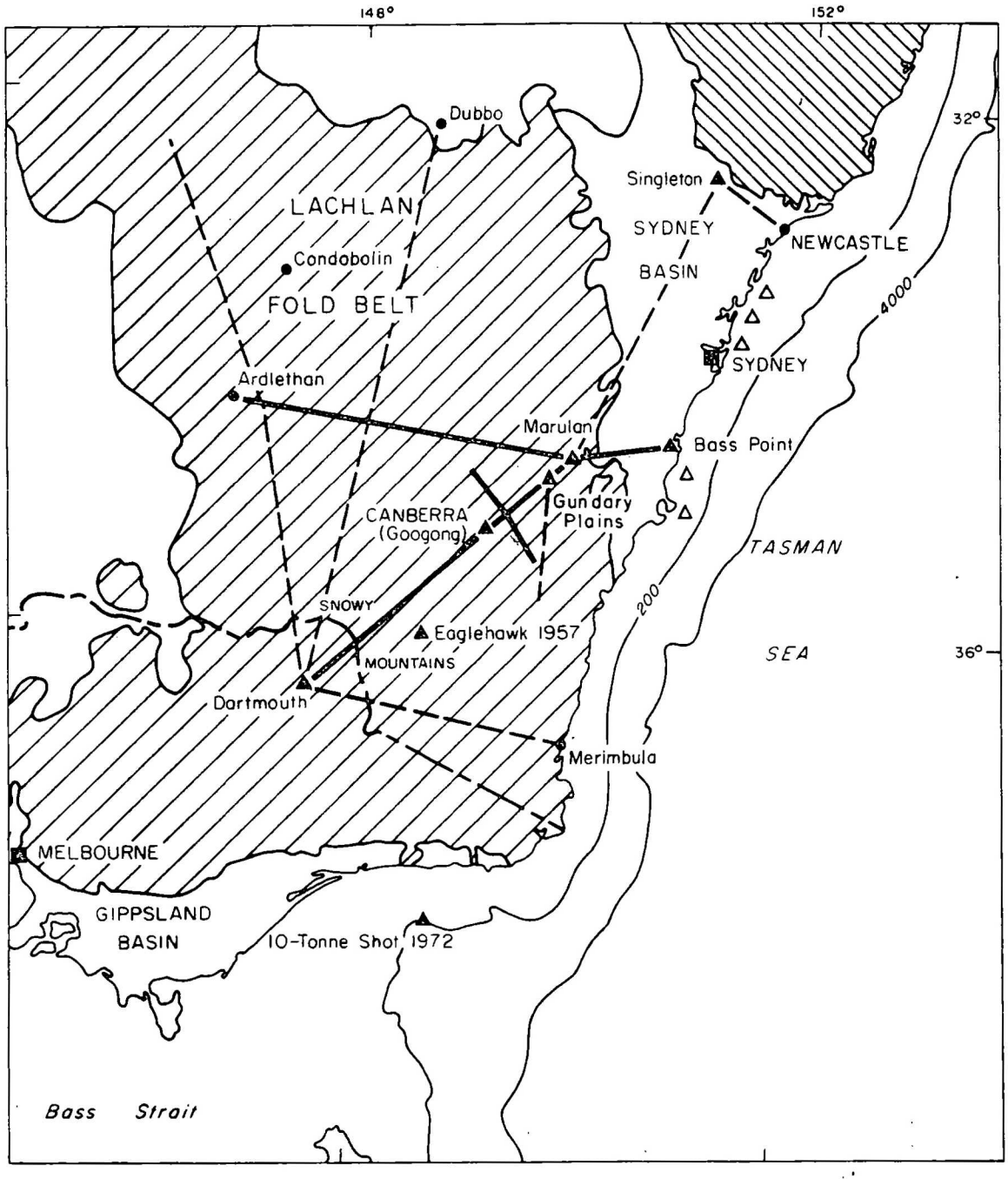
Mr Coutts spent considerable time in helping the technical review committee, the trainee technical officers scheme, and the survey of opinions of science technical grades.

REGIONAL STRUCTURAL STUDIES GROUP (D.M. Finlayson)

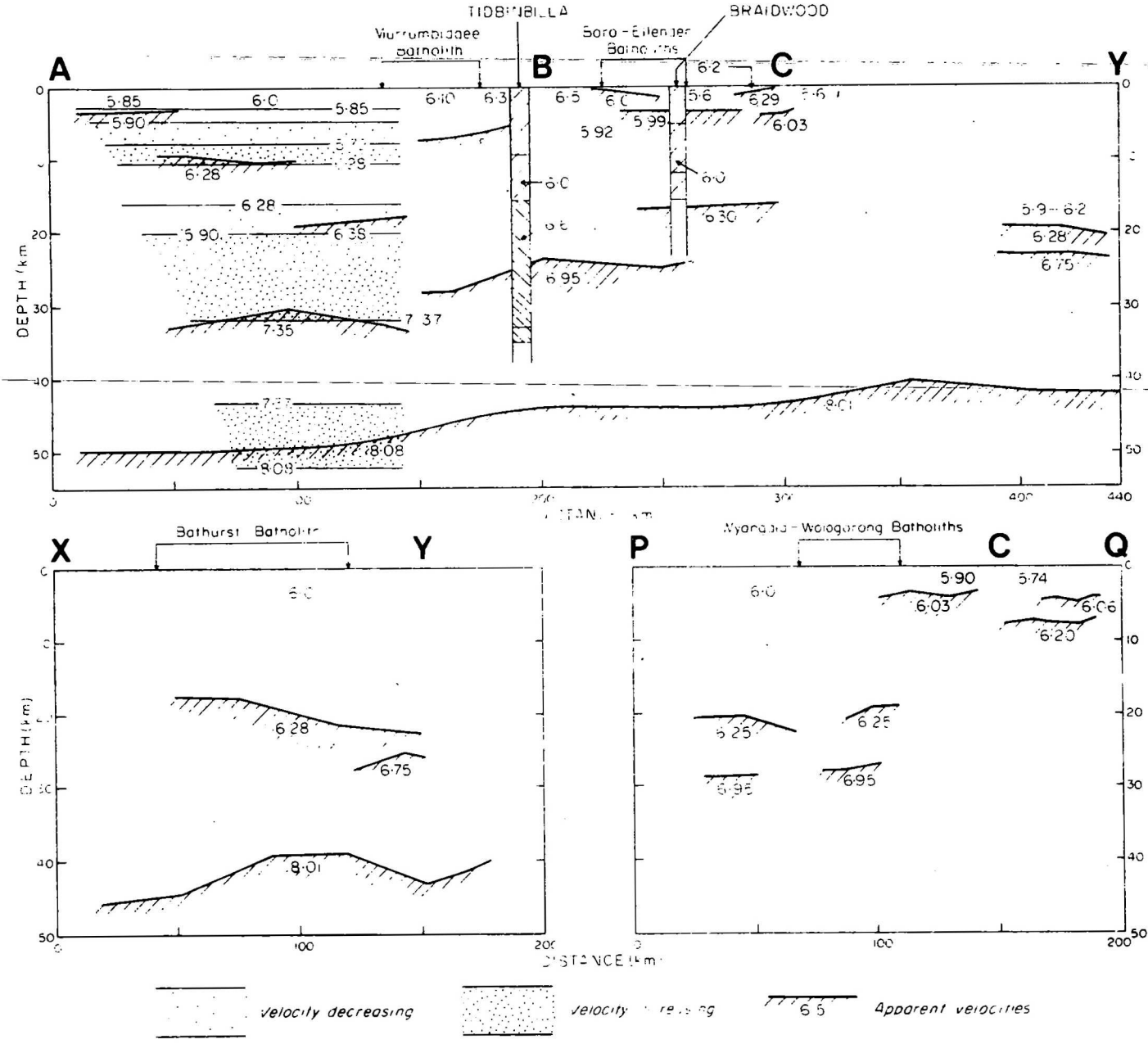
Lachlan Fold Belt Crustal Investigations (D.M. Finlayson, C.D.N. Collins, D. Denham, J. Williams, J.B. Connelly)

As indicated in the Branch Summary of Activities for 1977, seismic recordings were made in the Lachlan Fold Belt of southeastern Australia along a number of traverses during 1976 and 1977 using quarry blasts as seismic sources (Figure OR 10). Interpretations of the data along two main traverses were made during 1978; these traverses were Dartmouth to Marulan and Bass Point to Ardlethan. Figures OR 11 and OR 12 indicate a crustal model in the region and a preferred velocity-depth profile from Dartmouth shots.

The results indicate a depth to the Moho of between 40 and 52 km, with P-wave velocities in the upper crust between 5.6 and 6.3 km/s, lower crustal velocities between 6.7 and 7.4 km/s, and upper mantle velocities between 8.0 and 8.1 km/s. Velocity changes within the crust and at the Moho boundary are transitional rather than discontinuous. A well-defined low

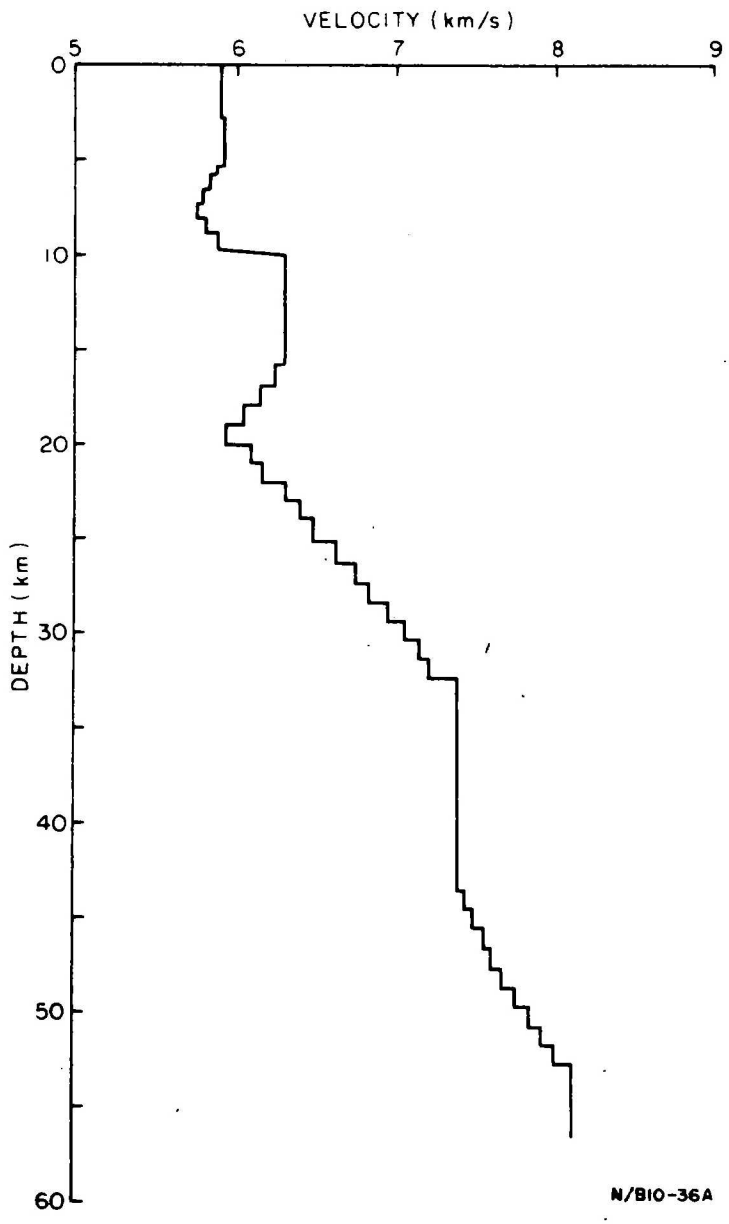


LACHLAN SEISMIC TRAVERSES, 1978



CRUSTAL SECTION DARTMOUTH-MARULAN

Record No. 1978/97



VELOCITY DEPTH PROFILE FOR DARTMOUTH SHOTS

velocity layer in the crust, at a depth of about 15-20 km, is evident throughout the region and localized low velocity layers may be present in the upper crust at shallower depths. The thickness of the upper crust increases considerably (from 21 to 33 km) along a 300 km northeast-southwest traverse with the greatest thickness occurring under the highest mountains. S-wave velocities are close to 3.65 km/s in the upper crust and 3.9 km/s in the lower crust.

Many previous discriptions of the orogenic evolution of south-eastern Australia invoke models analogous to the tectonic processes occurring in western Pacific island arc areas. The present interpretation with very thick crustal section in the Lachlan Fold Belt indicates that such orogenic evolution was unlikely, and that an Andean type model is probably more appropriate.

Major granitic batholiths in the Lachlan Fold Belt have a P-wave velocity of about 5.9 - 6.0 km/s compared with interspersed metamorphosed Palaeozoic sediments which have a velocity of about 6.25 - 6.5 km/s. There is evidence that the thickness of the batholiths varies from 15 to 25 km.

Further field recordings were also made in 1978. The Dartmouth dam construction was rapidly approaching completion and it was essential to obtain further recordings while spillway blasting was still in progress. Consequently recordings were made between Dartmouth and Merimbula during April-May (Figure OR 10), a distance of about 220 km, and between Dartmouth and Condobolin (400 km) and between Dartmouth and Dubbo (480 km) during July-August. Recorder station spacing was generally 10-15 km.

Also during May, recordings were made of 6 BMR deep seismic sounding shots detonated at Gundary Plains near Goulburn. The recording traverse of about 100 km was between Gundary Plains and Snowball (Figure OR 10).

During all these recording periods, a shot point monitor was located at the Marulan limestone quarry so that data from there could also be used in the interpretation.

In the latter half of 1978, playing back and digitizing of recordings was proceeding and interpretation will extend into 1979.

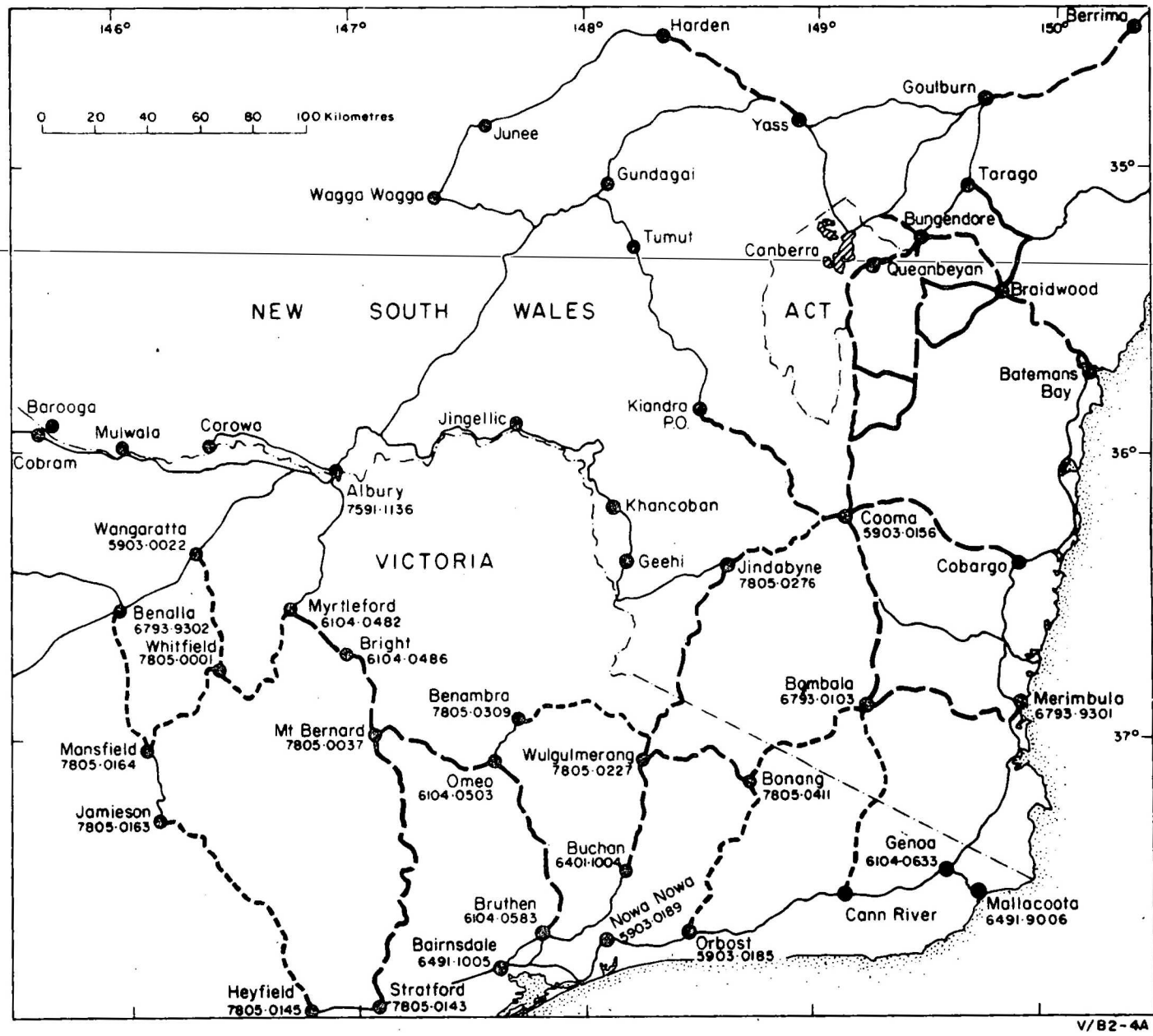
Lachlan Fold Belt gravity investigations (J.B. Connelly, J. Van Son)

Figure OR 13 shows the localities and station spacing of gravity traverses which were made in S.E. Australia during 1978. The objects of the survey were (1) to improve the regional gravity net which had some serious mis-ties in it resulting from the use of barometric heights in earlier surveys; (2) to provide continuous gravity traverses across the Lachlan Fold Belt; and (3) to provide semi-detailed traverses across granites in the Canberra area. The traverses in Central and eastern Victoria were made to improve the regional net in that area but they also provided continuous regional traverses across that part of the Lachlan Fold Belt. The traverse from Cobargo to Kiandra and the traverses north of Canberra were part of continuous regional traverses which will be completed in later years. A number of long range seismic refraction profiles have been shot north-south along the Lachlan Fold Belt and the regional gravity traverses will be used to interpret the crustal structure between the seismic traverses. The 1 km spaced traverses S.E. of Canberra cross the main granite outcrops in this area and will be used in conjunction with aeromagnetic data to define the shape and subsurface extent of the granites. Interpretation of the shape of the granites from the aeromagnetic data has already been made and a start was made to interpret their shape from gravity data.

Lachlan Fold Belt magnetic interpretation (J.B. Connelly)

An interpretation of aeromagnetic surveys of the Canberra and Bega 1:250 000 sheet areas was started during the year, and preliminary results from the study were presented at the Applied Magnetic Symposium at Sydney University in August.

The granites appear to be the source of most of the anomalies; susceptibility measurements in hand samples give values in the range 0.006-0.075 SI units. Geological mapping indicates that the more magnetic granites are more mafic, and limited density measurements indicate that these granites are also more dense. Two dimensional magnetic modelling of the granites shows that the majority have the form of broad north-south elongate domes



1 kilometre station interval — 1·5-2 kilometre station interval ----- 8 kilometre station interval

LACHLAN GRAVITY TRAVERSES, 1978

Record No. 1978/97

with the dip of the sides of the domes in the range 10^{o}-30^{o}. However some of the less magnetic granites appear to have the form of a cone with the apex downwards. For these bodies a basal depth of 3 km below sea level fits the longer wavelength features adequately.

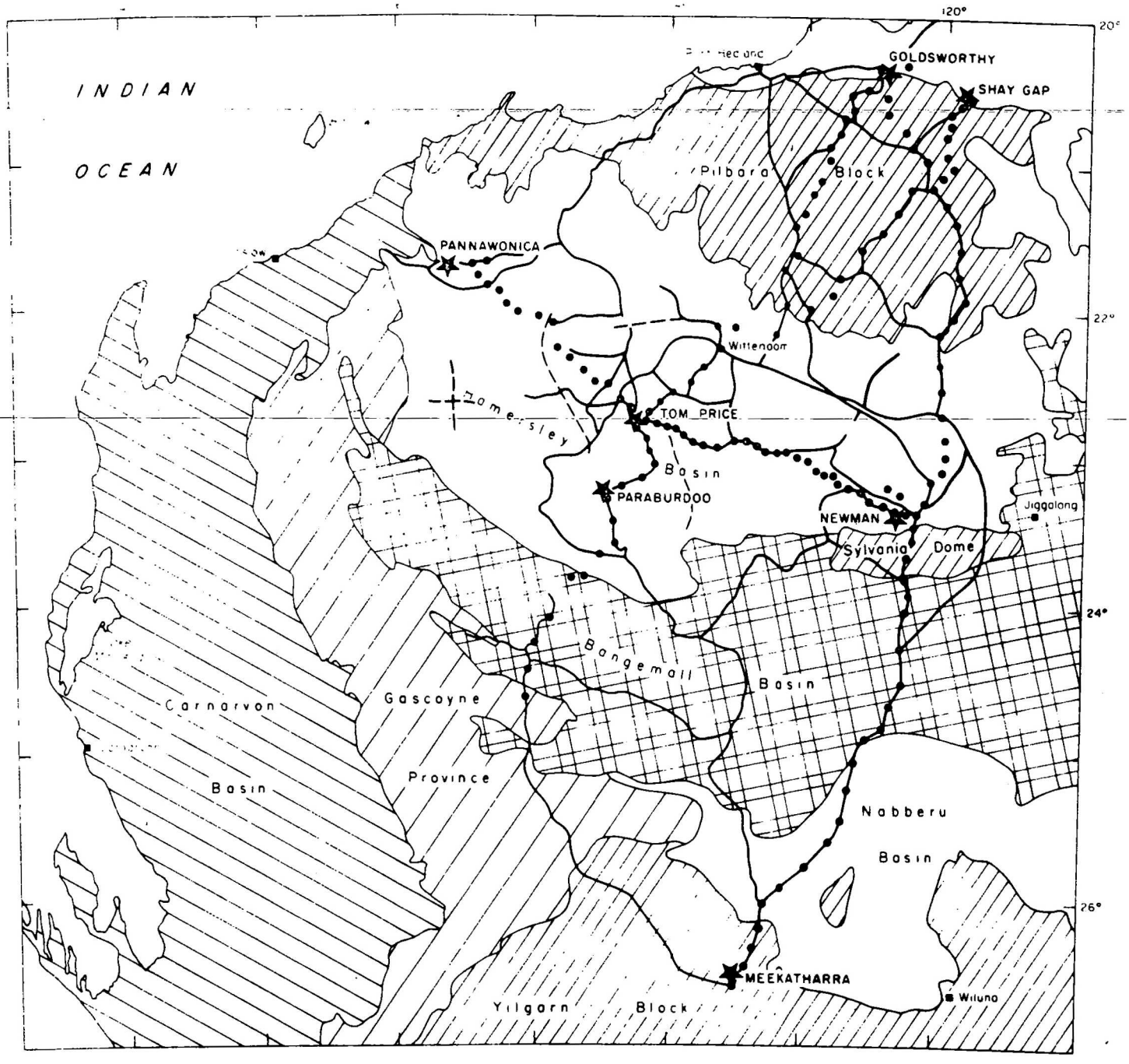
A change in tectonic style is evident between the Canberra and Bega sheets. The I-type granites in the Canberra sheet are elongate north south bodies which are separated from each other by Ordovician and Silurian sedimentary and volcanic rocks. The volcanic rocks are mainly dacites, rhyolites and derived sediments of Silurian age and they are thought to be the extrusive equivalents of the granites. The majority of the I-type granites in the Bega sheet area occur in one large composite body, the Bega Batholith. The northern part of this batholith appears to be stratified into a number of layers. The more mafic and presumably denser granites form the centre of the intrusion, and the overlying less magnetic layers dip away from the central intrusion at angles of 10-15 degrees. No extrusive volcanic rocks are associated with these granites and they appear to have remained at depth in a situation where crystal settling could occur to produce the observed stratification. Presumably crystal settling did not occur in the granites on the Canberra sheet because they were more mobile.

Pilbara Crustal Survey, Seismic Interpretation (B.J. Drummond)

Processing of the Pilbara Crustal Survey seismic data continued throughout the year. The coordinates of the recording stations and mine blasts were determined, and the mine monitor tapes replayed. 116 shot times were determined. However several shots that were reported by the mines could not be found at the specified times on the mine monitor tapes or on the seismograms from the Marble Bar observatory (MBL).

The draft operational report for the survey was completed and includes tables of the shot details. The station positions are also listed in the report, along with the elevations, equipment numbers, amplifier gains, and the recording periods at each site.

Most of the shots were sufficiently large to have been recorded throughout the survey area. However, the Goldsworthy, Shay Gap and Sunrise Hill shots were not sufficiently well recorded to give clear arrivals at some of the stations on the line between Goldsworthy and Meekatharra (Figure OR 14).



PHANEROZOIC

PROTEROZOIC
- *Bangemall Basin*
- *Gascoyne Province*
  Paterson Province
- *Hamersley Basin*
  Nabberu Basin

ARCHAEAN
- *Yilgarn Block*
  Pilbara Block
  Archaean inliers

0 100 200 km

- *Gravity road traverse*
- *Gravity helicopter traverse*
- *Shot point*
- *Recording station*

PILBARA CRUSTAL SURVEY SEISMIC AND GRAVITY OPERATIONS

Record No. 1977/46, 1978/97

WA/B10-10AR

Digitising of the analog field tapes has begun. Tapes from all of the stations on the line from Goldsworthy through Newman to Meekatharra, and on the line from Newman through Tom Price to Pannawonica, were digitised, for on-line events. Tapes from 94 stations are involved and over 400 traces have been digitised. Three minutes of trace were digitised for each event. This is sufficient to encompass both the P and S arrivals, but the interpretation to date has dealt only with the P arrivals.

Record sections have been prepared for every event digitised, and for each section of the profile a composite record section with digitally filtered traces was prepared. Figures OR 15 and OR 16 show examples of these. The arrows indicate arrivals that have been used to determine velocities and intercepts of the various phases. A simplified model for the section from Goldsworthy to Newman is presented in Figure OR 16, and a theoretical time-distance curve derived by ray tracing techniques is shown superimposed on the record section. South of Newman, the structure appears more complex, as evidenced by an abrupt change in the apparent velocity of the first arrivals beyond 250 kilometres.

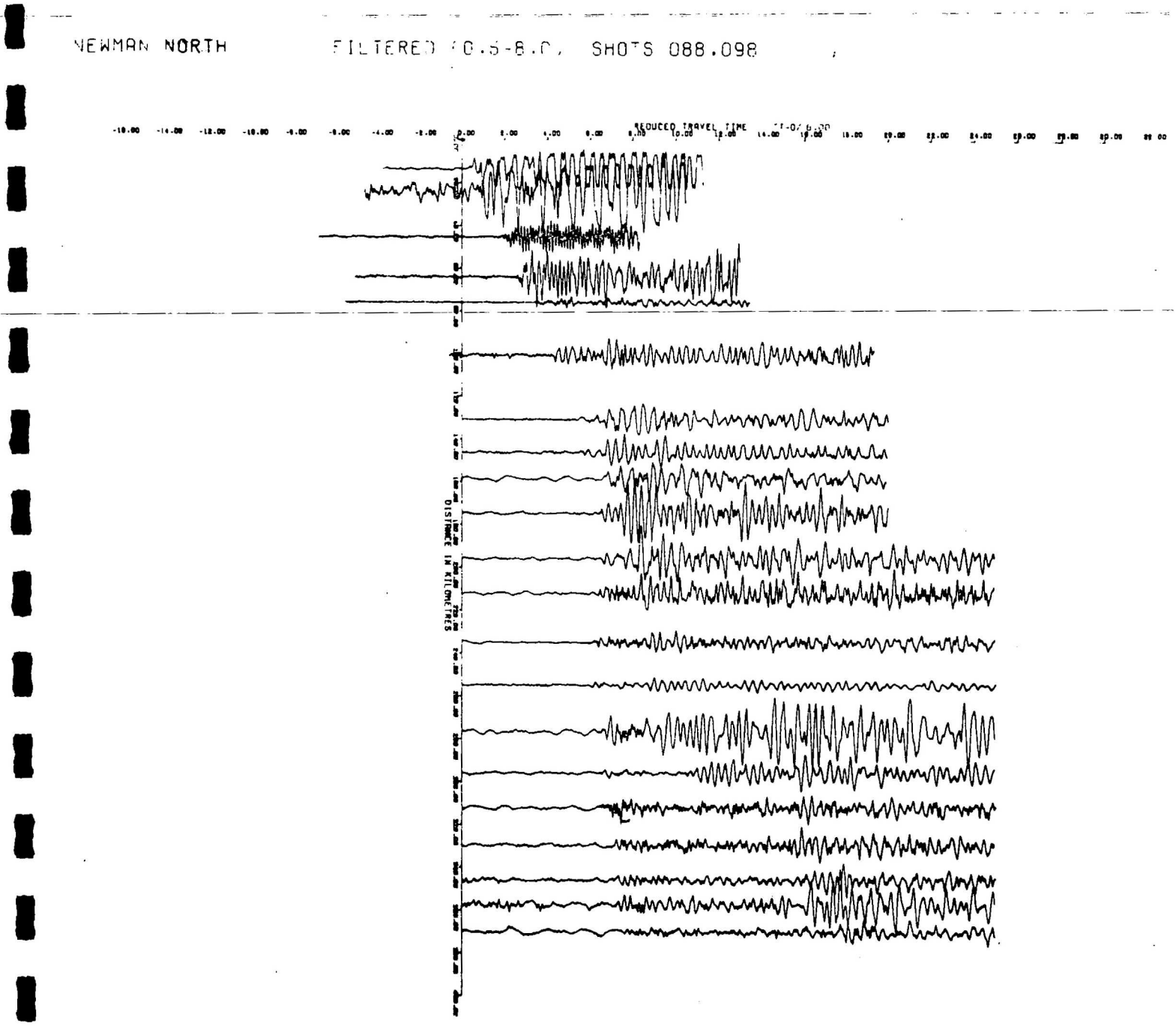
It should be emphasised that the model in Figure OR 16 is derived only from the time-distance data and is therefore a preliminary interpretation. A second phase of interpretation to consider the amplitudes of the arrivals is now under way.

Pilbara Gravity Interpretation (H. McCracken)

Reduction of gravity data from the 1977 Pilbara Crustal Survey was completed. These data, together with all other available gravity data in the Pilbara region, were incorporated into the Regional Gravity data bank.

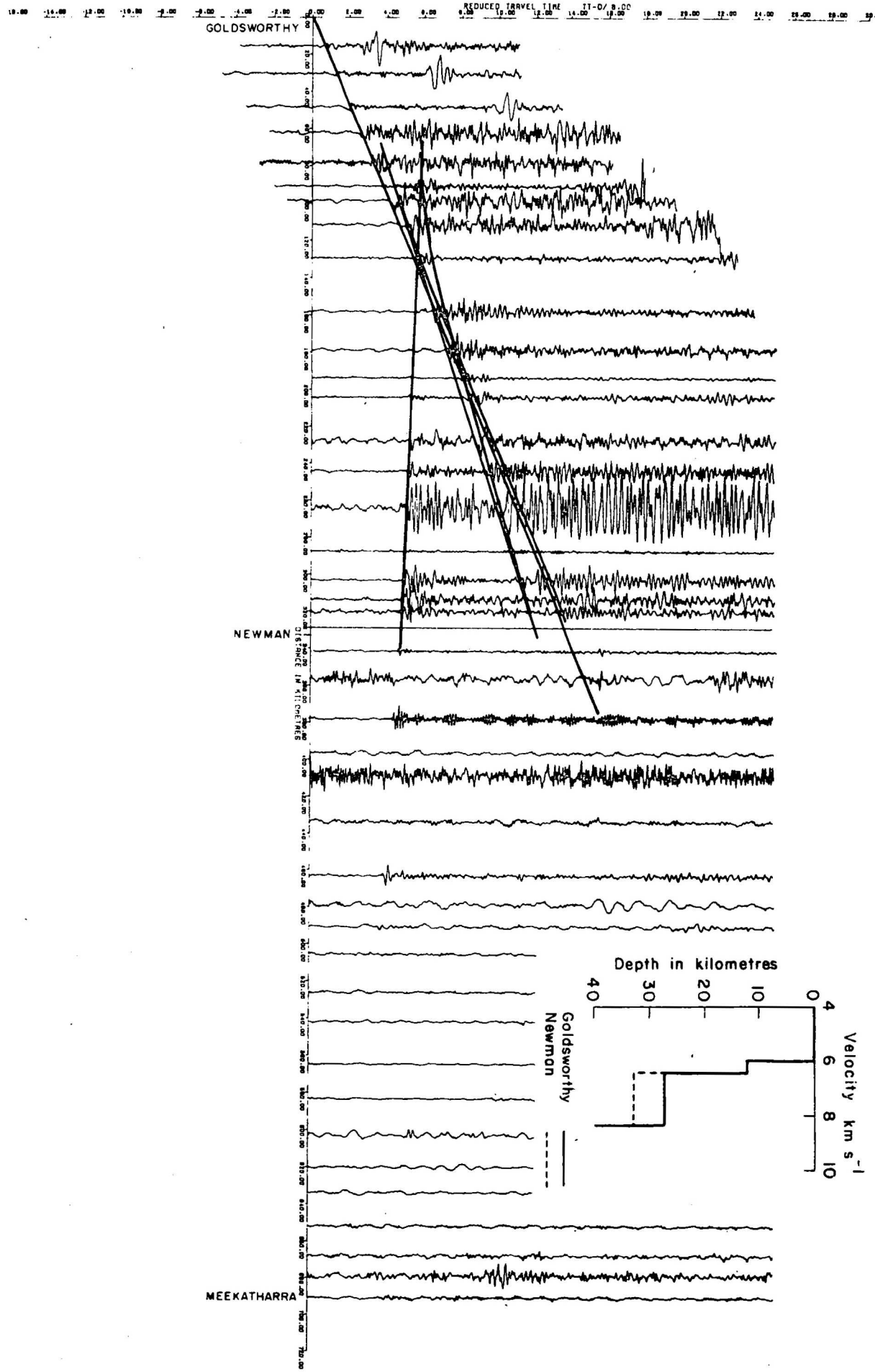
The 1:250 000 Bouguer Anomaly maps covering the area were produced and correlated with the available geological maps. A Bouguer Anomaly map is shown in Figure OR 17 detailing part of the Pilbara Block and the Hamersley Basin at a scale of 1:2.5 M; some of the gravity traverses are included.

Estimates of the densities of different rock types were made using rock samples collected during the survey and some collected in 1975 by BMR geologists. Density information from private companies was also compiled.


NEWMAN NORTH
FILTERED (0.5-8.0) SHOTS 088.098
REDUCED TRAVEL TIME
DISTANCE IN KILOMETRES

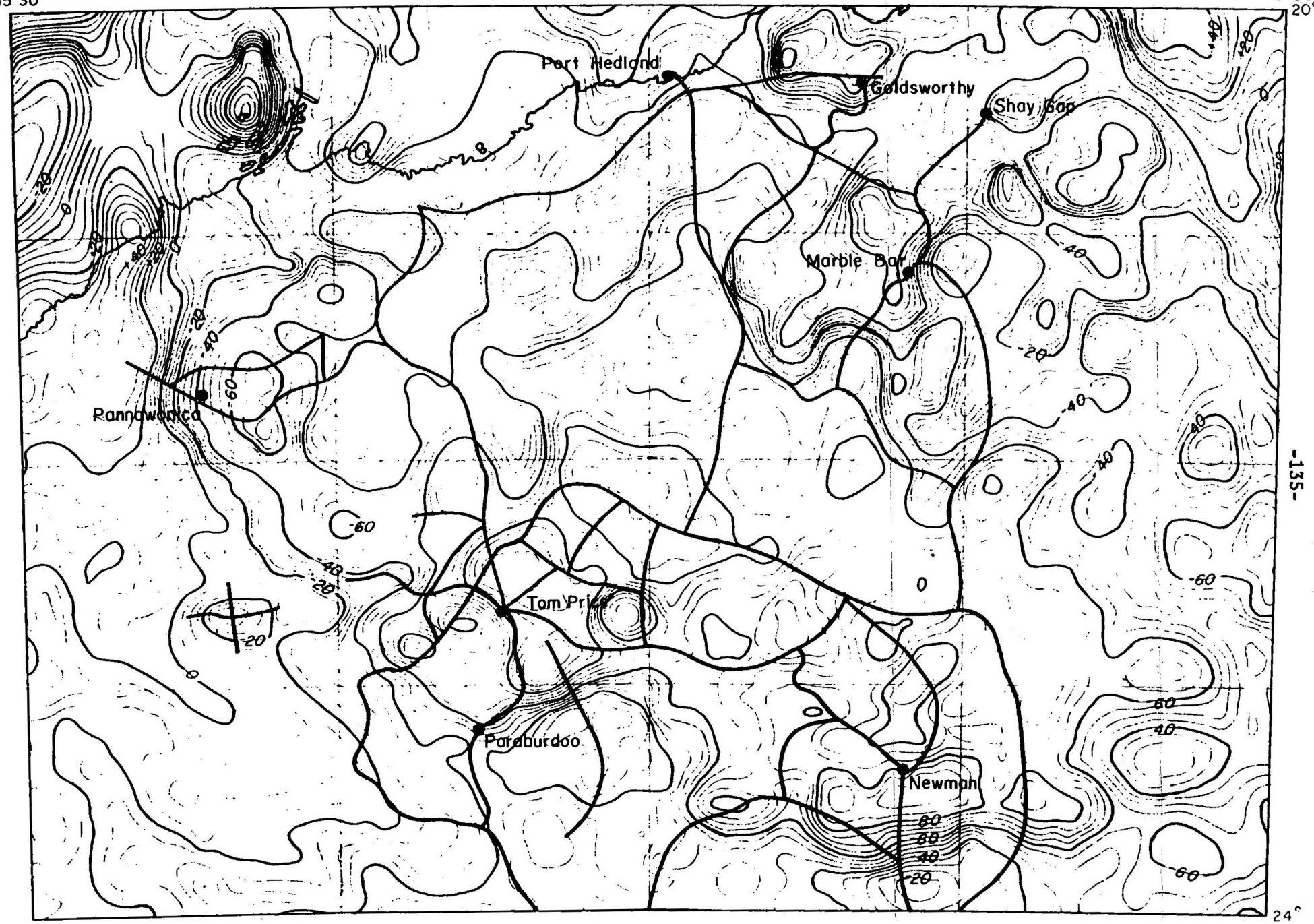
GOLDSWORTHY SOUTH FILTERED (0.5-8.0) SHOTS 135.063.082 AND 100

OR-16



Record No. 1978/97

WA/BIO-16A



Scale 1:2 500 000
Australian National Spheroid
Standard Parallels 18°S and 36°S

BOUGUER ANOMALY MAP, PILBARA REGION

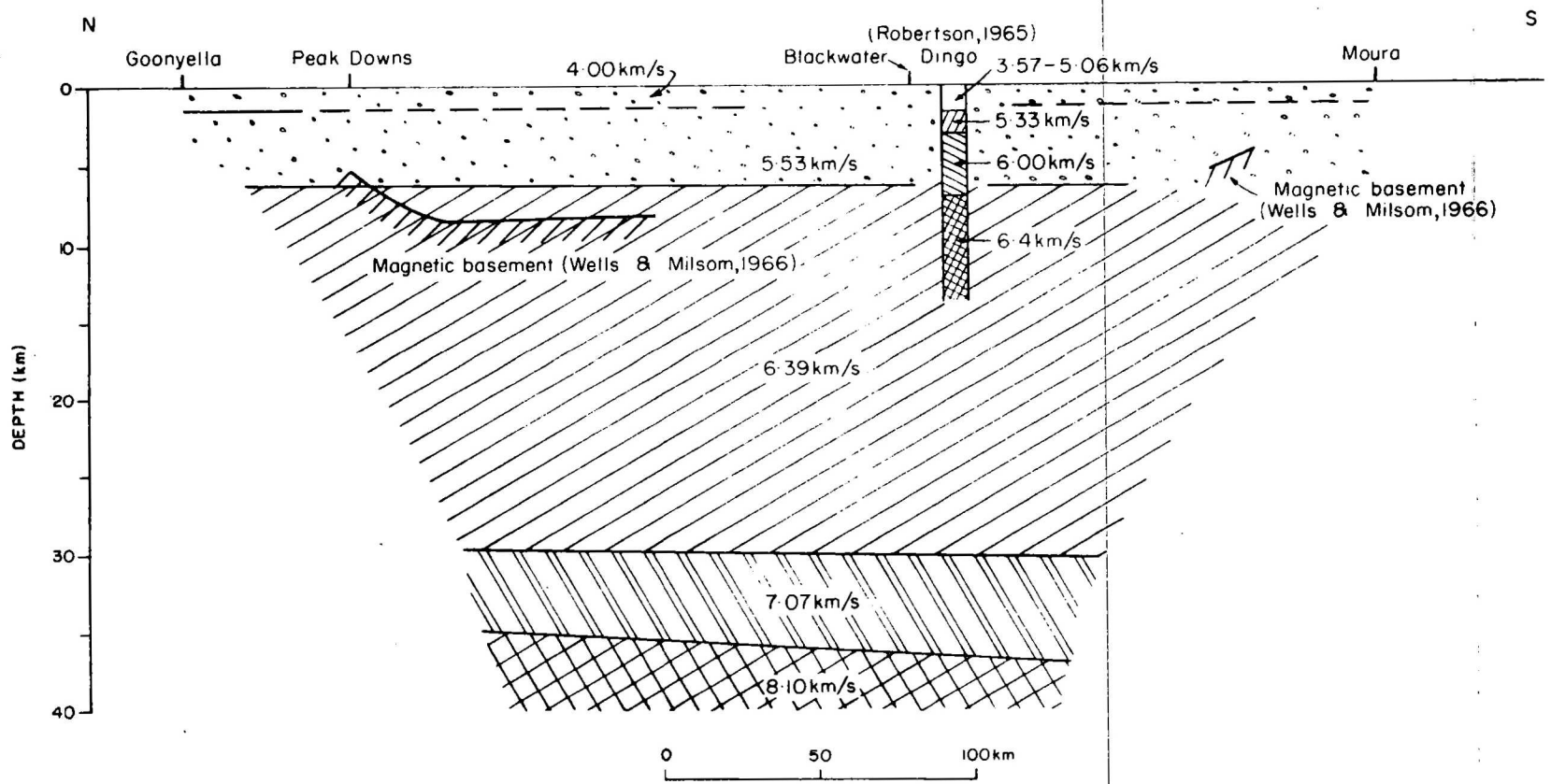
Contour interval 50 μm sec^{-1}
Gravity Traverses

Gravity modelling was carried out for the granite greenstone sequences of the Pilbara Block with particular attention being given to the Marble Bar area. Initial estimates limit the thicknesses of these sequences to between 5 and 10 km. Several profiles across the Pilbara Block/Bangemall Basin boundary were studied in an attempt to determine the inter-relationship of those tectonic provinces. The gravity data alone provide insufficient control for unique interpretation of crustal structure and further interpretation will be carried out during 1979 in conjunction with seismic modelling and interpretation.

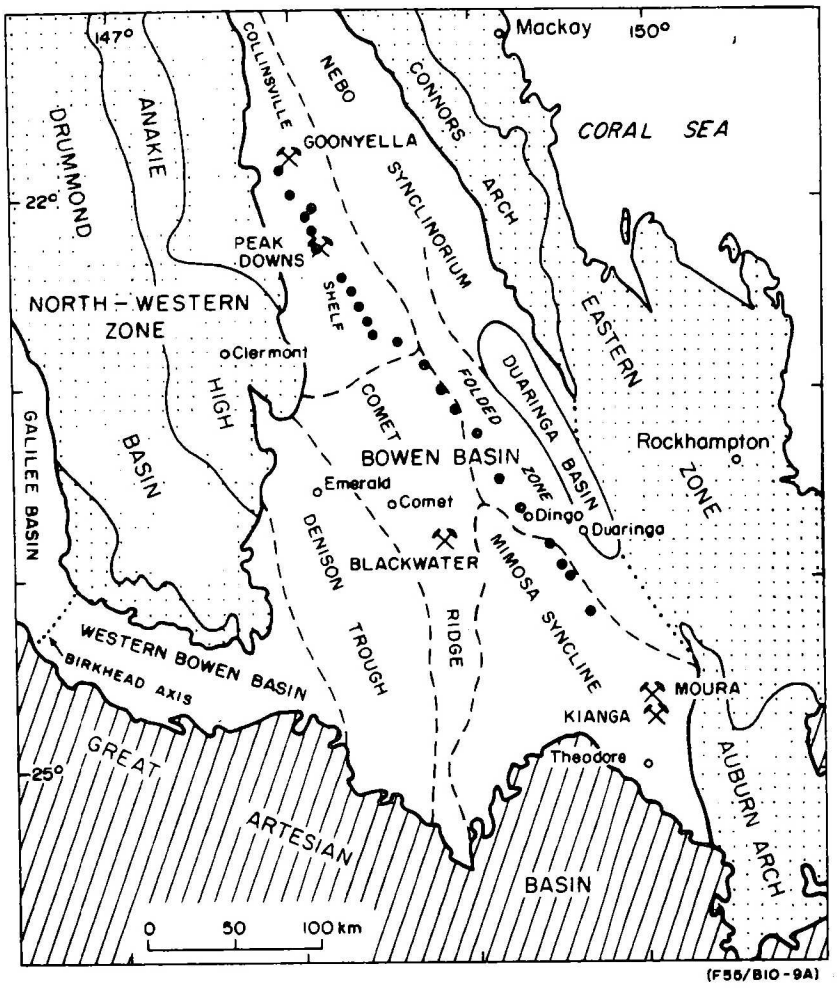
Bowen Basin (C.D.N. Collins)

The interpretation of the Bowen Basin deep crustal seismic refraction survey was published in the September issue of the BMR Journal. The preferred model is shown in Figure OR 18. A four layer crust was interpreted from the seismic data, with P-wave velocities of 4.00 $\pm$ 0.22, 5.59 $\pm$ 0.08, 6.39 $\pm$ 0.07 and 7.07 $\pm$ 0.02 km/s respectively. There is some evidence of a 6.00 km/s layer in the north based on early arrivals at some stations close to Goonyella and Peak Downs (Figure OR 19); however the data are inconsistent and there is no supporting evidence in the south. The combined thickness of the 4.00 and 5.53 km/s layers is about 6 km under Goonyella, and slightly more under Dingo, 130 km north of Moura. They comprise folded Permian-Triassic sediments and possibly also Early to Middle Paleozoic rocks. Earlier magnetic and gravity work indicates that there are two layers which thin southwards towards Moura. The 6.39 km/s layer probably represents crystalline basement. A lower crustal layer, with a velocity of 7.07 km/s and thickness ranging between 5 and 6 km, has been interpreted from later-arrival data.

The total crustal thickness at the centre of the traverse is 36 km and the upper-mantle P-wave velocity is 8.10 $\pm$ 0.11 km/s. The velocity from southern shots is slightly higher than from northern shots and may imply a slight southward dip on the Moho. The observed gravity along the traverse does not support this unless a more complex model for the upper crust is assumed. Evidence of a complex upper crust can be seen in the geology, in previous shallow seismic work, and from magnetic basement depth estimates.



BOWEN BASIN CRUSTAL SECTION



Major boundary
Major boundary (inferred)
Recording station
Mine
Town

LOCATION OF SHOTS AND RECORDING STATIONS, AND MAJOR STRUCTURAL UNITS

East Papua (C.D.N. Collins, B.J. Drummond)

The interpretation of the Coral Sea seismic refraction data from the 1973 East Papua Crustal Survey was completed. Similar recordings were made at stations along the southern coast of the east Papua peninsula, from shots fired in the Coral Sea along the coast from the Gulf of Papua to the eastern tip of the peninsular, and along two lines extending about 300 km from the Coast into the Coral Sea.

The data were treated by various interpretation methods; in particular an evaluation of the non-linear least-squares inversion program ECRUST was made using these data. Selection of data for use in ECRUST and TERMAT, a time-term inversion program, was carefully made because of the complexity of the east Papuan crustal structure. Reciprocal pairs of stations were chosen and pseudo-reciprocal times were calculated for these from the data. The data were rejected if their reciprocal times were not in agreement within specified limits.

There is a large scatter in velocities obtained at these stations, but the best data indicate crustal velocities of about 4.0 km/s, 6.07 km/s and a possible lower crustal layer with a velocity of about 7 km/s. A sub-Moho velocity of 7.96 km/s was derived along the coast. The upper crustal layer thickens from about 6 km in the southeast to 12 km in the southwest. The crustal thickness varies from about 25 to 30 km, increasing towards the northwest.

The data from the two traverses into the Coral Sea are unreversed and therefore any interpretation based on seismic data alone is ambiguous, since true velocities cannot be derived. Furthermore, arrivals from shallower layers were not recorded from beyond about 100 km from the coast. Crustal and mantle velocities were assumed to be the same as those along the coast; this may not be a valid assumption as different tectonic regimes are involved. Gravity provides useful control on the interpreted structures; previous marine seismic work is useful only for superficial sediment thicknesses (1-2 km); and the interpreted magnetic basement, where available, probably reflects depths to volcanics within the sedimentary pile and not true basement.

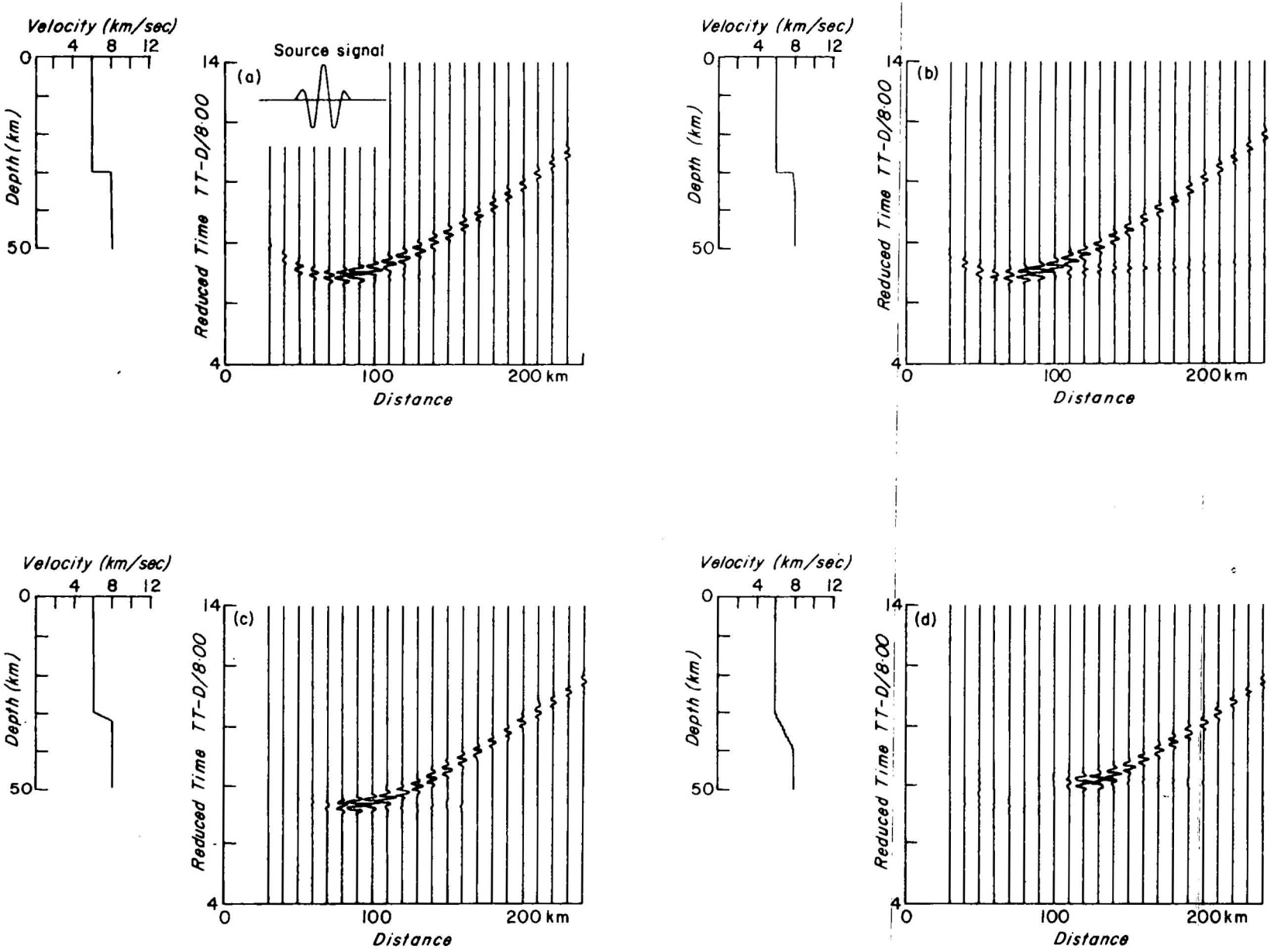
The conclusions drawn from earlier work regarding the Aure and Moresby Troughs have not been altered;. the Moresby Trough is a continuation of the Aure Trough and crustal thinning under them is necessary to satisfy the observed gravity though there is no direct evidence of this from the seismic data.

Synthetic Seismograms (C.D.N. Collins)

The adaptation of the synthetic seismogram program REFLEX to the CSIRO CYBER 76 computer has been documented as a BMR Record. REFLEX was developed by K. Fuchs of the University of Karlsruhe and uses the reflectivity method to compute theoretical seismograms for horizontal plane-layered models. Positive and negative velocity gradients can be approximated by large numbers of thin discrete layers; numerous options exist for selecting the parameters used in computation, for example, the frequency pass-band of the signal, and any required source signal may be specified.

This program was used in the interpretation of crustal refraction data in South Eastern Australia; it has clearly shown that simple first-order velocity discontinuities in the crust and at the crust-mantle boundary are inadequate when attempting to explain the amplitude information. The need to invoke velocity gradients and inversions is evident in the relative amplitudes of refracted waves and reflections from velocity boundaries, and in the distance at which maximum amplitude wide-angle reflections are observed: they simply cannot be reproduced by plane-layered models with first-order velocity discontinuities. Provided that lateral variations in the structure are not too severe, synthetic seismograms can be used to interpret far more detailed and realistic models than travel-time analysis alone.

A simple example of the effects of introducing gradients to discontinuities is shown in Figure OR 20. The first example (a) shows synthetic seismograms for a first-order discontinuity, or simple step in the velocity-depth function, as is usually interpreted from seismic refraction data. The refracted arrivals are very small compared to the wide-angle reflections. Observed seismograms are more like (b), with a prominent refraction branch.



SYNTHETIC SEISMOGRAMS USING PROGRAM "REFLEX"

In this model, a velocity gradient is introduced below the step-increase in velocity. Both (a) and (b) show prominent sub-critical reflections (at distances less than about 80 km) and to suppress these the entire velocity increase is modelled as a gradient (c). Increasing the thickness of the gradient zone results in the critical distance occurring further away from the source (d). In this way, the amplitudes of sub-critical, critical and wide-angle reflections, and refractions, can be matched to the observed seismic records once the time-distance information has been approximated by simple step-models. Low velocity layers may need to be included to explain large separations between reflected and refracted branches of the travel-time curve and attenuation of arrivals.

A second synthetic seismogram program, STPSYN, is being adapted to the CYBER 76 and simple models have been run successfully. STPSYN, developed by D.V. Helmberger and R.A. Wiggins, uses the Cagniard-de Hoop algorithm to calculate synthetic seismograms for spherical earth models. Further work needs to be done before a full evaluation of the program can be made.

Seismic digital data system (B.J. Drummond, B. Liu, D. Kerr, D. Gardner, G. Russell-Smith)

Development of the seismic playback system continued throughout the year, but with the completion of the link to the BMR HP21 MX computer the development emphasis changed from the hardware to the computer software.

The data acquisition program to digitise seismic traces and store the data on disc was written by the ADP section which also established a data base. Every time a seismic trace is digitised an entry is made in the data base. All other programs were written by B.J. Drummond.

Data are collected on disc, processed, and archived to magnetic tape when the processing is finished. About 500 seismic traces of 3 minutes duration can be stored in the allocated disc space. Data from several surveys may be collected on the disc together, and manipulated by means of discrete security codes and standard system programs.

The principal form of presentation of data is by seismic record section. Once the seismic traces have been digitised and corrected, record sections can be produced on a Gould electrostatic plotter or a Calcomp drum plotter. The data can be manipulated to include amplitude normalisation factors, filters, and terrain corrections.

The limited size of the HP21 MX computer on which the processing is done makes the multi-step process necessary. It is hoped in the future to reduce the effort involved, by making use of the data base system to streamline the programs.

Not all development of the data system in 1978 was in software. The time decoder in the playback was updated so that it now gives the correct tape time at every stage. Originally the decoded time was correct only after the thirty-third second of every minute, since the time code was updated after all of the coding of each minute had been read. In addition, a programmable anti-aliasing filter was designed and built, so that when a sampling interval for digitising is specified, the anti-alias filter is automatically set. This allows variation of the sampling rate without having to worry about manually setting the filter.

Seismic recording instruments (D.M. Finlayson, B.J. Drummond, D. Kerr, B. Liu, J. Williams)

The Regional Structural Surveys Group operates 21 sets of automatic long playing seismic tape recording equipment and these were routinely overhauled and repaired for use in the field. Maintaining the equipment in a fully operational state is a major task.

The Group, in association with Engineering Services Branch, identified the need to improve various aspects of the existing equipment and to produce additional recording capacity. The power consumption of the existing system is a major deficiency and two prototype developments were started to incorporate:

(1) the design of a new NCE-3 clock to replace the existing NCE-1 clock, and

(2) the installation of a new motor tape drive system.

Both these developments were well advanced at the end of the year and further work will be conducted in 1979 before a refitting of the existing equipment is undertaken.

Another major requirement for the existing system is to repackage the 6 PI tape recording systems. Repackaging would reduce the bulk, reduce the number of connections and improve the ease of operation. The prototype for this repackaging was under way at the end of 1978.

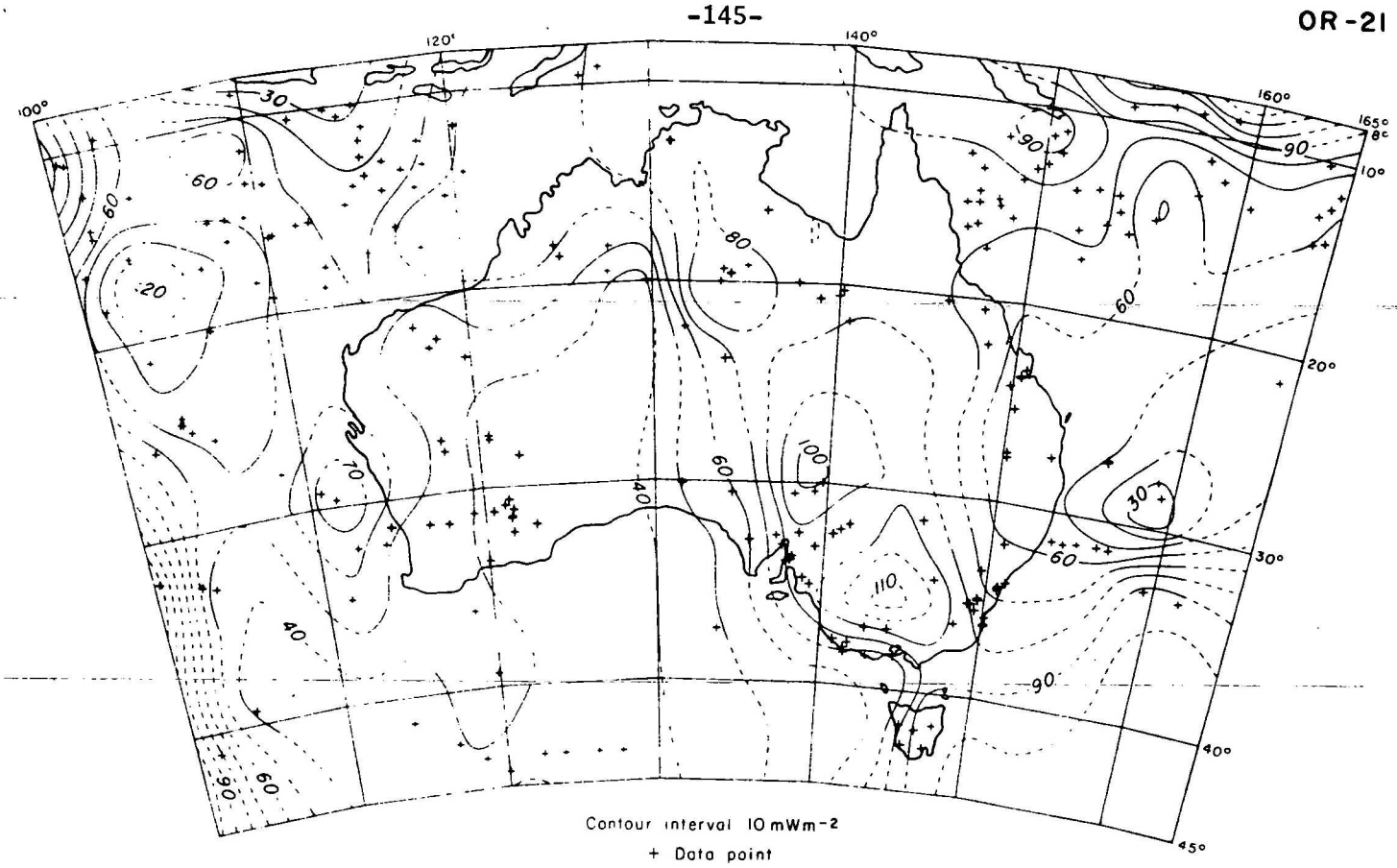
Increasing the recording capacity of the Group was identified as a need for future surveys. Twelve second-hand Tanberg tape decks were purchased during the year and development studies were conducted to maximise the use of commercially produced components in the production of 12 new systems. Two Labtronics time signal receivers, a Geotech S500 seismometer and 42.50-1 amplifier were purchased for evaluation. The 12 new systems will use the NCE-3 clock being developed as a replacement for the NCE-1 clock. These developments will continue into 1979.

The existing seismic recording equipment uses truck batteries for power. Continual maintenance is required and consequently the battery charging facilities at Fyshwick store were improved in a major overhaul during the year.

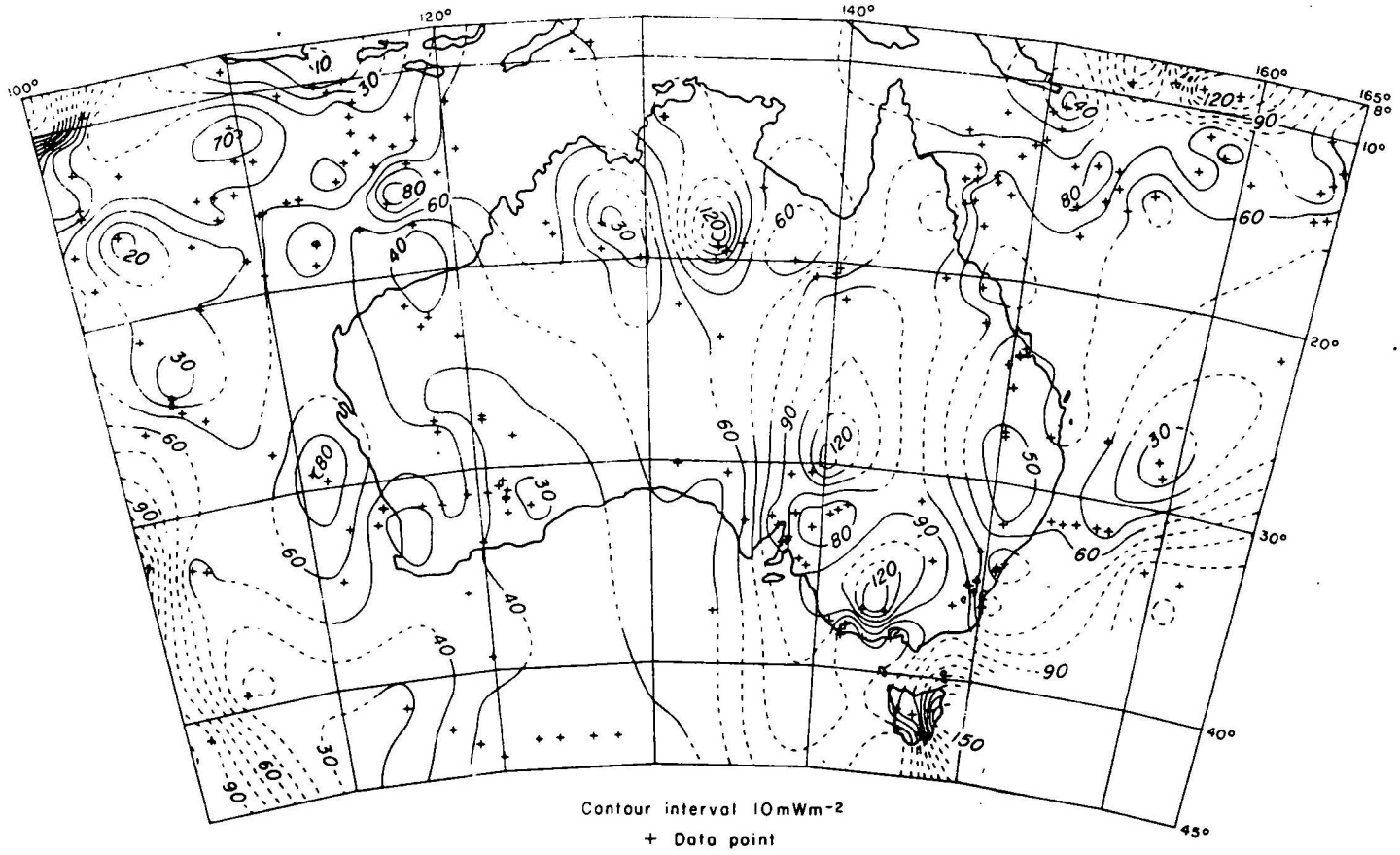
Heat flow (J.P. Cull, D. Denham)

During 1977 thermal gradients were measured in 20 boreholes primarily in North Queensland, the Pilbara, and the Canning Basin. Thermal conductivities have now been measured from representative core samples in each hole and heat flow values determined. The data were combined with previously published values and contour maps produced for the area between 90-170^{o}E and 0-45^{o}S (Figure OR 21).

Positive correlations were noted between heat flow and P wave travel time residual while a negative correlation was obtained with heat flow and upper mantle velocities.



3° GRID



1° GRID

Record No. 1978/97

HEAT FLOW CONTOURS

A/BIO-76A

Temperatures have also been measured in boreholes near Canberra, Boulia, Cloncurry, Georgetown, and Herberton. Thermal conductivity data are not yet available for determinations of heat flow.

Boreholes located near Batchelor, Jugiong, and Berrigan have been cased to ensure access for logging after temperatures have returned to equilibrium. Core samples have been extracted from Berrigan for uranium, potassium and thorium analysis for future estimates of crustal heat production.

Thermal modelling (J.P. Cull)

Systematic increases in heat flow have been noted with increasing depth of determination in boreholes in the region of the ACT. Such trends are consistent with increasing surface temperatures. Observed temperatures are reasonably matched in models assuming an increase in surface temperature of $10^{\circ}C$ at 15000 yr B.P. corresponding to ice retreat in the Snowy Mountains. Corrections of +30% may therefore be required for values of heat flow determined in boreholes at depths less than 300 m. More detailed models of climatic history can be formulated only when unambiguous values of heat flow are determined at depths greater than 1000 m.

Geothermal energy (J.P. Cull)

Reconnaissance studies have been conducted in the Otway Basin of western Victoria. Low enthalpy prospects have been identified in the Portland region where water of $52^{\circ}C$ is obtained from depths near 1400 m. Flow rates of 70 l/s can be maintained representing usable power of 6 MW (thermal) per bore. Much of this heat could be used for process heating in small industries prior to normal domestic reticulation.

No high enthalpy resources have been located but increasing thermal gradients were observed near Mt Gambier, a centre of recent volcanism. Heat flow in the region was calculated to be 92 ± 3 mW m^{-2}. This exceeds the world average (62 mW m^{-2}) but is similar to other values found throughout southeast Australia.

Geothermal data detailing Otway Basin prospects were presented in lectures given to the Association for Scientific Cooperation in Asia (ASCA) in New Zealand, the BMR symposium, and the Geology Department of Melbourne University. A draft manuscript was completed for the BMR journal.

Thermal conductivity measurements (J.P. Cull, H. Hughes)

Approximately 600 samples were measured for thermal conductivity during 1978. Well-consolidated materials were cored and lapped to directly complete the thermal circuit of a conventional divided bar apparatus but friable materials were crushed and packed in a perspex cell with dimensions identical to the core samples. However because of variations in side loss different calibrations were required for each technique.

Needle probes have now been constructed for transient measurements of thermal conductivity in muds or soils. Tests have been conducted in Pattern-stone casts. Plugs of the same material have been prepared for the divided bar and conductivity results are in good agreement.

Stress Measurements (D. Denham, L. Alexander and G. Worotnicki, CSIRO)

During February and March a series of stress measurements was made in the Lachlan Fold Belt, NSW. The measurements were carried out with standard overcoring techniques according to the practices of the US Bureau of Mines which were previously adopted in the 1976 survey in South Australia. However instead of overcoring at a standard 150 mm the diameter of the overcoring bit was reduced to 86 mm, to improve the drilling rate and to reduce the cost of drilling bits. The diameter of the pilot hole remained the same (38 mm).

Thirteen successful tests were completed at Milton (4), Moruya (1), Berrigan (2), Tocumwal (2) and Ardlethan (4). The five sites were located in sound rock, and in areas where the topography would not effectively disturb the stress field.

All the tests were carried out in the 3-9 m depth range using the USBM borehole deformation and the CSIRO hollow inclusion gauges.

Orientations of major principal stress were near NS on the coast and near ENE inland. Magnitudes ranged from 5 to 20 MPa and at all sites the stresses were compressive. Surface indications of high stress in the granites of the Tocumwal-Berrigan area were seen in the uplift and cracking of a quarry floor and the uplift of an exfoliated slab. These data support the results of the overcoring observations. Both data sets indicating east-west compression in the region.

Table OR 1 summarises the results from the survey and shows the average stresses observed at each site.

TABLE OR 1

Site	Rock Type	Instrument	Principal Stresses σ_1 MPa	σ_2 MPa	Bearing of σ_1 E of N
Milton 35.40°S, 150.35°E	Monzonite	USBM	16.9	5.7	22.5°
Moruya 35.91°S, 150.12°E	Silurian Granite	USBM	4.6	4.0	9.5°
Berrigan 35.68°S, 145.82°E	Devonian/ Silurian Granite	USBM	11.8	7.6	76°
		CSIRO	19.8	12.7	65°
Tocumwal 35.76°S, 145.63°E	Devonian/ Silurian Granite	USBM	17.6	11.5	76°
Ardlethan 34.20°S, 146.80°E	Silurian Porphyry	USBM	5.5	2.4	102°

σ_1 and σ_2 are the average maximum and minimum principal stresses

Palaeomagnetism and Rock Measurements (M. Idnurm, J. Giddings, H. Hughes, R.Eaton)

Rock Measurements: During the year physical properties were measured on 876 rock samples. The principal measurements were thermal conductivities, magnetic susceptibilities and remanences, sonic velocities, and specific gravities. Other properties determined included Curie temperatures and low- and high-temperature demagnetization curves. Nearly all requests originated from within the BMR; most were in support of geophysical field surveys. The types of measurement are indicated in Table (OR 2).

TABLE (OR 2)

Sonic Velocity	Magnetic Susceptibility	Magnetic Remanence	Specific Gravity	Porosity	Thermal Conductivity
108	370	335	524	7	600

Palaeomagnetism in the McArthur Basin: A magnetostratigraphic reconnaissance study was completed on the McArthur Basin. The section sampled outcrops in the Kilgour River and spans a 1000 m sequence ranging from the Masterton Formation to Emmerugga Dolomite. Stable remanence directions were generally obtained after partial thermal demagnetization. A tentative polarity reversal column, based on 80 pilot specimens, has been drawn up. The results indicate that the region was at high magnetic latitudes during the acquisition of remanence. A significant pole movement occurs within the sequence; this movement appears to be particularly pronounced at approximately the Mallapunyah Fm - Amelia Dolomite boundary.

Following the pilot study, the Kilgour River section was sampled at approximately 1 m intervals. Sampling was also extended on a reconnaissance basis to the Wollogorang Fm, Amos Fm, Balbirini Dolomite and Dungaminnine Fm. A 250 m section of the Emmerugga Dolomite which outcrops near the Top Gassing was sampled to test the consistency of the reversal pattern noted with the Kilgour River Emmerugga Dolomite. The isotopically dated Hobblechain Rhyolite and Packsaddle Microgranite units underlying the Wollogonang Fm were sampled in order to fix the time scale of the polar wander curve which is emerging from the McArthur Basin work. Altogether 1000 oriented samples were collected in 1978 from the McArthur Basin.

Palaeomagnetism in the Pine Creek Geosyncline: A second magnetostratigraphic study, on the Kombolgie Sandstone in the Deaf Adder Ck and Edith River localities, was also completed. The stabilities of remanence directions were generally excellent but the scatter between the sample directions was larger than normally observed. Large scatters have been reported previously from the Hart Dolerite where it is attributed to a very small dipole field in comparison to the quadripole field. A tentative reversal pattern has been drawn up from these results. Detailed sampling at approximately 1 m intervals is in progress at the time of writing (late Sept.). Oriented samples were also collected in 1978 from the Westmoreland Conglomerate, Qld, in order to compare the pole positions with those of the Kombolgie Sandstone, N.T.

Palaeomagnetism in the Georgina Basin: A set of pilot specimens was measured from Mount Cornish, Central Mount Stewart and the Field River Beds Tillites to determine whether more than one tillite is found in these localities. A distinct grouping of the remanence directions was observed around a shallow westerly inclination in all three areas; this is consistent with the measurements reported from the Areyonga Fm of the Amadeus Basin and from the Tapley Hill Fm and Merinjina Tillite of the Adelaide Geosyncline. The small number of directions available from the pilot specimens at the time of writing is insufficient to statistically distinguish different tillites.

Palaeomagnetism in the Georgetown region: Two hundred samples were collected from the Newcastle Ranges Qld in order to correlate rhyolite sequences of the fault-separated eastern (Main Range) and western parts of the ranges; four units were sampled in the eastern part and three units in the western part.

Equipment development: A number of palaeomagnetic instruments and equipment were designed and manufactured during the year. These include a kerosene recirculating system for the laboratory diamond coring drill, and a chemical demagnetization cell, based on the Hassler cell, for injection of acid at high pressure into palaeomagnetic samples. The use of various magnetic anisotropy equipment was investigated for magnetic determination in rocks.

International Union of Geodesy and Geophysics (IUGG) Assembly (D.M. Finlayson)

The 17th IUGG Assembly will be held in Canberra during 2-15 December 1979. Detailed planning was conducted in 1978 and BMR staff were involved. Finlayson was appointed to the position of chairman of the sub-committee on scientific excursions; he prepared excursion schedules for the first and second Assembly circulars, with the assistance of BMR secretarial staff and services.

Gravity Map of Melanesia (J.B. Connelly, A. Murray, D. Finlayson, D. Denham, B.C. Barlow)

The final drafting and scribing of the 1:5 000 000 colour map was completed during the year in BMR Drawing Office. Contracts for the printing of the map have been let and it is expected that the first colour proof will be available in November 1978. Printing of the map should be completed in the first half of 1979.

BMR Atlas (H. McCracken, P. Wellman)

A plate tectonic map of part of the Indian-Australian plate was compiled for the BMR earth science atlas. The map shows the age of the sea-floor, transform faults, earthquakes, spreading centres, areas of lithospheric plate interaction, active volcanoes, continent-oceanic boundaries, continent margin rifting, and sediment thickness. On land, the map shows generalized tectonic divisions and stress measurements. The area covered by the map is 10^{o}N - 75^{o}S, 80^{o}E - 170^{o}W.

4. ENGINEERING GEOPHYSICS GROUP

(E.J. Polak, F.J. Taylor, *B.H. Dolan, P.J. Hill, D.C. Ramsay, D.G. Bennett, G.S. Jennings, *P. Swan, D.H. Francis, L.W. Miller, *R.J. Wilson) *part of year

The Engineering Geophysics Group was formerly part of the Geophysical Services Section but since November 1977, when this Section was removed for the Geophysical Branch to form the Interim Engineering Services Branch, the Engineering Geophysics Group became directly responsible to the Assistant Director (Geophysics).

During 1978, the program of the Group included detailed engineering investigations in the ACT, bore hole logging, vibration measurements, development and application of special techniques for detection of unexploded ordnance, development of a digital seismic reflection system for shallow high-resolution work related to coal and engineering problems, and assistance to foreign aid projects.

Digital seismic system for shallow investigation

Software for digital seismic recording was completed and tested during 1978. In general the equipment performed satisfactorily but problems remain with the detection of time-breaks. Major modifications have now been made to the RA49 amplifiers to improve their reliability.

A search for a more suitable seismic energy source is continuing. Although data have been collected using a simple sledge-hammer system this mode of operation is considered too time consuming and uneconomic. A road compactor was therefore used as a repetitive energy source but, because the impacts were non-random, the quality of recordings was poor.

Two experimental surveys were conducted using seismic reflection techniques. In the first survey the equipment was tested at Lake George using 24 channels, 5 m spacing, with a sledge hammer for an energy source. The second survey was conducted over a coal seam at Wangi near Newcastle. The coal seam lies at a depth of 20 m to 40 m over the area investigated.

Once again a sledge hammer was used for an energy source. Reflections from the coal seam can be seen on approximately 10 percent of the records obtained; they arrived close to the first break refraction energy. High and low band-pass filters and velocity filters have not been successful in improving the signal to noise ratio. Further investigations are proceeding.

An application was made for a grant under the Coal Research Assistance Act 1977 to buy additional equipment including a commercial energy source.

ACT Engineering Surveys

There is continuing deterioration of the bridge over the Murrumbidgee at Tharwa and it has become necessary to replace it in the near future. For this purpose, a geological and geophysical survey of the river banks close to the location of the present bridge was undertaken. This work indicated that any of the six nominated sites would be suitable from a geological standpoint.

A seismic refraction survey was also conducted at Tharwa to locate a suitable site for a permanent water supply for Cuppacumbalong homestead. It was the intention to locate a depression in the sand/bedrock interface; feeder pipes leading to this subsurface reservoir would then provide some protection from floods and drought. However, the results of the survey did not indicate any suitable depression.

In the still undeveloped suburb of Tuggeranong, two possible sites for the Gilmore reservoir were investigated. The results of the seismic refraction survey indicate a thin layer of unconsolidated material overlying slightly weathered tuff. For the proposed floor levels of the reservoir on either site, blasting will be necessary for excavation.

It is proposed to drive a sewer tunnel from Gould St, Turner across the centre of Canberra to the Commonwealth Ave pumping station. To interpolate between bore-holes, a seismic refraction investigation of the subsurface was requested. Three traverses were recorded on undeveloped land close to the tunnel line, using conventional methods. Interpretation of the results is not yet complete.

Typical of the unusual requests occasionally received by the group, was one to locate an asbestos cable conduit buried in a reinforced concrete slab on the site of the Australian National Gallery. This was successfully done by pushing an energised coil down the conduit, and locating its position on the surface with a search coil linked to an amplifier tuned to the coil frequency. Later, at the same site, a buried electricity mains cable was located again using a search coil and an amplifier tuned to 50 Hz frequency.

Vibration measurements

During the year, vibration measurements were recorded at several sites in the ACT in connection with blasting close to private residences.

The Research School of Chemistry at the ANU requested vibration measurements to see if a particular room would be suitable for housing an electron microscope. The location for such an instrument must comply with strict limits on the vibration levels at specified frequencies. The vibration recordings, taken over several days, indicated that these conditions could be met.

Ground vibrations resulting from shelling on the artillery range at Holsworthy army camp were monitored on behalf of the Department of Defence. Measurements taken at three sites outside the range proved that there was no vibration caused by energy propagated through the ground from the impact site. The only vibration detected was caused by ground coupling of the air blast, or sound, of both the gun firing and the shell exploding.

Location of unexploded shells on disused firing ranges

The site of the ACT Police Drivers' Training Centre, now under construction, was formerly part of an Army firing range and any unexploded devices had to be cleared before construction could begin. With sample shells provided by the Army, the Group conducted tests to determine the feasibility of detecting buried devices using (a) magnetometers and (b) transient electromagnetic (TEM) equipment. These tests indicated that the

TEM equipment was more effective (e.g. a 17 lb shell could be detected at a depth of at least 0.5 m). Using this equipment, about 2000 m^2 of the excavation site was searched with a negative result. Nothing was unearthed in the subsequent construction work.

When a similar request was received to search an area of sand dunes near Warnbro Sound, W.A., again for unexploded shells, further tests were conducted. In an effort to enhance the magnetic anomaly produced by a buried ferromagnetic object, current was passed through the ground close to the object. This technique was found to increase slightly the amplitude of the anomaly, depending on the magnitude of the ground current. Tests in WA indicated that the magnetic method could be used without this enhancement technique in the quiet magnetic environment there, to successfully pinpoint shells buried to a depth of up to one metre. Several hitherto undiscovered shells were found.

Down-hole logging

Normal maintenance of tools and associated equipment, as well as power plant and hydraulic systems of the logging facility took up a significant proportion of the year. A literature search was conducted to determine the availability of density, velocity, magnetic susceptibility, and eH-pH tools, and conversion to a digital data acquisition system was considered.

In conjunction with the Metalliferous Section, a down-hole IP tool was designed and manufactured and an existing down-hole EM tool was modified. Exploration boreholes were logged at Broken Hill and Cobar using this equipment. A stratigraphic borehole drilled by the Geological Survey of Queensland near Beaudesert, was also logged but with a normal suite of tools.

An application was made to the National Energy Research, Development and Demonstration Council for a grant to update the complete logging system.

Work outside Australia

A short seismic refraction survey was conducted at a proposed tunnel site in Suva, Fiji, on behalf of the Department of Construction and in conjunction with the Australian Development Assistance Bureau. The survey was designed to assist in locating the tunnel portal in generally unfavourable rock conditions.

The Group also carried out computer interpretation of vertical electrical sounding (VES) data, collected by Geoquest Pty Ltd in Indonesia as part of a foreign aid project.

5. MULTIDISCIPLINARY PROJECTS

Program manager : A.R. Jensen

Project co-ordinators : E.C. Druce (Georgina Project)
K.A. Plumb (McArthur Project)

GEORGINA BASIN PROJECT

Compiled by E.C. Druce

STAFF:

J. Draper (until April 1978), E. Druce (Project Co-ordinator) J. Giddings (part time), P. Harrison, K. Heighway, M. Idnurm (part time), P.J. Jones (part time), K. Jackson (part time), J. Kennard, S. Mathur (part time), B.M. Radke (study leave), J. Rees (part time), J. Shergold, C. Simpson (part time), D. Tucker (part time), M. Walter (part time), G. Warren (part time), Gavin Young (part time) and B. Wyatt (part time), P.J. Kennewell (until June 1978), P. Green (GSQ), P. West (ANU), P. Kruze (Sydney University) and R. Fortey (British Museum).

Research is aimed at increasing our understanding of the geological history of the basin. This research into the distribution of the lithological units in time and space will aid exploration for hydrocarbons, phosphate, and base metals. Studies were undertaken in geophysics, geochemistry and geology by a multidisciplinary semi-autonomous team of specialists.

WORKSHOPS

A Georgina Basin workshop was held during the 7th BMR Symposium (April 1978) which was attended by 56 people. The latest research results of the BMR project were presented for discussion and critical comment (E. Druce).

The inaugural field workshop and seminar of IGCP Project 156 (Phosphorites: Proterozoic/Cambrian of Australia and Asia) was held in August 1978. Some 58 scientists from 12 countries attended a field workshop in the Georgina Basin (J. Shergold).

SEISMIC RESEARCH

Seismic research involved a detailed interpretation of the Toko Syncline using seismic and gravity data collected during the 1977 field season.

The Toko Syncline is a downwarp with a thrust faulted western margin (Toomba Fault). The fault is generally a high angle reverse fault and several seismic lines show reflections from bedded units beneath shallow basement; gravity studies confirm the presence of Arunta basement overlying Palaeozoic sediments. Within the syncline three major reflectors have been identified: the base of the Cambrian, the top of the Georgina Limestone (U. Cambrian), and the top of the Kelly Creek Formation (L. Ordovician). Structure contour maps for the top of the Georgina Limestone show a large structure, closed against the Toomba Fault, which includes the Ethabuka and Mirriea structures partly delineated by Alliance Oil Development. This structure has a minimum closure of 700 m over an area of about 130 km^2. A study of the stratigraphy shows that the southeast plunge was caused by tectonic activity rather than syndepositional subsidence although there is some southerly thickening of the Ordovician sequence. A 400 m thick southeastward prograding sequence, identified on the seismograms, is considered to represent the Steamboat Sandstone. Within the Middle Ordovician "Ethabuka Beds" an unconformity has been recognized on the seismic records which ties to an unconformity at 1024 m in Ethabuka No. 1 well (P. Harrison).

GEOPHYSICAL ANALYSIS OF BASEMENT

A basin wide study of the pre-Phanerozoic crustal geology is in progress. Preliminary results show that there are four regions with differing anomaly characteristics based on gravity and magnetic data. This divi-

sion comprises regions which are: Arunta-like, comprising the westerly and southerly parts of the Basin; Mt Isa-like, essentially the eastern margin; Lovelle-like along the south-eastern rim; and Intermediate, a zone between the Arunta-like and Mt Isa-like regions which appears to be an extension of the zone of high Bouguer anomalies associated with the Musgrave Block. Lateral composition changes in Precambrian rocks primarily responsible for variation in the gravity and magnetic pattern: the Toko Syncline is an exception with a thick sequence of Adelaidean and Palaeozoic sediments causing an elongate gravity low. Two major magnetic gradients are present in the southerly part of the basin and both are attributed to reverse faulting. An east-west gradient in the southern part of the Tobermory and western part of Mt Whelan 1:250 000 Sheet areas probably represents a low angle (15^{o}) thrust sheet at a depth of 4-6 km. The thrusting is to the north and partially coincides with the Craigie Fault, suggesting that the Craigie Fault is, in part, caused by reactivation along an older thrust plane. The second gradient is in the southeasterly part of the Basin and forms the boundary between the Mt Isa-like and Lovelle-like regions. It is considered to be a high angle reverse fault with overthrusting to the south: in part the modelled fault coincides with the Cork Fault (D.H. Tucker, B. Wyatt, S. Mathur, E. Druce).

GEOCHEMICAL RESEARCH

Both organic geochemistry and regional whole rock geochemical studies are in progress. Regional geochemical investigations have demonstrated that strontium, iron and manganese are the best elements for the geochemical discrimination of rock units and for the interpretation of depositional environments. The Upper Cambrian Arrinthrunga Formation has high fluorine values and sphalerite is present in minor quantities (J. Draper).

Source rock studies continued and nine samples from Brothers No. 1 and Netting Fence No. 1 wells were analyzed by Esso Australia from core material held by BMR under the Petroleum Search Subsidy Act. Total organic carbon figures suggest that possible source rocks are rare apart from a

horizon at 1955.6 m (6416 feet) in Netting Fence No. 1 well (?Middle Cambrian Marqua Beds). Thermal indices measured vary from 2.5 to 3+; the latter values indicate overmaturity, the rocks having passed through the oil generating stage. The C15+ analysis on the sample from 1955.6 m suggests that it is a good oil source and some liquid hydrocarbons may have been generated because there is oil staining at 1882.4 m (6176 feet) within the presumed Marqua Beds (K. Jackson).

SEDIMENTOLOGICAL AND STRATIGRAPHIC RESEARCH

Basement rocks exposed at the southern limit of Palaeozoic sediments are representative of the Arunta Block comprising two metamorphic units intruded by four different granites. Age determinations (1725 m.y., 1719 m.y., and 1662 m.y.) based on K-Ar ratios from muscovite in granite and coeval pegmatites, are considered to represent the age of initial crystallization implying that Arunta Block rocks east of the Tarlton Fault have not been affected by post Carpentarian metamorphic events (R.G. Warren).

A small inlier of basement rocks has been discovered on the Mt Whelan Sheet area, 22 km southeast of Sun Hill. Very weathered granitic material similar to granites within the Arunta Block on the Hay River Sheet area is overlain by arkose and shale (C.J. Simpson and J.H. Shergold).

Further examination of Adelaidean sediments in the Sun Hill-Watchie Hut area (Mt Whelan Sheet area) has shown that:

- lithologically the Sun Hill Arkose is more similar to the Black Stump Arkose than the Gonallan-a-gea Arkose (of the Hay River Sheet area);

- the Pb and Ag bearing arkose at Watchie Hut is probably Sun Hill Arkose - it is overlain by dolomitic grit, dolarenite and sandy dolostone which may be equivalent to the Wonnadinna Dolomite (Hay River Sheet area);

- the tillite at Duchess is overlain by a dolostone and shale sequence, unlike the cap rock of the tillite on the Hay River Sheet area, and is considered to be a younger tillite (C.J. Simpson).

The stratigraphy of the Adelaidean rocks, the oldest sequence in the Basin, has been further elucidated and the former Field River Beds have been divided into six formations. The tillite in the Hay River Sheet area ("Yardida Tillite") has been shown to be equivalent to the lower of two tillites generally present in central Australia. The "Yardida Tillite" is unconformably overlain by the Field River Group which includes arkose, siltstone and dolomite units some 1300 m thick. The overlying Grant Bluff Formation is a correlative of the Cyclops Member of the Pertatataka Formation of the Amadeus Basin and there is now considered to be a longer time break between the Precambrian and the Cambrian in the southern part of the Basin than elsewhere in central Australia (M.R. Walter).

The Grant Bluff Formation is unconformably overlain by "Desert Bore Beds" and the unconformity is marked by silicification and the development of quartz crystals with fluid inclusions some of which contain hydrocarbons - the minimum temperature of formation is considered to be in the range $76^{o}C$ - 93^{o} (C. Simpson).

The carbonates of the Upper Cambrian Arrinthrunga Formation cover a wide spectrum of petrographic types, the most predominant being peloidal and ooid grainstone, algal boundstone, mudstone and crystalline dolostone. The sequence represents deposition in shallow subtidal, intertidal and locally supratidal environments. There is a general shallowing of water depths from the southeast to the northwest, and this trend is paralleled by an increase in the proportion of dolomite and terrigenous sand and shale. Evaporites (gypsum, halite and ?anhydrite), fluorite and occurrences of galena and sphalerite are restricted to the west and northwest.

A karst erosion surface has been identified between the Arrinthrunga Formation and the overlying sandstones of the Tomahawk Beds: diagnostic features include laminar and pisolitic calcrete, cavity fill breccia, an irregular topographic surface overlain and infilled by sandstone, and

the disruption of drainage and joint patterns near the contact. Two solution collapse cauldrons after evaporites are present within the Eurowie Sandstone Member 3.2 km NNE of Eurowie Yard (Huckitta Sheet area); they are 80 - 120 m in diameter and filled with jumbled sandstone blocks up to 20 m long. Examination of core from BMR Huckitta No. 1 (formerly Grg No. 1) and BMR Elkedra No. 5 (Grg 5) has shown that the sequences in both holes represent the Arrinthrunga Formation rather than the Tomahawk Beds as originally proposed. Thus the distribution of the Arrinthrunga Formation has been extended westward to the edge of the Huckitta Sheet area and northward to near the southern margin of the Precambrian of the Hatches Creek area (J. Kennard).

The Lower Ordovician Kelly Creek Formation in the Tobermory Sheet area comprises a lower sandstone unit (with tracks, trails, and burrows) and an upper dolomitic unit, informally designated the "Withillindarmna Dolomite". This latter unit interfingers with the overlying Coolibah Formation in the central part of the Sheet area. Further west the Kelly Creek clastic unit becomes gypsiferous and both the "Withillindarmna Dolomite" and the Coolibah Formation become progressively more clastic: at the southern end of the Tarlton Range rocks with a fauna similar to the Coolibah Formation are cross bedded sandstones which are included in the Kelly Creek Formation. The Kelly Creek Formation straddles the Tremadocian/Arenigian boundary and may be both conformable and unconformable on the underlying dolomitic units of the Ninmaroo Formation. The Tomahawk Beds comprise clastic rocks coeval with the Ninmaroo Formation (carbonates) and Kelly Creek Formation. In the Huckitta Sheet area there are three distinct units: a lower richly glauconitic sandstone, a middle calcareous and peloidal sandstone, and an upper sandstone with a rich ichnofauna. The latter is indistinguishable from the Kelly Creek Formation (E.C. Druce).

The Lower to Middle Ordovician Mitchaka Formation, which is confined to the Toko Syncline, comprises dark grey pyritic mudstone with numerous thin lensoid sandstone interbeds; it is bioturbated and contains rare phosphatic pellets. The fauna and lithology are consistent with sedimentation in a lagoon as postulated in the sedimentary model proposed for the underlying Carlo Sandstone (J.J. Draper).

PALAEONTOLOGY

The stromatolite Acaciella australica Walter has been found in the Adelaidean "Yackah Beds" of the Hay River sheet area, supporting the correlation of those beds with the Bitter Springs Formation of the Amadeus Basin (M.R. Walter).

Archaeocyathids from the Lower Cambrian "Desert Bore Beds" of the Hay River Sheet area indicate any Atdabanian - early Lenian age (in terms of the Siberian stages) and a correlation with the Mount Baldwin Formation (P. Kruse).

The conodont Clarvohamulus primitus Miller has been recovered from the Lower Ordovician Ninmaroo Formation in the Burke River Structural Belt and the Tobermory Sheet area: its presence, together with Cordylodus prouvus, provides a much firmer correlation of Australian Tremadocian sequences with those in North America (E.C. Druce).

Trilobites from the Lower Ordovician Nora Formation indicate that the unit spans nearly all the Arenigian. The faunas are characterised by endemic species belonging to families which existed in the Late Cambrian together with some extra-Austral forms which may provide a basis for correlation with northern hemisphere sequences (R. Fortey and J. Shergold).

The Wuttagoonaspis fauna has been recovered from the Devonian Cravens Peak Beds (sandstones) together with several new placoderms resembling forms from the lower part of the Dulcie Sandstone. An unnamed limestone unit on the western margin of the Toko Syncline has yielded abundant onychodontid crossopterygian remains (teeth, scales, fin rays) tentatively referred to Onychodus sp. together with rare placoderm plates and acanthodian spines (G.C. Young).

The limestone unit has also yielded thelodont scales - Turinia australiensis Cross and T. pagei (Powrie) - abundant eridostracans (Cryptophyllus) and some ostracods. The thelodont scales indicate an Early Devonian (Dittonian) age whereas Cryptophyllus sp A. Jones 1962 suggest that the unit could be as young as Late Middle/earliest Late Devonian (P.J. Jones, J.J. Draper and Susan Turner, Hancock Museum, UK).

Trilobites from the Upper Cambrian Chatsworth Limestone have been described: they are post-Idamean but pre-Payntonian in age and have affinities with faunas from northern China, Korea, the north Siberian Platform and Kazakhstan (J. Shergold).

PALAEOMAGNETISM

Samples from tillitic beds in the Georgina Basin were analysed to determine their palaeomagnetic character. There is a distinct grouping of measurements around a shallow westerly inclination: a result which is consistent with measurements from the Areyonga Formation of the Amadeus Basin and from the Tapley Hill Formation and Merinjina Tillite of the Adelaide Geosyncline (M. Idnurm).

ECONOMIC GEOLOGY

Numerous clasts of galena and tourmaline-quartz rock have been observed at a locality within the Adelaidean Oorobra Arkose near Oorobra Rockholes in the Huckitta Sheet area. These had previously been noted by Brown (1896). The galena clasts are poorly sorted, are 2-12 cm in size and, considering the fragile nature of the 5-15 mm galena crystals, have undergone minimal transportation. Regionally the arkose occurs as isolated wedges resting directly on the eroded surface of the Proterozoic Jinka Granite. The arkose comprises pebbles and cobbles of the granite and it is probable that the galena source is within the granite (J. Kennard and M.R. Walter).

A petroleum resource assessment of the Mirrica-Ethabuka structure was undertaken: the probability of occurrence of critical factors was estimated to be - reservoir (0.8 probability), source rocks (1.0), necessary thermal history (1.0), effective trap and seal (0.4), correct timing (0.9), absence of flushing (0.8). Conodont maturation indices indicate that the reservoir is gas prone and the estimated chance of gas discovery is about one in four. Should gas be present there is a 95% probability of recovering 0.6 trillion cubic feet and a 5% chance of recovering 3.2 TCF: the mean recoverable reserves are estimated to be 1.5 TCF (P. Harrison, E. Druce, K. Jackson, and E. Riesz and D. Forman, Petroleum Exploration Branch).

McARTHUR BASIN PROJECT

Compiled by K.A. Plumb

STAFF: W. Anfiloff (part time), K.J. Armstrong, J.W. Giddings (part time), D. Gregg, M. Idnurm (part time), M.J. Jackson, P. Jorritsma (part time), D. Kerr, J.A. Major (part time), M.D. Muir, K.A. Plumb, C.J. Simpson (part time), A.G. Spence (part time).

The basic aim of the McArthur Basin Project is to elucidate the evolution of the McArthur Basin, using stratigraphic, sedimentological, geochemical, tectonic, and other studies and to apply this information so as to understand the genesis of ore deposits in the region.

OBJECTIVES OF 1978 PROGRAM

The main objectives of the 1978 program were:

(1) Commence a study of the sedimentology and palaeogeography of the Wollogorang Formation, Masterton Formation, Mallapunyah Formation, and Amelia Dolomite.

(2) Commence a study of the sedimentology, palaeogeography, and micro-palaeontology of the Balbirini Dolomite, Dungaminnie Formation, and their stratigraphic equivalents.

(3) Map the geology of the Mallapunyah-Kilgour 1:100 000 Sheet area and parts of adjoining areas, at photo-scale (1:25 000).

(4) Complete laboratory measurements on 1977 magneto-stratigraphic reconnaissance samples from the McArthur Basin.

(5) Make further detailed collections of magneto-stratigraphic samples in order to (a) determine the magneto-stratigraphic column of polar reversals through the McArthur Basin, as an aid to chronostratigraphic correlation, and (b) determine the polar wander curve for the Carpentarian.

(6) Carry out detailed magneto-telluric and gravity surveys along a profile across the Wearyan Shelf and eastern Batten Fault Zone, to determine the applicability of the methods to (a) defining the configuration and depth of basement beneath the McArthur Basin, (b) defining thickness variations within the basin succession, (c) locating and defining the form of major structures, with the immediate aim of defining the basement and McArthur Basin succession beneath concealed areas of the Wearyan Shelf, immediately to the east of the Emu Fault.

SYSTEMATIC MAPPING M.J. Jackson (Task Leader)

Mapping of the Mallapunyah-Kilgour 1:100 000 Sheet area was almost completed. Photo-scale compilations of the area mapped are almost complete. The principal changes made to the existing 1:250 000 maps are:

(1) Areas previously mapped as Emmerugga Dolomite have now been subdivided into Mara Dolomite Member, Mitchell Yard Dolomite Member, Teena Dolomite, Coxco Dolomite Member, Barney Creek Formation, and Reward Dolomite (K.A. Plumb, C.J. Simpson, M.D. Muir);

(2) Areas previously shown as Billengarrah Formation, in the area mapped, have been shown to consist of Balbirini Dolomite and Dungaminnie Formation (M.D. Muir, K.A. Plumb);

(3) A new basin of Roper Group rocks has been identified in the south, between Top Springs homestead and the Mallapunyah Dome (M.D. Muir, M.J. Jackson);

(4) New understanding of the stratigraphy of the McArthur Group has allowed radical revision of the map along the Kilgour River, around the southeastern end of thebner Range (M.D. Muir).

REGIONAL STRATIGRAPHIC AND STRUCTURAL STUDIES

TAWALLAH GROUP (M.J. Jackson)

Tawallah Group rocks are exposed in three meridionally-trending structural highs at the southern end of the area mapped. Detailed mapping has better defined their distribution and shown that the rocks are more intensely faulted than previously thought. New information resulting from this work is summarized below:

1. The McDermott Formation consists mainly of massive recrystallised red carbonate rock lacking obvious sedimentary or algal structures. It differs noticeably from carbonate rocks found in the remainder of the McArthur Basin sequence.

2. Glauconite has been found at several localities in the Mallapunyah Dome, within rocks previously mapped as Sly Creek Sandstone; they should therefore be reassigned to the Rosie Creek Sandstone. Gypsum pseudomorphs have been identified in the unit.

3. The Gold Creek Volcanic Member (of the Masterton Formation) has been identified throughout the southern area. It is usually emplaced at or near the base of the Masterton Formation, but has been found intruding the Wollogorang Formation. Together with the Wollogorang Formation, the Gold Creek Volcanic Member forms an attractive mineral prospect, as both units contain widespread disseminated lead, zinc, and copper mineralisation.

4. A distinct break has been identified between the Wollogorang Formation and the overlying sandstone member of the Masterton Formation. This observation adds new confirmation of the unconformity predicted at the base of the Masterton sandstone unit in recent publications by Plumb.

McARTHUR GROUP

The Mallapunyah, Tawallah, and Hot Springs Faults are now shown to have been important hinge zones during deposition of the McArthur Group. New erosion breaks or unconformities have been identified or con-

firmed at several levels within the McArthur Group. Widespread karstic features, of several ages, have been identified in several rock units, and are important to the interpretation of the evolution of the basin and the origin of mineralisation.

Unconformities (M.D. Muir, K.A. Plumb): To the southeast of the Abner Range, erosion breaks and unconformities have been identified at the base of the "Lower Lynott" Formation and Yalco Formation. An unconformity occurs between the "Lower Lynott" and "Upper Lynott" Formations around the northern end of the Abner Range.

A regional unconformity occurs at the base of the Balbirini Dolomite, which rests directly on all units down to the Reward Dolomite.

A regional unconformity at the base of the Limmen Sandstone cuts out most of the Dungaminnie Formation/Balbirini Dolomite succession on the eastern and southern sides of the Abner Range.

Karstic Features (M.D. Muir, K.A. Plumb): Many types of karstic features have been recognised in carbonate-rich units: vertical-zoned veins; breccia-filled veins, cavities, and caves; sinkholes; irregular upper surfaces grading into tower karst; silicified upper surfaces; recrystallisation of carbonates to coarse-grained, equant dolomite and siderite. They are particularly characteristic of the Mitchell Yard and Coxco Dolomite Members and the Reward Dolomite. They have probably been formed during several periods of exposure and erosion.

In the less well exposed areas to the north, it is usually not possible to separate fossil karst features from those related to Cainozoic erosion surfaces, but in the better dissected areas to the east of the Abner Range fossil karst surfaces have been identified.

Fossil karst may be related to: the pre-Bukalara Sandstone (Early Cambrian) surface; the pre-Limmen Sandstone surface; the pre-Balbirini Dolomite surface; the pre-Yalco Formation surface; the pre-"Upper Lynott" Formation surface. The age of karsting on the Mitchell Yard and Coxco Dolomite Members is problematical.

Mineralisation (M.D. Muir): The unconformities and karstic surfaces are often marked by the presence of thin, generally siliceous ironstones, and trace to fairly large amounts of secondary copper minerals, mainly malachite, are common in the underlying rocks. This is particularly apparent at the Reward Dolomite/Balbirini Dolomite unconformity: small caves in the Reward Dolomite can be wholly or partly filled with malachite and chrysocolla (e.g., Yah Yah and Darcy's copper prospects), and copper traces always occur where the Balbirini Dolomite overlies the stromatolitic facies of the Reward Dolomite.

Traces of chalcopyrite occur at the Yalco Formation/Balbirini Dolomite unconformity south of the Abner Range, and traces of malachite have been found at the Balbirini Dolomite/Limmen Sandstone unconformity near Top Springs homestead. Traces of cuprite occur at the Leila Sandstone Member/Bukalara Sandstone unconformity at William Creek, on the edge of the Bukalara Plateau.

A small cave-fill deposit of secondary copper minerals occurs at the contact between the Mara and Mitchell Yard Dolomite Members, in a heavily karsted area of unknown age near Tooganinie Creek (K.A. Plumb).

These karstic unconformities are clearly prospective, but large amounts can only be expected where suitable caves or open veins occur in the carbonate units. The source of the copper is not known.

Miscellaneous Stratigraphy: The area to the east and south of the Abner Range is much more complex, both stratigraphically and structurally, than previously mapped. The Hot Springs Fault is the axis of several significant facies changes.

The subunits of the Emmerugga Dolomite, Teena Dolomite, and Barney Creek Formation retain their usual characteristics, as previously determined by M.C. Brown, throughout the area mapped (K.A. Plumb, M.D. Muir, C.J. Simpson). An important new feature is the discovery of pseudomorphs after evaporite minerals (acicular gypsum needles and prismatic laths after (?) gypsum) in the Mitchell Yard Dolomite Member (K.A. Plumb).

The Teena Dolomite and Barney Creek Formation show marked variations in thickness, with several sub-basins of relatively thick Barney Creek Formation. The Barney Creek Formation shows wide variations in carbonate, carbon, and iron content between different areas.

An important new discovery in the western area, around the upper Tooganinie Creek, is clusters of radiating acicular gypsum casts in the Barney Creek Formation, identical to those previously considered to be characteristic of the underlying Coxco Dolomite Member (K.A. Plumb, C.J. Simpson).

The Reward Dolomite varies widely in thickness and rock type throughout the area mapped; it is an excellent indicator of the overall tectonic setting of both itself and the underlying Barney Creek Formation. The massive carbonate-rich turbidite facies to the northeast of the Abner Range (measured section G1 of 1977 work) changes to a very thin stromatolitic facies, containing Conophyton and radiating acicular gypsum casts, between the Hot Springs and Tawallah Faults. Farther west massive coarse dolarenites characterise the unit. At the southern end of the Abner Range these facies occur together; turbitites, overlain by stromatolitic dolomite, and dolarenite at the top.

All the shallow subtidal to supratidal facies which were identified in the Batten Subgroup during 1977 have been traced continuously throughout the area mapped during 1978. Redefinition of the turbiditic "Lower Lynott" Formation as a separate formation is warranted. The component units of the Batten Subgroup have now been identified and mapped within the "Billengarrah Formation" at Top Crossing, but outcrops of Batten Subgroup only continue for about 10 km west from Top Crossing (K.A. Plumb).

An important new result of mapping between Leila Creek and Top Crossing is the recognition that the Amos Formation and Looking Glass Formation are stratigraphic equivalents. Both are highly altered carbonate units: the Amos Formation may be a fossil calcrete, while the ubiquitous silicification of the Looking Glass Formation might be attributed to either early diagenesis or to silcrete formation on an emergent surface (K.A. Plumb, M.D. Muir).

Structure (M.D. Muir): McArthur Group rocks are preserved in a series of structural basins separated by faults, except on the east and especially in the south of the Abner Range, where they are folded in a similar style to that of the overlying Roper Group; the Balbirini Dolomite is involved in this folding.

Elsewhere, to the south and west of the Abner Range, the Balbirini Dolomite and Batten Subgroup are unaffected by folding which affects the older formations of the McArthur Group, and overlie the folded sediments without disturbance.

ROPER GROUP (M.D. Muir)

Rocks from the Roper Group were mapped in the Abner Range and to the east of Top Springs homestead. In addition, core from a drill hole to the west of Bauhinia Downs Homestead was sampled, in Darwin, for micropalaeontological and stratigraphic studies. This drill hole penetrated the Bessie Creek Sandstone, Corcoran Formation and Hodgson Sandstone Member (of the Abner Sandstone). Since the Corcoran Formation is everywhere poorly exposed, this drill core provides possibly the only complete section of the unit available.

To the east of Top Springs Homestead, a sequence of rocks which were previously mapped as Billengarah Formation, Mallapunyah Formation, Masterton Formation, and Tatoola Sandstone have now been identified as Limmen Sandstone, Arnold Sandstone Member, and Hodgson Sandstone Member of the Roper Group. An undifferentiated Proterozoic sequence, to the south, has also been identified as the Abner Sandstone. Slightly to the north of this area, a sub-circular black-soil plain is rimmed by Limmen Sandstone, as if it may have been a large sinkhole (M.D. Muir).

Structure: In the Abner Range, the Roper Group is folded into a series of northwest-trending anticlines, synclines, and monoclinal flexures, parallel to the Hot Springs Fault. The Cambrian Bukalara Sandstone is involved in the same folding as the Roper Group in the Abner Range, but whether

this indicates that the Roper Group sediments had not been folded prior to deposition of the Bukalara Sandstone, or that the old Precambrian fold axes were rejuvenated, remains to be seen. Elsewhere, the Bukalara Sandstone is flat-lying and strongly unconformable on the McArthur Basin rocks.

SEDIMENTOLOGICAL STUDIES

UPPER TAWALLAH GROUP - LOWER McARTHUR GROUP (M.J. Jackson)

Detailed sedimentological studies were commenced in the Wollogorang Formation, Masterton Formation, Mallapunyah Formation, and Amelia Dolomite, in the southern part of the area where the best exposures are found.

Wollogorang Formation: A lateral change from a quiet-water carbonate facies to a higher-energy more clastic facies was established in the lower part of the Wollogorang Formation, around the eastern and northern sides of the Mallapunyah Dome. Higher up in the formation, uniform deposition in a quiet-energy environment is indicated. Disseminated copper mineralisation is widespread near the top of the unit.

Masterton Formation: Although only one detailed section was measured through the formation, it seems to be representative of the formation as a whole throughout the southern area. The sequence is interpreted as indicating a regressive sequence, from open marine, through intertidal shallow marine, to lagoonal environments. Ripple orientation and cross-stratification measurements indicate a wide range of current directions.

Mallapunyah Formation: The Mallapunyah Formation consists mainly of thin to medium-bedded dolomitic siltstone and silty dolomites, with interbeds of conglomeratic cross-stratified silty sandstones. A lagoonal or flood plain type of environment is envisaged. Coarser spherical quartz grains may be of aeolian origin, whilst cross-stratified silty sandstones are probably from short-lived fluvial events. The well-known "cauliflower chert" nodules, after evaporite minerals, are diagenetic features.

Amelia Dolomite: The Amelia Dolomite is of uniform thickness and rock type throughout the whole of the southern area. It consists of interbedded stromatolitic and non-stromatolitic (pisolitic, oolitic, intraclastic, conglomeratic) dolostones, with gypsum and halite pseudomorphs at several different stratigraphic levels. Bioherms of Conophyton-like stromatolites may be traced for many tens of kilometres. Disseminated copper mineralisation was found in massive recrystallised stromatolitic dolomites in several sections.

UPPER McARTHUR GROUP (M.D. Muir)

Balbirini Dolomite: The almost 900 m-thick Balbirini Dolomite contains a number of well defined units. The lowermost unit is a red siltstone facies, of probable supratidal or terrestrial origin, but a coarse water-laid basal conglomerate occurs in some areas. The siltstone passes up into an evaporitic sequence containing a variety of pseudomorphs of: possible polyhalite; "cauliflower cherts"; discoidal, hexagonal prismatic, and equent seed gypsum; and sideritic or ferroan dolomitic marble after massive gypsum replacement of earlier carbonate.

The evaporite sequence is overlain by a stromatolitic unit containing several forms, but characterised by a laterally-persistent bed of a characteristic branching Conophyton. This unit is followed by a quartz sandstone sequence, which is capped by another stromatolite bioherm complex, characterised by a form of Kussiella.

The upper parts of the exposed sequence are dolarenites and flake breccias, with minor evaporites, and were deposited under shallow-water to desiccating conditions.

Dungaminnie Formation: This unit crops out only around the northern end of the Abner Range, and it is neither well-exposed or well-preserved. The lower part of the section consists of siltstone, sandstone, and some stratiform-stromatolitic dololutite. Higher in the sequence there is a conspicuous but laterally impersistent bed of Conophyton, in which the columns are inclined at about 60^{o} to bedding. The highest part of the Dungaminnie Formation consists of rapidly-deposited detrital carbonate rocks and quartz sandstone.

PALAEOMAGNETIC RESEARCH (M. Idnurm (Task Leader); J.W. Giddings)

Laboratory Measurements: The magnetostratigraphic reconnaissance study of the McArthur Basin, started in 1977 and was completed this year. 35 pilot specimens had been collected from the Kilgour River area (measured sections K1-K12), at equal stratigraphic intervals through 1000 m of section, from the top of the Masterton Formation to the upper Emmerugga Dolomite. Duplicate sections were sampled in some cases.

After progressive thermal demagnetization had been carried out, up to the Curie Point of hematite, remanence intensities remained well above the sensitivity limit of the cryogenic magnetometer, and stable remanence directions were generally obtained. No secondary components, other than a pronounced Recent field component, were found.

A distinct polarity reversal pattern is emerging from these measurements and a tentative polarity reversal column has been drawn up. Tentative correlations can be made in each of the two cases where duplicate sections were sampled. The reconnaissance study clearly demonstrates the magnetostratigraphic correlation has definite potential in the McArthur Group and the uppermost Tawallah Group, if not in the McArthur Basin generally, and further work is warranted.

Significant polar wander is observed within the sequence. In particular, a large shift in the pole position appears to have taken place at about the Mallapunyah Formation-Amelia Dolomite boundary. Although this shift coincides with a general change in rock types, from dominantly siltstone to dominantly stromatolitic dolomite, the stratigraphic evidence suggests that the transition is gradational.

The pole positions also indicate that the region was at high (magnetic) latitudes during the deposition of the sediments (or strictly, during the acquisition of the primary remanence). This,aagain, is at variance with the abundance of evaporites and stromatolites in the sequence, which is usually taken to indicate a warm hot climate.

A second reconnaissance magnetostratigraphic study was completed, on samples of Kombolgie Formation, from the Deaf Adder Creek and Edith River localities, about 400 kms to the northwest of McArthur River. The Kombolgie Formation is the basal unit of the McArthur Basin succession in this part of the basin.

The stabilities of remanence directions were generally excellent, but the scatter between the sample directions was larger than normally observed. Large scatters had been reported previously from the Hart Dolerite of the Kimberley region, which is of roughly similar age. There it was attributed to a very strong dipole field in comparison to the quadripole field. A tentative reversal pattern has been drawn up from these results. Further work is warranted.

1978 Field Program: Following the completion of the McArthur Basin reconnaissance, a further 1200 samples were collected during 1978 to better define the magnetostratigraphic column.

The Kilgour River sections (K1-K12) were sampled at 1 m stratigraphic intervals, through the 1000 m from the Masterton Formation to Emmerugga Dolomite. Thirty test samples were collected from various localities in the Kilgour River area to delineate the time of acquisition of the remanence. A 260 m-thick section of Emmerugga Dolomite near Top Crossing (measured section MCB4) was sampled at 3 m intervals, to compare the consistency and correlation of the reversal pattern with that of the Kilgour River sections.

The sampling of the magnetostratigraphic column was extended, on a reconnaissance basis, to include the Wollogorang Formation of the Tawallah Group in the Mallapunyah Dome, and the Amos Formation, Balbirini Dolomite, and Dungaminnie Formation near Balbirini Homestead. A total of 370 samples were collected from these units.

Further sampling of the Kombolgie Formation was also carried out, where 500 samples were collected at 1 m stratigraphic intervals through the sequence, so as to better define the magnetostratigraphic column.

40 samples were collected from the Westmoreland Conglomerate near the southeastern margin of the McArthur Basin, to compare the pole position with that of the stratigraphically equivalent Kombolgie Formation. 35 samples were collected from the isotopically-dated Hobblechain Rhyolite Member and Packsaddle Microgranite, at the top of the Tawallah Group, to help fix the time scale of the polar wander curve which is emerging from the McArthur Basin.

SUBSURFACE STRUCTURAL RESEARCH

The hypothesis that the McArthur Basin contains the central meridional faultbounded Batten Trough, bounded by shallow shelves on either side, is fundamental to all palaeogeographic analyses and to ore genesis (the McArthur River (H.Y.C.) orebody is adjacent to one of the bounding faults). The concept of a sudden change in thickness at these faults is speculative, however, because younger cover immediately adjacent to them always obscures the structure of the critical zones on the shelves.

The objective of the 1978 program was to test convenient methods of resolving alternative models of the subsurface structure beneath the reasonably accessible, but unexposed zone, between the Emu Fault and Wearyan River (Figure MP1).

MAGNETO-TELLURIC RESEARCH (D. Kerr (Task Leader), J.A. Major, A.G. Spence)

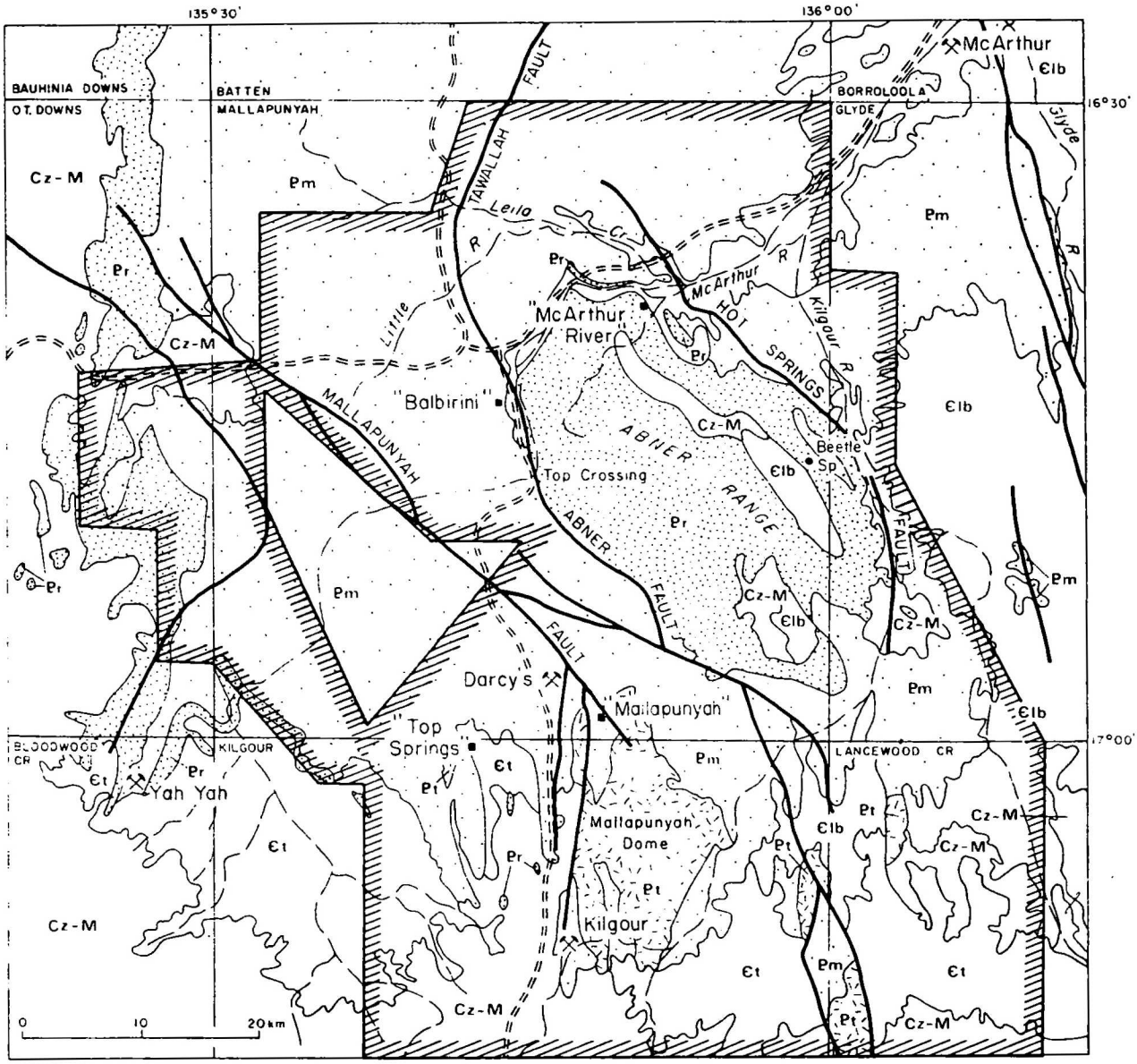
Field Survey: Theoretical modelling of structural profiles along the selected traverse indicated that the magneto-telluric method should be able to differentiate between the alternative models.

17 magneto-telluric sites were occupied between 28 July and 10 October (Figure MP2). Electromagnetic responses were recorded continuously for about 2-3 days at each site. Good-quality data was obtained from all sites. A portable computer facility allowed preliminary one-dimensional inversions to be carried out on site, to check the progress of the survey.

The five sites to the east of the Wearyan River are control sites in an area of simple predictable structure. The more closely-spaced stations over the problem area, to the west of the Wearyan River, follow the same line as the gravity survey.

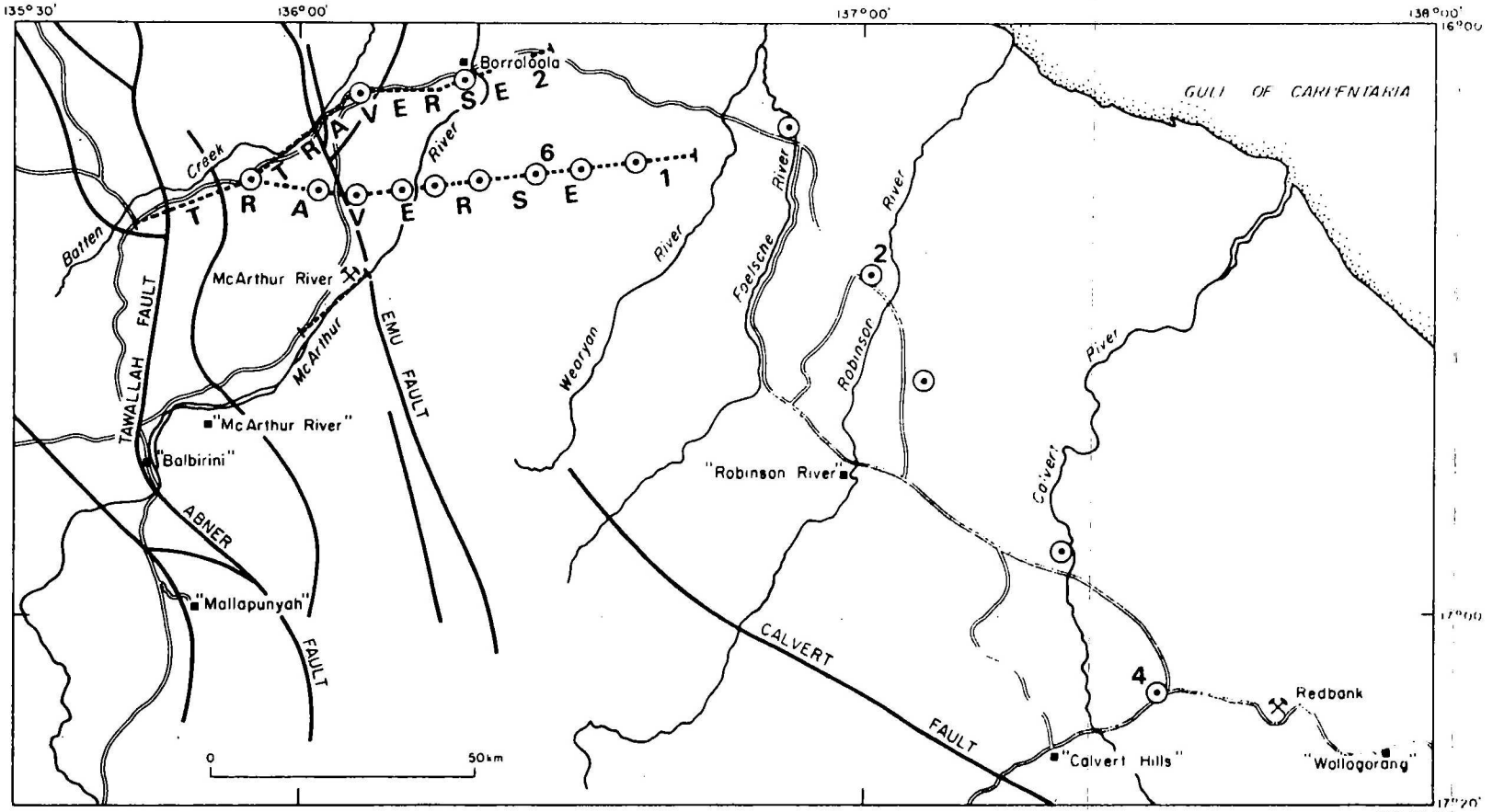
Results: Computer analysis of the data has only just begun. Preliminary one-dimensional modelling of the control sites reveals a well-defined basement of good contrast, with resistivity of about 95 k m.

This is overlain by a fairly consistent high-conductivity layer- 70 m - about 800 m thick. Above this, is a more resistive layer, with resistivities in the range 600-900 m.



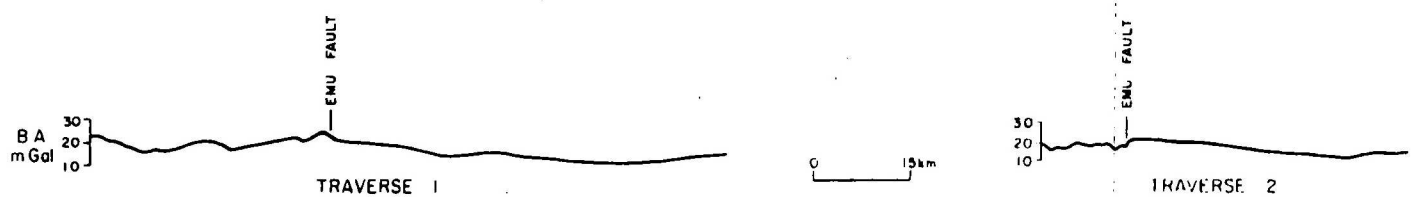
Generalised geological map and progress of mapping – McArthur geological research, 1978.

Record No. 1978/97



Gravity survey line — Fault — Principal roads

4 Magneto-telluric station — Mine or prospect — Homestead or settlement



Locality map and preliminary Bouguer anomaly profiles — McArthur Basin magneto telluric and gravity survey, 1978

A highly conductive overburden, about 10 m thick, has a resistivity of about 2.5 m.

The preliminary calculations indicate a depth to basement of about 2.8 km near Calvert Hills (Site 4), rising to about 3.5-3.6 km near Robinson River (Site 2). Approaching the Emu Fault a preliminary depth to basement of about 6.7 km has been calculated for site 6, but no data are available from adjoining sites yet, to indicate the nature of the depth change.

These data reveal the presence of well-defined electrical layers, which appear to be capable of simple geological interpretation. The control sites are within reasonable agreement with predicted geological profiles, and the potential of the method for resolving selected structural problems in the McArthur Basin is good.

GRAVITY RESEARCH (W. Anfiloff)

Field Survey: Detailed gravity measurements were made along about 160 km of optically-levelled traverse lines (Figure MP2), with the aim to assess possible local applications of the method. Station spacing of 0.5 km was used in areas of complex structure or topography, and 1.0 km elsewhere. One short traverse passed over the McArthur River (H.Y.C.) orebody.

Results: Figure MP2 shows preliminary Bouguer Anomaly profiles for traverses 1 and 2, from field reduction of the data. More accurate data reduction and interpretation will be carried out with the aid of a computer.

Gravity anomalies in the area are of low amplitude - less than 10 mGal over the whole traverse. This suggests small density contrasts between the various rocks in the area, and the need for detailed and accurate surveys to resolve any structural features.

There is good agreement between the two profiles to the east of the Emu Fault: Bouguer Anomaly values in both profiles decrease slowly southwards across the platform, away from the fault. The more disturbed profiles to the west of the fault are in agreement with the more complex structure of the Batten Fault Zone.

The profiles are suitable for detailed mathematical modelling and should be of use in resolving problems of subsurface structure. The results of this survey will be used to plan and assess the feasibility of future gravity work.

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1977/37	Hill, P.J.	Waniassa reservoir No. 2 seismic refraction blast-induced vibration.
1977/51	Hohnen, P.D.	The control of groundwater seepage by pumping from a bore at Torres St, Red Hill, ACT.
1977/50	Hsu, H.D., & Tilbury, L.A.	A magnetic interpretation program based on Wenner deconvolution.
1977/52	Lambourn, S.S.	South Eucla Basin airborne magnetic and radiometric survey, S.A. 1973.
1977/9	Major, J.A.	Rum Jungle area gravity survey, Northern Territory, 1974.
1978/20	Ogilvy, R.D.	Cloncurry area test resistivity survey, Queensland, 1973.
1978/62	Ogilvy, R.D.	Field tests with the Scintrex DHP-4 down-hole EM prospecting system, NSW, 1975.
1976/108	Pettifer, G.R., & Polak, E.J.	The use of surface geophysical methods in underground water investigations

1977/55	Robson, D.F.	Magnetic induced polarisation (MIP) survey, Woodlawn, New South Wales, 1975.
1978/56	Sampath, N.	Geophysical investigations of minor zones of mineralisation in the Cloncurry 1:250 000 Sheet area, northwest Queensland, 1973
1977/43	Stagg, H.M.J.	The Scott plateau - structure, isopach and potential field maps.
1978/76	Wellman, P.	National Report on gravity in Australia, July 1974 to June 1978.
1978/71	Wronski, E.B.	Gravity survey, Alligator River 1:250 000 Sheet area, Northern Territory 1972-73.

Records in advanced stages of preparation

	Collins, C.D.N.	Adaptation of the synthetic seismogram program "REFLEX" to the CSIRO CYBER 76 computer.
1978/18	Karner, G.D.	Vema cruise 33 leg 13 in the Bismarck, Solomon and Coral Seas, 20 Dec - 19 Jan 1977; observers report.
	Major, J.A.	Investigation of airborne geophysical anomalies, Georgetown area, Qld, 1976.
	Major, J.A.& Wilson, D.R.	Geophysical surveys at the Jubilee Plunger deposit, Georgetown area, Qld, 1974-6.

1978/65	Mutton, A.J., & Ogilvy, R.D.	Airborne and ground geophysical mapping in the Mount Basedow-Mount Partridge Range area, Alligator Rivers region, Northern Territory, 1974.
	Ogilvy, R.D.	Geophysical surveys, Rum Jungle area, NT 1974.
	Ogilvy, R.D.	An interactive computer program to calculate the magnetic anomaly of a dipping prism.
	Ogilvy, R.D.	An interactive computer program to calculate the gravity anomaly of a dipping prism.
	Pinchin, J., Schmidt, D.L., & Anfiloff, W.	Galilee Basin seismic survey 1976.
	Silic, J.	Induced polarisation/resistivity logging and depth soundings, Flying Doctor prospect, Broken Hill, NSW 1976.
1978/85	Spies, B.R.	Interpretation of transient electromagnetic measurements using the apparent conductivity concept.

ADDRESSES AT MEETINGS AND CONFERENCES

Cull, J.P.	Western Victoria, a geothermal energy prospect? 7th BMR Symposium, Canberra, May 1978.
Cull, J.P.	Geothermal resources in Australia. Seminar on volcanology. Geology Department, University of Melbourne, September 1978.

Denham, D., & Finlayson, D.M.	Crustal structure in Australia from explosion seismology. 7th BMR symposium, Canberra, May 1978.
Johnston, C.R.	Regional tectonic development of Timor. Geophysical seminar, Flinders University, Adelaide, 8 March 1978.
Johnston, C.R.	An evolutionary link between the Java trench and the Timor trough. Geophysical seminar, Research School of Earth Sciences, ANU, Canberra, 7 September, 1978.
Leary, C., Souter, D., & Kimber, T.	Application of automated plotting in airborne geophysical map production. Study Group on Geology and Mineral Exploration from The Peoples Republic of China, October 1978.
Mutton, A., & Winters, L.	BMR Airborne geophysical data acquisition systems. Study Group on Geology and Mineral Exploration from The Peoples Republic of China, October 1978.
Mutton, A.J.	Physical property measurements as an aid to magnetic interpretation in basement terrains. Applied Magnetic Interpretation Symposium, University of Sydney, 9-10 August 1978.
Pinchin, J.	A seismic investigation of the eastern margin of the Galilee Basin, Queensland. 7th BMR Symposium, Canberra, May 1978.
Spies, B.	TEM applications and modelling in Australia. Study Group on Geology and Mineral Exploration from The Peoples Republic of China, October 1978.
Stagg, H.M.J.	The geology and evolution of the Scott Plateau. APEA conference, Melbourne, 9-12 April 1978.
Stuart, D.C.	Applications for geophysics in Australian mineral exploration. Study Group on Geology and Mineral Exploration from The Peoples Republic of China, October 1978.
Tucker, D.H., Sampath, N., & Hone, I.	Configuration and composition of the Pine Creek Geosyncline, Northern Territory. 7th BMR Symposium, Canberra, May 1978.

Tucker, D.H. The sources and interpretation of magnetic anomalies in the Pine Creek Geosyncline, NT. Applied Magnetic Interpretation Symposium, University of Sydney, 9-10 August 1978.

Wellman, P. Gravity evidence for abrupt changes in mean crustal density at junctions of Australia's crustal blocks. 7th BMR Symposium, Canberra, May 1978.

Wilkes, P.G. The use of magnetic methods for exploration in the Cobar area. Applied Magnetic Interpretation Symposium, University of Sydney, 9-10 August 1978.

Young, G.A. Australia wide airborne magnetic and radiometric reconnaissance mapping. Study Group on Geology and Mineral Exploration from The Peoples Republic of China, October 1978.

OVERSEAS VISITS AND CONFERENCES

Connelly, J.B. Paris: International Gravimetric commission 12-16 September, 1978.

Cull, J.P. Wellington, New Zealand: Delegate to 6th ASCA conference. Presentation of paper on geothermal resources in the Otway Basin.

Exon, N.F. Wellington, New Zealand: official attendance at the 7th session of CCOP/SOPAC, 9-13 October, 1978.

Hill, P.J. Madrid: attended 3rd International Congress of Engineering Geology, September 1978.

Karner, G.D. New York, U.S.A.: to co-operate with Lamont-Doherty Geological Observatory in processing and interpretation of data from VEMA cruise 33-13 and related material. February-August, 1978.

Mutter, J.C. New York: 2-year Commonwealth scholarship for post-graduate study at Columbia University's Lamont-Doherty Geological Observatory, from August, 1978.

Polak, E.J.	Prague: attended Groundwater Pollution Conference, June-July 1978. Dublin: delivered paper on Groundwater Survey on Christmas Island, prepared jointly with G.R. Pettifer, at the annual meeting of the European Association of Exploration Geophysicists, June-July 1978.
Rees, J.R.	Philippines: on behalf of ADAB (Foreign Affairs Dept). Seconded for further period to prepare report. May 1978.
Willcox, J.B.	Honolulu: to address 2nd Circum-Pacific Energy and Mineral Resources Conference, 28 July-4 August 1978.

LOCAL CONFERENCES

Coutts, D.A.	ANZAAS - AIST Conference on science technology, Canberra.
Johnston, C.R., Hogan, A.P., & Brassil, F.M.	High resolution seismic techniques, Sydney, 28 March 1978.
Rees, J.R.	Applied Magnetic Interpretation Symposium, Sydney, 9-10 August 1978.
Stuart, D.C.	South Australia - Exploration Potential - AMF Workshop, Adelaide, 8th December to 9th December, 1977.
Tucker, D.H.	Geological Environments of Ore Deposits - AMF Workshop, Adelaide, 21 November - 2 December 1977.
Whitworth, R.	Antarctic marine science seminar, Melbourne, 1-2 February, 1978.
Wilkes, P.G.	Geological Survey of NSW, Cobar geological excursion, 28 November - 2 December 1977.
Wilkes, P.G.	Workshop on volcanogenic massive sulphides, CSIRO Mineral Physics, Sydney, 25 January 1978.
Wyatt, B.W.	Australian Institute of Mining and Metallurgy, Annual Conference, Townsville, September 1978.

TRAINING COURSES

Internal

Hegvold, T.R., Fowler, P.J.	ADP appreciation. Departmental course, 24-25 May.
Harrison, P., Johnston, C.R., Brassil, F.M., Brown, F.W., & Pinchin, J.	Writing in BMR: a course for authors

External

Pinchin, J.	Seismic stratigraphy - Prof. M. Dobrin, August Sydney, Earth Resources Foundation
Stagg, H.M.J.	AMF course, the new seismic interpreter, Adelaide 16-20 October 1978.
Bennett, D.G.	Sixth underground water school, AMF, Adelaide.

MAPS PRINTED AND RELEASED

Gravity maps (1:500 000)

Dixon Range, WA
Gordon Downs, WA
Highland Rocks, NT
Lake Mackay, NT
Lennard River, WA
Londonderry, WA
Mt Doreen, NT
Mt Ramsay, WA

Mt Theo, NT
Medusa Banks, WA
The Granites, NT
Warburton, VIC
Yampi, WA

(refer Table MA2 for preliminary airborne maps)