DEPARTMENT OF
NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1976/91

GEOPHYSICAL BRANCH SUMMARY OF ACTIVITIES 1976

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CONTENTS

		Page
SUMMARY		
1.	METALLIFEROUS AND AIRBORNE SECTION	1
	METALLIFEROUS SUB-SECTION	1
	Heavy-mineral sand deposits	1
	Georgetown area, Qld	2
	Interpretation of Forsayth Sheet airborne data	2
	Down-hole electromagnetic investigations	4
	Transient electromagnetic methods	5
	AIRBORNE SUB-SECTION	5
	Canberra/Wagga Wagga airborne survey, ACT and NSW, 1973-1975	5
	Bega/Ulladulla airborne survey, NSW, 1976	7
	Yilgarn Block airborne survey, WA, 1976	8
	Reports on Broken Hill airborne survey, NSW, 1975	8
	Report on Spencer Gulf airborne survey, SA, 1975	8
	Report on Carpentaria basin airborne survey, QLD, 1973-1974	9
	Arunta Block airborne survey, N.T., 1976	9
	Systems development in aircraft VH-BMG and VH-BMR	9
	Airborne reductions and contracts group	10
	ADP development	10
	Data processing	11
	Preliminary maps	11
	Officer Basin	11
	Magnetic map of Australia	11
2.	SEISMIC, GRAVITY, AND MARINE SECTION	11
	SEISMIC SURVEYS	16
	Galilee Basin seismic survey, Qld, 1976	16
	Braidwood seismic test survey, NSW, 1976	17
	Galilee basin seismic survey, Qld, 1975	17
	Pre-Eromanga basins review	19
	Wiso Basin review	20
	Georgina Basin review	21
	Darling Basin review	21
	Long-term seismic program	22
	Gosses Bluff, N.T.	22
	Deep crustal and upper mantle studies	22
	Seismic data processing	23
	Seismic equipment	23

	Page
GRAVITY SURVEYS	23
Galilee basin gravity survey, 1976	23
Galilee basin gravity survey, 1975	24
Gravity survey reporting projects	24
McArthur Basin gravity review	25
Gravity map of Australia	25
MARINE SURVEYS	26
Interpretation and reporting	26
Carnarvon Terrace and Wallaby Plateau project	27
Naturaliste Plateau and Trough project	29
Scott Plateau project	30
Exmouth Plateau project	31
Reviews of island territories	31
Great Australian Bight	32
Bismarck Sea structure	35
Offshore Australia gravity	36
Cuvier Abyssal Plain	37
Co-operative surveys	37
Lamont Observatory co-operation	39
National Mapping co-operation	40
Woods Hole Institution co-operation	41
West German Government co-operation	42
Perth Abyssal Plain - HMS Diamantina	42
Future marine surveys	43
Hardware development	44
Software development	44
Digital acquisition	45
Data processing	46
Archiving	46
Libraries	47
Gravity processing	47
Digital processing and display	50
3. OBSERVATORY AND REGIONAL SECTION	53
OBSERVATORIES SUB-SECTION	53
Headquarters Observatory Group	54
Geomagnetism	55
Seismology	55
Ground action	56
Regional surveys	56
Secular variation	57

	Page
Mundaring Observatory Group	57
Geomagnetism	57
Ionospherics	57
Seismology	57
Stress measurements	58
Port Moresby Observatory Group	58
Standard programs	58
Regional seismology	59
Toolangi Observatory Group	59
Geomagnetism	59
Seismology	60
Antarctic programs	60
REGIONAL SUB-SECTION	60
Regional Gravity Group	60
Gravity compilation	60
Earth tides	62
Calibration of gravity meters	63
Antarctic surveys	63
Gravity map of Australia	64
Gosses Bluff	64
Gravity survey along seismic traverses	64
Mean height map	65
Regional Crustal Surveys Group	65
East Papua survey	65
Quarry blast recording	65
Pilbara crustal survey	67
Melanesia gravity map	67
Computing methods	68
Heat flow	69
Bowen Basin	69
Seismic data processing	70
Seismic recording	70
Earthquake foci	71
Stress measurements	71
4. GEOPHYSICAL SERVICES SECTION	72
ELECTRONICS SUB-SECTION	72
Instrument and Systems Development Group	72
Electronic Maintenance and Testing Group	79

		Page
	MECHANICAL SUB-SECTION	81
	Mechanical Engineering Design Group	81
	Mechanical Instrument Construction Group	83
	Mechanical Maintenance and Testing Group	83
	SERVICES SUB-SECTION	84
	Procurement Group	84
	Rock Measurement Group	84
	Engineering Geophysics Group	85
	ACT surveys	85
	Vibration measurements	86
	Digital seismic system	87
	Kiewa River survey	87
	Christmas Island groundwater	88
	Magneto-tellurics	88
	Geophysical Drawing Office	89
	Ground surveys group	90
	Engineering geophysics group	90
	Metalliferous subsection	90
	Observatories subsection	91
	Regional structural group	91
	Miscellaneous surveys	91
	Airborne surveys group	91
	Compilation	91
	Preliminary releases	92
	Publication	92
	Gravity surveys group	92
	Cartographic group	93
	Automated cartographic group	93
	Map editing, photo services group	94
5.	REPORTS, MAPS, LECTURES, COURSES AND OVERSEAS VISITS	95
	BMR Publications	95
	Bulletins and Reports issued	95
	Bulletins and Reports in preparation or in press	95
	Contributions to BMR Journal	96
	External Publications	97
	BMR Records (an unpublished series)	99

	Page
Records issued	99
Records with Publication and Information Section	101
Records in preparation	103
Addresses to meetings and conferences	108
Overseas visits and conferences	110
Local conferences	110
Training courses	111
External	111
Internal	111
Maps printed and released	113

SUMMARY

Metalliferous and Airborne Section

Financial and staffing problems encountered during the year resulted in the cancellation or delay of a number of major projects programmed for the Section for 1976. In effect, field work remote from Canberra was restricted to the second half of the year. Projects cancelled included ground geophysical surveys in the Alligator River and Cloncurry regions and an airborne geophysical survey of the northern part of the McArthur Basin; projects delayed included the processing and map production of airborne geophysical data for the Darwin/Katherine survey 1975, Duchess survey 1975, and Cootamundra survey 1975. Interpretation of survey results from the Carpentaria Basin South region was also delayed.

The locations of the field activities which could be undertaken by the Section during 1976 are shown in Figure MA1.

The Metalliferous Sub-section continued investigations into the use of geophysical methods in heavy-mineral sand exploration. Work was done at Jerusalem Creek, Stradbroke Island, and Myall Lakes over a variety of heavy-mineral occurrences of different grade and geometry. Preliminary investigations into the feasibility of carrying out marine geophysical surveys for the detection of offshore heavy-mineral deposits are scheduled to complete this year's work.

Only one major ground geophysical survey could be mounted this year in support of Geological Branch projects. This was based on Georgetown, work comprising ground checks of airborne geophysical anomalies to assist a recent interpretation of the FORSAYTH 1:100 000 Sheet area airborne geophysical results, and surveys at Jubilee Plunger and Mt Turner to investigate base metal occurrences of significance in evaluating the mineral resources of the region. Work at Mt Turner was the most intensive and time-consuming. The principal result which emerged was a clear indication of the value of semi-regional induced polarisation surveys to delineate sulphide mineralisation associated with porphyry copper prospects in this region.

Increased emphasis was placed on research into the application of electrical geophysical methods. This included an extensive program of analogue modelling to investigate the application and prospecting capabilities of fixed-source Turam-type down-hole electromagnetic system (DHEM) for off-hole mineral exploration. The findings of this study are in agreement with field survey results obtained in 1975.

Work continued on the application of the transient electromagnetic (TEM) method with specific reference to depth sounding capability.

Members of the Sub-section made a substantial contribution to the 25th International Geological Congress with the presentation of geophysical papers on work dealing with heavy-mineral sand exploration, the application of the TEM method, and results obtained over the Woodlawn orebody.

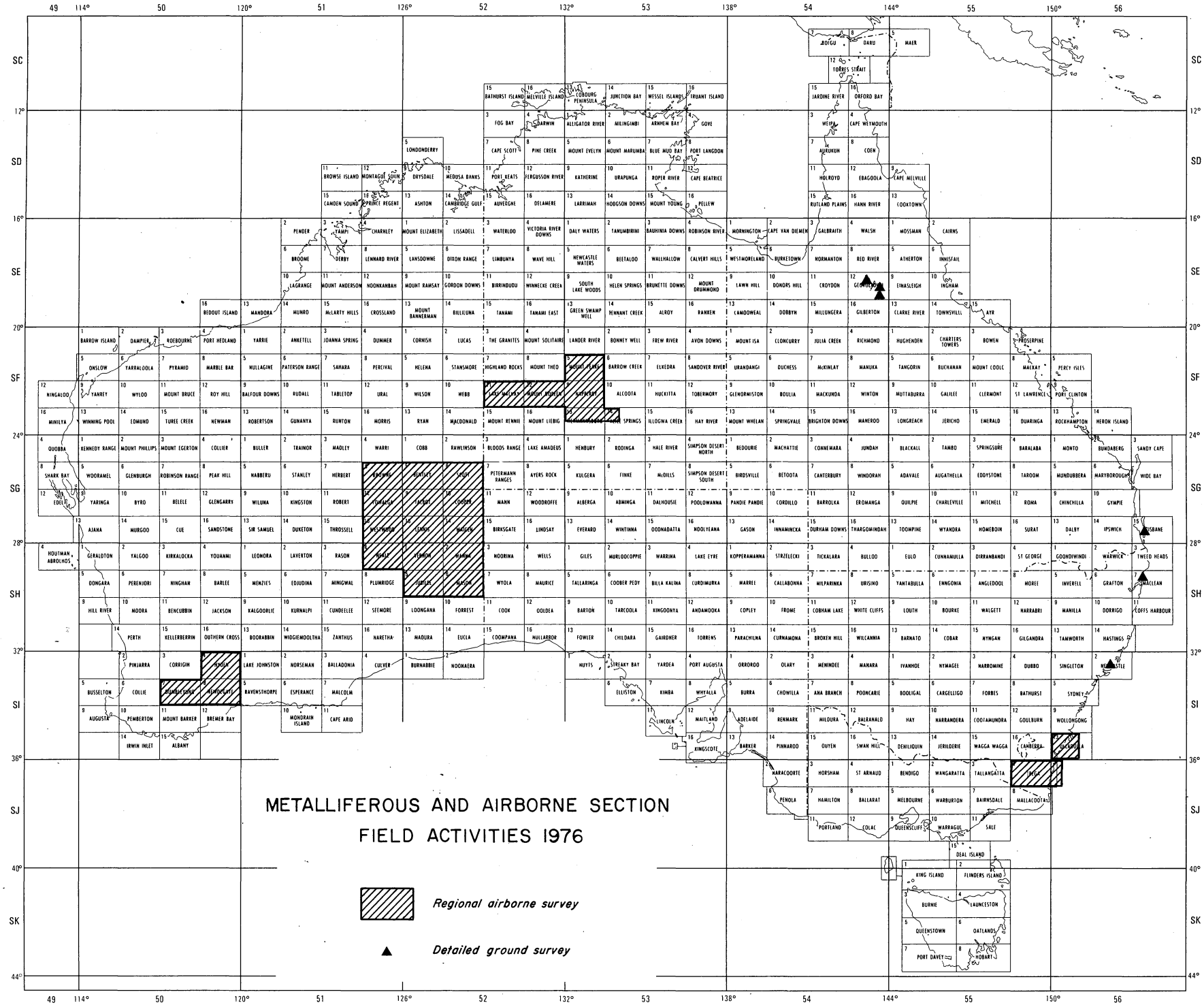
The Bureau's Twin Otter and Aero Commander aircraft were only able to operate without restriction in the second half of the year. Until July 1 only limited work was flown by both aircraft from Canberra over the east coast region. As a consequence, the distance flown in routine magnetic and gamma-ray spectrometer mapping of 1:250 000 map Sheet areas was reduced to 120 000 km this year. A further 25 000 km of magnetic data were recorded early in the year in the form of long line traverses to support the Observatory Group's magnetic secular variation project. The principal use made of the Aero Commander aircraft on this project was to transport staff and equipment between First-order magnetic sites around central and eastern Australia.

As a partial replacement for work proposed in the McArthur Basin region from the commencement to middle part of the survey year (April to mid-July), magnetic surveys were made by both aircraft of the BEGA and ULLADULLA (Pt) 1:250 000 Sheet areas. Data recorded from this project do not command a high priority for processing and as such, total magnetic intensity maps are unlikely to be available for release before 1979.

The 1976 field survey season commenced in mid-July in the Arunta Block of central Australia. Both aircraft were used on this project, the Twin Otter surveying the MOUNT PEAKE, NAPPERBY, and northern half of HERMANNSBURG 1:250 000 Sheet areas plus the BURT 1:100 000 Sheet area. The Aero Commander was used in the surveying of LAKE MACKAY and MOUNT DOREEN 1:250 000 Sheet areas. About 60 000 km were flown, both aircraft having similar geophysical equipment configurations involving fluxgate magnetometer, gamma-ray spectrometer, and digital data recording facilities. Results of this work are expected to become available by mid-1977.

In the October-November period both aircraft again combined to undertake a survey of the HYDEN, DUMBLEYUNG, AND NEWDEGATE 1:250 000 Sheet areas.

Contractural work continued throughout the year on the major aeromagnetic survey of the Western Australian portion of the Officer Basin which covers sixteen 1:250 000 Sheet areas. Magnetic contours for the first two Sheets flown, ROBERT and THROSSELL, are expected to be released this year. 90 000 km of surveying are expected to be completed this year leaving 30 000 km to be flown in early 1977.



(BASED ON A/BO-53-1A)

The Airborne Reductions and Contracts Group completed its work on the aeromagnetic component of the Magnetic Map of Australia, the map being published in August. Owing to financial and staffing problems previously mentioned, the group could not maintain as high a rate of data processing during 1976 as that achieved last year. Work commenced on 15 map areas and was completed on 9. Nevertheless the group, in association with the Airborne Drafting Office, was responsible for the release of 156 maps relating to 22 map areas during 1976.

2. Seismic, Gravity, and Marine Section

BMR purchased a new DFSIV seismic digital recording system for use on future surveys. This equipment was field-tested at Braidwood NSW after a course on the theory and operation of the system was given to a number of geophysicists and technical officers. The DFSIV equipment performed satisfactory and was used from July to November on a seismic survey to investigate the nature of the eastern margin of the Galilee Basin and the extent of possible Lower Devonian sediments north of the Adavale Basin.

The review of previous knowledge of older sediments benath the northern Eromanga Basin, basic data from well logs, and seismic, gravity, and aeromagnetic surveys was continued. Shot-point location maps were digitized and composite maps were prepared for all seismic surveys in the northern and central Eromanga Basin to form the network for a data base for further geophysical studies.

Following the seismic survey in the Lovelle Depression in the Galilee Basin in 1975, the results have been analysed in conjunction with a reassessment of previous petroleum exploration results from the surrounding area. The Permian sediments in the Lovelle Depression are more widespread than previously determined and although the seismic results did not define the southern margin of the Permian it is concluded that no direct link exists between the Galilee and Cooper Basins in the area but that Permian sediments may exist in a minor sub-basin in the area.

Distribution of the BMR Record on possible future seismic program resulted in a number of State Mines Departments and petroleum exploration companies offering comments and proposals for high-priority seismic work by BMR to assist in upgrading petroleum prospects in a number of basins. These proposals are being examined in detail, together with other proposals from within BMR, to formulate future programs for seismic surveys.

The Gravity Group was engaged mainly in compiling, plotting, and checking gravity land and marine data for the 1:5 m Gravity Map of Australia produced to coincide with the IGC, Sydney. Other work in the group was mainly on the interpretation

and reporting of previous work, making gravity measurements in conjunction with the seismic survey in the Galilee Basin, and reviewing regional gravity information for future surveys in the McArthur Basin.

The Marine Group worked mainly on the assessment and processing of data, and the interpretation and reporting of results from the Continental Margin Survey, 1970-73. The group also participated in cooperative marine surveys, mainly with American Institutions, and made preliminary preparations for future BMR marine surveys.

Data processing was hampered throughout much of the year by shortages of computing funds and problems with the performance of the CYBER 76 computer. Processing staff documented and improved the efficiency of programs which are frequently used, reorganized marine processing program libraries, and improved computer programs used in seismic interpretation. Progress was also made in archival storage of preliminary data tapes from the early stages of processing when gross errors were removed from the data, with processing of the navigation data integrating satellite and sonar doppler information, and with reprocessing of gravity data to eliminate spurious short-wavelength oscillations.

Interpretation of data from the Continental Margin Survey, supplemented with data from petroleum exploration companies and oceanographic institutions continued during the year. The major effort was made on interpretation reports on the Carnarvon Terrace, Wallaby Plateau, Naturaliste Plateau, Exmouth Plateau, and Cuvier Abyssal Plain. Records were prepared reviewing geophysical results over the Great Australian Bight, the Bismarck Sea, the Lord Howe Rise, and the sea-bed surrounding most of Australia's island territories. Several broad reviews and special interpretation projects were also made. These included a discussion of the continental slope and shelf of Australia presented at the IGC Sydney; a regional analysis of Australia's offshore gravity field reported in the BMR Journal; and a comparative study of 2-D structural models based on gravity results across plateaux of the western margin.

Cooperative projects with Lamont Doherty Geological Observatory and Woods Hole Oceanographic Institution in carrying out the marine geophysical surveys in the Australian region were successful. The Lamont survey comprised four cruises, one each over the Naturaliste Fracture Zone and the Magnetic Quiet Zone south of Australia and two over the Southeast Indian Ridge. Geophysicists from the Marine Group assisted in each cruise and J.C. Mutter visited the Lamont headquarters in New York from April to October 1976 to interpret the results from the work over the Magnetic Quiet Zone. The Woods Hole survey comprised two cruises, in and around the Banda Sea, and one over the Argo and

Gascoyne Abyssal Plains and over the Java Trench. A marine geophysicist and explosives expert from BMR participated in the first and a geophysicist in the second project.

Arrangements are being made for BMR to co-operate in surveys proposed by Lamont and the West German Government. In co-operation with the Royal Australian Navy, magnetic field measurements were made aboard HMAS Diamantina over the Perth Abyssal Plain and preparations were made to make further magnetic measurements aboard vessels used by the Division of National Mapping for bathymetric surveys.

Preparations for future BMR marine surveys continued during the year. The development of a new data acquisition system (DAS) progressed and draft tender specifications for contract marine surveys were prepared together with proposals for survey priorities.

3. Observatories and Regional Section

The Section comprises two sub-sections - Observatories, with Headquarters Group at Canberra, and geophysical observatories at Mundaring, Port Moresby, Toolangi, Mawson, and Macquarie Island; and Regional, with Gravity and Structural Survey Groups.

A wide-band three-component borehole seismograph was installed at Narrogin (W.A.) by U.S. Geological Survey and is operated by Mundaring Geophysical Observatory. A vertical seismograph was installed on Christmas Island in the Indian Ocean.

Negotiations continued for the transfer of the Port Moresby Geophysical Observatory to the Papua New Guinea Government. New observatory buildings at East Kowen (near Canberra) and the proposed transfer of Toolangi Magnetic Observatory were deferred because of curtailment of funds.

Contracts were made with Universities of Adelaide and Queensland for supply of seismological data from their networks.

Other observatory recordings continued as in 1975 and strong-motion recorders were operated. Data analysis, in particular final computation of the backlog of magnetic mean hourly values, was delayed because of lack of funds for computing. Magnetic absolute instruments were intercompared, internally and internationally, to improve the Australian magnetic standards.

The re-occupation of first-order regional magnetic stations for study of secular variation was completed; analysis shows an anomalous pattern in Western Australia. Several long aeromagnetic profiles were recorded on flights between the first-order stations and are being analysed in relation to geology. Fourteen regional magnetic observations were made in Enderby Land (Antarctica) in a highly successful summer expedition.

A magnetic recorder was set up at Omeo (Vic) to record the effects of the total eclipse in conjunction with observatory instruments at Toolangi, Kowen Forest (ACT), and Hobart.

A coloured Gravity Map of Australia at a scale of 1:5 M was published and distributed at the International Geological Congress in Sydney. A preliminary version of a Gravity Map of Melanesia at the same scale was also produced. Further old surveys were recomputed by contract and added into the magnetic tape data bank. Several papers relating to the gravity map will be published in the BMR Journal.

The tidal tiltmeters at Cooney were lent to University of New England from July; the results up till then are being analysed by BMR. The tidal gravity recording project in co-operation with Profs Melchior (Belgium) and Hather (University of NSW) was nearly completed; one meter will continue to record at Alice Springs for several months.

Several gravity meters were calibrated on a tilting table on loan from USSR; results show a systematic difference from hillside calibrations.

Further gravity measurements were made in Enderby Land, Antarctica, and previous measurements were analysed.

Preparation of a mean height map of Australia was begun, for use in isostatic and geodetic studies.

A seismic crustal profile was measured along an east-west line from Bass Point to Adlethan in southern NSW using quarry blasts as energy sources. Seismic recording equipment was modified to facilitate field operation, and development of play-back equipment continued. Interpretative programs were developed and modified.

Data on Australian heat flow and hot springs were collated to formulate a program in geothermal studies; a start was made with temperature logging of bores in the Canning Basin and assembling equipment for thermal conductivity measurements of bore cores.

Stress measurements in Australia were reviewed, and stress was measured at several points near the epicentre of the 1968 Meckering earthquake. East-west compression appears to be the dominant pattern in Australia.

A catalogue of earthquake focal mechanisms for the western Pacific region was compiled for the International Geo-dynamics Project.

Interpretation and reporting continued on previous projects, including New Britain, east Papua, and Bowen Basin crustal surveys, Trans-Australia seismic survey, and gravity surveys at Gosses Bluff (NT) and Prince Charles Mountains/Lambert Glacier (Antarctica). In east Papua, gravity and seismic data are consistent with a northeasterly-dipping ophiolite sequence cropping out at the Papuan Ultramafic Belt. A major structural break is suggested in the Lambert Glacier region.

4. Geophysical Services Section

The Section comprises three Sub-sections: Electronics, Mechanical, and Services. The Electronics and Mechanical Sub-sections are concerned primarily with equipment development, construction, and maintenance; the Services Sub-section covers procurement and utilization of equipment, measurements of physical properties of rocks, engineering geophysics, and geophysical drafting.

Digital data acquisition systems constituted much of the work-load of the Electronic Subsection. These included additions and modifications to both geophysical survey aircraft systems which are now being documented, system design and components for a marine data acquisition system being assembled for the next major survey, an engineering seismic and magneto-telluric system and several systems for regional magnetic and observatory applications. A major task in the preparations for field surveys was the assembly of special instrumentation for a geophysical groundwater survey on Christmas Island.

The Mechanical Sub-section expects to complete a trailer-mounted borehole pump test unit for the Engineering Geology Group by the end of 1976, and is well advanced on modifications to the winch control system of BMR's 3000-metre bore-logging vehicle. Significant advances were made on the theory and development of sparker energy sources and work commenced on an experimental compact multi-electrode source. Instrument racks, bins, and panels were built in support of electronic instrumentation projects, and many instruments and items of equipment were repaired and serviced for field and laboratory use.

In the Services Sub-section, the Engineering Geophysics Group carried out a major groundwater survey on Christmas Island, and initial indications are that a large zone of low resistivity, which is a potential acquifer, probably exists in the central core of the island at economically accessible depths. At Albury-Wodonga resistivity techniques were used to locate further sand and gravel reserves. In the ACT, the investigation of two Tennent dam sites is a major investigation that will continue into 1977. Surveys were carried out on 13 reservoir sites, several building

and refuse disposal sites, and along the Googong pipeline and along several sewer lines. Measurements carried out at an ammunition depot and demolition range near Kingswood, NSW, for the Department of Defence showed that ground vibrations due to bomb demolitions were within safety standards.

A joint magneto-telluric survey in the northeast Officer Basin in South Australia was carried out in co-operation with the S.A. Mines Department and Macquarie University. Twelve sites were occupied in an investigation of the suspected Musgrave Block overthrust. The top of the overthrust and its lateral extent can be resolved, the existence of sediments below the overthrust can be deduced, and the effect of basement below the sediments can be seen. However a quantitative interpretation cannot be made until two-dimensional modelling techniques, which have been developed to an advanced stage during the year, are used on the data.

The Rock Measurements Group made measurements of physical properties such as rock magnetisation, electrical conductivity, sonic velocities, and elastic parameters on over 300 rock and sediment samples in support of BMR projects. Palaeomagnetic techniques were used successfully in age determinations of deep weathering profiles in the Eromanga Basin, and in the sand dune sequence of southeast South Australia. A program in magneto-stratigraphy to aid in age correlation studies in BMR was started. Work began on the assembly of laboratory equipment for the measurement of heat conductivity of rock samples.

The Geophysical Drafting Office completed drafting the Magnetic Map of Australia and the Gravity Map of Australia and these two maps were printed and available at IGC, together with a preliminary issue of the Gravity Map of Melanesia. Nine hundred and fifty plates of geophysical survey results were prepared for BMR Records and other publication series. Thirteen aeromagnetic maps were printed. In addition, 111 miscellaneous drawings were completed and 199 lecture slides prepared. One hundred and thirty-one preliminary maps of airborne survey results were issued and pre-survey compilation of eleven 1:250 000 Sheet areas completed. Ten maps of total magnetic intensity contours at 1:1 000 000 scale, and flight-path recovery of nine 1:250 000 Sheet areas were completed. Amendments and additions were carried out on 912 drawings. The Automated Cartography group produced 311 maps, contours, profiles, and other plots on the flat-bed plotter and 3225 plots on the drum plotter. A second Draftsman Grade 2 was transferred permanently to the group in June, and the Supervising Draftsman worked with the ADP and Marine groups for four months on programming and cartographic techniques.

1. METALLIFEROUS AND AIRBORNE SECTION

by G.A. Young

The Section comprises two Subsections: Metalliferous and Airborne. The Metalliferous Subsection is concerned with providing ground 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 Subsection 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 assessment of mineral potential.

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

Heavy-mineral sand deposits (N. Sampath, B. Spies, P. Wilkes, H. Reith)

Investigation of the use of geophysical methods in heavy-mineral sand exploration continued in 1976. Work undertaken or to be undertaken this year included the processing and evaluation of an airborne geophysical survey in the Evans Head area, and ground geophysical surveys at Jerusalem Creek, Stradbroke Island, and in the Myall Lakes area.

The Evans Head airborne geophysical survey was made in November 1975 and covered a large area of coastal plain north and south of the Evans Head township (Fig. MA2). The survey used magnetic and gamma spectrometry methods and was flown at an altitude of 100 m and a line spacing of 400 m. The results of the airborne magnetic survey show a positive magnetic gradient to the south and east of about 3 to 5 nT per km. The sources of all magnetic features are deep, and there is no indication of magnetic sources within or at the base of the beach system. Evaluation of the airborne radiometric survey is still continuing; however, a preliminary assessment of the data shows a few large and some small radiometric anomalies superimposed on a low background of less than 0.5 microroentgens per hour. Thorium anomalies with a radioactivity intensity of up to 4 microroentgens per hour were recorded over heavy-mineral stockpiles and smaller anomalies were observed over mining sites and along some sand ridges. The results indicate that the heavy-mineral deposits at Jerusalem Creek are radioactive but easily masked by overburden. The small anomalies recorded along sand ridges might reflect local increases in heavy-mineral concentrations.

At Jerusalem Creek located 15 km south of Evans Head, ground surveys were made to follow up the Sub-section's 1975 work which indicated that induced polarization and gamma radiation methods might be used to search for heavy-mineral sand deposits. The 1976 surveys were made in the period September 6 to October 22 and used induced polarization (electrical and magnetic), self potential, gamma spectrometry, and magnetic methods along long traverses which crossed a zone containing a number of heavy-mineral deposits of various grades. Station intervals of 50 m were used and the work was aimed at evaluating the effectiveness of the various geophysical methods as reconnaissance exploration tools. The results of the surveys have not been fully assessed, but it appears that none of the methods are suitable for the reconnaissance exploration of buried heavy-mineral deposits in this area. Detailed induced polarization surveys proved to be effective in defining heavy-mineral occurrences over small areas.

At Stradbroke Island, work commenced on October 25 and will comprise induced polarization, gamma spectrometry, and magnetic surveys. These surveys were designed to investigate a variety of deposits including some which lie beneath a shallow cover of sea water. The results of this work will be used to establish the response of heavy-mineral deposits of a different type and geometry to those at Jerusalem Creek and to investigate the possibility of marine geophysical surveys for offshore heavy-mineral deposits.

The work proposed in the Myall Lakes area will further expand the range of deposit types investigated by geophysical surveys.

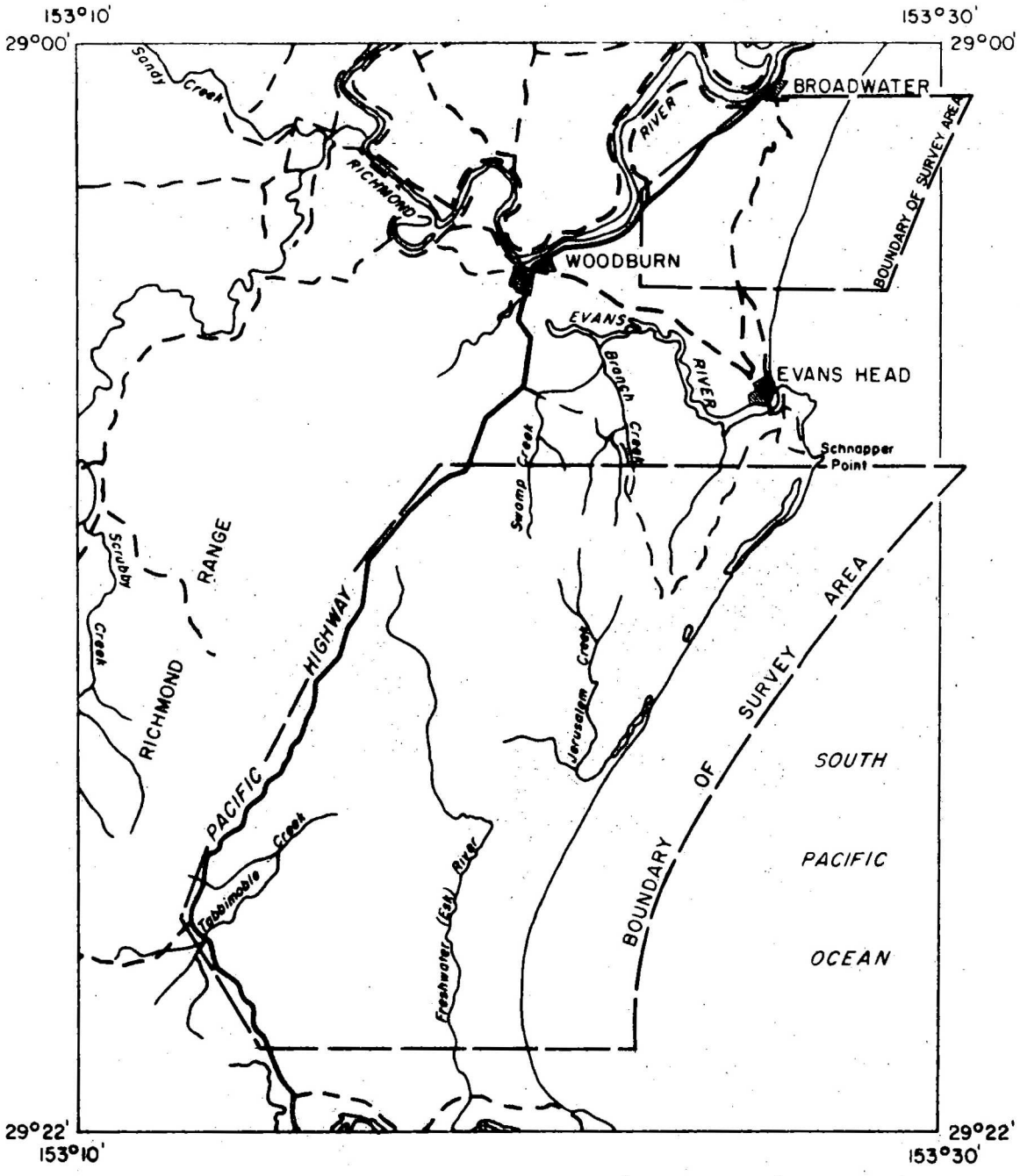
Georgetown Area, Qld (J. Major, P. Wilkes, D. Robson, D. Wilson, J. Pittar)

In early 1976 a detailed interpretation of the 1973 BMR Georgetown airborne geophysical results restricted to the FORSAYTH 1:100 000 Sheet area was made. In the period 26 July to 22 October ground observations were made over selected airborne geophysical anomalies to check office interpretation. In addition, ground geophysical surveys were made at Jubilee Plunger and Mt Turner to investigate base metal prospects of significance in evaluating the mineral resources of the region. The location of the various survey areas is shown on Figure MA3.

Interpretation of FORSAYTH* Sheet airborne data

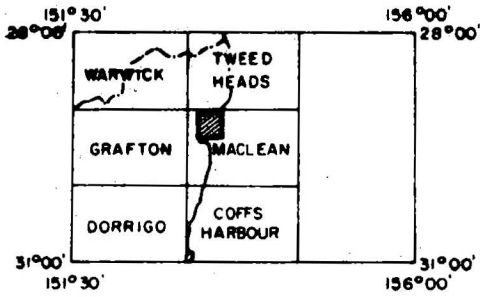
The interpretation of the 1973 BMR airborne geophysical coverage of the FORSAYTH 1:100 000 Sheet area was made to assist geological mapping and to investigate survey parameters for any future airborne geophysical work in the Georgetown area.

*Sheet areas are in capital letters to distinguish then from ordinary place names.



LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES



AIRBORNE SURVEY, EVANS HEAD, NSW 1975
BEACH SANDS PROJECT

LOCALITY MAP

5 0 5 10 15 KILOMETRES

Record No. 1976/91

H56/BI-17-1A

Aeromagnetic results The aeromagnetic results are complex but the major rock types in the area can be identified by characteristic levels and patterns of magnetic induction. In detail, the available data provide little additional information to assist 1:100 000 scale geological mapping. Because of the regional nature of the airborne survey, the data are not suitable for a detailed interpretation of most magnetic patterns generated by complex sources, the location of rock boundaries, and magnetic anomaly trends which might be associated with zones of mineralisation. Nevertheless to assess and optimise interpretation carried out in the office a program of ground work was designed to investigate key anomalies.

Aeroradiometric results The aeroradiometric results consist of four-channel gamma spectrometer data which were obtained without height control. Interpretation was made with a view to identifying broad and localized changes in radioelement concentrations. The results of the survey show that the Forsayth Granite has a high radioactivity which is principally due to potassium. Most of the survey area has a low radioactivity, but part of the Einasleigh Metamorphics 45 km southeast of Forsayth exhibits a fairly high radioactivity which is predominantly due to thorium daughters. No outstanding small source anomalies were observed and the results do not show any radioactive sources which are enriched in uranium.

Ground follow-up The locations of the ground surveys conducted in the follow up of the airborne geophysical interpretation are shown in Figure MA3. These surveys comprised gamma spectrometer and/or magnetic traverses, rock sampling, and geological mapping. Analyses of this work is in progress; however, it appears that clear understandings of the airborne geophysical anomalies investigated will be possible in only a few cases.

Jubilee Plunger At Jubilee Plunger, IP, magnetic, gravity, and TEM surveys were made to investigate the regional setting and the extent of the base metal mineralisation intersected by BMR diamond drilling in 1975. The regional setting of the prospect was investigated by east-west IP, magnetic, and gravity traverses up to 2 km in length. The results of the regional IP and magnetic traverses show several weak northeast-trending chargeable and magnetic zones which may indicate fracture or shear zones within the Robin Hood Granodiorite. One of these zones contains the Jubilee-Plunger prospect. The extent of mineralisation at the Jubilee-Plunger prospect was investigated by detailed IP, magnetic, gravity, and TEM surveys. Only the IP method indicated the presence of the base metal mineralisation. The absence of associated gravity or TEM anomalies indicates that the extent of massive sulphide mineralisation is small.

Mt Turner At Mt Turner, a program of resistivity and IP depth soundings, drilling, and down-hole geophysical logging, magnetics, and gamma spectrometry was carried out to assist in the mapping of porphyry copper type mineralisation and to establish what geophysical techniques might be useful in the exploration and evaluation of similar prospects in this region.

Resistivity and IP surveys: The resistivity and IP depth soundings used the Schlumberger array and were made on a 1 km x 1 km grid which covered an area of over 50 km^2 centred on the Mt Turner prospect. The soundings provide a three-dimensional picture of the chargeability and resistivity throughout the area. The zone of alteration and pyritisation is clearly defined by an area of high chargeability and low resistivity. Small-scale affects observed in the sounding curves may provide further information on the geometry and alteration zoning of the prospect. Figure MA3 shows most of the sounding sites, the chargeability measured at an AB/2 spacing of 400 m and the surface expression of the alteration.

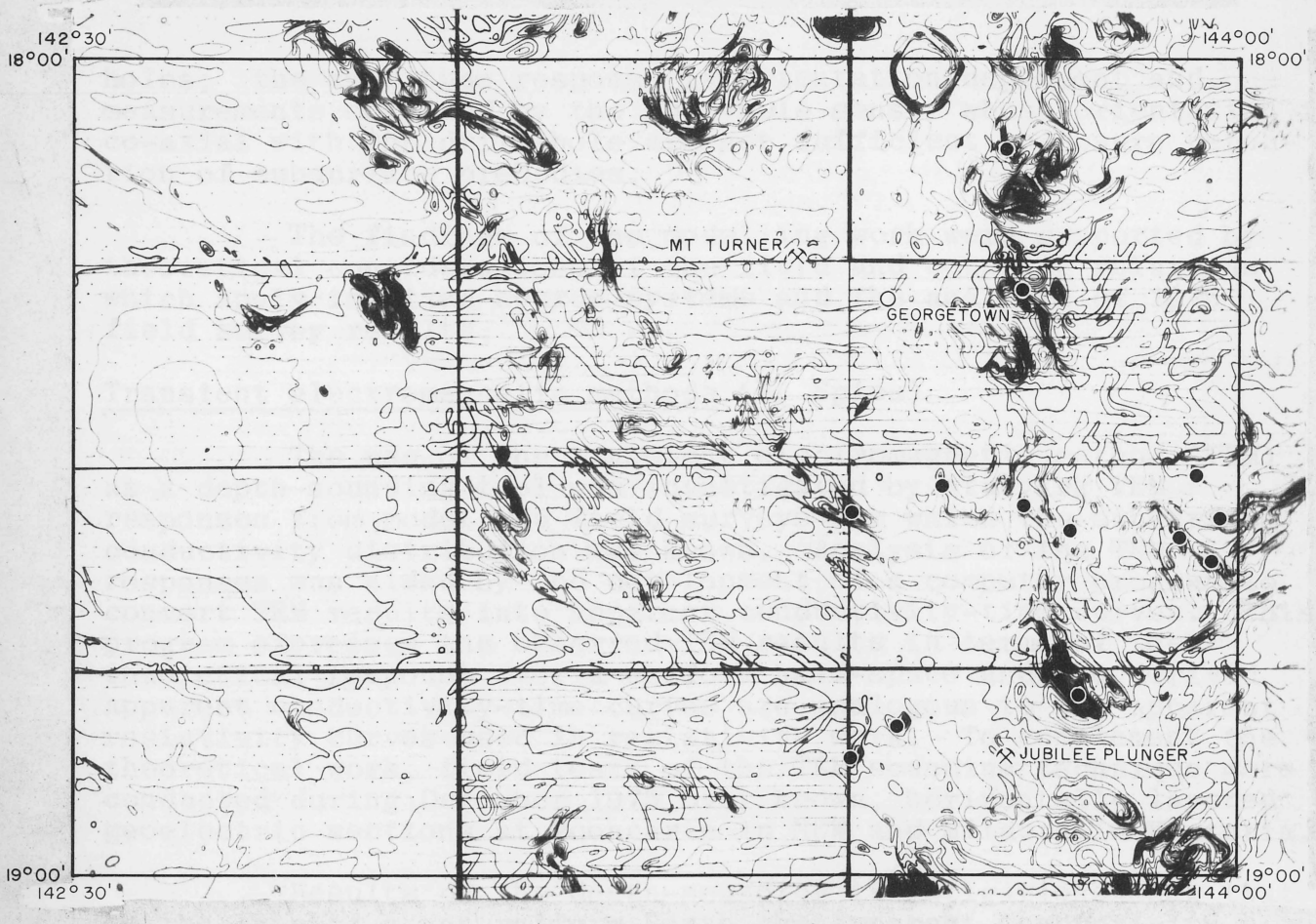
Spectrometer and magnetic surveys: Spectrometer and magnetic surveys were made throughout the area to establish possible patterns in the distribution of K, U, Th, and magnetite. The results of the magnetic and spectrometer work are not encouraging; nevertheless, analyses are continuing.

Down-hole electromagnetic investigations (R. Ogilvy)

The valuation of down-hole electromagnetic (DHEM) methods for off-hole mineral exploration was continued in 1976. This year work concentrated on assessing the applications and prospecting capabilities of fixed-source Turam-type DHEM systems. A literature search was continued, a re-evaluation was made of DHEM field surveys conducted by BMR in 1975, and analogue model studies were carried out in conjunction with the Mineral Research Laboratories of the CSIRO in the period 6 September to 22 October.

The analogue modelling was carried out jointly by BMR and CSIRO personnel and used the model tank facility of the CSIRO Mineral Research Laboratories at North Ryde, Sydney. This study of the fixed source system was designed to investigate detection capabilities, provide an analytical basis for quantitative interpretation of anomalies, and indicate avenues for equipment development. A total of 450 model cases was obtained using various combinations of primary loop size, excitation frequency, and target conductivity and geometry. Analysis of the results of the model work is in progress but preliminary observations are: the search radius of fixed-source systems appears to be of the order of 30-60 m depending on frequency, loop size, target and host rock conductivity and ambient noise level; there is no 'a priori' reason why fixed-source DHEM systems cannot be used in deep drill-

GEORGETOWN

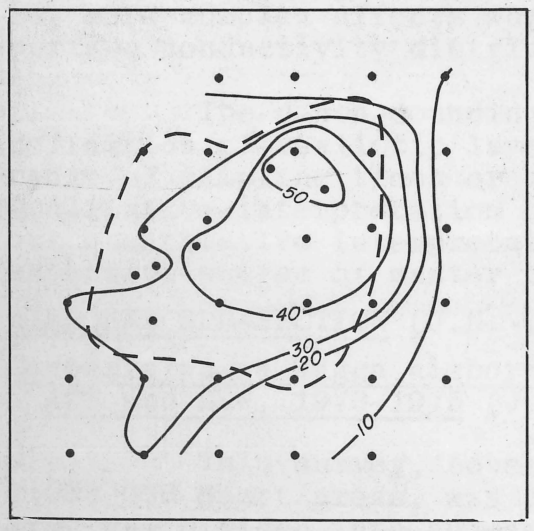


LOCALITY MAP

AND AEROMAGNETIC CONTOURS (CONTOUR INTERVAL 50nT)

10 0 10 20 30 40 50km

● Site of ground follow-up of airborne geophysical data



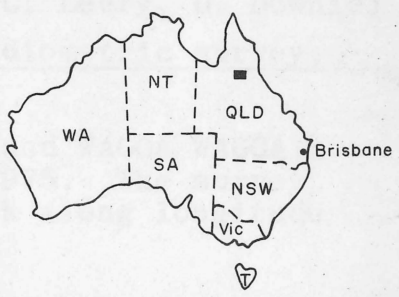
MOUNT TURNER AREA

1 0 1 2 3km

LEGEND

- IP Depth sounding site
- —30— Chargeability contour (ms)
- — — Approximate boundary of pervasive alteration zone

LOCATION DIAGRAM



GEOPHYSICAL SURVEY, GEORGETOWN, QLD 1976

Record No. 1976/91

holes; the amplitude response is orientation-dependent and measurements obtained by the down-hole sensor whose orientation is co-axial with the drill-hole are not sufficient to ensure detection of subsurface orebodies.

The findings of the modelling work were supported by theoretical considerations of the field and coupling relations which apply in fixed-source systems and the analysis of 1975 field survey results.

Transient electromagnetic methods (B. Spies)

The use of the transient electromagnetic method (TEM) as a depth-sounding tool was investigated by studying TEM responses from model and field surveys for which the subsurface conductivity distribution was known. Analysis of the TEM responses was aided by the development of a computer program to convert TEM results into apparent conductivity-time curves. This program expresses the observed TEM results in terms of the theoretical response over a uniform half-space and the derived apparent conductivity-time curves are analogous to the apparent resistivity curves used in resistivity work. To complement the theoretical work, field tests of the TEM sounding technique were conducted during December 1975 over known, horizontally layered geoelectric sections at Pooncarie in NSW and Mildura in Victoria.

Results of the depth-sounding investigations show that in the case of a non-uniform Earth the apparent conductivity changes with sample time in a fairly predictable manner even though the changes are often complicated by interactions between conductors. For horizontally layered ground the variation of apparent conductivity with sample time depends on the loop size and on the depth, thickness, and conductivity of the layers. The top layer affects the apparent conductivity at early sample times and the influence of deeper layers on the apparent conductivity curve is observed at successively later sample times. Similar, but more complex affects were observed for the more complex subsurface conductivity distributions.

The depth-sounding investigations indicate that adequate definition of realistic layered structures may require a wide range of sampling times or alternatively a range of loop sizes. Qualitative interpretation of sounding curves is fairly simple but quantitative interpretation will require the preparation of extensive suites of master curves.

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

Canberra/Wagga Wagga airborne magnetic and radiometric survey, ACT and NSW, 1973-1975 (J.W. Giddings)

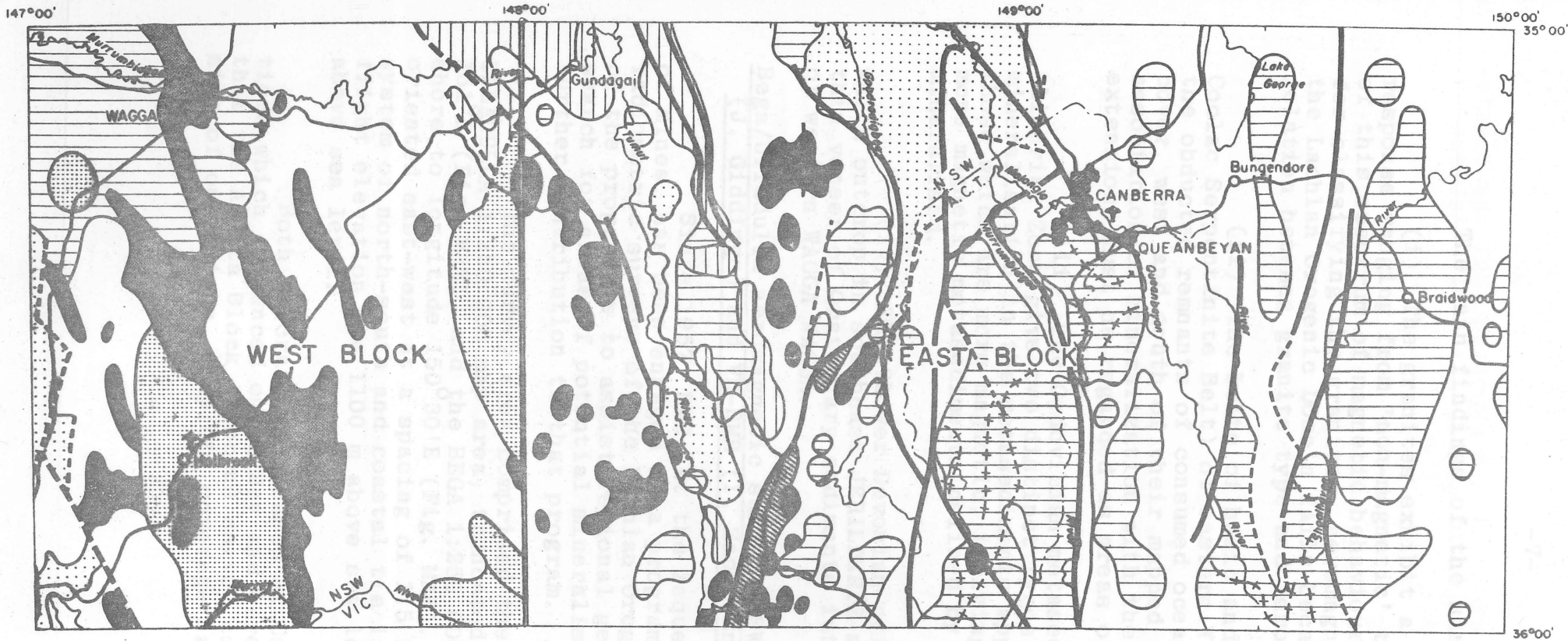
This survey, covering the CANBERRA and WAGGA WAGGA 1:250 000 Sheet areas, was completed in May 1975. The survey area was divided into an east and a west block along longitude

148°E. Flight lines were oriented east-west at a spacing of 1.5 km. Flight altitude over the east block was a nominal 1750 m above mean sea level; over the west block, a nominal 150 m above ground level. Radiometric data (4 channels - Total Count, Potassium, Uranium, and Thorium) were recorded for the west block only. Contour maps of the total magnetic intensity, the flight-line system, and stacked profiles of the radio-altimeter data and individual channels of the radiometric data, at a scale of 1:250 000, were released through the Australian Government Printer between September 1975 and March 1976.

Interpretation of the survey, which was completed in October 1976, is displayed in Figure MA4. Zones have been delineated on the basis of geophysical and geological criteria. Some features recognized over the west block cannot be resolved over the east block because of the higher flight altitude. This is responsible for the discontinuity in interpretation along longitude 148°E. Overall, the aeromagnetic data correlate well with the known geology. Over much of the west block, the magnetic field is generally only weakly disturbed, anomalies rarely exceeding 100 nT, whereas over the east block the field is considerably more disturbed with regional scale and short-wa-elength anomaly amplitudes frequently in the range 100 nT - 500 nT. The correlations suggested by the magnetic interpretation are summarized below:

West Block		East Block
Zone	Interpreted Source	Zone
A_w	Granite	A_e
B_w	Granite	
C_w	Mainly Metasediments	
D_w	Metasediments	
E_w	Acid to intermediate volcanics	E_e
F_w	Intermediate to basic intrusives/extrusives	F_e
G_w	Basic to ultrabasic rocks	G_e
	Intermediate to basic volcanics	H_e

WAGGA WAGGA – CANBERRA



LOCATION DIAGRAM

AIRBORNE SURVEY
WAGGA WAGGA–CANBERRA, NSW–A.C.T. 1973
MAGNETIC INTERPRETATION

KILOMETRES 20 0 20 40 60 KILOMETRES

LEGEND

WEST BLOCK: A_W, B_W, C_W, D_W, E_W, F_W, G_W

EAST BLOCK: A_E, E_E, F_E, G_E, H_E

Geologically mapped fault

Interpreted fault

Interpreted (probable) fault

Phase boundary (granites)

The main findings of the survey are:

(i) The granites exhibit a wide spectrum of magnetic response ranging from 'non-magnetic' to strongly magnetic. Use of this spectrum of magnetic behaviour as the basis of a method for classifying the granites, aeromagnetically, in other parts of the Lachlan Orogenic Domain fails because of the unsystematic relation between granite type and aeromagnetic response.

(ii) The belts of basic and ultrabasic rocks (e.g. Coolac Serpentinite Belt) of eastern WAGGA WAGGA, representing the obducted remnants of consumed ocean floor, extend beneath cover, west and south of their mapped outcrop. In view of the association of mineralization with the serpentinites, those extensions must be regarded as areas of potential mineralisation.

(iii) The Ordovician metasediments of the Wagga Anticlinorial Zone give two distinct types of magnetic response. Tin mineralisation in the metasediments appears to be concentrated in those which are more magnetic, implying that other large areas of more magnetic metasediments defined by the survey may be similarly mineralised.

(iv) The ?Lower Devonian acid to intermediate volcanics which outcrop in southeast JERILDERIE seem to extend beneath a thin veneer of Quaternary sediments into the Henty-Culcairn area of western WAGGA WAGGA.

Bega/Ulladulla aeromagnetic survey, NSW, 1976: VH-BMG (J. Giddings) and VH-BMR (I. Zadoroznyj)

Since 1957, BMR, at the request of the NSW Department of Mines, has been engaged in a program of airborne magnetic and radiometric surveys of the Lachlan Orogenic Domain. The purpose of the program is to assist regional geological mapping and the search for areas of potential mineralisation. This survey is a further contribution to that program.

The survey area comprised the western two-thirds of the ULLADULLA 1:250 000 map area, truncated offshore at longitude 151°E (Fig. MA5), and the BEGA 1:250 000 map area, extended offshore to longitude 150°30'E (Fig. MA6). Survey lines were oriented east-west at a spacing of 1.5 km and were crossed by a system of north-south and coastal tie lines. Over ULLADULLA, flight elevation was 1100 m above sea level: over BEGA, 1650 m above sea level.

Both aircraft were based at Canberra for survey operations which commenced on 11 May and were suspended on 13 July so that the Arunta Block Airborne survey could commence. At suspension of operations, complete coverage had been obtained of

ULLADULLA and about 85% of BEGA. It is expected that the remaining 15% of BEGA will be flown in December, after the airborne survey of Yilgarn Block, W.A.

Owing to a backlog in the processing of airborne survey data the contour maps of the total magnetic intensity will not be available for erelease until 1979.

This was the first survey to make use of an improved doppler navigation system in the Twin Otter which was recently developed by BMR to reduce navigation errors caused by sea drift when flying offshore. The results were most satisfactory.

Yilgarn Block, airborne magnetic and radiometric survey, W.A. 1976, VH-BMG and VH-BMR (D. Downie, K. Horsfall, I. Zadoroznyj, R. Curtis-Nuthall, J. Eurell, K. Mort, L. Miller, S.J. Wilcox)

This survey was made at the request of the W.A. Geological Survey to support its geological mapping program in the southwest of the State. The survey area comprised the 1:250 000 Sheet areas of HYDEN, DUBLEYUNG, and NEWDEGATE (Fig. MA7).

Both aircraft were based at Narrogin. Survey operations began in early October and continued until early December. The aircraft were flown at a nominal ground clearance of 150 m along east-west flight lines spaced at an interval of 1.5 km. Both aircraft were equipped with a fluxgate magnetometer gamma-ray spectrometer and radioaltimeter, the data collected being digitally recorded. It is expected that the preliminary survey data will be released late in 1977.

Reports on Broken Hill regional and detailed airborne geophysical survey, 1975 (B. Wyatt)

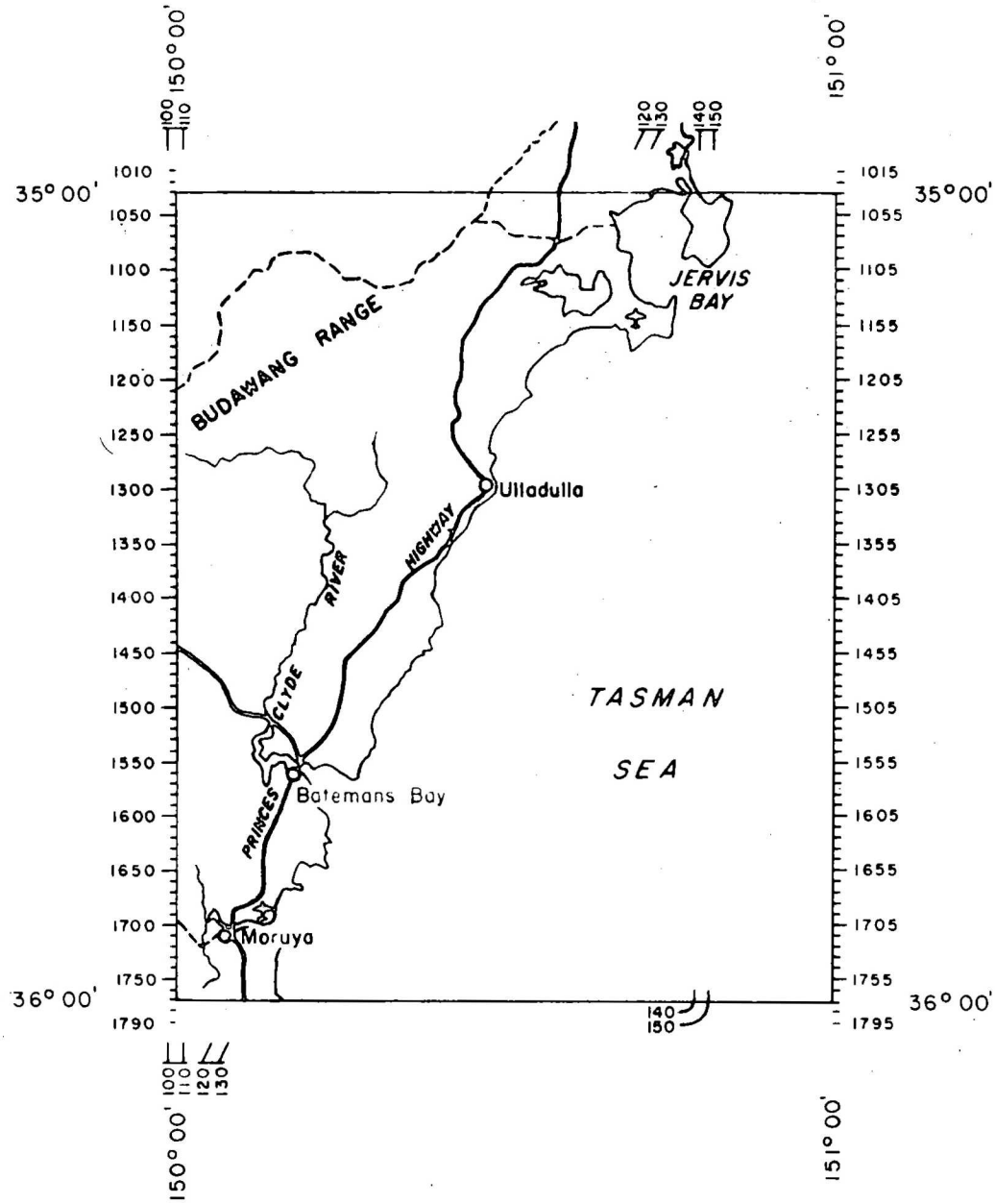
Processing of both regional and detailed surveys was completed and preliminary maps were released early in 1976. Operational reports describing data acquisition and processing are in preparation.

Interpretation of survey results is in progress. BMR is concentrating on gamma spectrometer data analysis and NSW Geological Survey on the interpretation of the magnetic data (Figs. MA11-14).

Report on the Spencer Gulf airborne magnetic and radiometric survey, S.A., 1975 (K. Horsfall)

This survey, which was flown in 1975, covered the 1:250 000 Sheet areas of PORT AUGUSTA, WHYALLA, MAITLAND (part), and LINCOLN (part). The preliminary data were released in June 1976 (Figs MA 16 to 29).

An operational report, describing the mode of data acquisition and processing was prepared and will be released early in 1977.



AIRBORNE SURVEY, ULLADULLA, NSW 1976

LOCALITY MAP

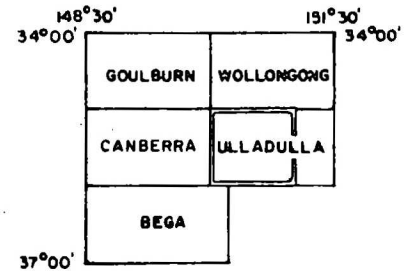
AND

FLIGHT-LINE SYSTEM

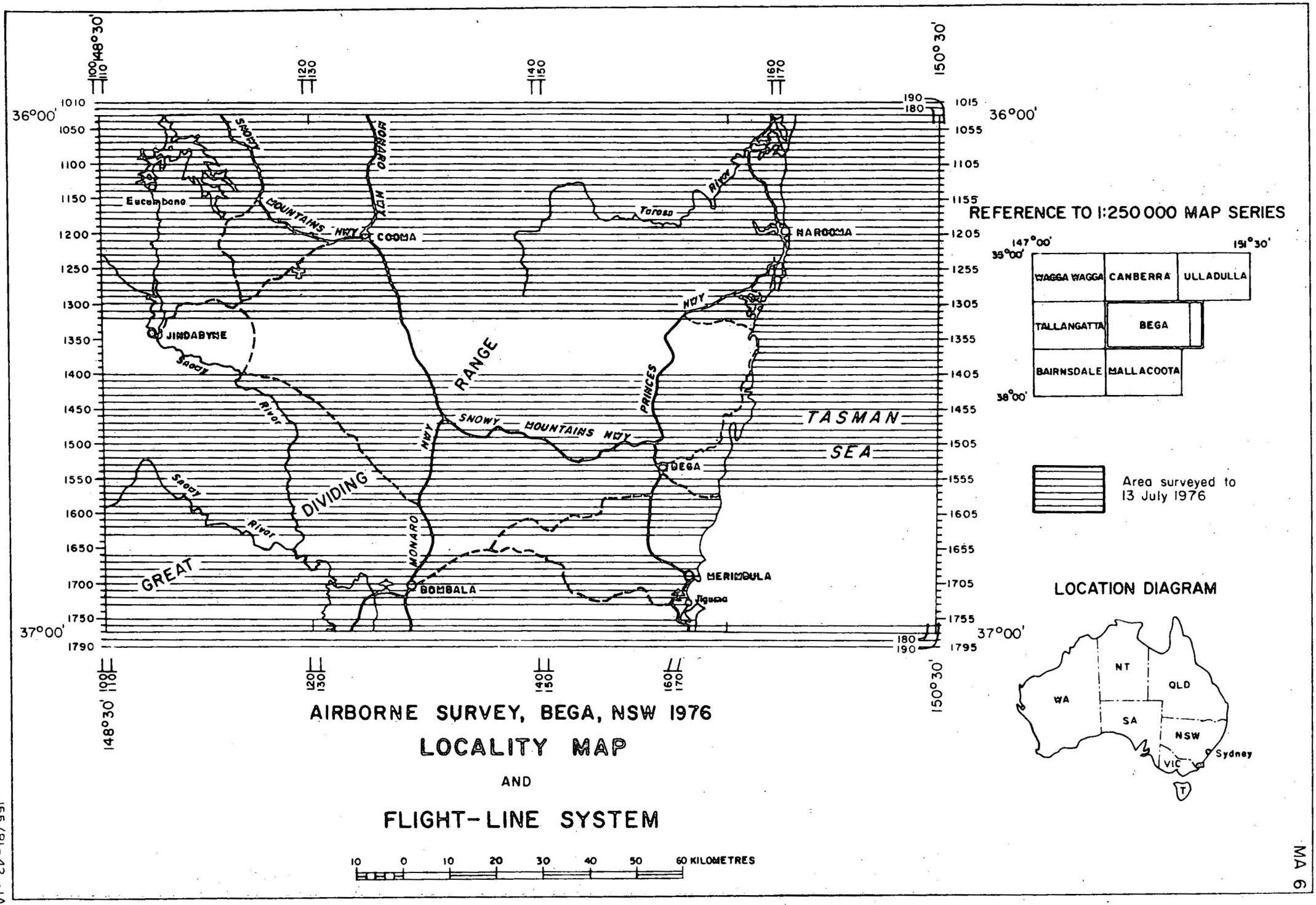
10 0 10 20 30 40 50 60 KILOMETRES

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

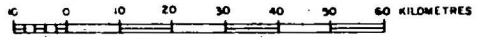


Record No. 1976/91


148°30'
150°30'
36°00'
37°00'
Eucumbene
SNOWY MOUNTAINS HWY
MONARO HWY
COOMA
JINDABYNE
Snowy River
GREAT DIVIDING RANGE
SNOWY MOUNTAINS HWY
MONARO HWY
PRINCES HWY
Toreso
NAROOMA
BEGA
TASMAN SEA
BOMBALA
MERIMBULA
Tigana
REFERENCE TO 1:250 000 MAP SERIES
147°00'
151°30'
35°00'
38°00'
WAGGA WAGGA
CANBERRA
ULLADULLA
TALLANGATTA
BEGA
BAIRNSDALE
MALLACOOTA
Area surveyed to 13 July 1976
LOCATION DIAGRAM
NT
QLD
WA
SA
NSW
VIC
Sydney
T
AIRBORNE SURVEY, BEGA, NSW 1976
LOCALITY MAP
AND
FLIGHT-LINE SYSTEM
10 0 10 20 30 40 50 60 KILOMETRES
MA 6
J55/BI-42-1A

AIRBORNE SURVEY, YILGARN BLOCK, WA 1976

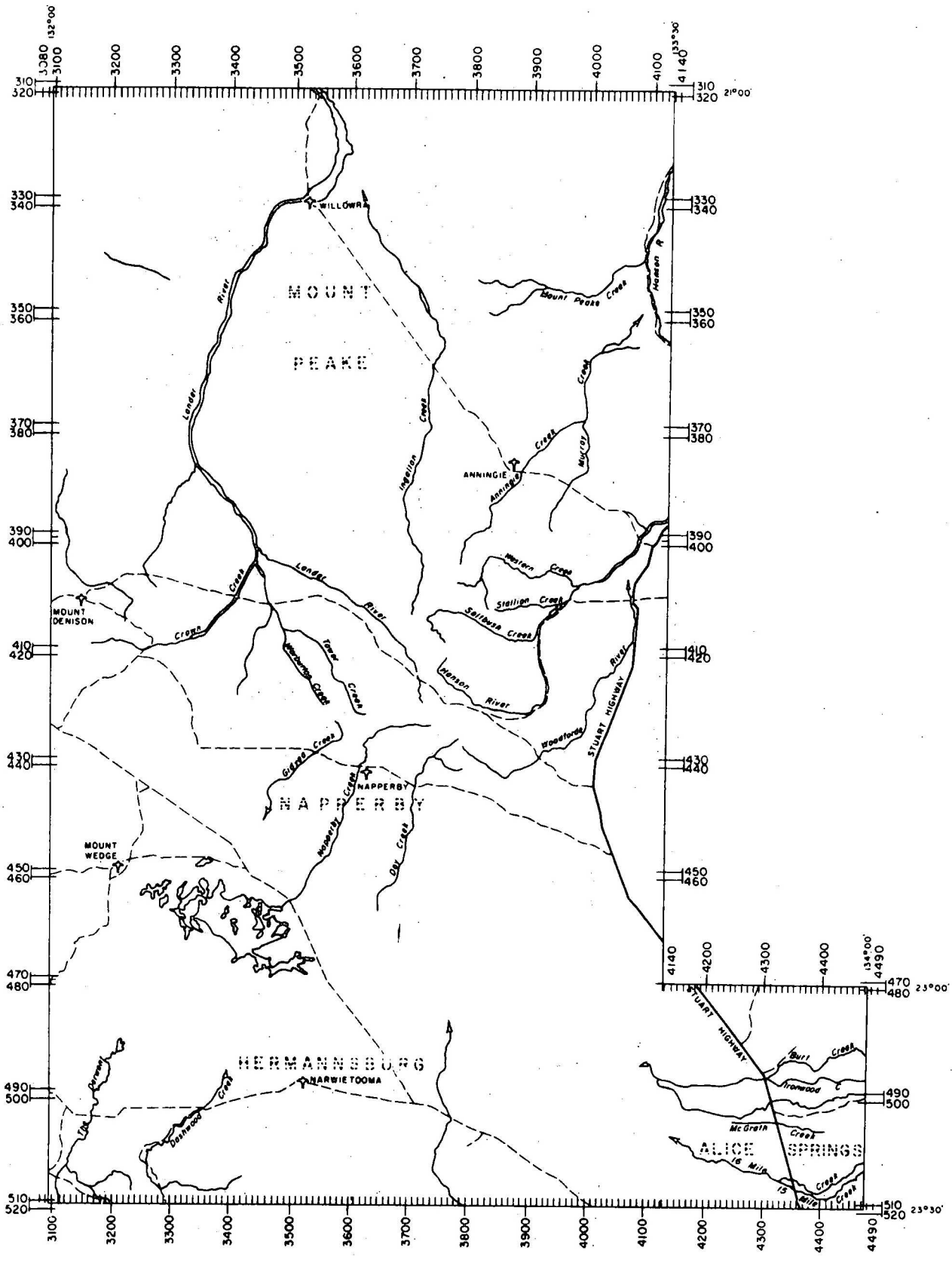
LOCALITY MAP
AND
FLIGHT-LINE SYSTEM



LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

	KELLER-BERRIN	SOUTHERN CROSS	BOORAAGOON
PINJARRA	CORRIGIN	HYDEN	LAKE JOHNSTON
COLLIE	DUMBLEYUNG	NEWDEGATE	RAVENS-THORPE
PEMBERTON	MOUNT BARKER	ESPERANCE BAY	



AIRBORNE SURVEY MOUNT PEAKE - NAPPERBY, NT 1976

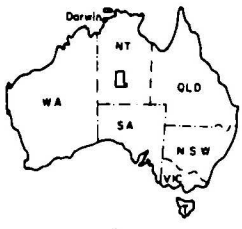
LOCALITY MAP

AND

FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60 KILOMETRES

LOCATION DIAGRAM



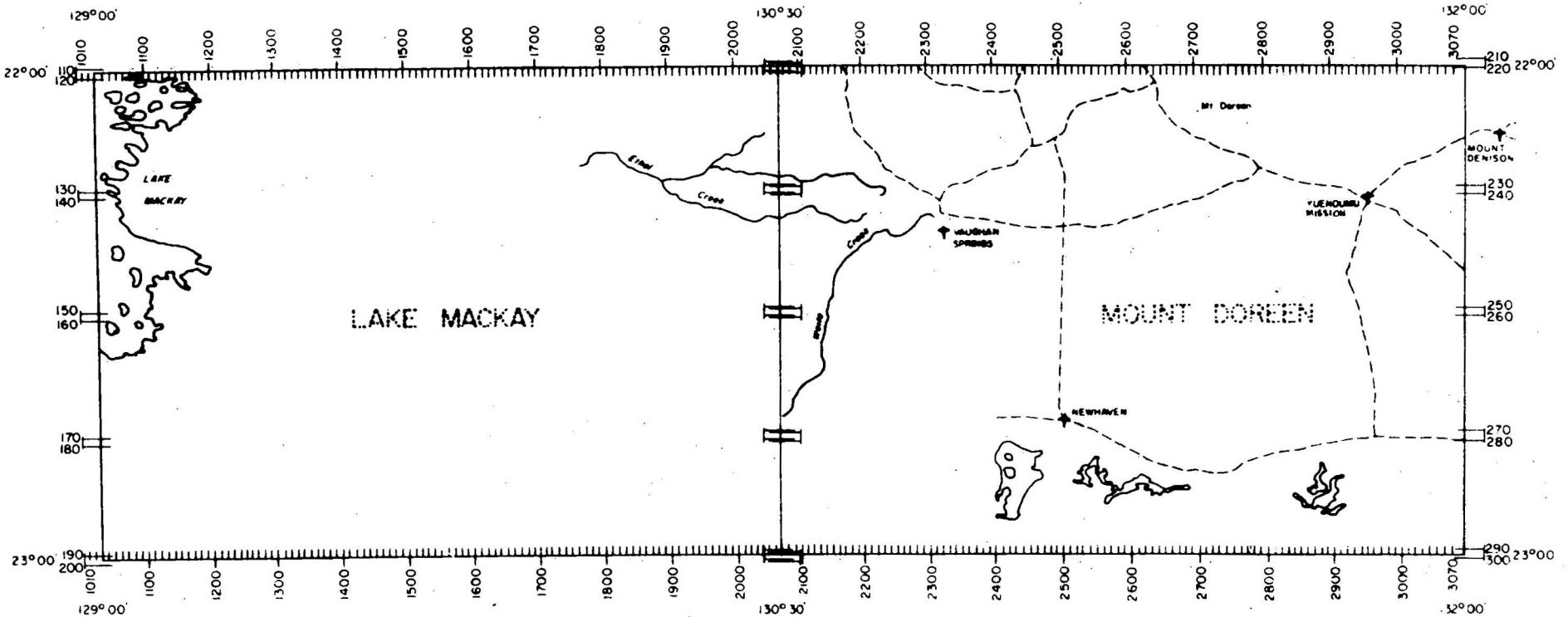
REFERENCE TO 1:250 000 MAP SERIES

MOUNT SOLITAIRE	LANDER RIVER	BONNEY WELL
MOUNT THEO	MOUNT PEAKE	BARROW CREEK
MOUNT DOREEN	NAPPERBY	ALCOOTA
MOUNT LIEBIG	HERMANNSBURG	ALICE SPRINGS

130°30' 135°00' 20°00' 24°00'

Record No. 1976/91

F53/B1-145-1A



AIRBORNE SURVEY LAKE MACKAY – MOUNT DOREEN, NT 1976

LOCALITY MAP

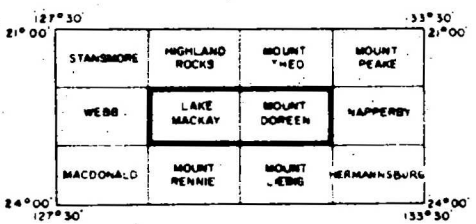
AND

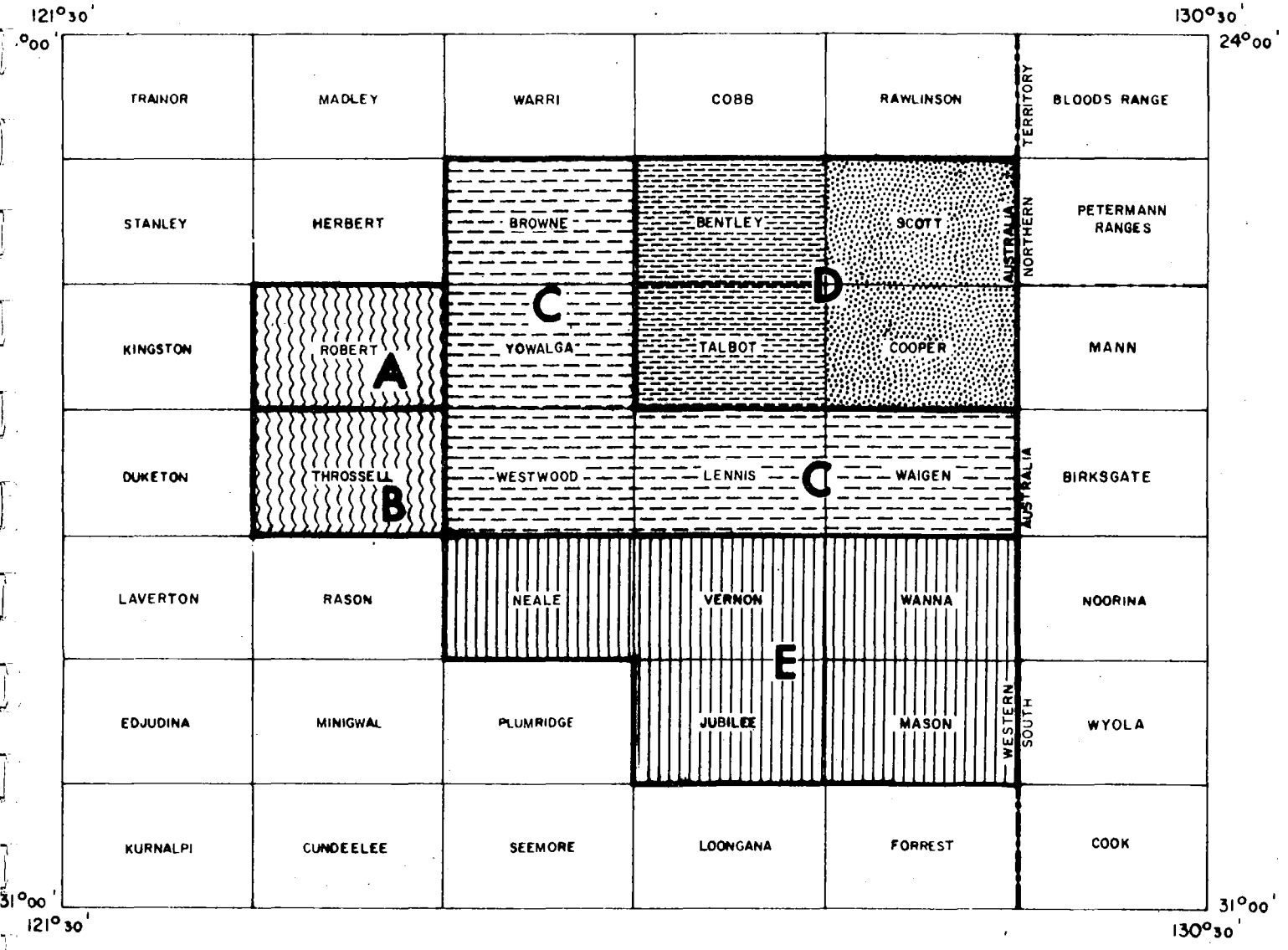
FLIGHT-LINE SYSTEM

KILOMETRES 10 0 10 20 30 40 50 60 KILOMETRES

LOCATION DIAGRAM

REFERENCE TO 1:250000 MAP SERIES





OFFICER BASIN AIRBORNE SURVEY, WA 1975-77

PROGRESS REPORT

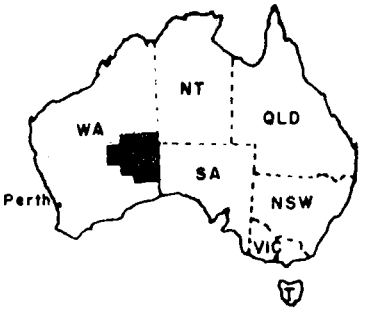
Magnetic contours produced

Magnetic data levelling near completion

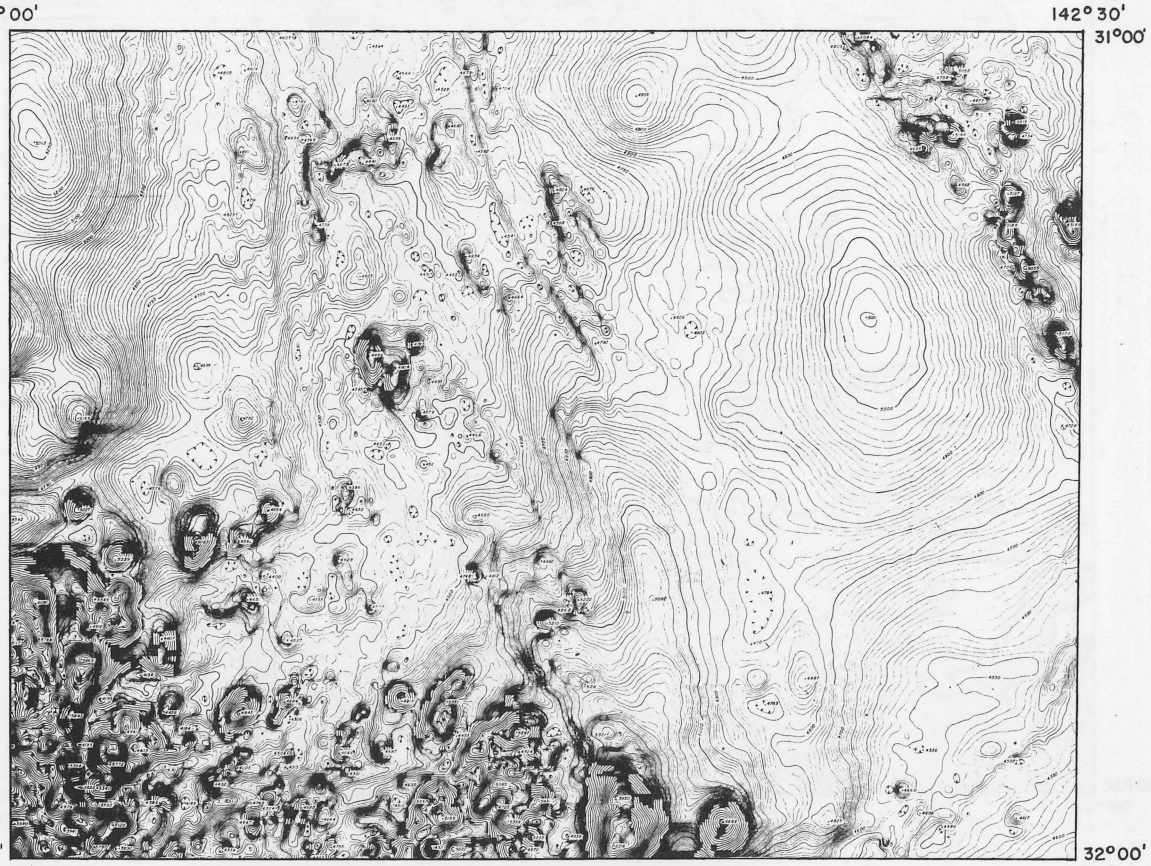
Flight path recovery near completion

Flight path recovery in progress

Flying operations in progress



BROKEN HILL



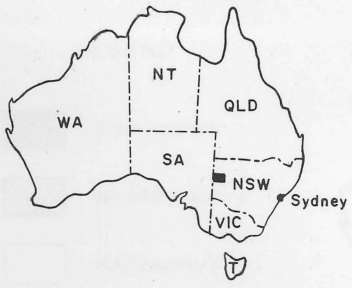
AIRBORNE SURVEY, BROKEN HILL, NSW 1975

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



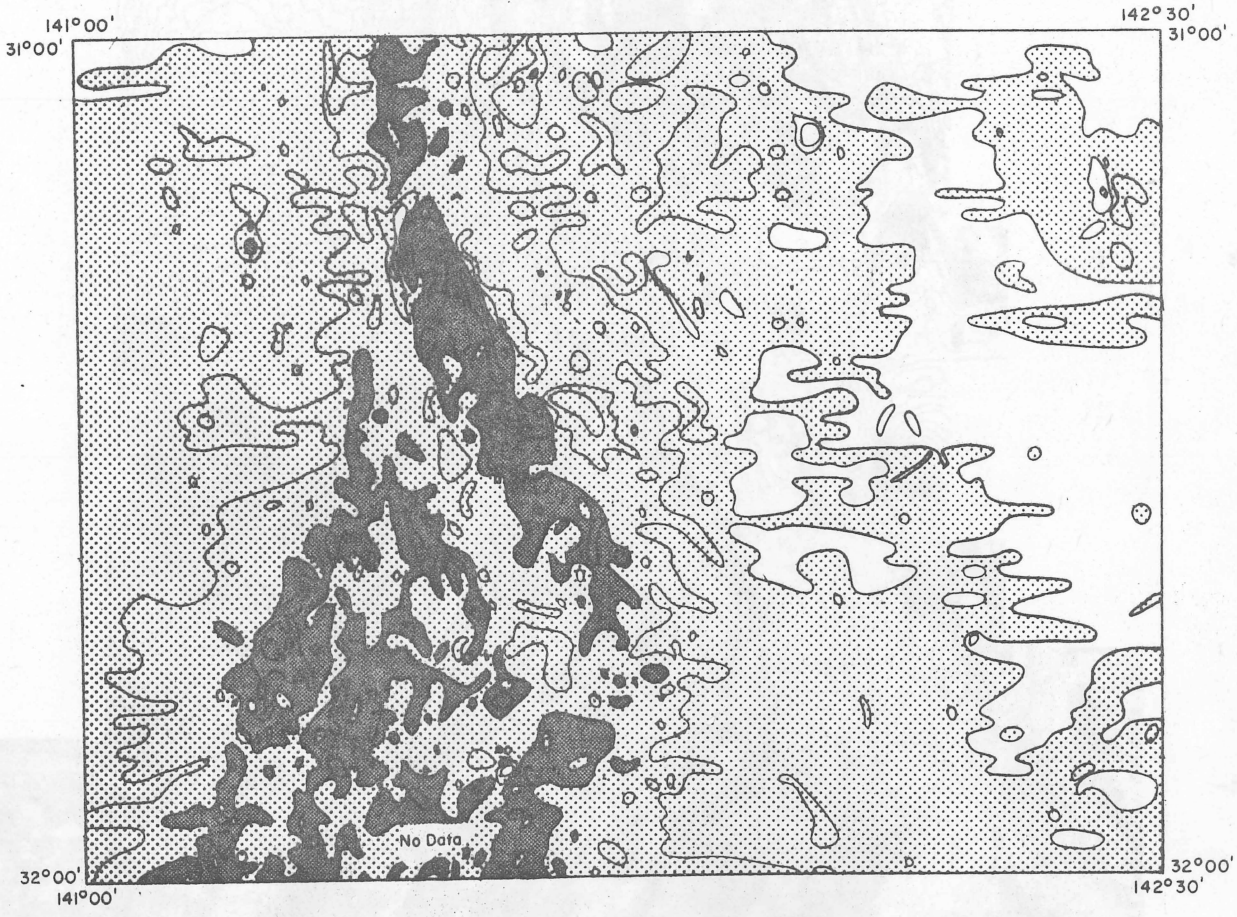
REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1976/91

H54/BI-94A

BROKEN HILL



AIRBORNE SURVEY, BROKEN HILL, NSW 1975
RADIOMETRIC CONTOURS
TOTAL COUNT

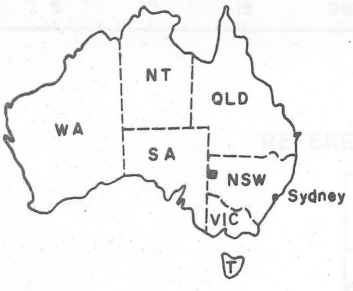
SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LEGEND

- >150 counts/s
- 50-150 counts/s
- <50 counts/s

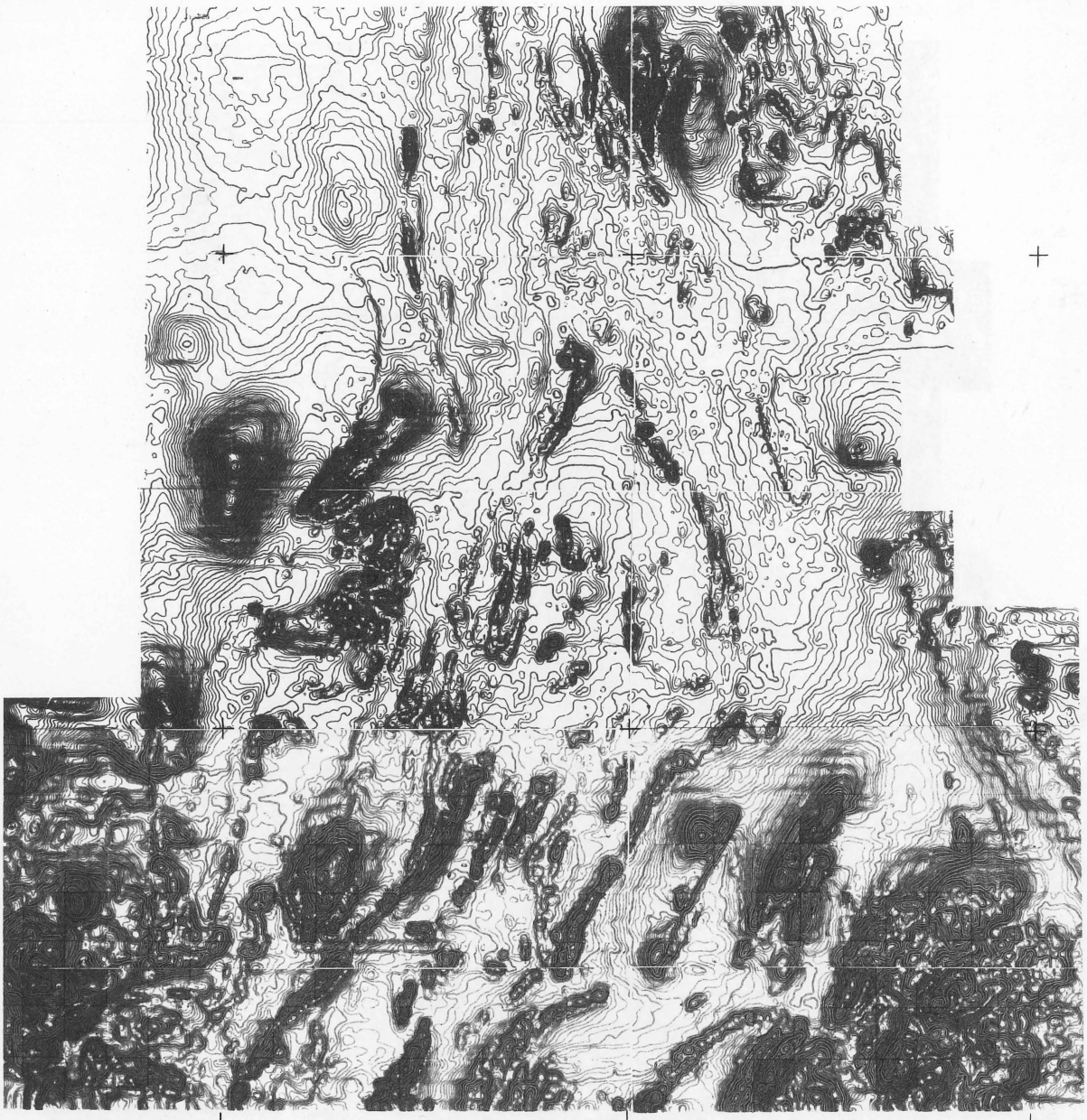
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1976/91



CONTOUR INTERVAL 10nT

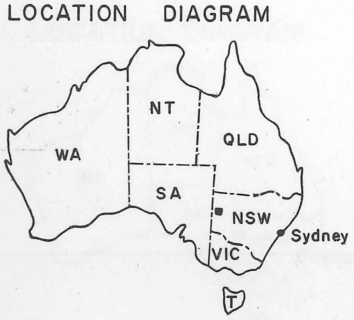
AIRBORNE SURVEY, BROKEN HILL (DETAILED) NSW, 1975

TOTAL MAGNETIC INTENSITY

SCALE 1:400 000

5 0 5 10 15 20 25 KILOMETRES

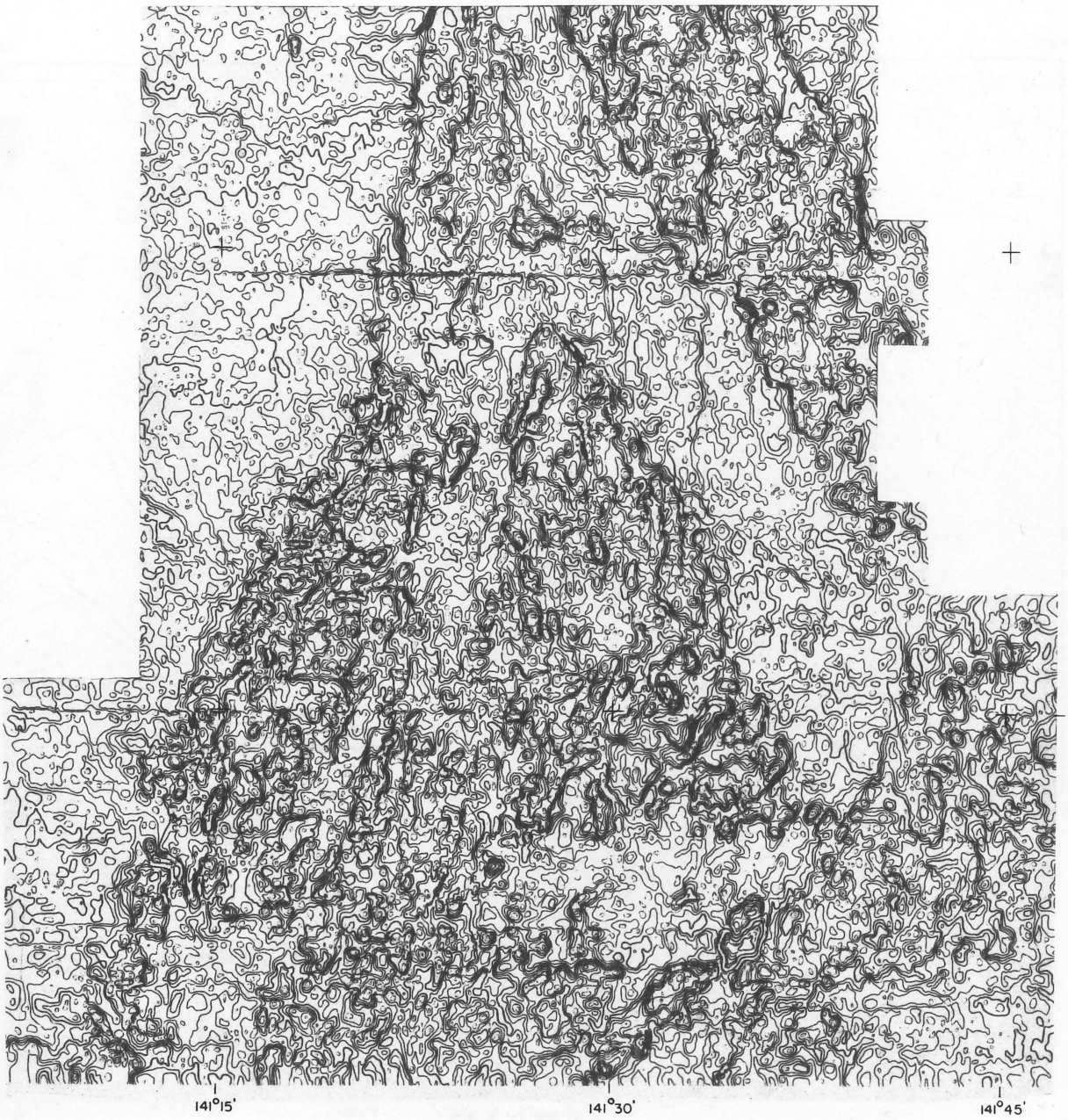
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1976/91



AIRBORNE SURVEY, BROKEN HILL (DETAILED), NSW 1975

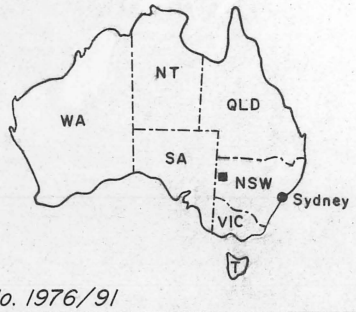
RADIOMETRIC CONTOURS, TOTAL COUNT

CONTOUR INTERVAL: 10 counts/s

SCALE 1:400000

5 0 5 10 15 20 25 KILOMETRES

LOCATION DIAGRAM

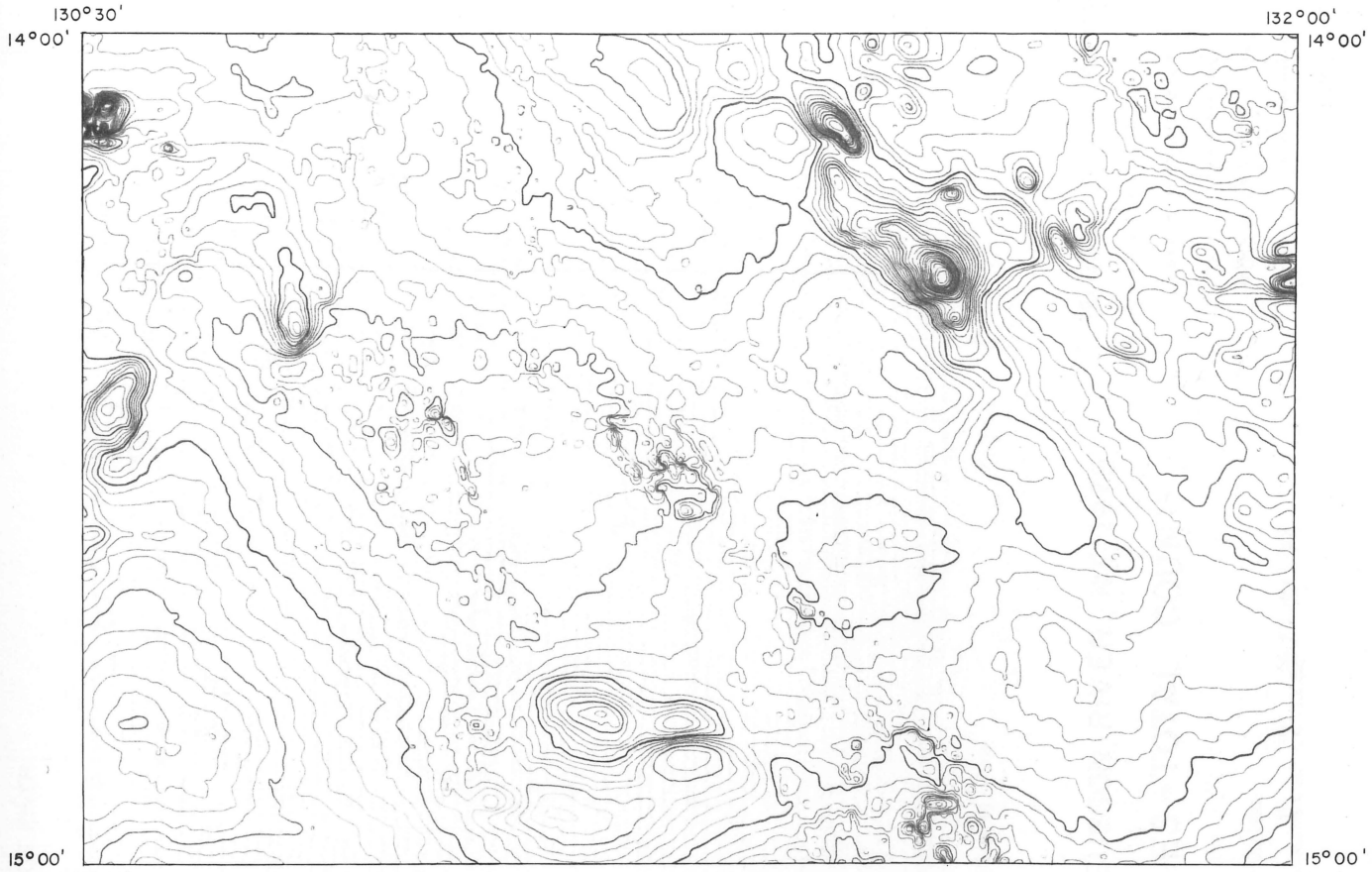


REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1976/91

FERGUSSON RIVER



CONTOUR INTERVAL 10nT

AIRBORNE SURVEY, FERGUSSON RIVER, NT 1975

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM

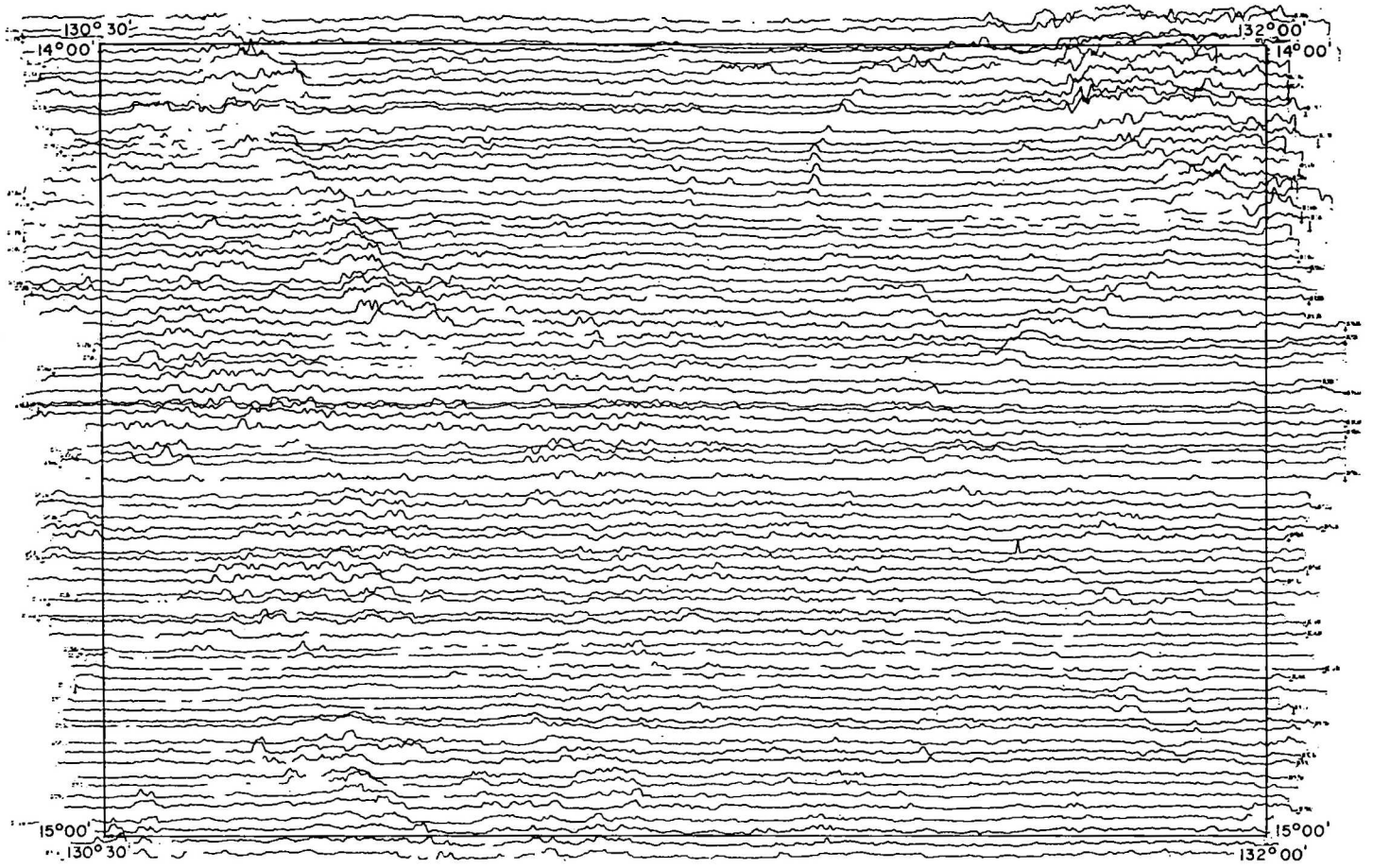
REFERENCE TO 1:250000 MAP SERIES

CAPE SCOTT	PINE CREEK	MOUNT EVELYN
PORT KEATS	FERGUSSON RIVER	KATHERINE
AUVERGNE	DELAMERE	LARRIMAH

Record No 1976/91

Record No. 1976/91

FERGUSSON RIVER



VERTICAL SCALE : 80 counts/s/mm

LOCATION DIAGRAM

AIRBORNE SURVEY FERGUSSON RIVER, NT 1975

RADIOMETRIC PROFILES - TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

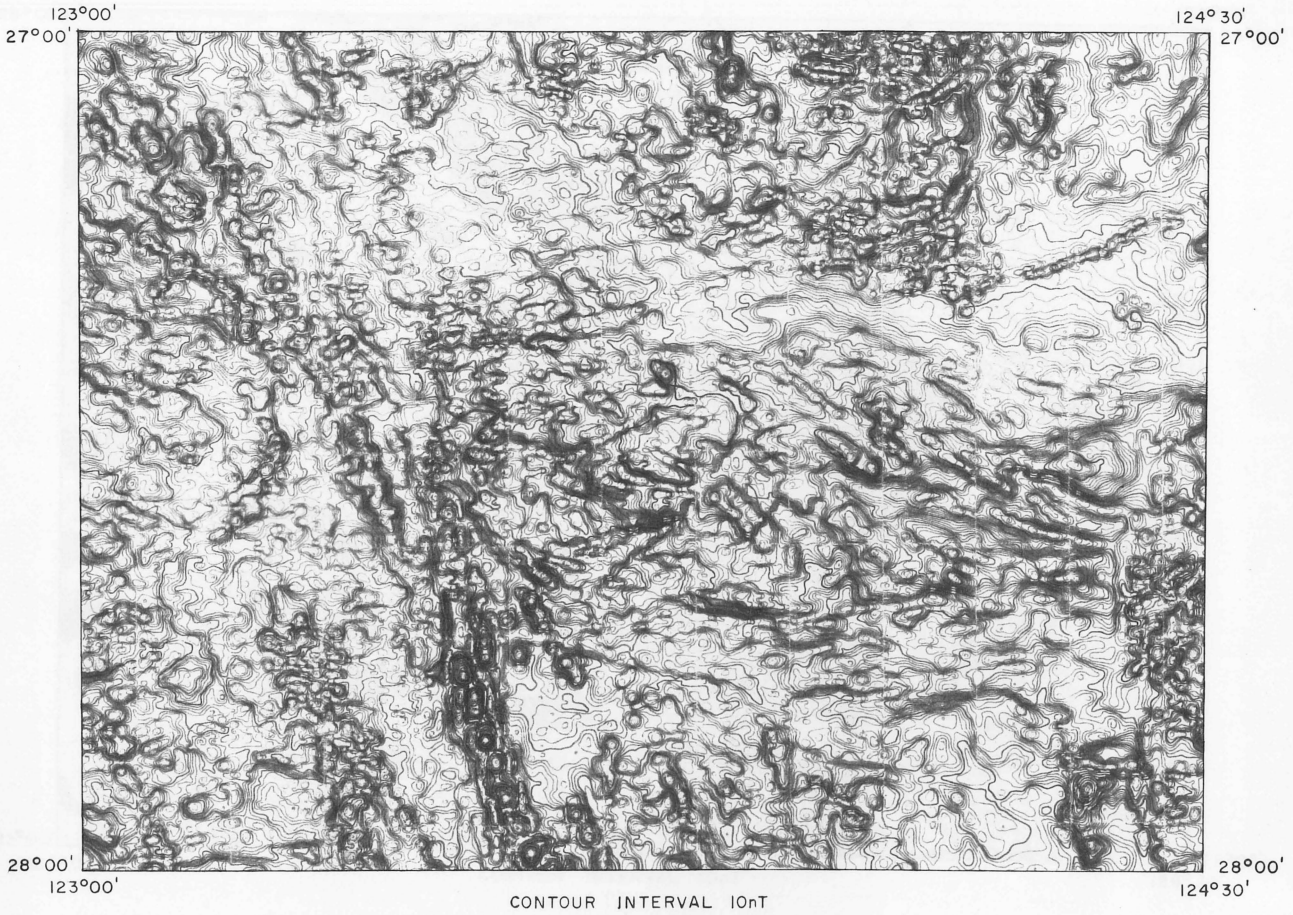
REFERENCE TO 1:250 000 MAP SERIES

CAPE SCOTT	PINE CREEK	MOUNT EVELYN
PORT KEATS	FERGUSSON RIVER	KATHERINE
AUVERGNE	DELAMERE	LARRIMAH

D52/B1-149A

MA 16

THROSSELL



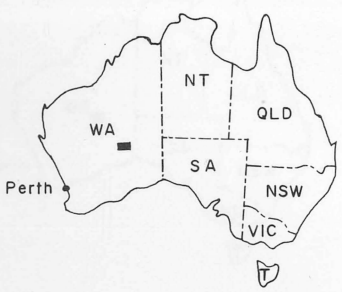
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

KINGSTON	ROBERT	YOWALGA
DUKETON	THROSSELL	WESTWOOD
LAVERTON	RASON	NEALE

G51/BI-67A

Record No. 1976/91

ROBERT

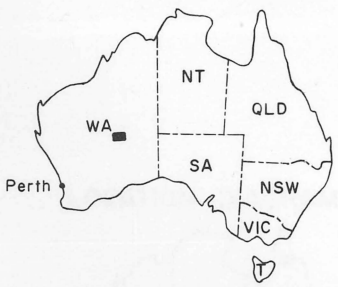
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



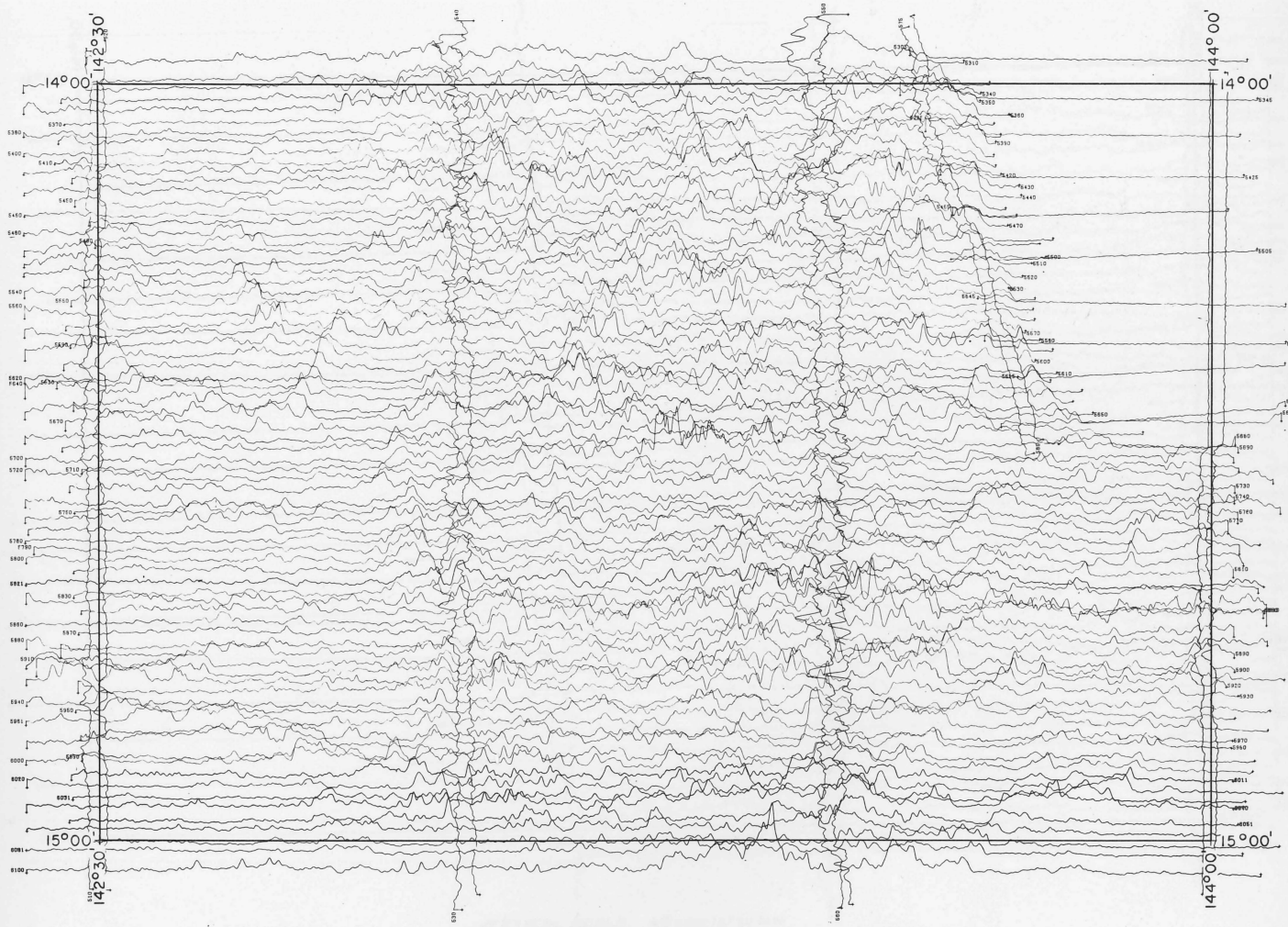
REFERENCE TO 1:250 000 MAP SERIES

STANLEY	HERBERT	BROWNE
KINGSTON	ROBERT	YOWALGA
DUKETON	THROSSELL	WESTWOOD

G51/B1-66A

Record No. 1976/91

EBAGOOLA



VERTICAL SCALE 40 counts/s/mm

AIRBORNE SURVEY CARPENTARIA BASIN (HOLROYD, EBAGOOLA, CAPE MELVILLE) QLD 1973

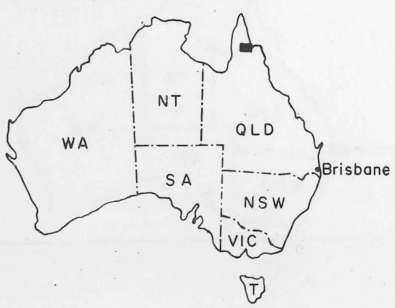
RADIOMETRIC PROFILES

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

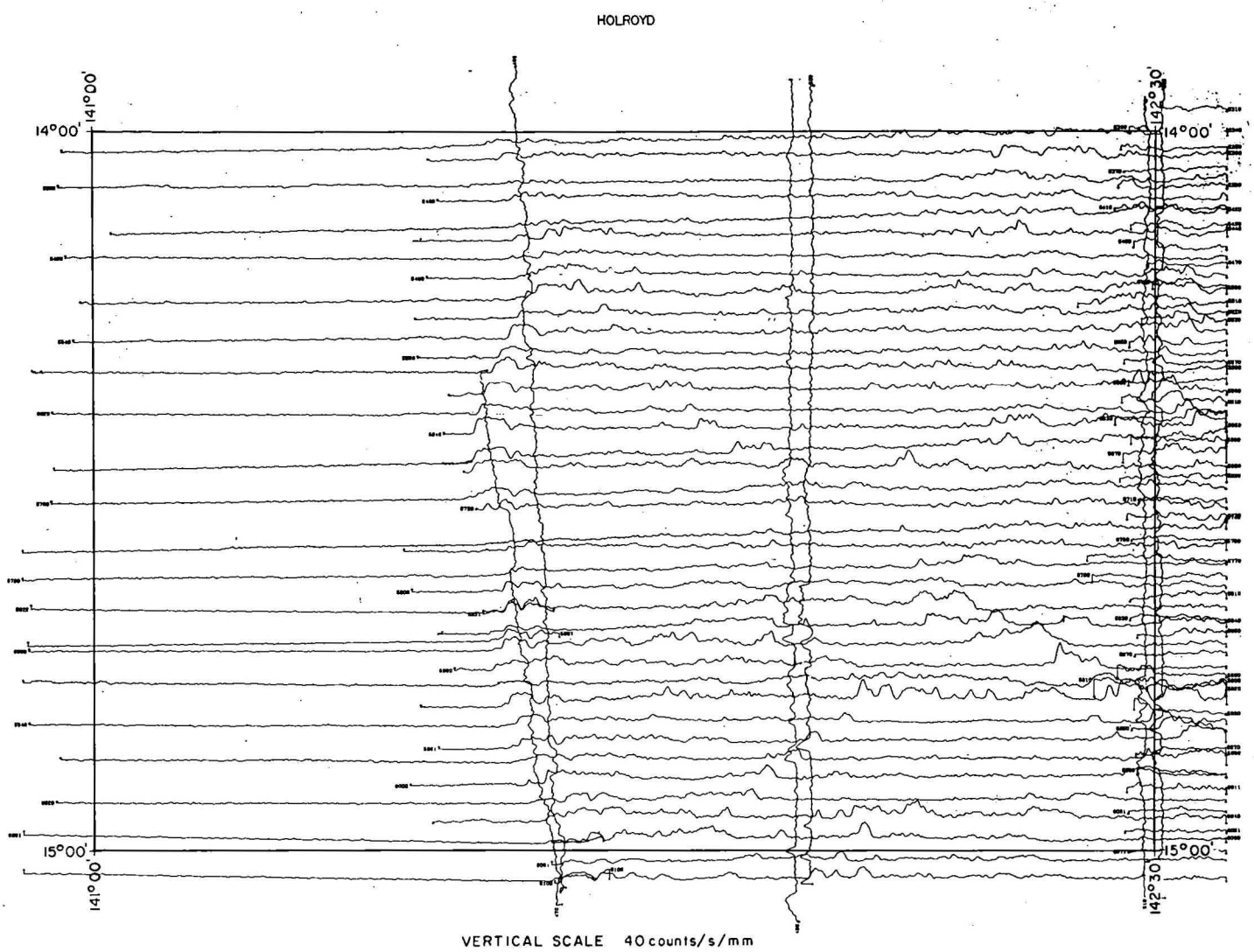
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

AURUKUN	COEN	
HOLROYD	EBAGOOLA	CAPE MELVILLE
RUTLAND PLAINS	HANN RIVER	COOKTOWN

Record No. 1976/91



AIRBORNE SURVEY CARPENTARIA BASIN (HOLROYD, EBAGOOLA, CAPE MELVILLE) QLD 1973

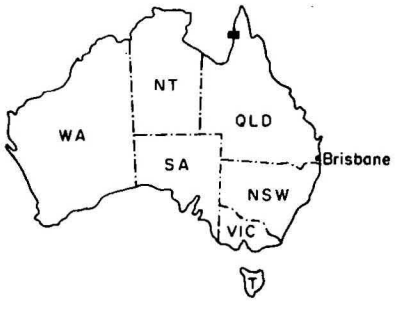
RADIOMETRIC PROFILES

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM

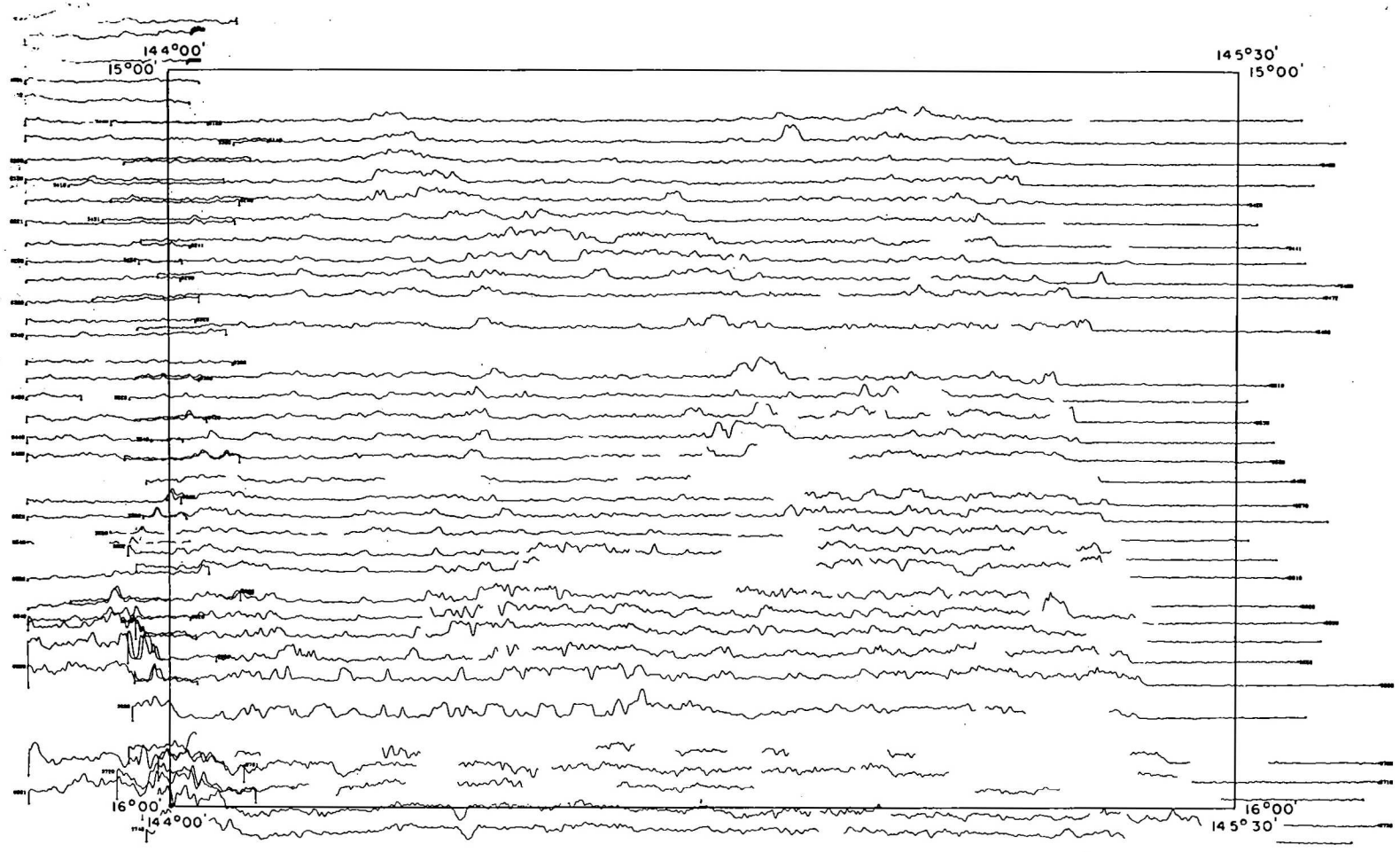


REFERENCE TO 1:250 000 MAP SERIES

	AURUKUN	COEN
	HOLROYD	EBAGOOLA
	RUTLAND PLAINS	HANN RIVER

Record No. 1976/91

COOKTOWN



LOCATION DIAGRAM

VERTICAL SCALE 40 Counts/s/mm

AIRBORNE SURVEY CARPENTARIA BASIN, QLD 1974

RADIOMETRIC PROFILES, TOTAL COUNT

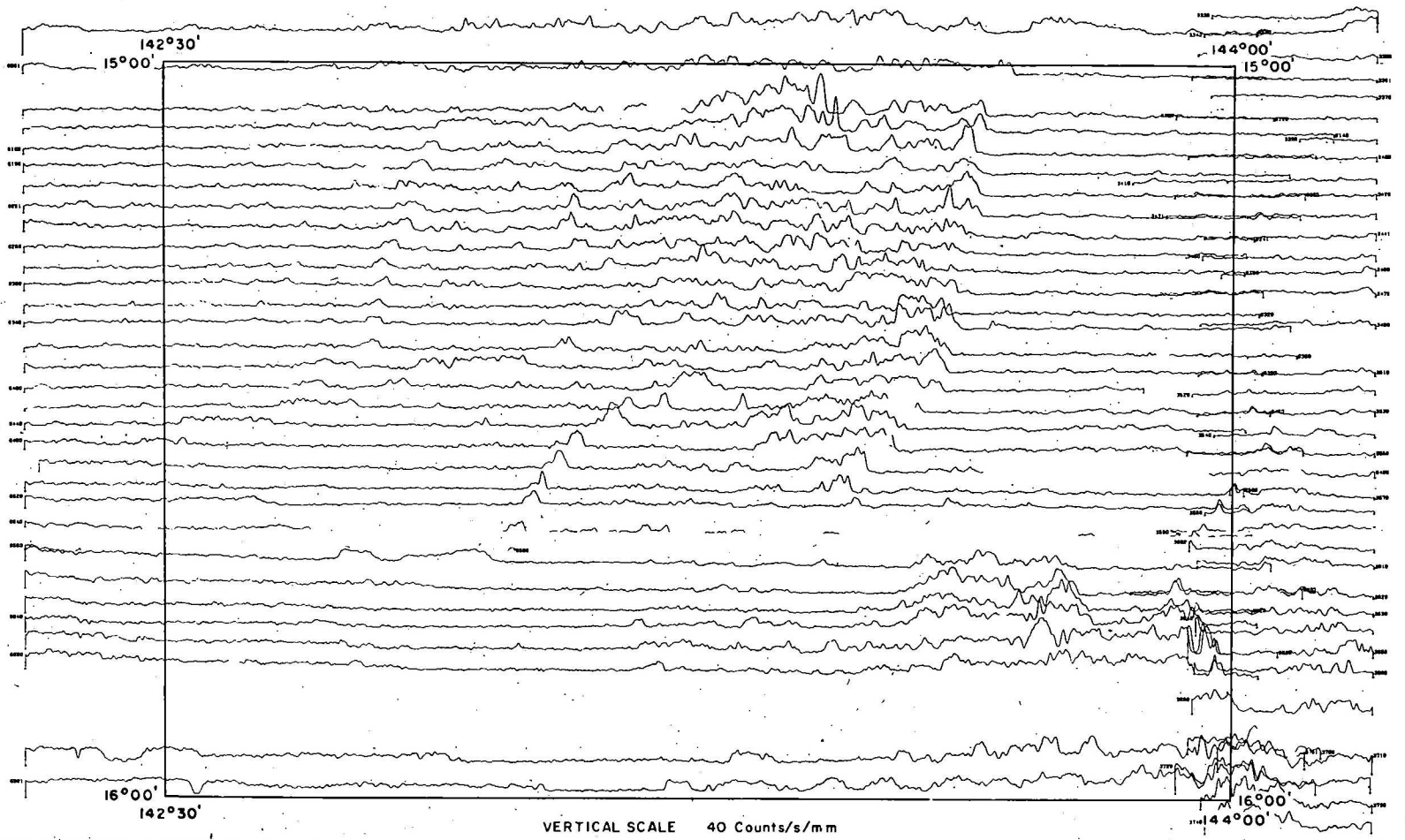
SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

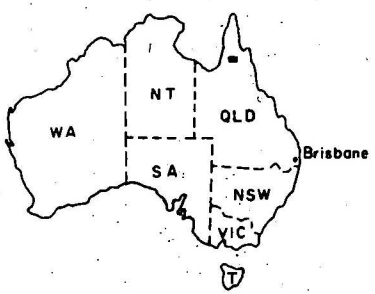
EBAGOOLA	CAPE MELVILLE	
HANN RIVER	COOKTOWN	
WALSH	MOSSMAN	CAIRNS

HANN RIVER



VERTICAL SCALE 40 Counts/s/mm

LOCATION DIAGRAM



AIRBORNE SURVEY CARPENTARIA BASIN, QLD 1974

RADIOMETRIC PROFILES, TOTAL COUNT

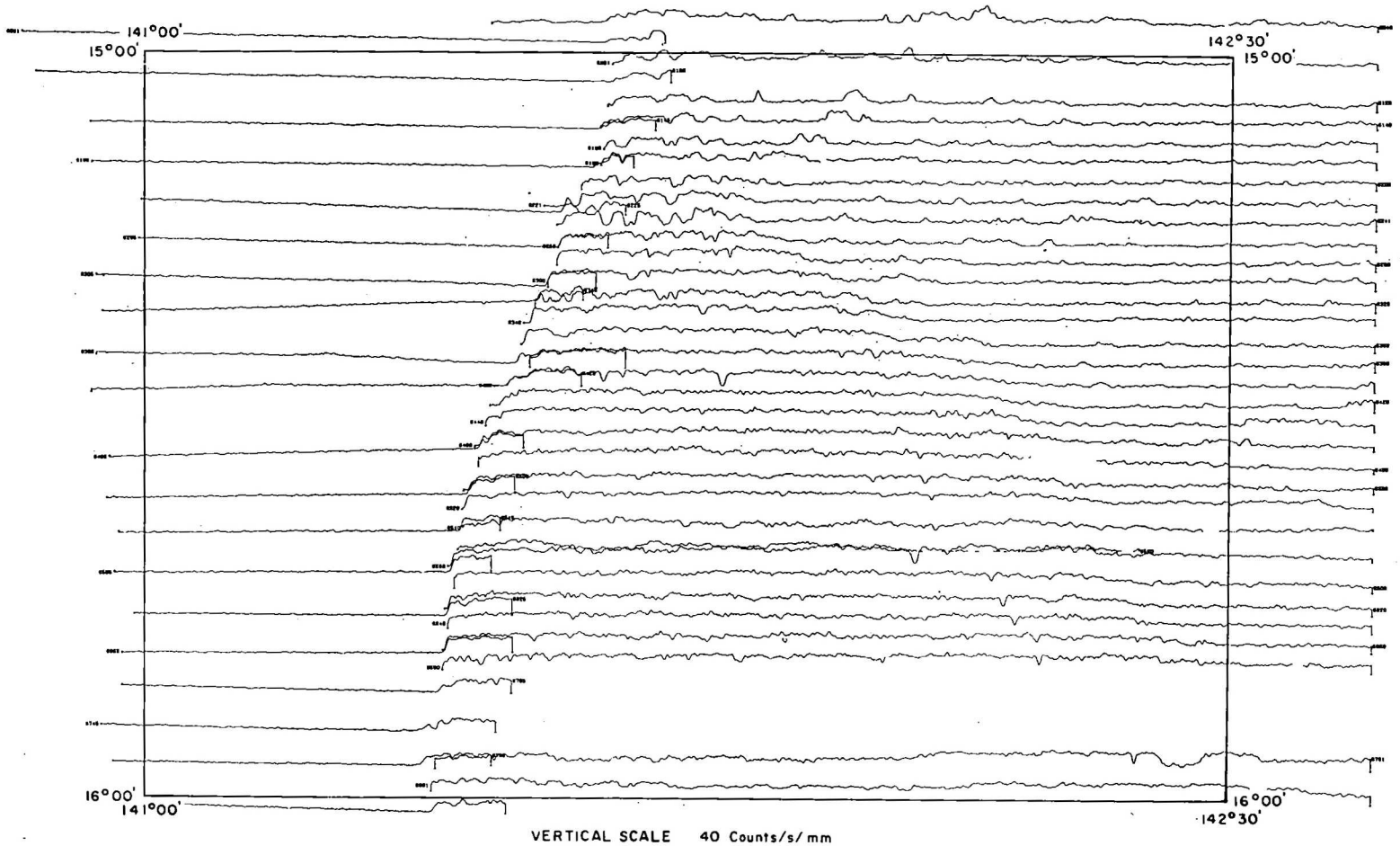
SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

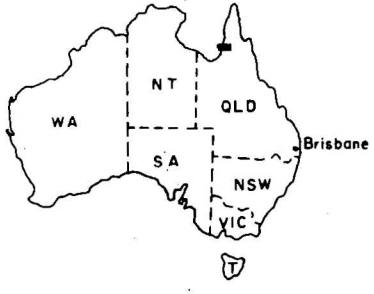
HOLROYD.	EBAGOOLA	CAPE MELVILLE
RUTLAND PLAINS	HANN RIVER	COOKTOWN
GALBRAITH.	WALSH	MOSSMAN

RUTLAND PLAINS



VERTICAL SCALE 40 Counts/s/mm

LOCATION DIAGRAM



AIRBORNE SURVEY CARPENTARIA BASIN, QLD 1974

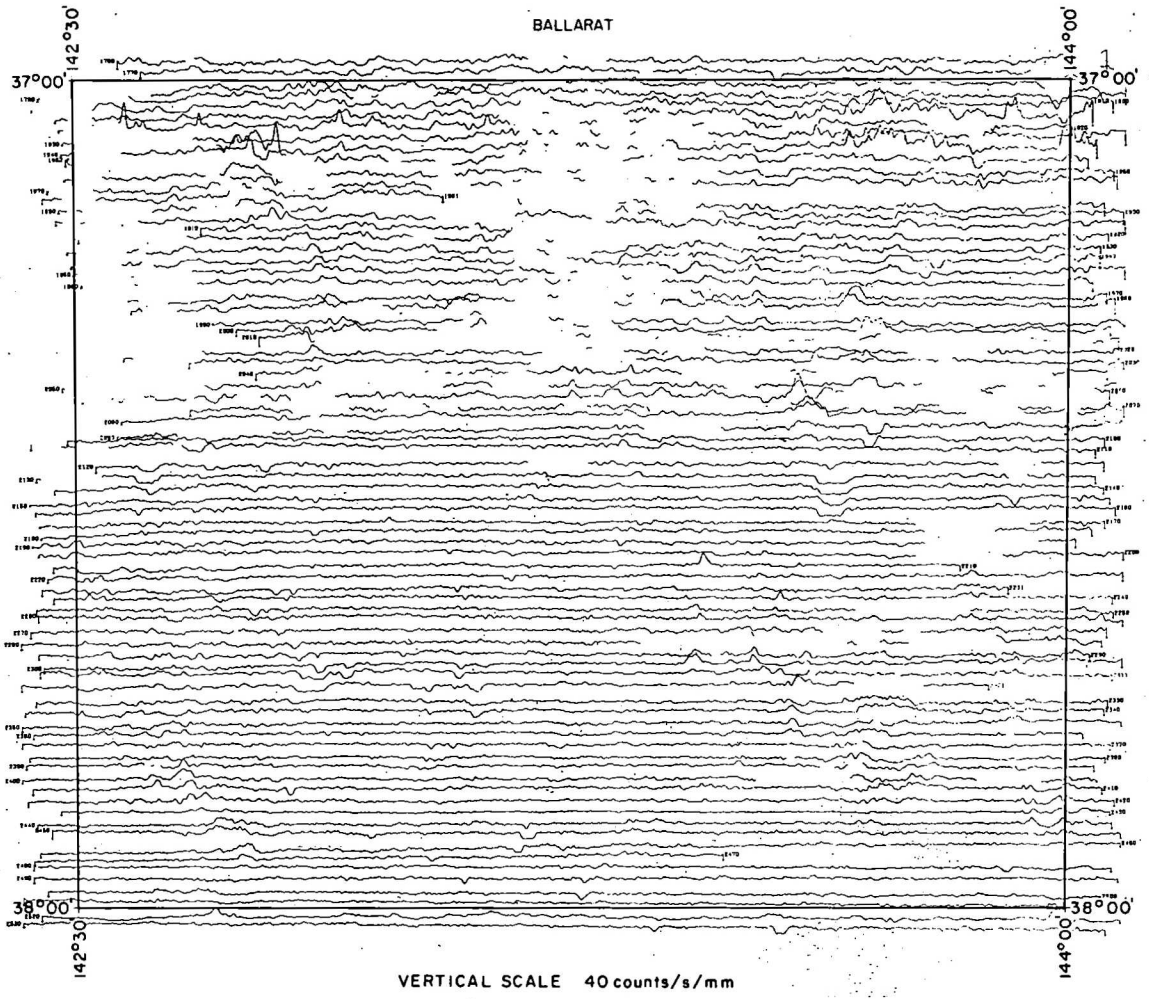
RADIOMETRIC PROFILES, TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

	HOLROYD	EBAGOOLA
	RUTLAND PLAINS	HANN RIVER
CAPE VAN DIEMEN	GALBRAITH	WALSH

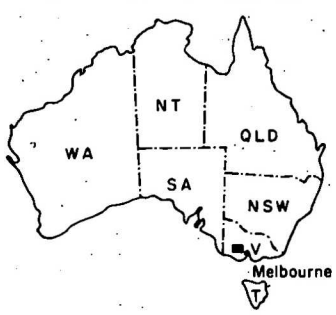


AIRBORNE SURVEY ST ARNAUD - BALLARAT, VIC 1974
RADIOMETRIC PROFILES
TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

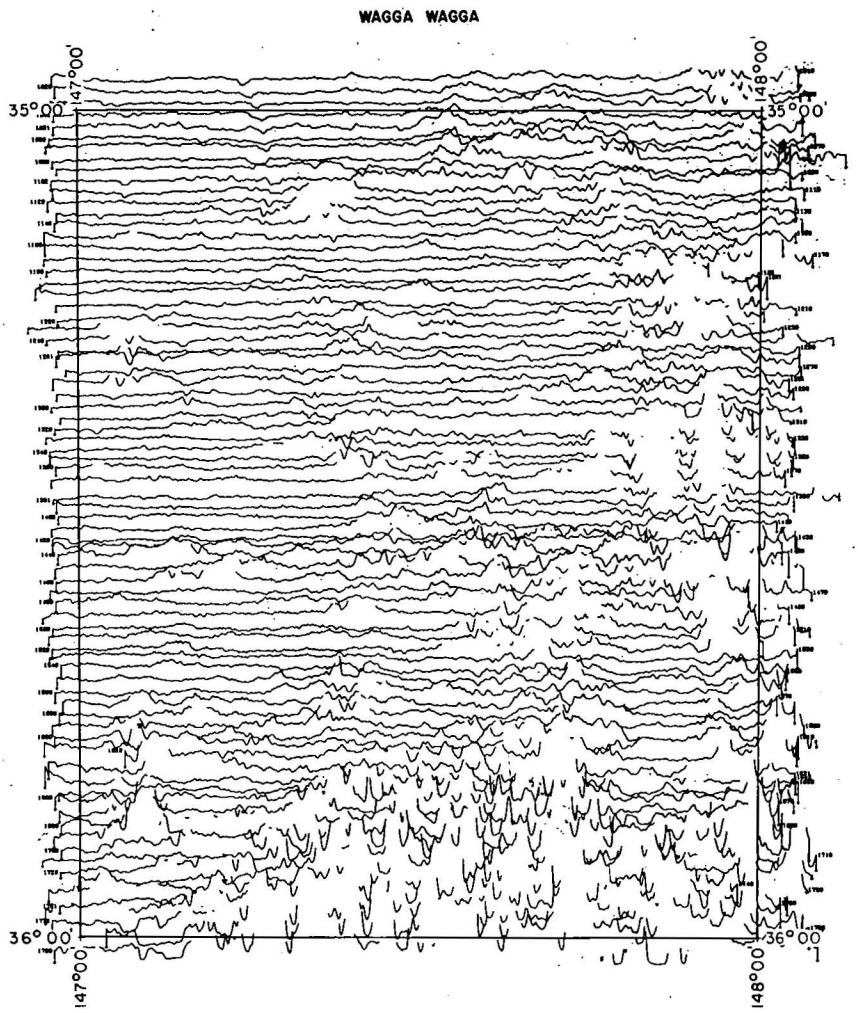
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

HORSHAM	ST ARNAUD	BENDIGO
HAMILTON	BALLARAT	MELBOURNE
PORTLAND	COLAC	QUEENSCLIFF

Record No. 1976/91



VERTICAL SCALE 60 counts/s/mm

AIRBORNE SURVEY CANBERRA-WAGGA, A.C.T.-NSW 1973-74

RADIOMETRIC PROFILES

TOTAL COUNT

SCALE 1:1 000 000

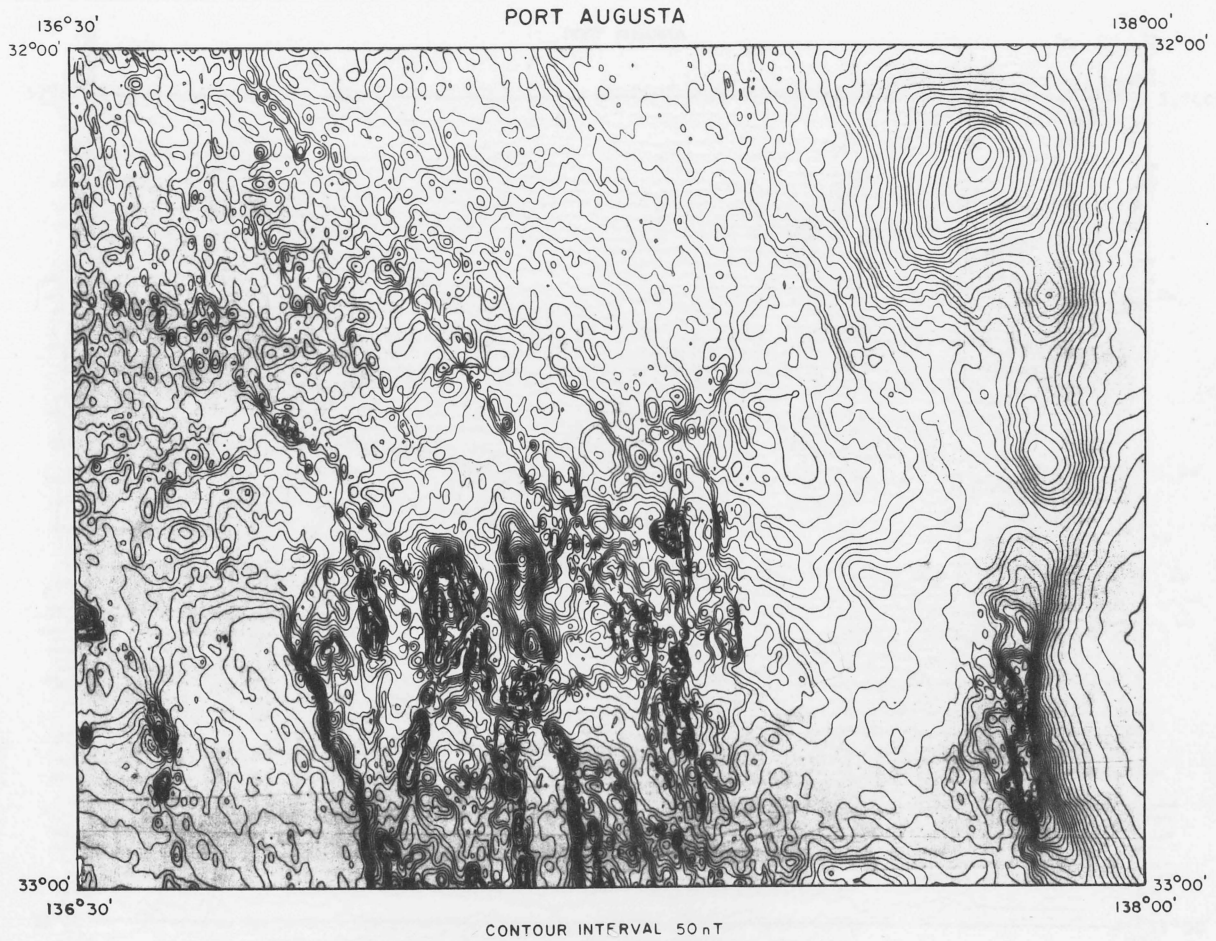
10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

NARRANDERA	COOTAMUNDRA	GOULBURN
JERILDERIE	WAGGA WAGGA	CANBERRA
WANGARATTA	TALLANGATTA	BEGA

Record No. 1976/91



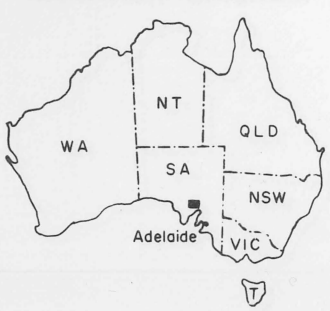
AIRBORNE SURVEY GAWLER BLOCK (PORT AUGUSTA), SA 1975

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

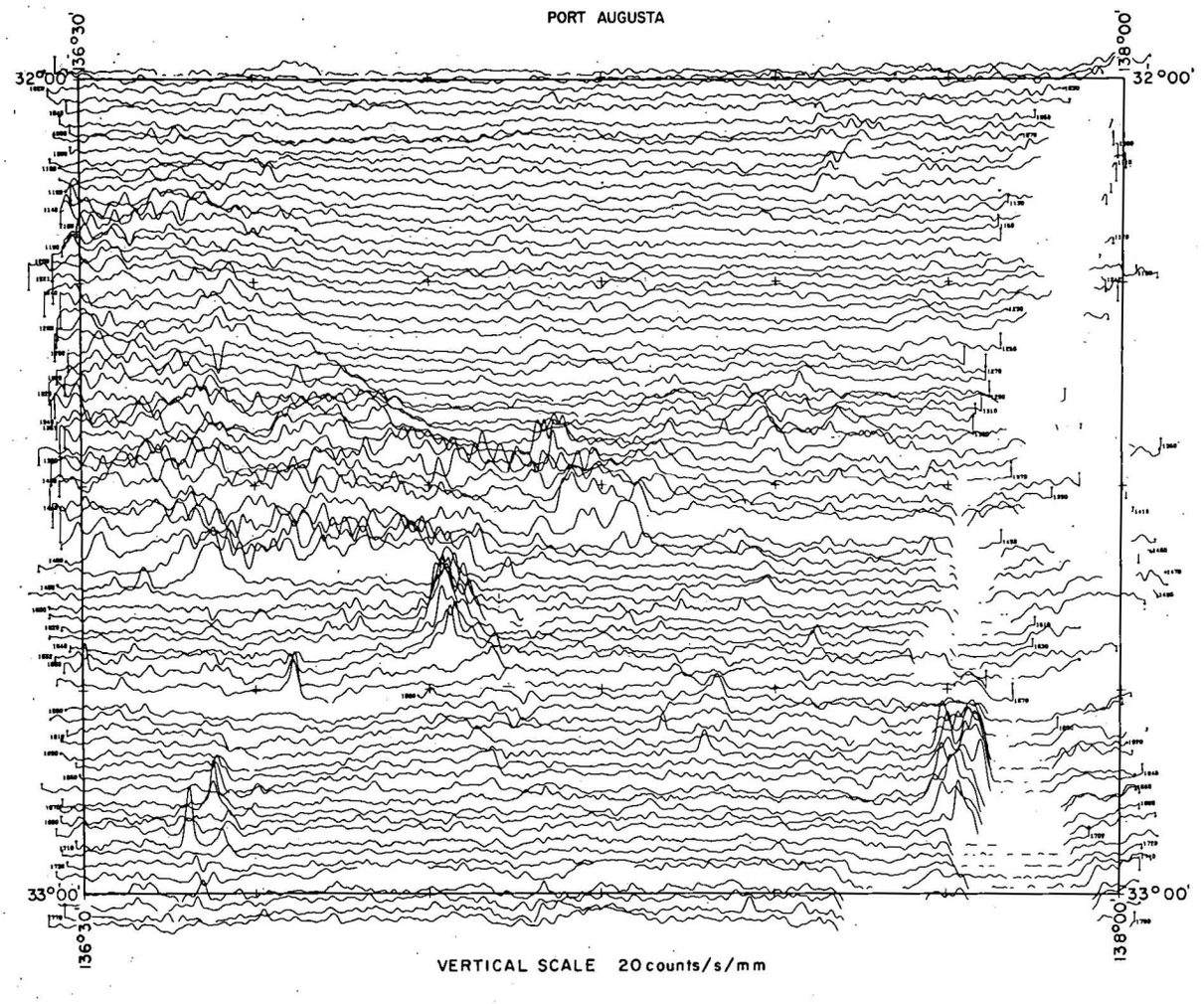
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORRORoo
KIMBA	WHYALLA	BURRA

Record No 1976/91



AIRBORNE SURVEY GAWLER BLOCK (PORT AUGUSTA), S.A 1975

RADIOMETRIC PROFILES

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

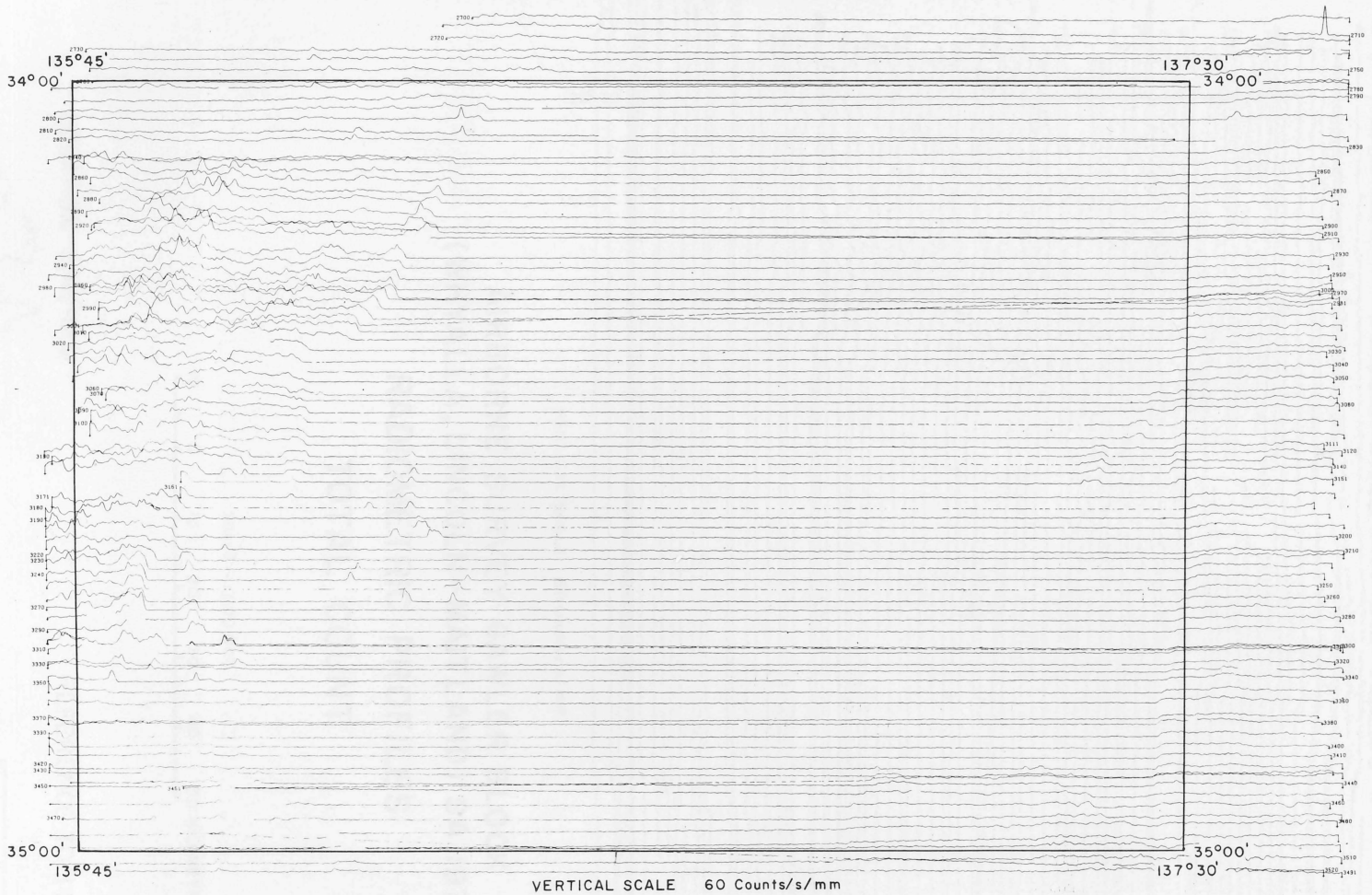
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

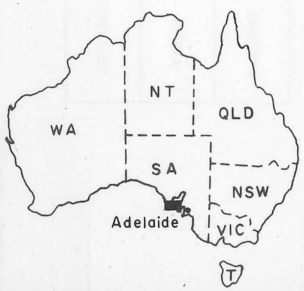
GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORRORoo
KIMBA	WHYALLA	BURRA

Record No. 1976/91

LINCOLN-MAITLAND



LOCATION DIAGRAM



AIRBORNE SURVEY

GAWLER BLOCK (WHYALLA, LINCOLN-MAITLAND), SA 1975

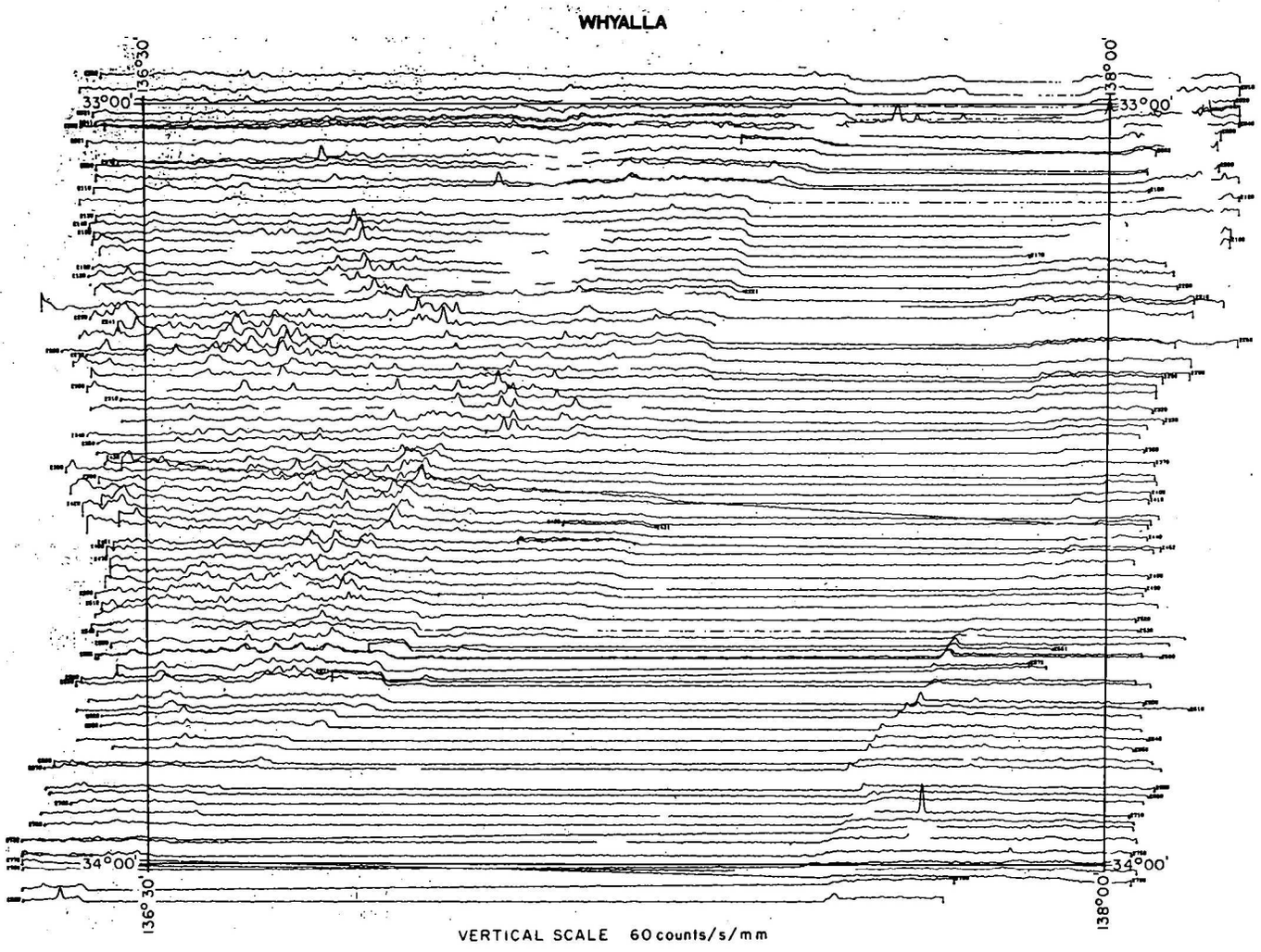
RADIOMETRIC PROFILES, TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

KIMBA.	WHYALLA	BURRA
LINCOLN.	MAITLAND	ADELAIDE
	KINGSCOTE	BARKER



AIRBORNE SURVEY GAWLER BLOCK (WHYALLA, LINCOLN–MAITLAND) SA 1975

RADIOMETRIC PROFILES

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM

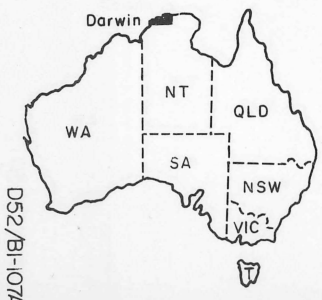
REFERENCE TO 1:250 000 MAP SERIES

YARDEA	PORT AUGUSTA	ORROROO
KIMBA	WHYALLA	BURRA
LINCOLN	MAITLAND	ADELAIDE

Record No. 1976/91

FOG BAY-DARWIN

LOCATION DIAGRAM



AIRBORNE SURVEY

FOG BAY-DARWIN, CAPE SCOTT-PINE CREEK, NT 1974-75

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

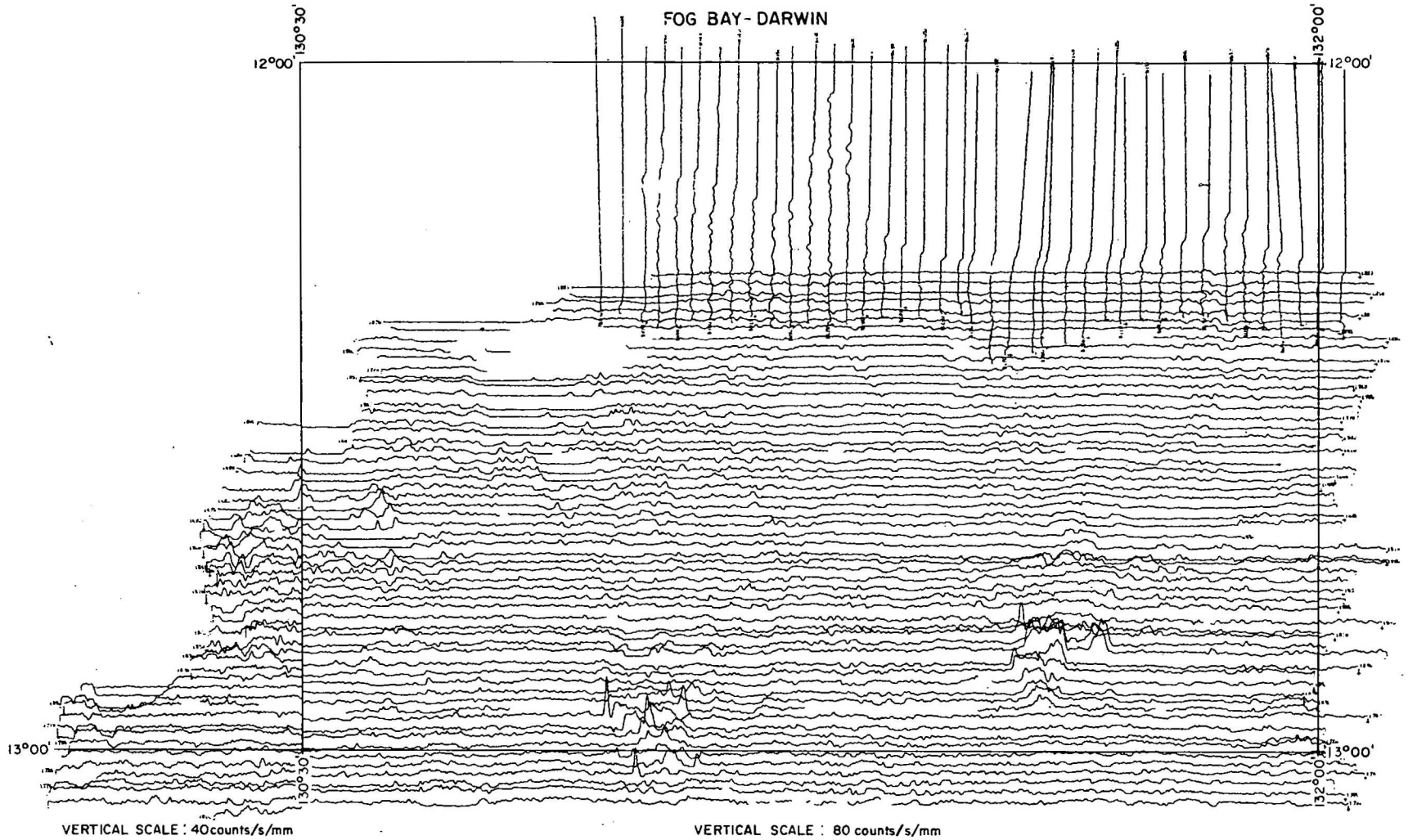
REFERENCE TO 1:250000 MAP SERIES

BATHURST ISLAND	MELVILLE ISLAND	COBOURG PENINSULA
FOG BAY	DARWIN	ALLIGATOR RIVER
CAPE SCOTT	PINE CREEK	MOUNT EVELYN

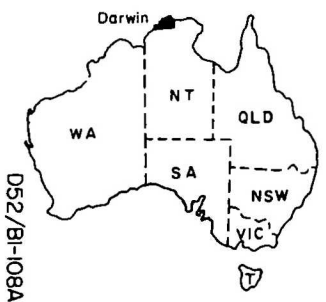
D52/BI-107A

MA 30

Record No. 1976/91



LOCATION DIAGRAM



AIRBORNE SURVEY

FOG BAY - DARWIN , CAPE SCOTT - PINE CREEK, NT 1974-75

RADIOMETRIC PROFILES, TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

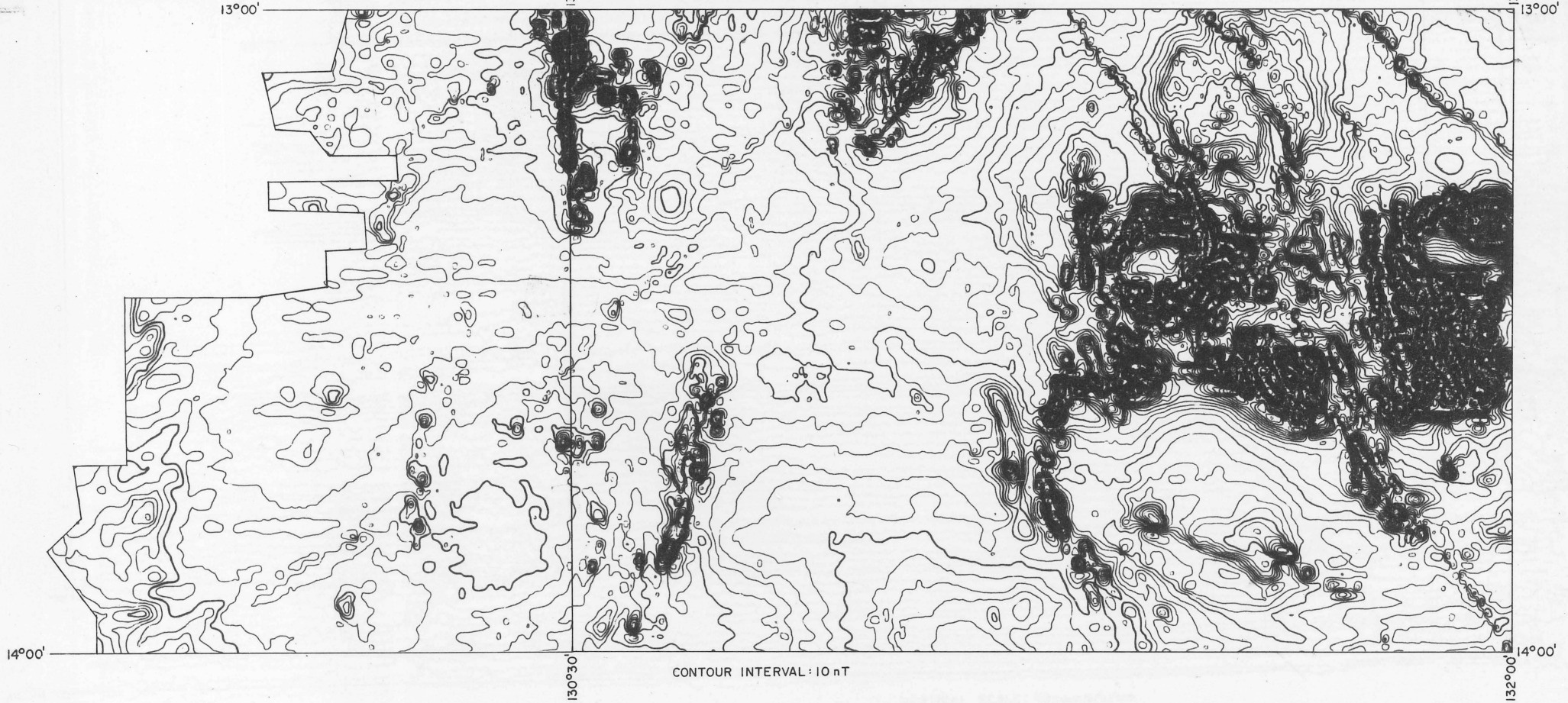
BATHURST ISLAND	MELVILLE ISLAND	COBOURG PENINSULA
FOG BAY	DARWIN	ALLIGATOR RIVER
CAPE SCOTT	PINE CREEK	MOUNT EVELYN

D52/BI-108A

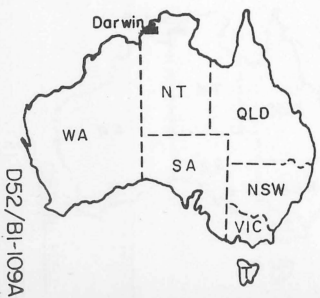
MA 31

Record No. 1976/91

CAPE SCOTT-PINE CREEK



LOCATION DIAGRAM



AIRBORNE SURVEY

FOG BAY-DARWIN, CAPE SCOTT-PINE CREEK, NT 1974-75

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250000 MAP SERIES

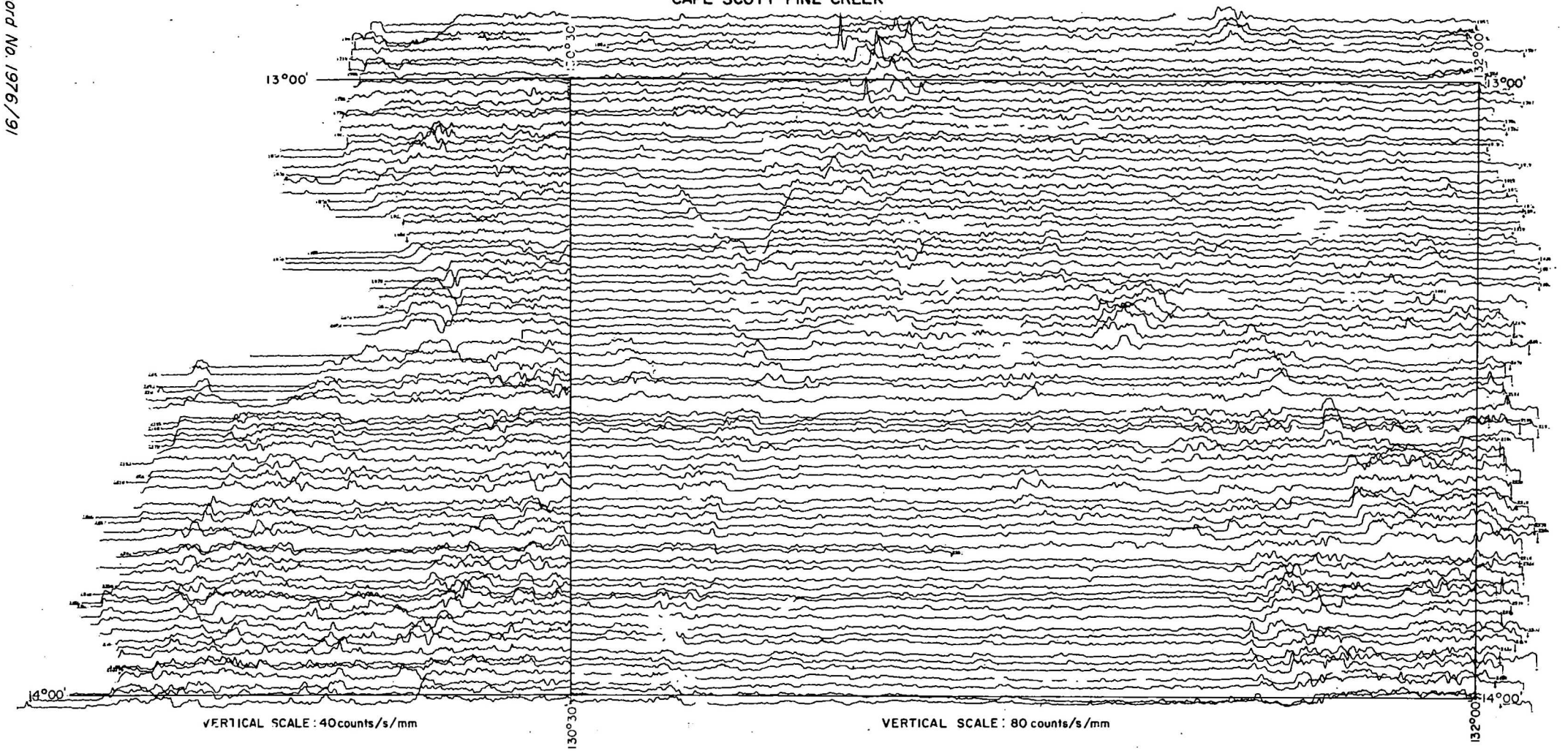
FOG BAY	DARWIN	ALLIGATOR RIVER
CAPE SCOTT	PINE CREEK	MOUNT EVELYN
PORT KEATS	FERGUSSON RIVER	KATHERINE

D52/B1-109A

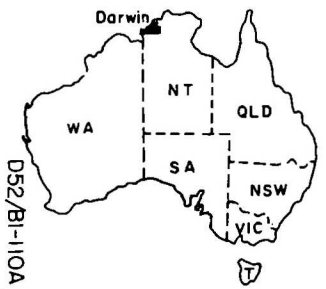
MA 32

Record No. 1976/91

CAPE SCOTT-PINE CREEK



LOCATION DIAGRAM



D52/B1-110A

AIRBORNE SURVEY

FOG BAY-DARWIN, CAPE SCOTT-PINE CREEK, NT 1974-75

RADIOMETRIC PROFILES, TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

REFERENCE TO 1:250 000 MAP SERIES

FOG BAY	DARWIN	ALLIGATOR RIVER
CAPE SCOTT	PINE CREEK	MOUNT EVELYN
PORT KEATS	FERGUSSON RIVER	KATHERINE

MA 33

CUNDEELEE

CONTOUR INTERVAL 25nT

AIRBORNE SURVEY

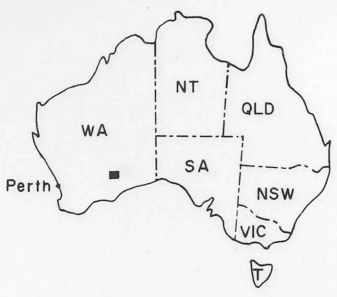
RASON, MINIGWAL, PLUMRIDGE, CUNDEELEE, WA 1970-71

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM

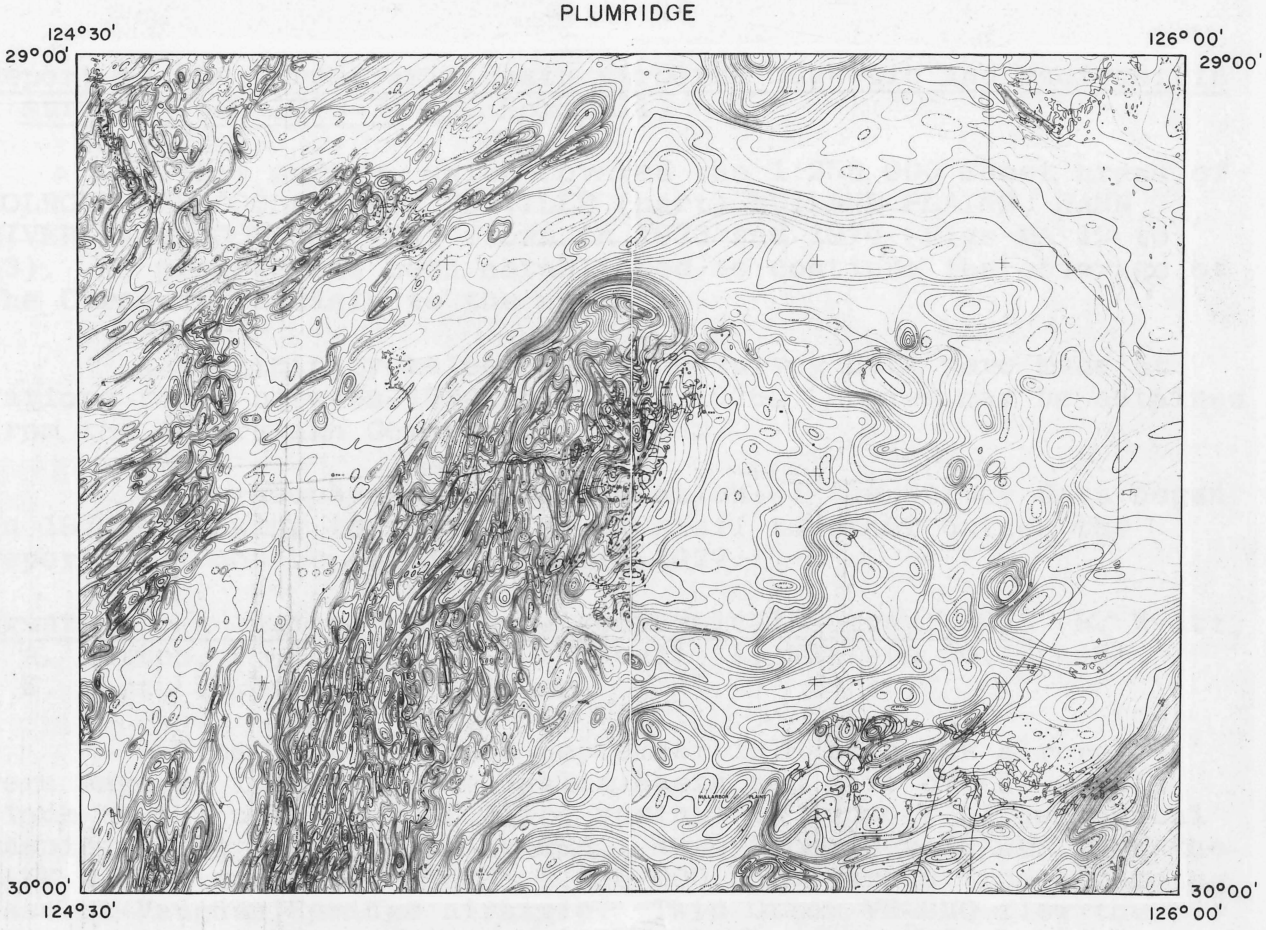


REFERENCE TO 1:250 000 MAP SERIES

EDJUDINA	MINIGWAL	PLUMRIDGE
KURNALPI	CUNDEELEE	SEEMORE
WIDGIE-MOOLTHA	ZANTHUS	NARETHA

Data purchased from Ausminex
Contours drawn by G.R.D.

PLUMRIDGE



CONTOUR INTERVAL 25nT

AIRBORNE SURVEY

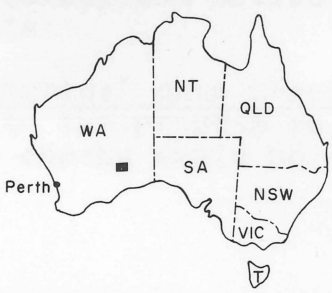
RASON, MINIGWAL, PLUMRIDGE, CUNDEELEE, WA 1970-71

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



REFERENCE TO 1:250000 MAP SERIES

RASON	NEALE	VERNON
MINIGWAL	PLUMRIDGE	JUBILEE
CUNDEELEE	SEEMORE	LOONGANA

Data purchased from Ausminex
Contours drawn by G.R.D.

Report on the Carpentaria Basin airborne magnetic and radiometric survey, Qld, 1973-74 (K. Horsfall)

This survey, which covered the 1:250 000 Sheet areas of HOLROYD, EBAGOOLA, CAPE MELVILLE (part) RUTLAND PLAINS, HANN RIVER, and COOKTOWN, was flown in 1973 and 1974 (Figs MA 19 to 23). No program has been established to continue the coverage of the Carpentaria Basin to the north.

Preliminary releases of the survey data were made at various times between 1974 and April 1976. Copies may be obtained from the Australian Government Printer.

The geophysical interpretation of the survey data began in 1976 but owing to a transfer of staff to other duties the report will not be completed until 1977.

Arunta Block regional airborne geophysical survey, 1976 (B. Wyatt, A. Mutton, P. Bullock, I. O'Donnell, L. Winters, G. Greene, K. Mort, S. Wilcox, L. Miller)

From 19 July to 28 September 1976 both BMR aircraft were engaged in flying the Ngalia Basin and part of the Arunta Block to the northwest of Alice Springs in support of geological mapping being carried out by BMR. Aero Commander VH-BMR flew the LAKE MACKAY and MOUNT DOREEN 1:250 000 Sheet areas from a camping base at Vaughan Springs airstrip. Twin Otter VH-BMG flew the BURT 1:100 000 Sheet area and MOUNT PEAKE, NAPPERBY, and the northern half of HERMANNSBURG 1:250 000 Sheet areas from Alice Springs (Figs MA 8 and 9).

The survey was flown at 100 m ground-clearance along north-south lines 1.5 km apart. Both aircraft were equipped with a fluxgate magnetometer, four-channel gamma-ray spectrometer, and a radio altimeter. Data were digitally recorded.

Systems development in survey aircraft VH-BMG (Twin Otter) and VH-BMR (Aero Commander) (D. Downie)

The most important development in aircraft equipment systems in 1976 was the replacement of the Hewlett Packard 2114B computer in the digital acquisition system in VH-BMG with a Hewlett Packard 21MX. This lighter weight and physically smaller computer was equipped with a much larger memory which made possible the development of more sophisticated data acquisition software. As a result, useful improvements were made in both the accuracy and reliability of the system in the following respects:

i) Numerical data checking. Several checking routines were added to the program so that a variety of in-flight and post-flight checks would be made of recorded data quality by address-

ing the computer through the system's teleprinter. Advantage was taken of the rewind and read facility of the tape recorder to enable samples of recorded data to be verified at regular intervals. This removed the reliance on the flux check facility as a means of detecting tape-writing errors which had proved unsatisfactory in the past. The possibility of recording errors to remain undetected is now remote.

ii) Doppler system accuracy. Although the Marconi AD 560 navigation system integrated with the airborne computer had proved to be a satisfactory means of flight-line navigation and recovery, some difficulties arose in the removal of gyrosin compass errors when changes in crosswind drift caused the aircraft to adopt a heading different from that for which compensation had been made at the start of flight. The new computer program makes it possible for changes in drift angle to be fed to the computer as they occur so that the computer can compensate for such changes by reference to a stored look-up table of previously measured compass errors.

A similar improvement was achieved in sea-drift compensation for offshore operations. It is now possible for estimated changes in sea drift to be incorporated as the flight progresses.

Generally airborne survey operations benefitted from the recruitment of two additional Technical Officers. In particular there was a marked improvement in the reliability and performance of the ALT 50 radio altimeters.

Documentation of airborne hardware and software systems proceeded throughout the year and it is expected that a comprehensive users' manual will be available to airborne field parties in 1977.

Airborne Reductions and Contracts Group (C. Leary, J. Rees, P. Bullock, A. Luyendyk, S. Chee, P. O'Rourke, O. Terron, J. Park)

ADP DEVELOPMENT. Refinements of the program library were completed to standardise the control for running all programs. The Input and Output routines were modified to compress data stacking. This has resulted in enhanced cost effectiveness of data processing by virtue of reducing disc space used and data access requirements.

Three documents have been produced to define the data processing system and general operating procedures.

1. System manual This describes procedures for management of data processing projects, program control, the program library data and file structures, and data processing facilities. The manual includes a section outlining the special needs of airborne survey data processing.

2. Project catalogue This documents all airborne survey data held in analogue or digital form and defines access and maintenance procedures for the data of all projects.

3. Software catalogue This is the formal documentation of the function and use of every module in the program library.

DATA PROCESSING AND PRESENTATION. The status of the processing and presentation of airborne data as it is expected to be at the end of 1976 is shown in Table 1. During the year the data processing for 15 map areas was started and the work completed on 9 map areas. This resulted in the production of 53 geophysical data profile maps and flight path and 20 contour maps. Because of the lack of computing funds during the first half of the year and staff shortages throughout the year a backlog of 3 man-years processing has accumulated.

PRELIMINARY MAP RELEASES. The maps displaying magnetic and gamma-ray contours and stacked profiles as released through the Government Printer and the relevant State mines departments during 1976 are shown in Table 2. There has been an output of 156 maps relating to 22 map areas.

OFFICER BASIN CONTRACT. The aeromagnetic survey of 16 map areas in the Officer Basin, W.A. began at the end of November 1975. The status of operational flying and processing of the navigational and magnetic data is shown in figure MA10. It is expected the contract will be completed by 30 April 1977.

MAGNETIC MAP OF AUSTRALIA. The production by contract of the airborne magnetic contours was completed in February. Marine magnetic contours produced by BMR were merged with the airborne data resulting in the completion of the map in late July and its release in August.

2. SEISMIC, GRAVITY, AND MARINE SECTION (A. Turpie)

The BMR seismic recording equipment was upgraded early in 1976 with the purchase of a Texas Instruments DFSIV seismic digital recording system. The DFSIV and ancilliary equipment was field-tested at Braidwood, NSW, before a major seismic and gravity survey in the Galilee Basin, Qld.

Professional and technical staff from the Seismic and Gravity Groups continued to work in the Marine Group to supplement the effort there mainly on the assessment and processing of data and interpretation of results from the Continental Margins Survey, 1970-1973. Members of the Marine Group participated actively in co-operative marine surveys with the Lamont-Doherty Geological

TABLE 1. DATA PROCESSING AND PRESENTATION 1976

C = Processing completed P = Processing in progress S = Data Stockpiled

PROJECT	MAP NAMES	SURVEY			CONFIGURATION		DATA STATUS		CONTOUR MAPS			PROFILE MAPS		
		Mag	Gamma Ray	Doppler	Spacing km	Alt m	Mag	Gamma Ray	No of Maps	Scale	Data Type	No of Maps	Scale	Data Type
Gawler Blk	Pt Augusta	X	X		1.5	150	C	C	1	250 000	Mag	4	250 000	Gamma Ray
												2	250 000	Nav/Alt
Willyama	Broken Hill (Detail)	X	X	X	.3	100	C	C	10	25 000	Mag	1	100 000	Mag
									1	100 000	Mag	5	100 000	Gamma Ray
									1	100 000	Ray	2	100 000	Nav/Alt
Lachland G/S	Cootamundra	X	X		1.5	150	S	S						
	Bairnsdale	X	X	X	1.5/3.0	150	S	S						
	Ulladulla	X	X	X	1.5	650	S	S						
	Bega	X	X	X	1.5	650	S	S						
Pine Creek	Darwin	X	X	X	1.5	150	C	C	1	250 000	Mag	1	250 000	Mag
												4	250 000	Gamma Ray
												2	250 000	Nav/Alt
	Fog Bay	X	X	X	1.5	150	C	C	1	250 000	Mag	1	250 000	Mag
												4	250 000	Gamma Ray
												2	250 000	Nav/Alt
	Pine Crk	X	X	X	1.5	150	C	C	1	250 000	Mag	1	250 000	Mag
												4	250 000	Gamma Ray
												2	250 000	Nav/Alt
	Cape Scott	X	X	X	1.5	150	C	C	1	250 000	Mag	1	150 000	Mag
												4	250 000	Gamma Ray
												2	250 000	Nav/Alt
	Fergusson R.	X	X	X	1.5	150	C	C	1	250 000	Mag	1	250 000	Mag
												4	250 000	Gamma Ray
												2	250 000	Nav/Alt
	Mt Evelyn	X	X		1.5	150	P	P						
	Katherine	X	X		1.5	150	P	P						
Mt Isa	Duchess	X	X	X	1.5	150	P	P						
Arunta	Mt Peake	X	X	X	1.5	100	P	P						
	Napperby	X	X	X	1.5	100	P	P						
	Hermansburg	X	X	X	1.5	100	P	P						

TABLE 1 (continued) C = Processing completed P = Processing in progress S = Data Stockpiled

PROJECT	MAP NAMES	SURVEY			CONFIGURATION		DATA STATUS		CONTOUR MAPS			PROFILE MAPS		
		Mag	Gamma Ray	Doppler	Spacing km	Alt m	Mag	Gamma Ray	No of Maps	Scale	Data Type	No of Maps	Scale	Data Type
	Mt Doreen	X	X		1.5	100	S	S						
	Lake Mackay	X	X		1.5	100	S	S						
Yilgarn	Hyden	X	X				S	S						
	Dumbley	X	X	X	1.5	150	S	S						
	Newdegate	X	X	X	1.5	150	S	S						
Officer Bsn	Robert	X			3.0	600	C	C	1	250 000	Mag	1	250 000	Mag
												1	250 000	Nav
	Throssell	X			1.5	600	C	C	1	250 000	Mag	1	250 000	Mag
												1	250 000	Nav

TABLE 2: PRELIMINARY AIRBORNE MAP RELEASES 1976

Project	Map Names	No of Maps	Scale	Contours	Profiles	Fig No
Broken Hill	Broken Hill (Regional)	1	250 000	Magnetic		MA11
	"	1	250 000	Gamma Ray		MA12
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Broken Hill (Detail)	10	25 000	Magnetic		MA13
	"	1	100 000	Magnetic		
	"	1	100 000	Gamma Ray		MA14
	"	1	100 000		Magnetic	
	"	7	100 000		Gamma Ray	
Carpentaria	Ebagoola	6	250 000		Gamma Ray	MA19
	Holroyd	6	250 000		Gamma Ray	MA20
	Cooktown	6	250 000		Gamma Ray	MA21
	Hann River	6	250 000		Gamma Ray	MA22
	Rutland Plains	6	250 000		Gamma Ray	MA23
Lachlan Geosyncline	Ballarat	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA24
	St Arnaud	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Wagga Wagga	6	250 000		Gamma Ray	MA25
Gawler	Port Augusta	1	250 000	Magnetic		MA26
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA27
	Whyalla	1	250 000		Magnetic	
		6	250 000		Gamma Ray	MA29
	Lincoln	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA28
	Maitland	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA28
Pine Creek Block	Darwin	1	250 000	Magnetic		MA30
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA31
	Fog Bay	1	250 000	Magnetic		MA30
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA31
	Pine Creek	1	250 000	Magnetic		MA32
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA33
	Cape Scott	1	250 000	Magnetic		MA32
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA33
	Fergusson River	1	250 000	Magnetic		MA15
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	MA16

TABLE 2 (continued)

Project	Map Names	No of Maps	Scale	Contours	Profiles	Fig No
Officer Basin	Robert	1	250 000	Magnetic		MA18
	"	2	250 000		Magnetic	
	Throssel	1	250 000	Magnetic		MA17
	"	2	250 000		Magnetic	
Yilgarn Block	Cundeelee	1	250 000	Magnetic		MA34
	Plumridge	1	250 000	Magnetic		MA35
		156				

Observatory, USA and the Woods Hole Oceanographic Institution, USA and arrangements are being made to co-operate in future surveys planned by Lamont and the West German Government. Magnetic measurements were made off Western Australia from HMAS Diamantina and preparations were made for making magnetic measurements from vessels operated for bathymetric surveys by the Division of National Mapping. Preparations continued for future marine surveys by BMR.

The Seismic Group continued the review of geophysical and geological data for formulating proposals for forward seismic land surveys, and continued the interpretation and reporting on previous surveys and reviews. The Gravity Group cooperated with the Regional Gravity Group in the compilation and preparation of an integrated data bank of reconnaissance gravity data and production of a 1:5M Gravity Map of Australia. The interpretation and reporting on previous gravity work continued.

SEISMIC SURVEYS (F.J. Moss)

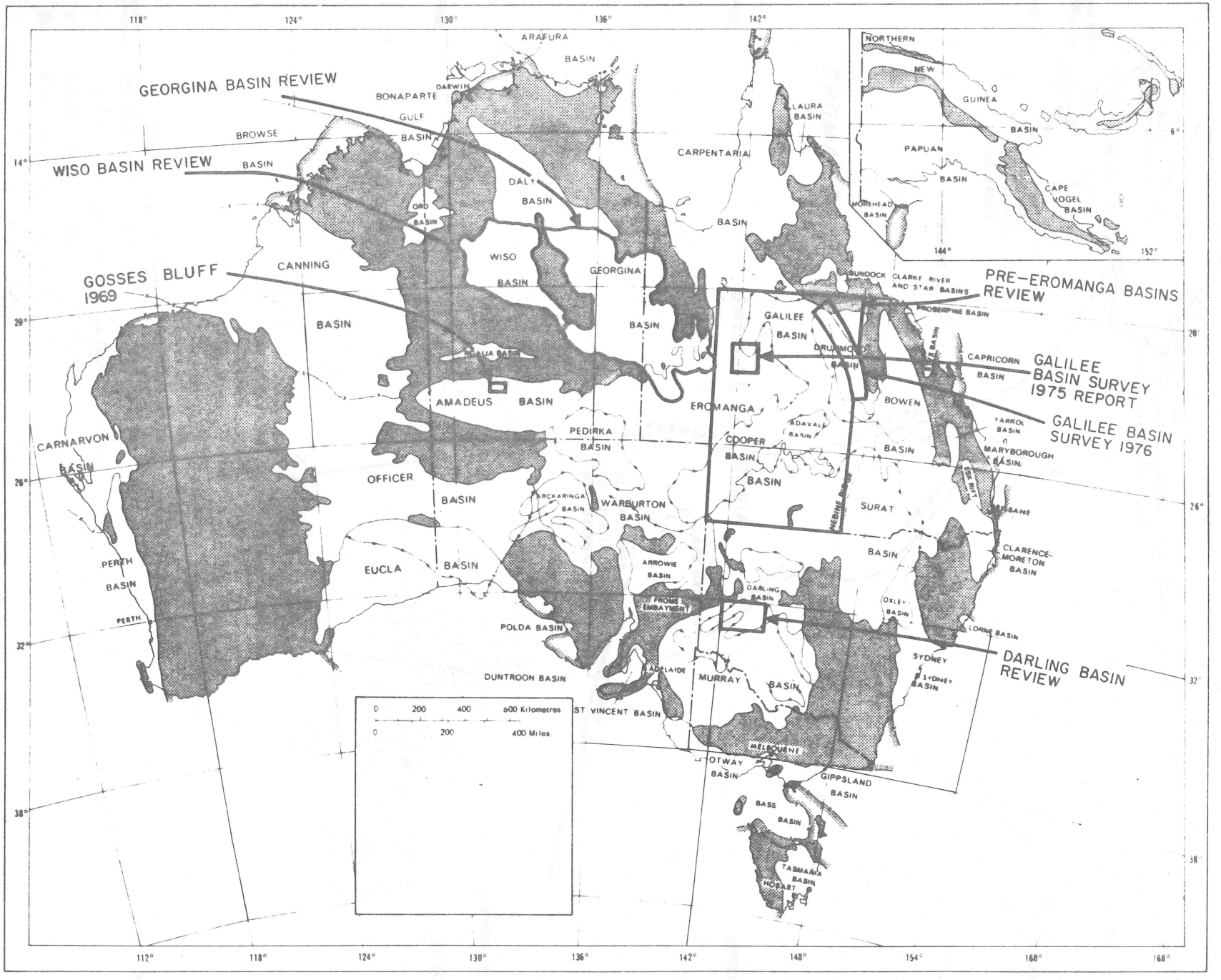
The areas concerned in the work of the Seismic Group are shown in Figure SGM1.

Galilee Basin seismic survey, Qld, 1976 (J. Pinchin, J.A. Bauer, P. Petkovic, D.L. Schmidt, F.M. Brassil, J.K.C. Grace, G.S. Jennings, W. Trenchuk, W.E. Gunner, R.D.E. Cherry, L.A. Rickardsson, A. Nelson (G.S.Q.)).

A seismic survey was made in the eastern part of the Galilee Basin from August to November 1976. The locations of seismic traverses are shown in Figure SGM2.

The objectives of the survey in the north (Traverses 1 & 2) were to investigate the thickness and structures of the Galilee Basin sediments and to provide information on the nature of the basin margins. Midway up the eastern margin Traverse 3 was ran from east of the Lake Galilee No. 1 well over the margin near Clermont, with the main objective of providing information on the extent and structure of probable Lower Devonian sediments of Adavale Basin age underlying Drummond Basin sediments. In the southern part of the basin Traverse 4 is planned to tie previous seismic traverses near Jericho No. 1 well in the west to outcrops of the basal unit of the Drummond Basin in the east, to determine whether the sediments encountered at the bottom of Jericho No. 1 well are part of the Drummond or of the Adavale Basin sequence.

Traverse 1 extended 54 km northeast from Torrens Creek, where it was tied to a previous traverse; it passed through the GSQ Hughenden 3-4R stratigraphic hole, and crossed the northeastern margin of the Galilee Basin near Pentland. Six-fold CDP



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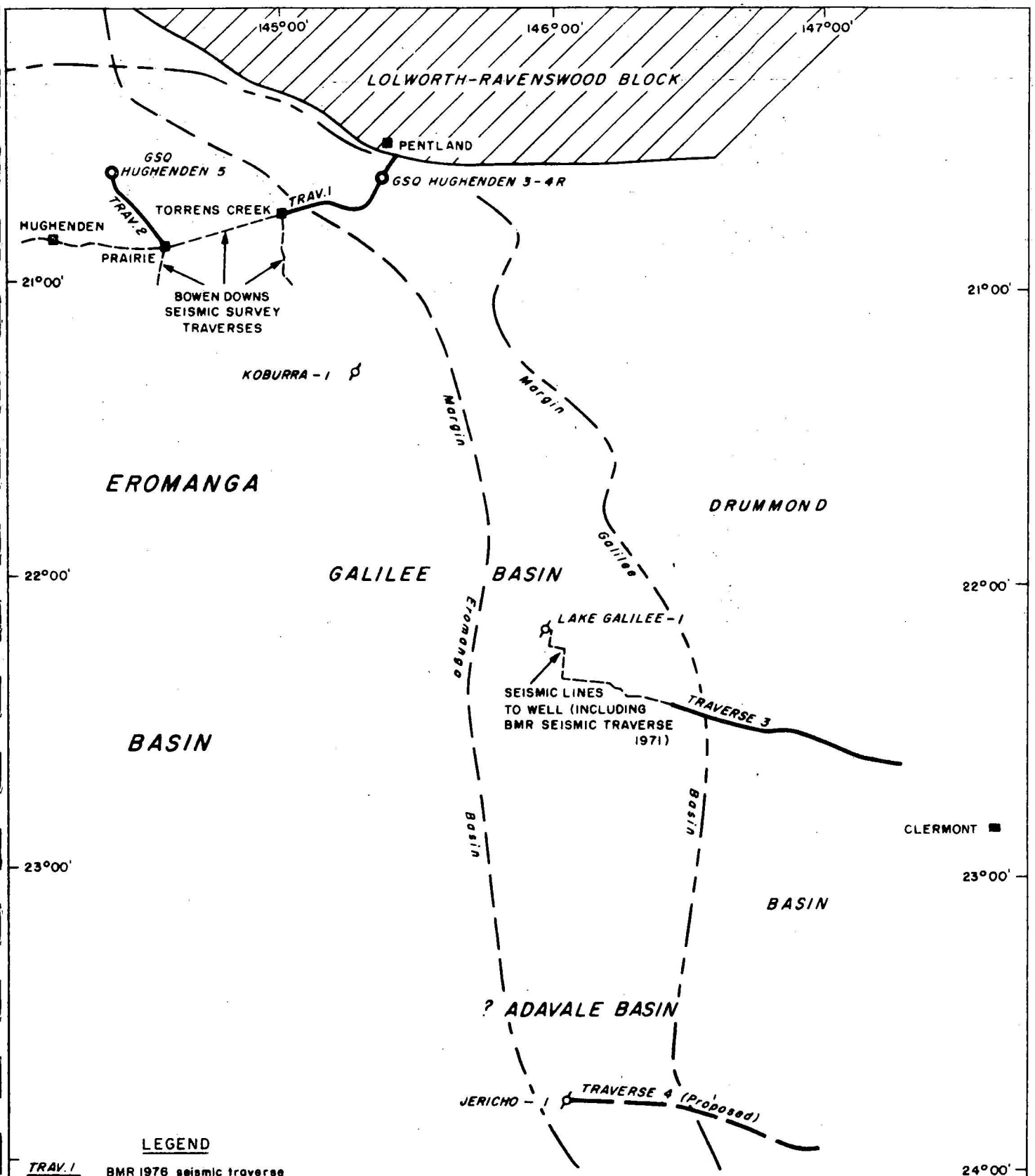
AREAS COVERED BY SEISMIC REVIEWS, REPORTS AND SURVEYS

SGM 2



LEGEND

TRAV.1 — BMR 1976 seismic traverse

Previously recorded seismic traverses (some only shown)

Petroleum exploration well

Stratigraphic hole

SCALE

20 0 20 40 km

GALILEE BASIN SEISMIC SURVEY, QLD 1976

Record No. 1976/91 F55/B3-119A

reflection shooting gave field records of fair to poor quality. Only one reflection, the Permian 'P' horizon was clearly visible on the field records; this horizon shallows gradually from about 1000 m at Torrens Creek to where it is near the surface at GSQ Hughenden 3-4R.

From GSQ Hughenden 5 stratigraphic hole, northeast of Hughenden, Traverse 2 extended 35 km southeast to Prairie where it was tied to a previous traverse. The record quality using 6-fold CDP shooting was fair. The 'P' horizon deepened gradually southeastwards from about 800 m to about 1100 m. Deeper reflections were evident on the field records at the southern end of the line but have not been interpreted yet.

Fair to poor-quality reflection events have been recorded over most of Traverse 3 in the Lake Galilee to Clermont area but no interpretation has been made of the reflection information at the end of October. The seismic party will move to the Jericho traverse late in the survey.

The seismic reflection results have been recorded using the new DFS IV digital seismic system and are being processed digitally by Geophysical Services International, Sydney. Gravity measurements along the seismic traverses will be interpreted with the seismic results.

Braidwood seismic test survey, NSW, 1976 (J. Pinchin, D.L. Schmidt, F.M. Brassil, G.L. Abbs, W. Trenchuk)

Field tests of the new DFS IV digital seismic recording system and associated equipment were made at Braidwood in June. The equipment performed satisfactorily, apart from two minor problems with the remote firing unit. About 10 km of 6-fold CDP reflection recordings were obtained using 50 kg charges. Preliminary results indicated fair to good-quality reflections from depths down to about 40 km. An attempt to interpret the results in terms of deep crustal and upper mantle structure will be made when the results have been digitally processed by Geophysical Services International, Sydney.

Galilee Basin seismic survey, Qld, 1975 (P.L. Harrison, J.A. Bauer, F.M. Brassil, D.L. Schmidt)

The processing, analysis, interpretation, and reporting on the results of the seismic survey in the Lovelle Depression in the western part of the Galilee Basin were done during the year. An operational report was prepared, giving details of the seismic and gravity work along seismic traverses and a preliminary interpretation of the seismic data. The preliminary interpretation was presented at the BMR Symposium.

Analogue processing was done to provide the data for preliminary analysis, and digital processing of about two-thirds of the data was done by Geophysical Services International. Several computer programs were developed for use with the HP 2100 computer for calculation of elevation and weathering corrections, time-depth conversion, and plotting cross-sections.

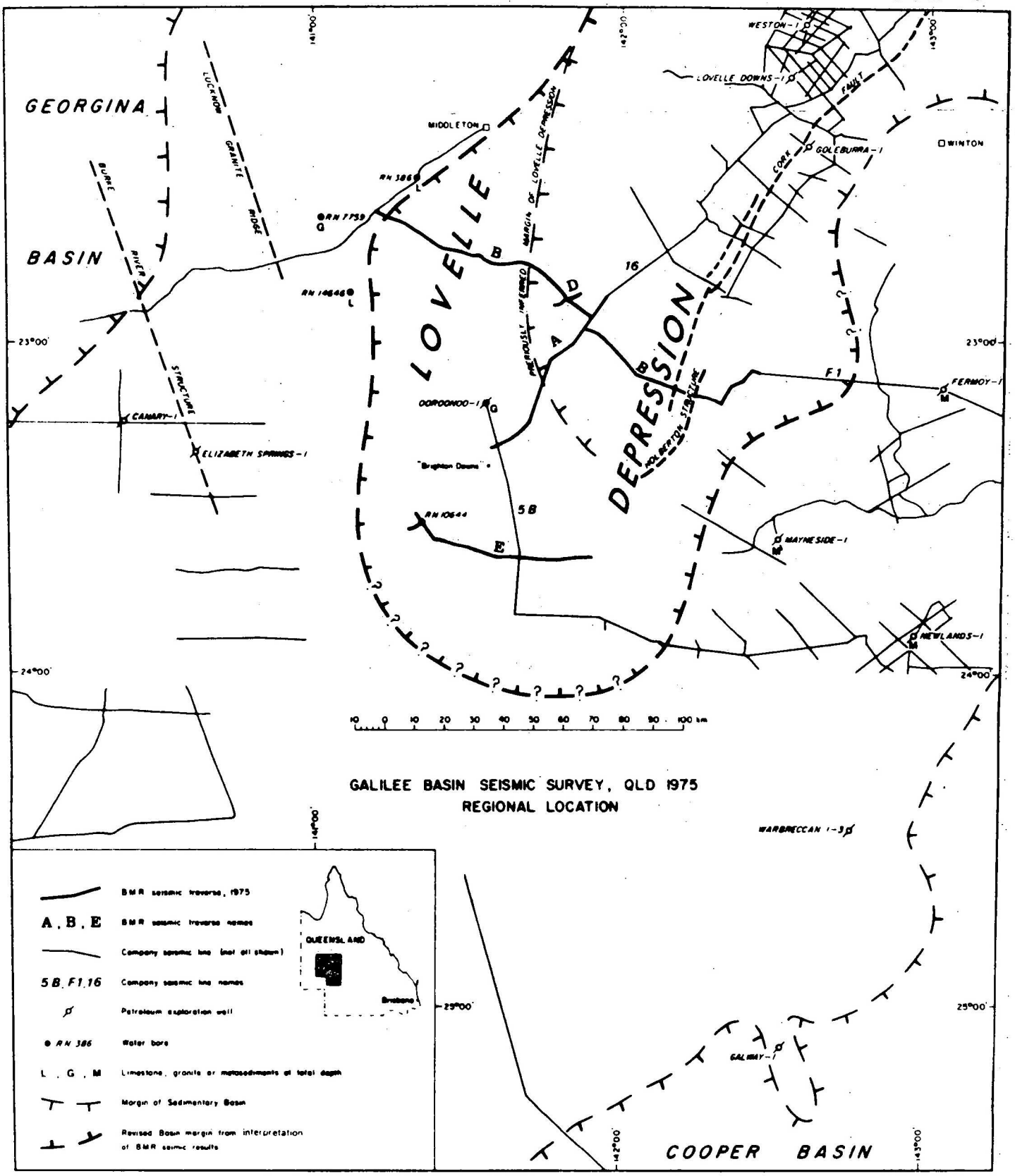
Four reflection horizons were mapped on the BMR traverses and previous company traverses in the Lovelle Depression. They were identified by ties to the Lovelle Downs No. 1, Fermoy No. 1, and Ooroonoo No. 1 wells as near top of the Cretaceous Toolebuc Formation, near top of the Lower Cretaceous/ Upper Jurassic Hooray Sandstone, near top of the Permian and basement. Structure contour maps of the four horizons, and an isopach map of the Permian have been produced at 1:250 000 scale. The Permian, comprising mainly terrestrial sandstones, siltstones, and thick coal sequences, is overlain by Eromanga Basin sediments ranging in thickness from 650 m to 2000 m. By analogy with the Permian of the Cooper and Bowen Basins the Galilee Basin here has some hydrocarbon potential.

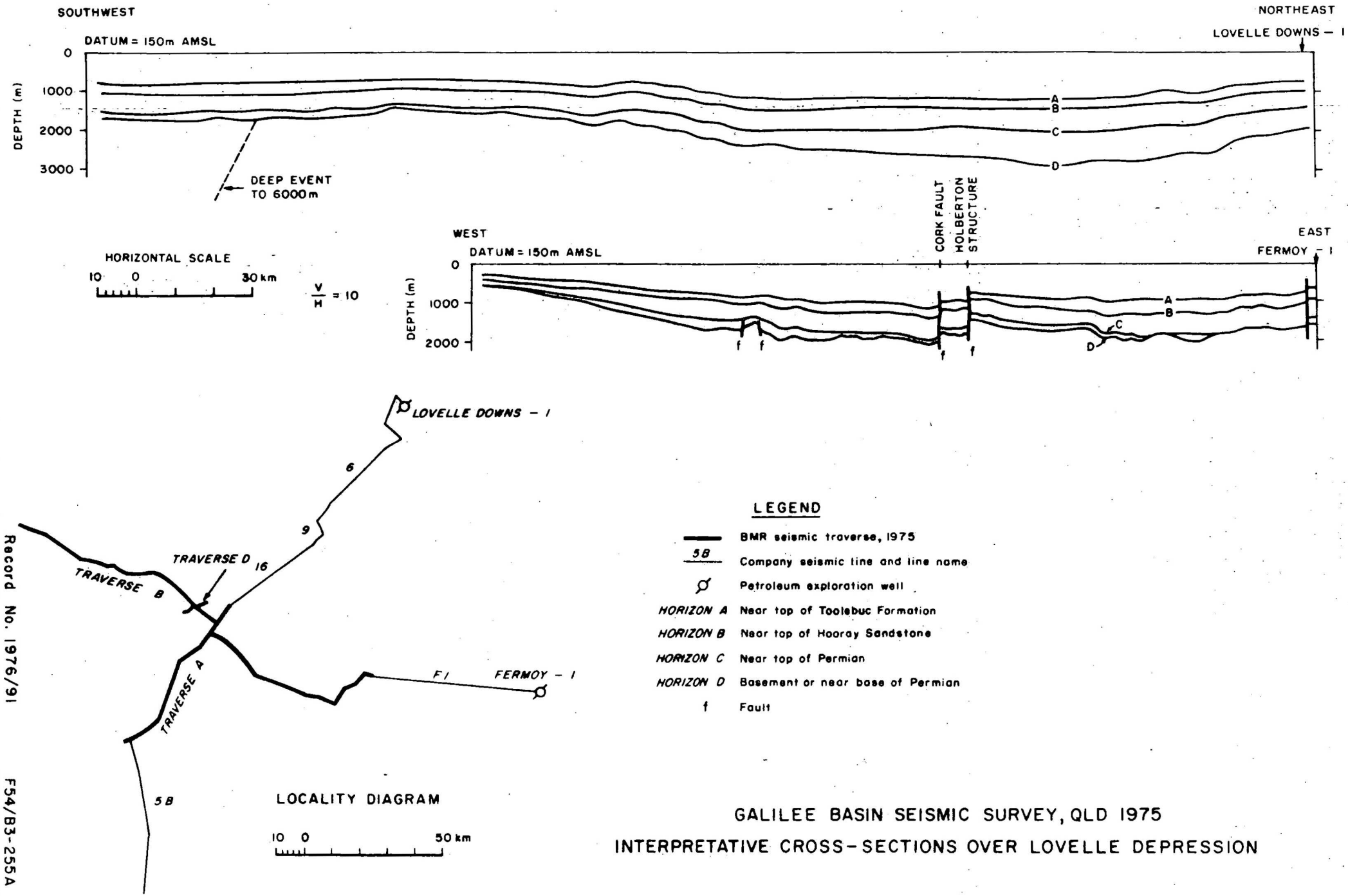
The Permian sediments in the Lovelle Depression are more extensive than was previously recognized as indicated in Figure SGM3. The southerly limit, previously broadly defined by the absence of Permian in the Ooroonoo No. 1 and Mayneside No. 1 wells, was redefined as a result of the interpretation of the BMR results and reinterpretation of previous company results to indicate the presence of Permian Sediments at the southern end of Line 5B. The Ooroonoo No. 1 well is now believed to have been drilled on a basement high which has Permian sediments on the flanks but no Permian on top of the feature.

Although the southern limit of the Galilee Basin Permian sediments is only placed tentatively it is unlikely that a direct link now exists with the Cooper Basin. The Permo-Triassic sequence in the Cooper Basin appears to thin out completely about 100 km south of Line 5B. Permo-Triassic sediments may, however, exist in pockets on the large unexplored area between the basins.

Structural information on the nature of the eastern and western margins of the Lovelle Depression was obtained on Traverses B and E. Cross-sections in the Lovelle Depression are shown in Figure SGM4.

The seismic results on Traverse B indicated some significant structure. The Holberton Structure, previously inferred from geological mapping, was shown to be a fault with a downthrow of about 400 m to the west. Another fault, with a downthrow of about 200 m to the west, lying about 10 km to the west of the Holberton Structure, has been interpreted as the southerly con-


GEORGINA
BASIN
LOVELLE
DEPRESSION
LUCKNOW GRANITE RIDGE
BURKE RIVER STRUCTURE
MARGIN OF LOVELLE DEPRESSION
PREVIOUSLY INFERRED
ISOLATION STRUCTURE
FAULT
CORK
MIDDLETON
WESTON-1
LOVELLE DOWNS-1
GOLEBURRA-1
WINTON
RN 3869
RN 7759
RN 14646
RN 10644
OORDONOO-1
"Brighton Downs"
CANARY-1
ELIZABETH SPRINGS-1
FERMOY-1
MAYNESIDE-1
NEWLANDS-1
WARBRECCAN 1-3
GALWAY-1
COOPER BASIN
A
B
D
E
F1
16
5B
23°00'
24°00'
25°00'
140°00'
141°00'
145°00'
146°00'
0 10 20 30 40 50 60 70 80 90 100 km
GALILEE BASIN SEISMIC SURVEY, QLD 1975
REGIONAL LOCATION
BMR seismic traverse, 1975
A, B, E BMR seismic traverse names
Company seismic line (not all shown)
5B, F1, 16 Company seismic line names
Petroleum exploration well
RN 386 Water bore
L, G, M Limestone, granite or metasediments at total depth
Margin of Sedimentary Basin
Revised Basin margin from interpretation of BMR seismic results
QUEENSLAND
Brisbane



GALILEE BASIN SEISMIC SURVEY, QLD 1975

INTERPRETATIVE CROSS-SECTIONS OVER LOVELLE DEPRESSION

Record No. 1976/91

F54/B3-255A

SGN 4

tinuation of the Cork Fault. A basement high was found on Traverse B and cross-Traverse D. The high which is about 5 km x 2.5 km is faulted on its flanks and is elevated about 150 m above the general basement level. The Permian sediments are draped over the high and appear to thin from about 300 m on the flanks to about 100 m on the crest of the structure with closure at the top of the Permian.

Steeply-dipping seismic reflection events recorded from below the Permian on Traverse E and Line 5B have been interpreted to indicate pre-Permian sediments or metamorphics up to 10500 m thick and dipping to the southeast. The nature of the sequence is not known, but it could be related to metasediments similar to those on the Maneroo Platform to the east or Proterozoic sediments to the west.

Pre-Eromanga basins review (L.A. Tilbury, F.M. Brassil, V. Carberry, J. Purcell)

The review began in 1975 with the objective of studying geophysical and geological information in the basins underlying the Eromanga Basin, to indicate areas where additional seismic surveys may be required. The objectives of the 1975 and 1976 seismic surveys in the Galilee Basin were defined in the early stages of the review.

The need for accurate seismic shot-point location maps and better-quality seismic reflection cross-sections than those presented in private company reports for surveys mainly done in the 1960s was recognized early in the project. The main effort so far has been to produce new cross-sections using the BMR analogue processing equipment and in digitizing and replotting the seismic location maps.

Shot-point location maps for all seismic surveys in the northern Eromanga Basin between latitudes 20°S and 24°S and longitudes 141°E and 147°E, and about 80% of seismic surveys in the central Eromanga Basin between latitudes 24°S and 29°S and longitudes 141°E and 147°E have been digitized, plotted using the Cyber 76 computer on 1:100 000 scale and checked against the original location maps. The checked coordinates for these surveys are stored on a computer file and can be plotted on any scale and projection. A guide to the digitizing and production of the shot-point location maps has been prepared.

The review will continue with completion of shot-point location maps for other parts of the Eromanga Basin, re-interpretation of the seismic cross-sections, the production of cross-sections between wells using seismic control, and contour maps for the main reflection horizons.

Wiso Basin review, N.T. (S.P. Mathur)

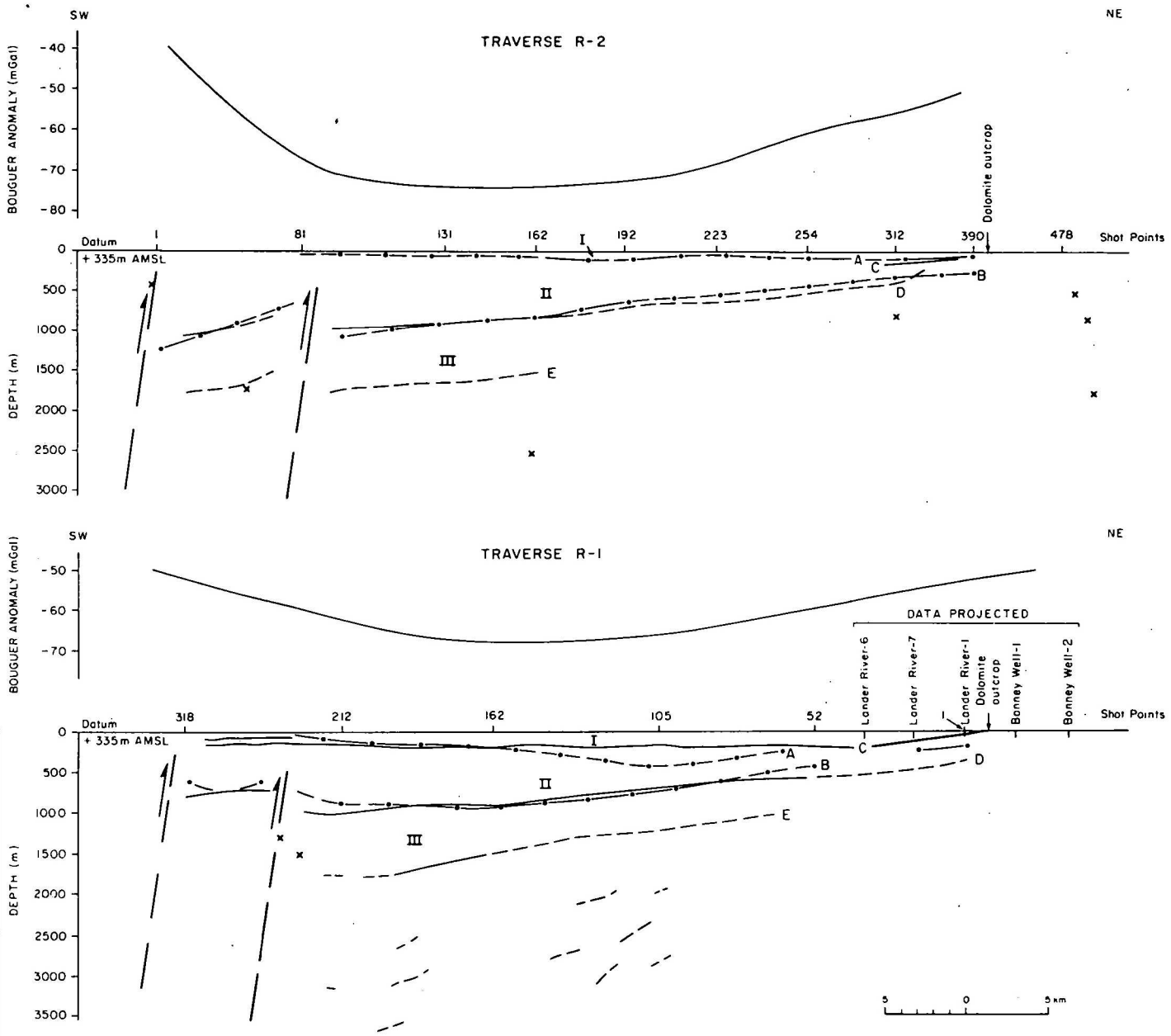
The review of geophysical and geological information in the Wiso Basin continued in co-operation with P. Kennewell, Geological Branch and P.G. Wilkes. The joint studies were confined to the Lander Trough area in which American Overseas Petroleum Ltd had conducted the only seismic survey in the Wiso Basin.

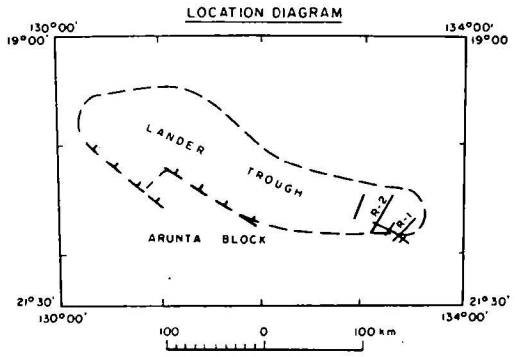
The seismic results, Bouguer anomalies, magnetic basement depths and relevant bore-hole and surface geological information are shown along two seismic traverses on the section in Figure SGM5. The differences indicated between the depths to Refractor A and Reflector C and between the depths to Refractor B and Reflector D are within $\pm$ 20%, considered to be within the accuracy of the methods in the area. Thus these refactors and reflecting horizons probably represent the same geological discontinuities.

The shallow bore-hole and surface geological information indicate that about 60 m of Lower Palaeozoic Lake Surprise Beds overlie dolomite of the Ordovician Hanson River Beds in Lander River No. 1 Bore near the northeastern end of Traverse R-1, and the dolomites crop out near SP390 on Traverse R-2. This suggests that Refactor A/Reflector C represents the boundary between Lake Surprise Beds and Hanson River Beds. The interface represented by Refractor B/Reflector D, if projected to the northeast along Traverse R-2, comes close to the surface in the area where the aeromagnetic data yield shallow magnetic basement depths. This interface probably represents the base of Palaeozoic sediments.

The geophysical and geological data suggest the presence of three main rock sequences:- Layer I consisting of flat-lying Lake Surprise Beds, Layer II consisting of Hanson River Beds and Lower Palaeozoic sediments in a trough faulted near its margin in the southwest, and Layer III consisting of Proterozoic basement rocks. The regional Bouguer anomalies show a low, in the Lander River Sheet area, which is much larger in extent and magnitude than can be accounted for by the trough of sediments suggested by the seismic data. The anomalies thus imply that the trough is an area of crustal downwarp bounded by deep crustal faulting in the south. The aeromagnetic basement depth estimates support the interpretation that Refractor B/Reflector D represents the basement of the Palaeozoic sediments.

A geophysical contribution to a review paper on the geology and geophysics of the Lander Trough has been prepared and a contribution to the proposed Bulletin on the Wiso Basin is almost completed.





REFLECTION VELOCITIES ESTIMATED

0 – 0·2s	2135 m/s
0·2s – D	3050 m/s
Below D	6100 m/s

REFRACTION VELOCITIES MEASURED

Layer I	2100 – 2930 m/s
Layer II	3260 – 4180 m/s
Layer III	5790 – 6460 m/s

LEGEND

- Geological boundary
- Reflector (fair)
- Reflector (poor)
- Refractor (fair)
- Refractor (poor)
- Magnetic Basement depth estimates

$\frac{V}{H} = 5$

SECTIONS ACROSS LANDER TROUGH, WISO BASIN, NT

Georgina Basin review, N.T. & Qld (S.P. Mathur)

Magnetic, seismic survey, and exploration well data have been compiled and indexed, and shot-point location maps for the seismic traverses have been prepared. The review of geophysical and geological information in the Toko Syncline in the southeastern part of the basin is continuing. An initial objective of the review is to indicate areas where further seismic surveys may be necessary to assist in providing a better understanding particularly of the structure of the southeastern part of the basin and its margins. The results of the review will be integrated with information from geological field mapping being done by the Geological Branch.

Darling Basin review, NSW (S.P. Mathur, H.M.J. Stagg, P.L. Harrison, J.A. Bauer)

A brief review was made of the geology and geophysics of the three main sub-basins, viz., Bancannia, Menindee, and Blantyre Troughs of the Silurian-to-Lower Carboniferous Darling Basin where these are overlain by Murray Basin sediments. The purpose of the review was to outline areas where additional seismic surveys could be made principally to investigate the Lower Devonian marine sequence which is considered to have petroleum source-rock potential.

Previous seismic surveys have indicated the presence of up to 7500 m of sediments in the troughs. Exploratory wells have penetrated only about 3400 m of sediments in the Bancannia Trough and about 2300 m of sediments in the Blantyre Trough: no deep wells have been drilled in the Menindee Trough. Most wells bottomed in Upper Devonian Red Beds, but Mt Emu No. 1 well, drilled on a local basement high in the Blantyre Trough, penetrated about 700 m of the Lower Devonian marine sequence of the Amphitheatre Formation.

The review suggests that the northern and western flanks of the Blantyre Trough and the eastern, western and northern flanks of the Menindee Trough should be investigated to look for Lower Devonian sediments at shallow depth. An important objective for any future seismic surveys will be to tie between existing seismic surveys, tie to well and extend traverses to outcrops to provide an integrated interpretation. Since the seismic data obtained so far on the troughs seem to deteriorate in quality towards the margins of the troughs seismic techniques using high multiplicity coverage digital recording and processing would appear to be necessary to obtain improved quality data. A seismic survey of approximately 3 months duration involving approx 300 km of single and CDP coverage is envisaged to provide the necessary information.

Long-term seismic program (F.J. Moss, S.P. Mathur)

Record 1975/20 on preliminary long-term program proposals for land seismic investigations by BMR was distributed to State Mines Departments and petroleum exploration companies active in Australia requesting comments and suggestions.

In the replies received, mostly there was general agreement with the BMR proposals, a small number suggested that BMR use only contracts services, and many suggestions were received concerning seismic problem areas where BMR might make a valuable contribution to a basic understanding of the regional geology.

Seismic surveys were suggested in the Adavale, Amadeus, Bonaparte Gulf, Bowen, Canning, Darling, Galilee, Georgina, Otway, and Perth Basins, and background information is being assembled to complement the information in the existing Record. A committee with representatives from Geophysical, Geological, and Petroleum Exploration Branches has been formed to consider the relative merits of these and other specific survey proposals.

Gosses Bluff, N.T. (D.J. Milton USGS, F.J. Moss, B.C. Barlow)

Work continued on completion of the regional and detailed geological maps of Gosses Bluff. Dr Milton visited BMR to assist in amendments to the compiled maps and to discuss the gravity and seismic interpretations. The need for preparing better-quality base maps for use particularly in the gravity interpretation became apparent in reviewing the compilation of the geological maps. Some further analysis of the gravity results is in progress and it is proposed to complete the geophysical contribution to the Bulletin, being prepared jointly by BMR and USGS, early in 1977.

Deep crustal and upper mantle studies by seismic reflection, refraction, and gravity methods (S.P. Mathur, F.J. Moss)

A paper has been written for publication in the BMR Journal, on the relation of Bouguer anomalies to the crustal and upper mantle structure in southwestern and central Australia. In southwestern Australia the regional Bouguer anomalies have been shown to be consistent with the model of the crust obtained from seismic reflection and refraction measurements. In central Australia, the anomalies can be interpreted in terms of a model of a folded and faulted two-layer crust which is compatible with the geological and sparse deep seismic data available in the area.

Little further work has been done on the compilation of the results from the deep seismic reflection soundings made since 1955 during seismic surveys throughout Australia.

Seismic data processing (G.L. Abbs, W. Trenchuk)

During the year a large number of cross-sections were produced for the pre-Eromanga basins review and from the Galilee Basin using data obtained by both BMR and private companies. Generally the presentation of the older company data showed an improvement over previous presentation. The performance of the MS-42 seismic data processing equipment continues to be satisfactory despite evidence of wear in the magnetic playback heads. Two used headbanks have been purchased from SIE, Brisbane and these should be satisfactory throughout the remaining use of the equipment.

Some computer programs were developed for use on the BMR HP2100 computers. These were mainly for use in the computations of weathering and elevation corrections, velocity analysis, and in time-depth conversion plots along traverses.

Seismic analogue data from the Galilee Basin Seismic Survey 1975 were digitally processed by Geophysical Service International, Sydney and data from the 1976 survey were processed during the survey.

Seismic equipment (J. Pinchin, G.L. Abbs, W. Trenchuk, J.K. Grace, G.S. Jennings)

The PT-700/PMR-20 analogue seismic equipment and ancillary equipment was removed from the main seismic recording cab and set up in the laboratory. The cab was renovated to house the DFS IV digital seismic recording equipment. The DFS IV arrived in May and Mr D. Stringer, a Texas Instruments engineer from Houston USA, assisted in setting up the equipment and conducted a two-weeks course on the theory and operation of the equipment. On completion of the course Mr Stringer supervised the installation of the DFS IV and associated equipment in the cab and assisted in a two-weeks equipment test and familiarization survey at Braidwood NSW. Several minor problems on the DFS IV were fixed and the equipment performed satisfactorily.

The new equipment continued to operate satisfactorily during the Galilee Basin Seismic Survey. However, there have been a number of problems with ancillary equipment including the Input/Output Seismic Source Synchronizer, the TRO-6 oscillograph camera, the Geospace electrostatic camera, and the new seismic cables designed for CDP work.

GRAVITY SURVEYS (F.J. Moss, W. Anfiloff)

Galilee Basin gravity survey, 1976 (W. Anfiloff)

Gravity measurements were made along four seismic traverses in the HUGHENDEN, GALILEE and JERICHO 1:250 000 Sheet areas, in conjunction with the BMR seismic survey in the eastern

part of the Galilee Basin, Qld. The gravity results will be interpreted with the seismic results to provide information on the structure of the eastern margin of the Galilee Basin.

Galilee Basin gravity survey, 1975 (C. Allen, W. Anfiloff)

Gravity measurements were made at shot-points along seismic traverses during the 1975 Galilee Basin Seismic Survey in the Lovelle Depression.

The interpretation of the gravity results is being made jointly with that of the seismic results. On Traverse B, the main trans-basin seismic traverse through 'Old Cork' station, the gravity anomalies cannot be attributed solely to basin sediments and structures. A possible interpretation of the gravity results along Traverse B (Fig. SGM6) indicates density variations within the basement accounting for the major parts of the anomalies. The prominent negative anomaly at the western end of the traverse is part of a northwest-trending elongate low seen in the reconnaissance gravity map and is probably caused by a granite body beneath the Upper Palaeozoic and Mesozoic sediments, part of which crops out in the north-western part of the elongate low. The small low in the centre of the traverse may be caused by a small granitic intrusion in the basement over which the sediments show draping. The two lows in the eastern half of the traverse may be interpreted as low-density rocks within the basement which may be older sediments/metasediments. The Cork Fault has little discernible gravity expression.

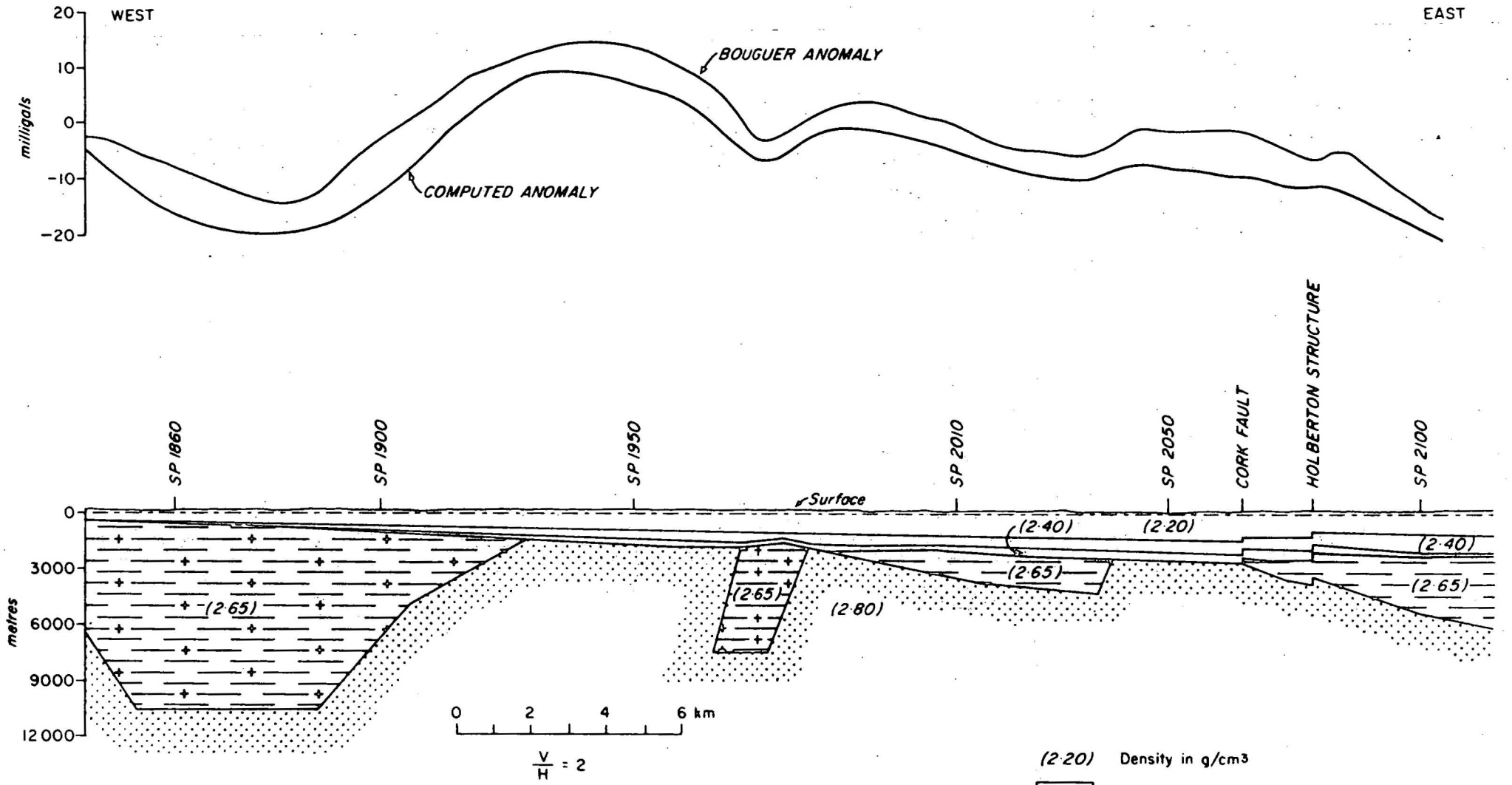
Gravity modelling on Traverse E through 'Mt Windsor' station in the southern part of the Lovelle Depression is continuing. The main gravity effect is probably caused by density variations in the basement and by the presence of a deep trough of older Palaeozoic or Proterozoic rocks.

Gravity survey reporting projects (F.J. Moss, W. Anfiloff)

Revisions were made to a number of reports on detailed and reconnaissance gravity surveys and on gravity review projects. The major reports completed are as follows:

Reconnaissance helicopter gravity survey NSW., Vic, Tas. & S.A., 1973-74 (I. Zadoroznyj). Minor revisions were made to the interpretation report. The main features of the interpretation are discussed in the Geophysical Branch Summary of Activities for 1975.

Melbourne area gravity survey, 1975 (I. Zadoroznyj, P. Gunn, Geol. Survey of Vic.). The report was finalized. The interpretation of the survey results is discussed in the Geophysical Branch Summary of Activities for 1975.



GALILEE BASIN SEISMIC–GRAVITY SURVEY 1975
GRAVITY INTERPRETATION, TRAVERSE B

Record No. 1976/91

F54/83-254 A

SGM 6

Gravity measurements along seismic traverses in the northeastern part of the Eromanga Basin, 1967 (M.D. Watts, F.W. Brown, F.J. Moss). After minor revisions to the test and plates the report was finalized.

Geological interpretation of the Bouguer anomalies of the SURAT and DALBY 1:250 000 Sheets (F. Darby, F.J. Moss). Minor revisions were made to the text of this report and plates were drafted.

Barometric levelling test survey, ACT., 1973 (W. Anfiloff). The report was issued after amendments to the text.

Kalgoorlie detailed gravity survey, W.A., 1970 (W. Anfiloff, A.R. Fraser). The gravity data were plotted in plan and profile form for inclusion in the operational report of the survey, and work has begun on revisions to the text of the operational report. The preliminary interpretation of the survey results is discussed in the Geophysical Branch Summary of Activities for 1974.

Reconnaissance gravity survey of Australia (A.R. Fraser, F.J. Moss, A. Turpie). Revisions were made to the text and figures of a paper on the survey. A broad outline of the contents of the paper is included in the Geophysical Branch Summary of Activities for 1975 and the paper will appear in 'Geophysics' in December 1976.

Minor amendments were made to a report on the gravity provinces of Australia, updating the earlier work by Darby & Vale in Record 1969/110.

McArthur Basin gravity review (W. Anfiloff)

Gravity anomalies in the McArthur Basin were studied in an attempt to provide information on the structural geology of the basin. A detailed gravity survey is proposed to investigate the structure of the Batten Trough, one of the major subdivisions of the McArthur Basin, to ascertain the trend of the Trough and to gauge the value of the reconnaissance gravity results in expressing the structural framework of the basin.

The reconnaissance gravity results do not support the northerly trend of the trough inferred from surface geological mapping, nor do they support the suggested connection between the northern and southern portions of the trough.

Gravity Map of Australia (W. Anfiloff, F.J. Moss, O. Terron)

A coloured 1:5 million Gravity Map of Australia was produced for distribution in time for the IGC meeting in Sydney in August. The compilation of the data for this map is described in the Geophysical Branch Summary of Activities for 1975. A paper on the compilation of the data and the geological significance of the major gravity anomalies was presented at the IGC.

Papers on the compilation of gravity data and the production of the map and a selected bibliography of reports on gravity surveys pertinent to the map have been prepared for publication in the BMR Journal. A more comprehensive bibliography of all reports on gravimetry in Australia has been compiled and sorted by computer. Preliminary copies will be circulated to Mines Departments, Universities, Advanced Colleges of Education and Technical Colleges and major mineral and petroleum exploration companies for additions and amendment before completing it as a publication.

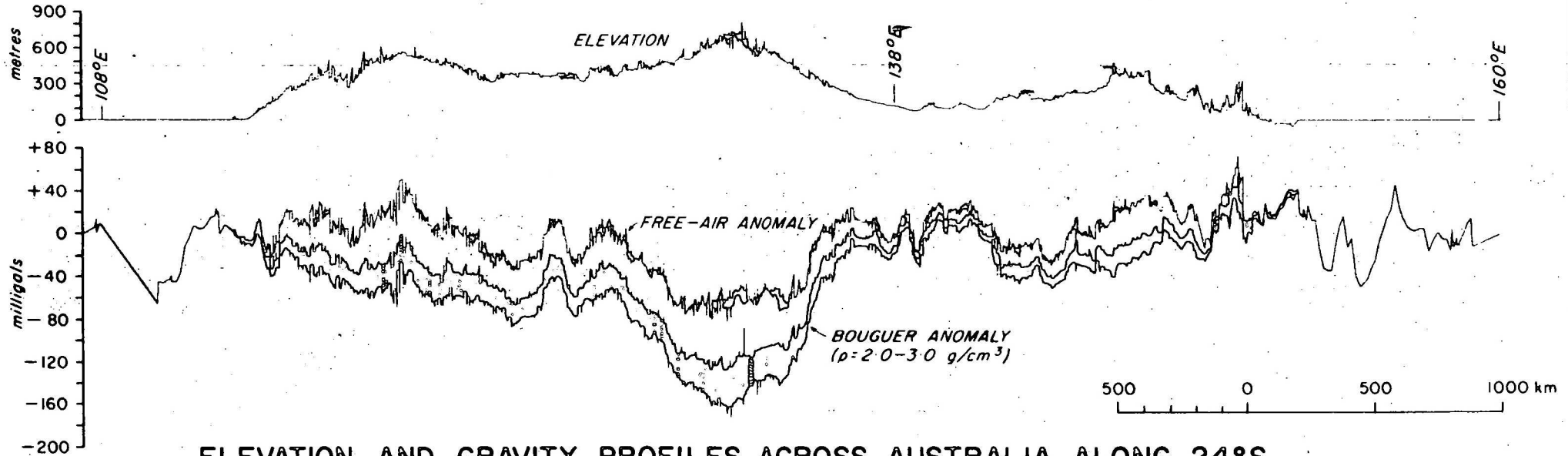
Elevations, free-air anomalies, and Bouguer anomalies for a range of reduction densities were plotted along lines of latitude and longitude across Australia; the relevant data wire extracted, by computer, from the data bank which had been compiled to produce the Gravity Map of Australia at 1:5 million scale. The profiles, of which examples are shown along Longitude 140°E and Latitude 24°S in Figure SGM7, show significant variations in the regional free-air level over the continent. They also indicate that most of the continent west of the Great Dividing Range is sufficiently flat so that there is little change in the shape of Bouguer anomalies if the reduction density is changed.

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

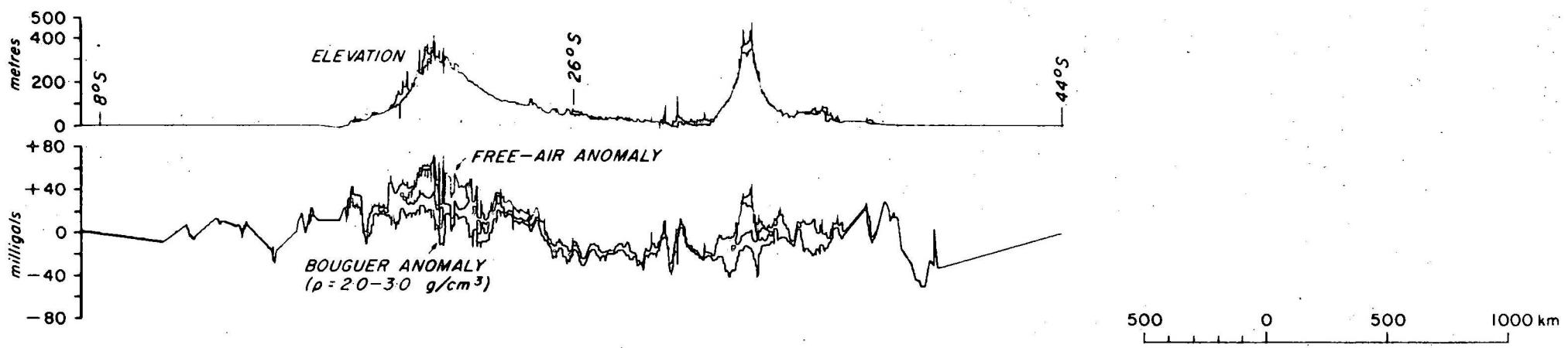
Interpretation and reporting (A. Fraser, J.B. Willcox, N. Exon, D. Jongsma, P. Symonds, P. Cameron, P. Petkovic, H. Stagg, J. Branson).

Interpretation of data from BMR's Continental Margin Survey 1970-73, supplemented by data from surveys by oil companies and oceanographic institutions, continued during the year. Most effort was concentrated on Australia's western margin and BMR Bulletins and Records and external publications are being prepared on the Naturaliste Plateau, the Carnarvon Terrace and Wallaby Plateau, the Exmouth Plateau, the Scott Plateau, and the Cuvier Abyssal Plain (Fig. SGM8). Records were prepared reviewing geophysical results over the Great Australian Bight, the Bismarck Sea, the Lord Howe Rise, and the sea-bed surrounding most of Australia's island territories (Fig. SGM8). Several broad reviews and special interpretation projects were also undertaken: these include a discussion of the continental slope and shelf of Australia (presented at the IGC); a regional analysis of Australia's offshore gravity field (BMR Journal); and a comparative study of 2-D structural models based on gravity data across plateaux of the western margin.

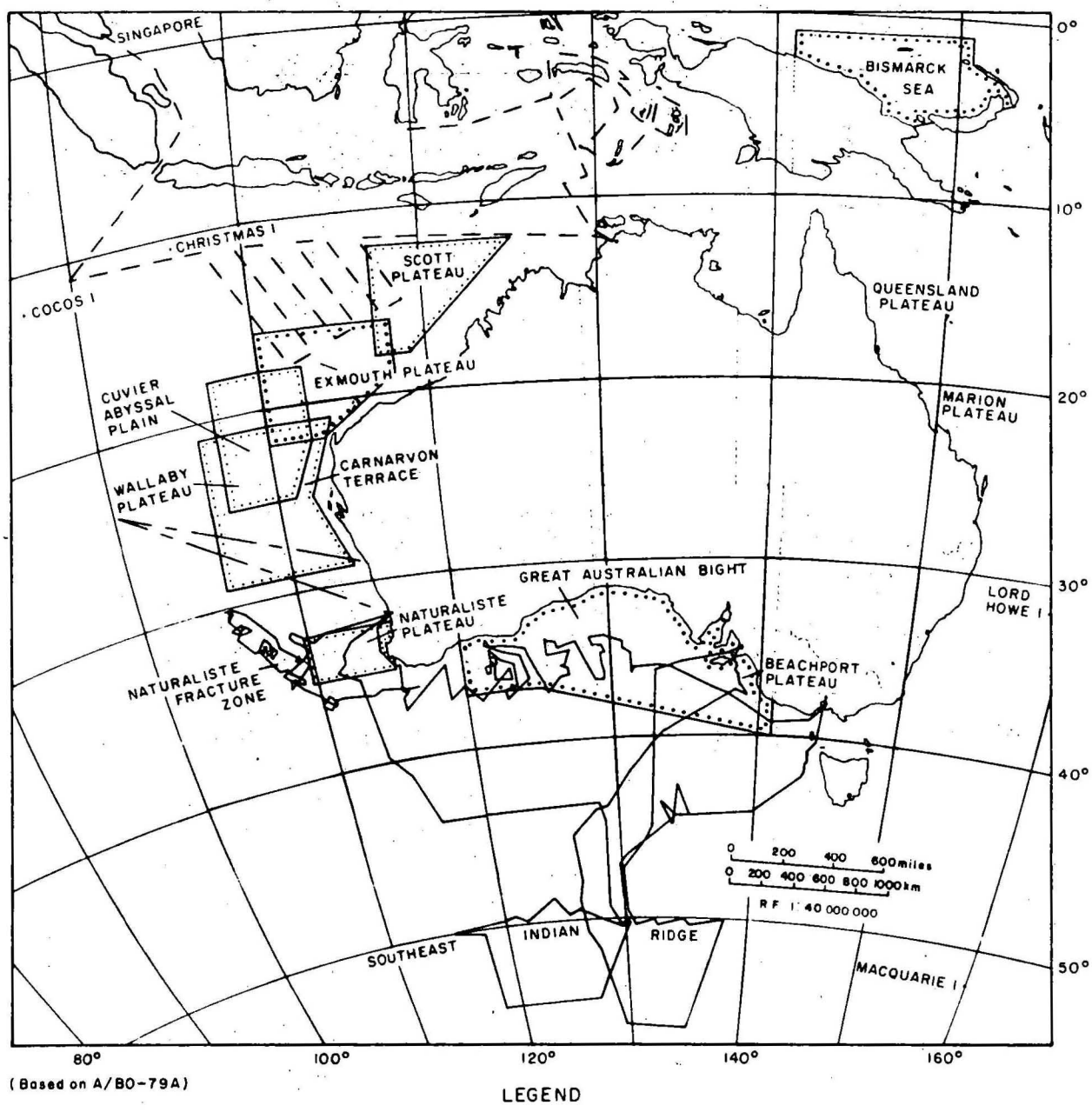
Several new practices were introduced during the year which proved to be a considerable aid to interpretative work. Computer software was developed by L. Tilbury and R. Whitworth



ELEVATION AND GRAVITY PROFILES ACROSS AUSTRALIA ALONG 24°S



ELEVATION AND GRAVITY PROFILES ACROSS AUSTRALIA ALONG 140°E



(Based on A/80-79A)

LEGEND

——— Lamont cruise (Vema)

— — — Proposed Woods Hole cruise (Atlantis II)

— - — Diamantina cruise (approx. position)

Interpretation in progress

Record prepared

Note: Records were also prepared containing reviews of the geology and geophysics of the Lord Howe Rise and Norfolk Ridge, Macquarie Island and the Macquarie Ridge Complex, the Marion Plateau, Cocos Island and Cocos Rise, the Queensland Plateau, the areas around Mellish, Frederick, Kenn and Wreck Reefs and Cato Island, and Christmas Island and the Christmas Rise.

INTERPRETATION PROJECTS AND CO-OPERATIVE CRUISES

which enables seismic horizons to be digitized using BMR's digitizing table, and the digital data to be stored in a file and reproduced as line cross-section profiles or structure contour and isopach maps for chosen horizons. Having the interpreted seismic data in digital form means that the maps and profiles may be presented at various scales and projections, and that isopach and structure contour maps in depths may be produced for any chosen velocity function or selection of interval velocities.

Progress with the processing of data from the continental Margin Survey and the writing of several new programs and the revision of old ones has facilitated the production of geophysical profiles and contour maps, and ship's track maps.

A worthwhile effort was made to optimize the procedure for digitally processing seismic sections at GSI, Sydney. By paying careful attention to filtering, choice of velocity function, and trace editing, a procedure was developed which greatly suppressed water-bottom multiples and improved the general data quality along 140 km of profile across the Carnarvon Terrace.

Carnarvon Terrace and Wallaby Plateau project (P.A. Symonds and P.J. Cameron).

The 400 000 km^2 area under investigation lies offshore from Western Australia and covers the Carnarvon Terrace, Wallaby Plateau, and their environs (Fig. SGM8). The interpretation is based on 17 000 line kilometres of geophysical data, comprising data collected during the BMR Continental Margin Survey and Shell and Teledyne seismic data (Fig. SGM9).

Up to October, most of the work on the project was concerned with presentation of the basic data. A map of all ships' tracks in the area was prepared and bathymetric, magnetic, free-air anomaly, and Bouguer anomaly profiles and contour maps were drawn. The seismic data were interpreted and water-bottom reflections and two important marker horizons that occur throughout the area were digitized using BMR's digitizing table. The interpreted seismic information will eventually be reduced to isopach and structure contour maps in two-way time and depth using the Marine Group's seismic interpretation package. Seismic data from several lines throughout the area have been processed by GSI for companies and BMR. The processed data have proved to be a great aid to interpretation and it is hoped that before the project has been completed, more data will have been processed. The two seismic horizons used in the interpretation have been assigned ages of Senonian (Toolonga Calcilutite) and Neocomian on the basis of ties to wells Pendock ID No. 1, Edel No. 1, and Gun Island No. 1.

A paper on the project is being prepared for APEA 1977 and a BMR Record containing 1:1 million maps should be completed by early 1977. The final report on the study will be a BMR Bulletin.

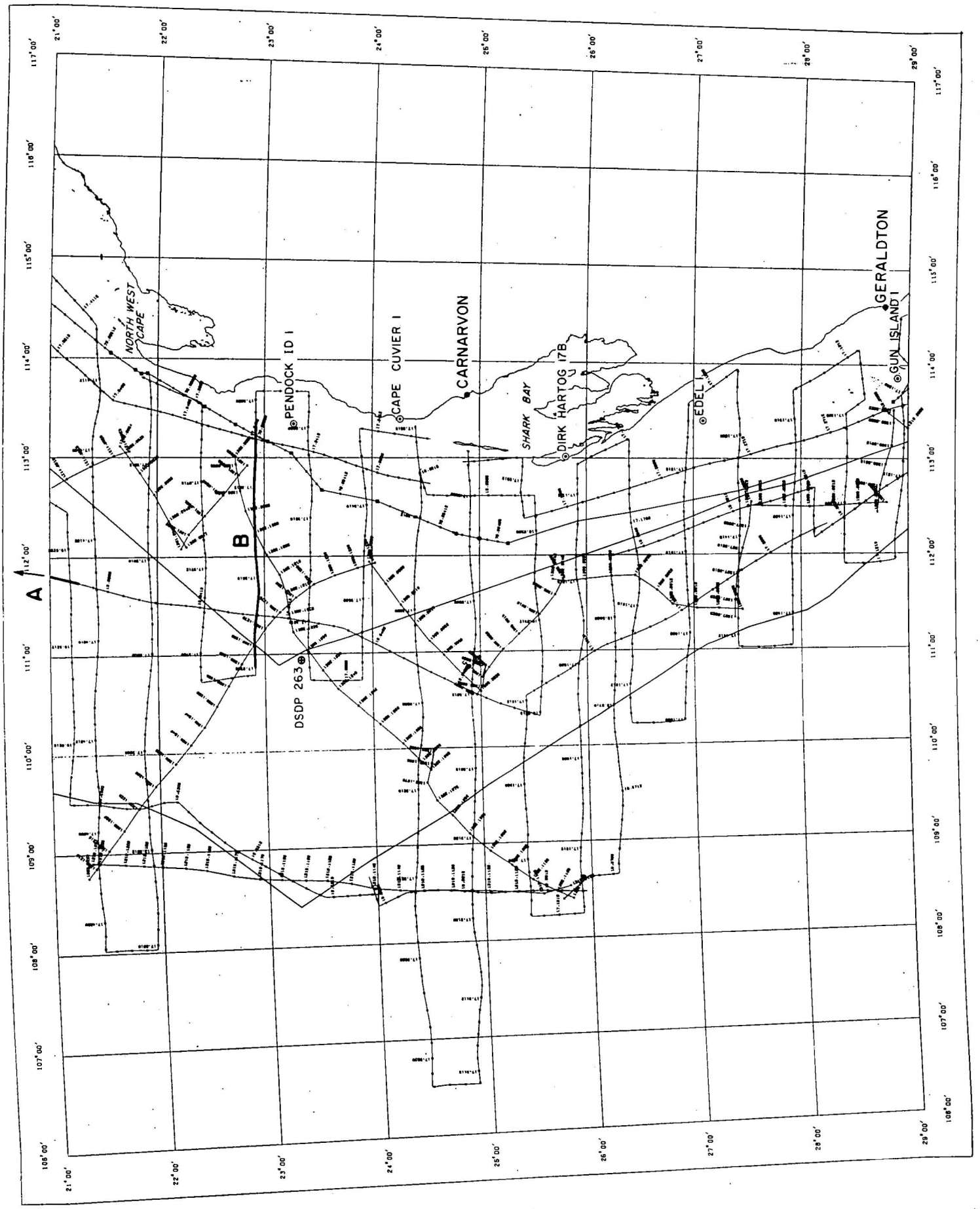
The Carnarvon Terrace is parallel to the continental shelf and is formed by a reduction in the gradient of the continental slope from the shelf break to a depth of 1500 m (Fig. SGM10). It averages about 950 m in depth, and its maximum width is about 140 km, west of Shark Bay. In the north the outer slope of the Carnarvon Terrace bounds the Cuvier Abyssal Plain, a very flat sea-floor about 5000 m below sea level. To the west the relatively rugged Wallaby Plateau, with a minimum depth of about 2200 m, is separated from the Carnarvon Terrace by the 4000-m-deep Wallaby Saddle. In the south the slope of the Terrace lies adjacent to the Perth Abyssal Plain, which is 5600 m below sea level.

The Carnarvon Terrace region is structurally complex and can be best described by subdividing it into five structural entities.

The Bernier area lies west of Carnarvon and consists mainly of a north-northeast-trending basement high (Bernier Platform), which has remained high throughout much of the Phanerozoic history of the region. Palaeozoic sediments lap onto the high from the west and from the east where they form the Gascoyne Sub-basin. The Palaeozoic sequence, which may be up to 6000 m thick in the east, consists of shallow marine and terrestrial sedimentary rocks ranging from Carboniferous to Ordovician in age in the offshore area.

The north Mesozoic province, which lies southwest of North West Cape, is characterised by a northeast structural grain and the presence of several troughs of similar character to the Exmouth Sub-basin. The largest of these troughs becomes shallower to the southwest and is bounded to the east by a major down-to-the-west fault which can be traced for about 270 km. This fault is similar to the Rough Range Fault in that vertical movement along it appears to have brought Triassic and possibly Jurassic sediments into juxtaposition with Palaeozoic rocks to the east.

The southern Mesozoic province lies northwest of Geraldton and is characterised by a north-northwest-trending asymmetric trough, about 400 km long and up to 100 km wide. The trough narrows to the north and terminates southwest of the Bernier area. A Palaeozoic structural high forms the western margin of the trough, whereas its eastern margin is probably a major fault downthrown to the west. The trough appears to connect in the south with the Abrolhos Sub-basin which contains Jurassic and Triassic sediments. This implies that the trough also contains Jurassic and Triassic sediments. Antithetic faulting is prevalent within the trough.



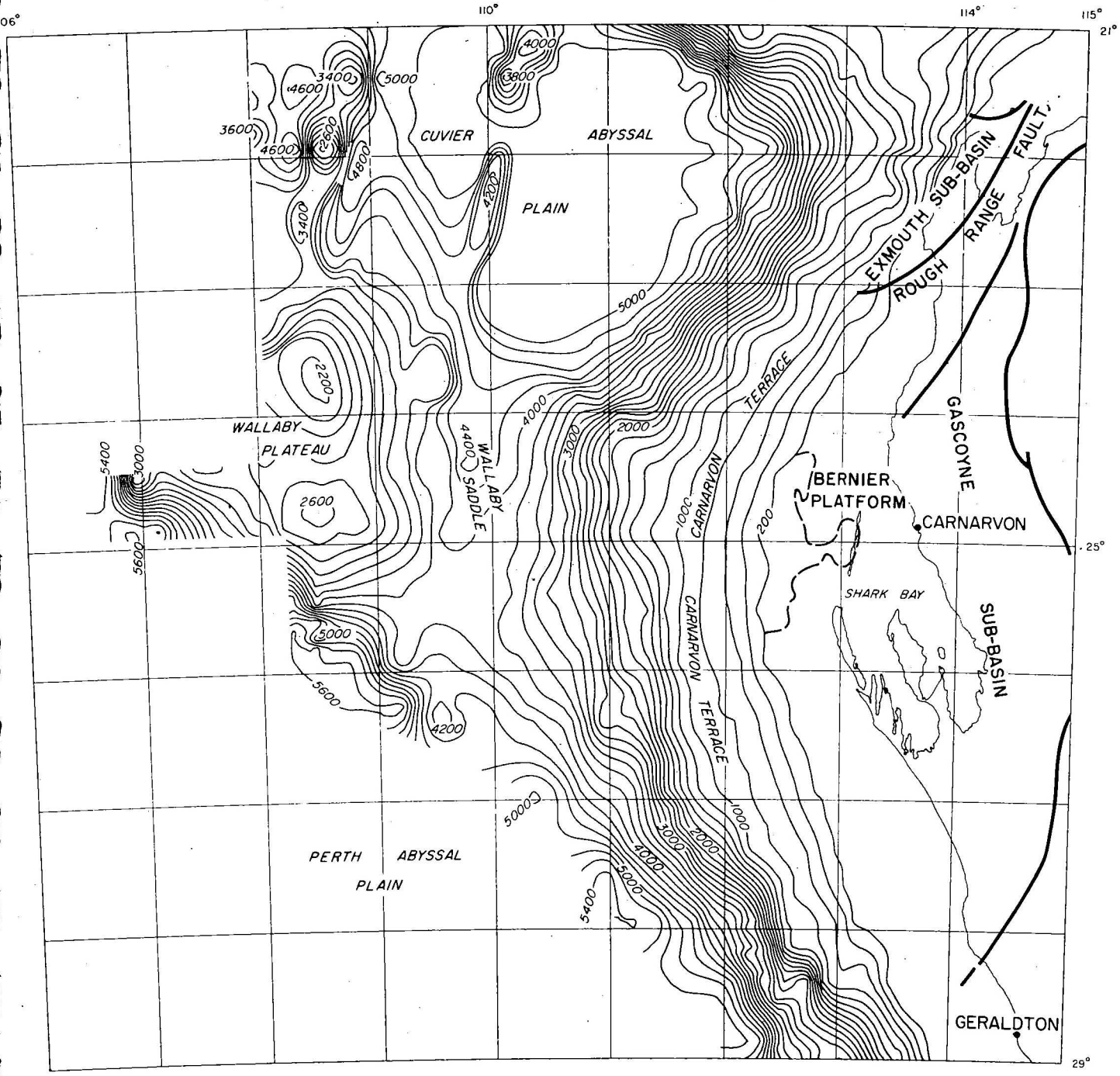
CARNARVON TERRACE : TRACK MAP

50 0 50 100 150km

Showing position of profiles A and B
See SGM 18

Record No. 1976/91 WA/B8-147A

SGM 10



CARNARVON TERRACE BATHYMETRY

Contour Interval 200m

50 0 50 100 150km

Structural features

Record No. 1976/91

WA/B8-148A

The Wallaby Plateau area is structurally very complex (Fig. SGM11). The northern and eastern parts of the Plateau exhibit north-northeast structural trends, but a strong northwest cross-trend has developed in the south in response to rifting processes that led to the formation of the Perth Abyssal Plain. Much of the Wallaby Pleateau consists of large fault-blocks of sedimentary rock. The seismic character of some of these sediments suggests they are of Mesozoic age. The southern and western margins of the Plateau have been greatly affected by igneous intrusions.

The Cuvier Abyssal Plain area also exhibits a strong north-northeast structural grain which is evident from the trend of basement highs, basement faults, and faults within the sedimentary section.

The Carnarvon Terrace and the Wallaby Plateau were subjected to an intense period of erosion in the Neocomian. The erosion surface was overlain by Aptian-Cenomanian shallow marine siltstone and mudstone (Winning Group) (Fig. SGM11). This sequence varies in thickness from 100 to 500 m over the Carnarvon Terrace but thickens considerably towards the base of the slope to a maximum of 2000 m. Equivalent shallow marine sediments overlie basement on the Cuvier Abyssal Plain and indicate rapid post-Cenomanian subsidence of this feature. On the Carnarvon Terrace these sediments are unconformably overlain by a Senonian to Recent carbonate sequence, which averages about 400 m in thickness (Fig. SGM11).

The existence of a trough of Mesozoic sediments in the southern half of the Carnarvon Terrace considerably upgrades the hydrocarbon potential of the area. Other hydrocarbon prospects are fault traps in the northern Carnarvon Terrace, along the possible offshore extension of the Rough Range Fault.

Naturaliste Plateau and Trough project (D. Jongsma & P. Petkovic).

An interpretation of 6000 line km of BMR's Continental Margin Survey data and 3000 line km of shell seismic data over the Naturaliste Plateau and Trough was completed during the second half of 1976. A paper to be presented at the APEA Conference in April 1977 and published in the APEA journal was prepared.

The seismic profiling results indicate sediments, ranging in thickness from 500 m over the plateau to 1800 m in the trough, and which overlie a basement of pre-Neocomian sedimentary, igneous, and metamorphic rocks. Faulting and folding is largely confined to this basement. An interesting feature of the region is the contrast in character between the northern and southern margins of the Naturaliste Plateau. Whereas reflectors along the

northern margin dip gradually down to abyssal depths, seismic results over the southern margin indicate that sediments are draped over a steep fault scarp. The contrast may be due to the difference in orientation of the margins with respect to spreading centres on either side of the plateau. The geophysical results indicate that the Naturaliste Plateau is continental in origin. Neither the plateau nor the trough appear to be highly prospective for minerals or hydrocarbons.

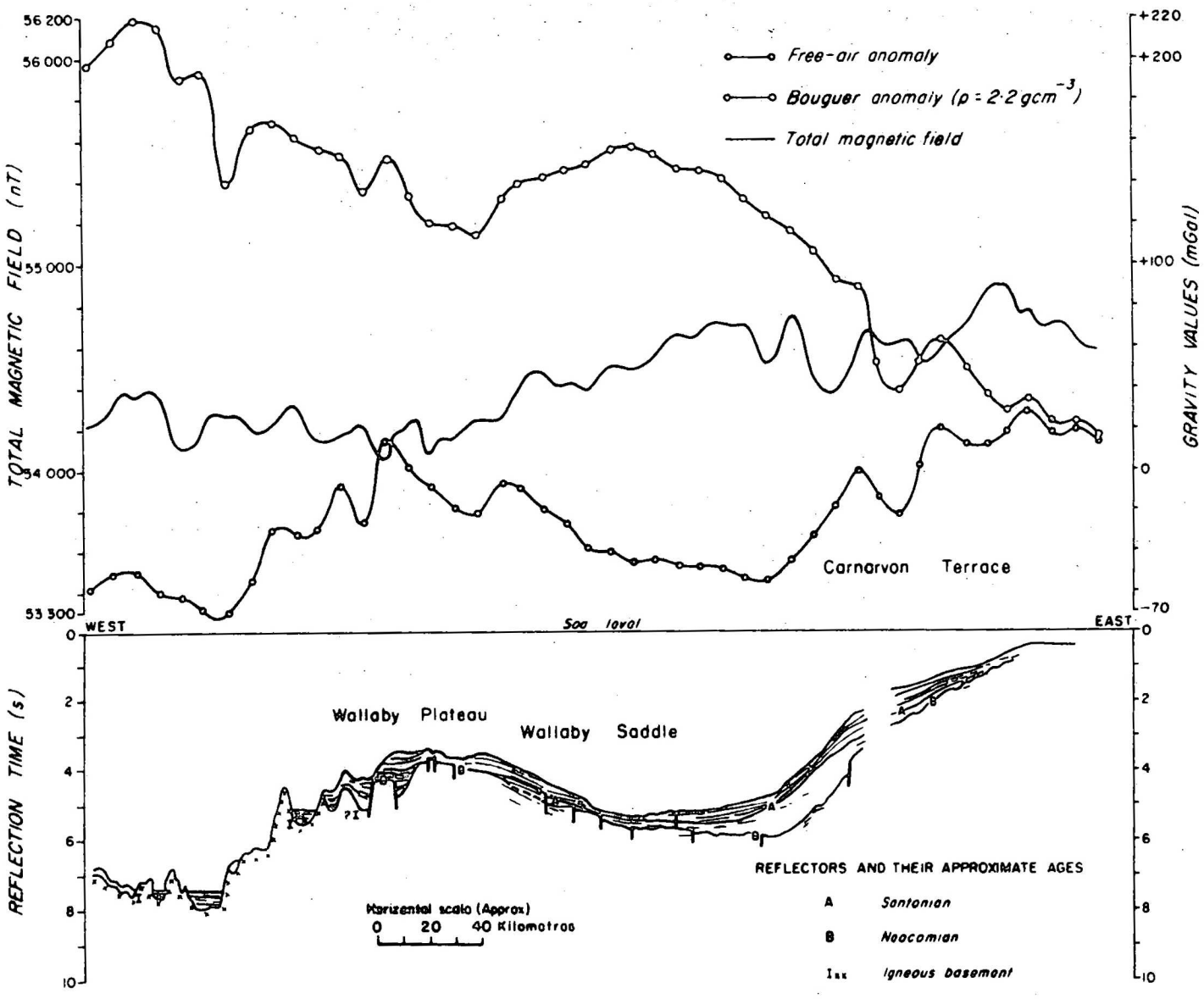
Scott Plateau project (N.F. Exon, H.M.J. Stagg)

Work on this project began in June 1976, with the aim of interpreting seismic and other data collected by BMR and oil exploration companies, and producing isopach and structure contour maps for sedimentary sequences in the area. The project area (Fig. SGM12) is about 220 000 km^2; it overlaps slightly with the Exmouth Plateau project area in the southwest and extends northeastwards to just short of the Timor Trough. The major bathymetric features are the Scott Plateau and Scott Plateau Trough in the north, the Ashmore Terrace landward of the Scott Plateau, an un-named terrace southwest of the Scott Plateau, and the Argo Abyssal Plain in the northwest. The broad Northwest Shelf, in water depths of less than 200 m, is not included. A map of ships' tracks has been compiled for the project (Fig. SGM13) and it shows that geophysical coverage of the area is extensive. In addition to the BMR's Continental Margin Survey 1970-73, seismic surveys have been done by Shell, Gulf, and Teledyne.

The quality of the seismic data is generally good. The company data are mostly of high quality, and the BMR single-channel monitor records are as good as any obtained in the continental margins survey. About half of the BMR seismic data has been digitally processed by companies, and although the improvement in record quality is not great, the processed sections are definitely an aid to interpretation.

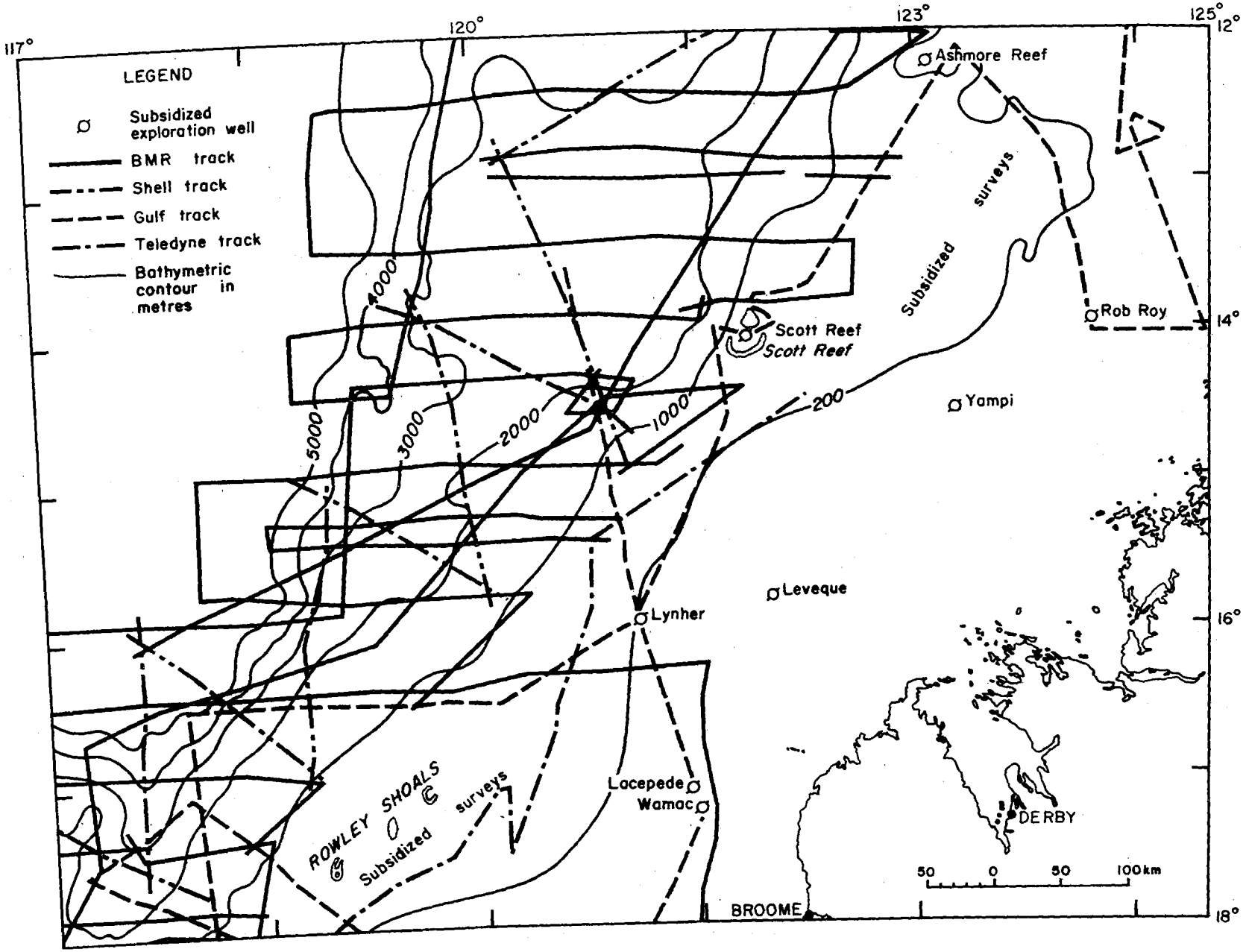
About three-quarters of the BMR seismic sections were picked by October 1976. When all the BMR and company sections have been picked and the necessary ties made, it is planned to use the Marine Group's digitizing/contouring package with BMR's GRADICON digitizing table, the CSIRO CYBER-76 computer and BMR's CALCOMP to produce isopach and structure contour maps automatically.

Interpretative work done so far indicates that the area is structurally complex, especially in the outer half of the Scott Plateau and the terrace to the south. The cruise of the West German Government's R/V Valdivia in 1977 may complement the sparse coverage of parts of the Scott Plateau and help solve problems in the area.

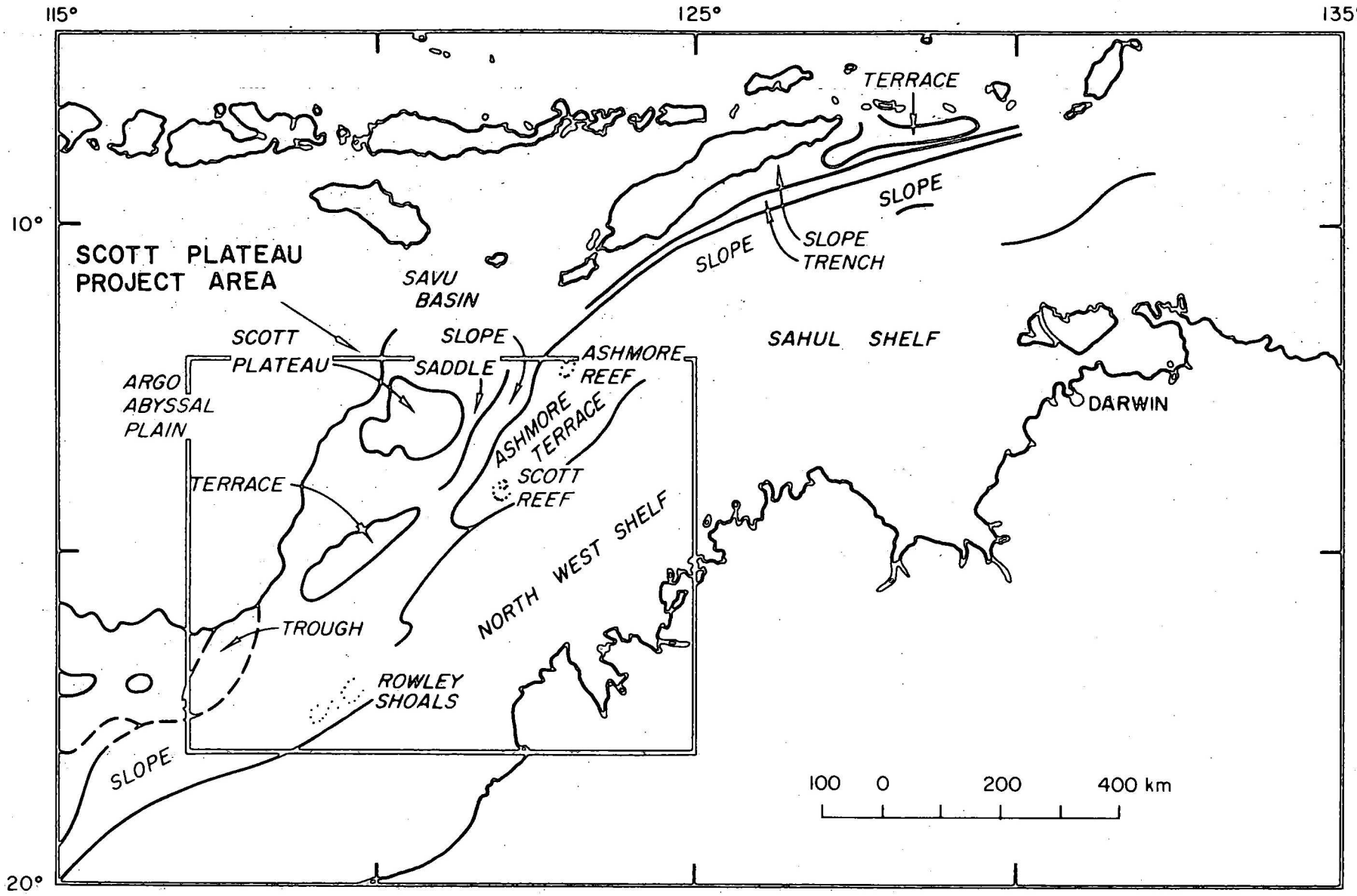


CARNARVON TERRACE AND WALLABY PLATEAU

SEISMIC, GRAVITY, AND MAGNETIC PROFILES



BATHYMETRY AND TRACKS: SCOTT PLATEAU PROJECT



NORTHWEST MARGIN, TOPOGRAPHIC FEATURES

After Branson, 1974

Present plans are to produce a BMR Bulletin on the project with maps at 1:2 500 000 scale, a short Record with maps at 1:1 000 000 scale, and a paper for the 1978 APEA Conference.

Exmouth Plateau project (N.F. Exon, J.B. Willcox)

Most of the time on this project was spent in preparing figures, maps, and texts for various publications. The summary of the geology of the area as presented in the Geophysical Branch Summary of Activities for 1975 remains essentially correct and will not be repeated here.

A paper entitled "The regional geology of the Exmouth Plateau" was presented at the APEA Conference in Adelaide in April. This dealt mainly with the central part of the plateau above the 2000-m isobath, which is the area of greatest immediate interest in the search for petroleum. Another paper entitled "The geology and petroleum potential of the Exmouth Plateau area off Western Australia" was delivered at the IGC Conference in Sydney in August and has been submitted to the AAPG Bulletin for publication. This presents a broad description of the geology of the plateau and its surroundings and discusses the petroleum potential of the area.

A short paper, "Mesozoic outcrops on the lower continental slope off Exmouth, Western Australia", was published in the BMR Journal. This documents the occurrences of older outcrops on the continental slope and points out that they could be sampled from an oceanographic vessel.

A draft of a Bulletin "The Exmouth Plateau: Stratigraphy structure, and petroleum potential" has been prepared and is being edited within Geophysical Branch. This is a comprehensive account of the geology of the plateau and will appear as an A3-sized atlas.

A draft of a BMR Record presenting isopach and structure contour maps for the Exmouth Plateau at a scale of 1:1 000 000 is being prepared. This is being done so that a complete set of the maps will be available to industry as soon as possible.

Reviews of Australia's island territories (D. Jongsma)

A series of Records on the geology and geophysics of the areas surrounding the Australian island territories (Fig. SGM8) was written during the latter part of 1975 and early in 1976. All of Australia's island territories were covered except for Heard and MacDonald Islands. The following is a short summary of the prospectivity of the areas covered.

1. Lord Howe Rise and Norfolk Ridge have some potential for hydrocarbons in small basins recently discovered during surveys by French oil companies.

2. Macquarie Ridge has little prospectivity except for manganese nodules, which are at present only marginally prospective because they are low in nickel, copper, and cobalt content compared with those of the central Pacific.

3. Queensland Plateau has very low mineral and hydrocarbon prospectivity.

4. Marion Plateau also has low prospectivity.

5. The reefs and islands including Mellish Reef and Cato Island are composed of coral and probably have volcanic basalt cores. Again prospectivity is very poor.

6. Christmas Island and East Christmas Rise are composed of limestone on top of a basaltic volcanic core and apart from the phosphates at present being mined, their prospectivity is poor.

7. Cocos Islands and Cocos Rise are similar in nature to the Christmas Islands and are also poor prospects for minerals and hydrocarbons.

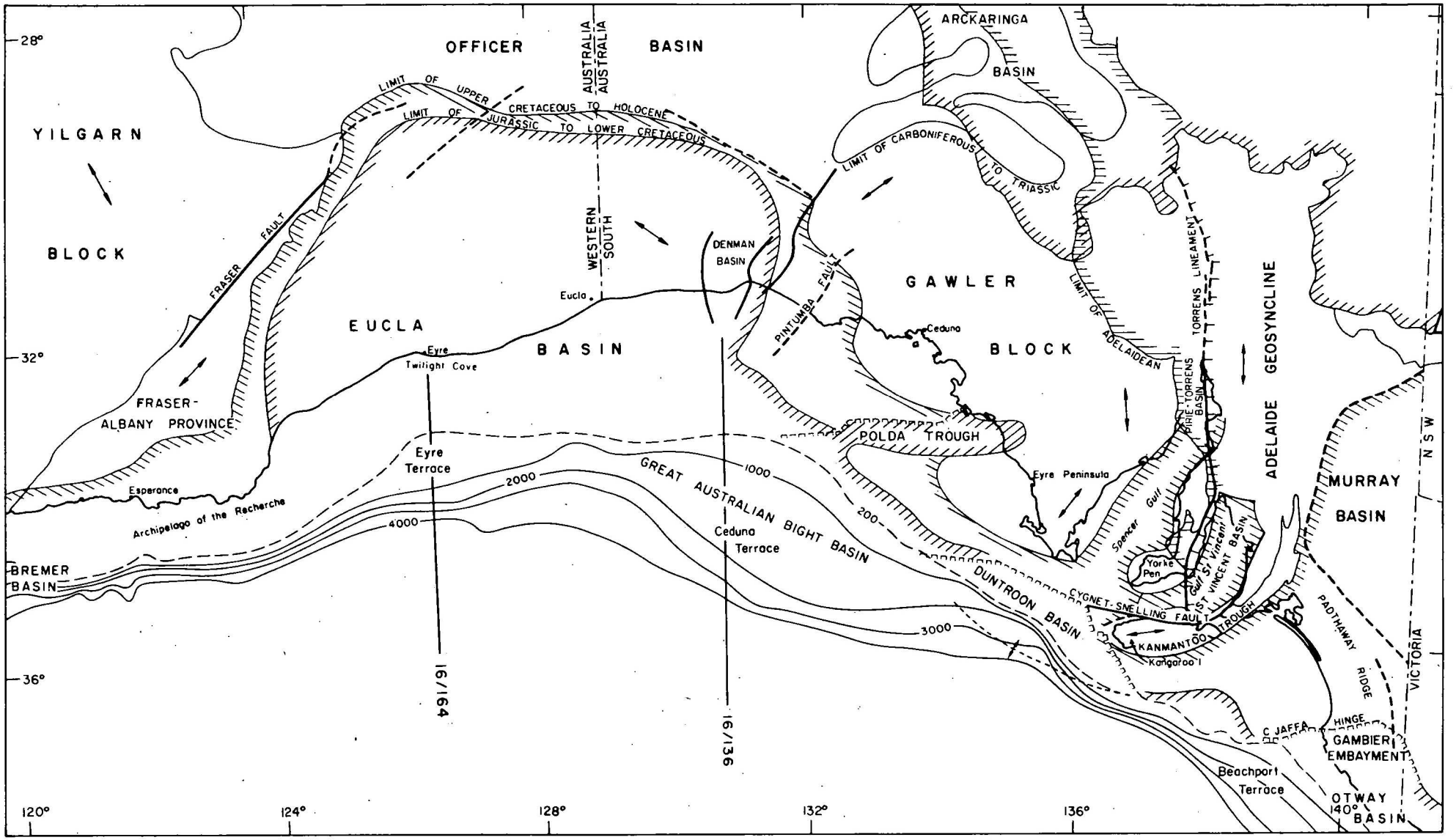
The series of Records will be available at the end of 1976.

The Great Australian Bight: a regional interpretation of gravity, magnetic and seismic data from the Continental Margin Survey (J.B. Willcox)

A report on Continental Margin Survey data in the Great Australian Bight, lying between 120° and 141°E and extending to the foot of the continental rise, was completed in February 1976 (Report 201). The portion dealing with the seismic interpretation of the Great Australian Bight Basin formed the basis of a lecture given at the BMR Symposium.

The continental shelf is an arcuate plain sloping southwards to a shelf break between 125 and 165 m (Fig. SGM14). It ranges in width from 20 to 200 km. A major part of the continental slope, between about 200 and 2000 m, is occupied by the Eyre, Ceduna, and Beachport Terraces. The continental rise is generally about 50 km wide but attains a width of 250 km south of the Eyre Terrace.

Basement is probably composed of Proterozoic crystalline rocks overlain in places by Proterozoic sediments and volcanics, and Palaeozoic sediments. The margin is dominated by six



(Based on the Tectonic Map of Australia and New Guinea, Geological Society of Australia, 1971.)

50 0 50 100 150 200 250 300 km

Structural trend
Basement flexure
Basement ridge
Fault with throw
1000 Isobaths (metres)
State boundary

STRUCTURAL FRAMEWORK OF SOUTHERN AUSTRALIA

Record No. 1976/91

SA/B8-23-1A

SGM 14

basins which contain Mesozoic and Tertiary sediments: from west to east these are the Bremer, Eucla, Great Australian Bight, Polda, and Otway Basins (Fig. SGM14).

The seismic evidence suggests that 200 to 500 m of sediments underlie most of the continental shelf and the Eyre Terrace, and are continuous with the Upper Cretaceous to Upper Tertiary sequence in the Eucla Basin. A much thicker section occurring in the Bremer, Great Australian Bight and Otway Basins, and beneath the continental rise is divided by four unconformities. By analogy with the Otway Basin, and by comparison of the structural style with that suggested in Falvey's model for the formation of Atlantic-type continental margins (APEA J., 1974), the section is considered to comprise four units: a Lower Cretaceous fluviatile-lacustrine unit (Otway Group equivalent), an Upper Cretaceous and Lower Paleocene mainly fluviatile-deltaic unit (Sherbrook Group equivalent), an Upper Paleocene and Eocene shallow marine clastic unit (Wangerrip and Nirranda Group equivalents), and an Oligocene to Recent prograded carbonate shelf unit (Heytesbury Group equivalent). This is consistent with the log of Shell's Potoroo No. 1 well which is located near the northern margin of the Great Australian Bight Basin (130°46'E, 33°23'S). The interpretations of Line 16/136 (Fig. SGM15) which passes within 8 km of Potoroo No. 1, and Line 16/164 (Fig. SGM16) near the western end of the basin are shown. The total thickness of the section is at least 2 km in the Bremer Basin, 6 km in the Great Australian Bight Basin, 6 km in the Otway Basin, and 2-3 km beneath the continental rise.

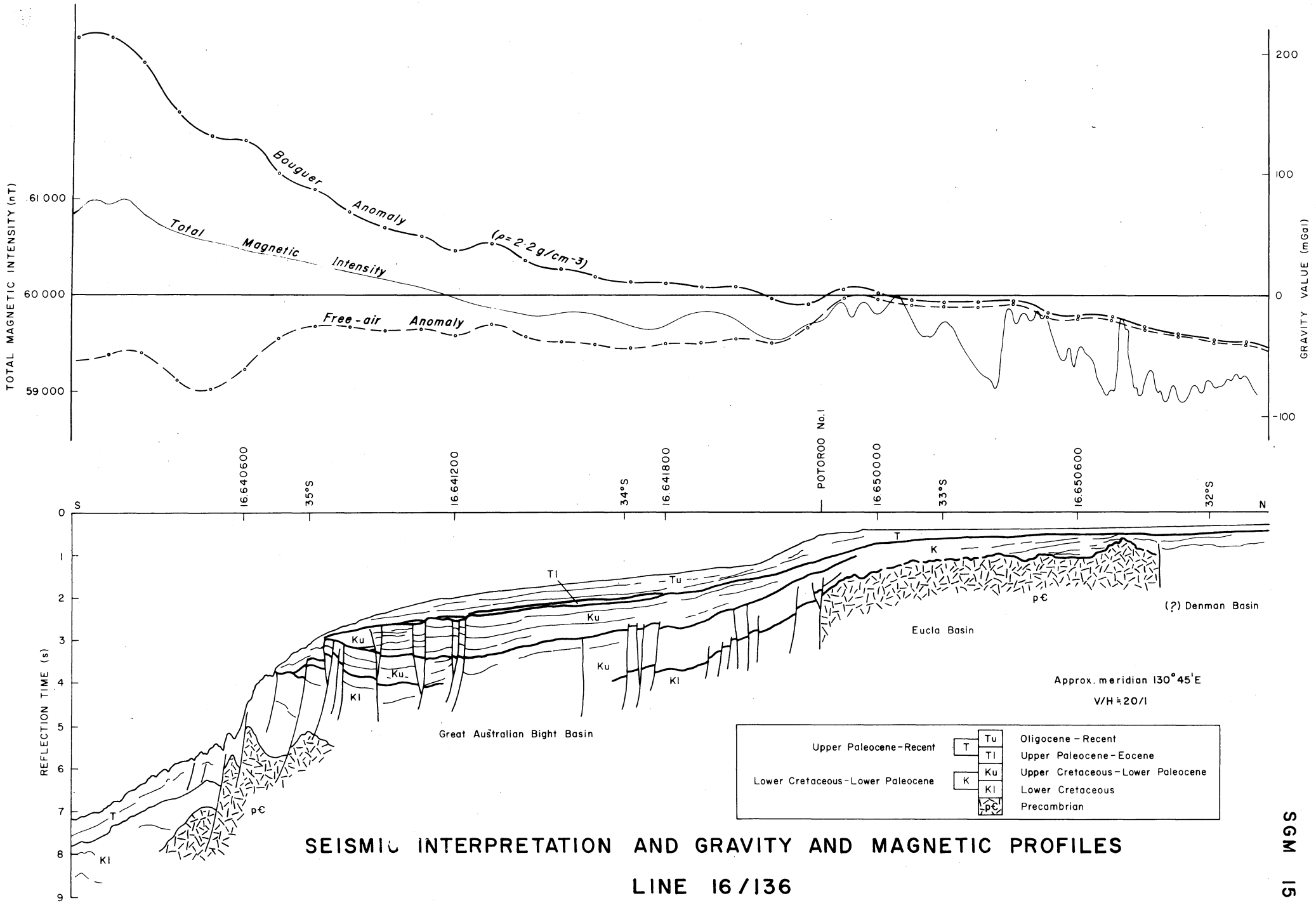
The Lower Cretaceous and basement rocks are sliced by extensive normal faults which trend parallel to the continental margin. The zone of faulting underlies the continental slope in the Bremer Basin, the continental rise south of the Eyre Terrace, the Ceduna Terrace, and occurs throughout the seaward portion of the Otway Basin. In general, the fault-blocks are downthrown southward and tilted northward, and beneath the Ceduna Terrace form the basement to an elongate structural basin. The Upper Cretaceous and Lower Paleocene sediments which fill this basin are faulted at the margins only, probably by rejuvenation of the Lower Cretaceous faults.

The interpretation of the gravity and magnetic data largely supports the structure indicated on the seismic records if reasonable density and magnetic susceptibility contrasts are assumed. A well-defined gravity anomaly ridge, which forms an arc around the northwest margin of the Gawler Craton and extends southwards across the continental shelf, is the expression of a zone of high-density rocks of unknown origin. An area of very intense magnetic anomalies occupies the FOWLER and NULLARBOR 1:250 000 Sheets and about 10 000 km^2 of the continental shelf: the sources of the anomalies must lie in the Gawler Block just

beneath the Quaternary drift. A magnetic trough, and in places an associated gravity ridge, extends for several hundred kilometres along the continental margin. West of 130°E it corresponds with a fault zone which lies on the upper continental rise, and east of 130°E it corresponds with a band of igneous intrusions or diapirs which underlie the Ceduna Terrace. It may be related to an aborted seafloor-spreading rift of probable Jurassic or Early Cretaceous age. A magnetic anomaly ridge along latitude 36°S overlies oceanic basement and is equated with seafloor spreading anomaly number 22. The 'magnetic quiet zone', a region of quiet magnetic field over the continental rise off shouthern Australia and also off the Antarctic coast, appears to be caused by deep-seated continental crust. However, the gravity values suggest that this crust is only 10-15 km thick. The crust probably ranges from 20 to 30 km thick under the marginal terraces and is about 33 km thick under the continental shelf.

The earliest geological event deduced from the interpretation is the erosion of basement, probably during the Permo-Carboniferous ice age. In the early Mesozoic, fault-bounded troughs probably formed near the edge of the present continental shelf (e.g. Polda Trough) and south of the Eyre Terrace. During the Early Cretaceous, fluviatile and lacustrine sediments were deposited south of the basement which now underlies the continental shelf and western Eyre Terrace. Shallow marine sediments may have been deposited southwest of the basin during this period; marine influence was detected in Early Cretaceous sediments in Potoroo No. 1. Towards the end of the Early Cretaceous, a thermally induced arch may have formed along the foot of the present continental rise causing tension which was relieved by normal faulting and formation of an incipient rift. By the early part of the Late Cretaceous a structural rift-valley basin had formed. This was followed by marine incursion, which probably spread from the west. Fluviatile and deltaic sediments were deposited in the subsiding rift-valley basin during most of the Late Cretaceous and early Paleocene. The readjustment of fault-blocks near the basin margins in the mid-Late Cretaceous caused a minor unconformity. In the late Paleocene, commencement of seafloor spreading led to subsidence of the southern fault-blocks and formation of the southern margin. A marine transgression resulted in deposition of shallow marine clastic sediments in the late Paleocene and Eocene. By the Oligocene, the source of detritus had been largely eroded down, and the northward drift of Australia into a warmer latitude possibly caused an abrupt change to carbonate sedimentation. As the margin continued to subside, a shelf of prograded carbonate sands built southwards and pelagic carbonates were deposited on the continental rise.

The main difference between this interpretation and the one presented by Bouef & Doust (APEA J., 1975), is that the 'break-up unconformity' is believed to be higher in the section and the post-break-up Tertiary section is about 600 m instead of 35 km thick. The upper Cretaceous is correspondingly thicker.



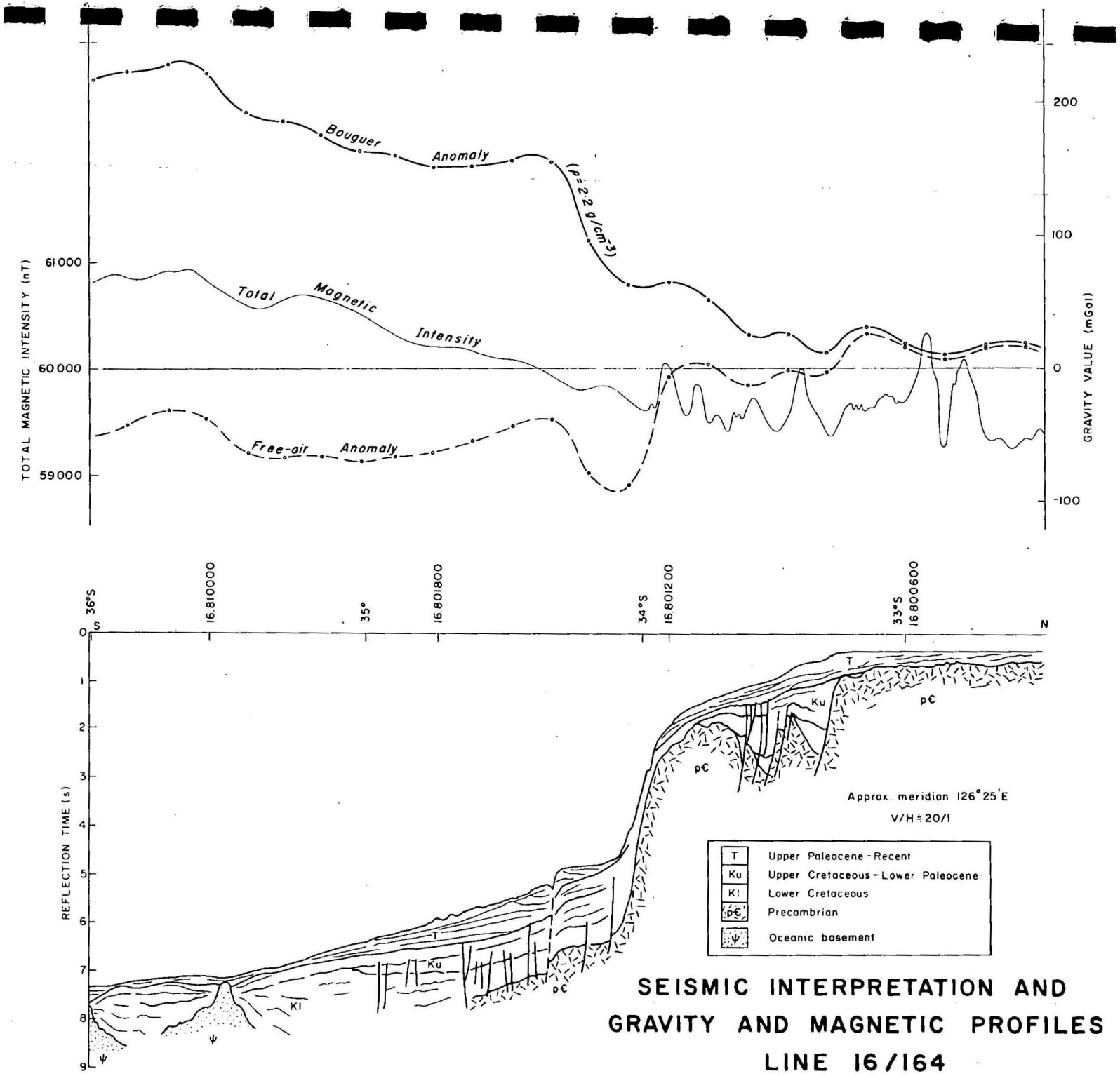
SEISMIC INTERPRETATION AND GRAVITY AND MAGNETIC PROFILES

LINE 16/136

Record No. 1976/91

SA/B8-26-1A

SGM 15



SEISMIC INTERPRETATION AND GRAVITY AND MAGNETIC PROFILES LINE 16/164

SGM 16

Record No. 1976/91

SA/88-25-1A

Potoroo No. 1, together with Echidna No. 1 and Platypus No. 1 which are located at the eastern end of the basin (Duntroon Embayment), cannot be regarded as an adequate test of its petroleum potential. Potoroo lies 100 km north of the depositional axes of the Cretaceous and Tertiary sediments, in an area where most of the Lower Cretaceous is faulted-out and where the Upper Cretaceous is relatively thin. Numerous faults separate this well from the major part of the basin which lies beyond the continental shelf. The favourable reservoir sands encountered in the Upper Cretaceous and Neocomian may persist into the deep-water part of the basin where suitable source rocks may have formed in the more marine conditions since the Late Cretaceous. The depth of burial of the Lower Cretaceous and lower part of the Upper Cretaceous sediments suggests that they may be sufficiently mature for the generation of hydrocarbons.

Structure of the Bismarck Sea (J.B. Willcox)

A BMR Record (76/59) giving an interpretation of gravity, magnetic, and seismic data in the Bismarck Sea was completed in September 1976.

Water depths in the Bismarck Sea range mainly between 1000 and 2500 m and average about 2000 m. The sea is bounded in the north by the West Melanesian arc, a topographic rise above the 1500 m isobath, and in the south by New Guinea and New Britain. It is divided into an eastern and a western basin by the 1000 to 1500 m-deep Willaumez-Manus Rise, a bathymetric high extending northwest from the Willaumez Peninsula in New Britain to Manus Island in the West Melanesian Arc. The continental shelves of New Guinea, New Britain, and New Ireland range in width from a few kilometres to 30 km.

The gravity and seismic data show that the sedimentary section is at least 1000 m thick northwest of Wewak and off the Sepik River delta. Sedimentary troughs, at least 2000 m deep, lie between the Huon Peninsula and the South Bismarck Volcanic Arc and between the Arc and a basement ridge farther north. About 1500 m of sediment occur off the New Britain coast. The west Melanesian Arc is a continuation of the New Ireland structure and is formed by at least 2000 m of sediment draped over a basement ridge. The western basin of the Bismarck Sea contains 100-200 m of sediment over smooth basement and is traversed by a single seamount chain which is probably an extension of the Bewani-Torricelli Ranges. Little sediment is found in the eastern basin which is floored by lavas and intrusive bodies and traversed by easterly trending seamount chains and grabens.

Finlayson & Cull (J. Geol. Soc. Aust., 20(1), 1973) have presented structural profiles between the Vitu Islands and the Gazelle Peninsula, based on seismic refraction data and

gravity modelling, which show a crustal thickness of about 20 km. In this study, estimates of crustal thicknesses under the remainder of the Bismarck Sea were computed from spatially filtered gravity, water depth, and sediment thickness values, with reference to a standard crust based on seismic refraction data in the New Britain/New Ireland region. Depths were found to average about 20 km which is 5-10 km greater than is typical for marginal basins.

Previous work has shown that a band of shallow earthquake epicentres, the Bismarck Sea seismicity lineation, extends across the area at about 3°30'S. Focal mechanism solutions computed by Johnson & Molnar (J. Geophys. Res., 77, 1972) suggest that the lineation is a zone of left-lateral shearing but magnetic models computed by Conelly (Geophys. J. Ast. Soc., 45, 1976) suggest that a limited form of north-south spreading has taken place about the lineation in the eastern basin.

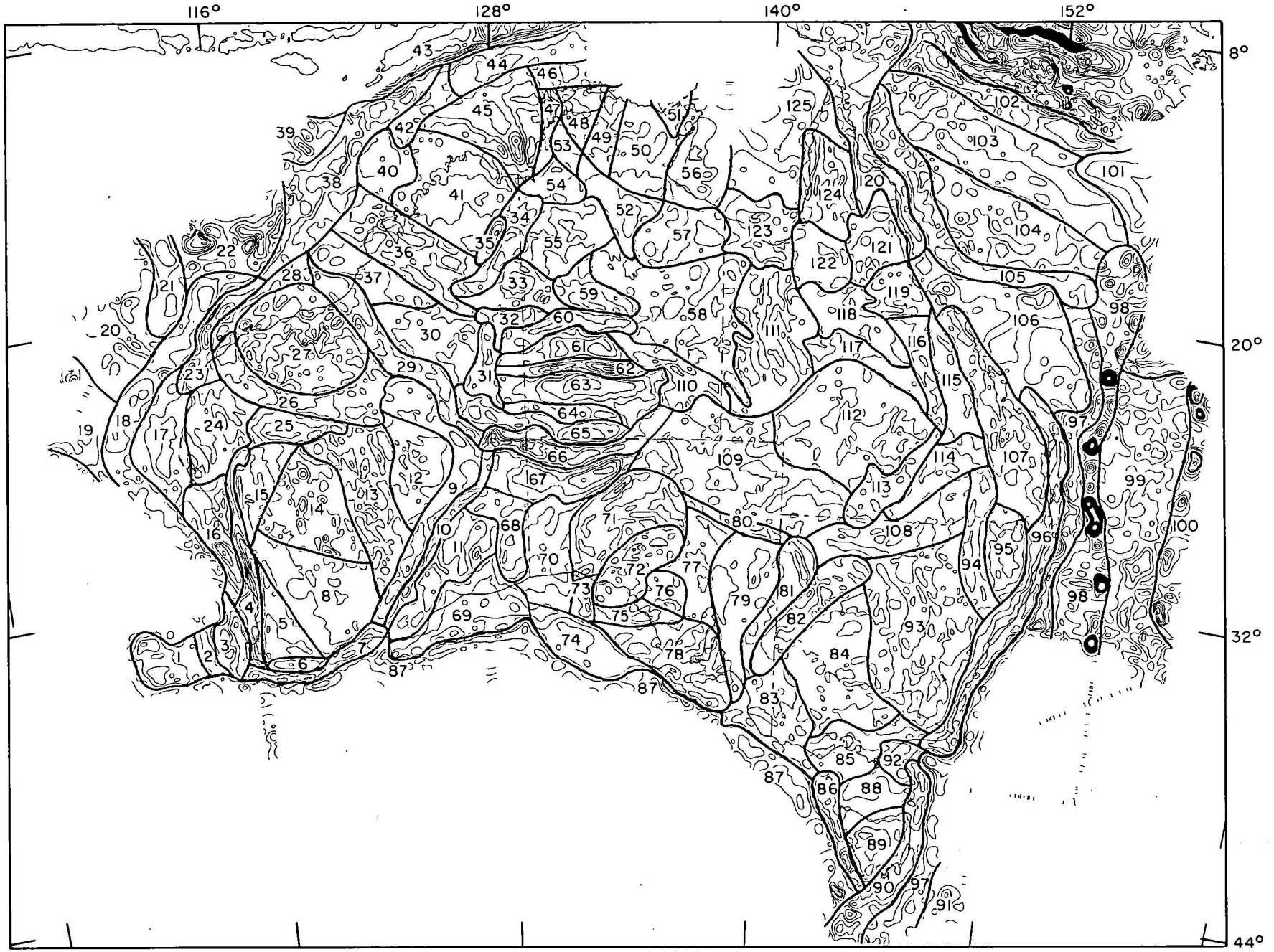
In this project, a close study was made of the spatial relation between magnetic anomaly features and the distribution of earthquake epicentres. Two magnetic anomaly ridges extend eastwards across the Bismarck Sea, parallel to and on either side of the seismicity lineation, and both features show corresponding right-lateral offsets in the eastern basin. Further examination of the locations of earthquake epicentres for which focal mechanism solutions have been obtained reveals that some of them lie on these right-lateral offsets. If the alternative focal planes are selected for the focal mechanism solutions, the shearing indicated has a right-lateral sense and lies within a plane which trends north-northwest. This is more in keeping with the observed offsets of the seismicity lineation and magnetic anomalies. Thus in the eastern basin, at least, a limited form of north-south spreading appears to be taking place about the seismicity lineation, which is offset in a right-lateral sense by trancurrent faults.

The gravity field of offshore Australia (P.A. Symonds & J.B. Willcox)

After publication of the Gravity Map of Australia, it was decided to carry out a qualitative study of the relation between the offshore gravity field and the main structural elements on the continental margin. This has been submitted for publication in the BMR Journal 1(4).

The free-air anomaly field of offshore Australia was divided into about fifty regional gravity provinces, each of which is characterized by uniformity of trend, free-air anomaly level, or degree of contour disturbance (Fig. SGM17). These were discussed in relation to structural and/or bathymetric features in each region. The Bouguer anomalies were used as a rough guide to variations in crustal thickness.

Record No. 1976/91



GRAVITY MAP OF AUSTRALIA SHOWING GRAVITY PROVINCES

(BOUGUER ANOMALIES ON LAND AND FREE-AIR ANOMALIES AT SEA)

A/B2-140A

SGM 17

On the continental slopes the free-air anomalies show a marked 'edge effect' which is made up of a gravity ridge along the top of the slope and a trough along its foot. It arises from differences in the rates of change of two opposing influences on free-air anomaly values as the continental margin is crossed: namely, the gravity effects at sea level due to variations in depth to the sea floor, and to variations in crustal thickness. The computed gravity values for two-dimensional schematic models for the Tasman Sea and Eyre Terrace margins (assumed to be in isostatic equilibrium according to the Airy hypothesis) show that the edge effect could reach 70 mGal in amplitude.

On the continental shelf the free-air anomaly provinces generally coincide with the main structural elements. The Precambrian shields are associated mainly with regional gravity lows, and the peripheral mobile belts mainly with gravity ridges. On the northwest and southern margins of Australia these mobile belts cut across the continental shelf and appear to be truncated at the shelf-break. On the marginal plateaus and terraces the free-air anomaly pattern largely reflects the relative elevation of basement and the thickness of sediment. The well-defined gravity highs on the Lord Howe Island and Tasmantid seamount chains are caused by the combined effects of seafloor topography and high-density igneous bodies.

Regional positive free-air anomaly values over the broad continental shelves of the northwest and southern margins, and negative values over the adjacent abyssal plains, indicate that slight readjustment of the crust/mantle interface must occur in these regions if isostatic equilibrium is to be attained. However, the well-defined free-air anomaly ridges and troughs which correspond to the top and foot of the continental slope respectively, are largely the edge effects referred to above. Regional positive free-air anomaly values over the Queensland and Marion Plateaus indicate that slight subsidence of these features is necessary if they are to attain isostatic equilibrium.

The Bouguer anomaly values indicate that the crust thins oceanward except in the Timor Sea area where crustal thickening occurs, probably owing to interaction of lithospheric plates along the Inner Banda Arc. Crust of typically oceanic thickness (10-15 km) is confined to the lower part of the continental slopes and the abyssal plains, generally oceanward of the 400 m isobath.

Cuvier Abyssal Plain project (J.B. Willcox & P.A. Symonds)

An interpretation of the structure of the Cuvier Abyssal Plain is underway and profile maps of bathymetry, gravity, and magnetic anomalies have been plotted, and a structural map has been prepared.

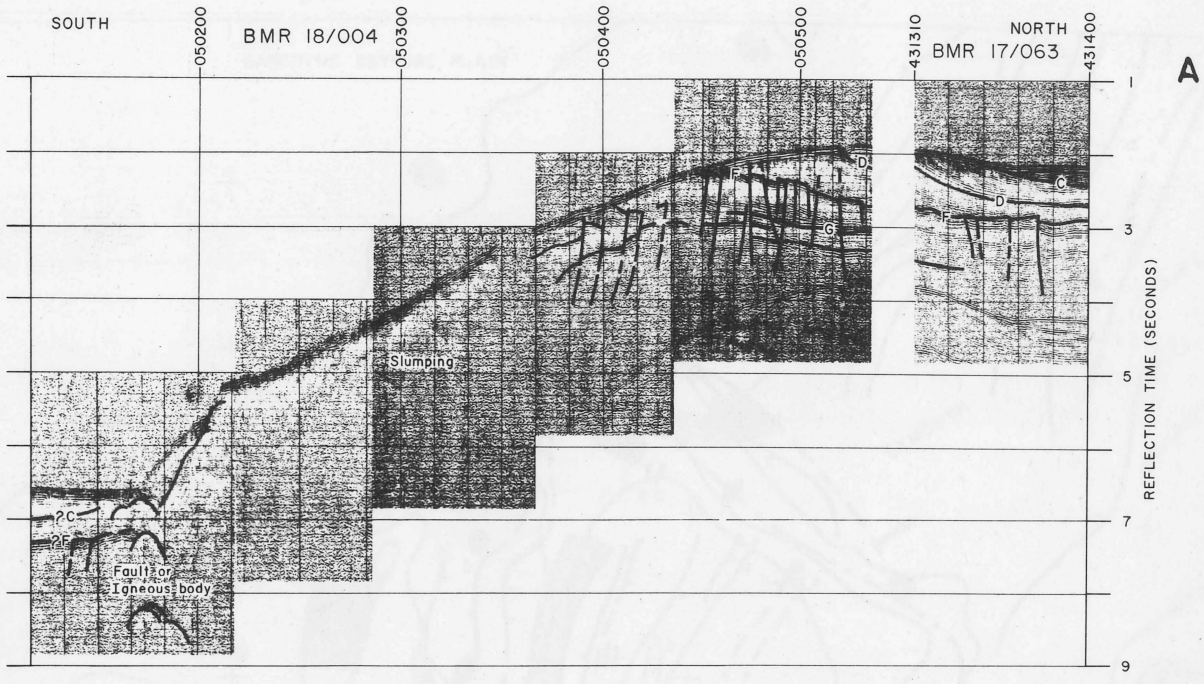
The Cuvier Abyssal Plain is flanked on three sides by the relatively shallow-water areas of the Exmouth Plateau, Carnarvon Terrace, and Wallaby Plateau. In the northwest it is bounded by deep basement ridges. Its northeast margin (Fig. SGM18A) is a linear fault-scarp with associated intrusive bodies which cause intense magnetic anomalies. Seismic reflectors and block-faults, similar to those on the Exmouth Plateau, occur just southwest of the scarp. On its southeast margin (Fig. SGM18B), the basement and a reflector attributed to the top of the Winning Group which comprises shallow marine claystone, alope gently down to the abyssal plain. Its southwest margin is complicated by basement ridges on the sea-floor, which project northward from the Wallaby Plateau.

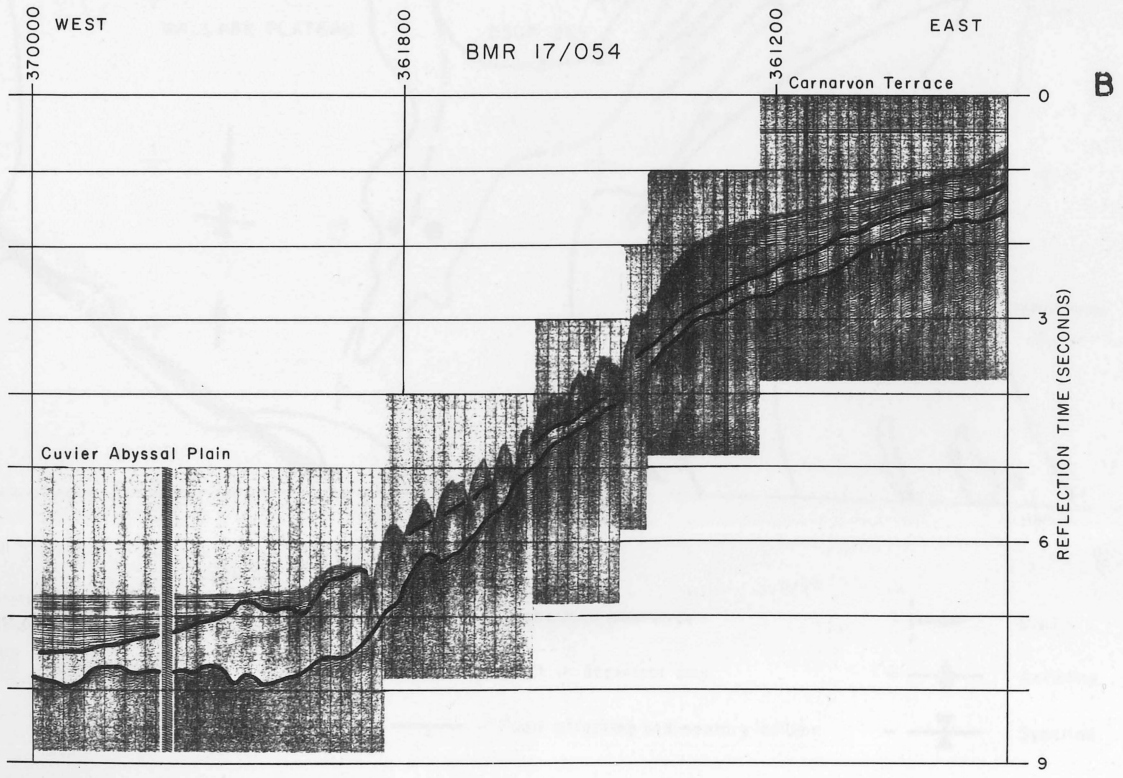
The structural map (Fig. SGM19) shows the well-defined north-northeasterly grain of the area with several faults traceable for 100 km or more. The basement ridges deepen northward and appear to extend across the abyssal plain to its northeastern margin. Here they are probably offset to the west by a transcurrent or transform fault and extend across the abyssal plain west of the Exmouth Plateau.

The magnetic anomaly profiles (Fig. SGM20) east of 109° 30'E are relatively quiet, although north-northeasterly-trending linear features appear to be present. The higher amplitude anomalies west of 109°30'E are associated with basement ridges.

At DSDP Site 263 on the Cuvier Abyssal Plain the oldest formations penetrated consist of about 650 m of Lower Cretaceous sediments which are mainly claystone. These sediments have been dated as either middle to late Albian (from nannoplankton) or Neocomian to early Aptian (from palynomorphs). Seismic profiles indicate that up to 200 m of sedimentary section lies between the well bottom and acoustic basement at the drill site. Palaeobathymetry indicates that the lower half of the Lower Cretaceous sediments was deposited in shallow water, whereas the upper half shows indications of seafloor subsidence 'perhaps below the lysocline' (Veevers, Hertzler, et al., 1974, Initial Reports DSDP). These sediments are equivalent to the 'mid-Cretaceous' sequence of the Exmouth Plateau, and the Winning Group of the Carnarvon Basin, and the lower half of the sequence has sunk more than 5000 m since deposition.

Veevers & Hertzler (1974, Initial Reports DSDP) consider that the eastern part of the Cuvier Abyssal Plain began to form in the Late Cretaceous by seafloor spreading about a north-northeast-trending spreading ridge; they imply that transform faults form the northeast (Exmouth) and southwest (Wallaby) margins. However, the seafloor spreading hypothesis for the region is difficult to reconcile with the continuity of basement ridges from the Wallaby Plateau onto the Cuvier Abyssal Plain; the downwarped rather than downfaulted southeast margin; apparent continuity of basement from the Carnarvon Terrace to the abyssal plain; and the quiet magnetic anomaly pattern.





SEISMIC PROFILES 18/004, 17/063 AND 17/054

For locations of profiles A and B, see SGM9

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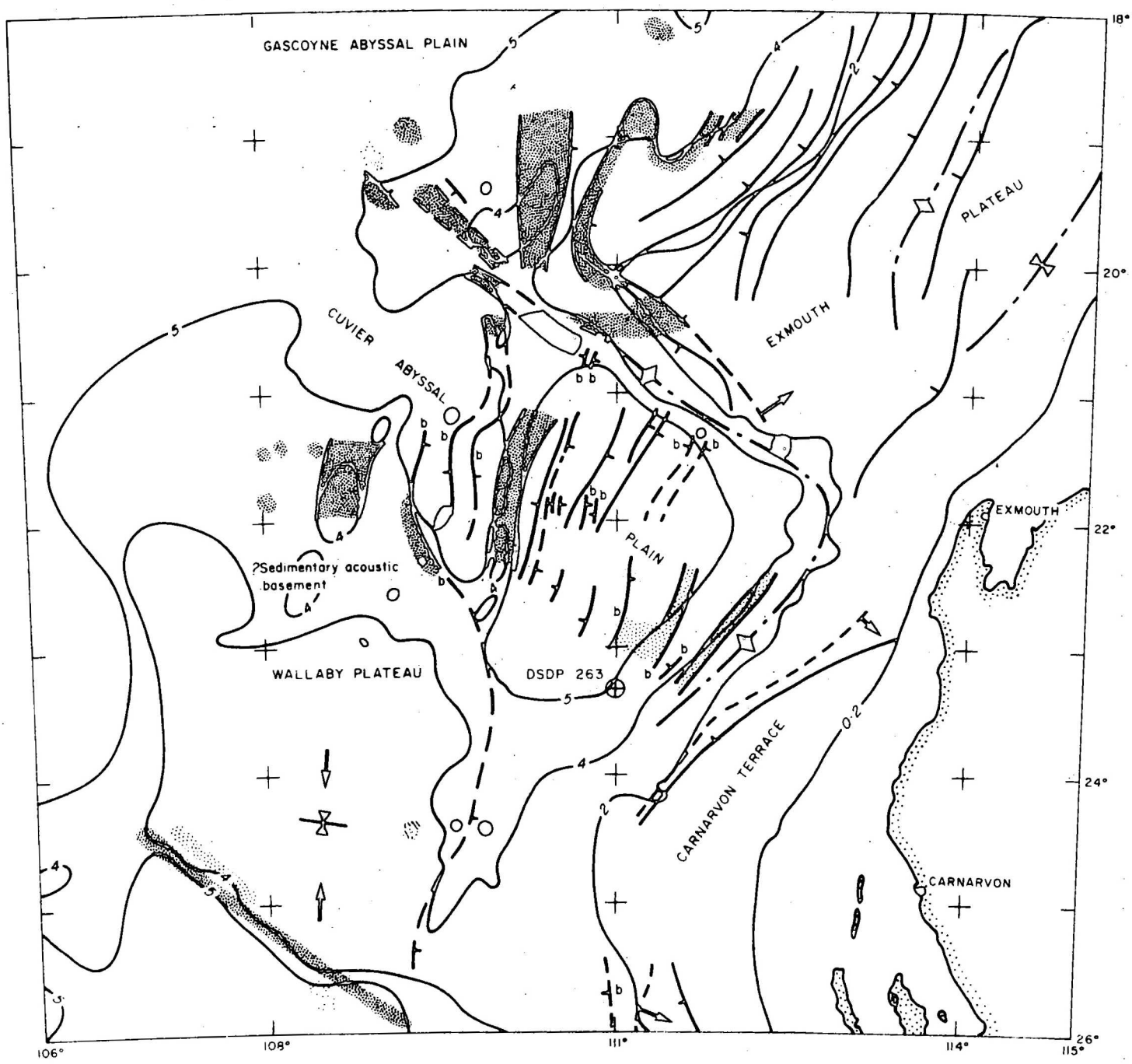


With bathymetric expression — Without bathymetric expression

Basement highs

Igneous bodies

4 — Isobath in kilometres

b — Fault in basement only

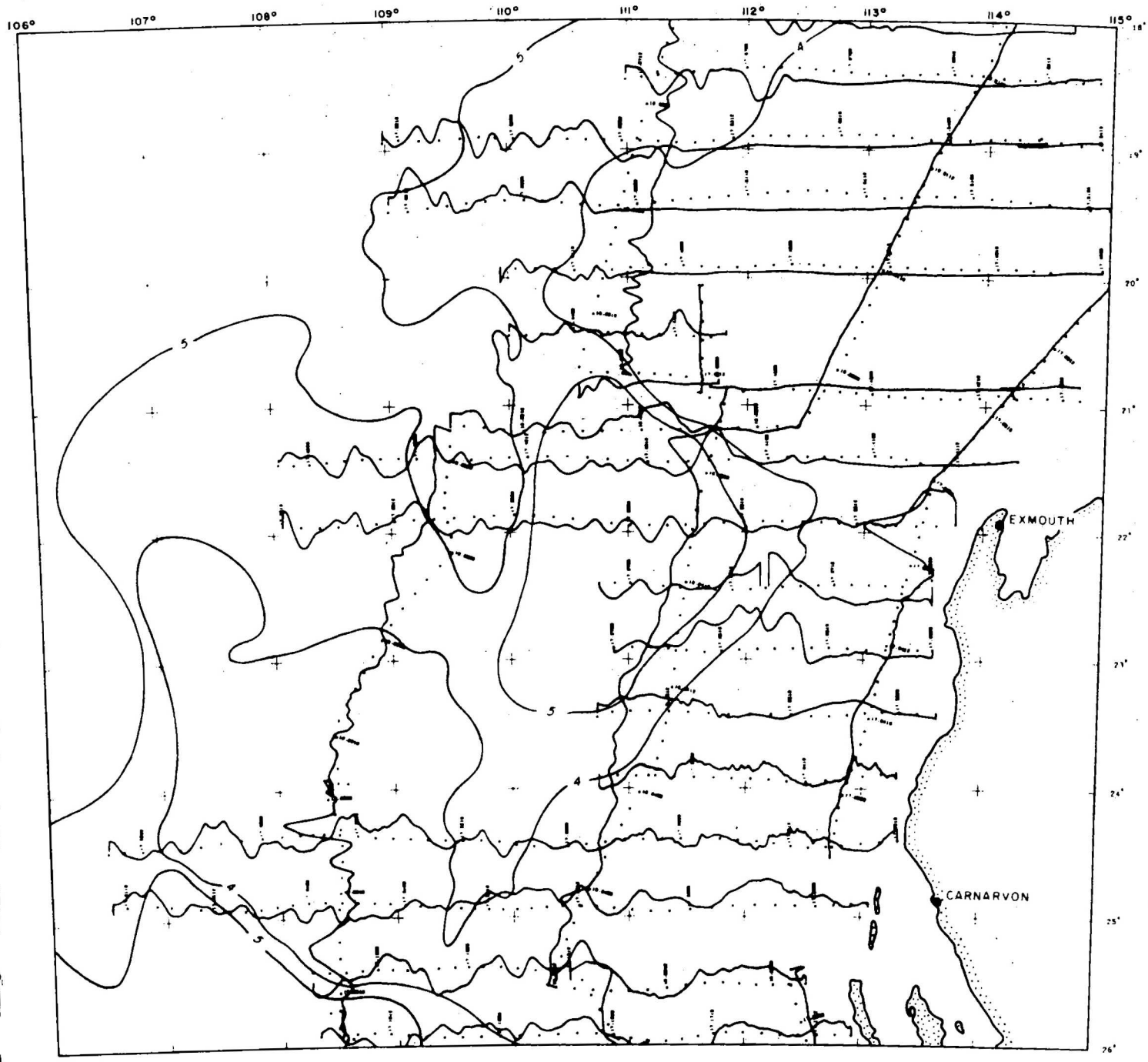
Fault affecting sedimentary column

Dip

Anticline

Syncline

STRUCTURAL SKETCH



MAGNETIC PROFILES

Co-operative surveys

BMR participated or is arranging to participate in several geophysical surveys in waters in the Australian region by overseas oceanographic institutes, the West German Government, the Division of National Mapping, and the Royal Australian Navy. The basis for co-operation with the overseas organizations was that BMR would contribute financially towards projects, and in return would receive copies of data collected, and be able to arrange for BMR observers to take part in the cruises and, if possible, in follow-up interpretative work.

Co-operation with Lamont-Doherty Geological Observatory (J.C. Mutter, L. Tilbury, H. Stagg, D. Jongsma, P. Petkovic, R. Dulski). BMR participated in Cruise 33 of Lamont's research vessel Vema between November 1975 and March 1976. The cruise comprised four legs in the waters to the south and southwest of Australia (Fig. SGM8); at least one BMR observer took part in each leg and reported on the techniques which were used to investigate the geology and geophysics of the survey area. BMR sensing and recording equipment were installed on the Vema for the cruise and useful data were obtained over the Australian continental margin in each leg.

Leg 1 (L. Tilbury, R. Dulski) covered about 9000 line km mainly along the Southeast Indian Ridge crest and along sea-floor-spreading magnetic anomaly 6 on either side of the ridge. Seismic refraction and reflection, gravity, magnetic, bathymetric, and heat flow data were collected and rock samples were dredged from the ridge crest. Apart from testing certain aspects of previous interpretations of the area, the objectives of the survey were to investigate the nature of asymmetrically generated crust, and to investigate a boomerang-shaped regional depression extending across the Indian and Antarctic Plates. Tilbury studied and reported on the computer system used aboard the Vema, and the performance of and technique for deploying ocean-bottom seismometers. Geophysical data were collected off western Tasmania and on the Beachport Plateau off South Australia.

Leg 2 (D. Jongsma) also surveyed the Southeast Indian Ridge and anomaly 6 but was located farther to the west. Jongsma studied and reported on the heat flow measuring apparatus used aboard the Vema. Geophysical data were obtained along two traverses across the continental margin, one across the Great Australian Bight, and one across the Naturaliste Plateau.

Leg 3 (J. Mutter, H. Stagg) was a survey of the magnetic quiet zone to the south of Australia. The main technique of investigation was seismic refraction shooting and the aim of the survey was to study the nature and origin of the quiet zone and its significance in relation to the separation of Australia from

Antarctica. Stagg studied and reported on the refraction system and procedures used on the Vema, and acquired information which will be of value in future refraction work by BMR. Mutter spent 6 months at Lamont headquarters to participate in the reporting and interpretation of the results of Leg 3.

Leg 4 (P. Petkovic), covering about 7000 line km, was a physiographic and geophysical study of the Naturaliste Fracture Zone and included a number of lines across and along the fracture zone and its surroundings. The results indicate several important geological and topographic features in the general area of the fracture zone. Petkovic has written a report on the cruise.

BMR expects to co-operate with Lamont in a geophysical survey of the Coral Sea, New Hebrides, and South Fiji Basins in December 1976. The broad objective of the survey is to investigate the plate tectonic evaolution of the southwest Pacific since the late Cretaceous.

Reporting project of J.C. Mutter at Lamont-Doherty Geological Observatory, Palisades, N.Y. Mr Mutter was overseas at Lamont headquarters from 14 April to 29 October. He was the party leader of the BMR project of co-operation with Lamont on R/V Vema south of Australia between mid-December 1975 and mid-March 1976 and participated personally in the third leg, which investigated the magnetic quiet zone (MQZ). Subsequently he was allowed a period of 3 months from 14 April at Lamont to participate in the interpretation and reporting of the results of that leg. The chief scientist on this reporting project was Professor Talwani, Director of Lamont, who also took part also in the MQZ leg at sea.

Mr Mutter required more than 3 months and was allowed to prolong his visit privately on special recreation leave which he had accumulated previously during marine survey duty.

During his visit, he completed a paper in collaboration with R.E. Houtz on the interpretation of seismic data from the area, and a more general one with Professor Talwani on the overall interpretation of geophysical and other data. A third paper, also in collaboration with Professor Talwani, is in preparation. In it they develop a theoretical model to explain magnetic quiet zones in terms of a distinctive crust type which is formed in the initial stages of crustal extension and tends to be unique to continental margins. A paper presenting this in condensed form was prepared by Mr Mutter and delivered to a meeting of Lamont Industrial Associates.

Marine magnetic surveys: co-operation with Division of National Mapping (F.W. Brown, J. Grace, R. Dulski, M. Amar). These surveys have been conducted as simple extensions of the reconnaissance

bathymetric survey by the Division of National Mapping. They have used proton precession magnetometers mounted on vessels contracted to the Division for bathymetric work. The latest of these surveys was predicted to end early in 1976 but actually ended in December 1975, after completing 1679 n miles of magnetic traversing in very difficult conditions over the Kimberley Basin off northwest Western Australia. A magnetic field monitor station was operated continuously in Broome by courtesy of the Bureau of Meteorology.

The magnetic data have been collected in analog form on stripcharts and the depth and position data as handwritten, numerical entries on prited forms. To amalgamate them, and to incorporate them in the general data system of the Marine Group on digital magnetic tape requires considerable routine processing. This was proceeding until early in 1976 when shortages, first of computing funds and then of personnel, entailed temporary suspension.

The bathymetric surveying was confined during 1976 to the use of vessels chartered from the Department of Transport. Investigations have been made in BMR of ways to incorporate the magnetic surveying with these operations. At the same time a practical system using existing basic equipment for digital magnetic recording was being developed which would eliminate the need for labour-intensive hand digitizing and data-merging procedures of the past. These developments were well advanced by the end of 1976. The intention is to install a system on the Cape Don early in 1977 and test it during a cruise over the shelf off the southern coast of Western Australia. One of the obstacles to operation of the magnetometer equipment on Department of Transport vessels is shortage of alternating current power supply. To overcome this, the winch carrying the magnetometer sensor cable was converted during the year to operate on direct current which is in ample supply on these ships.

In connection with this work, a review was commenced during the year of airborne surveys which extend wholly or partly over the Australian continental shelf. The purpose of this is to establish priorities and assist in preparing pre-survey assessments of areas intended for bathymetric coverage.

Co-operation with Woods Hole Oceanographic Institution (C.R. Johnston and P.J. Cameron). BMR co-operated with Woods Hole Oceanographic Institution in two surveys carried out aboard the R/V Atlantis II. BMR contributed $10,000 towards the cost of the surveys and arranged for BMR personnel to assist with the collection of data. C.R. Johnston and R.D.E. Cherry participated on the first survey in the respective capacities of scientific observer and seismic shooter. P.J. Cameron participated on the second survey as a scientific observer. The traverse plans for both surveys are shown in Figure SGM 8.

The first survey began at Darwin on 2 September and was aimed at investigating the Banda Arc. Geophysical profiling techniques used included gravity, magnetics, seismic refraction, single-channel seismic reflection, and multi-channel seismic reflection techniques. Most of the refraction work was carried out in conjunction with the R/V Thomas Washington operated by Scripps Institute of Oceanography. In addition to acquiring the geophysical profiling data, heat flow measurements and core samples were obtained at several stations, geological observations were made on islands around the arc, and three island and one sea-bed seismometer stations were established for the duration of the survey. The survey finished in Darwin on 25 October.

The second survey from Darwin to Singapore began on 29 October. A series of gravity, magnetic, and single-channel seismic reflection profiles was obtained across the Argo and Gascoyne Abyssal Plains, and a single traverse was made across the Java Trench. The aims of this survey were to study the age relations between the basins off northwestern Australia and to investigate the distribution of piercement structures in the Argo Abyssal Plain.

Cooperation with the West German Government - Valdivia Cruise (N. Exon, R. Whitworth, H. Stagg). After discussions with Professor K. Hinz of the Bundesanstalt fur Geowissenschaften und Rohstoffe, Dr Hartono of the Geological Survey of Indonesia, and others, in May 1976, a proposal was formulated under which the German research vessel Valdivia would operate in Australian, Indonesian, and Philippine waters in the first half of 1977. Under these proposals Leg 1 of three parts would be mainly between Scott Reef and the Java Trench, Leg 2 in the Celebes Sea and Sulu Sea, Leg 3 in the SE China Sea and West Phillipine Sea, and Leg 4 in the anaerobic Sulu Sea. It was planned that two BMR geophysicists and one geologist would take part in Leg 1, which would consist of multi-channel reflection seismic work on the Australian margin, over the Argo Abyssal Plain and across the Java Trench; dredging on the Australian margin; and a short refraction seismic study northeast of Sumba. Professor Seibold of Kiel University has invited a BMR geologist to take part in Leg 4.

Magnetic survey aboard the HMAS Diamantina in the Perth Abyssal Plain (D. Falvey, R. Shaw (Sydney University); N.F. Exon (BMR). In February 1976, HMAS Diamantina was used for one week in a magnetic survey over the Perth Abyssal Plain off Western Australia. The survey was arranged by Dr D. Falvey, and consisted essentially of two subparallel traverses extending northwest from Geraldton and Perth, and intersecting near their northwestern ends just east of DSDP site No. 256. The traverse plan and a data tape are to be sent to BMR.

The aim of the survey was to help elucidate the complex tectonic history of the area. Correlation between the two lines was impossible, and it appears that the magnetic pattern is even more complex than had been envisaged. However the data will be useful in future interpretations in the area.

Preparations for future marine surveys (F.W. Brown, R. Whitworth, C.R. Johnston, J.C. Branson, A.R. Fraser, D. Hsu, A. Hogan, J. Grace).

Most effort was concentrated on the development of a data acquisition system (DAS) for use in future marine surveys, although time was also spent in drafting a new set of tender specifications for marine contract surveys, and in considering the priorities for possible future surveys.

The DAS project was formally established in 1975 with the object of developing a wholly self-contained BMR hardware and software system, which could be used in any continuous marine survey to acquire nonseismic geophysical and navigation data in digital form on magnetic tape. In addition, it was proposed that the system would process data on line to give corrected positions and field values, and would display in various ways selected observations, results, alarms, and routine checks.

At first it was intended to base the system on two Hewlett-Packard 2116B processors used in the BMR Continental Margins Survey. However, hardware obsolescence would have threatened flexibility in the evolution of the system, so it was re-designed to incorporate a current processor in the Hewlett-Packard line, the HP 2108.

To become acquainted with problems concerning the software development of the system, four members of the Marine Group attended an in-house course in the use of HP Assembly language for a month early in the year. This was followed by a practical study of the HP Real Time Executive operating system which is much more versatile than the previous Basic Control System.

During the year, practical means of achieving the objective were developed, with considerable effort being contributed by the Geophysical Services Section in drawing up the DAS schematic diagram in detail, and designing the interfacing circuits, amplifier/filters, and digital/analog converters. The hardware for direct purchase was specified and orders were placed for those items needed most urgently for continued software development.

At the end of the year, the pace of development had eased temporarily while awaiting delivery, testing, and integration of the high priority hardware, due mainly in early 1977.

Hardware for the data acquisition system. (J.C. Branson, A.R. Fraser, J.K. Grace). New equipment for the proposed new data acquisition system was purchased in the second half of 1976. Two new computer main frames, both Hewlett-Packard 2108 computers with 32 K of memory, and a 15 megabyte disc were purchased. The computers, together with an available multiprogrammer unit, a 4.6 megabyte disc, and interface cards provide the hardware basis for a new system to acquire magnetic, gravity, bathymetric, and navigation data at sea.

Two digital clocks were purchased to give reliable time control in marine surveys, and their design was specified so as to give automatic changeover if one clock was to become unreliable. A new 9-track tape recorder was also purchased to provide for higher-density packing of basic geophysical data. An available 7-track tape unit was used for system software development.

The seismic processing system was augmented with a Phoenix multiverter and a Geospace monitor recorder. An available computer (HP2116B), multiverters, and electrostatic pen recorders (EPCs) were reconfigured to improve seismic playback facilities within BMR.

A HP 2116 B computer was also configured with a magnetometer, clock, and fathometer in preparation for co-operative survey work with the Division of National Mapping.

Software Development (C.R. Johnston, H.D. Hsu, A.P. Hogan).

Software is being developed for the new data acquisition system (DAS). The proposed operating system is the Hewlett-Packard Real-Time Executive (RTE).

In the early stages of the design and development of the new DAS, the Hewlett-Packard Basic Control System (BCS) was adopted as the standard operating system, and some effort was put into programming for it. At the same time, a seismic data acquisition system, which was under consideration for development but separate from the DAS, was also planned to operate under BCS. The overall geophysical data acquisition system has been divided into these two subsystems for development purposes because of the quite dissimilar operational procedures involved in acquiring navigation and non-seismic geophysical data, and seismic data.

Whilst the development of the DAS based upon BCS was going ahead, it was still undecided as to which operating system would be used eventually. However, information was received from Hewlett-Packard representatives that support for BCS would soon be discontinued by H.P., and the general opinion within BMR was in favour of a move towards the use of Hewlett-Packard RTE. Thus, an investigation of the RTE system was conducted. The objectives of this investigation were:

1. To examine the suitability of the RTE system as an ad hoc operating system.

2. To determine the extent of CPU time utilization and the extra overheads involved.

3. To investigate the availability of RTE system software expertise within BMR.

4. To determine the saving in total programming effort.

5. To assess the consequent need for alterations or increases in the hardware requirements.

6. To examine the problems of training personnel in the use of the RTE system.

The particular RTE system under investigation was RTE-II, a disc-based multiprogramming system that allows several programs to operate concurrently. Programs can be written in FORTRAN IV language which is an advantage in developing the DAS. When the new core-based RTE system (RTE-M) becomes available, it will be investigated as an alternative operating system for the new DAS. Because the RTE systems are mutually compatible, programs written for RTE-II will also operate under RTE-M.

Findings from the investigations of RTE-II favour the change of operating system from BCS to RTE and it is now proposed that both the DAS and the seismic data acquisition system will operate under RTE. Figure SGM21 shows the hardware arrangement of the total data acquisition system in the proposed RTE operating environment.

The two CPUs shown in the figure have quite different functions. CPU No. 1 will mainly handle input/output of geophysical and navigational data, whereas CPU No. 2 will mainly perform the processing of data files.

Program development of the DAS software based on RTE-II was still in progress at the end of the year. A number of programs for the operation of CPU No. 2 have been completed in a preliminary form, but testing of these programs can not be carried out until the basic DAS hardware becomes available.

Digital acquisition system for seismic data (C.R. Johnston)

A review was begun of the requirements for acquiring digital marine seismic data. The basic objective was to initiate the development of a comprehensive BMR marine recording/processing system, the completion of which is the eventual aim. In its initial stages the objective is to be prepared to acquire data digitally from analog systems using formats and processes to the

greatest advantage. It is proposed that the system will enable processes to the greatest advantage. It is proposed that the system will enable straightforward preliminary processing steps, such as demultiplexing and true amplitude recovery, to be carried out. This facility will substantially reduce total processing costs.

The study is continuing and part of the purpose of Mr Johnston's participation in the survey by Woods Hole Oceanographic Institution in the Timor and Banda Seas late in 1976 was to gain familiarity with the operation and performance of their seismic data acquisition equipment. This equipment is similar to that proposed for the BMR system; it comprises a processor with 3 zK words of core memory, a disc, and two tape drives.

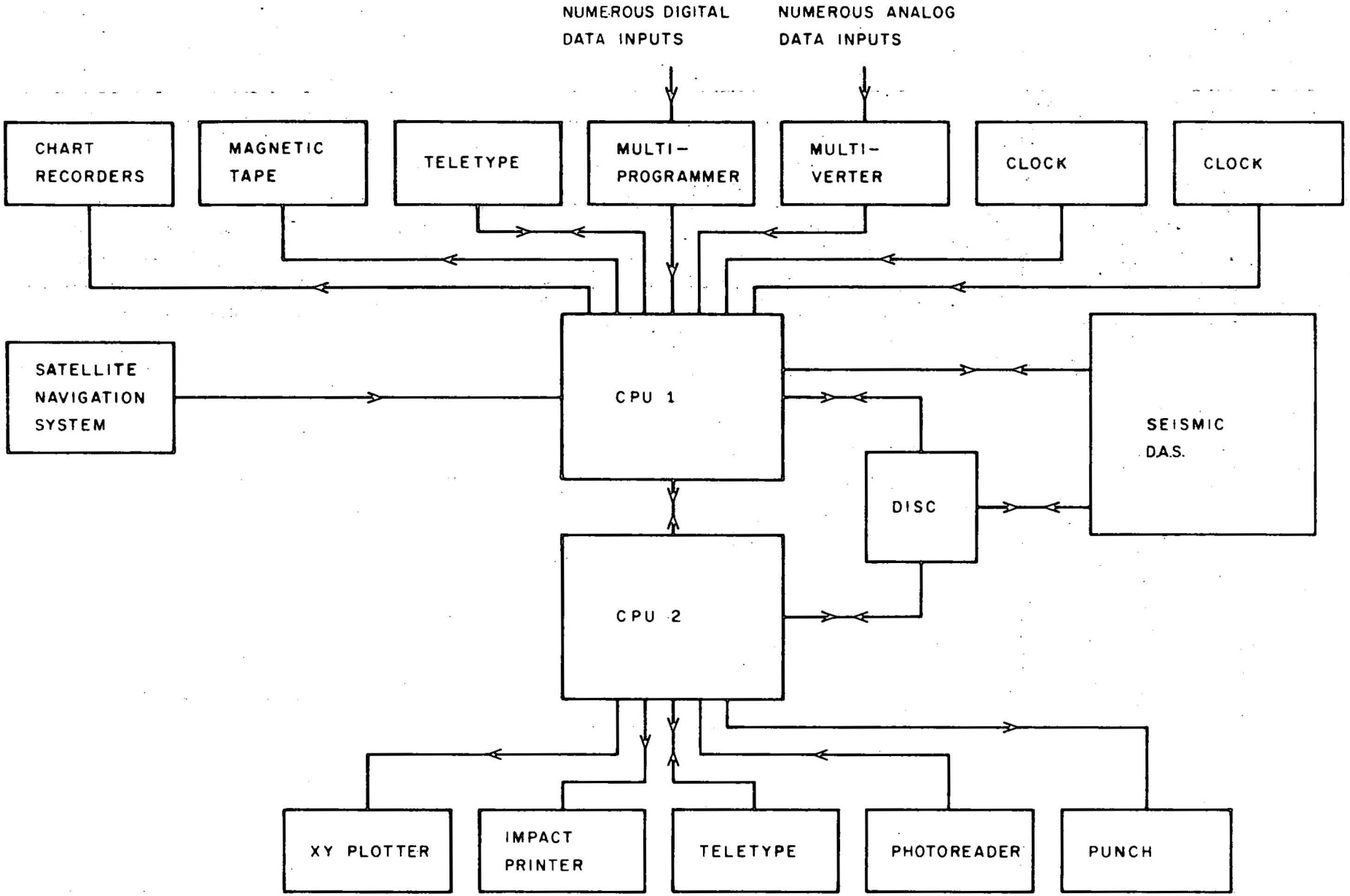
Data processing (R. Whitworth, L.A. Tilbury, G. Karner, J.C. Mutter, J. Fisher, J. Walsh, J. McIntyre, U. Hammerling, J. Kuta)

The most significant feature of the year was the almost total cessation of processing in the first half of 1976, because of lack of computer funds. To reduce overhead costs to a minimum, all active magnetic tapes were purchased and rental costs were thus eliminated. During this period the opportunity was taken to improve the efficiency of those programs which are frequently used. The differences in the charging algorithms between the CDC 6600 and CYBER 76 have required almost total re-writing of some programs.

On resumption of processing, difficulty was experienced in reading tapes purchased from CSIRO six months earlier. Fatal tape errors, which prevented the input of data files, appeared to be mainly associated with the control words coded onto the tape when using system default options. Copying of the faulty tapes using the HP 2100 computer within BMR usually eliminated the fault, but in two cases special programming was needed.

One continuing problem with the CYBER 76 is the poor quality of magnetic tapes provided by CSIRO. A significant percentage of re-runs are required because the system rejects tapes that were previously acceptable. Generally, resubmission of the job gave an acceptable result. The increased workload necessary to ensure acceptable results has greatly reduced our rate of progress.

Archiving of Phase 1 data tapes. Data tapes from Phase 1 of the processing contain information at 10-second intervals. Although the chances of having to use the data in this form are slight, the unedited and edited versions have been retained for archival purposes. The tapes have been converted from CDC 6600 SCOPE file structure to default CYBER 76 file structure; i.e. W-type records and I-type blocking. The time channel was also reformatted into



HARDWARE ARRANGEMENT OF THE PROPOSED MARINE ACQUISITION SYSTEM OPERATING UNDER HEWLETT-PACKARD REAL-TIME EXECUTIVE

standard survey time format of SS.DDHHMM. The individual files were then concatenated on the HP2100 computer at BMR. Where possible, the files for a cruise were merged onto a single tape but this could not always be done. In such cases the multiple files were terminated at significant breaks in time. Because the HP2100 cannot produce tapes fully compatible with the CYBER 76, special input staging procedures are necessary on the CYBER to recover a data file from an archive tape.

Phase 2 processing. The water depth and magnetic diurnal processing described in last year's summary of activities have been completed, and the updated information has been merged into the Phase 2 tapes. Multichannel stripchart plots were produced for final inspection of the data.

As expected, gravity results obtained during turns were inadequate with pulses of a few minutes in period and amplitudes of up to some tens of milligals. Normal editing procedures allow the elimination of such noise. However on survey 18 Cruise 2, a large-amplitude, long-period damped oscillation lasting about 30 minutes occurred after each turn. A technique was developed to recover the data, which would otherwise have been lost. The technique was to find the zeros of the damped harmonic curve that best fitted the observations, identify the equivalent points on the gravity trace, and interpolate between these points.

Preliminary track charts and current vector maps were plotted to help in the assessment of navigation processing. The navigation data were reprocessed as necessary to eliminate unrealistic undulations in the ship's track. These were generally caused by inadvertently using poor-quality satellite fixes.

Marine geophysics group program libraries. During the year, the libraries containing the Marine Group's programs have been reorganised to simplify their use and keep them at a reasonable size. All libraries are stored on the Group's on-line disc pack and standard cards are provided for their use to avoid mistakes. There are now 8 libraries:

LIB 1 - PHASE1BINARY
LIB 2 - PHASE2BINARY
LIB 3 - PHASE3BINARY
LIB 4 - PHASE4BINARY
LIB 5 - DIGITISING BINARY
LIB 6 - SERVICEABINARY
LIB 7 - PLOTBINARY
LIB 8 - MERCATOR,TRANSVERSEMERCATOR,LAMBERTCONFORMAL,
SIMPLECONIC,MILLER,RECTANGULAR

These are arranged in a hierarchy so that they may be attached in numerical order, thus avoiding incorrect loading of the libraries. LIB 1 to LIB 5 contain the major programs for the

four phases of processing and digitising respectively; LIB 6 has service programs and standard routines used by the first five libraries; LIB 7 holds all basic plot software used by LIB 1 to LIB 6 and LIB 8 consists of a variety of coordinate routines mainly used by LIB 7.

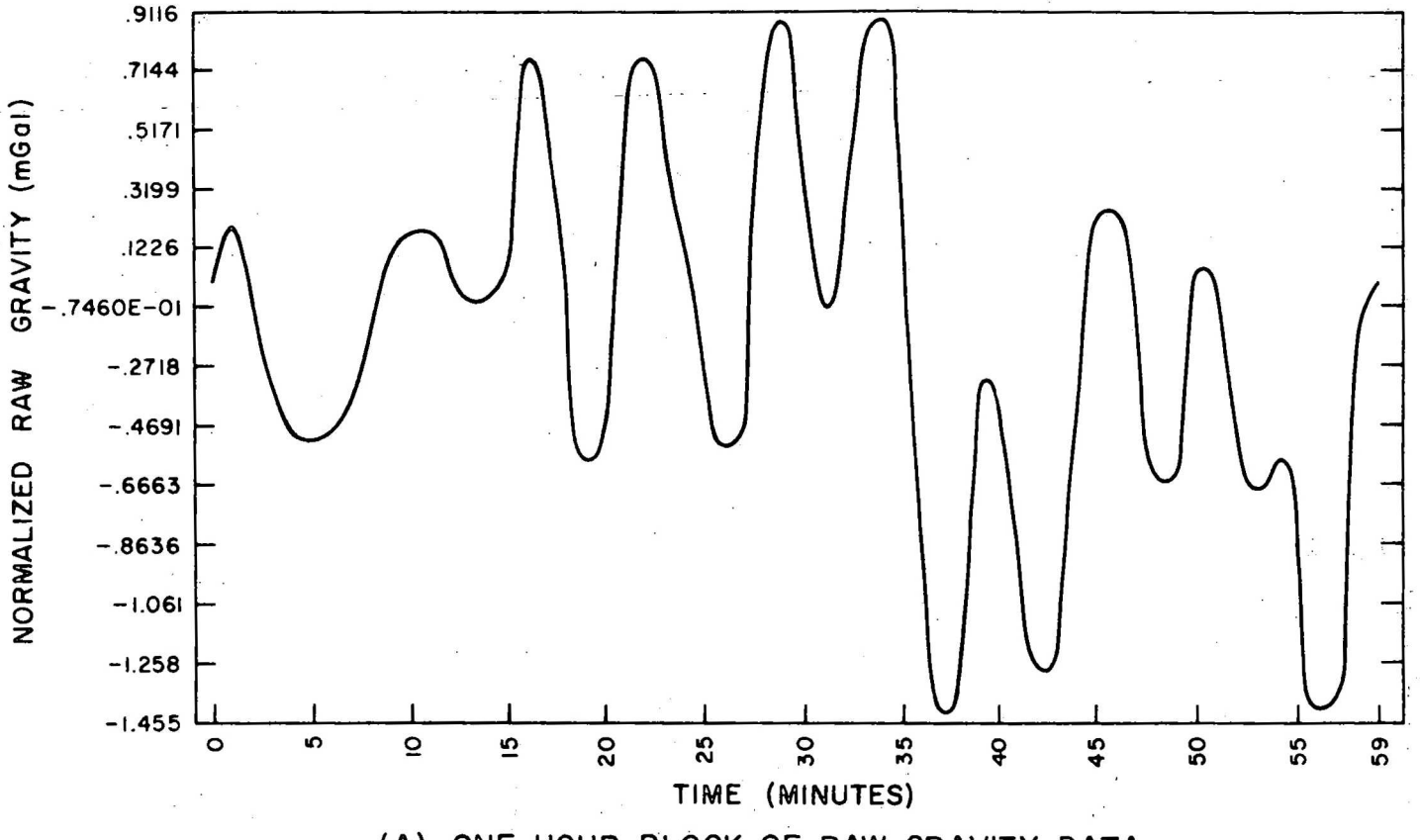
User instructions for the most commonly used programs have been revised. As far as control cards are concerned the instructions have been deliberately kept general; the particulars for standard operations such as mounting disc packs and libraries can be found in the CDC manuals. This avoids having to make drastic revisions to the instructions each time the CYBER 76 operating system is modified.

Documentation of computer routines continued throughout the year. Commenting of all routines added to the system is now mandatory and must explain all formal parameters. A utility routine extracts all such comments to provide a moderate level of routine description. Little else is feasible with the manpower presently available.

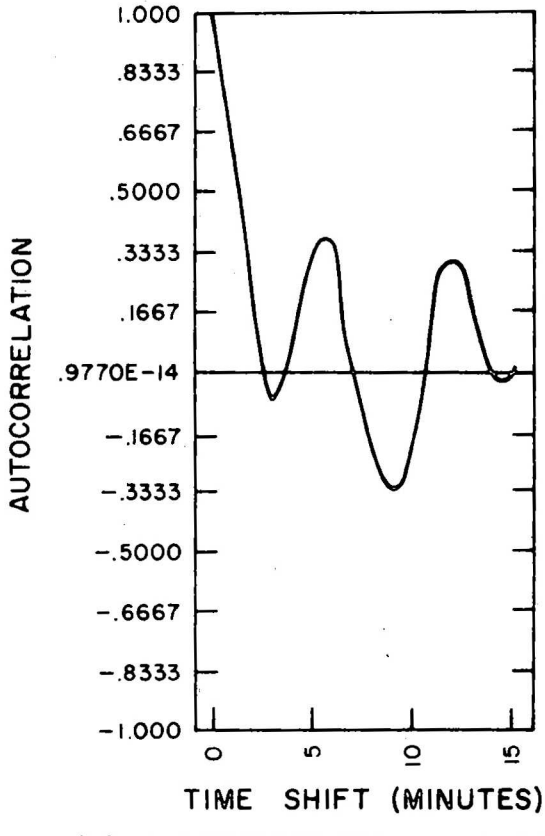
Gravity reprocessing (G. Karner) Inspection of plotted gravity profiles from the Continental Margin Survey has shown that a significant amount of the data contains oscillations with amplitudes up to 20 mGal peak-to-peak and periods ranging from 5 to 30 minutes. Real gravity variations with equivalent periods in this range could occur over shallow water, but the oscillations were observed over both shallow and deep water, suggesting that they are instrumental in origin.

To investigate their origin, a spectral study was made of two samples of gravity data, one from survey 13 cruise 5 and the other other from survey 17 cruise 1; that is, before and after the gravity meter was overhauled by the manufacturer. Auto-correlation and Fourier analysis techniques were used to find the periodicities of the data. Using autocorrelation techniques, it was found that the dominant component was in the range 8 to 10 minutes; using Fourier analysis techniques major peaks were found in the power spectrum from 5 to 20 minutes and from 30 to 60 minutes (Fig. SGM 22). An identical spectral study was made of the simulated gravity profiles across a horizontal cylindrical body at varying water depths. The results of this study suggest that the 5 to 20 minute periods in the power spectrum of the data are instrumental in origin, whereas the 30 to 60 minute periods are caused by real variations in gravity.

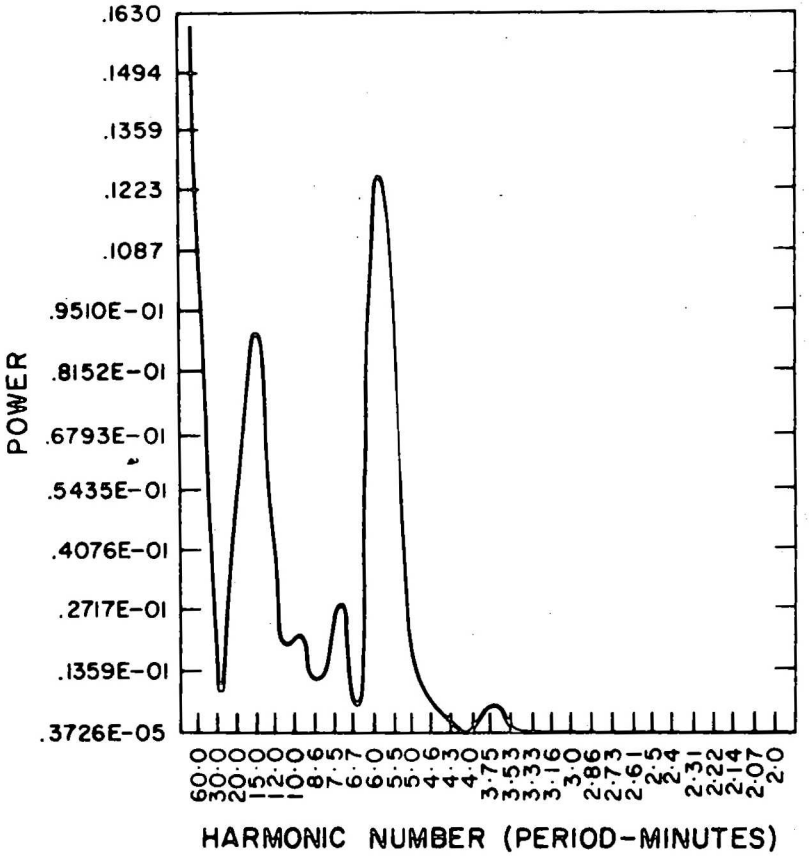
A further investigation was made to see whether or not the cause of the noise could be found, and if more reasonable values could be obtained by recomputing the gravity waveform from the components of gravity that had been recorded digitally during the survey. These components are computed gravity, spring tension, total correction, and cross coupling correction.



(A) ONE HOUR BLOCK OF RAW GRAVITY DATA



(B) AUTOCORRELATION FUNCTION OF RAW GRAVITY IN (A)



(C) POWER SPECTRUM PLOT OF RAW GRAVITY IN (A)

Computed gravity is calculated with the LaCoste meter using the equation:

$$G = S + KB + CC$$

where G = computed gravity, S = spring tension, K = a constant that is a function of meter sensitivity, B = dB/dt (i.e. beam velocity), cc - cross coupling correction, and KB + CC = total correction. A consistent error in the computation or summation of any of these components could account for the noisiness of the gravity data. If so, it should be feasible to recompute gravity using a suitable correction procedure.

In deep water, any short-period component in spring tension should be balanced by an equal and opposite short-period component in total correction. If the amplitudes of the components were equal, the oscillations in the computed gravity waveform could be attributed to either a phase mis-match or faulty addition of spring tension and total correction. If the amplitudes of the components were not equal, it could be inferred that the total correction had been mis-computed.

The total correction and spring tension components for the test period from survey 13 were passed through a series of bandpass filters that dispersed the waveforms into several period intervals. For each passband, the optimum time shifts and amplitude ratios were determined by cross-correlation. The values thus determined were used to minimise the residual noise in each passband, and the corrected passbands were then summed to recreate the computed gravity waveform (Fig. SGM 23). The resultant trace is significantly quieter than the original gravity trace computed within the meter.

The time shifts and amplitude ratios computed allow us to deduce why the original gravity data were of poor quality. The time shifts vary linearly from -2 to 1 minute from the shortest to the longest period passband; the amplitude ratios vary similarly from 1.3 to 0.7. The RC analogue filtering of the total correction within the meter resulted in the various periodicities being differentially attenuated and phase shifted relative to the spring tension. As a result, summation of the two components produced beating or 'mismatch' residuals superimposed on a smoothly varying gravity waveform.

Theoretically, the above procedure essentially inverts the non-linear filtering effect caused by inadequacies in meter performance. While some further study is required, it appears justifiable to apply the same basic correction procedure to the gravity components in shallow water, where genuine short-period gravity may occur.

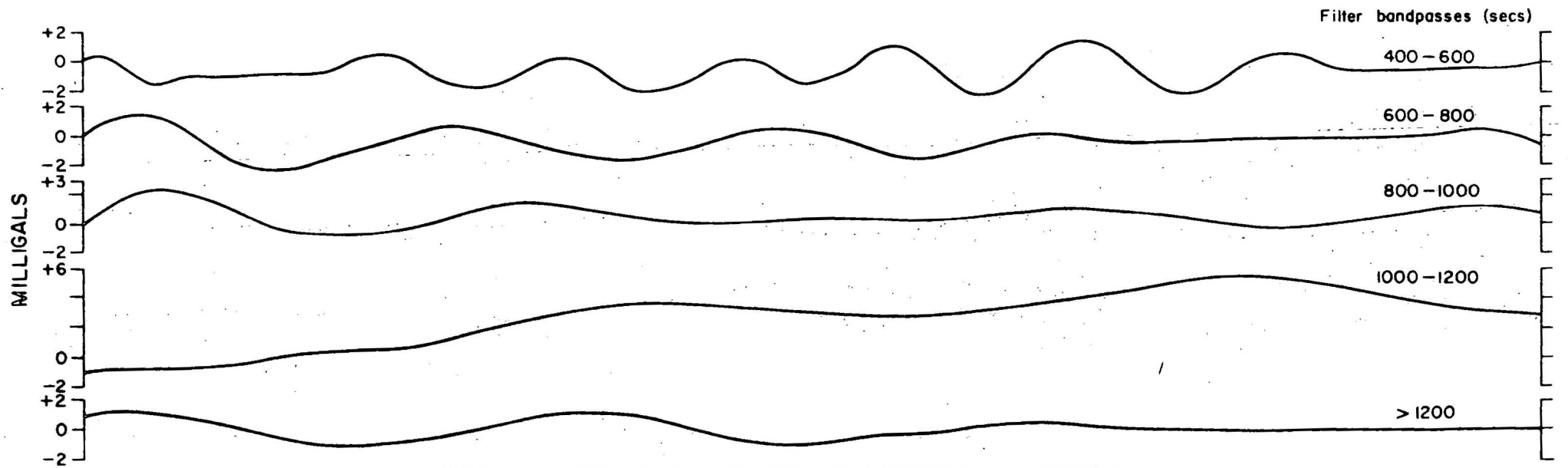
Digitisation and display of interpreted seismic data (L. Tilbury, R. Whitworth). One of the greatest bottlenecks in the production of structure contour and isopach maps from seismic reflection records is the considerable effort needed to convert two-way reflection times into depths. In particular, if the initial velocity function requires modification, the process must be repeated for all lines in the map area. Further work is required if the scale and projection of the maps has to be changed.

As the interpretation load has built up within the Marine Group, the desirability of using automated techniques to reduce the time spent on data manipulation has become more pressing. After discussions on the facilities required, a pilot scheme was initiated. An existing program was modified to provide digital station locations for non-BMR surveys in the same format as for BMR surveys. A procedure for digitising seismic sections was extended to provide further facilities needed in more detailed interpretation. New programs were developed to allow the automatic posting and contouring of horizon and isopach values.

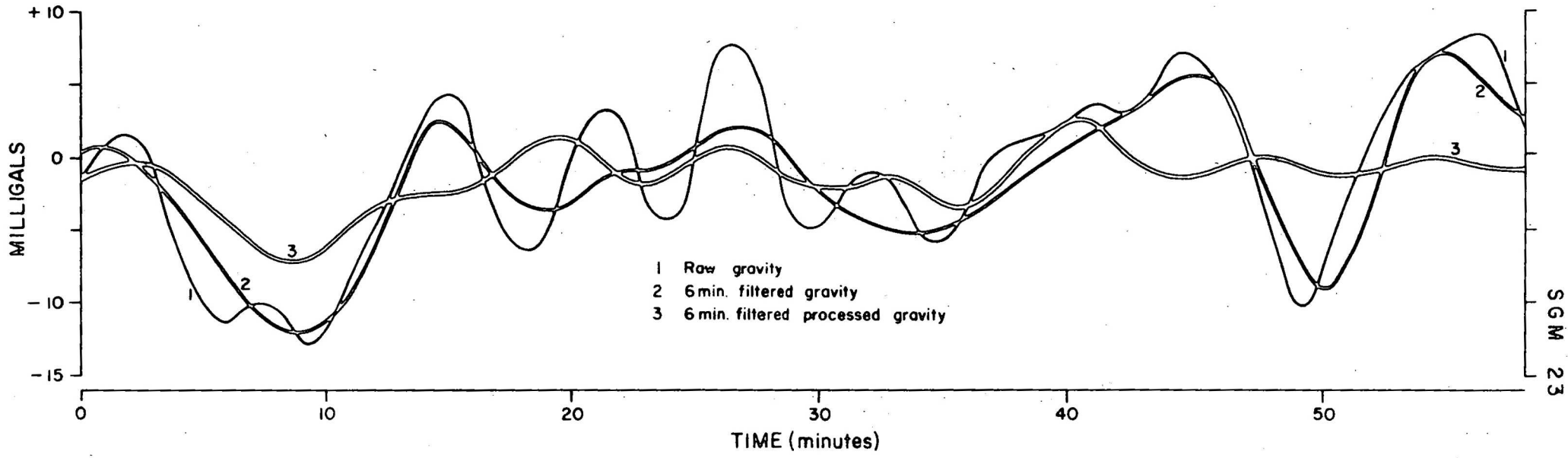
After development of the programs to a usable stage, a seminar was held for BMR staff in June 1976, when procedures and facilities were outlined. Following the discussion that arose, further modifications were made and a working system is presently being implemented. An outline of the system is given below.

1. Digitising station locations. Two essentially independent steps are involved in converting station locations to digital form. Firstly, stations are digitised from source maps on a suitable digitising table such as the GRADICON system at BMR. The user digitises the map graticule to control conversion to geographic coordinates, then systematically digitises the required locations, identifying only the first location number in each continuous sequence. Secondly, the digitised data is converted by program DIGMAP into station number, latitude, and longitude. A least squares routine adjusts the digitised graticule to minimise the effects of irregularities caused by folds and stretching of dyeline prints, etc. The program supplies an estimate of the accuracy of conversion to geographic coordinates, and each station number, its latitude and longitude are stored in digital form in the standard file format used for BMR marine surveys.

Using this basic data file, program TRAKMAP can be used to plot the station location maps at any specified scale and projection. Facilities exist to plot the track between consecutive stations to produce maps showing the density of data in a region, to plot the track and annotate it at specified intervals for regional maps, and to plot and annotate each station for detailed maps.



RECOMPUTED GRAVITY FOR BANDPASS RESIDUALS
OF TOTAL CORRECTION AND SPRING TENSION
PROCESSED GRAVITY = Σ(BANDPASS GRAVITY)



EXAMPLES OF RAW/FILTERED/PROCESSED GRAVITY

Record No. 1976/91

G449-178A

2. Digitising seismic sections. Again two steps are involved: one on the digitiser, the other on the computer. The horizontal scale in survey time for marine surveys, or shot points for land surveys is used to control conversion to station number whereas the vertical scale is used for two-way reflection times. Each horizon is digitised in turn and given a particular identifier so that all the data for any given horizon may be extracted easily at a later stage.

Facilities have been provided to input supplementary information during digitising. For example, flags can be set to indicate the quality of reflectors, the type of geological feature, areas of interpolated data etc., and the corresponding digitised data will be flagged as a particular type. This information is extracted during later processing and is posted along with the seismic time-depth data onto the seismic map.

The major program DIGDATA converts the digitized data into seismic two-way time versus station number. Data are stored in horizon strings which contain reflection times and station numbers for one horizon. A plot at the original digitized scale may be output for checking purposes.

These data are then resampled at regular times or shot-points using program SAMPLE, and the file is reformatted with program SEEPACK into shot-point strings containing shot-point numbers and seismic times for all horizons. At this stage, the seismic data file can be merged with the station location file produced by DIGMAP to create the principal facts file.

3. Display of interpreted data. Seismic data maps complete with one or more contoured horizons can easily be produced using program SEISMAP and the merged location and horizon principal facts file (Fig. SGM24). In complex areas the user may adopt the option to post only basic data and then manually contour the structure, inserting faults and trends that cannot presently be mapped satisfactorily by this system. The supplementary information provided by the user when digitising the original section is also displayed, helping to define areas with particular structural or seismic characteristics. On the isopach map shown in Figure SGM24 for example, U/O indicates 'undefined' (interpolated) for the upper horizon, and 'outcrop' for the lower horizon.

When contouring, the supplementary information flagged during digitising is used in programs DATAMAP, SURFACE, and PEN-PUSH to suppress contours where, for example, an horizon or isopach interval is unidentified, or the data are considered unreliable. Options also permit contours to be labelled either automatically or by manual intervention following a preliminary plot.

Horizon and isopach maps may both be displayed in two-way time (milliseconds), or true depth (metres) using constant interval velocities, velocity function, or a user-supplied velocity conversion process. Generally, only a few cards within a program deck need to be changed to produce a suite of maps that would previously have required repetition of a slow, tedious, manual process to produce.

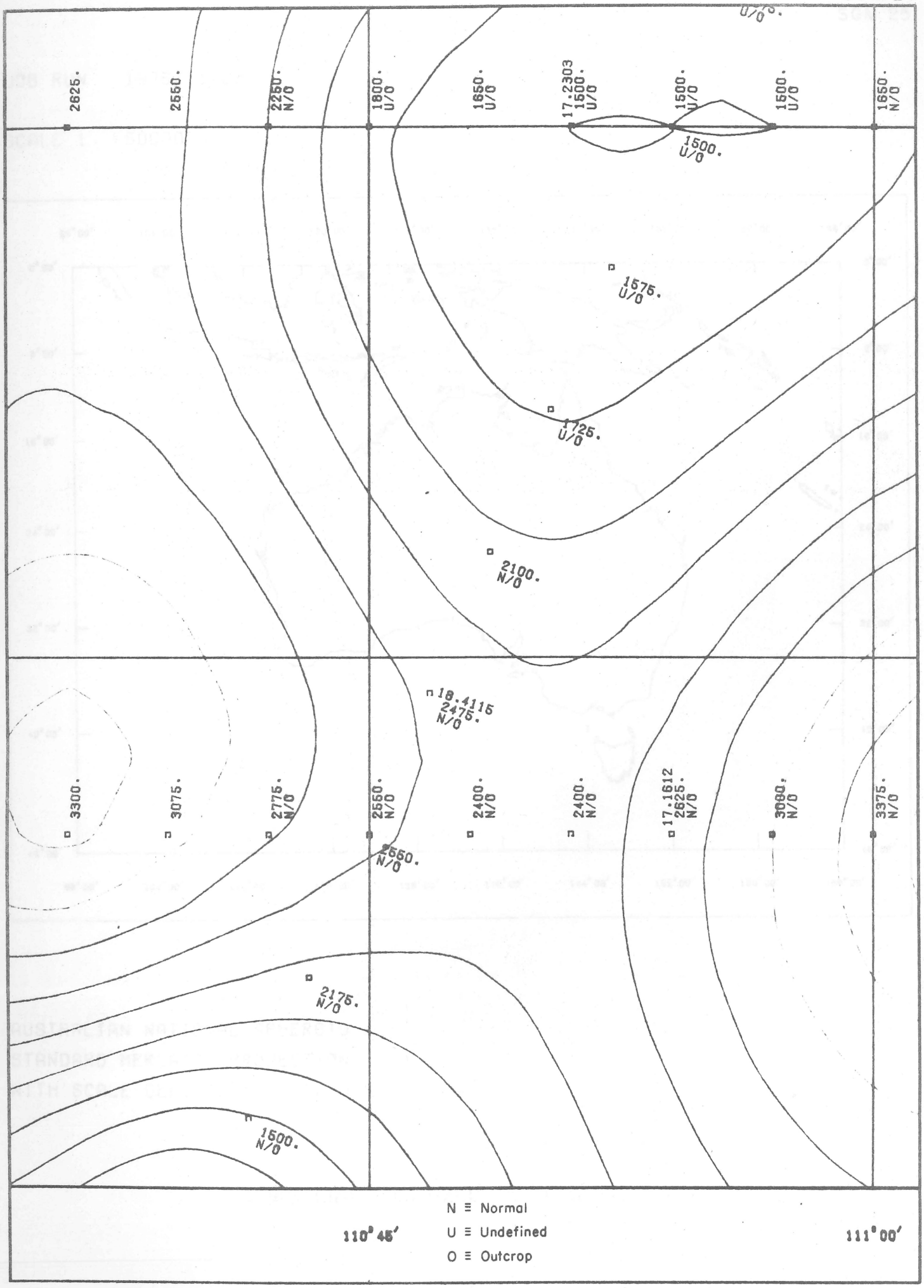
Digitizing of coastlines (R. Whitworth, L. Tilbury). To further expedite the production of maps, track charts, profiles and contours, it was decided that the capability should exist for plotting coastlines and other topographic information automatically. A data base for the coastline of Australia has been obtained from the Division of National Mapping and made compatible with the Marine Group's processing system. This is intended to be used eventually for the production of detailed maps, but New Guinea, the islands of Indonesia, and reefs and islands in Australian waters are not included at present. As a temporary measure, the coastline has been digitized at 1 : 10 m to cover our area of interest (Fig. SGM25). A data bank suitable for plotting coastlines at 1:2.5 m and smaller scales is also being prepared and will replace the 1:10 m version. In co-operation with the Drawing Office, the Marine Group is also planning to digitize those coastlines external to Australia which are needed for detailed mapping at 1:250 000 scale.

Digital processing of marine seismic data (J.C. Branson, C.R. Johnston). Two seismic lines recorded during the Continental Margin Survey 1970-73, were digitally processed in Sydney by Geophysical Services Incorporated (GSI) for BMR in the early part of 1976. These lines extend for 140 km across continental slope and shelf off Western Australia near Geraldton.

The unprocessed sections (Fig. SGM26) contain a strong water-bottom multiple obscuring the geologic section deeper than 1-1½ seconds below water bottom. On adjacent lines there are indications of sedimentary structures below 1-1½ seconds and so a series of tests were carried out on the two lines to determine the most effective procedure for processing the data.

By examining results of the tests, a simple technique was developed which requires careful attention to velocity functions, filtering, and trace editing. In the resulting processed sections (Fig. SGM27), water-bottom multiples were greatly suppressed and a significant improvement in general data quality was obtained.

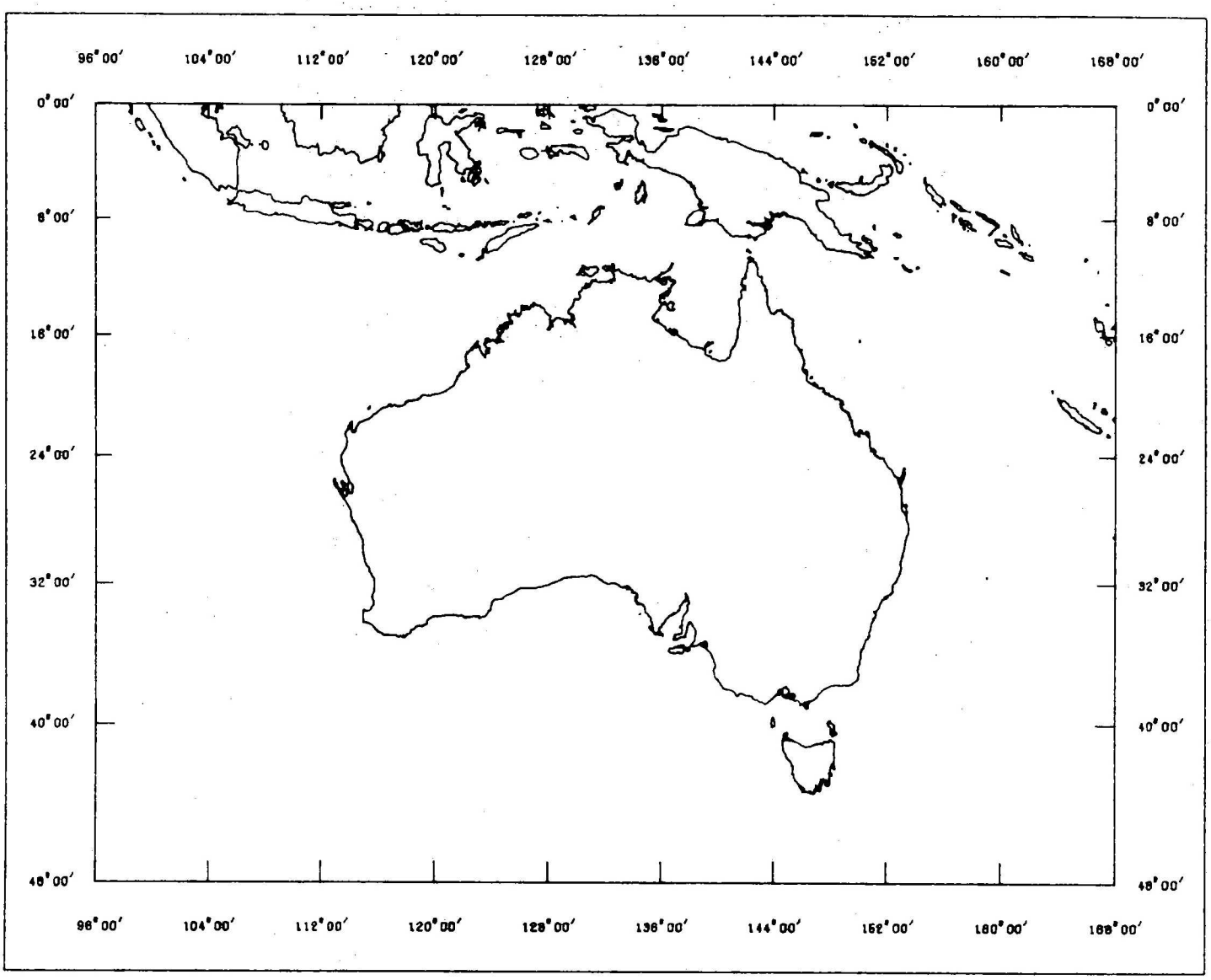
A more extensive program of digital processing in two areas along Australia's western coast was undertaken; about 500 line km of seismic data were processed. Water-bottom multiples in sections over the shelf break and upper slope were removed, and in sections over the lower slope the quality of deeper seismic information was improved.



EXAMPLE OUTPUT FROM PROGRAM SEISMAP
(ISOPACH MAP WITH A CONTOUR INTERVAL OF 250 METRES)

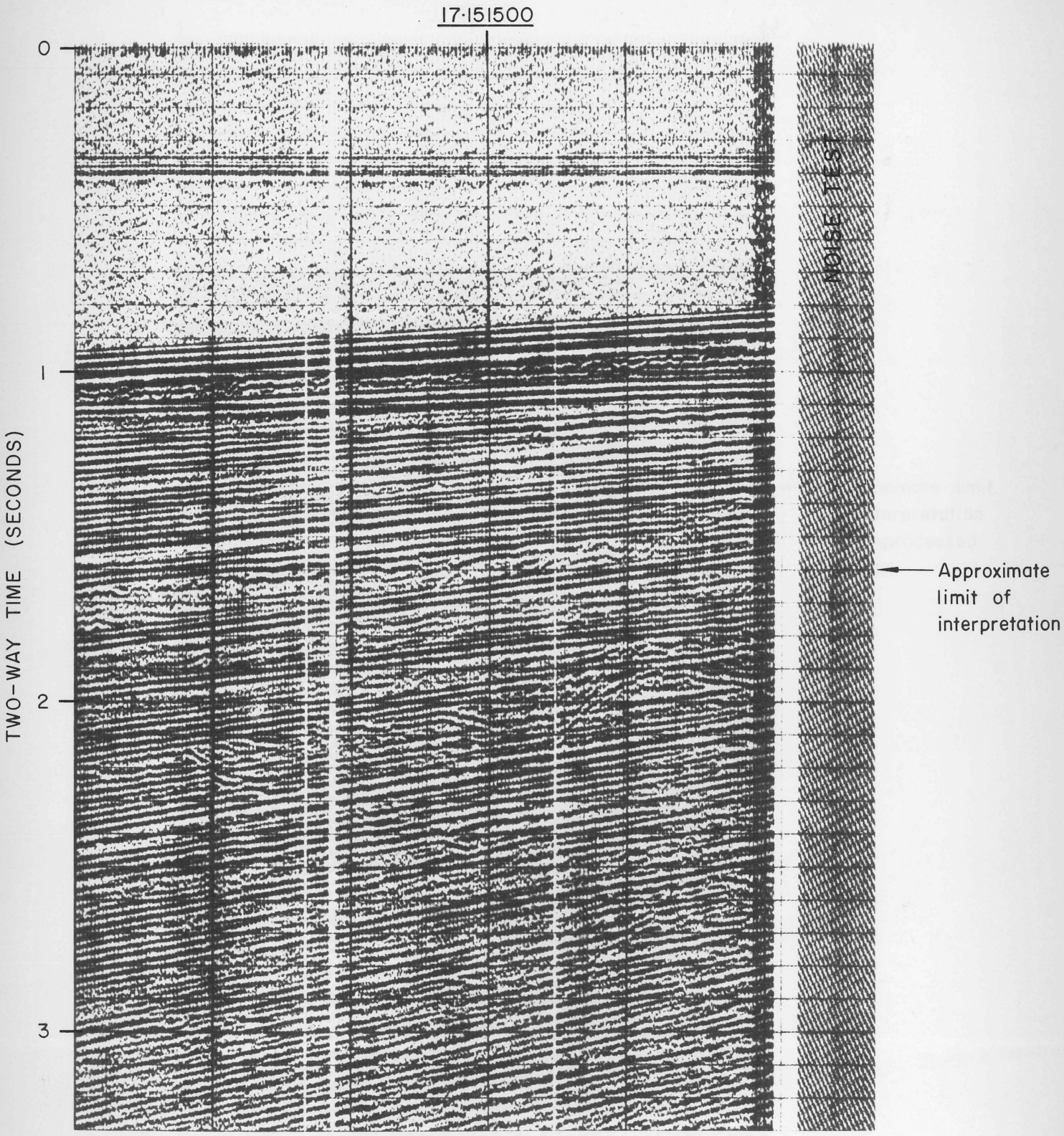
JOB RUN 1976/11/03

SCALE 1 50000000.

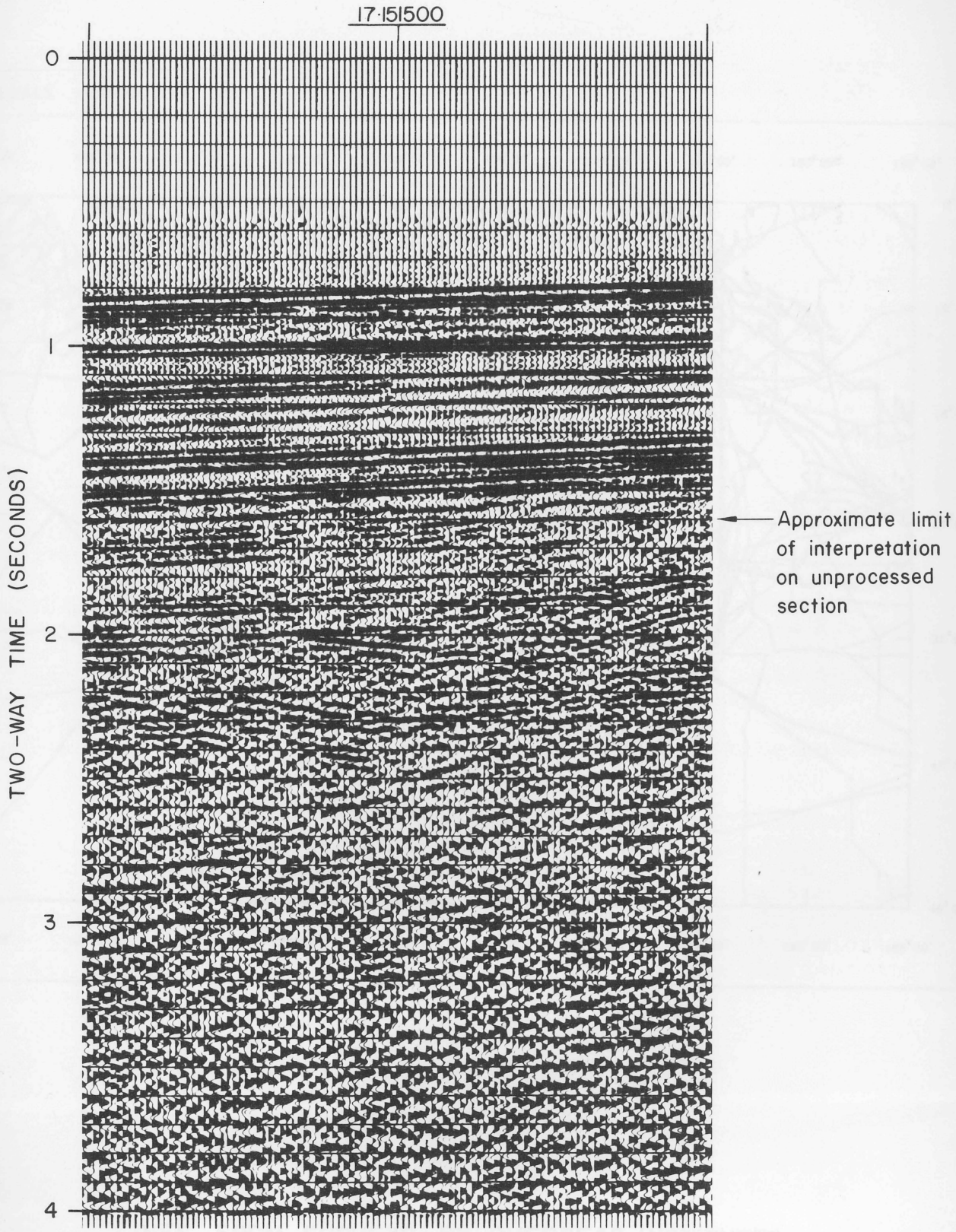


AUSTRALIAN NATIONAL SPHEROID
STANDARD MERCATOR PROJECTION
WITH SCALE DEFINED AT 0 0 S

COASTLINE DIGITIZED AT 1:10 000 000



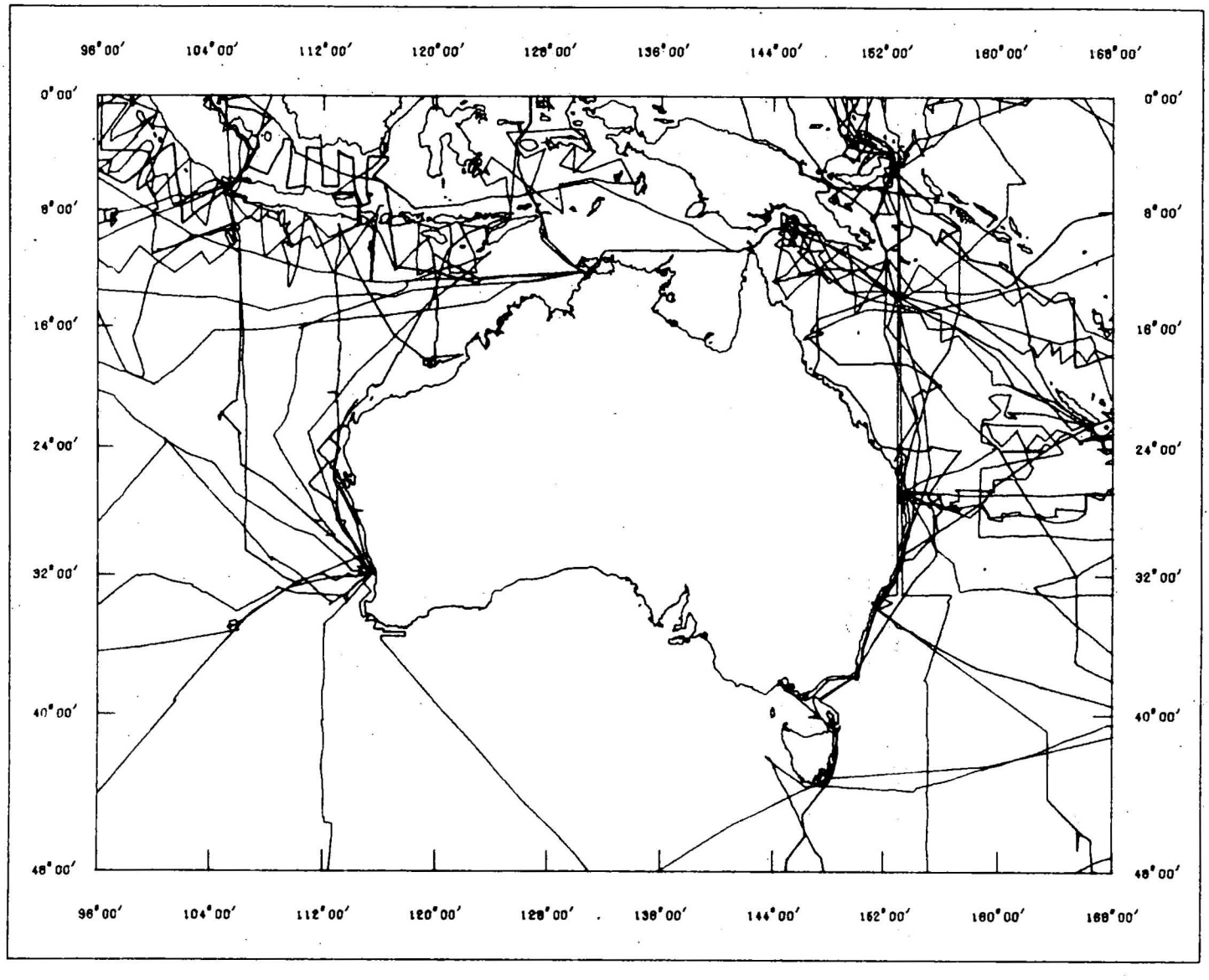
DIGITAL PROCESSING OF MARINE SEISMIC DATA
-UNPROCESSED SECTION (SINGLE FOLD COVERAGE)



DIGITAL PROCESSING OF MARINE SEISMIC DATA

PROCESSED SECTION (SIX-FOLD STACK)

SCALE 1:50 000 000



LINES FROM SURVEYS BY OVERSEAS INSTITUTES
FOR WHICH BMR HOLDS DIGITAL DATA

Compilation of external marine data (R. Whitworth, L. Tilbury). Where possible, geophysical data from surveys in Australasian waters collected by organizations other than BMR are being obtained directly from the organizations concerned. Magnetic tapes containing digital geophysical data have so far been obtained from the Hawaii Institute of Geophysics, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Tokyo Ocean Research Institute, and the U.S. Defence Mapping Agency. Although far from complete, the coverage is considerable, particularly in waters to Australia's north (Fig. SGM28). Integration of the data into the marine data collection awaits further analysis and network adjustment. For those surveys for which BMR is unlikely to obtain digital data in the short term, ships' tracks are being digitized and processed through DIGMAP. In this way the Marine Group is gradually building up a digital file of station positions for all work done in the region.

Release of data - Continental Margin Survey. Copies of the analog magnetic tapes of reflection seismic data were made publicly available late in 1973 and a number of oil companies took the opportunity to digitally process the data of special interest to them. The processing usually consisted of a six-point common depth point stack. As a condition of release, the companies undertook to provide copies of the processed sections to BMR and agreed that these might be released for sale to the general public after 12 months. During the year, 277 processed seismic sections were released according to this agreement, through the Copy Service, Australian Government Printer (Production). About 150 sections representing intermediate stages of processing have not been released but are available for inspection.

The other data from the Continental Margins Survey - station locations, water depths and gravity and magnetic field data - were processed during the year to a stage suitable for public availability on digital magnetic tape as preliminary data suitable for analysis in profile form. Therefore an interim circular to this effect was prepared and distributed to interested organisations and the information was also given in the general monthly BMR circular announcing new releases.

3. OBSERVATORIES AND REGIONAL SECTION

(J.C. Dooley)

OBSERVATORIES SUB-SECTION (P.M. McGregor)

The Sub-section deals with basic investigations in geomagnetism and seismology, and comprises four Groups situated at Canberra Headquarters, Mundaring (WA), Port Moresby, and Melbourne. Essentially, the headquarters Group handles those aspects of data derivation and distribution which require special-

ized equipment, access to computers and computing expertise, and carries out research involving data from several observatories; the other three Groups operate geophysical observatories, networks of regional seismograph stations and accelerographs, and carry out research on local problems. The HQ Group also directs operations at Antarctic Observatories and in the Northern Territory, and carries out regional magnetic surveys. Figure OR-1 shows the disposition of all recording instruments operated by the Subsection.

The Port Moresby Geophysical Observatory and its dependent seismograph and accelerograph stations will be transferred to Papua New Guinean ownership in the near future. This will end nearly 20 years of BMR observatory activities in the country - the Observatory issued its first data in March 1957 - but it is expected that BMR will continue to be involved in the Observatory's operations for some time yet, by providing personnel and services requiring specialised equipment.

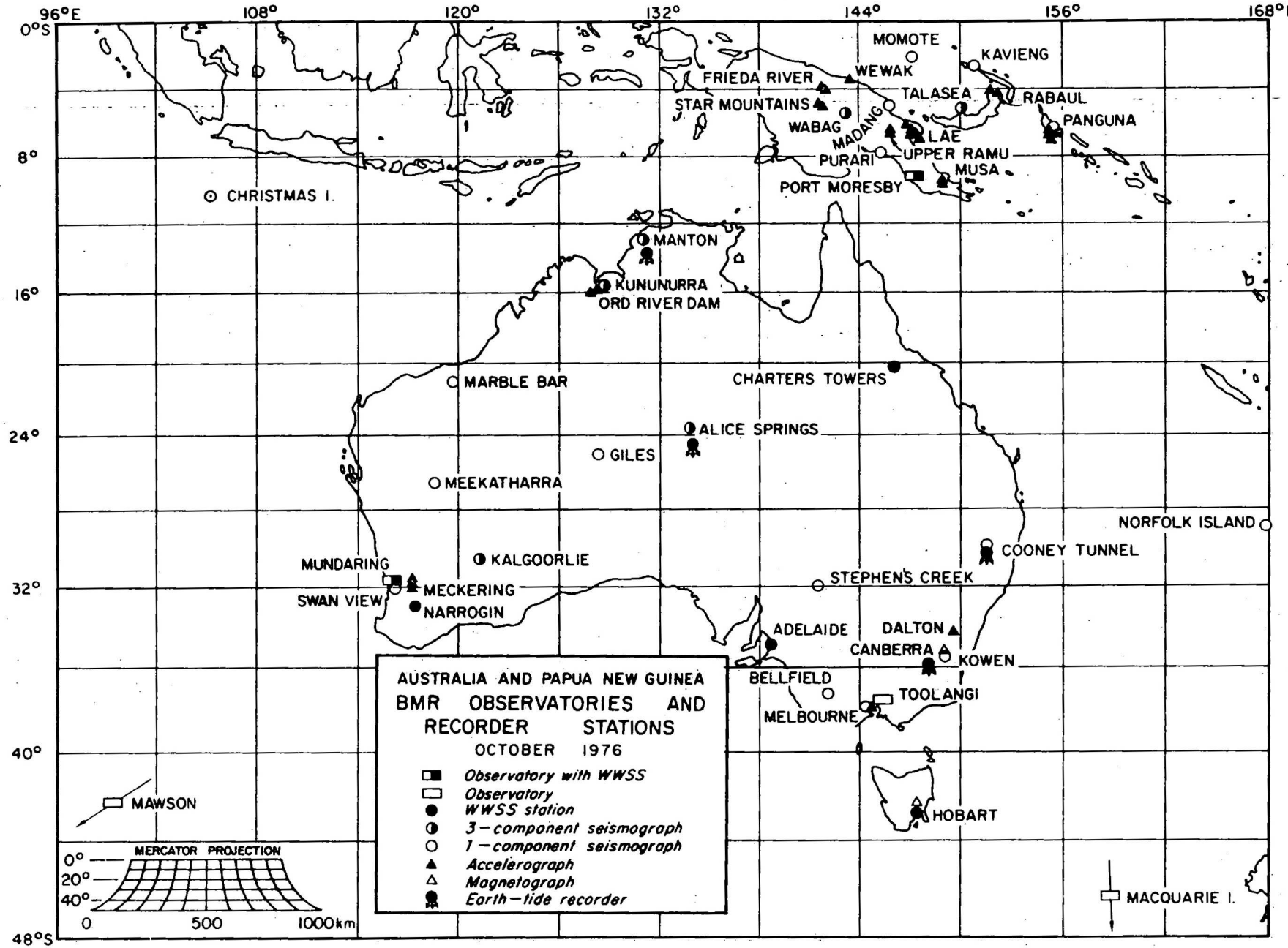
The World Standard seismographs at Adelaide and Charters Towers were transferred to BMR ownership and their operation was 'contracted' to the respective Universities, effective from 1 January 1976. At Alice Springs USAF personnel took over the attendance of the seismograph in July - previously Department of Defence officers have provided this service.

The establishment of Australian Geomagnetic Standards for declination, horizontal intensity, and vertical intensity was advanced significantly. A series of tests was made on the internal consistency of the declinometers at the main observatories, and the three BMR proton vector magnetometers (PVM) were compared with travelling intermediary magnetometers; the latter were being compared against the IAGA standard at Rude Skov (Denmark) in October. An exhaustive theoretical analysis of the adjustment-errors in PVMs was completed.

The first phase of program was completed to measure geomagnetic secular variation at shorter intervals than in the past. Several high-altitude transcontinental aeromagnetic profiles were obtained during the survey.

All groups except the one at Melbourne were affected by staff shortages and, to varying degrees, by lack of funds. In particular the HQ Group ADP programs were severely curtailed; in order to meet immediate commitments nearly all work on strong earth-motion and the derivation of magnetic mean hourly values was set aside for nine months of the year.

Headquarters Observatory Group (G.R. Small, R.S. Smith (part), M.J.M. Robertson (part), R.L. Paine (part), M.W. McMullan (part), A.J. McEwin, J. van der Linden, E. Smilek)


96°E
108°
120°
132°
144°
156°
168°E
0°S
8°
16°
24°
32°
40°
48°S
MOMOTE
KAVIENG
WEWAK
FRIEDA RIVER
TALASEA
RABAUL
STAR MOUNTAINS
WABAG
MADANG
PANGUNA
LAE
UPPER RAMU
PURARI
MUSA
PORT MORESBY
CHRISTMAS I.
MANTON
KUNUNURRA
ORD RIVER DAM
MARBLE BAR
CHARTERS TOWERS
ALICE SPRINGS
GILES
MEEKATHARRA
NORFOLK ISLAND
COONEY TUNNEL
MUNDARING
KALGOORLIE
STEPHENS CREEK
SWAN VIEW
MECKERING
NARROGIN
ADELAIDE
DALTON
CANBERRA
KOWEN
BELLFIELD
TOOLANGI
MELBOURNE
HOBART
MAWSON
MACQUARIE I.
AUSTRALIA AND PAPUA NEW GUINEA
BMR OBSERVATORIES AND RECORDER STATIONS
OCTOBER 1976
Observatory with WWSS
Observatory
WWSS station
3-component seismograph
1-component seismograph
Accelerograph
Magnetograph
Earth-tide recorder
MERCATOR PROJECTION
0°
20°
40°
0
500
1000km

Geomagnetism. Twenty-seven observatory-months of magnetograms were scaled and 103 months were reduced. The backlog of reductions has been considerably reduced but the scaling backlog increased owing mainly to a lack of funds and to persistent problems with the scaling maching and associated paper-tape processing equipment.

A new scaling system incorporating the old scaling table and a small computer with output to a magnetic tape cassette recorder is expected to be operational early in 1977. Software for the system was about half finished by October 1976.

The monthly issues of the Geophysical Observatory Report for July 1975 to August 1976 were prepared and distributed.

The Elsec automatic magnetic observatory (AMO) at Kowen Forest operated on a 1-minute schedule, successfully for about 80% of the year. In February the AMO was converted to magnetic tape recording, but this arrangement was still failing occasionally at October.

The Adkin 3-component autodigital magnetometer was completely overhauled by the workshops after a major electrical fault severely damaged many electronic components. The Adkin magnetometer and an Elsec proton magnetometer have been incorporated into a 4-component variograph with digital (magnetic tape) and analogue (strip chart) recording. This equipment was used to record the magnetic field at Omeo in Victoria for a 2-week period centred on the solar eclipse of 23 October 1976.

Seismology. Seismograms from Alice Springs and Cooney were analysed, and preliminary bulletins were distributed for these stations and for Manton, Toolangi, Norfolk Island, Bellfield, Stephens Creek, Macquarie Island, and Mawson. Final phase data from seismological institutions in Australia, Papua New Guinea, and the British Solomon Islands were compiled for the period December 1973 to February 1975 and sent to the International Seismological Centre (ISC) on magnetic tape. Each month about 4700 P-phases were sent to ISC (Figure OR 2 shows the number of P-phases reported by each BMR seismograph station). Time-sorted bulletins for the same period were also prepared and distributed to the Australian regional agencies. From September the time-sorted bulletins were produced on microfiche (the first fiche contained data for January 1975).

The Manton seismograph continued to operate at the vault as a conventional seismograph. The Kowen test station was operated as required and used to test new and repaired equipment. A maintenance visit was made to Cooney in December 1975 and the seismometer was replaced by one with a high impedance coil. Visits were made to Giles (two) and Cooney during the secular variation survey to make minor repairs and adjustments.

The regional Earthquake Data File was expanded and contains about 21 600 hypocentres from the area 0-90°S and 75-165°E. The file is complete to April 1975 and partly filled to December 1975. Numerous calls were made on the file and about 40 requests from within and outside BMR were handled. Epicentral data from Australian and Papua New Guinean sources on the file were sent on punched cards to ISC with the monthly phase data tapes.

A Sprengnether portable seismograph was lent to the Geological Survey of Fiji in July for about 6 months. Another Sprengnether portable seismograph was installed on Christmas Island by the Engineering Geophysics group during their survey in October. The seismograph will be operated by the staff of the British Phosphate Commission and preliminary phase data forwarded to Canberra by telex.

An earthquake of magnetude about ML 3.8 near Lockhart was felt over a wide area of southern NSW on 24 August. Earthquake questionnaires were distributed in the area and an isoseismal map was produced. The maximum intensity of MM IV was felt over a radius of about 40 km.

Ground action. Only minor damage was caused by earthquakes in eastern Australia during the year (see Toolangi Group) and the SMA1 accelerograph at Dalton was not triggered. Owing to lack of staff and funds, only two Papua New Guinea accelerograms were processed.

A paper entitled "Earthquake Risk in Australia" was prepared and published in the BMR Journal; the paper was used by the National Committee for Earthquake Engineering in the compilation of the 'Earthquake Risk Map of Australia'.

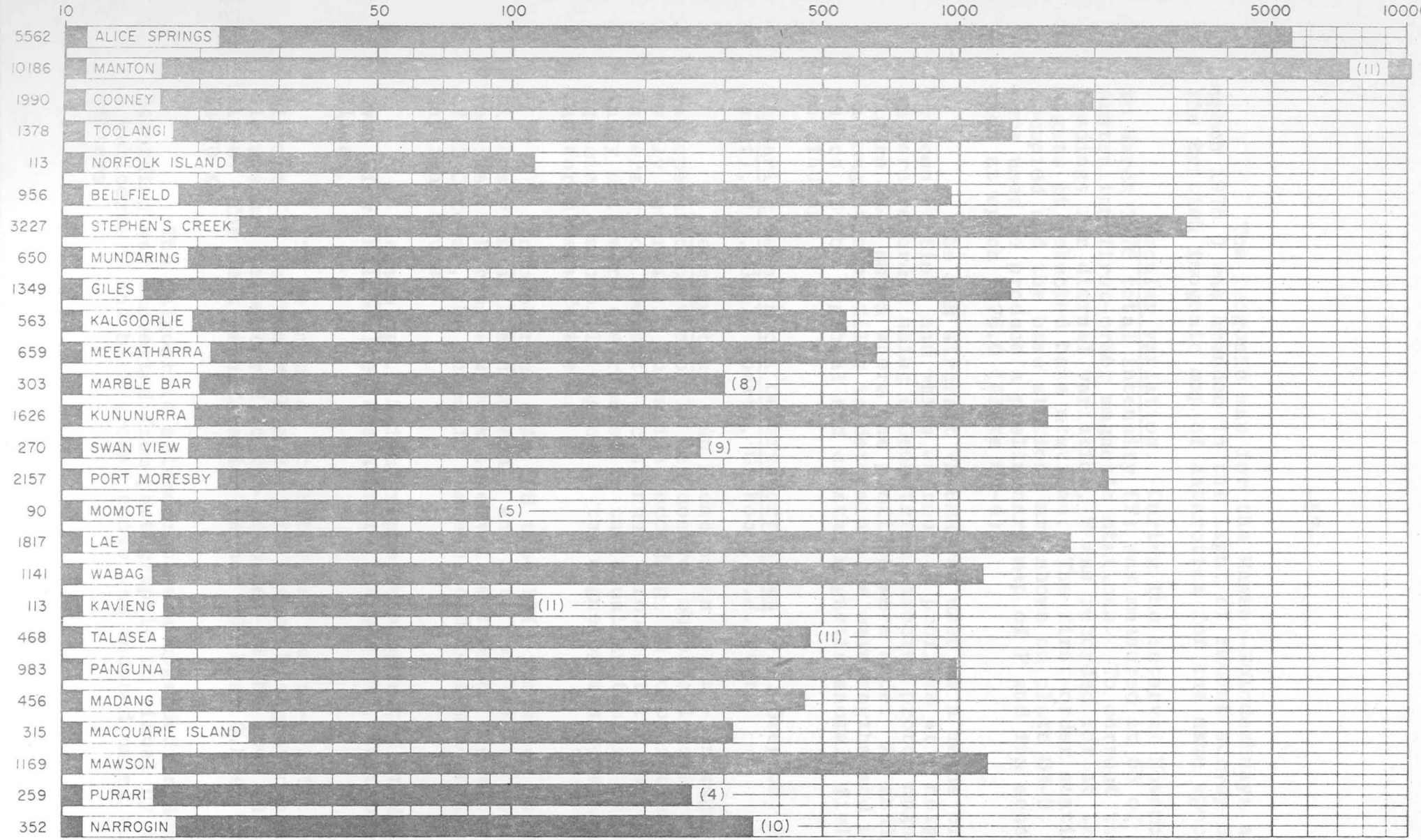
Twenty-two requests for seismic risk analyses were received and answered.

Digitized versions of 48 Papua New Guinea accelerograms were sent to the World Data Centre, Boulder, Colorado for distribution to interested scientific bodies.

Regional magnetic surveys. All the data from the 1975 third-order survey were added to the computerised data file. Computer lists of all data on the file were sent to World Data Centre A.

A start was made on fitting polynomials to all the third-order data to provide the basic maps of the Australian magnetic field at epoch 1975.0. These polynomials will be the basis for future isomagnetic charts. It is intended to reduce the third-order results to epoch 1965.0 and prepare unsmoothed charts as a contribution to the World Magnetic Survey.

Record No 1976/91
(Based on G441-39-1A)



P-WAVE ARRIVALS, BMR STATIONS

(SEPT. 1975 — AUG. 1976)

(8) No. OF MONTHS OPERATION IF NOT 12

G82/2-166-2A

The isogonic map for the Mawson-Molodezhnaya area for epoch 1975.0 was amended in the light of recent survey data and the British isogonic map of Antarctica for the same epoch.

Secular variation. During the interval November 1975 to March 1976 total intensity (F) was measured at 55 of the Australian first-order magnetic stations. To correct the station readings for diurnal variation, F was recorded for at least two nights at selected base stations. The first-order stations re-occupied and the base stations are shown on plate OR-3. The data were used to produce a preliminary map of F and its secular variation at epoch 1976.0 (Plate OR-4).

The BMR aircraft VH-BMR was used as a means of transport between stations and while en route F profiles at a height of 3 km were recorded using a Geometrics airborne proton magnetometer. Figure OR-3 shows where the profiles were made. An analysis of the magnetic profiles to determine the wavelengths and characteristics of the regional and crustal magnetic anomaly fields is continuing.

Mundaring Geophysical Observatory Group (P.J. Gregson, R.S. Smith (part), B.A. Gaull (part), G. Wood, B.J. Page)

Geomagnetism. An Eschenhagen normal-run magnetograph was operated continuously and control observations were made at weekly intervals. Pulsation recording, in co-operation with the University of Newcastle, continued throughout the year. Preliminary data were distributed to the usual Australian and overseas agencies; microfilm copies of the magnetograms were lodged in the World Data Centre A.

Ionospherics. An IPS type IIIE ionosonde operated continuously on a 15-min schedule and data were distributed as required. During a 2-week interval centred on the solar eclipse of 23 October, the schedule was expanded to 1-min soundings during daylight hours.

Seismology. Seismographs were operated at Mundaring, Swan View, Kalgoorlie, Meekatharra, Marble Bar, Kununurra, and Giles.

The seismometer at Marble Bar was re-positioned at the airport (10 km from Marble Bar) to reduce background noise. Signals are telemetered to the recorder in the town using Telecom lines. The peak magnification is now 400 K at 0.2 s; at 1 s it is 70 K.

The Kalgoorlie seismograph was upgraded in August. Recording was converted from photographic to visual by installing a helicorder, and back-ground noise was reduced using suitable filters.

A Seismic Research Observatory was installed by the U.S. Geological Survey during January and February. The seismometers are placed in a borehole at Narrogin and signals are telemetered to the Mundaring office. One short-period vertical and three long-period components are recorded visually on helicorders and digitally on magnetic tapes. Helicorder magnifications at 1-second and 50-second periods are 50K and 10K respectively. Regular recording commenced on 27 March.

Significant Western Australian earthquakes which occurred during the 12 months are shown below.

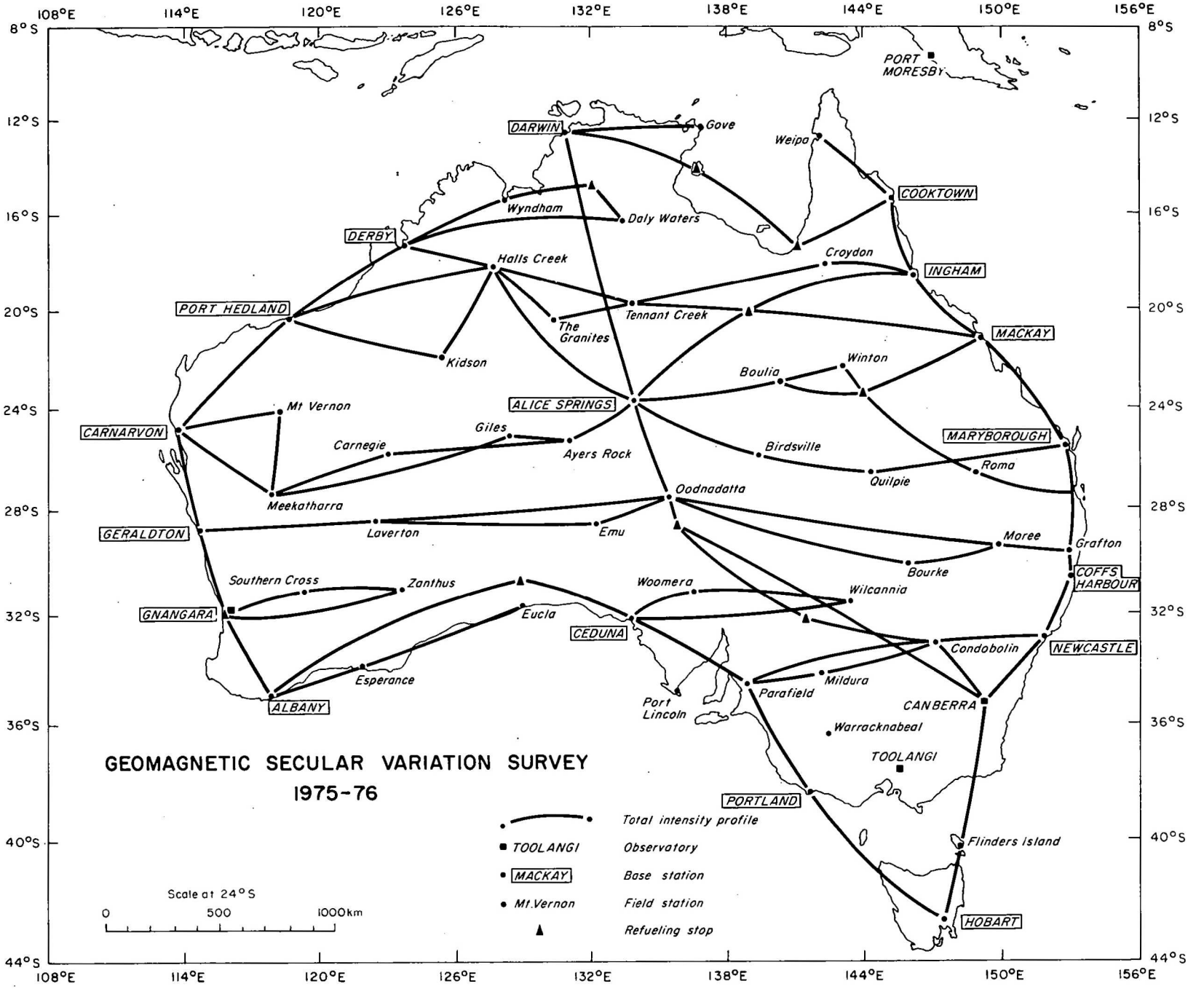
Year	Locality	Magnitude	Remarks
1975			
Oct 03	350 km NW Giles	mB, 5.6	
Oct 11	Brookton	ML, 3.7	Felt
Nov 06	200 km SW Geraldton	mB, 4.8	
1976			
Feb 19	250 km NW Onslow	mB, 5.6	
May 24	75 km ESE Narrogin	ML, 3.1	
Aug 08	13 km NNW Rocky Gully	ML, 2.9	3 events felt

Data were distributed to the National Earthquake Information Service (U.S. Geological Survey), International, and Australian centres.

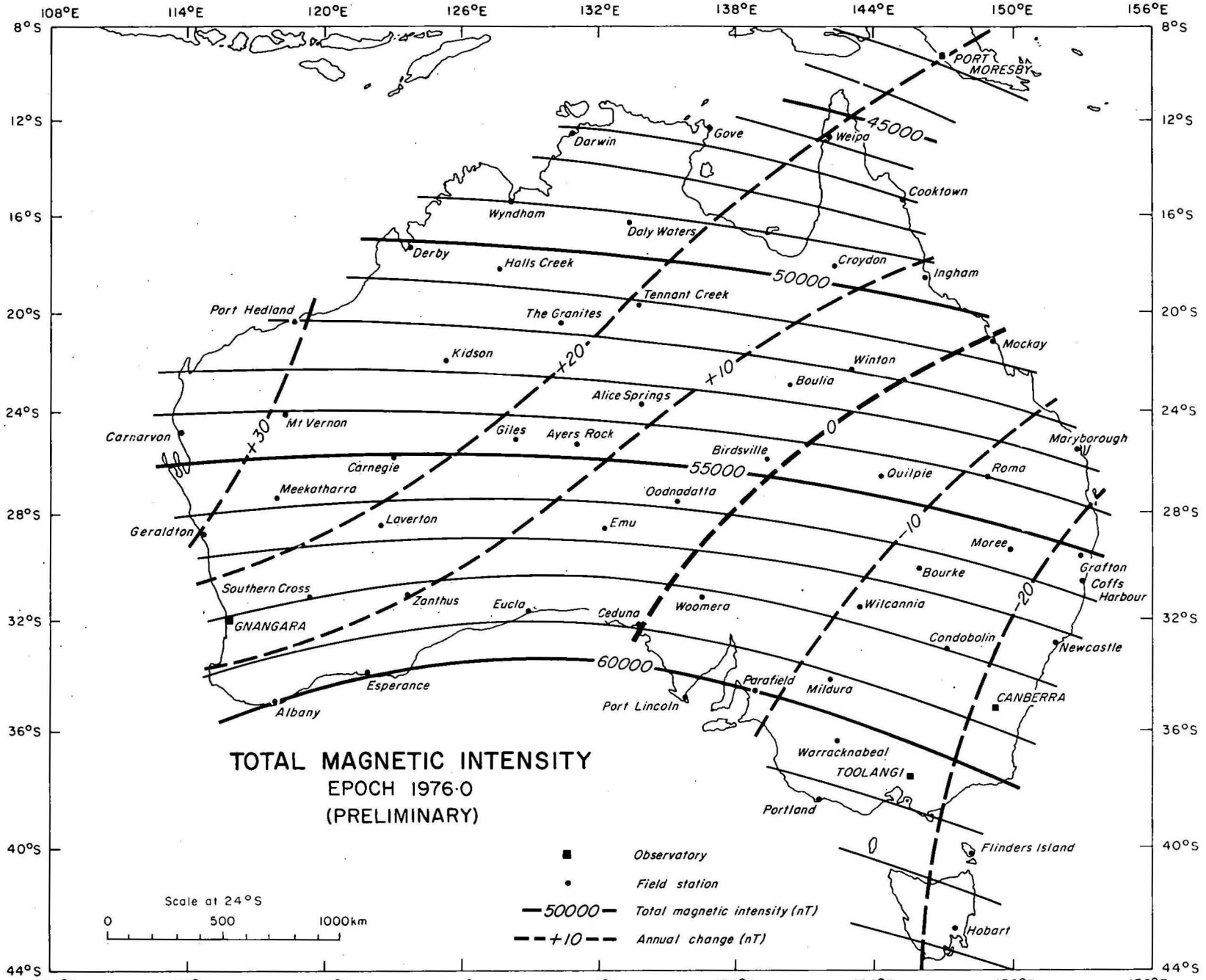
Stress measurements. Assistance was given to the Crustal Studies Group to measure in-situ stresses at seven sites between Wongan Hills and Popanyinning. This work was carried out between 19 January and 19 February 1976. Principal stresses measured ranged from 600 psi near Meckering to 400 psi at Wongan Hills.

Port Moresby Geophysical Observatory Group (I.B. Everingham, I.D. Ripper, S.N. Sheard, E. Hassel)

Standard programs. A La Cour normal-run magnetograph, a Worldwide Standard Seismograph, and supplementary seismographs



Record No. 1976/91
(Based on A/80-59AR)



A/B9-131A

were operated continuously at Port Moresby. The results were distributed regularly, as for Mundaring.

The computer storage and retrieval file for regional earthquake data could not be maintained because of PNG computer staff problems.

News media were given information on 15 felt earthquakes, and advice on PNG seismicity and earthquake risk was given to interested parties.

Regional seismology. Seismographs were operated at Kavieng, Lae, Momote, Talasea, Wabag, and Madang. In addition, the seismograms from the Bougainville Copper Limited station at Panguna and the Purari River hydro-electric project at Wabo were analysed.

There were 20 accelerographs in Papua New Guinea operated by BMR, other Australian and Papua New Guinea government departments, the University of Technology, and mining companies. The accelerograph network needed maintenance visits every four months. Triggerings occurred at Hong Kong (Star Mountains), Yonki, Lae, and Rabaul. Copies of accelerograms are available from the Headquarters Group in Canberra. Of special interest were the simultaneous triggerings at the Rabaul Observatory and Wanliss Stree sites (17 July). The ratio of accelerations was 8.5 : 1, which further proved that earthquake risk is much greater on hills and ridges.

Intensity questionnaires were issued for felt earthquakes on an average of once each two months.

Toolangi Geophysical Observatory Group (E.P. Paull until 15 Oct; M.W. McMullan from 5 Oct; C.H. Van Erkelens, G.H.Y. Thomas, J.F. Salib)

Geomagnetism. A La Cour normal run magnetograph was operated continuously at Toolangi and calibrated weekly. Preliminary data were distributed to Australian and overseas agencies and microfilm copies of magnetograms were lodged with World Data Centre A. K indices were telexed to Meudon Observatory, France for compilation of the aa indices.

The Elsec proton vector magnetometer coils were found to have a 7 nT effect on the total intensity. This was reduced to less than 1 nT by removing 115 magnetic screws, 2 steel dowels and the highly magnetic nickel plating from the footscrews. Levelling problems were cured by lapping the bearing with very fine abrasive to improve the fit and using a light oil as the lubricating agent.

Physicists from Antarctic Division (Department of Science) were trained in geomagnetic measurements for application at Davis and Casey 1977.

Seismology. Three-component short-period and long-period seismographs were operated at Toolangi and short-period seismographs were operated at Bellfield, Stephens Creek (N.S.W.), and Norfolk Island. Data from these stations plus those from Mawson and Macquarie Island were telexed to the National Earthquake Information Service, U.S. Geological Survey. At Melbourne a short-period visual seismograph was operated continuously and an accelerograph was maintained without being triggered.

Significant local earthquakes are shown in the table.

Antarctic programs

Observatories (P.R. Gidley, P.J. Wolter) Standard observatory programs in geomagnetism and seismology were continued at Mawson and Macquarie Island as part of the activities of the Australian National Antarctic Research Expenditions (ANARE).

The sensitive La Cour recorder at Mawson was changed from 15 to 20 mm/h rate to complete the conversion to 20 mm/h recording. A new Science Block with space for the geophysicist was constructed by ANARE members during the year. At Macquarie Island the search for a better seismograph site was continued without success. Various filters were tested with some success to try to reduce the recorded background noise. A horizontal-component seismograph (N-S) was set up using existing spare equipment.

Regional surveys (P.J. Hill). Regional magnetic and gravity measurements were made during the 1976 ANARE summer expedition to Enderby Land. Magnetic measurements of D, H, and Z were made at 14 stations (including 4 reoccupations) and gravity was measured at 17 stations, making this one of the most successful summer field seasons. Six declination readings were also obtained by Antarctic Division personnel on the over-snow glaciological traverse from Mt King to Mawson.

REGIONAL SUB-SECTION (D. DENHAM)

Regional Gravity Group

Gravity Compilation and preparation of maps (A. Murray, B.C. Barlow). Preparations continued for the computer drawing (in the next three years) of a series of Bouguer anomaly gravity maps at 1:250 000 scale using a density of 2.67 t. m^{-3}. These maps will show all major gravity surveys recomputed to International Gravity Standardization Net 1971 datum and scale, and to Australian Geodetic and Height datum.

Date	Locality	Mag.	Max. Intensity	Remarks
1975 Sep 08	Leongatha (100 km SE Melb.)	3.2	IV	
Nov 22	Mt Gambier (SE S.A.)	3.6		
1976 Feb 23	Airey's Inlet (SW Geelong)	3.1	IV	
Jun 26	Off Cape Schanck (100 km S Melb.)	3.1		
Jul 01	Caramut (200 km W. Melb.)	2.7	IV	
Jul 09	Preston (Melbourne)	1.3	VI	Very shallow depth; $8500 damage to one house near epicentre (Dept of Construction est.)
Jul 12	Millicent (SE S.A.)	3.5		
Aug 14	Beachport (SE S.A.)	3.6		
Aug 20	Pyramid Hill (70 km W Echuca)	3.0	IV	
Aug 23	NSW 90 km W of Wagga Wagga	3.7		
Sep 08	Snowy Mts near Vic-NSW border	3.9		
Sep 08	NSW Mathoura (S. Deniliquin)	3.4	IV	

A geophysical company under contract continued recomputing subsidized and unsubsidized oil company surveys. In the period October 1975 to September 1976 it finalized 17 surveys containing a total of 57 700 stations. Before the end of 1976 it is expected to complete the remaining seven private company surveys (containing a total of 40 000 stations) that together with recomputed State and Federal surveys complete the reconnaissance gravity coverage of Australia. It will then start recomputing the larger semi-detailed surveys (Fig. OR-5).

Extensive modifications were made to the plot and contour computer program in order to increase its efficiency and flexibility, and a start was made on documenting the changes. A new tidal gravity program ERTIDE was extensively tested.

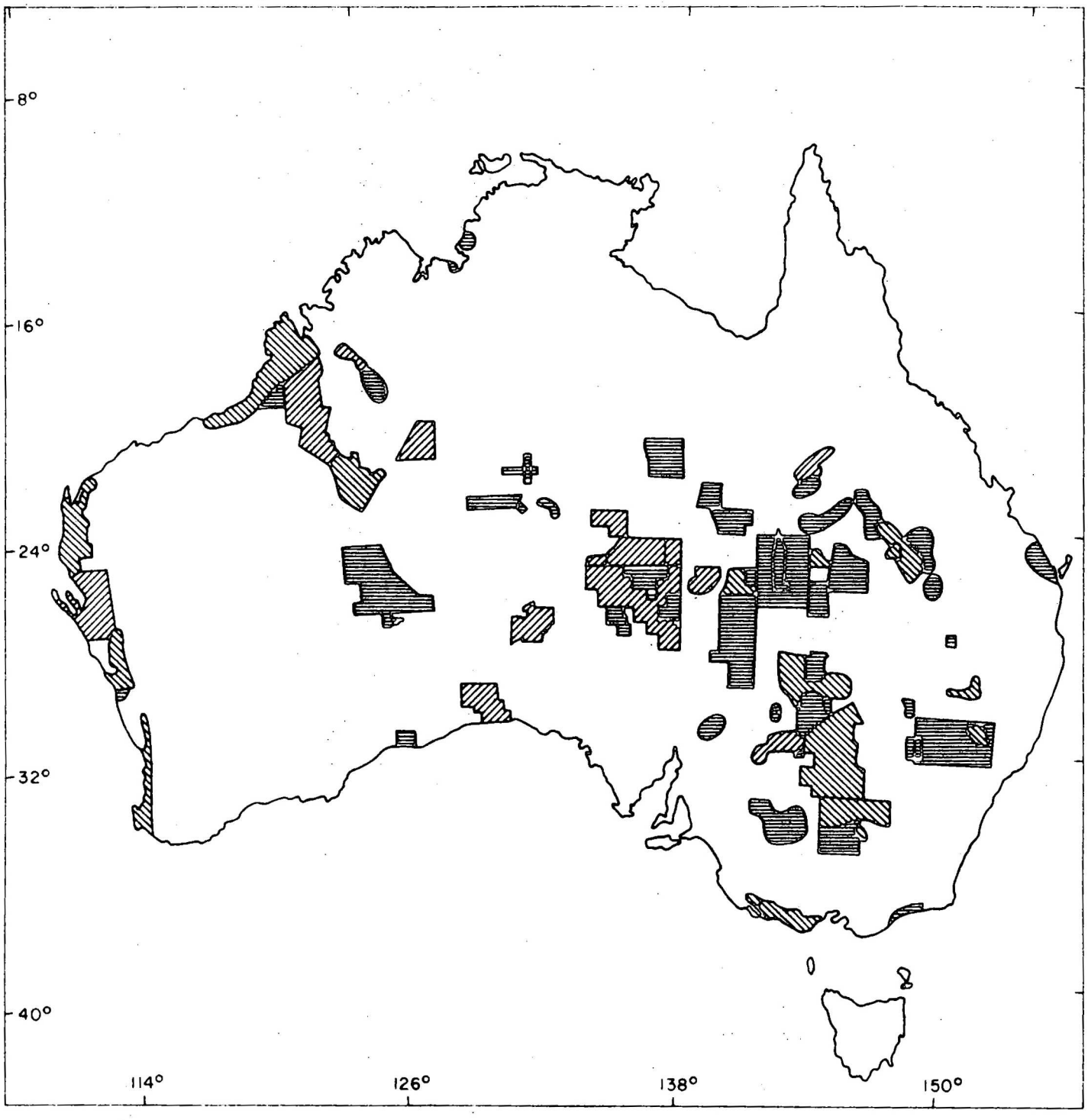
The gravity data bank compiled for the 1:5 million Bouguer anomaly map of Australia was used to draw a free-air anomaly map of Australia at 1:2.5 million scale (this map is the basis for a 20-mGal contour free-air map at 1:25 million to be published in the BMR Journal) and to compute $1^{o} \times 1^{o}$ area means of free-air anomaly, Bouguer anomaly, and altitude for regional gravity studies, copies of the data bank were supplied to Dr R. Mather of the University of New South Wales for geoidal studies (see Mather et al., 1976), Dr C. Bowin of Woods Hole Oceanographic Institute to prepare a 25-mGal contour interval free-air map of the world, and Professor R.L. Parker of the University of California to study the mechanism of isostatic compensation.

A paper tracing the improvement in gravity coverage and control during the periods 1819-1949, 1950-58 and 1959-76 was written for the BMR Journal (Dooley & Barlow, 1976).

Earth Tides (B.C. Barlow, J. van Son, D.A. Coutts). Earth tides are produced by the variation, at a point on the Earth's surface, in the gravitational potential of the sun and moon. Harmonic analysis of an earth tide parameter (gravitational intensity, or the deflection of the vertical) yields the amplitudes and phase angles of the component waves, which may be compred with those derived theoretically for a hypothetical rigid earth, in terms of amplitude factors and phase shifts.

Earth tide deviations of the vertical have been recorded at Cooney Observatory near Armidale using Verbandert-Melchior horizontal pendulums. Until July this was a co-operative program with the University of New England; after July the University of New England has continued recording using the BMR horizontal pendulums on long-term loan. The 1976 records will be analysed in conjunction with records of previous years.

Earth tide intensity was measured throughout the year using several recording gravity meters in a cooperative project with the International Centre for Earth Tides (ICET) and the



AREA OF GRAVITY SURVEYS
RECOMPUTED BY CONTRACT

Before 1976 During 1976 After 1976

University of New South Wales. Records were made by BMR at Manton Dam near Darwin for four months, at Cooney Observatory near Armidale for seven months, and at Alice Springs for fourteen months. One meter which had changed its scale factor was recalibrated in Canberra for five months. Since 1974, records have been obtained at eight sites in Australia and Papua New Guinea. Analysis of these records at the International Centre for Earth Tides has shown that between sites there are significant differences in amplitude and phase of some components owing to direct and indirect effects from oceanic tides. The results of this work will be used to improve the accuracy of the formula for earth tide gravity corrections and for geodetic studies and will be published in 1976 (Melchior et al., 1976).

Calibration of quartz-type gravity meters (D.A. Coutts, B.C. Barlow, H.M. McCracken). A tilt table on loan from the Soviet Academy of Sciences is being used to check the linearity of Worden, Sharpe, and Scintrex gravity meters and calibrate them at constant temperature and pressure. In the period November 1975 to September 1976 the measurements made during the previous year were reduced, and measurements were made on four more gravity meters. Of the 17 gravity meters that have been calibrated so far, most show the correct linear relation between dial reading and gravity variation; however two show a slight non-linear effect.

The tilt calibrations are systematically 0.14 $\pm$ .05% larger than the field calibration on the Canberra Calibration Range. This discrepancy is thought to be due to the field calibration being incorrect because of a pressure effect on the quartz-type gravity meter readings of 0.033 $\pm$ .011 mGal. Pa^{-1}. Using a vacuum chamber in the laboratory the pressure effect is found to be 0.02 mGal. Pa^{-1}, and field observations on stations with the same and different elevation give a pressure effect of 0.013 $\pm$ 0.004 mGal. Pa^{-1}. These results suggest that there may be small systematic errors in the present National Gravity Network gravity values.

Antarctic gravity surveys (P. Wellman). Australian gravity stations observed between 1955 and 1974 in the Mawson/Davis/Prince Charles Mountains area were analysed by P. Wellman and R.J. Tingey (1976). North-south trending gravity gradients suggest that there is a major structural break along the major trough in the ice surface occupied by the Amery Ice Shelf and Lambert Glacier (Fig. OR-6).

A record was prepared analysing all LaCoste & Romberg gravity meter ties to the Australian Antarctic bases of Mawson, Davis, Wilkes, Casey, and Macquarie Island. The ties establish gravity values at these stations to an accuracy of better than 0.5 mGal, and these values are consistent with the more accurate of the earlier ties.

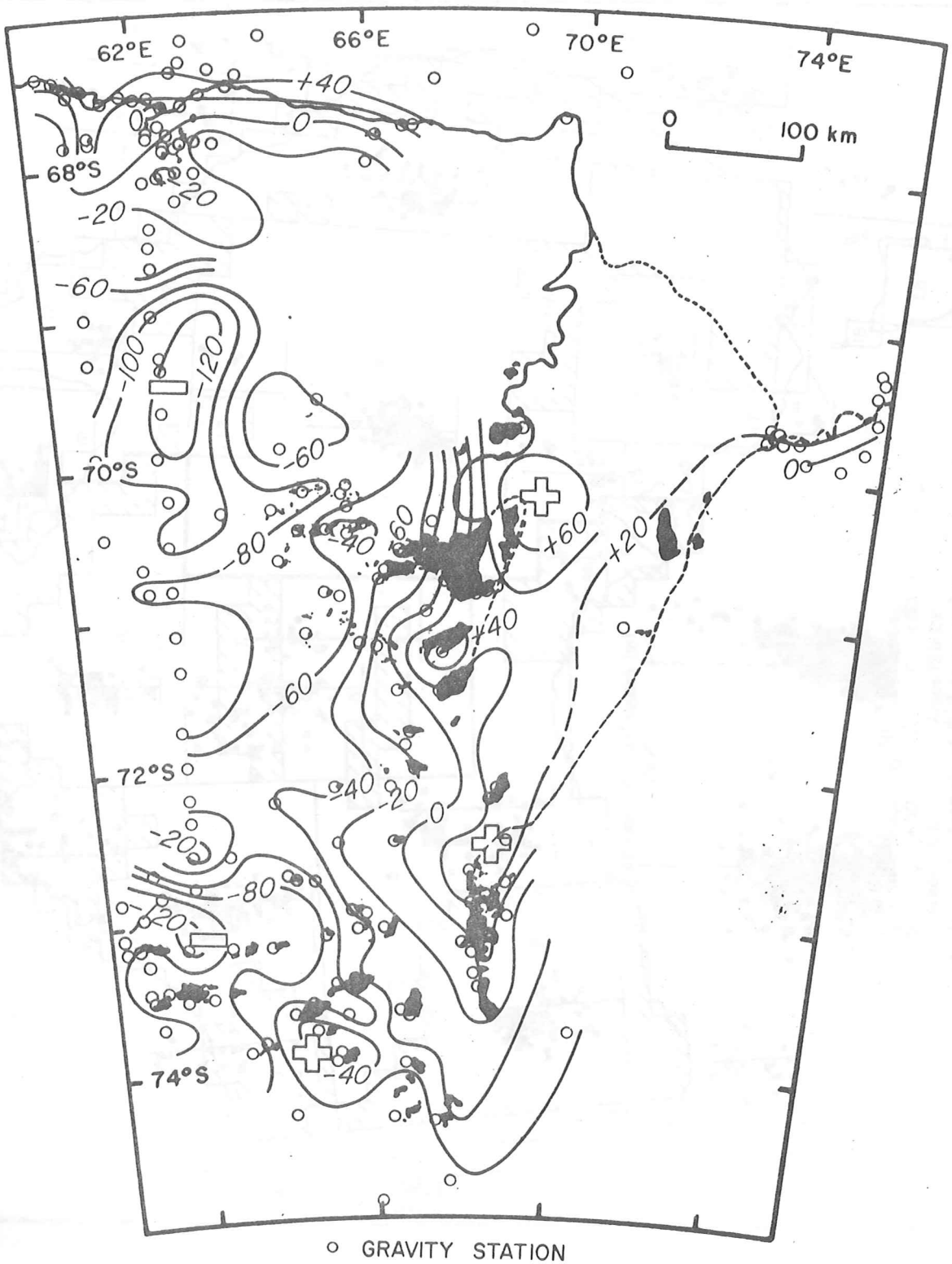
Antarctic Division and BMR co-operated in carrying out further gravity ties from Australia to Mawson Base, and in re-observing the glaciological traverse from Mawson to Enderby Land. The 1975 Mawson geophysicist made gravity observations at 16 survey points in Enderby Land.

Regional Interpretation of the Gravity Map of Australia (P. Wellman). Analysis of gravity and altitude variation throughout Australia (Wellman, 1976) shows that the correlation of average free-air anomalies and altitudes for $1^{o} \times 1^{o}$ areas is negative to zero in western and central Australia, and positive in eastern Australia (Fig. OR-7); this division corresponds roughly to the Precambrian and Phanerozoic basement areas. Precambrian and Phanerozoic areas overseas show a similar relation. The cause of the different gravity/altitude correlations is thought to be due to different isostatic compensation mechanisms; compensation in central and western Australia being at the base of the crust, and compensation in eastern Australia being both at the base of the crust and deeper in the mantle (possibly at the level of the low-velocity zone which is about 130 km in eastern Australia). The residual $1^{o} \times 1^{o}$ area gravity anomalies found by removing altitude, long-wavelength gravity, and sedimentary effects are used to predict variations in mean crustal density. By assuming isostatic equilibrium these, together with mean altitudes, can be used to predict crustal thickness.

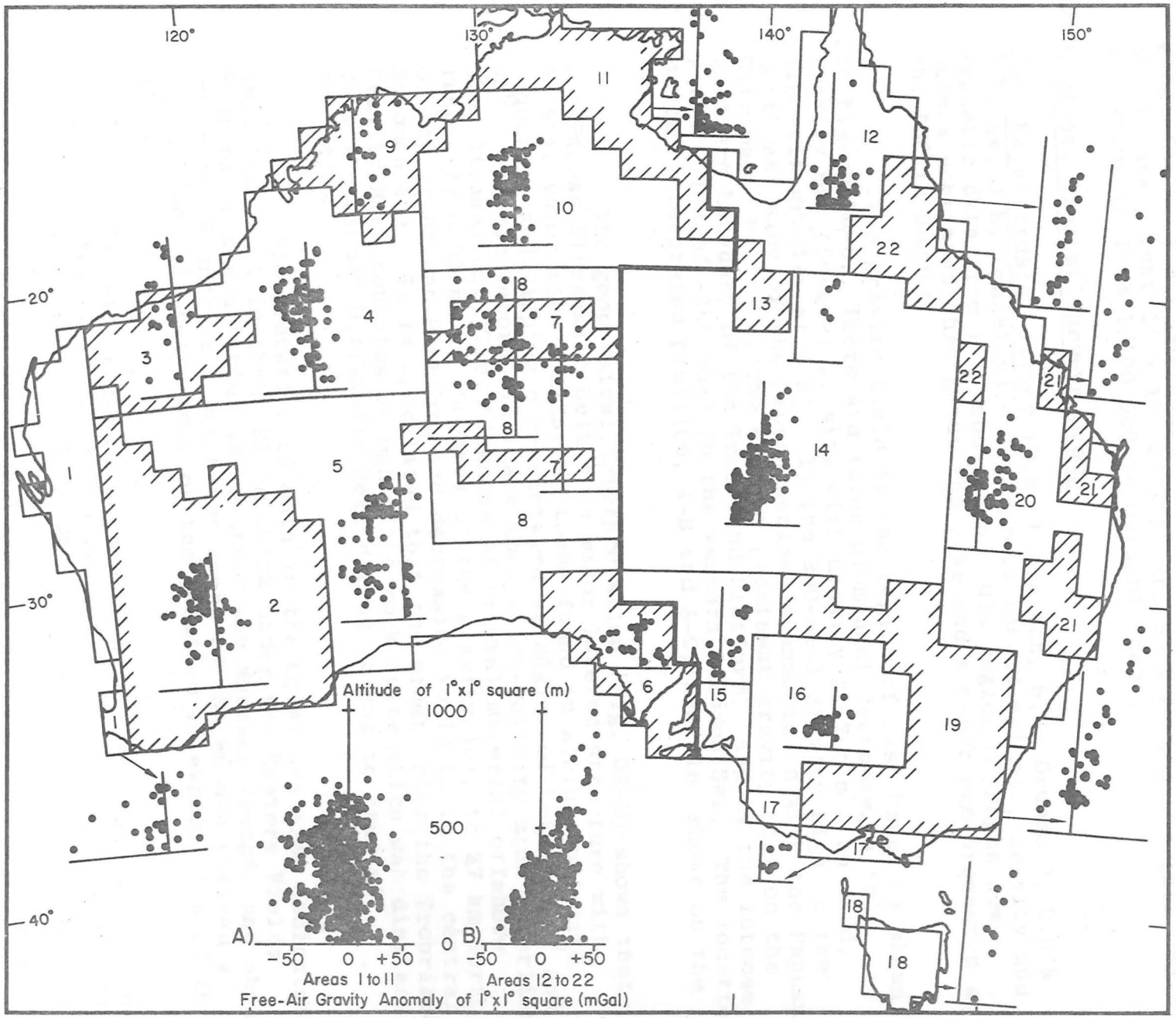
The Australian crust was compared between exposed and covered basement regions using gravity anomalies. There is no systematic change in gravity variability between the two regions when the thickness of cover is allowed for, so the pattern of density differences is inferred to be similar in the two basement regions. With one exception (Kimberly Basin) the trends of the gravity anomalies are continuous from covered to exposed basement regions; therefore geological sturcture and rock formation within the basement are inferred to be continuous. After making allowance for altitude and the effect of cover beds, covered basement has anomalies that are 5 mGal less than exposed basement; this is thought to be due to a lack of isostatic balance. It is concluded that there are no major differences between covered and exposed basement (Wellman, 1976 (b)).

Gosses Bluff gravity survey (B.C. Barlow). Interpretation of this survey continued intermittently with the preparation of new draft maps (base map, Bouguer anomaly map, regional Bouguer anomaly map, residual Bouguer anomaly map), and the estimation of maximum depth to anomalous bodies.

Gravity observations along seismic crustal survey traverses (H.M. McCracken). Preparations were made to carry out gravity observations along proposed seismic crustal survey traverses in south-eastern Australia and the Pilbara region of Western Australia. The part of the gravity field work between Canberra and southern ACT was completed in 1976.



BOUGUER ANOMALY MAP OF PRINCE CHARLES MOUNTAINS REGION, ANTARCTICA



RELATION BETWEEN FREE-AIR ANOMALIES AND ALTITUDE

OR-7

Record No. 1976/91

A/B2-124AR

Mean height map of Australia (F.N. Michail). Mean heights are required to correct gravity observations for effects of intermediate and far terrain corrections, and effects of isostatic compensation of the topography. Tests were carried out on the speed and accuracy that 1' x 1', 2' x 2' and 6' x 6' mean heights could be estimated from 1:100 000 topographic maps.

Regional Crustal Surveys Group

East Papua crustal survey (D.M. Finlayson, B.J. Drummond, C.D.N. Collins, J.B. Connelly). Interpretation of seismic, gravity and magnetic data from the Papuan peninsula region of Papua New Guinea continued throughout the year and a paper was presented at the IGC in August.

The gravity field in the region of east Papua is shown in Figure OR-8. There are three prominent features on this gravity map (Bouguer gravity with density 2.67 $t.m^{-3}$ on land, free-air gravity at sea): 1) the 200-mGal gravity high on the northeast side of the Papuan peninsula associated with the Papuan Ultramafic Belt; 2) the equally prominent gravity high on the northern boundary of the Trobriand Platform; and 3) the intense gravity low of -260 mGal in the western Solomon Sea. The location of two interpreted profiles, A-B and A-C, are also shown on the map.

The geophysical interpretation (Fig. OR-9) shows that the Papuan Ultramafic Belt is a major layered structure with seismic velocities similar to those found in Alpine ophiolite sequences and dipping northeastward at angles of between 13° and 25°. Seismic records indicate that a low-velocity zone underlies the ultramafics. The thickness of crustal material offshore ranges from 33 km in the area of the gravity low, to 27 km north of the Trobriand Platform and decreasing to 13 km in the central Solomon Sea. It is speculated that the crust under the Trobriand Gravity High contains an ophiolite rock suite which was displaced from the Papuan Ultramafic Belt during Cainozoic crustal extension.

Interpretation of data in the Coral Sea area indicates that the crust is about 22 km thick under the Eastern Fields Marginal Plateau, about 18 km under the Moresby Trough, and about 30 km thick under the southwest coast of the Papuan peninsula. Further work is being done on the detailed interpretation of this area.

Seismic residuals from a USSR nuclear explosion detonated on 27 October 1973 show a large scatter and a detailed examination of them has yet to be undertaken.

Quarry blast recording in southeast Australia (D. Denham and C.D.N. Collins). As part of a program of crustal studies in

southeast Australia, a deep seismic survey, using quarry blasts as seismic sources, was carried out in southern New South Wales during March, April, and May 1976.

Originally it had been planned to record between the Marulan limestone quarry and Dartmouth early in 1976, to take advantage of quarrying associated with the building of the Dartmouth Dam. However, when industrial disputes closed down the construction site at Dartmouth it was decided to record along a traverse across the Lachlan Geosyncline and the Sydney Basin (Fig. OR-10).

Sixty-six recording sites were occupied on a line between Bass Point on the New South Wales coast and Ardlethan. Records were also obtained at the permanent observatories at Cooney (Armidale), Riverview (Sydney), and Kowen Forest (Canberra). A station interval of 5 km along the line was planned but, owing to shortage of time and travel funds, some sections only had a 10-km spacing. Sixty sites were occupied with single-component vertical seismographs, and six sites with a three-component system. Unattended magnetic tape recorders were used at all sites. These were programmed to operate continuously from 0900 to 1800 h each day throughout the survey.

Eleven quarries provided seismic sources. These are shown in Figure OR-10 and can be grouped as follows:

(i) Eastern: Bass Point, Dunmore, and Albion Park blue metal quarries.

(ii) Central: Marulan limestone quarry.

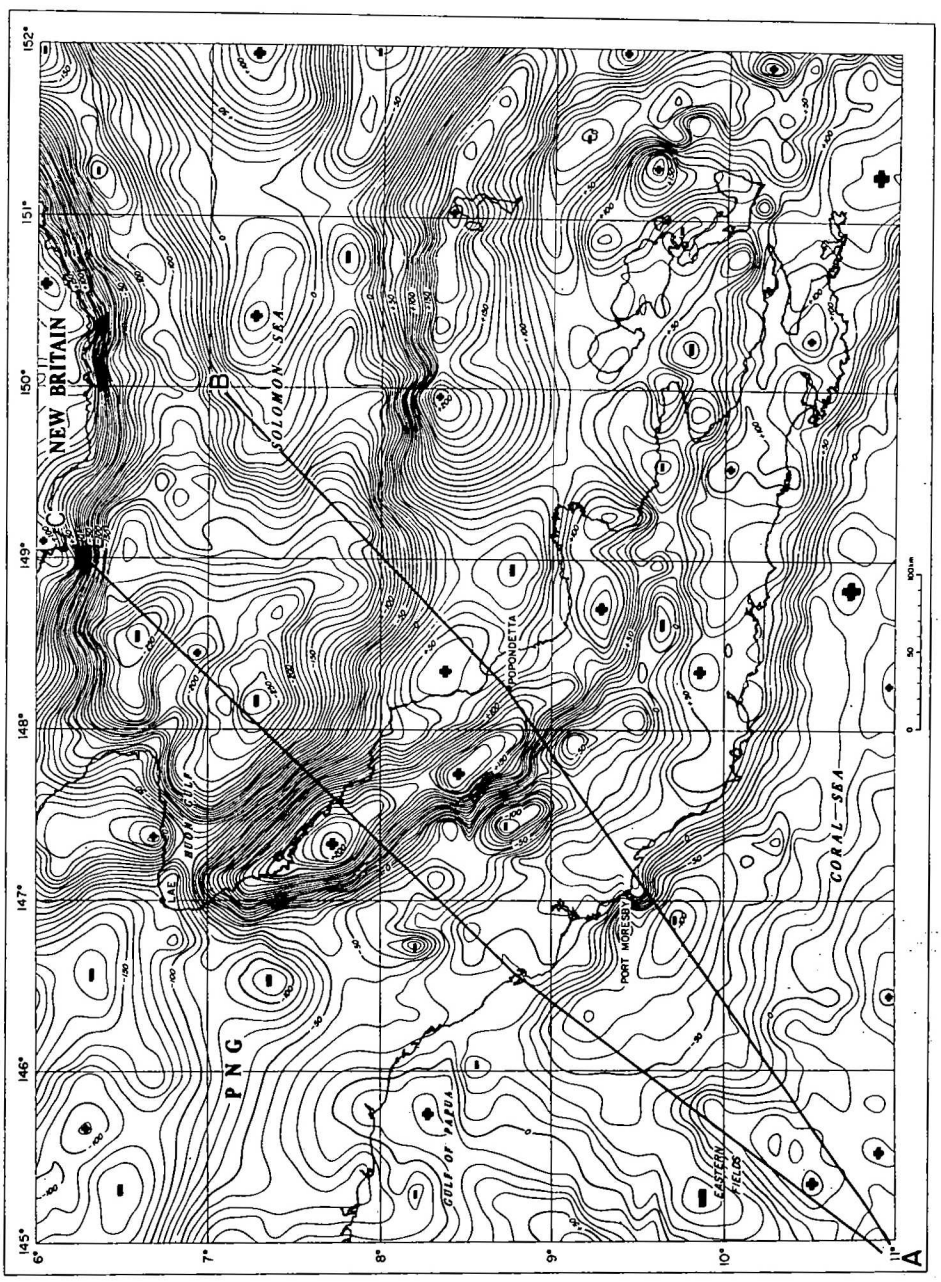
(iii) Western: Ardlethan tin mine.

(iv) Northern: Ravensworth, Swamp Creek, Foybrook, and Howick open-cut collieries, and the Prospect and Wallgrove blue-metal quarries.

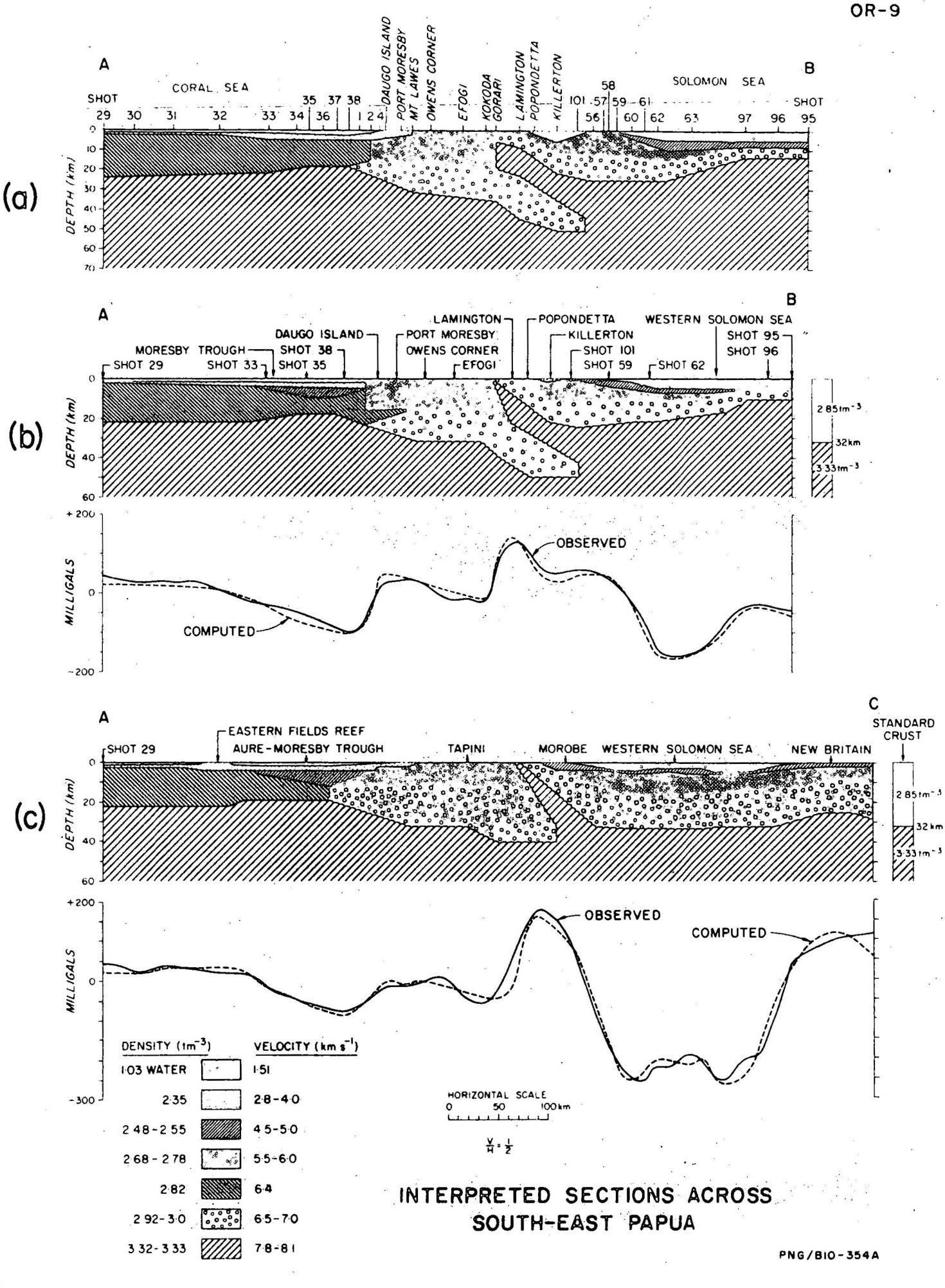
(v) Southern: Queanbeyan and Hall blue-metal quarries.

The shot instants were obtained by recording the explosion on or close to a mine site on a high-speed visual recorder, and also at a recording station a few kilometres away. Thus a station at Fitzroy Falls between Marulan and the coast was used to determine shot instants from the Marulan, Bass Point, Dunmore, and Albion Park quarries after the travel-times between these quarries and Fitzroy Falls had been determined from the on-site recorders.

The most useful sources were from Marulan and the Singleton area (northern group) where shots, large enough to be recorded along the whole line, were detonated regularly throughout the survey. Usually shots from Marulan greater than three



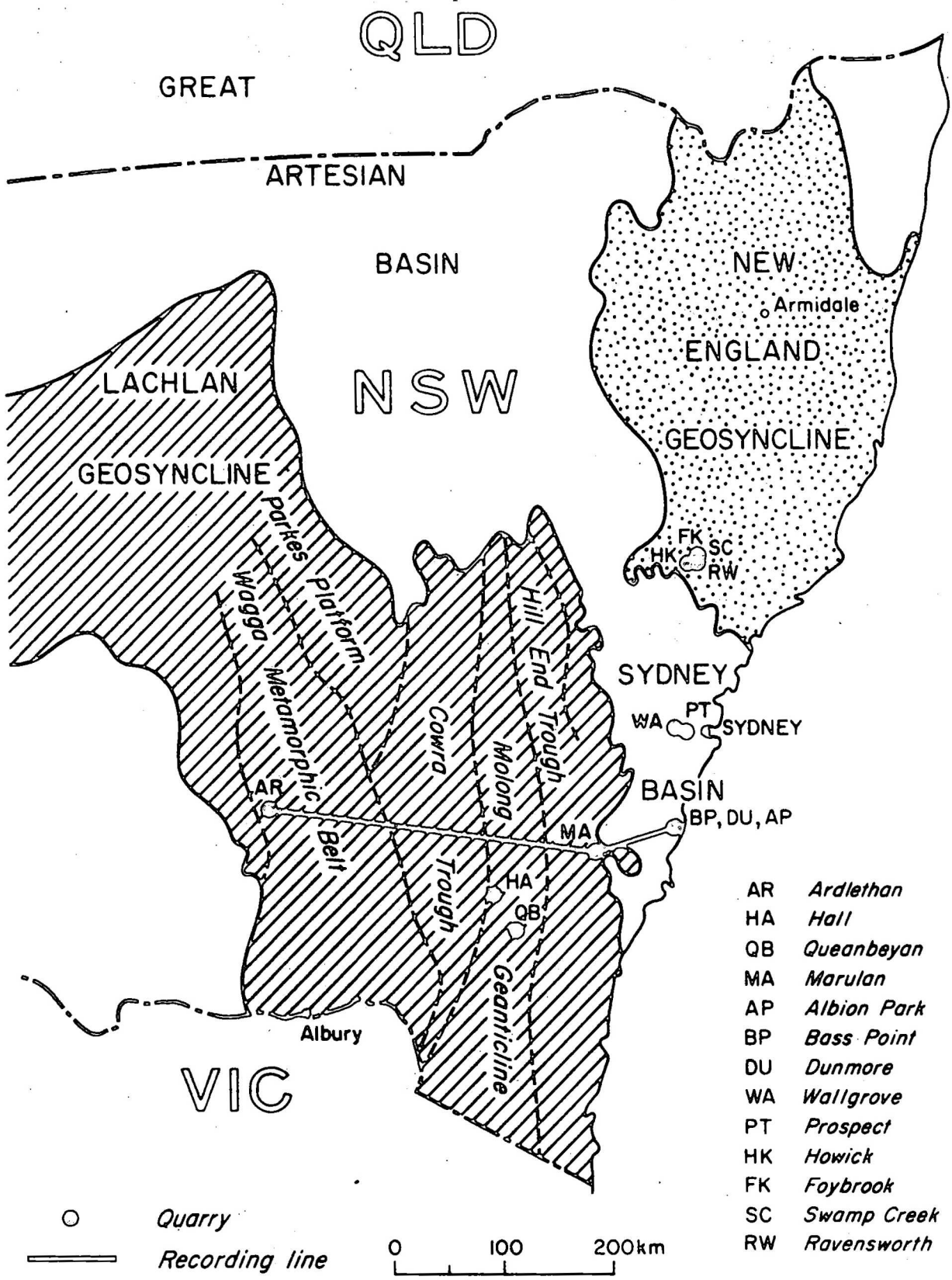
GRAVITY FIELD - EAST PAPUA
(BOUGUER ON LAND, FREE-AIR AT SEA)



INTERPRETED SECTIONS ACROSS SOUTH-EAST PAPUA

PNG/BIO-354A

Record No. 1976/91



QUARRIES AND RECORDING LINE USED ON 1976 CRUSTAL SURVEY

tonnes, and from the Singleton area greater than twenty tonnes, fell into this category. At the time of writing (September) all the field tapes had been played back and the main arrivals picked. However, record sections had not been prepared and the detailed analysis had not started.

Pilbara crustal survey 1977: reconnaissance (D.M. Finlayson, B.J. Drummond). During 1976 planning was started for the Pilbara Crustal Survey scheduled for July-Sept 1977. The survey is primarily a seismic refraction survey using the iron ore mining blasts as energy sources. It is proposed to make recordings along two lines, one between the mine sites at Newman and Pannawonica with Tom Price as an intermediate mine, and the other between Mt Goldsworthy and Paraburdoo with an extension southwards (Fig. OR-11). The first line runs along the axis of the Hamersley Basin and the other runs from the Archaean Pilbara Block across the Hamersley and Bangemall Basins onto the Yilgarn Block. The objective of the survey is to examine the crustal structure in the oldest cratons in Australia. The survey area has considerable potential for extension in every direction using the iron ore blasts.

A preview report was written for the survey, and a three-weeks reconnaissance of survey sites and the mine sites was conducted in September-October.

Gravity map of Melanesia (J.B. Connelly). The assembly of the data bank for the gravity map of Melanesia from numerous sources was completed and checked for errors. A preliminary black-and-white map covering the area 0-16°S by 140-164°E was produced for the International Geological Congress in August. A final coloured map is scheduled for production early 1977 and this phase of the project is now with the drawing office.

The data bank comprises data from a large number of sources (see Fig. OR-12). On land the main data sources are:

(a) BMR regional surveys in Papua New Guinea, New Britain, and New Ireland.

(b) University of Tasmania regional survey in Papua New Guinea during 1962-64.

(c) Detailed oil company work in southwestern Papua. Oil company work before 1963 was compiled by V.P. St John, and that after 1963 was recomputed under a BMR Contract.

(d) University of Wisconsin regional survey of the Solomon Islands, Admiralty Islands, and the Rabaul area.

At sea a number of surveys covering particular areas were available, but much of the data resulted from single crossings of the area. However, the totality of these crossings produced a reasonable data coverage for most of the area (Fig. OR-12). The surveys were:

(a) BMR surveys of the Bismarck Sea and Gulf of Papua.

(b) USS Shoup surveys of the north Bismarck Sea and Gulf of Papua.

(c) University of Hawaii surveys of the Solomon Sea and the parts of the Ontong Java Plateau.

(d) British Admiralty surveys of the Solomon Islands Region.

Single lines were surveyed by:

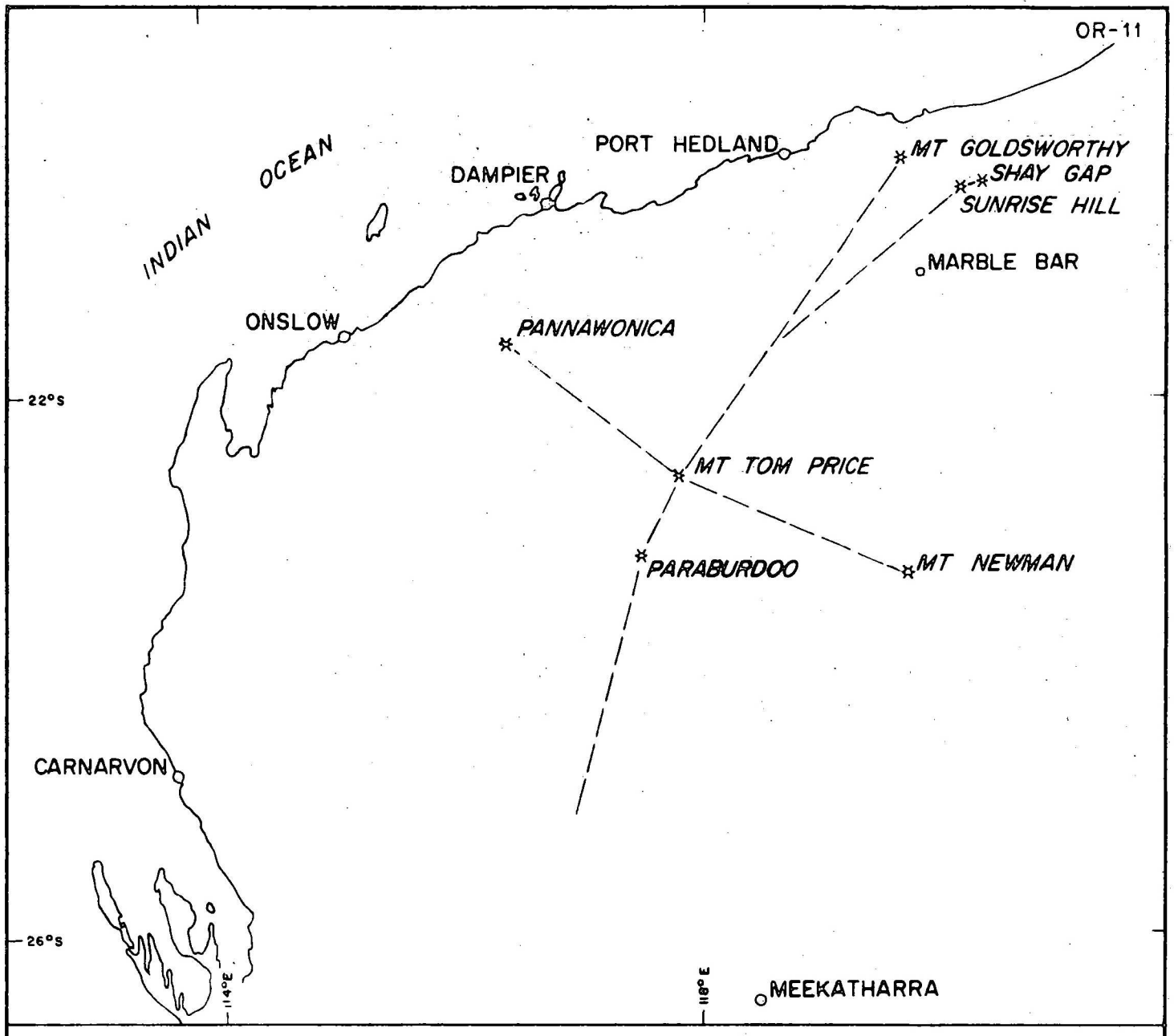
Gulf Research and Development Company; Institute of Physics of the Earth, Academy of Science of the USSR; Lamont-Doherty Geological Observatory, University of Columbia; Ocean Research Institute, University of Tokyo; Woods Hole Oceanographic Institute.

The data from the USS Shoup, and some of the Japanese, Russian, and Hawaiian surveys were obtained from the U.S. Reference Mapping Agency.

The main work in compiling the data bank was in the reduction of data from widely differing sources to a common format. This proved time-consuming in some cases; for instance the Hawaiian tapes were difficult to read on the CSIRO Cyber 76 computer, and the British Admiralty data were available only on charts and had to be digitized.

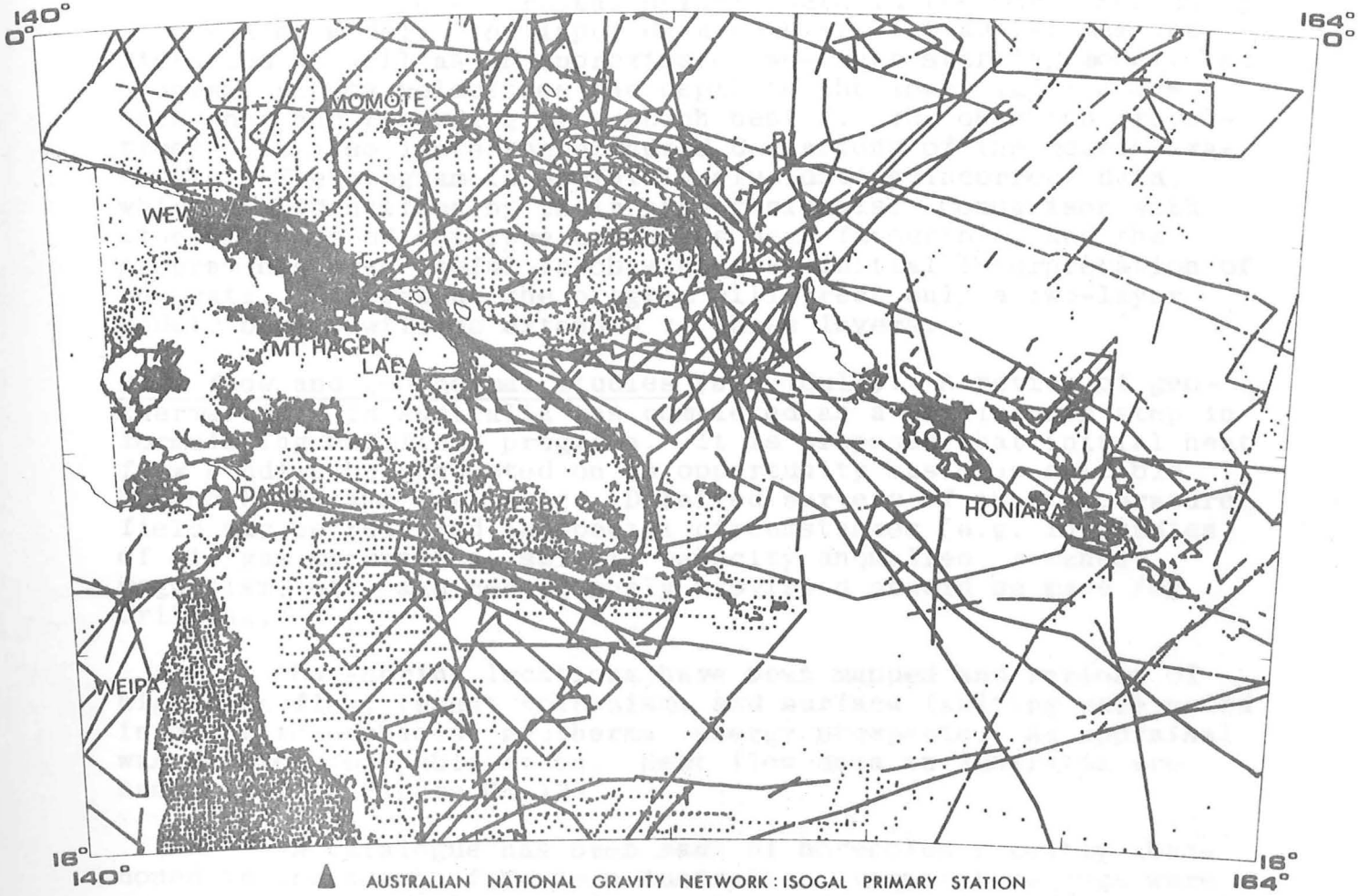
Comptuing methods in crustal investigations (C.D.N. Collins). The development of computer programs for seismic interpretation continued during the year. The development of the synthetic seismogram and seismic data inversion programs was undertaken in co-operation with the ANU.

Minor improvements were made to the ray tracing program which was used extensively during interpretation of the complex crustal structure of east Papua. In such areas it is difficult to apply standard interpretation methods and it becomes necessary to adopt an iterative approach. A model is adopted and is tested by computing the travel-times of seismic energy passing through it, using ray tracing techniques. Comparison is then made with the observed travel-times, and the model modified accordingly. Further control is maintained by computing the gravitational anomaly of the model and comparing it with the observed gravity.



BMR PILBARA CRUSTAL SURVEY 1977

LOCALITY MAP



GRAVITY DATA DISTRIBUTION - MELANESIAN REGION

The non-linear least squares inversion program, ECRUST, was used to interpret crustal seismic data in the Coral Sea using a two-layer model. The input data consist of travel-times and distances as well as an approximate two-layer starting model. The program outputs velocities and depth to the lower layer below each shot and recording site which best fit the observed travel-times. It also lists the standard deviations of the model parameters. The program is useful in elucidating incorrect data, which are identified by their high residuals. Comparison with other methods of interpretation has been favourable, and the program has been useful in obtaining an initial interpretation of the data. At present the program will treat only a two-layer model, but it will be extended to three layers.

Heat flow and geothermal studies (J.P. Cull). A review of geothermal data in Australia was completed as a preliminary step in formulating BMR field programs. It is proposed that initial heat flow studies be conducted on an opportunity basis as suitable boreholes became available. Detailed surveys of the temperature field may be required in special circumstances (e.g. in studies of oil/gas maturation, seismic velocity anomalies, remanent magnetism, etc) and consequently provision should be made for drilling.

Hot-spring locations have been mapped and regions of high heat flow, recent volcanism, and surface faulting were noted in order to emphasise geothermal energy prospects. An appraisal was drafted for publication. Heat flow data in Australia are summarised in Figure OR-13.

A catalogue has been made of boreholes recently abandoned in the north of Western Australia; temperature logs were made in some of these (Canning Basin region) during a three-weeks survey in October-November. Heat flow results will be available when sufficient core has been measured for thermal conductivity. Correlation with oil company logs is now possible.

Computer programs were written to assist in reducing bottom-hole temperature observations obtained during pauses in drilling, and to model the temperature field in buried cylinders. This work followed requests from the Parliamentary Library for assistance in predicting maximum temperatures in radioactive wastes buried in rock.

Borehole logging equipment, temperature probes, and laboratory facilities for conductivity measurements were procured and proving tests were conducted.

Bowen Basin (C.D.N. Collins). Final interpretation of the deep seismic survey in the Bowen Basin, central Queensland, was completed. The model was not substantially altered from that previously described (1975 Annual Summary of Activities) namely,

a four-layer crust, thickening from 35 km in the north to 40 km in the south. The P-wave velocities for the crustal layers are about 4.0, 5.5, 6.3, and 7.1 km/s, and for the upper mantle velocity is about 8.1 km/s. The results are being prepared for publication in the BMR Journal.

Seismic data processing (D.M. Finlayson, B.J. Drummond, J. Williams). Debugging of the prototype playback system for quarter-inch (4-channel Akai recorder) tapes was undertaken throughout 1976 in conjunction with routine tape playout associated with field work. The resulting modifications were incorporated in the first production model of the playback, construction of which continued throughout 1976. Construction was intermittent, however, owing to the heavy workload and staff shortages in the Design and Development Section.

A time channel decoder (TCD) was produced for the playback system by the design and Development section. It gives a read-out of the time from the tape as it is played back. It operates on all playback speeds and is extremely useful in searching for and locating events with known origin times. The TCD will provide the switching function between the playback and an analogue-to-digital converter interfaced with the ADP Group's HP2100 computer. Cable has been purchased to provide the link between the computer and the playback system and its line characteristics have been tested. A teletype and thermal printer have also been ordered.

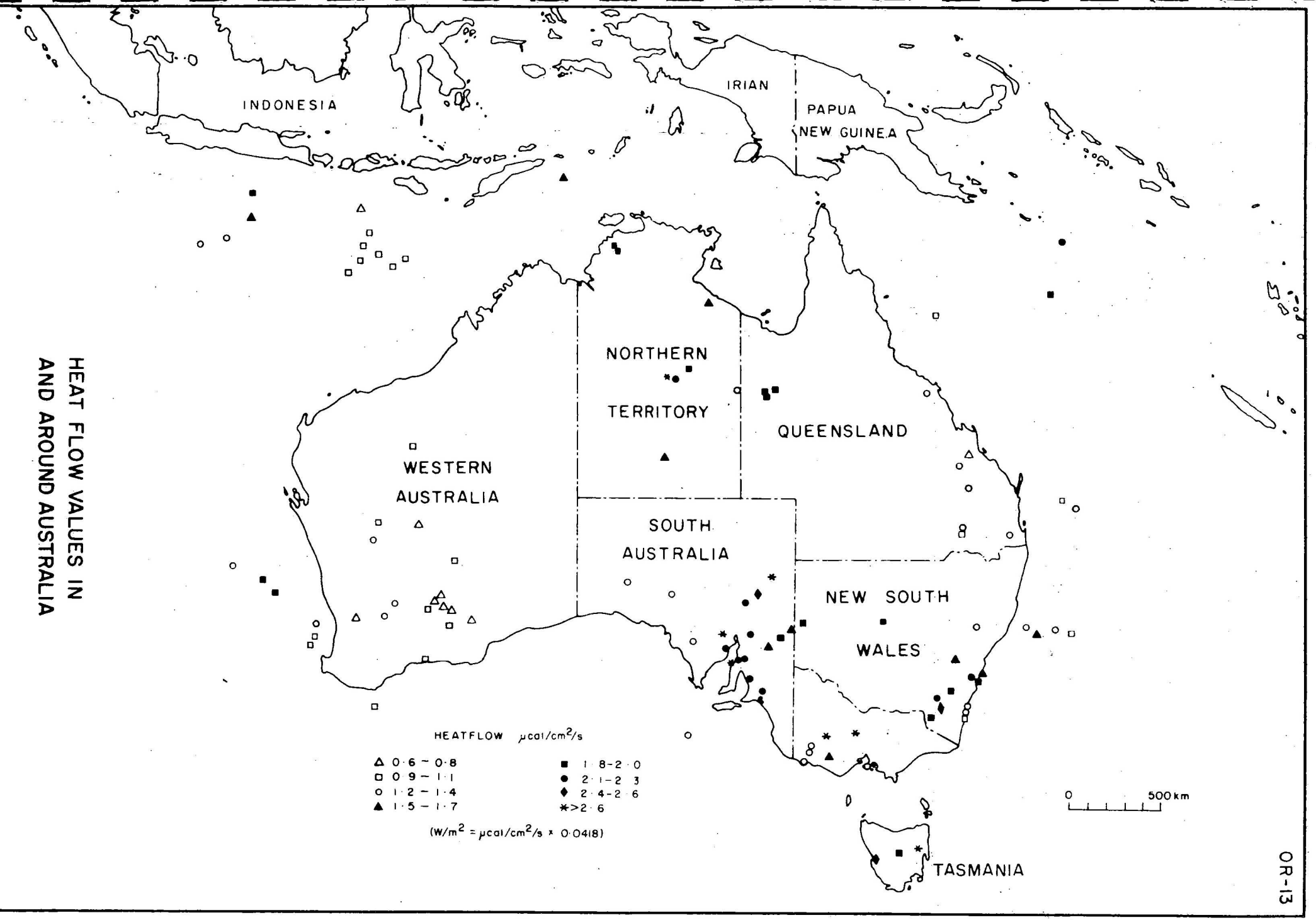
Owing to delays in the development of the interface hardware, completion of the Group's digital processing system has been delayed. The editing and data management programs cannot be written until the problems in the hardware system have been defined, and this cannot be done until the equipment is finished.

Seismic recording equipment (J. Williams). Conversion of all of the Group's Akai tape recorders to the new Mark II format was completed. Some problems were encountered with several of the tape recorders which had previously been modified for use as playback units and considerable time was spent correcting these defects.

Development of the Akai recorders continued. Temperature Compensated Crystal Oscillators (TCXO) were fitted to the NCE-1 low-power digital clocks, resulting in a saving of about 400 mA in power consumption. The power supply for the labtronics radio has been redesigned, resulting in a saving of up to 1200 mA. Ways to reduce the power consumption further are being assessed and power savings from all of the modifications should be in excess of 12 w when the recorder is in the 'operate' mode.

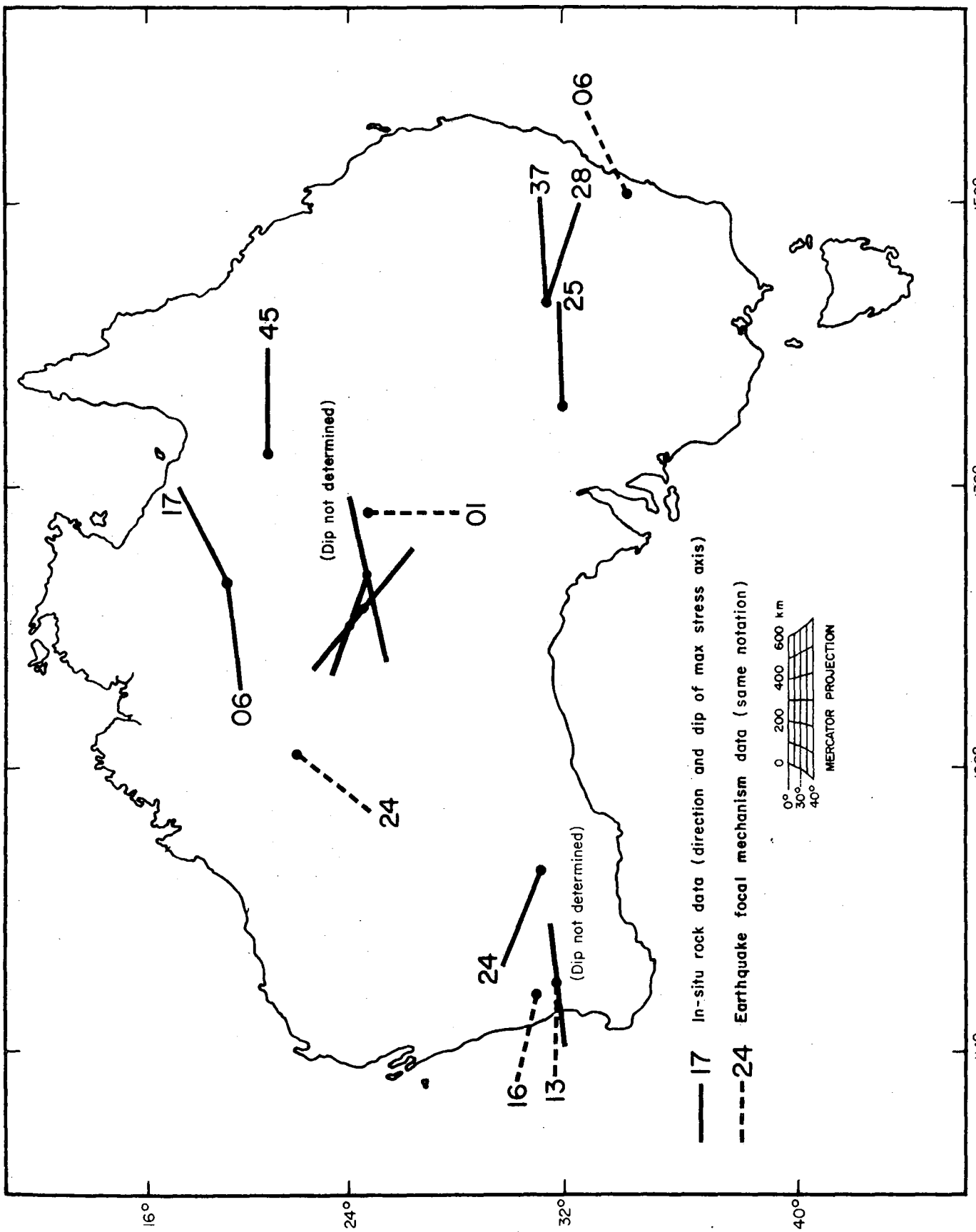
Record No. 1976/91

HEAT FLOW VALUES IN AND AROUND AUSTRALIA



G460-48-1-A

OR-13



DIRECTIONS OF MAXIMUM PRINCIPAL STRESS
AXIS FOR RELIABLE DETERMINATIONS

Record No 1976/91

(Based on A/BO-67A)

A/BIO-39-1A

Routine servicing of the Group's seismic recording equipment continued throughout the year. Most of the problems encountered resulted from field use in the Lachlan Geosyncline Survey during March, April, and May. The NCE-1 low-power digital clocks were most susceptible to faults. Fortunately, most of the clock faults were not serious enough to cause complete breakdown of the equipment.

The Group's six P.I. tape recorders have undergone modifications because replacement parts for these recorders are no longer commercially available.

Catalogue of earthquake focal mechanisms for the western Pacific and Indonesian regions (D. Denham). A catalogue of earthquake focal mechanisms for the western Pacific and Indonesian regions was completed and the data were sent to the World Data Centre A. The list was compiled as a contribution to the Geodynamics Project following a recommendation from Working Group 1 at its 1973 meeting in Bandung.

The catalogue contains 1714 solutions from 49 data sources and is arranged to include the data source, hypocentre, and magnitude of the earthquake (MB, ML, and MS), the poles of the two nodal planes, and the pressure (P), tension (T), and null (B) axes.

The program which lists the catalogue can present the solutions in either a time-sorted or latitude-sorted format. Both formats are available on microfiche.

New solutions will be added to the catalogue when they become available and when time permits.

Stress measurements (D. Denham). A review of stress measurements carried out in Australia to the end of 1975 was completed (BMR Record 1976/1). The results showed that most of the observations, obtained from earthquake focal mechanisms and overcoring measurements, indicate a compressive tectonic stress over most of the continent. This stress seems to act close to horizontal and in a predominantly east-west direction (Fig. OR-14)

In February a CSIRO/BMR survey measured the in-situ stress by overcoring techniques at seven sites along a 200-km north-south profile near the epicentre of the 1968 Meckering earthquake. Shallow holes (usually down to about 7 m) were drilled in competent flat rock and the principal stresses were determined in the horizontal plane. Preliminary results show that the tectonic stress increases significantly both to the north and the south of the earthquake epicentre by about 0.2 kPa/m. Furthermore the average direction of the maximum principal stress is close to east-west and agrees with that found from the focal mechanism solution of the Meckering earthquake.

This set of observations is the first to have been made close to the epicentre of a large earthquake. It suggests that this type of measurement may be used to give consistent results and can also be used for long-term earthquake prediction.

4. GEOPHYSICAL SERVICES SECTION

(M.G. Allen)

The section comprises three sub-sections: Electronics, Mechanical, and Services. The Electronics and Mechanical Sub-sections are concerned primarily with equipment development, construction and maintenance; the Services Sub-section covers procurement and utilisation of equipment, measurements of physical properties of rocks, engineering geophysics, and geophysical drafting.

ELECTRONIC SUBSECTION (K.J. Seers)

The subsection is divided into two groups: Instrument and System Development Group, and Electronic Maintenance and Testing Group.

Instrument and Systems Development Group (Y.S.B. Liu, M. Gamlen, A.S. Scherl, R. Gan, F. Clements, P.J. Hillman, K. Jurello, A.B. Devenish, W. Burhop, W. Greenwood).

This group comprises four units: Instrument development; Systems Development; Instrument Laboratory, and Electronic Drafting.

The Group designs and builds original electronic geophysical equipment or modifies equipment brought in from outside. Many of the projects carried out over the year involved the building of electronic units for data acquisition systems and the assembly of data acquisition systems for various geophysical purposes. The Instrument Laboratory provides facilities for instrument calibration and maintenance, and Electronic Drafting provides electronic drafting and documentation support.

An account of projects carried out through the year follows:

Construction of test system for radio altimeters. The two survey aircraft use Collin's Radio altimeters. There are four of these units belonging to BMR. A test set has been constructed to find faults and align the units. This will greatly increase the reliability of the units in the field.

Investigation and elimination of interference in MFS7 fluxgate magnetometers. The MFS7 is prone to interference from nearby equipment. Some two weeks was spent in trying to establish the cause of the interference. It was found that interference entered the magnetometer through the 28-volt supply line. Some modifications will be made to overcome this fault when the magnetometers become available to the laboratories.

MFS7 test facilities upgrade and design. The MFS7 test facility module currently in use is not satisfactory for field use. The MFS7 S.N. 4 currently being built will have a 3½-digit digital voltmeter on the front panel. This meter monitors power supply voltages, magnitude of the orienter spike signal, etc.

Additional test facilities required includes monitoring and setting the gains of the inner and outer orientor servos.

Construction of MFS7 magnetometer S.N. 4. A fourth MFS7 magnetometer is being constructed as a back-up for the two aircraft and to enable long-term evaluation at Kowen Forest. This unit should be ready for testing later this year.

Twin Otter installation. In the first few months of 1976, the Twin Otter survey data acquisition system was updated and tested. The following changes were made to the system.

The H.P. 2114 computer was replaced with a HP2108 computer. This computer has a larger memory which enabled greater data checking in the field.

The old Doppler digitizer was housed in the old timer and was subject to interference from nearby instruments. A new self-contained Doppler digitizer was developed and was in operation during the 1976 surveys.

A new timer has been developed which provides timing and control functions for the data acquisition system together with a digitizer for the radio altimeter. This unit was in operation during the 1976 surveys.

The Dana digital voltmeter type 5500/135 was modified so that it could operate in either aircraft. All three digital voltmeters used with the MFS7 magnetometers can be used in either aircraft except that not all the required cables have been manufactured.

The radiometric scaler units (RAS 1) were incorporated into the system for the 1976 surveys. Some modifications were required to the Hamner 1 bins for this.

A new permanent magnetic field compensator was developed and incorporated into the aircraft system. The new unit gave wider current ranges, higher stability, and improved adjustment linearity and monitoring facilities.

The D.C.E. 115/240 volt inverter was replaced with a Flintronics 50 Hz inverter, which is a more reliable unit.

VH-BMR Aerocommander. During the early part of the year much time was spent assisting the Airborne Group in preparing the aircraft for survey. This included the following:-

Incorporating the 5 BMR-made cards in the second Datamatic data acquisition system and debugging the system.

Removing the side pen drive circuitry from the back of the recorder and incorporating it in the Datamatic.

Testing of the system and updating the schematics.

Scalers RAS 1 for survey aircraft. All radiometric scalers in the gamma-ray spectrometers were modified so that the output was latched. This prevented half-count occurring due to mis-timing between the reset and strobe pulses.

Digital F data acquisition system. This system was designed as a data scanner to acquire up to 40 channels of BCD data for magnetic observatory use. In its present digital F acquisition system configuration, outputs from the ADKIN three component fluxgate magnetometer, the total field from the Elsec proton magnetometer, as well as the digital clock data are recorded on a magnetic incremental recorder. An analogue system has also been integrated as a back-up system.

Because of the difficulties encountered in obtaining reliable writing on a commercial incremental digital magnetic recorder, only the analogue system was packaged for the secular magnetic variation survey of Australia in January. The manufacturer has since withdrawn this model of recorder from the market, and substitution of a different incremental recorder necessitated some redesign of interface circuitry and system cablings.

Further difficulties were encountered with the ADKIN three-component magnetometer. Some circuitry modification and re-wiring had to be carried out before this instrument became functional.

The complete system was fully packaged and debugged by September. In October it was installed at Omeo as an automatic magnetic station for recording the magnetic field variations associated with the solar eclipse.

Construction work commenced on two more systems to be used in Macquarie Island and Mawson. An outside contractor was engaged in the assembly of printed circuit boards.

Automatic magnetic observatory controller. After receiving the alternative incremental magnetic recorder to replace the one with unreliable writing, the XMA-1 controller uilt by this Group was installed in Kowen Forest AMO in January. The Elsec punch controller and paper punch which has both been plagued by mechanical malfunctions in recent years, were then replaced after a trial period during which the reliability of the magnetic recording system was established.

Regional Structural Surveys Group seismic playback system. The prototype playback system was fully functional by the beginning of the year. A prototype time decoder system which decoded and displayed the IRIG time code for tape search was brought into service in March. A system power supply and a patch panel which interface the Akai tape playback system and Thermionic tape playback system with a 12-channel recorder were also completed by the middle of the year.

The completion of the production models of the playback system, time decoder preset module and computer interface, etc. was delayed to a certain extent by lack of technical-grade staff. However, the playback system should be completed by the end of the year. The time decoder/computer interface is scheduled to be completed at a later stage.

This project has grown quite substantially from its original simple playback concept. The system when completed will enable on-line data processing on the HP2100 in-house computer.

Magnetogram digitizer. This system was required to replace the existing obsolete and unreliable equipment used to digitize observatory magnetograms. The Group was involved in designing and building the control box, interface circuitry, and cabling. A small amount of the software was also written by the Group. The system is to be mounted in a rack and should be in operation by the end of 1976.

Construction of power supplies for Sprengnether seismometers. The Sprengnether MEQ-800 seismograph operates from re-chargeable batteries but the system (except for the clock) must be turned off to charge. Four power supplies were built which allowed the system to operate while the batteries were charging.

Design and construction of general-purpose clocks. The possibility of building a universal clock for BMR was investigated, and some experimental time-error correction circuitry was developed. However, it was decided to discontinue the project because it appeared likely that a commercial clock built to the BMR specification could be bought.

Construction of a timing unit for the observatory. A magnetograph time mark unit MTMU-1 was constructed for the Observatory Subsection. This unit produces various contact closure outputs from one-minute inputs.

Installation of TCXO crystals in NCE 1 clocks. The original crystals in the Crustal Group's remote recording seismic stations were the oven-controlled type. These caused a large current drain on the batteries so a compensated crystal was environmentally tested with replacement in mind. The tests indicated that the crystals were within specifications so some 20 clocks are to have the compensated crystal installed.

Design of heat flow instrumentation. A request was made for two instruments for geothermal studies. These were a thermistor amplifier for use in borehole temperature measurements and a needle probe amplifier for use in rock conductivity measurements. The construction of the thermistor amplifier is complete and the circuit design for the needle probe amplifier has been completed and the unit is under construction.

Computer interface for engineering seismic digital acquisition system. An instrument for interfacing the shot instant with a computer was requested by the Engineering Geophysics Group. The circuitry required has been tested and the instrument is under construction.

Design and construction of post-amplifiers for the magneto-telluric system. The electronics used in the original Geotronics equipment is now superseded, the equipment is difficult to service, and is becoming unreliable in the field. For these reasons, a model of a linear amplifier was tried in place of the chopper amplifier in a feasibility study. This improved the signal-to-noise ratio, sufficiently to justify replacing the original post amplifiers. This will be done in 1977.

Eight channel D/A cards for H.P. computers. A number of sections require D to A converters which will plug into H.P. mini-computers. Circuit models using three different types of D/A converters were constructed and tested, and for the production models a 2's complement D/A converter was selected.

An eight-channel card with interrupt and flag circuitry was constructed and tested. Further testing is to be carried out by the A.D.P. section.

An eight-channel card using 0 to 10 volt output D/A converters has also been constructed.

Use of solar cells - feasibility study. A feasibility study of the use of solar cells for various applications will be commenced later in the year. Two solar boards have been obtained, and

tests will be carried out with these boards to determine their average power output. Calculations indicate the two solar boards could power a remote seismic station provided it was not continuously recording.

MNS2 proton magnetometer detector/pre-amp optimization. Redesign of the pre-amplifier has been looked at in theory. A low-noise amplifier using multiple transistors should improve the signal/noise ratio. The use of this type of pre-amplifier would enable the elimination of the input transformer which could be picking up A.C. noise.

Building and testing of the circuitry should commence before the end of the year.

T.T.O. (Engineering) in-house training. The T.T.O.s (engineering) are rotated at 6 monthly intervals between sections where electronic work is carried out. Some time was spent by geophysicists and technical officers in these areas in training T.T.O.s (engineering).

Instrument Laboratory. During the year Instrument Laboratory calibration capability was improved with the purchase of a set of thermal converters and a Fluke Kelvin-Varley divider. The thermal converter will allow AC RMS to DC voltage comparison with an unvertainty of 0.1% up to 50 MHz for the calibration of digital multimeters and the setting of output levels of precision levelled oscillators. The 0.1 ppm linearity Kelvin-Varley divider will allow the two nominally 0.002% accurate 0-1KV DC voltage standard to be linearized and calibrated against standard cells, and will increase the certainty with which resistors may be compred and the linearity of D-A and A-D converters may be determined.

Capability in the general test and measurement area was improved by the addition of a H-P 8015A pulse generator, designed specifically for the testing of C-mos logic, a Tektronix 7904 oscilloscope-based test system, a small digital multimeter, and other minor items. The 7904 oscilloscope system will enable accurate digital instantaneous voltage and time interval measurements to be made interactively with the waveform display, eliminating much of the previous uncertainty encountered with a group of discrete instruments and greatly increasing the accuracy and range of information which can be obtained.

Considerable time was spent in the modification, construction, and checking of equipment for use by the Christmas Island groundwater survey party. The principal efforts were the modification of an S.I.E. RS-4 seismic recorder to interface with an Ampex 14-channel FM tape recorder to permit the recording of seismic signals over long periods in the field without loss of time interval accuracy or the unproductive consumption of materials, and the creation of an IP calibrator to enable the operation of time domain IP receivers to be vertified at any time.

Systems Development Group (P. Hillman)

The groups major projects during 1976 were, in order of priority, the Marine Data Acquisition System for the next major survey, the continuous recording magnetometer for ground traverses, and a comprison of the Telseis and Geostore systems for continuous seismic telemetry.

Marine D.A.S. for the next major survey. A revised system block diagram of the marine digital data acquisition system, which incorporated the new ideas of the Marine Sub-section, was produced in July and needs further revision now as the system concepts develop and improve.

Most of the system components will be bought from commercial sources but six specialised units are being designed and built by the Development and System Groups. They are the general purpose T.A.M.7 amplifier/filter units, D/A converter units, timing units, shot relay unit, interface units, and a patch panel for analogue data.

Only the T.A.M.7 development is on schedule despite a change to the filter specifications in March. A pre-production module will be built and tested before the end of the year provided its high-tolerance resistors are delivered on time. The bin and mechanical modules have been vibration-tested and need some modification to eliminate undesirable resonant vibration modes.

The detail design of the prototype electronic circuit for the timing units and the shot relay unit is finished and the P.C. card layout is being drawn. A card should be assembled and tested by the end of November. Commercial 'Elmaset' assemblies will be used to construct the bins for these units.

Detail design of the interface circuits is approaching completion and should be available shortly for P.C. card layout.

Only basic design of the D/A converters has been completed and the patch panel design has not been started.

A prototype model of the clock/time code generator which is being purchased has been examined in detail. The crystal oven was not adequate and the clock failed to meet the specification for crystal frequency variation with change in ambient temperature. The manufacturer will use a satisfactory crystal oven assembly in production clocks, and will also include several detail design changes requested by BMR. Two production clocks should be delivered by December 1976.

Continuous recording magnetometer for ground traverses. The first requirement was to produce a system that could be used by the Geophysical Engineering Group on foot traverses across

Christmas Island in August-September 1976. This was completed satisfactorily. The second, which is outstanding, is to compare the types of magnetometer which are available and recommends the one most suitable for BMR requirements.

The system developed for Christmas Island uses a Geometrics G803H.P. magnetometer with 150-mm spherical toroidal detector. The major problem was to identify the source or sources of the excessive noise recorded when the detector was moved and reduce this to an acceptable level of 1 nT or less. The noise introduced by moving magnetic material (e.g. the vehicle used for carrying the electronics, recorder, etc.) was reduced to less than 0.5 nT by separating the detector and vehicle by 30 m. Turbulence of the fluid in the detector head caused the majority of the remainder of the noise which was often large enough to make the equipment loose lock for several seconds. To reduce the turbulence the detector was completely filled with the polarising fluid, a lightweight non-magnetic cradle was designed, and the traverse speed was limited to 3.5 km/h. These measures together with operating the magnetometer in the fast response mode eliminated loss of lock and several satisfactory records were obtained over a 650-m traverse. Correlation between the magnetometer record and the distance traversed is obtained by using a modified bicycle wheel to operate the side pen on the recorder at 10-m intervals.

Comparison of the Telseis & Geostore systems. This project was started toward the end of 1975 and some preliminary reading completed before it had to be shelved for work with higher priority.

Filter for tidal gravity recording. A passive tunable twin T notch filter was designed and built for Regional Gravity Group to reduce the seismic noise on the tidal gravity records being made at Mount Stromlo. The notch frequency can be selected by a variable resistor, between the limits of 0.16 Hz and 0.32 Hz with an attenuation of at least 40 Db.

Electronic Maintenance and Testing Group (A. Spence, R. Cobcroft, A. Zeitlhofer, M. Jones, J. Jones, M. Bower, C. Rochford, W. Harkness. Airborne Group Technical Officers - L. Winters, G. Green, R. Curtis-Nuthall, J. Eurell).

The chief activity of this group is to prepare and service geophysical equipment, especially for those Groups with no technical staff of their own.

The Observatories Group's magnetic and seismic installation at Kowen Forest, ACT has received constant attention throughout the year. Components from seismograph installations at Giles and Alice Springs have been received and serviced. A new seismograph system has been prepared for installation at Mt

Isa, some time in 1977. A UED photographic type drum recorder is being modified for thermal writing and is expected to be ready by the end of the year. The Adkin 3-component fluxgate magnetometer was severely damaged as a result of mains voltage leaking to the frame of the instrument. It was repaired and used for measurements during the October solar eclipse. Three new digital clocks were received and modified for observatory use.

The Engineering Geophysics Group was assisted in its preparation for the Christmas Island survey. A major task was to provide down-hole antennas for a system using radio-wave attenuation measurements to detect cavities between boreholes in limestone. Technical support for engineering surveys in ACT area was also provided throughout the year.

The magneto-telluric survey party was assisted in preparing equipment for the East Officer Basin survey. A. Spence, from this group, participated in the fieldwork.

Marine seismic profiling equipment was prepared for installation on the vessel Cape Don on behalf of the Marine Geology group, and technical support was provided during the course of the survey.

The group is being increasingly called upon to service or modify a wide range of equipment operating within the BMR building. Most of the requests originate from the drawing office, the photographic laboratory, and the geological laboratories, with the range of equipment extending from spectrophotometers to pumps, and from computer equipment to fork lifts.

Equipment was prepared for loan to various external organizations. N.T. Water Resources Branch requested a well-logger for temperature and flow measurements; Papua New Guinea Geological Survey requested resistivity equipment, and Macquarie University a set of Turam equipment.

The Group collaborated with the Metalliferous Sub-section in preparation of equipment for its Georgetown and Jerusalem Creek surveys. A review was made of BMR's needs and this Group's role in the acquisition of transient E.M. equipment to replace the Russian MPPO-1 system. In view of CSIRO's work on similar equipment our effort has been restricted to maintaining liaison with the CSIRO group, and ensuring the MPPO-1 remains operational for another field season. A recording microbarometer was also redesigned for the Metalliferous Sub-section.

Tests on marine sparker electrode performance were carried out on behalf of the Mechanical Design Group. It was found that by sheathing the electrode in a metal tube, electrode life was prolonged and the pulse length was shortened.

This Group's contribution to the training of Trainee Technical Officers continued as in previous years.

MECHANICAL SUB-SECTION (J.M. Mulder)

The Sub-section comprises three groups: Mechanical Engineering Design, Mechanical Instrument Construction of which the machine shop is a part, and Mechanical Maintenance and Testing.

The staffing in the machine shop became critical during the year with the resignation of the Senior Instrument Maker, and the retirement due to ill health of the Foreman. These losses left the shop with one Instrument Maker to cope with the demands on it by the various sections in the Bureau. Consequently it was faced with an increasing number of work requests most of which could not be attended to in reasonable time. Another serious consequence was the deterioration in quality control which resulted from attempts to satisfy the greatest number of clients with staff available.

The loss of the labourer on extended sick leave added to the difficulties.

Mechanical Engineering Design Group (D.B. Stewart, J.W. Rutledge, G.W. Thom)

Development of shallow seismic profiling equipment. This project did not have high priority and progressed slowly from lack of testing facilities and personnel to conduct experimental testing. In May a long-awaited current-measuring probe arrived and in September the first tests were conducted to measure sparker circuit transient current in single and multi-electrode circuits in order to determine current distribution and repeatability. There are no problems with current distribution in multi-electrode circuits and an improved sparker electrode developed during the year shows promise of repeatability for extended maintenance-free operation and more desirable acoustic characteristics. A compact multi-electrode sparker energy source and depth-controllable tow fish were designed and construction of the sparker source will commence this year.

Bore-water flow test unit. The equipment is being built for Engineering Geology Group. Since mid-year, construction work has progressed steadily on the trailer and crane structure and also on the hydraulically powered winch. There were considerable delays in purchasing plant and materials owing to lack of funds and the unit is now expected to be completed in December.

20KVA Ford-Dunlite alternator. Shock abosrbers were added to the trailer suspension in an effort to reduce suspension wear and damage.

3000-metre well logger. The hydraulic power system for the logging winch was modified to give an increased speed range so as to reduce access time up or down bore-holes when not logging. Fail-safe braking was added to the logging winch to prevent creep in the event of a power failure when down hole with consequent loss of logs. A hydraulically actuated winch speed control mechanism was developed for the necessary remote operation of the hydraulic pump flow servo.

Mineral sands sampling. A report on vibrocores was written to evaluate and compare the equipment offered in relation to offshore drilling for heavy-mineral sands - tender schedule 31-9990/75/107 (not awarded). The report will be useful if and when further tenders are called for the purchase of drilling equipment or for contract drilling.

Shallow penetration marine core drill. The 0.3-m-penetration coral core sampling drill was further developed to include a waterproof housing and seal, to prevent water entering the geared speed reducer of the air-powered turbine.

Bin and module chassis for marine data acquisition system amplifiers. A prototype bin and module chassis for the TAM-7 general purpose marine amplifier filter units was constructed and further development work to improve the mounting of the modules and to incorporate variations in the numbers of modules is in progress.

Geotech recorders. Design modifications to Geotech photographic recorders were made to enable heat-sensitive recording paper to be used.

Special-purpose vehicle. A cab design and vehicle specification were prepared for the purchase or hire of a special purpose vehicle to house magneto-telluric and digital seismic equipment.

Miscellaneous. A novel mercury tilt switch was developed for use in radio transmitters and signal flashers which rely on change of orientation to trigger the switchable output. The device is intended for use in the tail marker buoy attached to marine seismic streamer cables.

An extended surface heat exchanger was designed for natural convection cooling of the detector coil in an experimental base station magnetometer.

Tenders for the bulk purchase of metric fasteners were assessed for the Australian Government Stores and Tender Board, as part of the interdepartmental co-ordinating role in the introduction of metric fasteners.

Several instrument chassis and racks were designed in support of projects in Electronics Sub-section.

Mechanical Instrument Construction Group. (A.H. Booth retired, G. Renton resigned, A. Kores, T. Piggott, G. Lockwood, R.J. Westmore, L.S. D'Arcy, E.C. McIntosh, R.L. Gibbs).

This group comprises the machine shop, the heavy workshop and the model maker's shop. It ismainly concerned with modifications to existing equipment, vehicle installations, and with the construction of prototype experimental equipment. Besides contributing to many of the projects mentioned under the heading Mechanical Engineering Design Group, this group supplied the following support:

Metalliferous surveys. Overhaul of a cable reel and a Wankel ground power unit. A number of wooden frames were constructed for scale electromagnetic modelling experiments.

Well-logging party. Construction of a holder for a photo multiplier tube and crystal in a gamma-ray logging tool. Construction of five gamma-ray calibration fixtures.

Marine Survey Group. Construction of stability fins and construction of hydrophone holders for a 16-element streamer cable.

Rock Measurement Group. Adjustments were made to a rock demagnetiser and some parts of the instrument were re-made.

Trailer-mounted explosives magazine. To enable the Regional Gravity group to occupy an underground vault near Alice Springs for tidal gravity observations, the vault had to be emptied of explosives. A Bureau-owned mobile magazine was extensively modified to satisfy new local safety regulations. New locks were fitted, a steel door was remade, and part of the outer skin replaced where necessary.

Geophysical Drafting Office. A number of lay-out tables were made and two mobile storage racks for map plans.

Machine shop. A Dean, Smith, and Grace lathe was converted to read metric dimensions.

Metalliferous (Geological). A rock crusher which had been damaged in operation was repaired.

I.G.C. An information booth, two wall display cabinets, and various other special items were made for the IGC and installed in Sydney.

Mechanical Maintenance and Testing Group (R.B. Grigg, D.O. Stevens, S. Prokin)

The group overhauled, repaired, and tested instruments such as Moseley potentiometric recorders; prismatic binoculars; a sketchmaster drafting instrument; a number of planimeters; a

M11D2 Westronics recorder; a Geometrics magnetometer sensor support; a vacuum pump; a Willmore seismometer; two BMR strip cameras; an Askania declinometer circle; a Elsec magnetometer, a number of paper perforators of various makes; a Hasselblad camera magazine; and a TR06 seismic camera. A set of Gerber scales were repaired; a pin extracting tool was made to assist in the repairs of tape perforators; a Turam coil was mounted on a tripod; and a sample holder was manufactured for a rock demagnetiser. Worden gravity meters used by BMR and other organisations were evacuated as required.

SERVICES SUBSECTION

The subsection comprises four groups: Procurement, Rock Measurements, Engineering Geophysics, and Geophysical Drawing Office.

Procurement Group (P.E. Mann, S. Waterlander)

The Procurement Group made technical investigations, wrote specifications, and assessed tenders on a wide range of plant and equipment approved in the Geophysical Branch buying program. Liaison with ADP section was maintained in drawing up specifications for computer or peripheral equipment, which comprised a significant proportion of the program.

A considerable amount of the time was spent in revising the buying program to meet financial restraints imposed before the general election in December 1975. Subsequently a further review of the buying program was necessary as a result of the election of the new government and the application of its fiscal policy for the supply period and financial year. Under these financial conditions only equipment with the highest priority could be purchased, but since the presentation of the budget the buying program has stabilized. However significant cost increases have been encountered for most items whose purchase had to be postponed during the period of tight finance.

Rock Measurement Group (M. Idnurm, R.I. Eaton)

During the year measurements were made on some 300 rock and sediment samples in support of BMR projects. The measurements comprised sound velocity, magnetic susceptibility, remanence, electrical conductivity, indiced polarization, uniaxial compression strength, and elastic parameters.

The Eromanga Basin palaeomagnetic project, commenced towards the end of last year, was completed. A total of 90 samples were measured from two weathering profiles to obtain the respective ages of deep weathering. The older of the profiles gave an Eocene/Palaeocene age, and the younger profile gave

Miocene as the minimum age limit. The pole position for the younger weathering profile lies close to pole positions reported for laterized sediments from the Perth Basin and from the Northern Territory, indicating an extensive weathering event in Australia at that time.

Reconnaissance measurements were carried out on a 100-km-wide sequence of stranded beach deposits near Naracoorte, S.A., in order to fix the time scale of the deposition. A polarity reversal corresponding to the 700 000 yr Brunhes - Matuyama boundary was found near Naracoorte. Further sampling is however required to consolidate these results.

A divided bar apparatus for measuring thermal conductivities of rock samples was designed and constructed. The equipment accepts samples of 25 mm and 35 mm diameter. Two pairs of crystallographically oriented quartz thermal conductivity standards were prepared.

The construction of an AF demagnetizer, commenced in 1975, was completed. A shear wave transducer and two sun compasses were manufactured. A PAR spinner magnetometer was purchased from the Australian National University.

Work was carried out on behalf of a committee set up to determine the future role of palaeomagnetism in the Bureau. The committee found that a need exists in the Bureau for palaeomagnetic work on a continuous basis, the principal application being magnetostratigraphic correlation. Negotiations were carried out with ANU and CSIRO to make joint use of palaeomagnetic facilities at ANU's Black Mountain laboratory, Canberra. The latest measurement technology, incorporating a SQUID magnetometer, will be used.

Engineering Geophysics Group (E.J. Polak, F.J. Taylor, G.R. Pettifer, D.C. Ramsay, C.L. Horsfall, D. Bennett, G.S. Jennings, D.H. Francis, R.F. Moore)

The group continued to provide engineering geophysics services throughout the ACT to other government departments. Several requests by State and Federal departments for work outside the ACT had to be declined.

ACT Engineering Surveys

Reservoir sites. Foundation investigations were carried out at reservoir sites throughout the ACT. Reservoir sites included Tuggeranong (3), West Murrumbidgee (3), Tharwa (2), Tennent (1), Calwell (1), Lanyon (1), and Gungahlin (2). Seismic refraction work was carried out at each of these sites in order to provide data on foundations and rippability. Most proposed sites included several optional positions for the reservoir.

Tennant damsite. Further seismic refraction traversing was carried out on two possible damsites. The work is continuing and emphasis is being placed on a more detailed investigation in order to map shear zones on the eastern side of the Gudgenby River.

Building sites. Foundation investigations were carried out at the proposed site of a new office block in Duntroon and also at the proposed site of the magnetic observatory buildings at Kowen Forest.

Sewer lines. Seismic refraction traverses were completed on the Lanyon Trunk Sewer and the City Trunk Sewer. Further work is likely to be required on both of these sewer lines.

Googong pipe-line. Additional seismic work was carried out along the Googong water pipe-line near Duntroon. Results indicate that blasting will be required in this area.

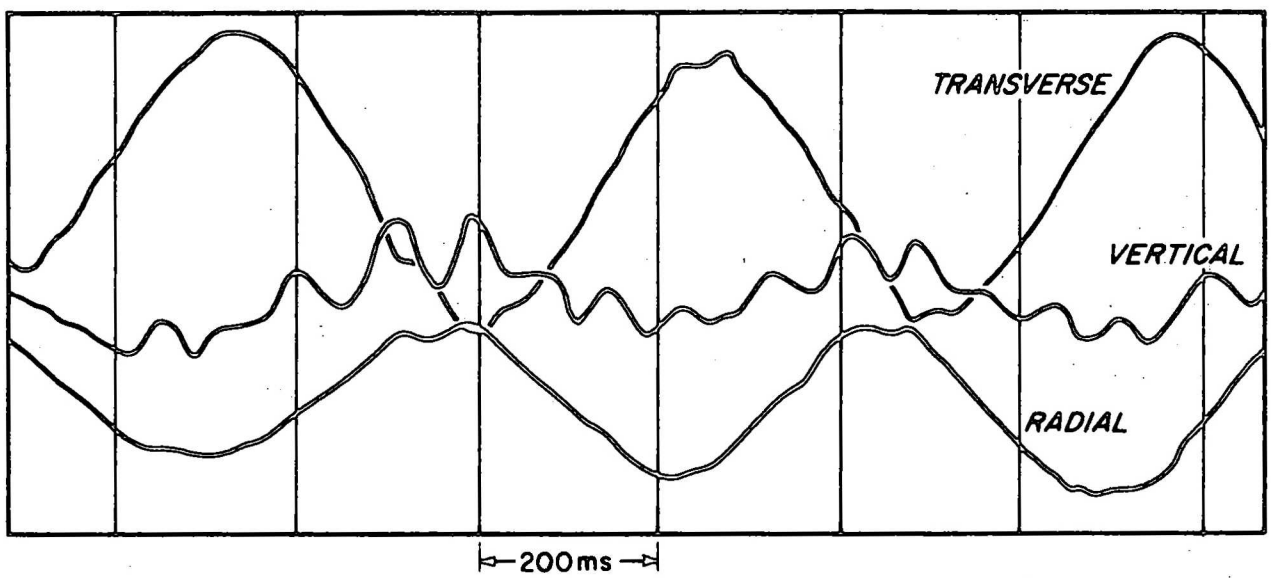
Deakin telephone exchange. Resistivity measurements were made near the Deakin telephone exchange in order to provide basic data on earthing. The information provided data which enabled the best location for earthing to be determined.

Vibration measurements

Routine vibration measurements to monitor the effects of blasting and other vibrations were carried out within the ACT as well as in NSW, using the Sprengnether Vibrograph and the Sinco Vibration Monitor. Requests for vibration monitoring have usually resulted from complaints from the public on the effects of blasting. However, in recent years more attention has been paid to avoiding such situations by determining the maximum charge size permissible in a certain environment at the commencement of operations.

ACT vibration measurements. Vibration measurements were made at the Lower Molonglo Water Treatment Plant, Monier Besser Quarry, Mt Stromlo pipeline tunnel, and Googong damsite. The objectives were to determine charge sizes compatible with safety codes and hence avoid damage to existing structures, and in the case of Mt Stromlo pipeline to limit charge sizes to levels w-ich would not disturb ANU's 74-inch telescope.

Vibration measurements were taken at various locations within the BMR building in order to determine a suitable site for the new electron scanning microscope, for which the manufacturer stipulated environmental limitations on frequency and amplitude of site vibrations. Fig GS1 shows a sample vibration record taken on the third floor. The investigation showed that the upper floors of the building and indeed the entire building



MODE : DISPLACEMENT
VERTICAL SCALE : 1cm = 2μm

Major component :

FREQUENCY : 2 Hz

AMPLITUDE,	TRANSVERSE	3·7 μm (micrometres)
	VERTICAL	1·9 μm
	RADIAL	2·0 μm
	TOTAL	4·6 μm

VIBRATION RECORD
BMR BUILDING
ROOM 362

oscillates at a frequency of 2Hz with a peak displacement in the order of 4.5 m. This level of vibration did not conform with the stated limitations. However, readings taken in the basement showed that the 2Hz component was not measureable, and hence a basement site was selected for the electron microscope.

Kingswood ammunition depot and demolition range. Vibration measurements were carried out at Kingswood, near Sydney for the Department of Defence, at their ammunition depot and demolition range. These measurements were designed to monitor the ground vibrations produced by exploding bombs, which ranged in size from 5 to 150 kg. Previous explosions within this area had produced complaints from urban residents, but the measurements showed the ground vibrations were within the limits set by the Standards Association Australia code. The vibration measurements formed part of a complete environmental impact study being undertaken by the Department of Defence on the Kingswood area.

Development of digital seismic system

During the year the Group has been involved in setting up a mini computer-based digital seismic system intended for seismic operations in noisy environments and in areas where explosives are not permitted. The equipment and techniques will be used for refraction work on building sites, tunnel lines, etc., as well as for investigations of shallow reflection techniques.

Considerable progress has been made in acquiring the necessary hardware and in the development of software. The final two units of hardware should arrive before December 1976 and the initial stacking system required for seismic refraction within the ACT is expected to be operational before the end of the year. Development of techniques for reflection and refraction surveys will be a major activity in 1977.

Kiewa River and Snowdons area

BMR is committed to carrying out engineering geophysical surveys requested by the Albury Wodonga Development Corporation. In 1976 the sand and gravel resources of the Kiewa River area and Snowdons Rd area on the Murray River were investigated using resistivity depth sounding and traversing techniques and magnetic profiling. Plate GS2 shows the 1976 survey areas in relation to the areas investigated in 1975.

The results show the sand to be confined mainly to a channel closely following the east bank of the Kiewa River with little sand on the western flank. The sands and gravels have a much higher mica content in this area than on the Murray flood plain. In the Snowdons area no clear sand channels could be defined.

Christmas Island groundwater survey

At the request of the British Phosphate Commissioners (BPC), the Engineering Geophysics Group sent a geophysical party to Christmas Island (Indian Ocean) to gather further data for the groundwater exploration programs. Previous investigations and groundwater extraction had concentrated on the karst limestone capping over the island.

In the 1976 survey deep electrical soundings showed the volcanic core of the island to be of low resistivity (15-50 ohm-metres). Preliminary interpretation suggests that underlying volcanics are deeply weathered, fractured, and porous in many places and are thus considered a better prospect for long-term groundwater supplies than the karst limestone.

Structural interpretation will be aided by the use of vertical and total magnetic field recordings over the central part of the island, and BPC is extending the total field magnetic coverage using BMR's continuous recording proton precession magnetometer. The gravity survey of the island has been extended and gravity ties to Cocos Island and Perth were also carried out.

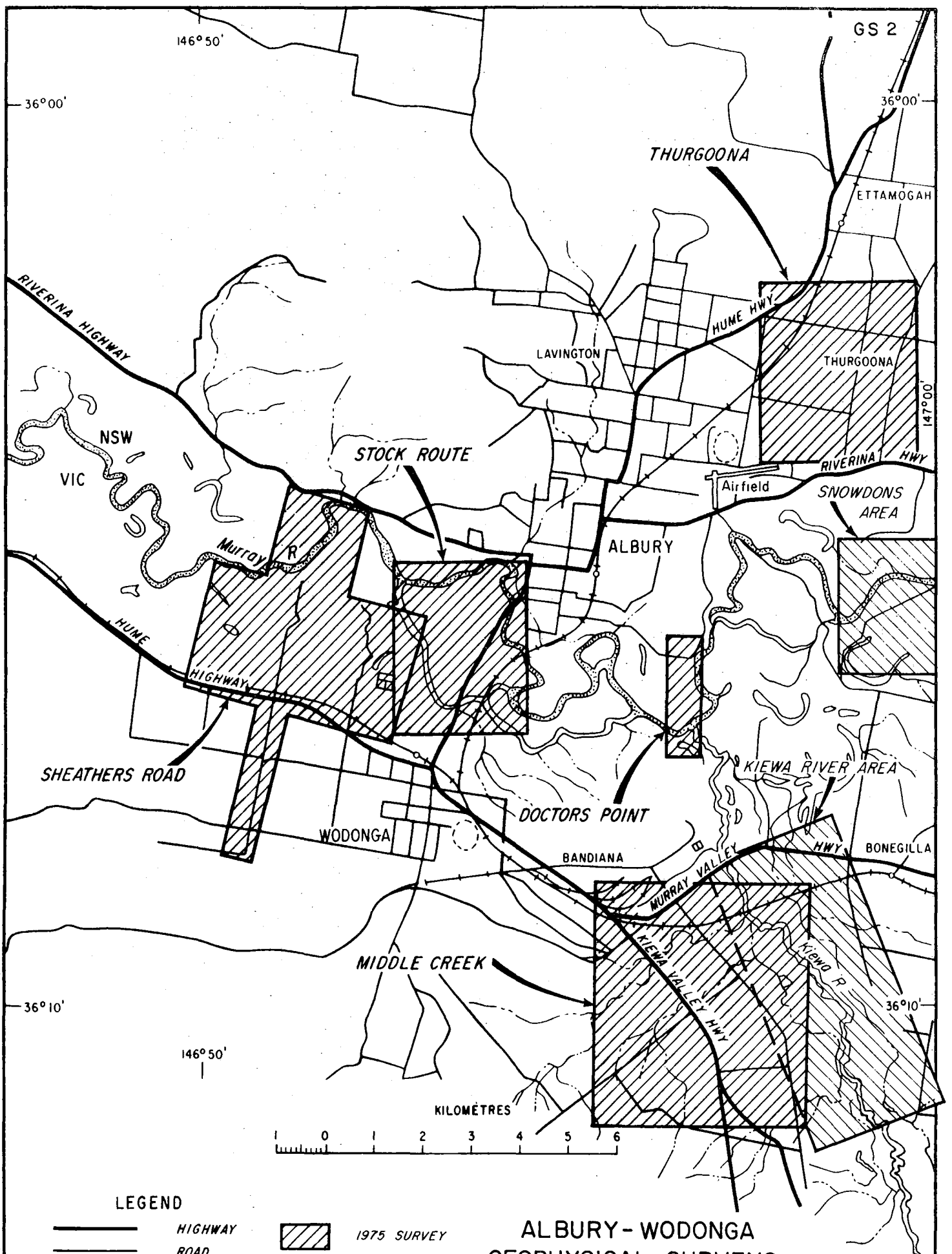
Magneto-tellurics (D.W. Kerr (ADP Group), R.F. Moore)

A joint magneto-telluric (MT) survey was conducted in the northeast part of the Officer Basin in South Australia. The co-operating authorities were the South Australian Geological Survey, Macquarie University, and BMR. MT recordings were made at 12 sites and DC resistivity data was collected at 8 of these sites. DC resistivity data was acquired to aid in the interpretation of the MT data in the uppermost part of the section. The party was in the field for 6 weeks.

The aim of the survey was to verify the existence of an overthrust associated with the Musgrave Block overlying the sediments of the Officer Basin. The existence of an overthrust appears justified from gravity and magnetic data but extensive seismic work has not been able to show whether sediments exist below the southern limits of the Musgrave Block.

To date, the data from all 12 MT sites have been processed to yield rotated impedance tensor and tipping vector data. One-dimensional interpretation has commenced and two-dimensional modelling and interpretation will be undertaken soon. The DC resistivity data will be interpreted by the S.A. Geological Survey staff. Although the interpretation is incomplete, 3 qualitative conclusions can be drawn from the processed data and preliminary one-dimensional inversions, namely:-

i) the top of the overthrust and its lateral extent is easily recognisable.



ALBURY - WODONGA GEOPHYSICAL SURVEYS, 1975 - 1976 LOCALITY MAP

Record No. 1976/91

J55/B5-132-1A

ii) sediments below the overthrust are apparent at some sites, and

iii) the basement below the basin sediments can be mapped.

Magneto-telluric program development has also continued throughout the year. Full MT processing was carried out in the Officer Basin and one-dimensional interpretation will be carried out in the field on future surveys. The MT data presentation programs have been completed and automatic data presentation is now possible in the field. A program for electromagnetic modelling (EMCAL) has been implemented for use on the Cyber 76 and should prove extremely useful to other groups (in particular, Metalliferous Geophysics) as well as magneto-tellurics.

Two Records have been completed and three were commenced during the year. One-dimensional interpretation for the 1975 Wentworth Trough survey has been completed. A preliminary pseudo-section indicates a shallow basement, in good agreement with seismic refraction data. The high-amplitude gravity lows remain unexplained although gross structural features in the lower crust appear to be the likely cause. Two-dimensional interpretation needs to be carried out before these views can be verified.

Geophysical Drawing Office (M. Nancarrow, R. Inglis)

The year saw some major staff changes in the Geophysical Drafting Office. The Chief Draftsman P. Gillespie, who had been on extended sick leave from September 1975, was placed on the unattached list in Februaryl The sudden death of the Acting Chief Draftsman B. Hamilton on 10 February was a sad loss to the group. M. Nancarrow and R. Inglis were confirmed in the positions of Chief Draftsman and Assistant Chief Draftsman respectively on 11 June.

The major event of the year was the IGC for which 68 slides, 57 captions and signs, and 38 publication plates were prepared. Coinciding with this the Magnetic Map of Australia at 1:2 500 000 and the Gravity Map of Australia at 1:5 000 000 were published and were available at IGC as well as a preliminary issue of the Gravity Map of Melanesia at 1:5 000 000 in dyeline form.

Supervising Draftsman G. Lamberts of the Automated Cartographic group spent 3 months on transfer to the ADP group then six weeks in the Marine Geophysics area and gained useful programming experience. During his absence D. Souter assumed responsibility and R. Watson, Draftsman Grade 2, was transferred permanently to the group on 16 June.

A draftsman worked in the field with the Albury-Wondonga engineering survey, and draftsmen accompanied the field parties on the Arunta and the Yilgarn airborne surveys. Draftsmen visited the contractor on five occasions to certify coverage and plotting accuracy of the Officer Basin Airborne survey.

For the first six months of the year four Trainee Draftsmen were under instruction in the office.

The Chief Draftsman became a member of the new BMR Centre Planning Committee during July and was seconded to work on a specific project for the committee for three weeks during September. He continued on part-time work for the committee for the remainder of the year.

Following the promotions which took place from June onwards, there remained four Draftsman Grade 1 positions vacant (in addition to two Draftsman Grade 1 positions withdrawn to the Departmental vacancy pool), plus two other vacancies, one of Technical Officer Grade 1, and one of Drafting Assistant Grade 1.

Ground Surveys Group (L. Bonazzi, K. Barrett, W. Pearson, G. Clarke, M. Schunke, K. Somerville, B. Holden, J. Rayner-Sharpe, A. Millynn, J. Janiuk, R. Jokinen).

The group is responsible for the drafting requirements of the five geophysical groups listed below. In addition work was done for the Gravity, Marine, Magneto-tellurics, Rock Measurements, and Petroleum Technology Groups, the BMR library, Operations Branch, Mineral Resources Branch, and Central Office. It provided a plan-printing service for the whole of BMR and carried out routine clerical duties, stores procurement, and plan registration and filing for the whole Geophysical Drafting Office. A Draftsman Grade 2 conducted a training program for Trainee Draftsmen throughout the office. Work was completed during the year for:

Engineering Geophysics Group. One hundred and twenty-nine plates were finalised for surveys carried out at Gungahlin Urban Development (16), West Murrumbidgee (22), Madang PNG (7), Lae PNG (4), Googong (4), Nebo Coalfield (10), Wanniassa (2), Tuggeranong (1), Canaway Ridge (9), Ramu PNG (1), Duntroon Mil. College (4), Wewak PNG (2), Markham Valley PNG (2), Albury - Wodonga (26), Cape York Peninsula BMR Journal (5), Workshop Vibration (6), Christmas Island (2), Slides (26), Miscellaneous Plates (6). Amendments and additions were made to 292 plates.

Metalliferous Sub-section. One hundred plates were drawn for surveys at Alligator River (21), Rum Jungle (23), Woodlawn BMR Journal (10), Woodlawn Symposium (19 slides), Woodlawn (1), Mary River (17), Elura-Cobar (2), Scale Model Studies (6), Miscellaneous (1), and amendments and additions were made to 23 plates.

Observatories Sub-section. A total of one hundred plates were drawn for Mawson Annual Report 1974 (4), Mundaring Annual Report 1974 (6), Earthquake Data File (7), Port Moresby Annual Report 1974 (2), Mawson Magnetic Variation (1), Earthquake Risk of Australia (3), Secular Variation (1), Earthquake Risk of Australia BMR Journal (5), Two Dimensional Interpretation (3), Earthquake Plate (1), Catalogue of Earthquake Mechanisms (1), Earthquake Hazard (14), Macquarie I. Annual Report 1975 (11), Mundaring Annual Report 1975 (8), Mawson Annual Report 1975 (3), First Order Magnetic Stations (6), Earthquake Risk and Damages (5), Miscellaneous Plates (19).

Amendments and additions were made to 148 plates and 15 slides of Earthquake Hazards were prepared.

Regional Structural Group. One hundred and one plates were drawn comprising Bismarck Sea (11), East Papua (45), Seismicity in NG/ Solomon I. (8), Taylor Memorial Volume (16), Stress Measurements (14), Quarry Blast (2), Geothermal Resources (6), Pilbara (1), Amendments and additions were made to 68 plates, and 16 lecture slides were prepared.

Seismic Surveys. A total of 22 plates were completed for Pre-Eromanga Basin (1), Amadeus Basin BMR Journal (6), Galilee Basin (5), Miscellaneous (10). Amendments and additions were made on 198 plates and 1 lecture slide was prepared.

Miscellaneous. Thirty-six electricity graphs were drawn for Central Office and 97 labels prepared on the Varityper for the Museum. For the IGC, 73 slides were made and 34 plates drawn; 350 name tags were prepared on the Varityper and 29 captions completed. Four plates were drawn of Magneto Telluric results, and for the Marine group 2 plates were drawn and 12 slides completed of the Continental Margins results. For BMR, 105 miscellaneous plates were drawn plus 11 slides. Amendments and additions were made to 80 drawings. Plan printing 80,836 paper prints and transparencies were made.

Airborne Surveys Group. (W. Gerula, A. Rudka, A. Parvey, T. Kimber, I. O'Donnell, P. Kersulis, F. Simonis, M. Steele, P. Corbett, M. Preiser). The work consists of pre-survey compilation, flight-path recovery and digitisation, preparation of data for preliminary release, and quality control of contract survey data. The group also prepares the plates and illustrations for airborne Reports and Records, and lecture and display material.

Pre-survey compilation. The following eleven 1:250 000 map areas of parts thereof were completed: Ulladulla, Bega, (NSW 1976); Mt Peake, Napperby, Hermannsburg (part), Alice Springs (part), Lake Mackay, Mt. Doreen, (NT 1976); Hyden, Dumbleyung, Newdegate, (WA 1976).

Flight-path recovery. The following nine 1:250 000 map areas or parts thereof were completed: Ulladulla (NSW 1976); Bairnsdale (Vic 1975); Duchess (Qld 1975); Mt. Peake, Napperby, Hermannsburg (part), Alice Springs (part), Lake Mackay (NT 1976); Maclean (part) Evans Head detailed survey (NSW 1975).

Preliminary releases. The following twenty-four 1:250 000 map areas (a total of 131 maps) were completed; Broken Hill, Wagga Wagga, (NSW); St. Arnaud, Ballarat, (Vic); Lincoln Maitland, Port Augusta, Whyalla, (SA); Minigwal, Rason,Cudeelee, Plumridge, Robert, Throssell, (WA); Darwin, Pine Creek, Cape Scott, Fog Bay, Fergusson River, (NT); Holroyd, Ebagoola, Rutland Plains, Hann River, Cooktown, (Qld).

Record publication. The following 5 Records were published: 1974/164, 1975/155, 1976/2, 1976/50 and 1976/60 involving a total of 55 plates, 19 of which were drawn in 1976.

TMI contours 1:1 000 000 series. The following 10 maps were completed: Broome-Brunswick Bay, Oakover River, Wiluna, Halls Creek, Lake Mackay, Newcastle Waters, Cloncurry, Cooper Creek, Townsville, Clermont.

Magnetic Map of Australia. A total of 21 base maps, masks and overlays were prepared.

IGC. Eighteen captions and diagrams were completed.

Miscellaneous. Forty-one maps, forms and diagrams were completed.

Amendments and additions were made to 93 drawings and display material was prepared for the BMR Symposium.

Gravity Surveys Group. (R. Sandford, L. Kerec, N. Price, L. Hollands, A. Jaensch, J. Maxwell). The group continued to handle most of the marine work as well as the gravity work.

Gravity surveys. Fifty-eight 1:250 000 Bouguer anomaly maps of the 1973-74 helicopter gravity survey of south-eastern Australia were completed by a drafting contractor. Final drafting of fifty-seven 1:250 000 Bouguer anomaly maps of the 1967 helicopter gravity survey of NT/WA was commenced. A coloured gravity map of Australia at 1:500 000 was prepared and printing completed for release at the IGC.

Coloured gravity and free-air anomaly maps at 1:25 000 000 were prepared and printed for inclusion in the December 1976 BMR Journal; 89 illustrations were drawn for inclusion in various publications.

Marine surveys. One hundred and fifty-six illustrations were prepared for inclusion in BMR Records, Reports, Bulletins, and the BMR Journal on the continental margins geophysical surveys.

Miscellaneous. For IGC 35 colour slides were pepared for marine/gravity group personnel who gave papers at the Congress. Thirty-six slides/overhead projector transparencies were produced for the BMR/APEA lectures on Exmouth Plateau by Willcox and Exon.

A preliminary 1:5 000 000 gravity map of Melanesia (B/W) was completed. A preliminary 1:2 500 000 free-air anomaly map of Australia is in progress.

Cartographic Group. (I. Cravino, P. Moffat, K. Dimakis). The group prepares fair drawings for lithographic reproduction. Thirteen 1:250 000 aeromagnetic maps were litho-printed; Bendigo, Wangaratta, Tallangatta (Victoria); Cape Melville, Ebagoola, Holroyd, Cooktown, Hann River, Rutland Plains (Queensland); Perth, Pinjarra, Kellerberrin, Corrigin (Western Australia).

The six 1:250 000 base maps completed were Cape Melville, Ebagoola, Holroyd, Cooktown, Hann River, Rutland Plains (Queensland). Another 20 are in progress including six at 1:500 000 scale of the Broken Hill detailed survey area.

Four colour plates for National Mapping Thematic Mapping Bulletin were prepared. Three-colour plates were prepared for the Cartographic Conference.

Scribing of contours for the gravity map of Australia 1:5 000 000, and free-air and Bouguer anomaly maps of Australia 1:25 000 000 were finalised.

Automated Cartography Group (G. Lamberts, D. Souter, R. Watson). The group completed the following work:

Flat-bed plotter Airborne: Radiometric contours (2), TMI contours (39), minamax (34), Werner plots (1), flight-path (10), 3-D (1), stacked profiles (3), levelling (4). Seismic: shot points (9), stations (1), well locations (3). Drafting Office: coastline (4), graticules (22), screens (2), contours (1), curves (4). Regional Gravity: contours (4), stations (9), coastline (2). Metalliferous: contours (1), Regional Structural: contours (3), stations (4). Marine: contours (11), stations (7), graphs (3), track maps (27), coastline (3), current vectors (4), stacked profiles (5). PEB: graticules (2).

Drum plotter Airborne: contours TMI (91), Radiometric (4), minamax (35), frequency distribution (2), levelling plots (30), 3-D (20), Werner plots (21), flight-lines (75), stacked profiles (219), multichannel (1648), depth estimates (1). Gravity:

contours (118), stations (10), grids (8). Marine: track maps (64), coastline (3), water depth (2), contours (38), magnetic models (7), graticules (2), well locations (7), profiles (101), seismaps (10), stacked profiles (9), magnetic sections (3), magnetic intensity (10), isopach (1), current vectors (6). Seismic: stations (33), well locations (2). Metalliferous: contours (4), profiles (50). Regional Structural: stations (64), contours (36). Geochemistry: stations (3). Drafting Office: coastline (4), graticules (4), stations (1), contours (1). Regional Gravity: contours (268), stations (106), graticules (5). Geological Drafting Office: graticule (1). ADP: flowcharts (20). PEB: stations (2). CSIRO: maps (3).

Flat-bed plotter: Machine tests 101 hours, program tests 22 hours, lost time 17 hours, down time 334 hours.

Drum plotter: Machine tests 32 hours, program tests 71 hours, lost time 13 hours, system down 93 hours.

Map Editor (A. Crowder) In editing all maps and drawings produced in the Geophysical drafting office, the map editor assumes responsibility for their accuracy and adherence to prescribed standards.

During the year, 855 drawings were edited and 48 slides were checked.

Map and Photo Library (D. Park, I. Perkovic) The group has been responsible for the acquisition and issue of aerial photographs for Geophysical Branch surveys, and has acquired and issues topographic maps for the whole of BMR.

In October the Geological Branch air-photo library was incorporated into the Geophysical photo library and the group will in future handle all air-photo requests for both branches.

In addition to handling the automatic distribution of airphotos from the Division of National Mapping, 9298 photos were purchased, indexed, and boxed in readiness for programmed surveys. A total of 3636 standard-scale topographic maps were acquired and issued as well as map compilations and special maps as requested.

5. REPORTS, MAPS, LECTURES, COURSES, OVERSEAS VISITS, BMR PUBLICATIONS

Bulletins, Reports issued in 1976

Bulletin 164	Ed. D. Denham	Seismicity and Earthquake Risk in Eastern Australia. A Symposium held in Canberra on 5 December, 1973.
Report 175	F.J. Moss & P.L. Harrison	Galilee Basin seismic and gravity survey, Qld 1971.
Report 179/PNG 9	J.C. Mutter	Marine geophysical survey of Bismarck Sea and Gulf of Papua, 1970.
Report 182	J. Rees & R. Taylor	Tottenham detailed aeromagnetic survey, NSW.
Report 183	J.C. Branson, F.J. Moss, & F.J. Taylor	Deep crustal seismic reflection test survey, Mildura, Vic, and Broken Hill, N.S.W.

Bulletins and Reports in preparation or in press

Bulletin 167c	MOND, A., & HARRISON, P.L.	Notes on the geology of the northwestern part of the Eromanga Basin, N.T. & Qld.
Bulletin 191	MATHUR, S.P., MOSS, F.J., & BRANSON, J.C.	Seismic and gravity investigations along the Geotraverse, W.A., 1969.
Bulletin	FRASER, A.R., & PETTIFER, G.R.	Gravity surveys of Western Australia and the west of South Australia.
Report 191	HARRISON, P.L. & ZADOROZNYJ, I.	Officer Basin seismic, gravity, magnetic, and radiometric surveys, W.A., 1972.
Report	FRASER, A.R., DARBY, F., & VALE, K.R.	A qualitative analysis of the results of the reconnaissance gravity survey of Australia.
Report	MOSS, F.J., & JONES, P.	Ngalia Basin seismic survey, Northern Territory, 1967-1969.
Bulletin 179	MUTTER, J.C.	The Queensland Plateau

Bulletins and Reports in preparation or in press

Bulletin	EXON, N.F. & WILLCOX, J.B.	The Exmouth Plateau: stratigraphy, structure, and petroleum potential.
Bulletin	SYMONDS, P.A. & CAMERON, P.J.	The Carnarvon Terrace
Bulletin	EXON, N.F. & STAGG, H.M.J.	The Scott Plateau
Report 201	WILLCOX, J.B.	Geophysical results from the Great Australian Bight
Report	RIPPER, I.D.	Earthquake focal mechanisms and tectonics in the PNG/ Solomon Is region.
Report	EVERINGHAM, I.B., GAULL, B.A. & DENT, V.F.	The east Solomon Sea earthquake of 20 July 1975.
Report	GAULL, B.A.	The attenuation of seismic energy in PNG.
Report	HILL, P.J.	Geomagnetic measurements in the Mawson regions, Antarctica 1954-1976.

Contributions to BMR Journal (1976)

ANFILOFF, W., BARLOW, B.C., MURRAY, A.S., DENHAM, D., & SANDFORD, R. - Compilation and production of the 1976 gravity map of Australia, BMR J., 1(4).

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1975/101	HOGAN, A.P. & JACOBSON, E.P.	Geophysical results from the north-west continental margin of Australia.
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1975/105	WHITWORTH, R. BROWN, F.W. & GRACE, J.K.	Preview report on marine geophysical survey No. 24 (magnetic), northwest continental shelf, 1975 (Division of National Mapping, contract No. 5).
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1975/122	DOLAN, B.H.	Westernport seismic profiling system Vic 1973.
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1976/17	CAMERON, P.J.	Mawson Geophysical Observatory annual report 1974.
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1976/47	OGILVY, R.D.	Geophysical test survey, Elura Prospect, Cobar, NSW, 1974.
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1976/36	JONGSMA, D.	A review of the geology and geophysics of Macquarie Island and the Macquarie Ridge Complex.
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1976/41	JONGSMA, D.	A review of the geology and geophysics of the Marion Plateau.
1976/58	PINCHIN, J.	Velocity analysis of two seismic sections across the Queensland Trough.
1976/59	WILLCOX, J.B.	Structure of the Bismarck Sea.
1976/65	TILBURY, L.A. & WHITWORTH, R.	A guide to the production of shot-point location maps using a digitizing table and computer.
1976/72	DOUTCH, H.F. NICHOLAS, E. BRANSON, J., PLUMB, K.A.	Contribution to the 1976 ICG Symposium 103.3. The structure of Australia and variations in tectonic style.
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COLLINS, C.D.N.	Seismic investigations of crustal structure in southeast Australia, March-May 1976: Operational Report.
DRUMMOND, B.J.	Preview report for the Pilbara crustal survey, 1977.
HILL, P.J.	Mawson geophysical observatory annual report 1975.
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McMULLAN, M.W., & ZEITLHOFER, A.	Installation of a seismograph at Cooney (Armidale) NSW.
ROBERTSON, M.J.	Third-order regional magnetic surveys in S.A., W.A. and Tas, 1971-1973.
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ANFILOFF, W. - Gravity map of Australia. International Geological Congress, Sydney, Aug. 1976.

BARLOW, B.C. - Cavity and topographic effects on hill and terrain measurements. Fourth Series of Research Seminars in Geodesy, the Univ. of NSW, Sydney November 1975.

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MAJOR, J.A. - Gravity investigation of the geometry of the granitic complexes at Rum Jungle, NT. BMR Symposium, Canberra, April 1976.

POLAK, E.J. & BENNETT, D.G. - Control of vibration due to blasting. Paper presented by Dr Polak at a Vibration & Noise Control Engineering Conference & Workshop, Sydney 11-12 Oct. '76 organised by The Institution of Engineers, Australia.

ROBSON, D.F. - Geophysical response of heavy mineral sand deposits at Jerusalem Creek, NSW. 25th IGC/ 3rd IGOGEO, Sydney, August 1976.

SAMPATH, N. - Geophysical surveys of heavy mineral sand deposits, Jerusalem Creek, NSW. BMR Symposium, Canberra, April 1976.

SPIES, B.R. - Absolute electromagnetic scale modelling and its use in the interpretation of TEM response. 25th IGC/3rd ICOGEO, Sydney, August 1976.

STUART, D.C. - Test surveys with the transient electromagnetic, magnetic induced polarization and down hole electromagnetic methods at Woodlawn, NSW. 25th IGC/3rd ICOGEO, Sydney, August 1976.

TAYLOR, F.S. - Shallow seismic techniques in coal exploration. Address given to ASEG meeting, Macquarie University, August 1976.

WILLCOX, J.B. - The stratigraphy and structural evolution of the Great Australian Bight Basin. BMR Symposium.

WILLCOX, J.B. - The regional geology of the Exmouth Plateau.

Overseas Visits & Conferences

Cameron, P.J.	Singapore; at the end of a cruise by the Woods Hole Geological Observatory vessel Atlantis II in waters to Australia's north. October-November 1976.
Mutter, J.C.	U.S.A. Visit to Lamont-Doherty Geological Observatory, New York, to interpret data from Cruise 33 of the R/V Vema. April-November 1976 (includes about 4(?) months recreation leave taken so that projects could be completed.
Stuart, D.C.	Denmark. IAEA consultants meeting on radiometric methods in uranium exploration, Riso Research Establishment, Roskilde, September 1976.

Local conferences

INGLIS, R.	Hobart, Conference of Chief Draftsmen of the State Mines Departments and BMR. 22-26 March.
NANCARROW, M. INGLIS, R.	Adelaide, Cartographic Conference 1976. 2nd Conference of the Australian Institute of Cartographers. 30 Sept - 1 Oct.
STUART, D.C.	Geology and Mineralisation of the Lachlan Fold Belt. SGIOD Conference of the Geological Society of Australia. Sydney, December 1975.
STUART, D.C.	Broken Hill Geological Research Conference organised by the Broken Hill Mining Managers Association. Broken Hill, May 1976.
ANFILOFF, W. BRANSON, J. DENHAM, D. DOOLEY, J.C. EXON, N.F. FINLAYSON, D.M. ROBSON, D. SPIES, B. STUART, D. TURPIE, A.	International Geological Congress Sydney, NSW Aug. 1976.

Training courses

External

BRASSIL, F.	Explosives appreciation course for supervisors, P.M.G., Sydney, March, 1976.
CHERRY, R.	Shotfirer's certificate refresher course, PMG, Sydney, July, 1976.
DEVENISH, B.) COBCROFT, F.)	Microprocessor seminar (Inst. of Engineers) November 1976.
PETTIFER, G.R.	Geophysical techniques in borehole applications (AMF) February 1976.
PRESTON-STANLEY, M.	PMG shotfiring course, April, 1976.
STAGG, H.M.J.	Geophysical prospecting for petroleum (AMF) June, 1976.
TAYLOR, F.J.	Input-Outputs DHR engineering digital seismic system, July, 1976.
WILSON, D.R.	Geophysical techniques in bore hole applications (AMF) February 1976.

Internal

BAUER, J.A.	ADP appreciation - March 1976
BAUER, J.A.	Report writing - March 1976
BRASSIL, F. & TILBURY, L.	Hewlett Packard computer - February 1976
BARRETT, K.	Man management (seminar) - June 1976
BENNETT, D.G.,) HORSFALL, C.L.,) RAMSAY, D.C.)	Rock slope stability (BMR in-house course) April, 1976
COLLINS, C.D.N.	Report writing - October 1976
CORBETT, P.	Introduction to ADP - April 1976
CRAVINO, I.	Man management (seminar) - June 1976
CAMERON, P.J.	Man management course - July 1976
DOOLEY, J.C.	Selection interviewing - March 1976

FINLAYSON, D.M.	Man management - July 1976
GERULA, W.	Selection techniques - April 1976
GIDDINGS, J.W.	Presentation of scientific papers - March 1976
HOGAN, A.P.,) TILBURY, L.A.,) HSU, D.,) JOHNSTON, C.R.)	Hewlett-Packard training course (BMR) February 1976
JAENSCH, A.	Introduction to ADP - April 1976
JENNINGS, G.S.,) SPENCE, A.G.,) IDNURM, M.)	Introduction to ADP - April and September 1976
KIMBER, T.	Man management (seminar) - June 1976
KUTA, J.	Introduction to ADP - September 1976
MURRAY, A.S.	Man management - July 1976
McINTYRE, J.	Introduction to ADP - November 1975
McEWIN, A.J.	Letter writing - September 1976
McGREGOR, R.M.	ADP Appreciation for Management - Dec. 1975
McMULLAN, M.W.	Man management - September 1976
MAJOR, J.A.	Man management - May 1976
OGILVY, R.D.	Man management - June 1976
PETTIFER, G.R.	Selection techniques
PARVEY, A.	Man management (seminar) - May 1976 On-the-job training - October 1976
PINCHIN, J.,) ABBS, G.L.,) BRASSIL, F.,) JENNINGS, G.D.,) SCHMIDT, D.L.,) TRENCHUK, W.,) TAYLOR, F.J., &) ZEITHLHOFER, L.)	DFSIV seismic training course, May 1976
RAMSAY, D.C.,) HORSFALL, C.,) BENNETT, D.G.)	Man management - 1976

ROBSON, D.F.	Report writing - April 1976
SMALL, G.R.	Hewlett-Packard Assemble - February 1976
SMILEK, E.	Introduction to ADP - September 1976
SCHUNKE, M.	Letter writing - September 1976
STEELE, M.	Introduction to ADP - April 1976
TAYLOR, F.J., RAMSAY, D.G., DEVENISH, B.	On-the-job training techniques - October 1976
TAYLOR, F.J., DEVENISH, B., MOORE, R.F.	H.P. Assembler course (BMR-in house course)
WILLIAMS, J.W.	Introduction to ADP - September 1976
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Maps printed and released

Aeromagnetic maps printed (1:½M scale)

Wangaratta	Vic
Bendigo	Vic
Tallangatta	Vic
Corrigin	WA
Perth	WA
Pinjarra	WA
Kellerberrin	WA
Bencubbin	WA
Moora	WA
Ningham	WA
Perenjori	WA

Magnetic Map of Australia 1:5M

Gravity Maps (new editions) printed (1:500 000 scale)

Wooramel	WA
Ajana	WA
Shark Bay	WA
Edel	WA
Yaringa	WA
Kennedy Range	WA

Gravity Map of Australia 1:5M

Preliminary airborne map releases 1976

Project	Map Names	No of Maps	Scale	Contours	Profiles	Fig. No.
Broken Hill	Broken Hill (Regional)	1	250 000	Magnetic		
	"	1	250 000	Gamma Ray		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Broken Hill (Detail)	10	25 000	Magnetic		
	"	1	100 000	Magnetic		
	"	1	100 000	Gamma Ray		
	"	1	100 000		Magnetic	
	"	7	100 000		Gamma Ray	
Carpentaria	Ebagoola	6	250 000		Gamma Ray	
	Holroyd	6	250 000		Gamma Ray	
	Cooktown	6	250 000		Gamma Ray	
	Hann River	6	250 000		Gamma Ray	
	Rutland Plains	6	250 000		Gamma Ray	
Lachlan Geosyncline	Ballarat	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	St Arnaud	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Wagga Wagga	6	250 000		Gamma Ray	
Gawler	Port Augusta	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Whyalla	1	250 000		Magnetic	
		6	250 000		Gamma Ray	
	Lincoln	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Maitland	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	

Preliminary airborne map releases 1976 (continued)

Project	Map Names	No of Maps	Scale	Contours	Profiles	Fig. No.
Pine Creek Block	Darwin	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Fog Bay	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Pine Creek	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Cape Scott	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
	Fergusson River	1	250 000	Magnetic		
	"	1	250 000		Magnetic	
	"	6	250 000		Gamma Ray	
Officer Basin	Robert	1	250 000	Magnetic		
	"	2	250 000		Magnetic	
	Throssel	1	250 000	Magnetic		
	"	2	250 000		Magnetic	
	Cundeelee	1	250 000	Magnetic		
	Plumridge	1	250 000	Magnetic		
		156				