REPORT 238

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GEOPHYSICAL BRANCH
SUMMARY OF ACTIVITIES
1981

Acting Assistant Director Geophysical Branch

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SUMMARY

METALLIFEROUS AND AIRBORNE SECTION (G.A. Young)

It was expected that during 1981 staff losses from the Section to the mineral exploration industry would continue consistent with the trend established over recent years. It was hoped however, that with increased emphasis to be placed on research-oriented work within BMR, a tapering off in this process would result at a time when a new staff recruitment program was initiated. This has not occurred to date; in fact the problem became more acute during 1981 with an increase in the rate of staff losses including some of the most experienced officers from the Section.

A small field program was planned for the Metalliferous Subsection this year with the main work emphasis being given to clearing reporting backlogs and preparing for new research programs which involve principally mineral province studies. The loss of key personnel meant that the main field project involving ground geophysics in the Davenport Range, NT, had to be deferred until 1982. This action was necessary to enable airborne surveys to proceed in this region as part of the multidisciplinary research project involving both BMR and the Northern Territory Geological Survey.

As mentioned in the Summary of Activities for 1980, funds have been provided to accelerate BMR's program of airborne geophysical mapping to assist research into the geology of Australia and its mineral deposits. The BMR Aero Commander aircraft VH-BMR returned to survey in April for a 5-month field season as scheduled. This aircraft was taken out of service in September to enable an improved gamma-ray spectrometer system and a doppler navigation unit to be installed to increase the efficiency of the aircraft for 1982 onwards. It is expected that this aircraft and the BMR Twin Otter VH-BMG will be operated in 1982 to the same extent as they were in 1981, namely 80 percent of their optimum annual capability. Staff numbers impose this limitation on field operations and some delays are expected to result in data processing and interpretation over the next 2 years.

A most significant change occurred in BMR's operation of survey aircraft in 1981 as a result of TAA withdrawing from crewing and maintenance of some Australian Government-owned aircraft including VH-BMG and VH-BMR. Operational agreements between the Commonwealth of Australia and the Australian National Airlines Commission in relation to aerial magnetic and radiometric surveys have served BMR well for 27 years. Future operations will be serviced by contracts let to the general aviation industry.

Figure MA 1 shows the location of the field activities of the Section during 1981. The major part of such activities was the enlarged airborne survey program which adheres to that foreshadowed in the Summary of Activities for 1980. Figure MA 1 also indicates map sheets for which data were released this year.

Staff from the Metalliferous Subsection attended to data analysis and reporting in two basic program areas during 1981 with limited support fieldwork.

1. Regional geophysical studies of the Lachlan Fold Belt, Mount Isa Block and Davenport Geosyncline.
2. Methodological research in metalliferous geophysics.

Work on the Lachlan Fold Belt project was complicated by the resignation of B. Wyatt midway through the year in which interpretation and reporting were to be concluded. R. Almond and I. Hone were transferred from other assignments to this project for parts of the remainder of the year in an attempt to complete work on schedule. Rock property and geological information on the samples and their sites, collected throughout the belt in NSW, now exist in a computer data base. Geochemical analyses of 400 granitoid and acid volcanic rocks were completed by the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) (West German Federal Institute for Geosciences and National Resources), the results being included in the data base. A comprehensive review of the stratigraphic and spatial characteristics of rock units throughout the Fold Belt has been made and the associated geophysical characteristics of these units have been established by reference to the rock property data base and analysis of regional geophysics data. This information forms the basis for the interpretation of the airborne magnetic and radiometric, and gravity transects made across the Fold Belt in previous years, this task constituting the final phase planned for the project.

Studies of the radiometric characteristics of granitoids of the Fold Belt in NSW were completed with a very limited program of aeroradiometric work over 13 plutons to determine the relationship between ground and airborne measurements. Results obtained indicate good agreement between both sets of data and demonstrate the ability of airborne survey to resolve the multiple phase nature of composite bodies. The interest generated by the results of this project in NSW with respect to tin-tungsten exploration encouraged the Department of Mines, Tasmania to request a similar study to be made over granitoids in northeast and northwest Tasmania. Results from this study, carried out in February by staff from BMR and the Department of Mines, have been released, and again indicate the value of gamma-ray spectrometry to highlight granitoids and, in Tasmania, greisens that host tin-tungsten mineralisation.

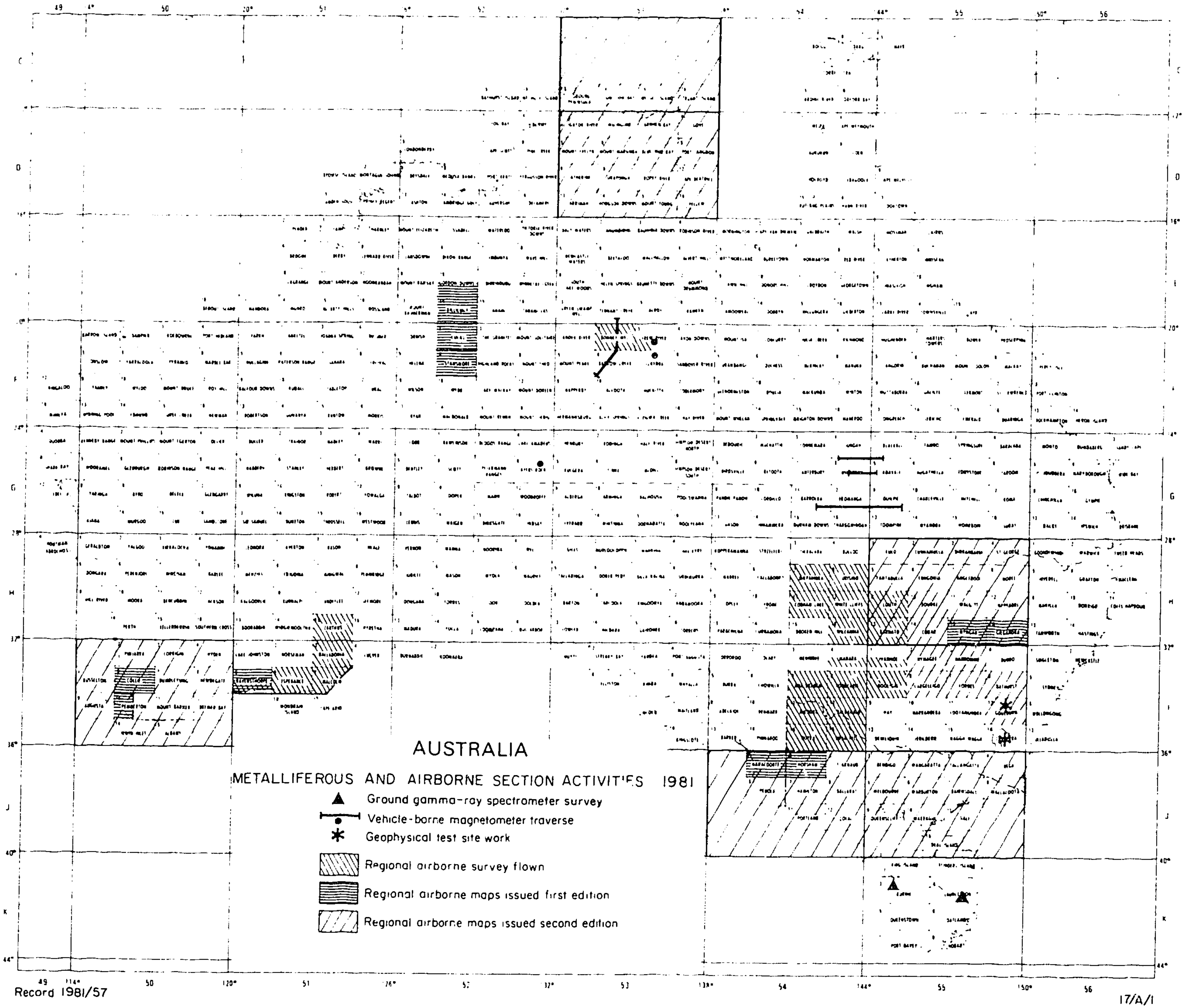

Fig. MA1. Metalliferous and Airborne section activities 1981

The regional overview of geophysics of the Mount Isa Block which commenced in August 1980 was completed in the second half of this year and the results were presented at a joint BMR/AusIMM symposium on geology of the Mount Isa region in September. The area studied was bounded by 17°S to 25°S and 138°E to 14 °E, with most detailed interpretation applied to CLONCURRY* and DUCHESS. The study has shown that Early Proterozoic rocks of the inlier and extensions under later cover, can be divided into major geological domains. The magnetic data indicate a central non-magnetic domain which broadly corresponds to acidic basement rocks, and eastern and western magnetic sequences. The gravity data indicate the distribution of granites, metasediments, and suites of basic intrusives, and best define the limits of the inlier.

A multidisciplinary project involving BMR and the Northern Territory Geological Survey (NTGS) commenced this year to carry out research into the geology of the Davenport Range province and its mineral resources. Extensive fieldwork was programmed for 1981; however, as mentioned above, the main ground geophysics component has been deferred until the second year of the project. A preliminary review was made of available regional geophysics data. Airborne surveys were flown over BARROW CREEK and BONNEY WELL where earlier coverage was both sparse and of poor quality. BARROW CREEK was flown in detail by contract for NTGS. A key area for BMR research is the Hatches 1:100 000 Sheet area. Accordingly a detailed magnetic and gamma-ray spectrometer survey was flown in 1981. It is planned to complete the geophysical component of this project by the end of 1982 with processing and interpretation of the airborne data supplemented by ground surveys as required.

Minor regional studies included the completion of the assessment of surface and down-hole gamma-ray spectrometry, and surface radon surveys as applied to mapping in the Rum Jungle area; the positioning of drill hole targets in the southwest Amadeus Basin to determine the source of shallow seated magnetic anomalies and thereby extend the geological understanding of this region; and the investigation of possible associations between surface magnetic mineral accumulations and faulting in the Central Eromanga Basin. Carborne magnetic surveys were employed in the latter two projects.

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*Names in capital letters refer to 1:250 000 sheet areas.

There was a slight increase in methodological research undertaken in 1981 as compared with 1980, with projects in general being of short duration. The main activities were: a continuation of down-hole EM investigations; commencement of a research program involving the use of a SQUID magnetometer in electrical methods surveys; application and interpretation of radon surveys for uranium exploration; enhancement of aeroradiometric data as displayed in map form; continued development of a carborne magnetometer system as previously referred to; and the development of a documented program package for the analysis of magnetic and gravity data. The most significant results to emerge from these studies were:

1. Model curves applicable to SIROTEM down-hole surveys which enabled field results from Elura to be matched.
2. Enhanced down-hole EM response obtained from the omni-directional probe as compared with conventional axial-component-only probes more commonly used.
3. The effectiveness of radon surveys in areas where gamma-ray measurements are of little value owing to surface radioelement contamination.
4. An improved application of emanometry involving the ratio of counts measured at early and late times, which provides information on the equilibrium state of radon in soil gas thereby assisting interpretation.

The lack of staff limited work in the Metalliferous Subsection's third basic program - mineral deposit geophysics - to rock property measurements from samples supplied from the Cleveland tin mine, Tasmania, and the documentation of work carried out in 1979 at the Austatom uranium prospect, NT. It is hoped that work in this program will increase in 1982.

BMR's Twin Otter and Aero Commander aircraft were operational for 1350 and 490 hours respectively in 1981 enabling a total of 189 000 line-km to be surveyed.

In accordance with the requirement to accelerate the program of airborne geophysical mapping, the first major project of 1981 commenced in mid-January using the Twin Otter to complete a systematic coverage begun in 1976 over the southern Yilgarn and Albany-Fraser provinces. Interpretation of the results will commence in the second half of 1982 following the release of the last of the maps resulting from the 1981 survey.

The second assignment for the Twin Otter was the survey of BONNEY WELL and Hatches 1:100 000 Sheet areas mentioned above. Work commenced in June, and was completed in late July. Results of this work will become available for public release towards the middle of 1982.

The third and final project of 1981 for the Twin Otter group involved a major survey program over the Darling Basin. Results are expected to become available for public release progressively from the end of 1982. Interpretation of survey results is planned to commence in 1983.

The Aero Commander became operational for survey work in March following recommissioning of the aircraft in January and subsequent equipment refitting. During the period April to August, a major survey program was completed in the Murray Basin. Results should become available to the public in map form progressivley from mid-1982. Interpretation of survey results is expected to commence in the second half of 1982.

As in recent years, most Airborne Subsection personnel contributed to work in the Airborne Reductions Group for long periods. Processing was undertaken on 12 1:250 000 sheet areas, 4 of which were processed to completion. Work was also completed on two special purpose surveys. 101 maps were released resulting from this processing as indicated in Figure MA 1 and Table MA 2. In addition, 6 magnetic contour maps at 1:1 million scale were updated by the Drawing Office, and magnetic contours were reproduced photographically at 1:250 000 scale from 1:100 000 maps for 9 sheets. Areas involved are also shown in Figure MA 1 and Table MA 2.

Requests by outside organisations for the supply of copies of airborne geophysical data or access to inspect original analogue charts continued at a high level in 1981. As at the end of October, data from 164 1:250 000 sheet areas had been sought, requests being almost evenly balanced between accessing recent digital data and older analogue data.

Airborne Subsection personnel were also involved in the development of computer programs to deal with specialised processing and interpretation of airborne geophysical data, and in the analysis of data obtained over sites chosen for the calibration of airborne gamma-ray spectrometer systems.

With the depleted staff from the Subsection having to devote their efforts principally to an enlarged survey program, as compared with the previous year, and the processing of 1980 survey data, data interpretation was restricted to the McArthur Basin project in 1981. As at the end of October, a basic depth-to-basement analysis had been completed. It is expected that the geological interpretation will be completed in early 1982.

The future success of the Section to carry out high quality interpretation of data obtained in such areas as Albany-Fraser, Murray and Darling Basins will depend to a large extent upon the ability of BMR to recruit experienced personnel. Accordingly, 1982 will be a critical year for the Section in determining whether an accelerated airborne geophysics program can be undertaken in the mid-1980s.

SEISMIC, GRAVITY AND MARINE SECTION (A. Turpie)

The Seismic and Gravity Groups continued field surveys on the Central Eromanga Basin project. Staff shortages seriously affected the ability of the groups to complete some programmed activities; however they were actively involved on a number of co-operative projects. These included reporting on the Ngalia Basin and McArthur Basin work with the Geological Branch, the Denison Trough project with the Geological Survey of Queensl GSQ), and surveys, interpretations, and reporting tasks on the Central Eromanga Basin project with other groups in BMR and with GSQ.

New seismic and gravity information obtained on a number of east-west traverses over the eastern margin of the Cooper Basin and the Devonian-Carboniferous Warrabin Trough in 1980 were processed and integrated with previously obtained and new information from surveys conducted by petroleum tenement holders. Detailed information on the eastern extent of the Permo-Triassic sediments of the Cooper Basin, the structure and stratigraphy of the Warrabin Trough, and the nature and structural history of the Canaway Fault system was obtained, and presented at the BMR Symposium (May, 1981) and at a meeting of the Geological Society and submitted for publication. Previous geophysical survey information, and geological information including well data, were reviewed to assist in planning the 1981 surveys. The surveys recorded approximately 450km of 6-fold CDP traverses with associated gravity measurements over the Quilpie Trough and the Thomson Syncline in the Windorah-Jundah area.

Deep crustal reflection data recorded to 20 s over the 1980 seismic traverses were processed using the Consortium for Continental Reflection Profiling (COCORP) facilities at Cornell University, Ithaca, USA, and at Virginia Polytechnic Institute (VPI). Preparations are being made to publish the results of the work carried out at Cornell and VPI. Similar results were obtained on the 1981 seismic traverses and these will be processed and a joint interpretation made with the previously obtained reflection results and the deep crustal refraction information. Work continued on analysing deep crustal reflection data recorded in northeast Australia in 1975-78 and preparing the results for publication.

Reporting was completed on the 1978-79 Denison Trough seismic surveys and the eastern Galilee Basin and Agate Creek Volcanics gravity surveys. A paper was also written on gravity and elevation profiles along a number of traverses across Australia. Work continued on the analysis of data from the 1978-80 gravity surveys in the McArthur Basin, integration of the data with previous data, interpretation, and reporting.

Marine geophysicists were more active in field surveys in 1981. This, coupled with further staff losses and staff engagement in planning and advisory functions, resulted in relatively low levels of data processing and interpretation.

The three surveys during 1981 comprised a co-operative project with BGR in the Coral Sea and further cruises in the Great Barrier Reef and in Antarctic waters.

The Coral Sea cruises aboard the R.V. SONNE followed on from earlier joint work with BGR in 1978 and produced 3000 km of multi-channel seismic and 7000 km of gravity and magnetic data, together with bottom samples and cores. Only preliminary studies of the data have been made, but our knowledge of the nature of the change from continental to oceanic crust around the Coral Sea Basin has been increased significantly. P.A. Symonds has gone to Hannover, West Germany to study further the data at BGR.

The central Great Barrier Reef survey is an ongoing joint project with Marine Geology Section where geophysical data around and between reefs are required to help better determine what geological processes have controlled the evolution of the Great Barrier Reef. Again the geophysical survey was conducted in a co-operative venture with the Division of National Mapping aboard the M.V. FEBRINA. In the area between Dunk Island and Townsville, 3500 km of bathymetric, magnetic, and navigation data were acquired, but this year, in addition, a system comprising 12 kilojoule sparker and single channel cable acquired 1000 km of shallow seismic data. Processing of data has started but is still at an early stage.

About 27 000 km of magnetic and bathymetric data were obtained aboard the M.V. NELLA DAN during the 1980/81 summer relief voyages to Antarctic stations and on the FIBEX biological cruise. Further cruise tracks in 1981/82 and coming seasons will be planned to give a progressive coverage in the Southern Ocean. A seismic capability is being added from 1981/82 onwards. Interpretations will be made progressively as new data are added.

In keeping with the proposed enhanced role for BMR in providing background information and understanding in support of the search for energy minerals, a proposal was made to the Australian Government to carry out a marine geophysical survey in the Bass Strait region with the particular objective of examining the origin and development of the Bass Basin and its relationship to the neighbouring Otway and Gippsland Basins. A total of $2.9 million dollars was allocated for this purpose in the August budget. Review and study of existing information have been made in readiness for and towards best planning for the contract survey in early 1982.

J.C. Branson was involved in advisory duties to CCOP/SOPAC and with preparations for joint US/Australia/New Zealand surveys in the CCOP/SOPAC region.

P.A. Symonds and J.C. Branson took part in an international COGS/AMSTAC-FAP Workshop on 'Australia and Deep Sea Drilling'. They prepared drill site proposals and were involved in the editing of the resulting publication.

P.A. Symonds has worked intermittently on a project to determine the extent, age, structure, and tectonic significance of rift grabens within the Australian continental margin. The project is associated with the Circum-Pacific Map project.

Considerable work was done on completing development of data acquisition systems, both seismic and non-seismic, and on preparation of other equipment in readiness for the Great Barrier Reef and Antarctic surveys. Work also continued on development of data processing systems and, in particular, on the in-house seismic processing capability, although at a diminished rate because of reduced staffing.

Engineering geophysics work continued at a low level. A short resistivity and magnetic survey was undertaken on Norfolk Island in association with the Engineering Geology Section aimed at defining water bore targets. One successful water bore has already resulted. Well logging was carried out for Geological Branch's oil shale methodology project.

GEOMAGNETISM, SEISMOLOGY AND REGIONAL GEOPHYSICS SECTION (D. Denham)

The overall staffing levels in the Section were essentially unchanged during 1981. However, the lack of specialist skills and technical support in key areas resulted in serious curtailments of some programs. In the Palaeomagnetic and Rock Measurement Group some projects had to be shelved when the last technical officer left, and in the geothermal discipline the absence of either a full-time technical or professional officer resulted in little progress being made during 1981.

The effects of the Review of Commonwealth Functions and the buoyant exploration industry made recruitment very difficult. Consequently, it was not possible to send a replacement geophysicist to operate the Macquarie Island Observatory at the normal change-over time.

A review of BMR activities in the fields of earthquake seismology and geomagnetism was completed during 1981 (Record 1981/15) but it was not possible to implement all the recommendations because of funding and staffing shortages.

Two of the main recommendations were: (1) 'that a national seismograph network should be developed to provide the capability for (a) locating continent-wide, all Australian earthquakes with magnitudes greater than 4.0 on the Richter Scale; (b) locating all earthquakes with magnitude greater than 3.0 on the Richter Scale in the continent's most seismically active and populous areas; and (c) detecting continent-wide, all earthquakes with magnitudes greater than 3.0 on the Richter Scale' and (2) 'BMR should aim to operate five more permanent magnetic observatories, near Darwin, Alice Springs, Charters Towers, Marble Bar, and Woomera.'

Geomagnetism

The normal magnetic observatory programs in both Australia and Antarctica were maintained throughout 1981, and Observatory Reports for June 1980 - June 1981 were published during the reporting period.

The 1980-epoch magnetic charts were delayed because of staff shortages but the D map of the Australian region was completed in October 1981.

In May-August, 12 first-order magnetic stations were occupied in Papua New Guinea, West Irian, Nauru, and the Solomon Islands. A new first-order station was occupied at Portland (Vic.) because the old site is being resumed by Alcoa for an aluminium refinery.

In Antarctica, monthly absolute readings at Davis and Casey continued and at Davis the base station was re-positioned because the old site was being polluted by the current building program. Several regional magnetic stations in the Vestfold Hills area were re-occupied.

J.C. Dooley attended the MAGSAT workshop and the 4th Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA) in Edinburgh during August. P. McGregor also attended the MAGSAT workshop and the early part of the IAGA Assembly.

Earthquake seismology

The normal seismological programs were maintained during 1981 but staff shortages restricted most activities to those of processing standard recordings. Phase data continued to be telexed to the National Earthquake Information Service in Golden, USA, for the preliminary determination of hypocentres, and final data for the Australian and Melanesian regions were despatched on magnetic tapes to the International Seismological Centre in Newbury, UK, for the period March 1979 - January 1980 inclusive.

No large damaging earthquakes took place in Australia during the report period, but the Bass Strait earthquake (38.9°S, 144.2°E) of 16 June 1981 (ML about 5.3, max MMI about V) was widely felt in Melbourne and environs and caused considerable interest. The event also highlighted the lack of an on-line recording and locating capability in BMR, resulting in unacceptable delays before the hypocentre was determined.

D. Denham visited the 21st Assembly of the International Association of Seismology and Physics of the Earth's Interior and attended the Governing Council meeting of the International Seismological Cent. - both in London, Canada.

P. McGregor attended the 11th and 12th meetings of the Committee on Disarmament's Group of Scientific Experts in February and August at Geneva. He is convenor of the Study Group on 'Format and Procedures for the Exchange of Level 1 Data through WMO/GTS'. During October 1980 a Global Telecommunication System Seismic Data Exchange and a Data Base Experiment took place. These involved BMR in the throughput of seismological data.

A conference on Stress and Seismicity in Southeastern Australia was attended in November 1980, and seven papers presented at this meeting were edited and collated by D. Denham for inclusion into a special issue of the Journal of the Geological Society of Australia.

Explosion seismology

No field work was carried out in the report period, most of the effort being spent on interpreting the data obtained from the McArthur and Eromanga Basins and between Tennant Creek and Mount Isa.

A paper by D. Finlayson analysing the deep lithospheric structure under southeast and central Australia was completed and submitted for publication.

Slow progress was made in upgrading the seismic tape-recording system, but the new NCE-3 crystal clocks were fitted to all sets and low-powered motors were installed in two systems. There is still a major requirement for more recorders to improve the cost effectiveness of field operations.

Meetings were held to investigate the possibility of setting up an Australian Continental Reflection Profile Program (ACORP). Representatives from industry and tertiary and government institutions are participating in these investigations.

A two-day workshop on the reflectivity method of computing synthetic seismograms was held at BMR in October 1980. It was led by Professor K. Fuchs from Karlsruhe, West Germany, and was attended by more than 20 participants from throughout Australia.

Gravimetry

Checking of gravity data in 1:250 000 sheet areas continued, and principal facts from about 560 000 gravity stations are now in the data bank of stations in the Australian region. 1:1 million maps for the Hamersley Range, Bourke, and Canberra Sheet areas, and their associated 1:250 000 Sheet areas, were published.

A gap on SINGLETON was filled by 10 stations in April but a similar gap on SYDNEY could not be accessed.

In the southwest seismic zone about 360 stations at 10 km intervals were occupied by R. Tracey. These were put in at new bench marks and will be used to monitor vertical strain in the region.

J. Williams carried out a multidisciplinary survey in the region south of Davis in Antarctica during the 1980/81 summer. 52 gravity stations with ice-radar observations were occupied in an area about 140 x 170 km.

Studies on crustal strain, from surveying observations taken since the middle of last century, were continued by P. Wellman, and a paper on strain rates in the southwest of Western Australia and southeastern Australia was prepared.

Papers by P. Wellman on erosion and uplift of the Prince Charles Mountains (Antarctica) and on glacial surging were also prepared.

Palaeomagnetism and rock measurements

Phase I of the development of the palaeomagnetic data reduction programs for the Black Mountain Laboratory and BMR was completed, and this enabled a start to be made on the several thousand samples taken in the McArthur Basin.

Analysis of the Tertiary weathered profiles, the Proterozoic sedimentary sequences, and the Vestfold Hills and Enderby Land dykes continued.

Field work was restricted to that carried out by J. Williams in the Vestfold Hills region and by M. Idnurm in the Australian continent. The aims of the Australian work were to consolidate the existing Tertiary polar wander curve, to complete an investigation of weathered profiles in central Australia, to extend the weathering study to the adjacent northwesterly regions, and to carry out a series of consistency tests on remanence directions in the Tawallah and McArthur Groups of the eastern McArthur Basin.

The group continued to provide a rock measuring service for other groups within BMR and several hundred samples were analysed for a number of physical parameters.

Assistance was given to the West Irian project - in particular to that aspect devoted to establishing a palaeomagnetic laboratory in Bandung. However, no Indonesian trainees were provided, and although several items of equipment have been procured no real progress has been made.

During 1981 the group lost its only technical officer and work on several programs was curtailed.

Magnetotellurics

Recording in the Eromanga Basin was completed in October 1980 and from then on the work effort was concentrated on interpreting the results. A 1-D inversion of the Eromanga Basin traverse (12 sites) and a 2-D inversion of the 1979 McArthur Basin survey were completed.

During the year a new HP 1000 E series CPU using RTE4 software was delivered, but lack of computing assistance is delaying the commissioning of the new unit.

Geothermal

Staff shortages prevented major activities in this discipline but two new heat flow holes - at Nulla Vale in Victoria (200 m) and Marla (700 m) in South Australia - were secured for logging at some future date.

J.P. Cull completed a new compilation of Australia-wide heat flow data and this was accepted for publication.

1. METALLIFEROUS AND AIRBORNE SECTION

(G.A. Young)

The Section comprises two Subsections: Metalliferous and Airborne. Both Subsections contribute to the Australia-wide Airborne Geophysical Mapping Project reflecting the importance given recently to accelerate this program to assist research into the geology of Australia and its mineral deposits. The Airborne Subsection is principally concerned with providing basic airborne geophysical data coverage of the continent at a regional scale, publishing results in map form, and contributing to multidisciplinary interpretative studies of Proterozoic and Phanerozoic sedimentary provinces. The regional group of the Metalliferous Subsection is assigned to contribute to complimentary multidisciplinary studies of hard-rock metalliferous provinces carrying out ground geophysical surveys as required to support airborne results. Research scientists are being recruited to strengthen the Section's ability to produce detailed interpretative reports which are seen as an essential component of background information required to assit mineral exploration and for the assessment of mineral potential.

The Metalliferous Subsection also engages in research into the development and application of improved ground geophysical methods to assist mineral exploration. Currently activities in this area are being revived as new staff are recruited to replace those lost over the last 3 years to the mineral exploration industry.

METALLIFEROUS SUBSECTION (D.C. Stuart)

Lachlan Fold Belt project (Project co-ordinator - D.C. Stuart)

Owing to further reduction in staff available for this project only a limited amount of new field work was undertaken in 1981. Work has concentrated on the processing, interpretation and reporting of work undertaken in previous years. The project will be concluded at the end of 1981.

Rock property data base (A. Yeates, B. Wyatt, V. Carberry, H. Reith). The rock property and geological information obtained on 900 samples collected throughout the fold belt in NSW has been organised into a computer data base to permit rapid retrieval and sorting of associations. The data base is currently being edited, and in addition to the computer data base, it will be published as a microfiche Report in 1982.

During 1981, petrographic descriptions of the samples collected during 1979 and 1980, and remanence, porosity, and density measurements of cores taken from the samples, were completed. These data, which represent information on about 900 sites selected to represent most of the rock types, rock units, and typical magnetic anomaly sources, were added to the data base. Also added to the data base were analyses of 400 granitoid and acid volcanic rocks for 10 major and 23 trace elements and in situ measurements of radioelement concentration and susceptibility. The analytical work was performed by the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) as part of a joint project described elsewhere in this Report.

Interpretation of transect data (R. Almond, A. Yeates, V. Carberry). The results of airborne magnetic and radiometric, and gravity transects carried out across the Fola Belt during 1979 and 1980 are being analysed and interpreted. This study will conclude in 1981 and will be the final major program of the Lachlan Fold Belt project.

To assist in the interpretation of the geophysical data, a comprehensive review of the stratigraphic and spatial characteristics of rock units throughout the Fold Belt has been prepared, and the geophysical characteristics of the rock units have been established by reference to the rock property data base and the regional geophysics.

As a prelude to interpretation of the magnetic data, extensive use of computer-based filtering and modelling methods are being used to analyse the data. Bandpass filtering and Fourier analyses have been applied to separate the effects of shallow and deep sources, and to characterise the magnetic characteristics of individual rock units. Inversion and forward modelling are being used to investigate the source of anomalies.

Interpretation of the gravity and radiometric data is also being undertaken by characterising the response of geological units and domains and, where appropriate, modelling.

Airborne radiometric characteristics of granitoids of the Lachlan Fold Belt in NSW (A.N. Yeates, B.W. Wyatt). This work formed the final phase of an investigation of the radiometric responses of Sn and W granites in the region. Ground gamma-ray spectrometer measurements made in 1979 had indicated that granites hosting Sn, W, or Sn/W mineralisation have enriched U and many also have high U/Th ratios.

To investigate if these differences could be detected by airborne gamma-ray spectrometry, a two-day survey was designed and conducted in January. Sixteen traverses were made over 13 plutons selected from ground survey results for their high U, high U/Th ratio, or lack of significant radioactivity, and their responses were compared.

The traverses were made over an unnamed granite in the Compton Downs area northeast of Byrock, the Nymagee Granite, Erimeran Granite, Ardlethan Granite (2 traverses), an unnamed granite a few kilometres southeast of Uranquity, an unnamed granite a few kilometres north of Wallbundrie, the Jinderra Granite at Goombargana Hill (2 traverses), a granodiorite 25 km northeast of Temora, the Wyangala Batholith west of Reids Flat, the Murrumbidgee Batholith east of Mount Nungar, the Forest Lodge Granite north of Goulburn, and the Marulan Granite west of Talong. Traverses were also made over two bodies of radioactive phlogopite leucitite near Byrock.

Four of these traverses (Ardlethan, Goombargana Hill, Nymagee, and Marulan) have been reported in a paper describing the results of ground gamma-ray spectrometer measurements. Reporting of the other profiles is scheduled for 1982.

The profiles obtained were in agreement with ground measurements. The multiphase nature of some composite bodies (e.g. Nymagee and Erimeran Granites) was clearly detected.

An indication of the responses obtained over the different granite bodies is indicated in Figure MA 2.

Spectrometry of Tasmanian granitoids (P.L.F. Collins (Dept. Mines Tas.), B. Wyatt, A. Yeates). Following investigations by BMR in the Lachlan Fold Belt of New South Wales which show that granitoids which are hosts to Sn, W, and Sn/W mineralisation have higher radioactivity owing to a detectable enrichment in U, the Department of Mines, Tasmania, invited BMR to investigate jointly the radioelement concentrations of Tasmanian granites. The work was undertaken during February and was designed to investigate the Sn/W prospectivity of the granitoids, and to provide data for heat flow and geothermal studies.

Gamma-radiation was measured at 196 outcrops of granitoids in northeast and northwest Tasmania, as well as at King and Flinders Islands. Measurements were made also at 12 outcrops of mafic and ultramafic rocks in western Tasmania. Magnetic susceptibility was measured at each site.

From the gamma-ray spectrometer measurements, values of mass % K_2O, g/t U, g/t Th, and heat-generation units were calculated. Analysis of these data indicated that all granitoids which are hosts to Sn and W mineralisation had enriched U values, and many had high U/Th ratios. The method was also suitable for delineating mineralised greisens which had the highest U/Th ratios.

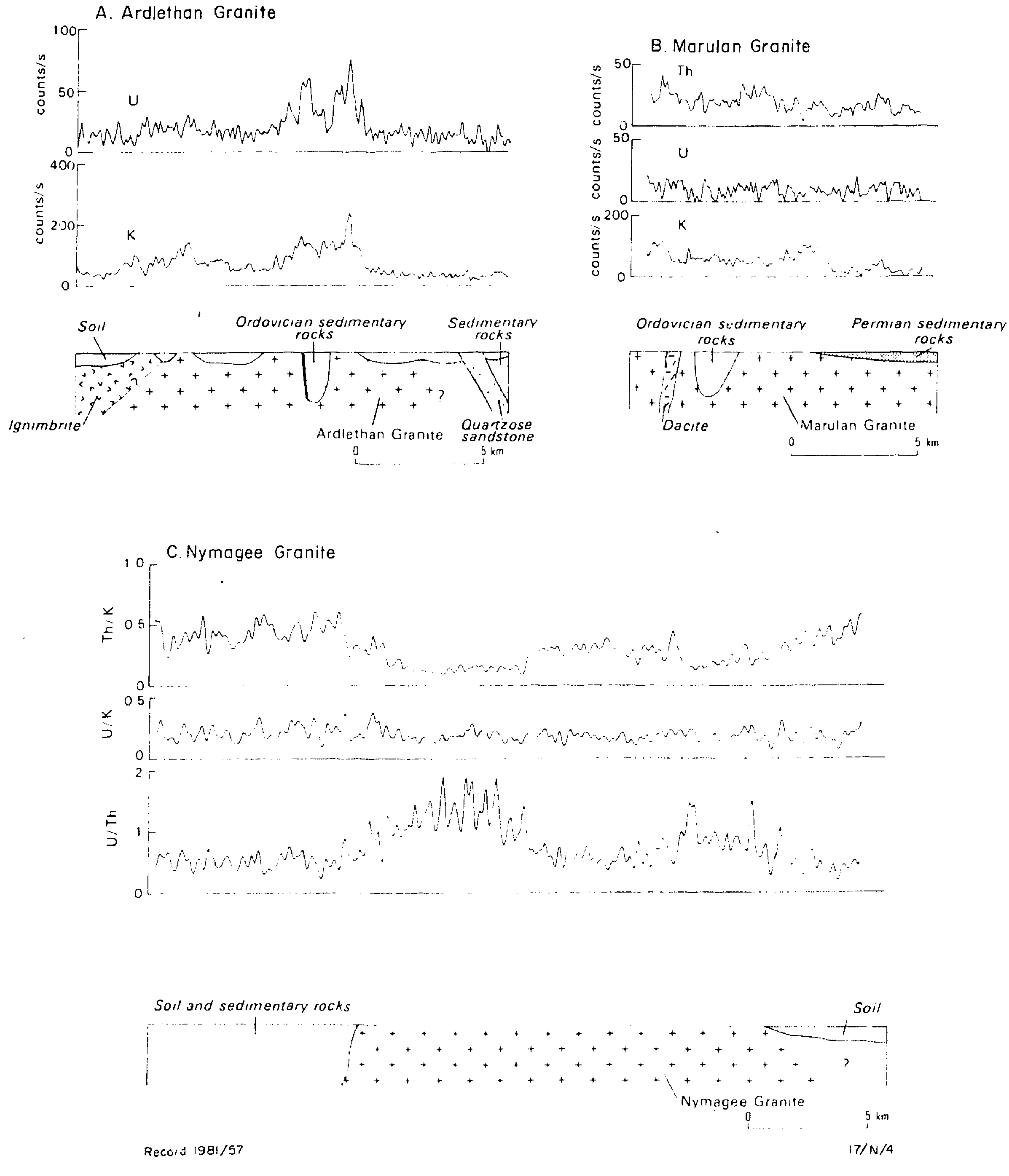


Fig. MA 2. Radiometric response of granitoids, Lachlan Fold Belt
Variations in the radiometric response of granitic rocks is a guide to their prospectivity for Sn/W mineralisation and petrological character. The prospective Aralethan Granite (A) exhibits abnormal uranium channel response. Unprospective Marulan Granite (B) has low uranium and thorium response. Different phases of the Nymagee Granite (C) are indicated by changes in ratio of uranium to thorium response.

Different variants of composite bodies, such as the Blue Tier Batholith, were easily delineated by their characteristic gamma-ray signature.

The results of the survey have been released in Tasmanian Mines Department unpublished report 1981/41.

BMR-BGR joint geochemical project on acid igneous rocks (A.N. Yeates, U.H.K. Vetter, BGR). A joint project with the Bundesanstalt für Geowissenschaften und Rohstoffe (West German Federal Institute for Geosciences and Natural Resources), begun in 1980, aims to geochemically characterise granitoids and acid lavas and tuffs from the Lachlan Fold Belt, so that their geophysical character and mineral potential can be better understood and assessed.

Initially, 400 samples of granitoids and acid volcanic rocks were analysed for 10 major, and 23 trace elements. These results have been added to the Project's rock-property data base.

A follow-up study of several granitoids that are hosts to Sn and W mineralisation was made in February and March, mainly by U.H.K. Vetter. At the end of October, analyses of a selection of the 150 samples collected were in progress. It is expected that these results will be released in a joint publication scheduled for 1982.

Mount Isa Inlier geophysical study (I. Hone, V. Carberry, H. Reith, A.Warnes)

A regional overview of the geophysical characteristics of the Mount Isa Inlier has provided a general guide to the principal geological factors controlling the size and distribution of gravity, magnetic, and radiometric anomalies. The area studied lay within 17°S-25°S and 138°E-141°E, with work concentrated on CLONCURRY and DUCHESS as these Sheets have the best geophysical data coverage and geological control.

The gravity field is controlled by the relative abundance of granites (which tend to generate gravity lows), and basic rocks and dense metasediments such as parts of the Corella Formation (which tend to generate highs). The most outstanding gravity features in the area are a series of north-northwest to north-trending long and relatively narrow highs and lows. The lows lie over granites. The highs lie mainly over basics and metasediments, but some lie over the central basement welt, which is mapped on a regional scale as granites, acid volcanics, and gneisses. Close inspection of detailed mapping and aerial photographs in the welt region indicates the presence of many basic intrusions which comprise up to 30-40 percent of the rocks. Modelling indicates that these basic intrusions could be the cause of the high gravity values.

Sources of the magnetic anomalies are basic volcanics and intrusives, some metasedimentary horizons, and some granites. Many magnetic horizons have been identified in the Mary Kathleen, Malbon, Soldiers Cap, Haslingden, and Tewinga Groups. Units younger than these have relatively few magnetic horizons. Although many basic intrusions are magnetic, many of those intruding the basement welt are non-magnetic, or only weakly magnetic.

The most radioactive rocks are granites such as the Williams and Naraku. The Mary Kathleen, Malbon, Soldiers Cap, and Tewinga Groups are moderately radioactive, with isolated areas of high radioactivity. The Haslingden and Mount Isa Groups generally have low associated radioactivity with few anomalous areas. Older granites such as the Kalkadoon have lower concentrations of radioelements than younger granites, and appear to be relatively deficient in uranium and thorium.

The Early Proterozoic rocks of the Mount Isa Inlier and extensions under later cover can be divided into major geological domains having strong regional gravity and magnetic characteristics (Fig. MA 3). The magnetic data indicate a central non-magnetic domain which broadly corresponds to acidic igneous and metamorphic basement rocks, and eastern and western magnetic sequences. The gravity data indicate the distribution of granites, metasediments, and suites of basic intrusions, and best define the limits of the Inlier.

The results of this work were presented at the BMR/AusIMM joint meeting on the geology of the Mount Isa region at Mount Isa, 15-16 September. A final report on the work is in progress.

Davenport Geosyncline study

This project forms part of the multidisciplinary Davenport Geosyncline project and is intended to establish the geological parameters controlling the regional geophysical features in the geosyncline, and to assist in geological mapping and resource assessment of the province.

Owing to staff losses early in 1981 a planned major program of ground geophysics was deferred until 1982. During 1981 work comprised additional airborne surveys, a preliminary interpretation of existing data, carborne magnetic traverses, and a study of rock property and geological associations.

Airborne survey (R. Almond). To assist in defining the geophysical characteristics of the geosyncline, an airborne magnetic and radiometric survey of BONNEY WELL and the Hatches 1:100 000 Sheet area was flown in June and July. In addition, 5 regional transects were flown over FREW RIVER and ELKEDRA. Details of the survey are contained in the Airborne Subsection summary of activities.

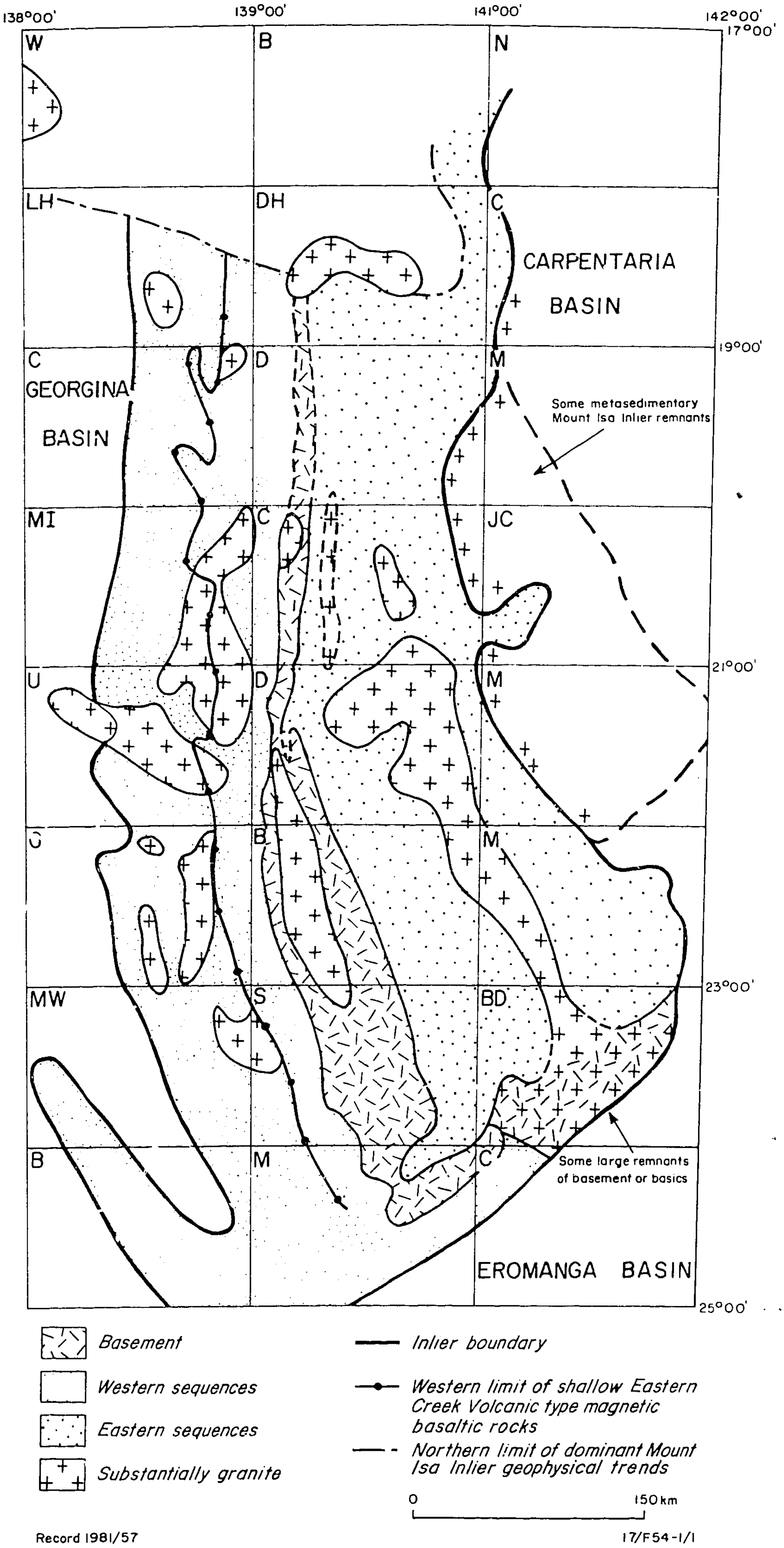


Fig. MA 3. Distribution of early Proterozoic units of the Mount Isa Inlier

In addition to the airborne work done by BMR, contractors to the Northern Territory Geological Survey carried out an airborne survey of BARROW CREEK along north-south flight lines 150 m above ground level and spaced at 500 m.

Preliminary interpretation (I. Hone, R. Almond, H. Reith). A review was made of the regional aeromagnetic and gravity data over BONNEY WELL, BARROW CREEK, FREW RIVER, and ELKEDRA. The aims of this were to determine the major characteristics of the data, and to assess their usefulness in assisting geological mapping.

The gravity data, which were acquired by the BMR reconnaissance gravity survey of Australia on an 11 km grid, show limited correlation with known geology. However the review suggests that more detailed gravity surveys will be able to map some rock units.

Amplitude, shape, and strike characteristics of magnetic anomalies were used to divide the Davenport area into geophysical zones. The extremely poor quality of the data over BONNEY WELL and BARROW CREEK severely restricted this process in these Sheet areas. It appears that most magnetic anomalies are attributable to basalts or porphyries which form concordant horizons. Basin and dome folding of such horizons is interpreted as the cause of the roughly annular-shaped zones in FREW RIVER.

The regional geophysical data show a discontinuity in characteristics across two intersecting lineaments in ELKEDRA. This discontinuity is interpreted as being the southern boundary of the Davenport rocks.

Carborne magnetometer survey (P. Davies, R. Curtis-Nuthall). A carborne magnetometer survey was conducted along 229 km of traverses in the period 3-10 July. A 203 km traverse along the Stuart Highway from 41 km south of Tennant Creek to Stirling Well (see Fig. MA 1) was sampled at 5 km intervals to provide data to compare with results from airborne surveys and to produce a magnetic section across the Davenport rock sequence. Three short traverses sampled at 2 m intervals were designed to detail characteristics of magnetic anomalies and changes in magnetic character across zone boundaries. Processing of the traverse data will be completed late in 1981.

Rock properties and geological associations (R.Shaw, I. Hone). To provide a physical property framework for interpreting regional magnetic, radiometric, and gravity surveys, a four-week program of rock sampling and field measurements of physical properties was carried out in August and September.

Magnetic susceptibilities and four-channel gamma-ray spectrometer readings were recorded over the major units, and oriented sampleswere collected for laboratory measurement of remanence, susceptibility, porosity, anddensity.

The field measurements show that Division 2 rocks of the Arunta Block in BARROW CREEK are less magnetic than rocks of the Warramunga Group with which they are correlated. Based on limited sampling, siltstones and shales of the Warramunga Group are seen to contain widely dispersed magnetite, whereas in the Hatches Creek Group, magnetite is concentrated in relatively narrow units.

The upper part of the Hatches Creek Group is relatively non-magnetic, and accounts for the aeromagnetic low in eastern FREW RIVER. The remainder of the Hatches Creek Group includes a number of acid volcanic units, some of which are magnetic, whereas within the Warramunga Group and within Division 2 rocks of the Arunta Block, granites are much more common. The preserved thickness of the Hatches Creek Group is greatest (14 000 m) in eastern FREW RIVER. Its thickness decreases rapidly towards Barrow Creek township.

Radiometric characteristics of the Rum Jungle area (D. Stuart, A. Warnes).

An assessment was made of the results of surface and down-hole gamma-ray spectrometer, and surface radon surveys, carried out during 1979 to investigate the use of radiometric methods for mapping in the area.

Camparison of down-hole and surface gamma-ray spectrometry indicates that the concentration of radioelements in the soils commonly reflects the radioelement concentration of underlying rocks. A comparison of radon and gamma-ray spectrometer surveys indicates that most radon anomalies reflect an increase in the concentration of uranium at the surface.

The results of gamma-ray spectrometer traverses are shown schematically in Figure MA 4 and indicate that a distinct anomaly in the ratio of apparent uranium to apparent thorium can be used to map the prospective boundary between the Batchelor and Namoona Groups. The results also indicate distinctly different radioelement concentrations in the Rum Jungle and Waterhouse granitic complexes.

Investigation of the source of aeromagnetic anomalies in the southwest Amadeus Basin (P.M. Davies, R. Curtis-Nuthall).

As part of the Petroleum's Exploration Branch's Amadeus Basin project, the source of shallow aeromagnetic anomalies in the southwest of the Amadeus Basin was investigated by a carborne magnetic survey and drilling.

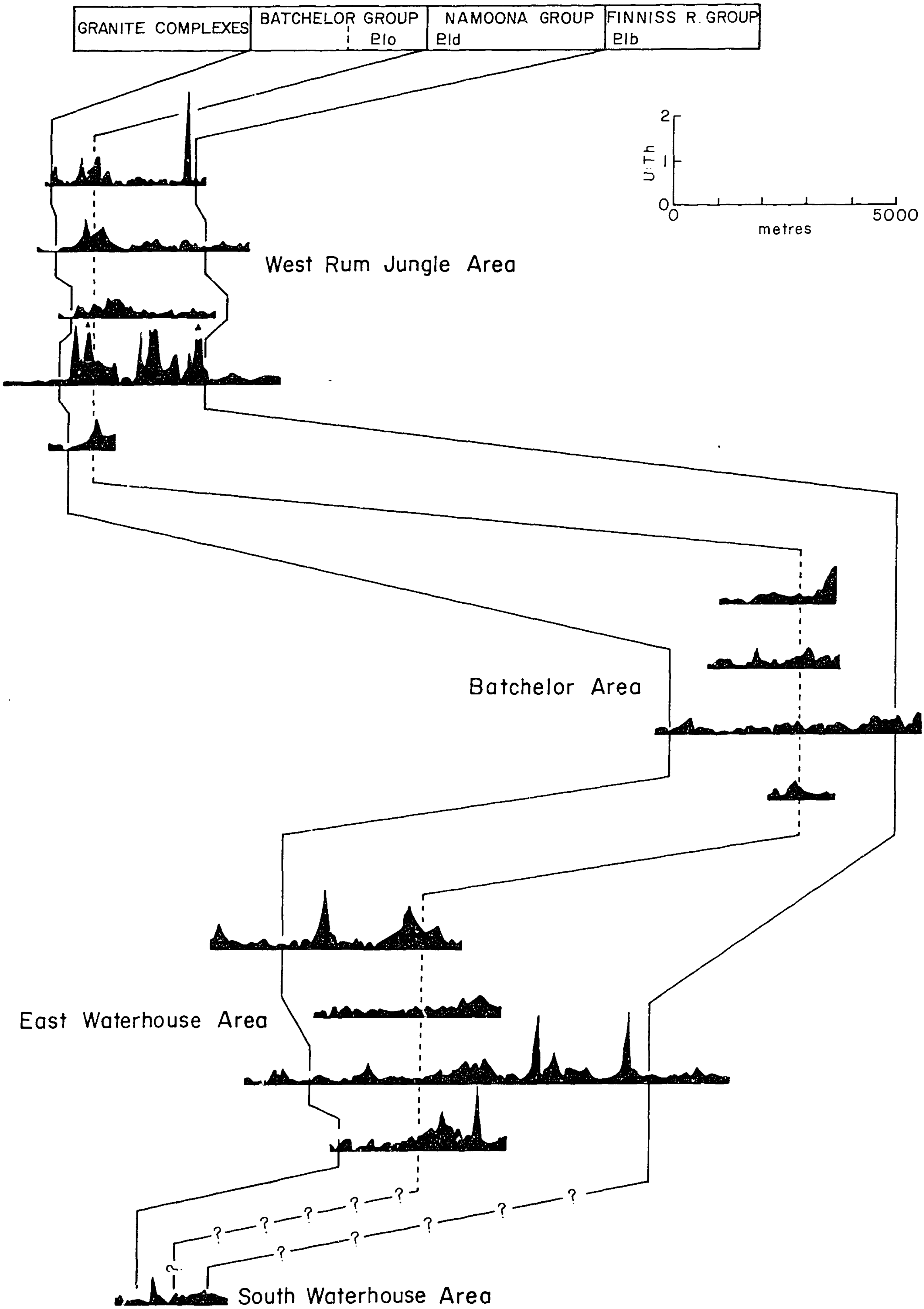


Fig. MA4. Radiometric mapping Rum Jungle area NT

The aeromagnetic anomalies have a linear character and were thought to be dykes associated with structural features or volcanic units within the basin sequences. As shown in Figure MA 5, five carborne magnetic traverses were made along roads in the area. Owing to restricted access, no traverses were made along flight lines.

Strong magnetic anomalies of 200 and 300 nT were detected on traverses 3 and 4 respectively; weak to indistinguishable anomalies only were detected on the other traverses. The anomaly on traverse 4 suggested a simple source whereas the anomaly on traverse 3 was indicative of several contributing sources.

Owing to the relative simplicity of the anomaly on traverse 4, it was selected as the most suitable for testing by drilling. Modelling suggested a steeply dipping source, approximately 200 m wide and at at depth of 100 to 150 m. Subsequent drilling of the target selected resulted in the intersection of a basic volcanic rock at a depth of 90 m. The magnetic properties of the rock, and its apparent dip determined by drilling, matched the model parameters. Geological inspection of the core suggests the volcanics are part of the Amadeus Basin Bitter Springs Group (see Petroleum Exploration Branch 1981 Summary of Activities).

Magnetic investigations, Eromanga Basin, Qld (P. Davies, R. Curtis-Nuthall, A. Warnes)

High resolution carborne magnetic surveys were made along BMR seismic traverses across the Basin in late October to early November with a view to investigating possible association between surface magnetic mineral accumulation and faulting (see Fig. MA 1). The results of this work are still being processed.

Mineral deposit geophysics

Owing to lack of staff, no new initiatives were undertaken in this project during 1981. Some work was necessary to complete the reporting of previous surveys and studies.

Physical properties of samples from the Cleveland mine, Tasmania (I. Hone, V. Carberry, H. Reith). Density, porosity, electrical, and magnetic properties of samples from the Cleveland (tin) mine, Tasmania have been measured as part of the program to document the physical properties and geophysical responses of

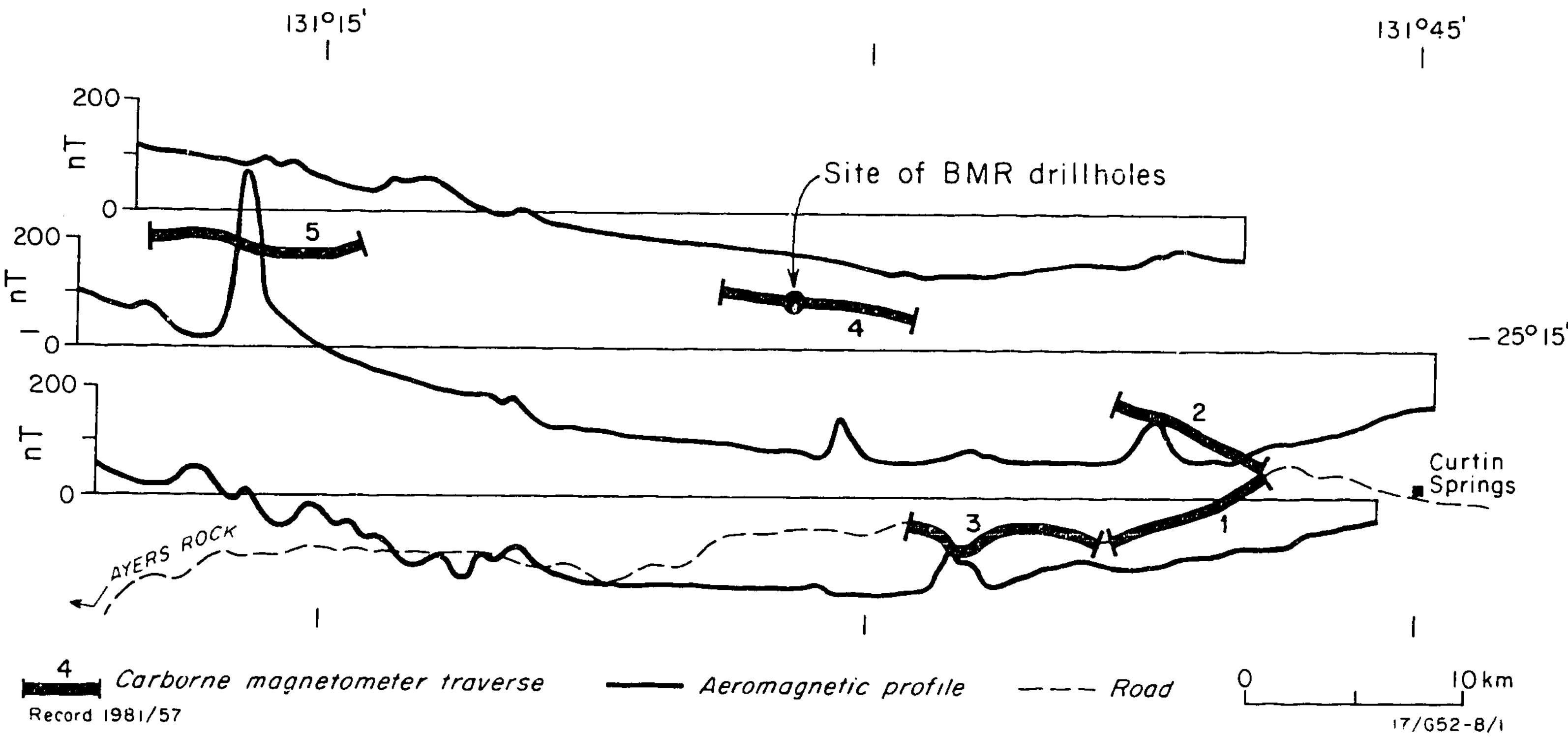


Fig. MA 5. Ground magnetic traverses Amadeus Basin mineral deposits. The samples were selected as being representative of the lodes, the Hanging Wall Basalt, and the Footwall Sandstone.

A summary of the measurements is shown in Table MA 1. The main lodes appear to be more magnetic and chargeable, and less resistive than the DP lode. These differences are probably due to a higher concentration of sulphides in the main lode, although different forms of minerals and rock textures in the lodes may be a contributing factor. A strong physical property contrast exists between the main lodes and the surrounding rocks, the main lode being less resistive, and more chargeable, dense, and magnetic. The DP lode is denser than the surrounding rocks, but measurements on more samples would be required to define precisely differences in electrical and magnetic properties.

Porosities of the Hanging Wall Basalt and Footwall Sandstone samples tend to increase as their depths decrease. This may be due to weathering, or the action of fluids associated with mineralisation.

Radiometric characteristics of the Austatom prospect, NT (D. Stuart, A. Warnes). Analyses and reporting of the results of radon and surface and down-hole gamma-ray spectrometer surveys at the Austatom 1 prospect carried out in 1979, were completed as BMR Record 1981/10.

The results show a close similarity between the relative amplitude and shape of surface radon, total gamma, and gamma-ray spectrometer anomalies. The prospect is associated with a broad radiometric anomaly which is more than 5 times background and covers an area of over 200 m^2 (Fig. MA 6).

Potential field methods research

Carborne magnetometer system development (M. Gamlen, R. Cobroft, R. Almond, R. Curtis-Nuthall). Surveys with the existing carborne magnetometer system at Cobar in 1980, and in the Davenport Range, Amadeus Basin, and Eromanga Basin in 1981, demonstrated the value of a digital carborne magnetometer system in regional and detailed surveys. However, as the system in use had serious deficiences in reliability and convenience and was constructed partly from equipment borrowed from other sections, a new vehicle-borne digital aquisition system (VBDAS) is now under construction, and a full account of the design of this system, is contained in the Interim Engineering Services (IES) Branch 1981 Summary of Activities.

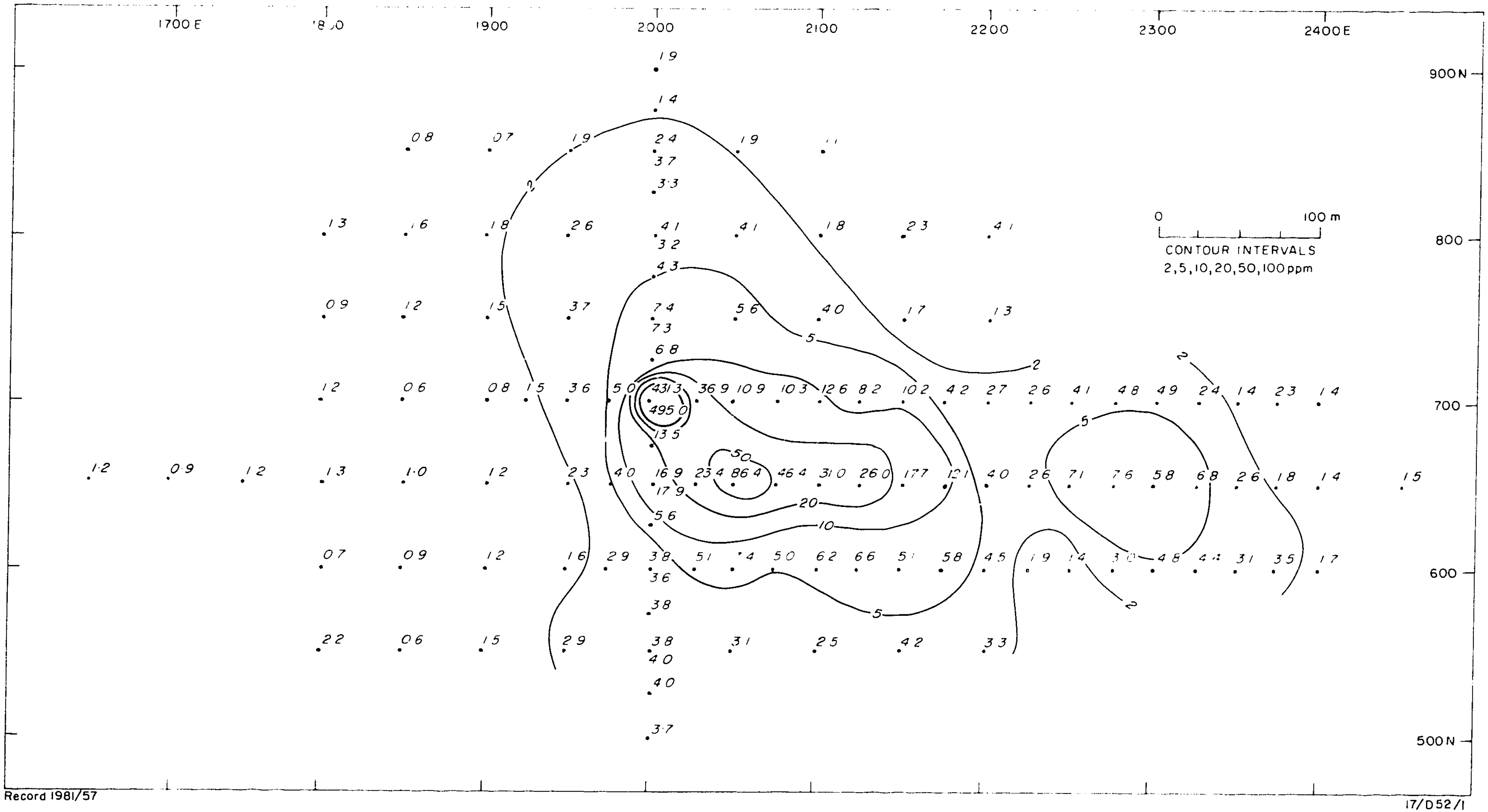


Fig. MA 6. Apparent uranium results, Austatom Prospect NT

The system will be mounted in an airconditioned Toyota Landcruiser, and should be ready for the 1982 field season. The system will comprise a Motorola microcomputer, which receives inputs from a magnetometer, an odometer, and a compass, and writes the data on to a flexible disc. Operator control is by a teletype printer/terminal. Two sets of software are under development; one to control the data acquisition, and one (for use at the field base) for data reduction, display, and interpretation. Future expansion of the system will include the addition of a gamma-ray spectrometer.

Development of programs for the analysis of regional magnetic and gravity data (P. Gidley). To assist in the interpretation and analysis of potential field data on a regional scale, an interactive package of eight programs was developed for BMR's Hewlett Packard 2000 minicomputer.

Programs were adapted from existing publications and are designed to read data directly from disc files. Although written in Fortran IV, the input/output characteristics of the programs are specifically designed for BMR's computing system.

The programs are described in BMR Record 1981/21 and perform the following operations.

(a) 1-dimensional polynominal filtering of data.

(b) 1-dimensional rectangular filtering of data.

(c) Magnetic modelling of up to 15 3-dimensional prisms.

(d) Gravity modelling of up to 15 3-dimensional prisms.

(e) Werner deconvolution for estimating depth and location of magnetic bodies.

(g) Estimation of magnetic basement depth.

(h) Inversion of gravity data to determine depth to a density interface.

Nuclear methods research

Application and interpretation of radon surveys (D. Stuart, A. Warnes). Field research into the application and interpretation of radon surveys undertaken throughout the Pine Creek Geosyncline during 1979 was assessed.

The results of the this study demonstrate that most radon anomalies can be attributed to surface concentrations of uranium which are discernible by surface gamma-ray spectrometry. Nonetheless, some radon anomalies were detected which were not associated with an apparent uranium anomaly, and radon surveys were shown to be very effective in areas where gamma-ray measurements are precluded by surface radioelement contamination.

The intrinsically high geological noise level attributed to the small sample volume employed in radon measurements was shown to be substantially reduced by the use of emanometer measurements in which count rate is normalised by the ratio of counts at early and late times. Furthermore, modelling of the decay of closed radioelement systems shows that emanometer ratio measurements can be used to indicate the equilibrium state of radon in soil gas, and this knowledge can be a valuable guide for interpreting the possible origin of radon anomalies.

Enhancement of Dubbo aeroradiometric data (B. Wyatt). A computer/photographic processing system was developed to merge 3-channel airborne gamma-ray spectrometer data into a single colour image as a means of assisting the interpretation of radiometric data from 1:250 000 Sheet area airborne reconnaissance surveys. The colour image was produced by assigning different colours to different fields of a three-component, percentage sum diagram.

Tests of this system on aeroradiometric data from DUBBO, NSW highlighted differences in the radiometric characteristics of granitic rocks and their phases, and different sedimentary lithologies.

Electrical methods research

Owing to shortages of staff and funds, a number of electrical methods projects were discontinued or deferred. However, work continued on down-hole EM investigations, and a study of the use of SQUID magnetometers in electrical methods surveys commenced. An attempt to bring a modern wide-band EM system to Australia for evaluation of its mapping and exploration potential was thwarted by lack of funds.

Down-hole TEM modelling (J. Major). The analysis and reporting of model experiments to investigate the response of a down-hole TEM survey in the presence of a conductive overburden was completed. These experiments were carried out in late 1980 using the analogue model facility on loan from Macquarie University.

The studies provided a set of curves illustrating the TEM response along drill holes through a conductive overburden into a resistive host, and through a conductive overburden overlying a conductive prism approximating the Elura orebody. The results showed that at early sample times, the overburden alone generates the near-surface signal. At depth the response of the body is complicated and may add to or subtract from the overburden response depending on the sample time and the transmitter-receiver and orebody geometries. These effects were also observed in the results of previously published field data from Elura. Comparison of the model curves with field observations obtained from SIROTEM down-hole surveys at Elura enabled the bulk resistivity of the overburden and orebody to be determined.

Evaluation of down-hole omni-directional EM probe (R. Cobcroft, R. Curtis-Nuthall, A. Warnes). Encouraging results were obtained at a test site near Peelwood in NSW during October 1980 using a system based on a Princetown Applied Research lock-in analyser and BMR constructed probes, filters, and amplifiers. In 1981 some modifications (which are described in the Interim Engineering Services (IES) Branch 1981 Summary of Activities) were made, and extensive calibration tests were carried out at BMR's Kowen Forest Laboratory. These confirmed substantial improvement in system sensitivity and accuracy. Field surveys were also made at the Peelwood test site, and a new algorithm and computer program were written to improve the reduction and processing of the omni-directional probe data in terms of the polarisation ellipse.

The field surveys at Peelwood illustrate the advantages of logging with the omni-directional probe when the conductive target is poorly coupled to the axial component of the probe. In the test survey two holes intersecting small bodies of conductive sulphides were logged using a 200 m x 200 m surface loop excited by an 800 Hz current source.

A comparison of the axial and omni-directional probe data from one of these holes, which intersected mineralisation at 185 m, is shown in Figure MA 7. Note that the minor axis of the polarisation ellipse exhibits greater sensitivity to the mineralisation at 185 m than does the axial (Z) component phase. Similarly, the minor axis indicates a change in the conductance of lithological units in the top of the hole, but these changes cannot be seen in the axial component data.

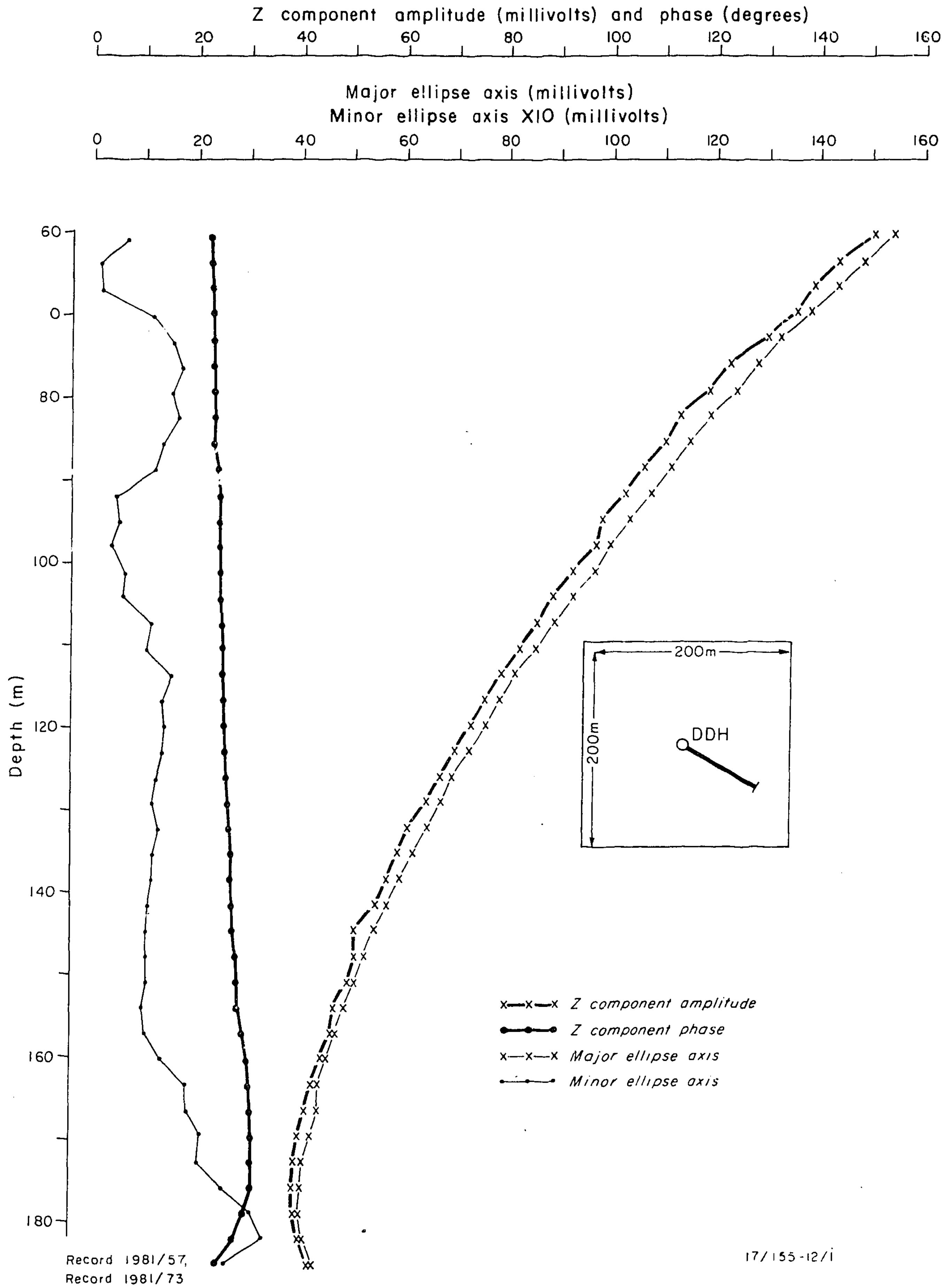


Fig. MA 7 Results of 3 component downhole electromagnetic survey at 800 Hz at Peelwood Prospect. The additional data provided by the 3 component probe is represented by the major ellipse axis and minor ellipse axis plots. The conventional 1D probe would provide only Z amplitude and phase

Numerical modelling of down-hole EM response (P. Hopgood). To assist the interpretation and evaluation of down-hole EM data a Fortran computer program has been written which models the EM field throughout a conductive halfspace. The program is currently being tested. The program is based on a mathematical outline provided by Dr Raiche of the Division of Mineral Physics, CSIRO, and involves the calculation in cylindrical polar co-ordinates of the three non-zero EM field components due to an infinitesimal current dipole.

Expressions for Hz, Hp, and Eo given by Dr Raiche were integrated to yield complex expressions for the three components in terms of position with respect to the dipole, loop current, frequency, and earth resistivity. To calculate the fields due to a large rectangular loop the three components were resolved into cartesian co-ordinates yielding Hx, Hy, Hz, Ex, and Ey, and each of these was numerically integrated over the loop area. The results are complex numbers, yielding both amplitude and phase of the five field components as a function of location with respect to the loop centre.

Experiments with a SQUID detector (J. Major, P. Hopgood, R. Curtis-Nuthall). As part of BMR's electrical methods research program, an SHE Corporation SGMP-45, three-component SQUID (Superconducting Quantum Interference Device) magnetometer has been obtained to investigate the possible advantages of using these high sensitivity devices in exploration and mapping surveys.

Calibration tests . Calibration tests of the sensitivity and frequency response of the three components of the magnetometer were conducted with a large Helmholtz coil at BMR's magnetic laboratory at Kowen Forest, NSW. The results showed 12 percent departures from the calibration data provided by the manufacturer. Although no specific noise tests were run, signals as small as $2 \times 10^{-4} nT/\sqrt{Hz}$ were observed above a total noise background of $1 \times 10^{-4} nT/\sqrt{Hz}$ between 1 and 2 kHz. The tests also showed that slow rate problems would be encountered for some instrument settings and equipment combinations.

Tests as an MMR detector. In an early shakedown test of the SQUID under field conditions, a magnetometric-resistivity (MMR) survey was carried out over a small body of massive sulphides near Peelwood, NSW. For these tests a gradient array of 1000 m current electrode separation was used, and the horizontal and vertical components of the SQUID were coupled directly to a Huntec Mk IV IP receiver (on loan from the Geological Survey of Victoria) for measurement and signal averaging. Owing to noise problems, which have now been overcome, the weak IP decay curves could not be measured. It was, however, possible to measure the stronger primary field and thus obtain MMR results.

Tests as an FEM/TEM detector. Following modifications to the SQUID to avoid mechanical oscillations, and additional calibration work, tests of the SQUID as an EM detector were conducted over a massive sulphide deposit south of Canberra.

Initial tests were made with the SQUID acting as an in-loop three-component detector coupled to the SIROTEM. In this mode slew rate problems were encountered with the vertical primary field, and clipping circuits to the input of SIROTEM prevented tracking of variations in the Earth's magnetic field. The slew rate problem was overcome by bucking out the primary field by passing a fraction of the transmitter current through a Helmholtz coil surrounding the SQUID. However, the problem of clipping at the input to SIROTEM will require extensive design work, either in the form of a highpass filter between the SQUID and SIROTEM, or in the form of a remote reference system feeding an out-of-phase replica of the low-frequency geomagnetic fluctuations to a set of Helmholtz coils surrounding the SQUID sensor. Alternatively a better proposition may be to digitise and process the received waveforms on the digital acquisition system currently being developed by the Interim Engineering Services (IES) Branch for the Metalliferous Subsection.

Experiments were also conducted in the frequency domain using a low power audio-amplifer transmitting periodic noise or sinusoidal signals into a square loop, and recording the amplitude and phase of three magnetic field components at the loop centre with the SQUID and spectrum analyser. Transfer function measurements relating the magnetic field to the loop current from 100 Hz to 5kHz were made at two sites, one over a TEM anomaly and the other off the anomaly. The results are still being processed.

AIRBORNE SUBSECTION (R. Wells, D. Downie)

During 1981 the Airborne Subsection flew approximately 126 000 line-km of survey traverses with the Twin Otter (VH-BMG) and approximately 63 000 line-km with the Aero Commander (VH-BMR). Most of the Subsection's resources were allocated to data acquisition and data processing, with only a few minor data assessment and interpretative projects undertaken.

On 30 June, 1981 Trans Australia Airlines ceased responsibility for crewing and maintaining BMR's aircraft. During the first half of 1981 H.C. Sleigh Aviation had provided most of these services to BMR under subcontract to TAA. Accordingly a short term contract was awarded to H.C. Sleigh Aviation to allow operations to continue while a long-term contract by open tender was obtained. This has taken much longer than expected but it is hoped that a contract will be awarded in early 1982.

A total of 116 maps were released (Table MA 2).

Albany-Fraser Block airborne magnetic and radiometric survey, WA 1981
(K. Horsfall, J. Dale, J. Eurell, J. Mangion, E. Chudyk, S. Wilcox)

In 1976 BMR commenced a systematic program of airborne coverage of the southern Yilgarn and Albany-Fraser Blocks in Western Australia following a request for such work from the Department of Mines, Western Australia. At the end of 1980 the following areas had been surveyed:
HYDEN, DUMBLEYUNG, NEWDEGATE, BREMER BAY, MOUNT BARKER, PEMBERTON, COLLIE, and RAVENSTHORPE (northern half).

In the period 14 January to 6 May 1981 an airborne magnetometer and gamma-ray spectrometer survey of the remaining sheets in the Albany-Fraser Block, WA was flow using the Twin Otter aircraft (VH-BMG) equipped with a fluxgate magnetometer taking readings five times per second, a multi-channel gamma-ray spectrometer with 16 800 cc of NaI crystal detector, doppler navigation, and digital data acquisition. Owing to navigation problems recognised after the survey, a small program of reflying was done in the period 8 to 16 August.

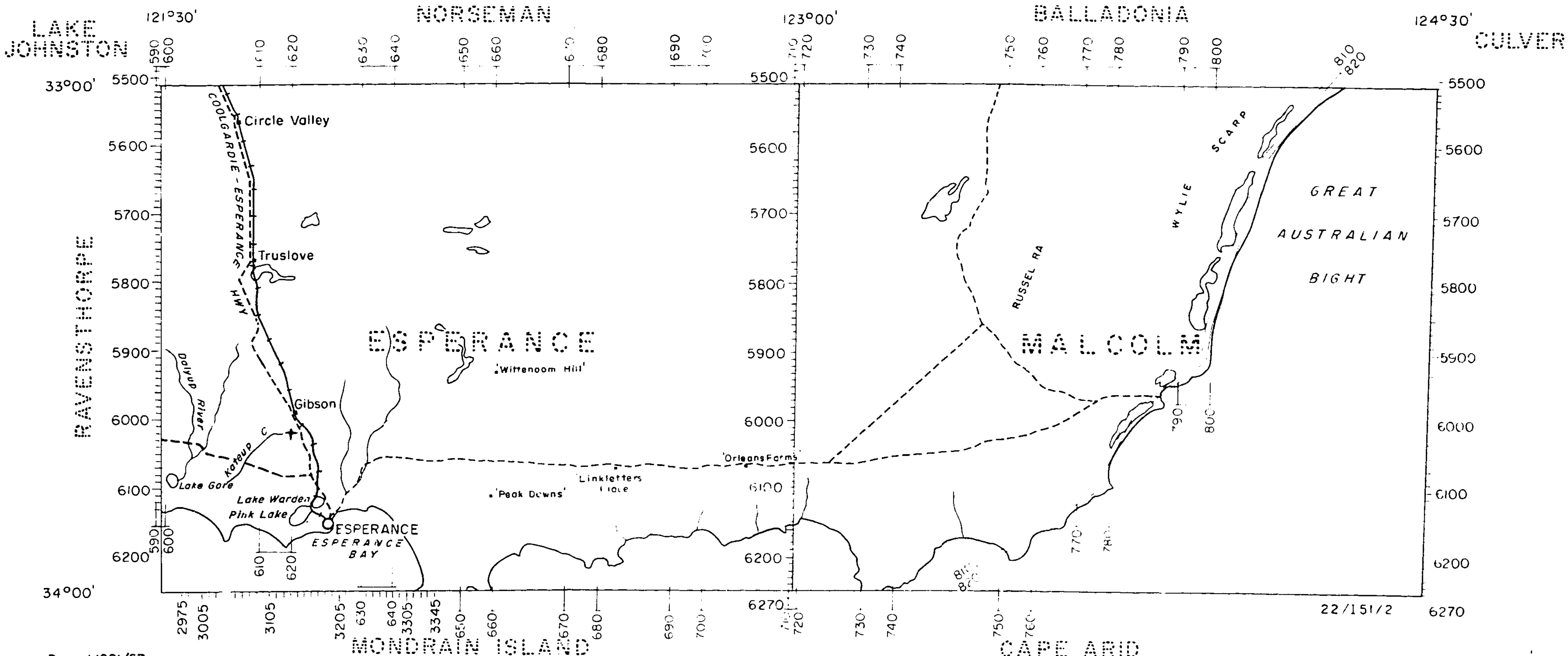
Total survey coverage amounted to 53 000 line-km flown at 1.5 km line spacing 150 m above ground level. Areas flown were the southern part of RAVENSTHORPE, and all of ESPERANCE, MALCOM, BALLADONIA, and ZANTHUS (Figs. MA 8 and MA 9).

Data are now in the preliminary processing stage. Preliminary profiles have been released for RAVENSTHORPE and it is anticipated that the remaining areas will be processed by mid-1982. Following this, a team will be assembled to interpret all Albany-Fraser regional geophysical and geological data.

Murray Basin airborne magnetic and radiometric survey, Vic/NSW 1981 (N. Sampath, J. Mulder, S. Sheard, G. Green, M. Schimizzi, S. Wilcox).

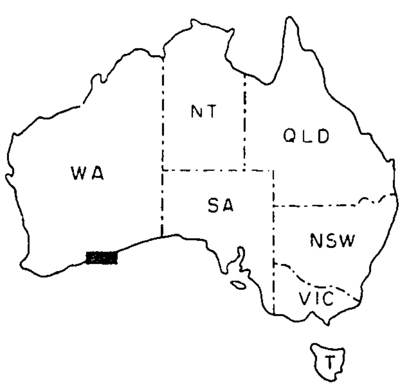
At the request of the Geological Branch, BMR, an airborne magnetic and radiometric survey was flown by the Aero Commander (VH-BMR) between 7 April and 1 August 1981 over the central part of the Murray Basin, covering ANA BRANCH, POONCARIE, BOOLIGAL, MILDURA, BALRANALD, OUYEN, and SWAN HILL as shown in Figure MA 10. A total of 53 000 line-km was flown at 3 km line separation and 150 m ground clearance with flight lines oriented east-west.

The aircraft was equipped with a proton precession magnetometer, 4-channel gamma-ray spectrometer, and digital data acquisition system. Magnetic data were recorded every second with a resolution of 0.25 nT. The four spectrometer channels, total count, potassium, uranium, and thorium, were recorded every second.



Record 1981/57

LOCALITY MAP



AIRBORNE SURVEY

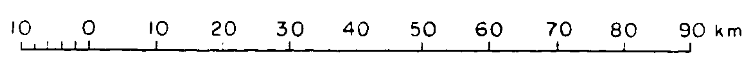
ALBANY – FRASER BLOCK, WA 1981

(ESPERANCE, MALCOLM)

LOCALITY MAP

AND

FLIGHT – LINE SYSTEM

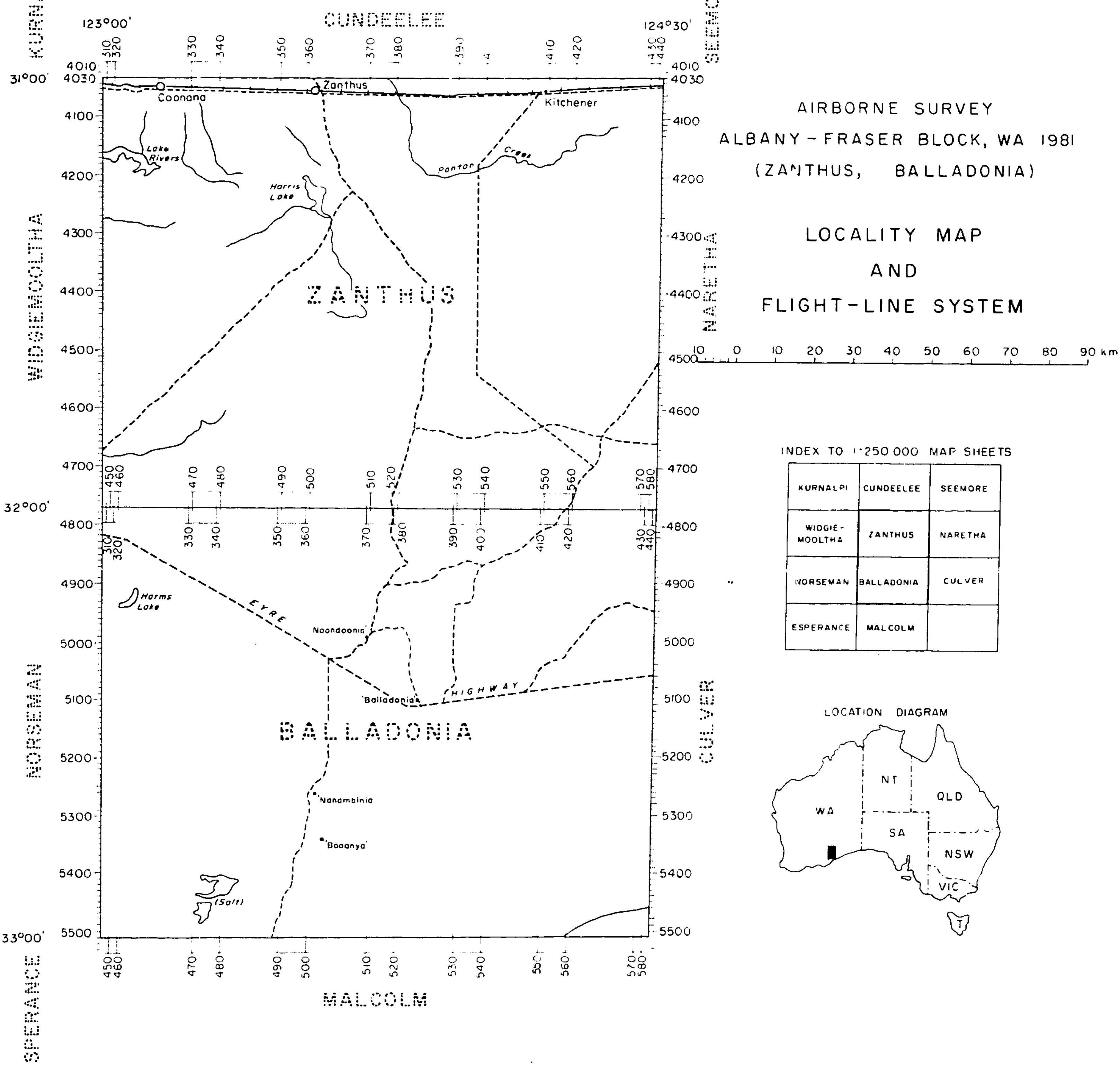


INDEX TO 1:250 000 MAP SHEETS

LAKE JOHNSTON	NORSEMAN	BALLADONIA	CULVER
RAVENS-THORPE	ESPERANCE	MALCOLM	
	MONDRAIN ISLAND	CAPE ARID	

Fig. M18

Fig. MA 9



22/WA/2

This project originated as a result of the Geological Branch's involvement in a joint BMR-States (SA, Vic., NSW) hydrological study of the Murray Basin which commenced in 1979. Although the emphasis for the study is on hydrology, the Basin's potential for all minerals including hydrocarbons, coal, heavy minerals, and sedimentary uranium is to be considered. This will be done via a geological synthesis involving the compilation of available information on the Cainozoic sequence as well as pre-Tertiary infra-basins underlying the Tertiary. Geophysics is expected to make an important contribution in determining the type and shape of the basement, hence the requirement for the digitally based airborne survey over a region with limited previous coverage of varying data quality.

A preliminary inspection indicates that the magnetic field over the eastern part of the survey area is basically undisturbed with only very low amplitude-long wavelength anomalies. Low-amplitude anomalies with shorter wavelengths trending north-west were recorded in ANA BRANCH, MILDURA, OUYEN, and SWAN HILL. The spectrometer data were uniform, indicating little variation in radioelement concentrations and providing little evidence for surficial accumulations of uranium mineralisation or heavy minerals.

Maps displaying survey data are expected to be released progressively through the second half of 1982. Following this, a team will be assembled to interpret all regional geophysical and geological data.

<u>Darling Basin airborne magnetic and radiometric survey, NSW 1981</u> (I. Zadoroznyj, S. Sheard, K. Horsfall, M. Bacchin, J. Mulder, J. Mangion, G. Green, E. Chudyk, S. Wilcox).

At the request of the Petroleum Exploration Branch, BMR, an airborne magnetic and radiometric survey was flown by the Twin Otter (VH-BMG) between 18 August and 16 November 1981, and the Aero Commander (VH-BMR) in August, over the Darling Basin covering MANARA and IVANHOE (commenced in 1980), WILCANNIA, COBHAM LAKE, WHITE CLIFFS, MILPARINKA, URISINO, LOUTH, and BARNATO as shown in Figure MA 10. The Aero Commander, equipped with a proton precession magnetometer, was used to fly most of the tie lines. The Twin Otter, equipped as above, flew all the survey lines and some tie lines in the south. Survey lines were flown east-west, except in LOUTH and BARNATO, with a separation of 3 km and a flying height of 150 m above ground. The total survey distance flown amounted to 56 000 line-km.

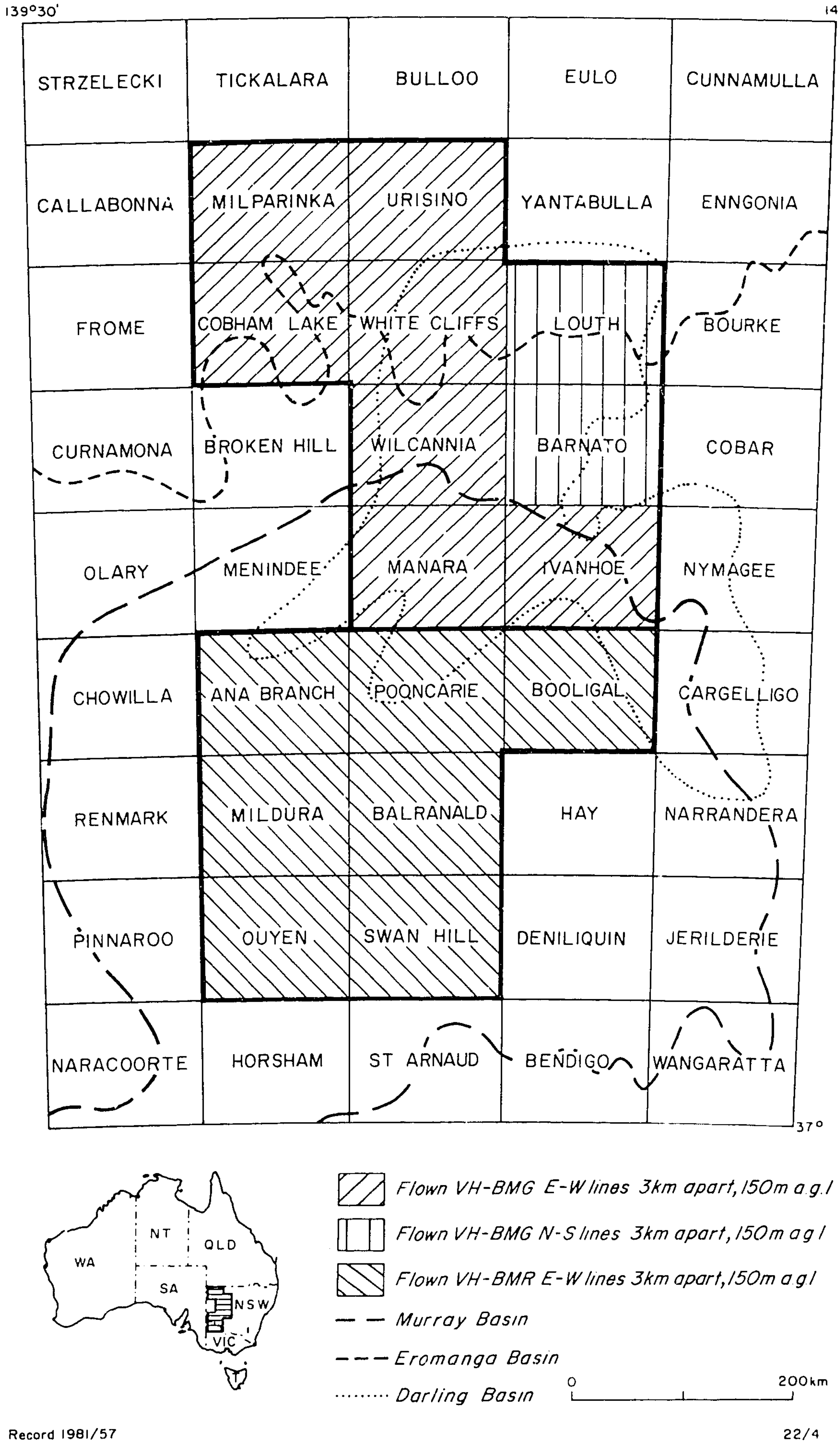


Fig. MA 10. Airborne survey, Murray-Darling Basins, 1981

The project originated as a result of reviews made by the Petroleum Exploration Branch, commencing in 1978, of the Basin's potential for petroleum accumulation. These assessments indicated that the prospectivity of the basin is only poor; however they are based on inadequate data. Because of its strategic position it was determined in 1980 that further investigation was essential, an aeromagnetic survey being proposed as the first step in a new regional program of investigation aimed at providing a better guide to future detailed exploration using seismic methods. The sparse aeromagnetic coverage flown previously in this region by companies was not considered adequate for this purpose. The specific objectives of the new work are:

(1) In conjunction with the gravity data, outline the extent of the Darling Basin sediments and the distribution and depth of the various troughs within the Basin.

(2) Help to define the type of margins to the troughs - fault bounded, erosional contact, etc.

(3) Indicate type of basement.

(4) Indicate degree of metamorphism of sediments westward from the Cobar area.

A preliminary inspection reveals that the magnetic field over MANARA and IVANHOE is very flat with a few, small-amplitude, high-frequency anomalies that suggest magnetic sources within the sedimentary section. Further north, in COBHAM LAKE the field is more disturbed with anomalies up to 500 nT. This disturbance continues into MILPARINKA, decreasing in amplitude to the north, and is believed to be the magnetic expression of the underlying rocks of the Kanmantoo Fold Belt. In WHITE CLIFFS and URISINO, magnetic anomalies are of smaller amplitude and are sparsely scattered. These probably reflect features of the underlying Eromanga Basin basement. In LOUTH and BARNATO, there are a few broad anomalies along the eastern edge over rocks of the Lachlan Fold Belt,marking the eastern boundary of the Darling Basin.

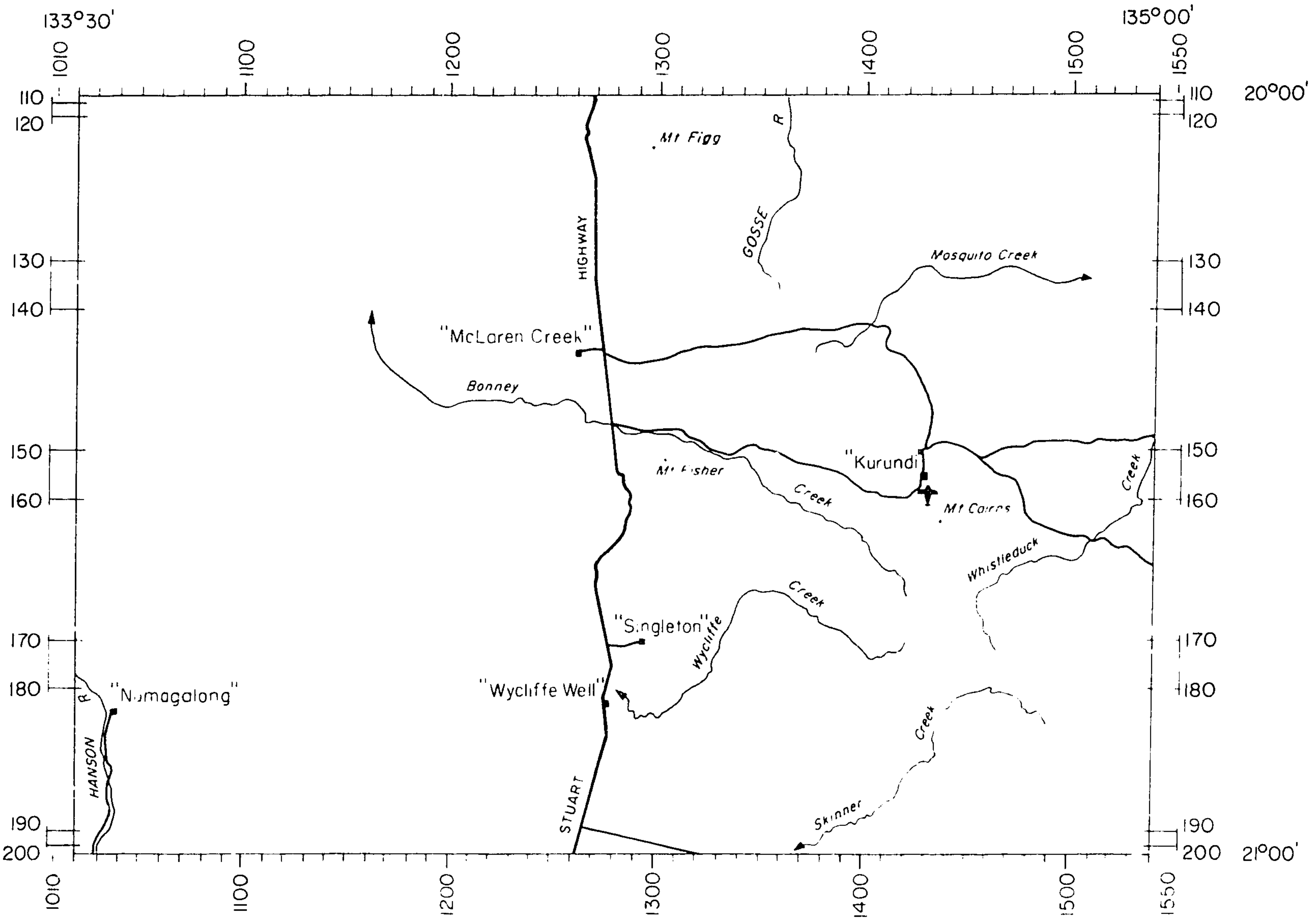
Data processing should be completed by late 1982, when maps will be released through the Government Printer Copy Service. Following this, a team will be assembled to interpret all regional geophysical and geological data.

Davenport Geosyncline airborne magnetic and radiometric survey, NT 1981

(B. Wyatt, R. Almond, J. Eurell, E. Chudyk).

Airborne magnetic and radiometric surveys of BONNEY WELL and the Hatches 1:100 000 Sheet area (Fig. MA 11 and 12) were flown between 11 June and 29 July 1981. The work was done to assist the Davenport Geosyncline

Fig. MA II



AIRBORNE SURVEY BONNEY WELL, NT, 1981.

(DAVENPORT RANGE PROJECT)

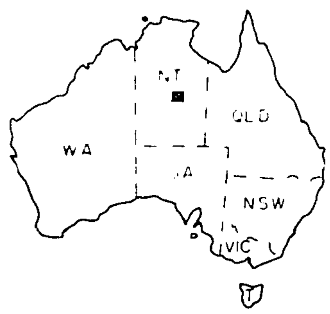
LOCALITY MAP

AND

FLIGHT-LINE SYSTEM

0 10 20 30 40 50 km

LOCATION DIAGRAM



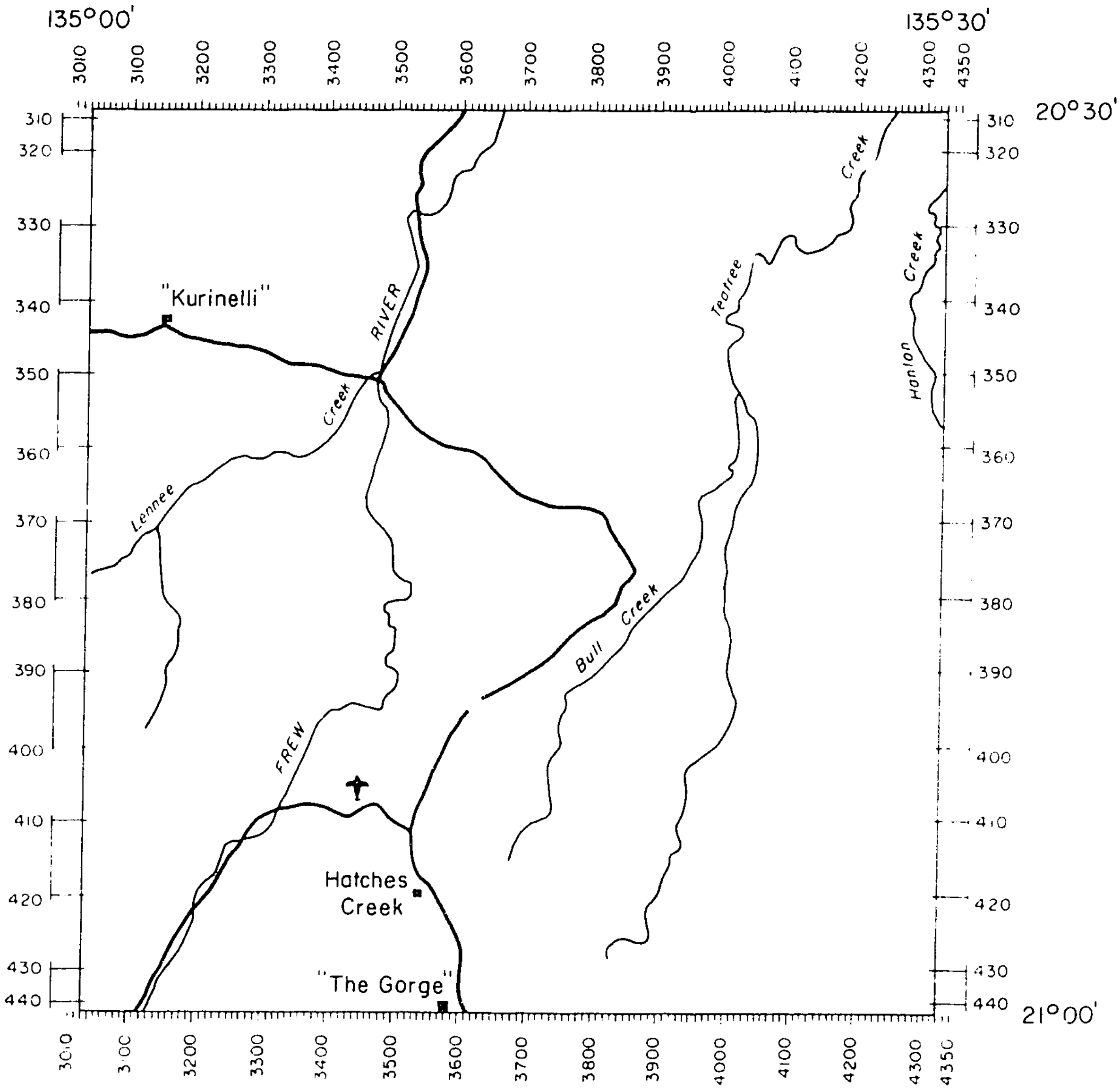
REFERENCE TO 1:250 000 MAP SERIES

GREEN SWAMP WELL	TENNANT CREEK	ALROY
LANDER RIVER	BONNEY WELL	FREW RIVER
MOUNT PEAKE	BARROW CREEK	ELKEDRA

Record 1981/57

22/F53-2/1

Fig. MA 12



AIRBORNE SURVEY HATCHES, NT, 1981.

(DAVENPORT RANGE PROJECT)

LOCALITY MAP

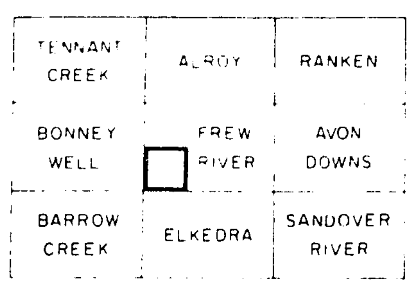
AND

FLIGHT-LINE SYSTEM

0 5 10 15 20 25 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES



multidisciplinary project by providing basic data that may help define the geophysical characteristics of the geosyncline and thereby assist geological mapping and mineral exploration.

The Twin Otter aircraft (VH-BMG), equipped as above, flew 16 600 line-km of useful work. BONNEY WELL was covered with lines flown north-south at 3 km spacing 150 m above ground level. A more detailed survey was flown over Hatches Sheet area with 400 m line spacing and at an altitude of 100 m above ground. Line orientation was north-south.

It is expected that preliminary maps will be available in the first half of 1982 and the results will be interpretated in the second half of the year.

Investigation of Minninup uranium anomaly, WA (K. Horsfall, J. Dale)

In May 1981 BMR, in collaboration with the WA Geological Survey, conducted a ground investigation of a conspicuous uranium anomaly detected during the 1980 airborne survey of COLLIE. The anomaly is located within a zone of swampy depressions 250 m inland from the coast, near Minninup, approximately 15 km south of Bunbury.

The anomaly was located on the ground with the aid of two portable gamma-ray spectrometers and ground samples were taken in the region of highest radioactivity. Analyses by both BMR and WA Geological Survey gave uranium concentrations in the range 2-4 ppm with a maximum in one sample of 12 ppm. The amplitude of the airborne anomaly is indicative of a uranium concentration of over 150 ppm if uranium is in equilibrium with its daughter products.

It now seems most likely that the high uranium anomaly is due to a daughter product of uranium, possibly radium-226, which has been leached from a distant uranium source and transported into the swamp, where chemical conditions have fixed the daughter element. Alternatively, uranium may be present in higher concentrations at depths below that sampled.

Canning Basin East airborne magnetic and radiometric survey, WA, preliminary data assessment (S. Sheard).

The airborne radiometric and magnetic survey of the eastern margin of the Canning Basin, covering the southern half of GORDON DOWNS and all of BILLILUNA, LUCAS, and STANSMORE, was completed in September 1980. Preliminary flight path maps, total magnetic intensity profiles, radiometric profiles, and radio altimeter profiles, were released in July-August 1981.

Magnetic data. The most obvious features are the complex magnetic anomalies evident over rocks of the Granites-Tanami Block. Different granite phases are evident from the various patterns of magnetic anomalies. Examples are high-frequency anomalies up to 50 nT amplitude prominent along the eastern boundary of BILLILUNA and LUCAS, which contrast with groups of lower frequency but larger amplitude anomalies extending into the western half of BILLILUNA. Preliminary interpretation suggests depths ranging from near surface to about 4000 m below surface for the sources of these anomalies.

The expressions of the magnetic basement within the Canning and Birrinduda Basins are subtle. The orientation of the north-south profiles is not ideal and tends to obscure some of the magnetic features. However, the Billiluna Shelf can be identified as a relatively shallow feature extending from the northern basin margin in western GORDON DOWNS and BILLILUNA to the Mueller Fault in the south. This fault has a surface magnetic expression with high-frequency, low-amplitude anomalies trending southeast, which appear to terminate as a north-south splay fault system in the centre of LUCAS, marking the boundary of the Billiluna Shelf and the Betty Terrace. The Stansmore Fault, at the boundary of the Betty Terrace and the deeper Fitzroy Trough, is not obvious in the magnetic data, although a subtle magnetic gradient change may indicate a change in basement depth along a southeast trend in STANSMORE. In the southwest corner of STANSMORE relatively shallow-seated magnetic anomalies define the boundary of the Barbwire Terrace, near where recent drilling has shown the presence of petroleum.

Radiometric data. In areas of good rock outcrop, as in the Halls Creek Mobile Zone in GORDON DOWNS and the Gardiner Sandstone in BILLILUNA, the radiometric data correlate well with the mapped geology. However, apparent discrepancies are evident in some areas. The Lower Proterozoic Slatey Creek Granite, mapped in the eastern part of BILLILUNA, gives distinctive anomalies in the potassium channel. Further south the same rock unit, as mapped, gives no radiometric anomaly and would therefore seem to be of different origin. In STANSMORE and LUCAS the radiometric data indicate that the laterite-covered Permian outcrop is more extensive than mapped, its western boundary defining the Stansmore Fault.

The 1980 Canning Basin East survey has provided useful information relating to the margin of the basin. When considered in conjunction with data available from earlier subsidy surveys to the west it has been possible to establish priorities for further work in areas along the basin's margins to the south and southwest of the 1980 survey.

McArthur Basin preliminary magnetic interpretation (I. Zadoroznyj)

Magnetic data from the McArthur Basin in the Northern Territory have been analysed using two interactive magnetic inversion programs for depth estimates of magnetic sources.

The results have been presented as a computer-drawn contour map of depth to magnetic basement with no account taken of known geological trends, but including zero depth points of known outcropping basement. Areas of shallow source anomalies, which often obscure deeper basement have been defined. Long, linear magnetic features are shown which have been interpreted as either dykes or faults. Although considerable thicknesses of sediment, consistent with geological hypotheses, are indicated in some areas, elsewhere a deep magnetic source is evident within the crystalline basement, showing that a careful review of the depth interpretation is necessary. Further work will be done integrating all geophysical and geological results.

Airborne gamma-ray spectrometer calibration sites (S. Sheard, B. Wyatt, J. Dale)

BMR has established three calibration sites in NSW - two sites 20 km south of Dubbo and one immediately south of Dalgety - over which airborne gamma-ray spectrometer systems may be calibrated. These sites enable BMR to establish instrument sensitivity coefficients so that airborne data may be converted to apparent radioelemental concentrations.

The sites were selected for their differing ratios of radioelement concentrations, size, and uniform internal distribution of elements. These parameters were determined using airborne and ground sampling techniques. The results were analysed and are summarised in Figure MA 13.

The data have been made available to industry through a paper presented at the ASEG Second Biennial Conference in Adelaide during August 1981. However, it is necessary for company personnel to check with the NSW Department of Mineral Resources to obtain prior authorisation to record geophysical information over these localities for the purpose of instrument calibration.

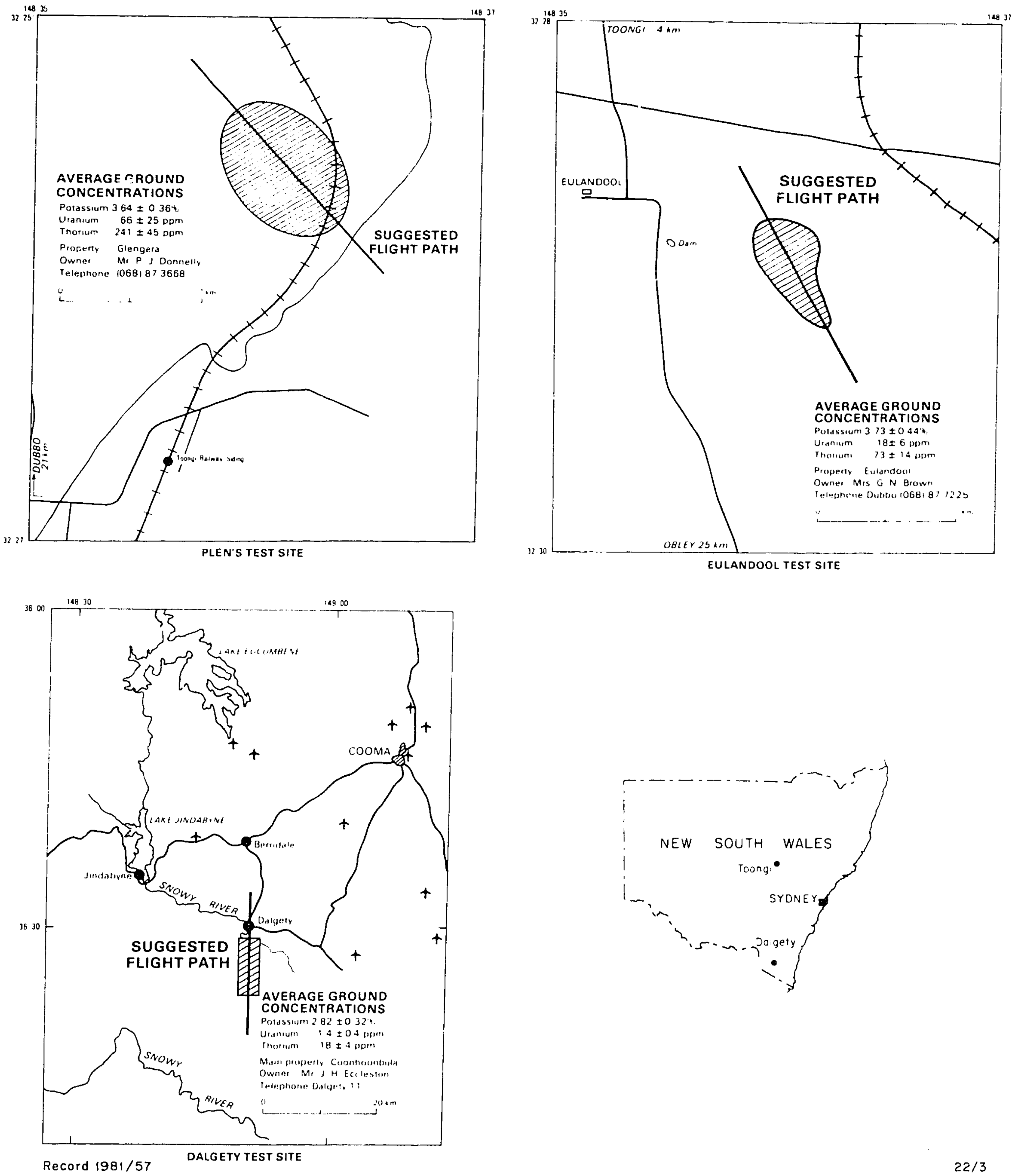


Fig. MA-13. Gamma-ray spectrometer calibration sites

AIRBORNE REDUCTIONS AND CONTRACTS GROUP (C. Leary, N. Sheard, N. Sampath, J. Dale, M. Bacchin, A. Luyendyk, D. Souter, P.O'Rourke, P. Black, R. Reitsma)

Airborne data processing

During 1981, work commenced or continued on data sets for 12 1:250 000 sheet areas. Of these, 4 were processed to completion. Work was also completed on two special purpose surveys, one in Queensland and one in NSW. The ALLIGATOR RIVER magnetic contours plus 8 1:250 000 sheets in NSW were reproduced photographically at 1:250 000 scale from 1:100 000 maps, and 6 of the 1:1 million series of magnetic contour maps were updated. The total output was 116 geophysical data maps (Table MA 2) all of which were released through the Australian Government Printer Copy Service. Data processing of 8 1:250 000 sheet areas will continue into 1982, and data for 20 areas await processing in 1982 when and if manpower becomes available. Also released through the Government Printer were 21 maps for GILGANDRA and DUBBO, which had been indexed for release in 1980 but which were delayed until January 1981. Total magnetic and total count contour maps are shown in Figures MA 14 to MA 23.

Supply of data to outside users

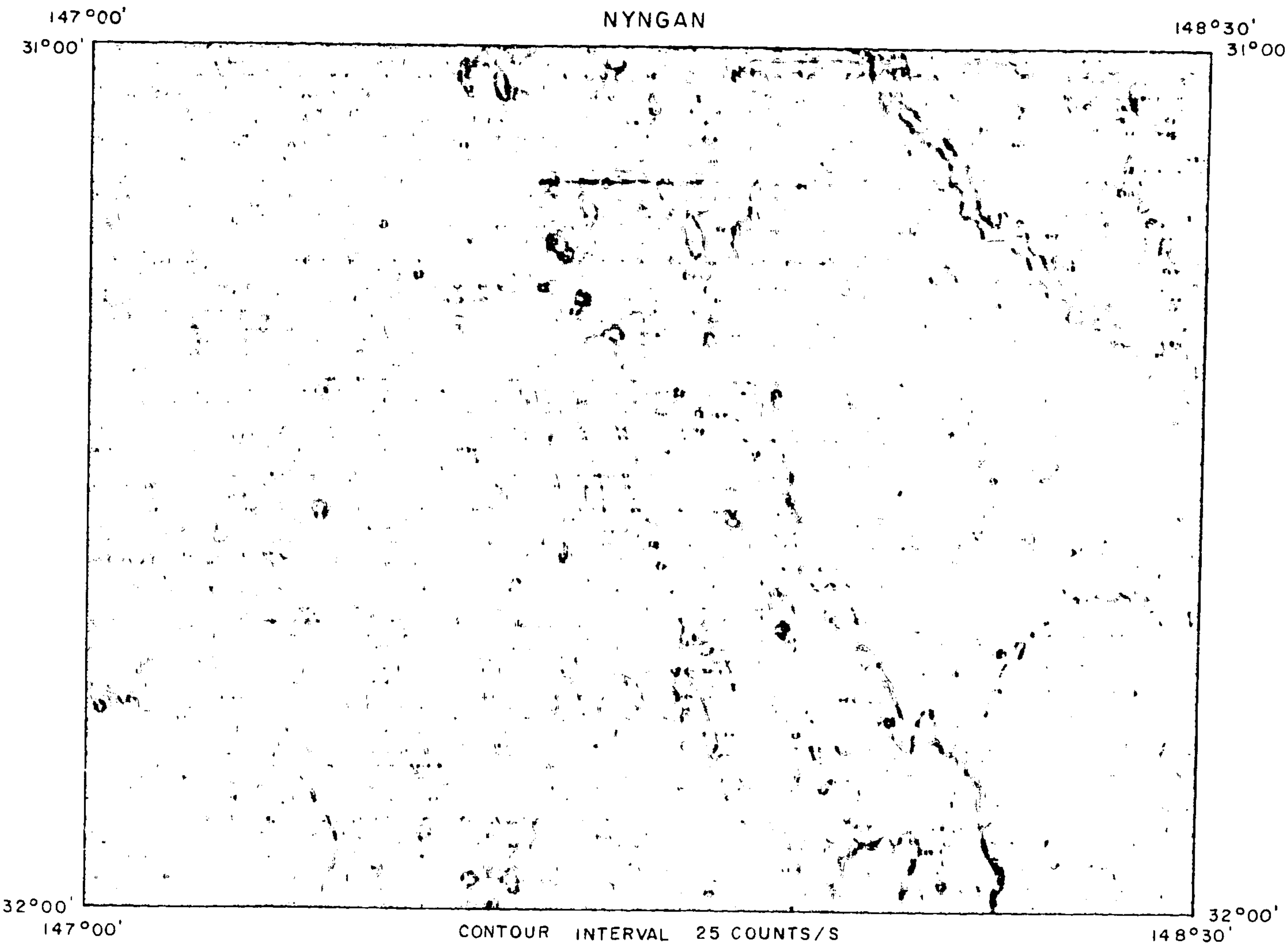
As at the end of October 1981, six organisations have sought access to or microfilm copies of the analogue data for a total of 85 1:250 000 map areas. The microfilm requirement was for 30 areas in WA, 11 in SA, 3 in NT, and 1 in NSW.

Analogue data access at BMR was sought for 24 areas in WA, 4 in NT, and 12 in Qld. All requests were satisfied.

For the same period, seven organisations sought digital copies of data for a total of 79 1:250 000 map areas. The requirement was for 33 areas in WA, 4 in SA, 24 in NT, 1 in Qld, 12 in NSW and 4 in Vic. With the exception of 8 areas in WA and 3 in SA, all requests have been satisfied by the supply of 125 digital data copies.

Two maps (Figs. MA 24 and MA 25) show the availability of magnetic and radiometric digital data for Australia.

Fig. MA 14

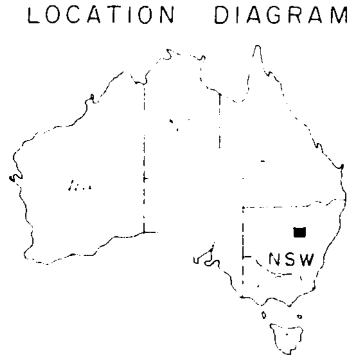


AIRBONE SURVEY, NYNGAN, NSW 1979

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

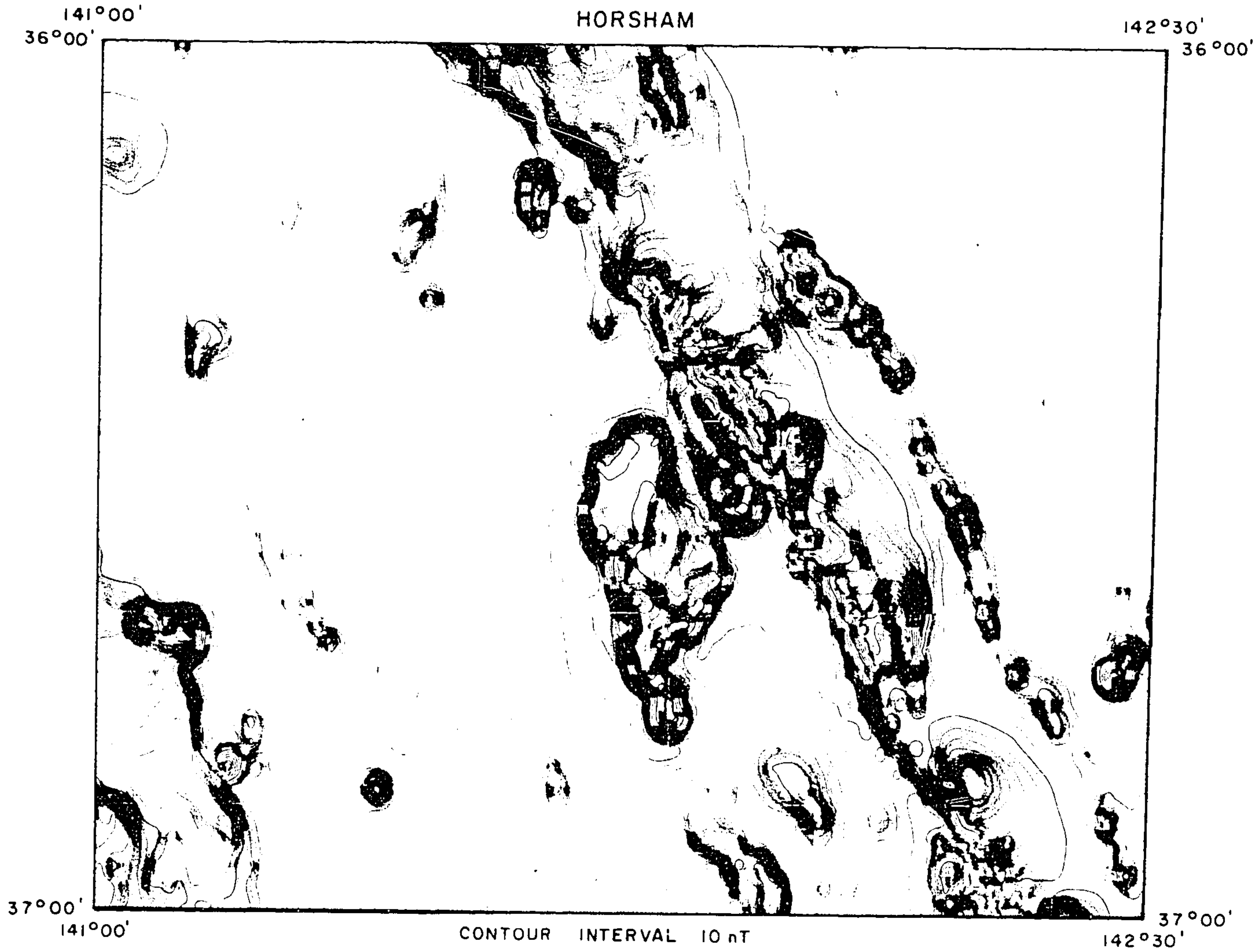
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

BOURKE	WALGETT	NARRABRI
COBAR	NYNGAN	GILGANDRA
NYMAGEE	NARROMINE	DUBBO

Fig. MA 15



AIRBORNE SURVEY, HORSHAM, VIC 1980

TOTAL MAGNETIC INTENSITY

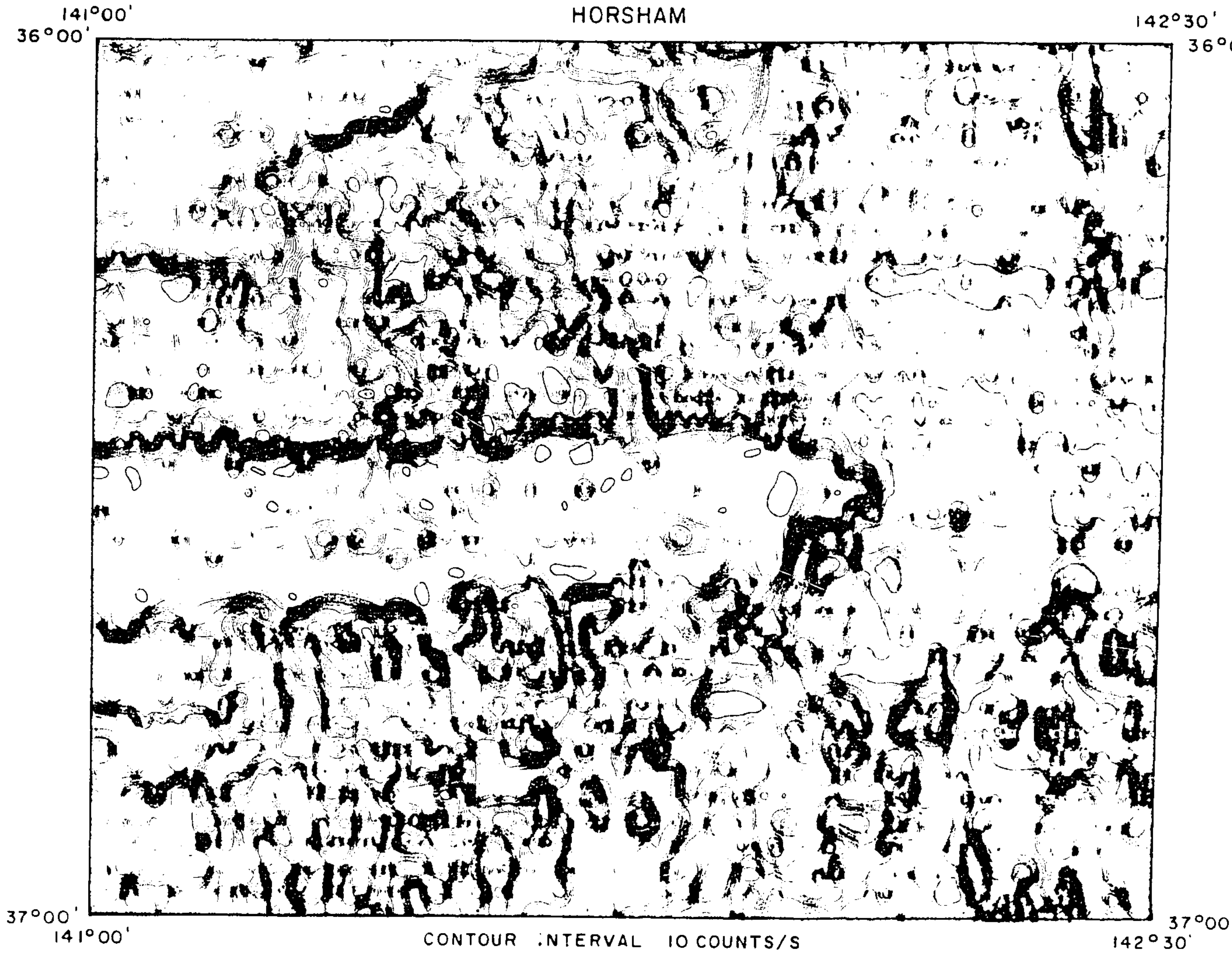
SCALE 1:1 000 000

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

PINNAROO	OUYEN	SWAN HILL
NARACOORTE	HORSHAM	ST. ARNAUD
PENOLA	HAMILTON	BALLARAT

Fig. MA 16



AIRBORNE SURVEY, HORSHAM, VIC 1980

RADIOMETRIC CONTOURS TOTAL COUNT

SCALE 1:1 000 000

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

PINNAROO	OUYEN	SWAN HILL
NARACOORTE	HORSHAM	ST. ARNAUD
PENOLA	HAMILTON	BALLARAT

Fig. MA 17

AIRBORNE SURVEY, NARACOORTE, SA 1980

TOTAL MAGNETIC INTENSITY

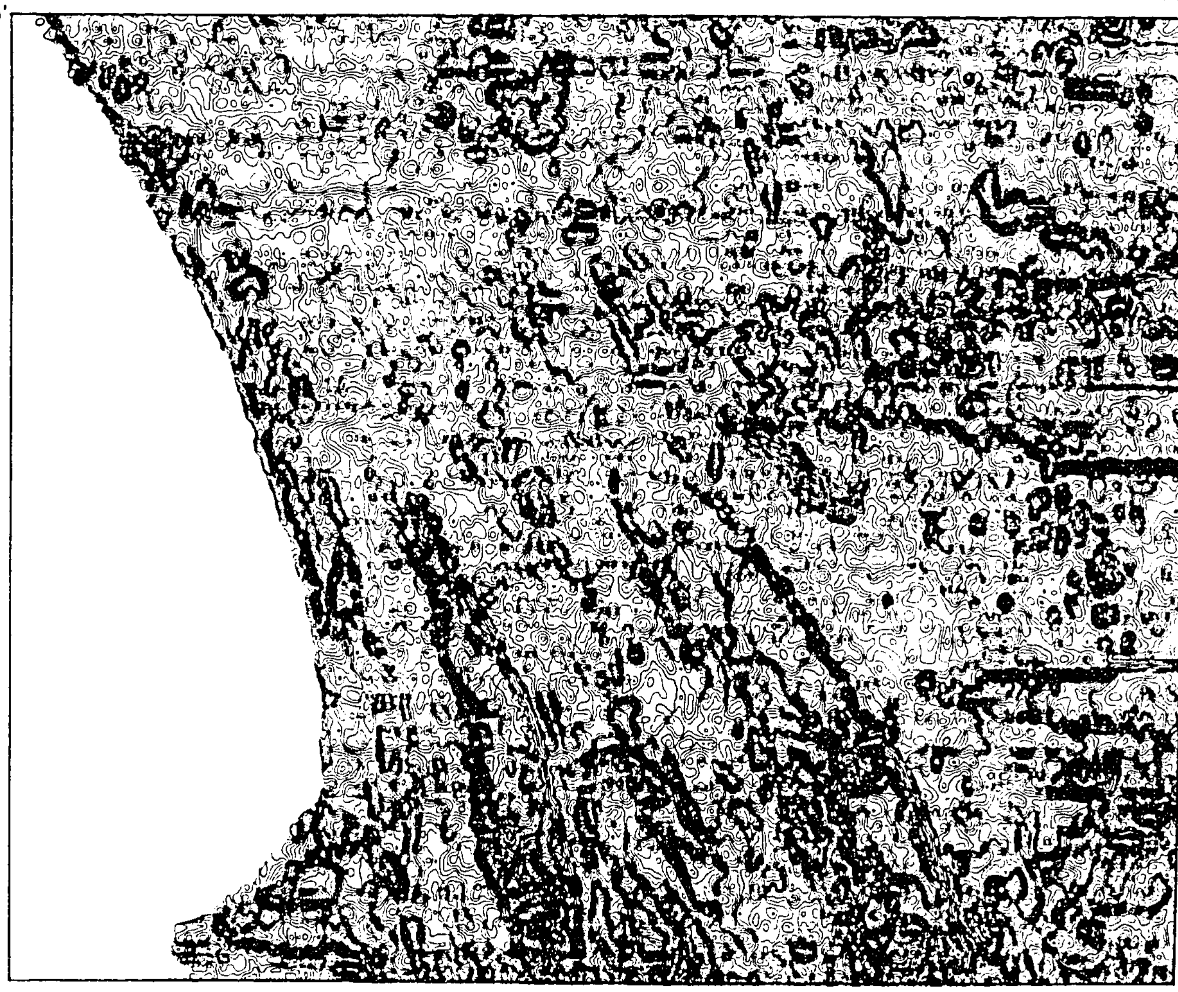
SCALE 1:1 000 000

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

BARKER	PINNAROO	OUYEN
	NARACOORTE	HORSHAM
	PENOLA	HAMILTON

Fig. MA 18

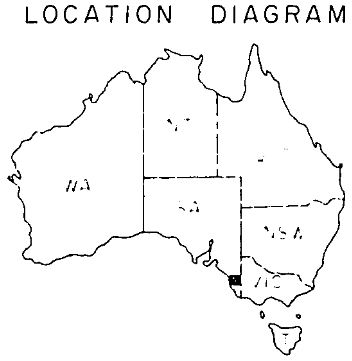


AIRBORNE SURVEY, NARACOORTE, SA 1980

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

LOCATION DIAGRAM

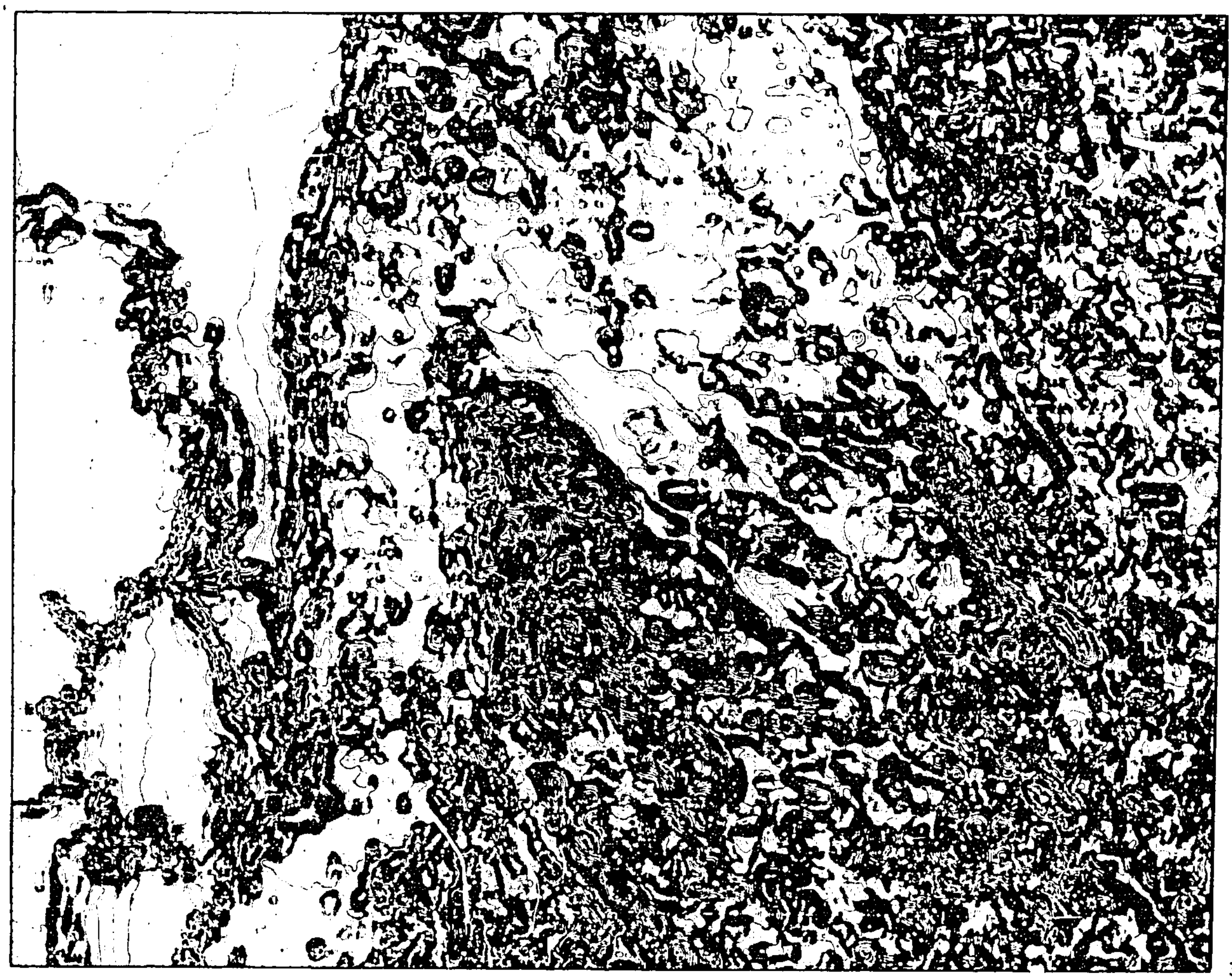


REFERENCE TO 1:250 000 MAP SERIES

BARKER	PINNAROO	OUYEN
	NARACOORTE	HORSHAM
	PENOLA	HAMILTON

Fig. MA 19

COLLIE



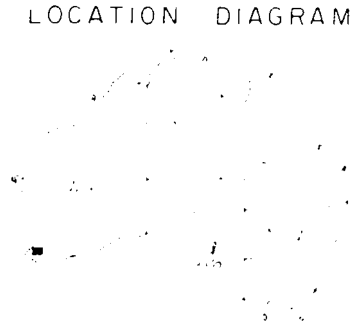
CONTOUR INTERVAL 10 nT

AIRBORNE SURVEY, COLLIE, WA. 1980

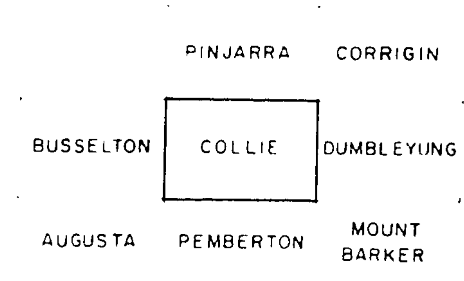
TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

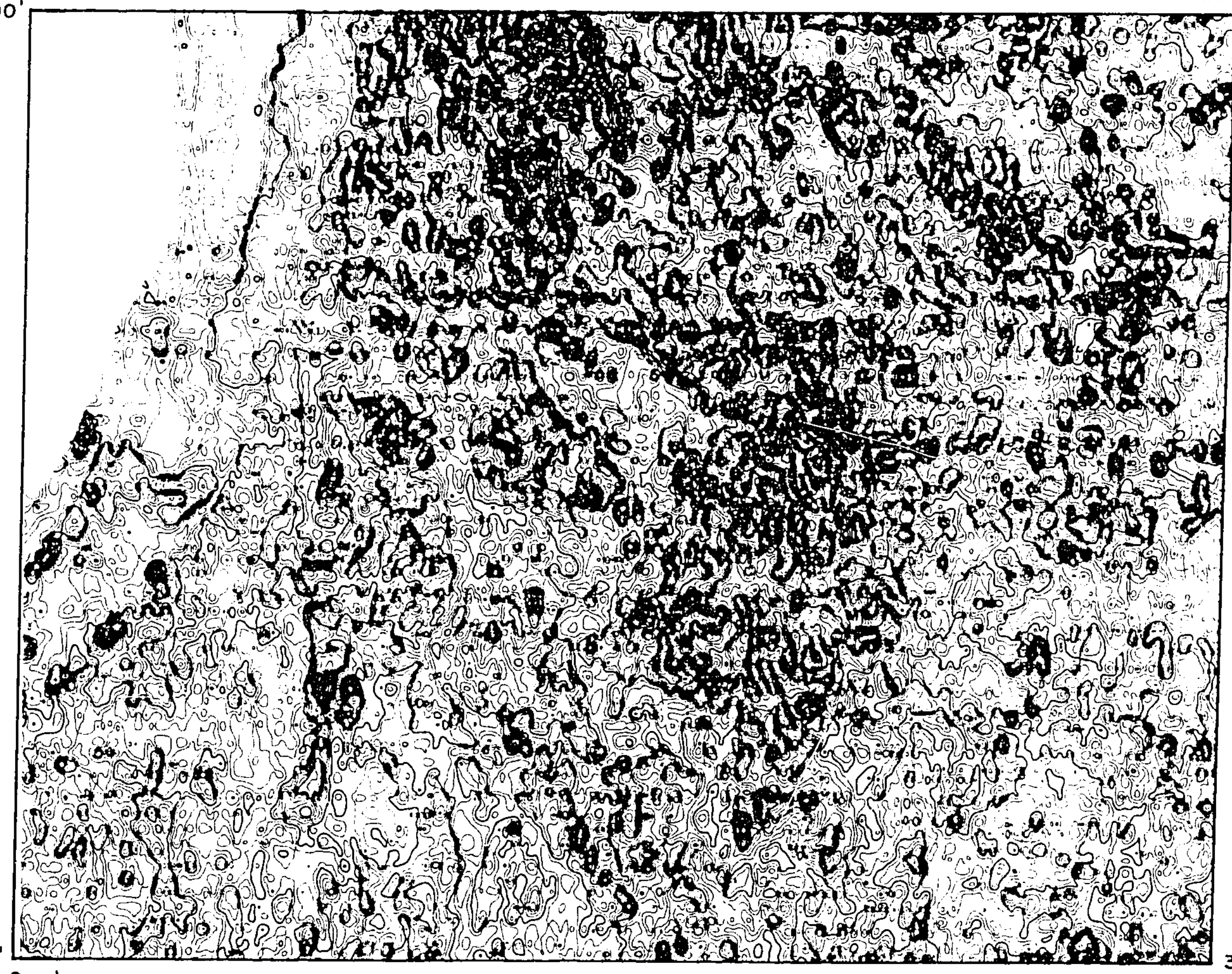


Record 1981/57

22/I50 -6/1

Fig. MA 20

COLLIE



CONTOUR INTERVAL 100 COUNTS/S

AIRBORNE SURVEY, COLLIE, WA. 1980

RADIOMETRIC CONTOURS TOTAL COUNT

SCALE 1:1 000 000

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

	PINJARRA	CORRIGIN
BUSSELTON	COLLIE	DUMBLEYUNG
AUGUSTA	PEMBERTON	MOUNT BARKER

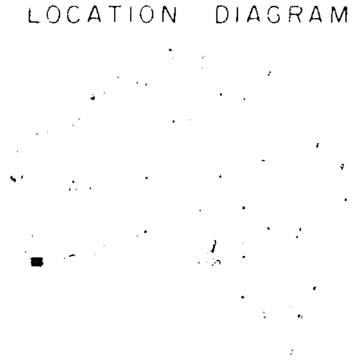
Fig. MA 21

AIRBORNE SURVEY, PEMBERTON, WA 1977/80

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

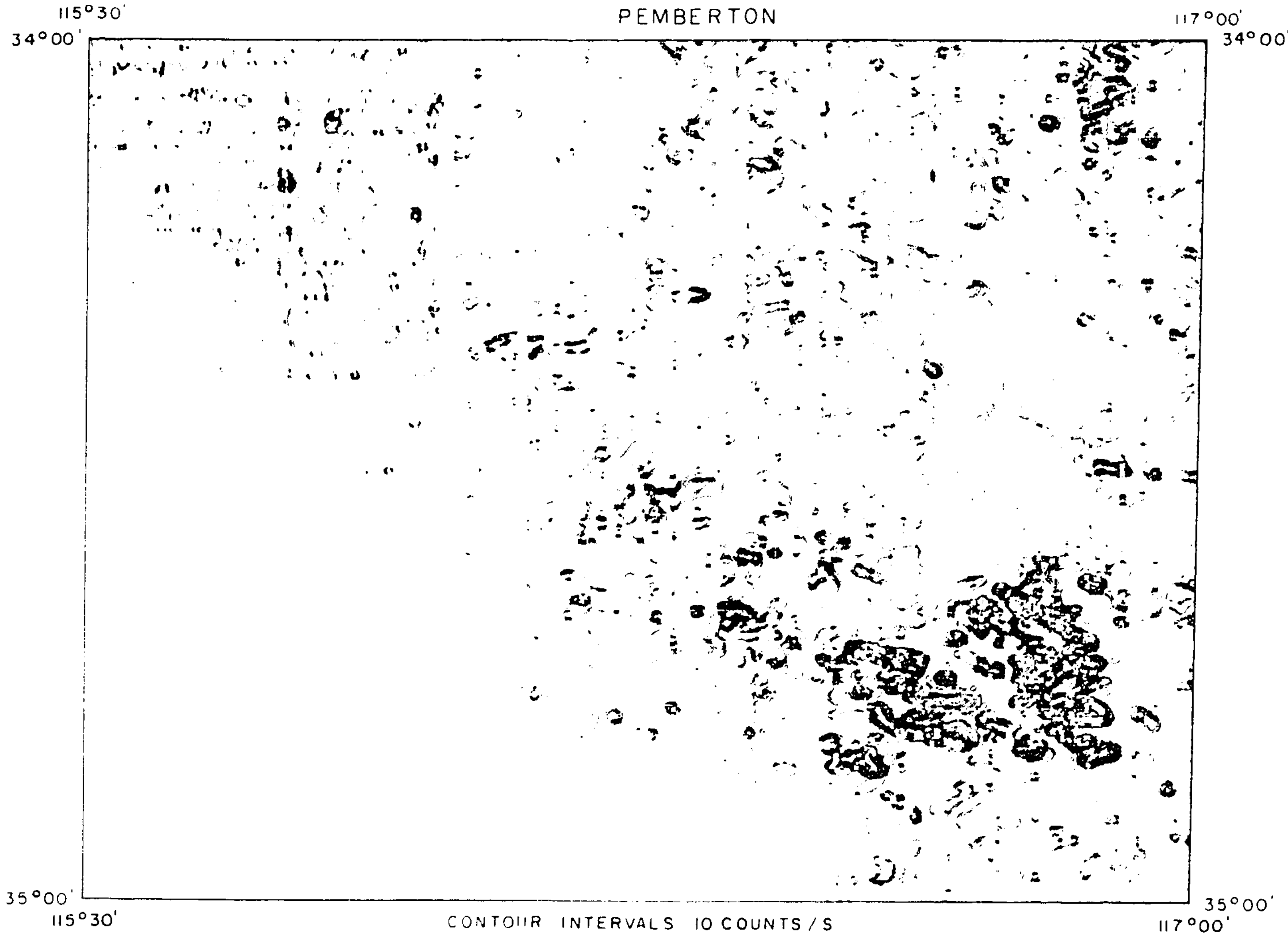
LOCATION DIAGRAM



REFERENCE TO 1 250 000 MAP SERIES

BUSSELTON	COLLIE	DUMBLEYUNG
AUGUSTA	PEMBERTON	MOUNT BARKER
	IRWIN INLET	ALBANY

Fig. MA 22



AIRBORNE SURVEY, PEMBERTON, WA 1977/80

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

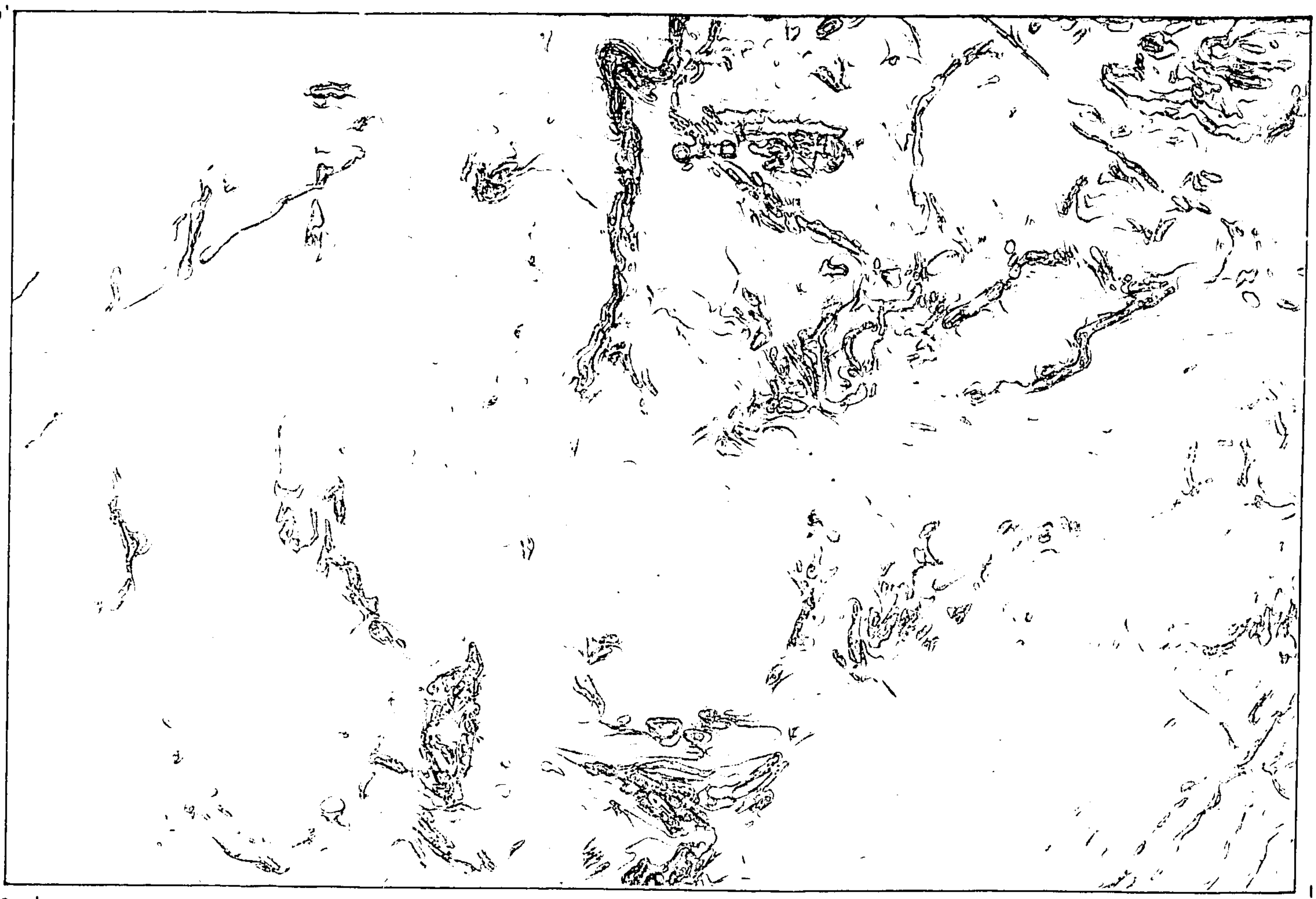
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

BUSSELTON	COLLIE	DUMBLEYUNG
AUGUSTA	PEMBERTON	MOUNT BARKER
	IRWIN INLET	ALBANY

Fig. MA 23

ALLIGATOR RIVER



CONTOUR INTERVAL 10 nT

AIRBORNE SURVEY, ALLIGATOR RIVER, NT 1971/72

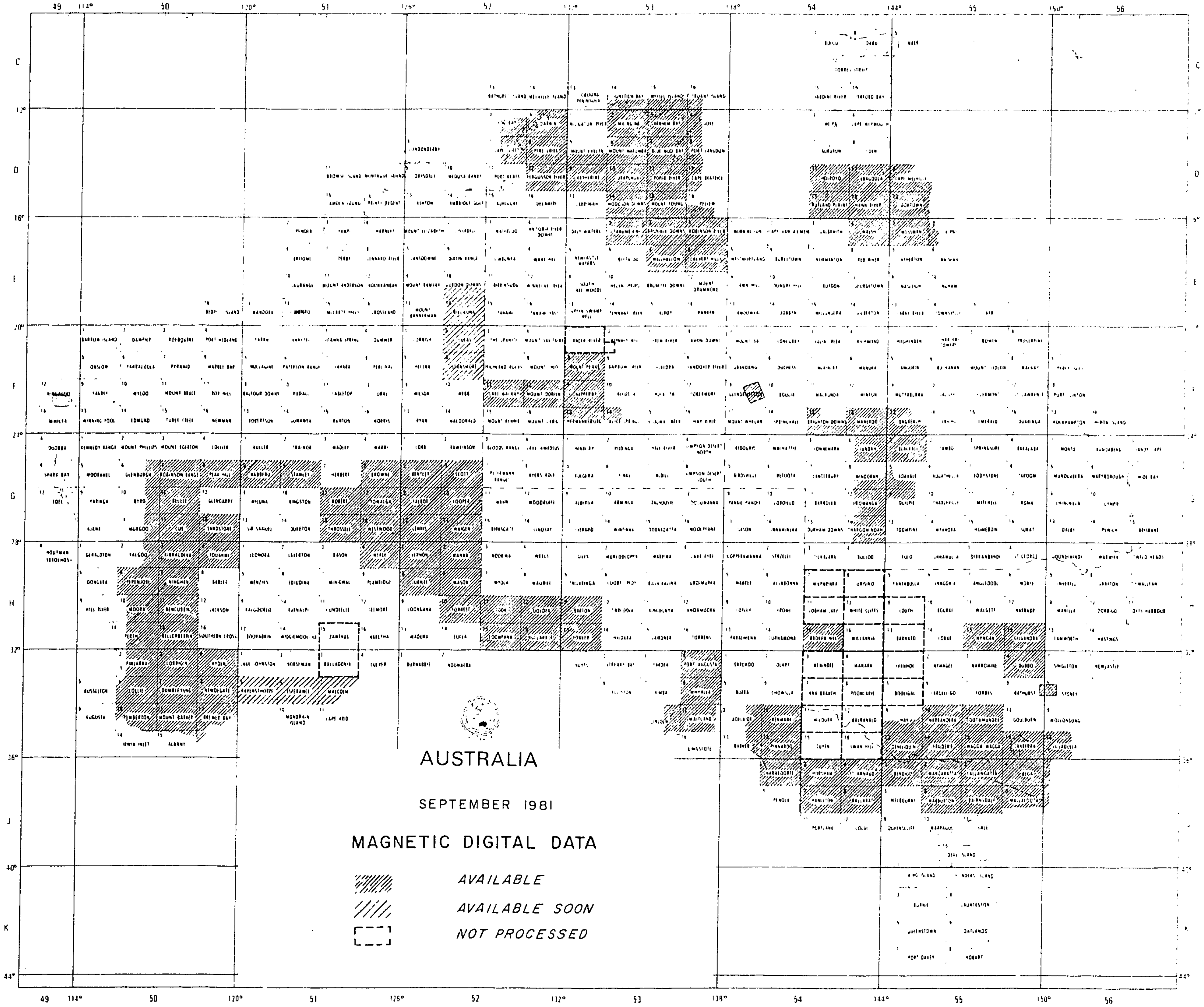
TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

MELVILLE ISLAND	COBOURG PENINSULA	JUNCTION BAY
DARWIN	ALLIGATOR RIVER	MILINGIMBI
PINE CREEK	MOUNT EVELYN	MOUNT MARUMBA



Record 1981/57

Figure MA 24

22/A/7

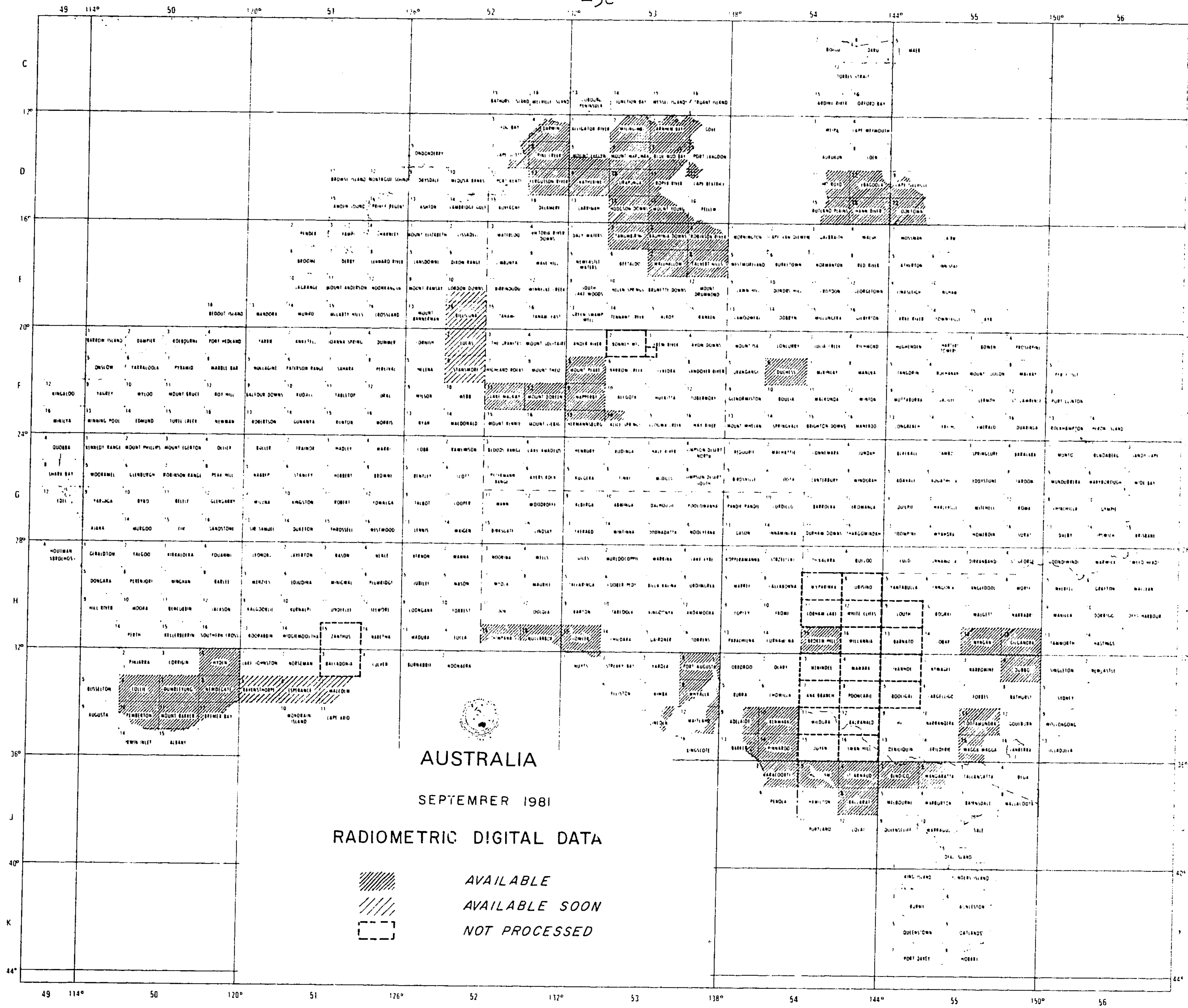

AUSTRALIA
SEPTEMBER 1981
RADIOMETRIC DIGITAL DATA
AVAILABLE
AVAILABLE SOON
NOT PROCESSED

Figure MA 25

Airborne ADP system development

The major projects undertaken were as follows:

1. Work continued throughout 1981 on the new gridding program with final testing nearing completion.
2. Marine Subsection's Werner deconvolution magnetic profile interpretation program was modified to permit its use within the Airborne Subsection system.
3. The magnetics archived for Eucla Basin have only the 8-second data levelled. A program was written to level the 1-second data by using the corrections applied to the 8-second data. The program has general application.
4. Programs were written to enter the Alligator River data, digitised from our analogue records by Mobil, into the Airborne Subsection data base.
5. A program was written to correct tapes archived via the HP2100 so that they can be read by CSIRO's Cyber 7600.
6. Random access I/O routines were developed to transfer data directly between large core memory and disc space on the Cyber 7600.
7. Significant additions were made to the suite of console programs and the library of job control statements. Both these facilities have proved very effective in increasing through-put and decreasing user errors.
8. A facility was provided to convert plotting symbols digitised by the Drafting Office into a format compatible with Airborne Subsection software.
9. Preliminary work was instigated on a program to compact survey data random access work files.
10. A general purpose program was written to enable basic processing of line/tie data. It provides a framework within which a routine can be rapidly written to carry out a specific task.

TABLE MA 1. Summary of physical properties of samples from Cleveland mine

Rock type	N	Range	Median	Mean	N	Range	Median	Mean
	Resistivity 1000 Hz (ohm-m)				Chargeability* M (0.24-1.14) (ms)			
Lode	44	2-8080	80	563	43	12-414	127	170
Lode/shale	1			593	1			49
DP Lode	2	70-8275		4173	2	3-7		5
Hanging Wall Basalt	7	70-7585	2555	2586	7	0-25	5	9
Footwall Sandstone	5	117-5272	2139	2434	5	5-25	7	13
	Saturated density (t/m^3)				Porosity (%)			
Lode	40	2.79-4.18	3.25	3.25	40	0.0-16.3	1.0	2.3
Lode/shale	1			2.98	1			0.0
DP Lode	4	2.81-3.23	3.12	3.07	4	0.5-8.9	1.6	3.1
Hanging Wall Basalt	4	2.82-3.05	2.99	2.96	4	0.7-14.9	5.4	6.6
Footwall Sandstone	5	2.33-2.76	2.64	2.58	5	1.4-22.4	5.9	9.0
	Susceptibility (SI x 10^6)				Koenigsberger ratio			
Lode	43	1510-306620	37700	53310	35	0.0006-84.76	1.90	6.61
Lode/shale	1			11940	1			3.71
Lode/chert	1			6660				
DP Lode	4	750-3020	1695	1790	4	0.1-2.0	1.02	1.02
Hanging Wall Basalt	7	750-4340	1380	1660	5	0.007-5.75	0.11	1.21
Footwall Sandstone	5	250-690	380	450	5	0.009-0.27	0.04	0.08

*The chargeability M (0.24-1.14) is given by the integral $\int_{0.24}^{1.14} Vs\,(t)/Vp\,dt$

where Vp and Vs are primary and secondary voltages, and t is in seconds.

TABLE MA 2.

AIRBORNE DATA PROCESSING/MAPPING RELEASES

X - Data Recorded
S - Data Stockpiled
P - Processing in Progress

C - Processing Completed
R - Maps & data released
FP - Flight Path

TMI - Total Magnetic Intensity
TC - Total Count Radiometric
Rad. - Radiometrics

STATE	SHEETS	SURVEY CONFIGURATION				PROCESSING			MAPPING		COMMENT	
		MAG.	RAD.	SPACING km	ALT. m	DATA STATUS	SCALE	NO. MAPS	CONTOURS	PROFILES		FIG.
NSW	Lithgow	x	-	1.0	1400	R	1:100.000	1	TMI	-	smoothed	
	Lithgow	x	-	1.0	1400	R	1:100 000	1	TMI	-	continued up	
	Lithgow	x	-	1.0	1400	R	1:100 000	1	TMI	-	continued down	
	Lithgow	x	-	1.0	1400	R	1:100 000	1	TMI	FP		
	Merindee	x	x	3.0	150	P	1:250 000	-	-	-		
	Ivanhoe	x	x	3.0	150	S	1:250 000	-	-	-		
	Manara	x	x	3.0	150	S	1:250 000	-	-	-		
	Ana Branch	x	x	3.0	150	S	1:250 000	-	-	-		
	Pooncarie	x	x	3.0	150	S	1:250 000	-	-	-		
	Booligal	x	x	3.0	150	S	1:250 000	-	-	-		
	Milparinka	x	x	3.0	150	S	1:250 000	-	-	-		
	Urisino	x	x	3.0	150	S	1:250 000	-	-	-		
	Cobham Lake	x	x	3.0	150	S	1:250 000	-	-	-		
	White Cliffs	x	x	3.0	150	S	1.250 000	-	-	-		
	Wilcannia	x	x	3.0	150	S	1.250 000	-	-	-		
	Louth	x	x	3.0	150	S	1:250 000	-	-	-		
	Barnato	x	x	3.0	150	S	1.250 000	-	-	-		
	Bathurst	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Bourke	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Cargelligo	X	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Cobar	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Forbes	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Goulburn	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Narromine	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Nymagee	x	-	1.6	150	R	1:250 000	1	TMI	-	revised scale	
	Nyngan	x	x	1.5	150	R	1:250 000	1	TC			MA 14
NSW/Vic	Mildura	x	x	3.0	150	S	1:250 000	-	-	-		
	Balranald	x	x	3.0	150	S	1:250 000	-	-	-		
Vic	Ouyen	x	x	3.0	150	S	1:250 000	-	-	-		
	Swan Hill	x	x	3.0	150	S	1:250 000	-	-	-		
Vic	Horsham	x	x	3.0	150	R	1:250 000		TMI			MA 15
	Horsham	x	x	3.0	150	R	1:250 000	1	TC			MA 16
	Horsham	x	x	3.0	150	R	1:250 000	1		TMI		
	Horsham	x	x	3.0	150	R	1:250 000	5		Rad.		
	Horsham	x	x	3.0	150	R	1:250 000	1		FP		
	Hamilton	x	-	-	-	R	1:1M	1	TMI		revised	
	Melbourne	x	-	-	-	R	1:1M	1			revised	
Qld	Glenormiston	x	x	1.0	100	R	1:125 000	1	TMI			
	Glenormiston	x	x	1.0	100	R	1:125 000	1		TMI		
	Glenormiston	x	x	1.0	100	R	1:125 000	1		TMI	surface	
	Glenormiston	x	x	1.0	100	R	1:125 000	1		FP		
Qld/NSW	Bourke	x	-	-	-	R	1:1M	1	TMI		revised	
SA	Naracoorte	x	x	1.5	150	R	1:250 000	1	TMI			MA 17
	Naracoorte	x	x	1.5	150	R	1:250 000	1	TC			MA 18

TABLE MA 2. cont'd

STATE	SHEETS	SURVEY CONFIGURATION				PROCESSING		MAPPING			COMMENT	
		MAG.	RAD.	SPACING km	ALT. m	DATA STATUS	SCALE	NO. MAPS	CONTOURS	PROFILES		FIG.
SA	Naracoorte	x	x	1.5	150	R	1:250 000	1		TMI		
	Naracoorte	x	x	1.5	150	R	1:250 000	5		Rad.		
	Naracoorte	x	x	1.5	150	R	1:250 000	1		FP		
	Santo	x	x	1.5	150	R	1:100 000	1	TMI			
	Santo	x	x	1.5	150	R	1:100 000	1		FP		
	Keith	x	x	1.5	150	R	1:100 000	1	TMI			
	Keith	x	x	1.5	150	R	1:100 000	1		FP		
	Cannawigara	x	x	1.5	150	R	1:100 000	1	TMI			
	Cannawigara	x	x	1.5	150	R	1:100 000	1		FP		
	Kingston	x	x	1.5	150	R	1:100 000	1	TMI			
	Kingston	x	x	1.5	150	R	1:100 000	1		FP		
	Lucindale	x	x	1.5	150	R	1:100 000	1	TMI			
	Lucindale	x	x	1.5	150	R	1:100 000	1		FP		
	Naracoorte	x	x	1.5	150	R	1:100 000	1	TMI			
	Naracoorte	x	x	1.5	150	R	1:100 000	1		FPight		
WA	Collie	x	x	1.5	150	R	1:250 000	1	TMI			MA 19
	Collie	x	x	1.5	150	R	1:250 000	1	TC			MA 20
	Collie	x	x	1.5	150	R	1:250 000	1		TMI		
	Collie	x	x	1.5	150	R	1:250 000	5		Rad.		
	Collie	x	x	1.5	150	R	1:250 000	1		FP		
	Collie	x	x	1.5	150	R	1:250 000	3		Ratios		
	Pemberton	x	x	1.5	150	R	1:250 000	1	TMI			MA 21
	Pemberton	x	x	1.5	150	R	1:250 000	1	TC			MA 22
	Pemberton	x	x	1.5	150	R	1:250 000	1		TMI		
	Pemberton	x	x	1.5	150	R	1:250 000	5		Rad.	W.third	
	Pemberton	x	x	1.5	150	R	1:250 000	1		FP		
	Pemberton	x	x	1.5	150	R	1:250 000	3		Ratios		
	Gordon Downs	x	x	1.5	150	P/R	1:250 000	1		TMI	S.half	
	Gordon Downs	x	x	1.5	150	P/R	1:250 000	5		Rad.		
	Gordon Downs	x	x	1.5	150	P/R	1:250 000	1		FP		
	Billiluna	x	x	1.5	150	P/R	1:250 000	1		TMI		
	Billiluna	x	x	1.5	150	P/R	1:250 000	5		Rad.		
	Billiluna	x	x	1.5	150	P/R	1:250 000	1		FP		
	Lucas	x	x	1.5	150	P/R	1:250 000	1		TMI		
	Lucas	x	x	1.5	150	P/R	1:250 000	5		Rad.		
WA	Lucas	x	x	1.5	150	P/R	1:250 000	1		FP		
	Stansmore	x	x	1.5	150	P/R	1:250 000	1		TMI		
	Stansmore	x	x	1.5	150	P/R	1:250 000	5		Rad.		
	Stansmore	x	x	1.5	150	P/R	1:250 000	1		FP		
	Albany	x	-	-	-	R	1:M	1	TMI		revised	
	Ravensthorpe	x	x	1.5	150	P/R	1:250 000	1		TMI		
	Ravensthorpe	x	x	1.5	150	P/R	1:250 000	5		Rad.		
	Ravensthorpe	x	x	1.5	150	P/R	1:250 000	1		FP		
	Esperance	x	x	1.5	150	P	1:250 000	-				
	Malcolm	x	x	1.5	150	P	1:250 000	-				
	Zanthus	x	x	1.5	150	S	1:250 000	-				
	Balladonia	x	x	1.5	150	S	1:250 000	-				
NT	Alligator River	x	x	1.5	150	R	1:250 000	1	TMI		revised scale	MA 23
	Bonney Well	x	x	3.0	150	S	1:250 000					
	Hatches	x	x	0.5	100	S	1:100 000					
	Cape Wessell	x	-	-	-	-	1:M	1	TMI		revised	

2. SEISMIC, GRAVITY AND MARINE SECTION

(A. Turpie)

SEISMIC AND GRAVITY SURVEYS (F.J. Moss)

The areas covered in the work of the Seismic and Gravity groups are shown in Figure SGM 1.

Central Eromanga Basin seismic and gravity surveys (F.J. Moss, J. Pinchin, S.P. Mathur, F.J. Taylor, K. Lockwood (PEB), B.R. Senior (Geol. Branch), O. Dixon (GSQ), M.J. Sexton, K. Wake-Dyster, W. Anfiloff, J.K.C. Grace, D. Gardner, G. Price, R.D.E. Cherry, L.A. Rickardsson, D.K. McIntyre, A.C. Takken, J.A. Somerville, W. Cox, D.W. Johnstone).

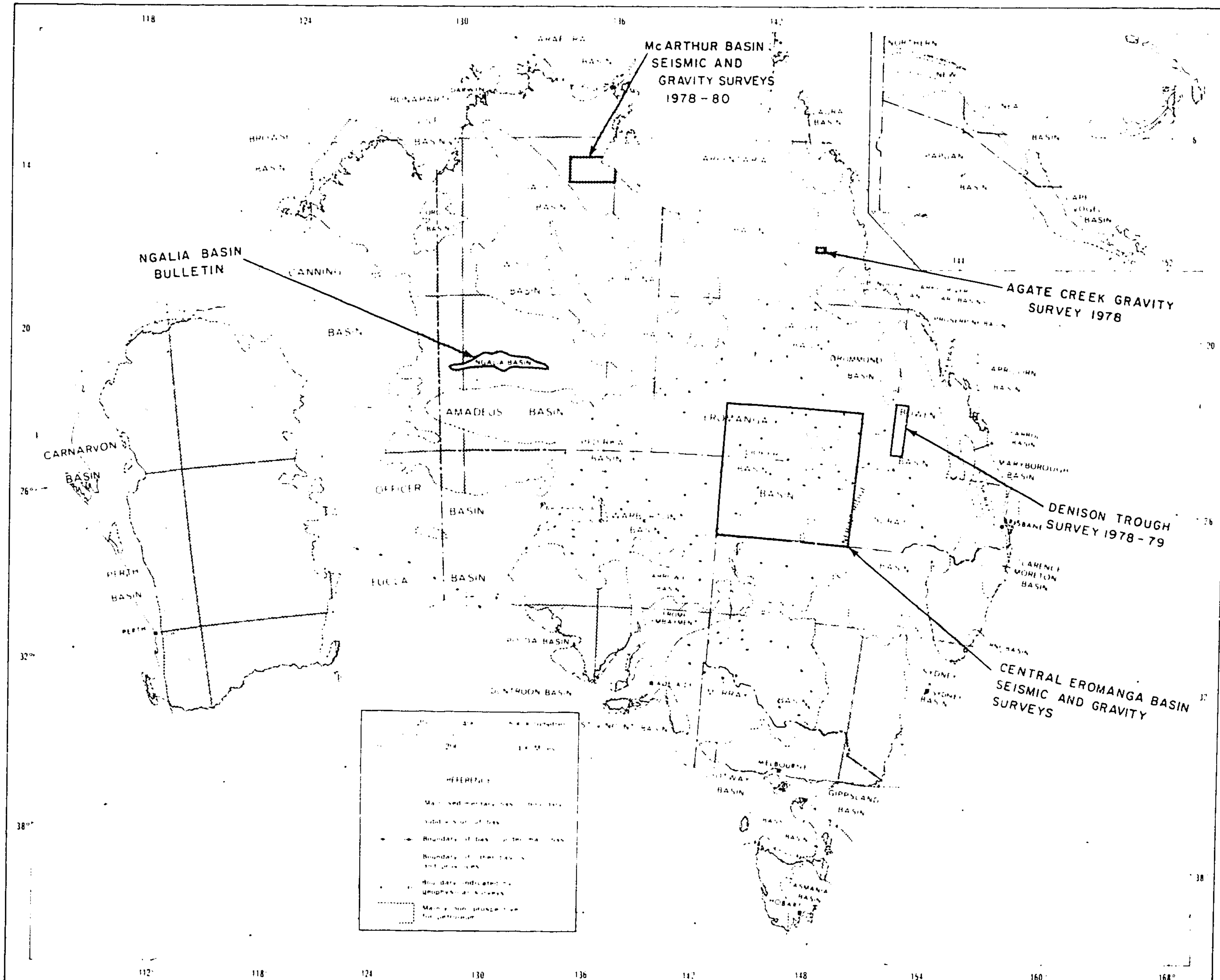
Seismic reflection surveys, 1980-1981. The broad objectives of the Central Eromanga Basin Project, outlined in BMR Record 1980/32, are to define the regional structural and depositional history of the central part of the Eromanga Basin and the underlying Cooper, Galilee, and Adavale Basins in southwest Queensland. Plans for seismic and gravity surveys in 1981, outlined in BMR Record 1981/33 (the preview report for the surveys), were to obtain regional 6-fold CDP coverage and gravity measurements at 0.5 km intervals -

(1) to complete traverses remaining from the 1980 program, particularly traverses 6 and 5 tying to Galway 1 and Barcoo Junction 1 wells respectively, and traverse 7 across the axis of the Cooper Syncline;

(2) to extend the investigation of the Jurassic-Cretaceous Thomson Syncline and underlying Devonian-Carboniferous Barcoo Trough by ties to the major Esso program in the Jundah area and ties to the Warbreccan wells;

(3) to commence work east of the Canaway Ridge to investigate the Quilpie Trough, tying to a proposed Esso program in the east, and to record a major traverse through the main part of the Adavale Basin through wells to tie to proposed company traverses in the Dartmouth area.

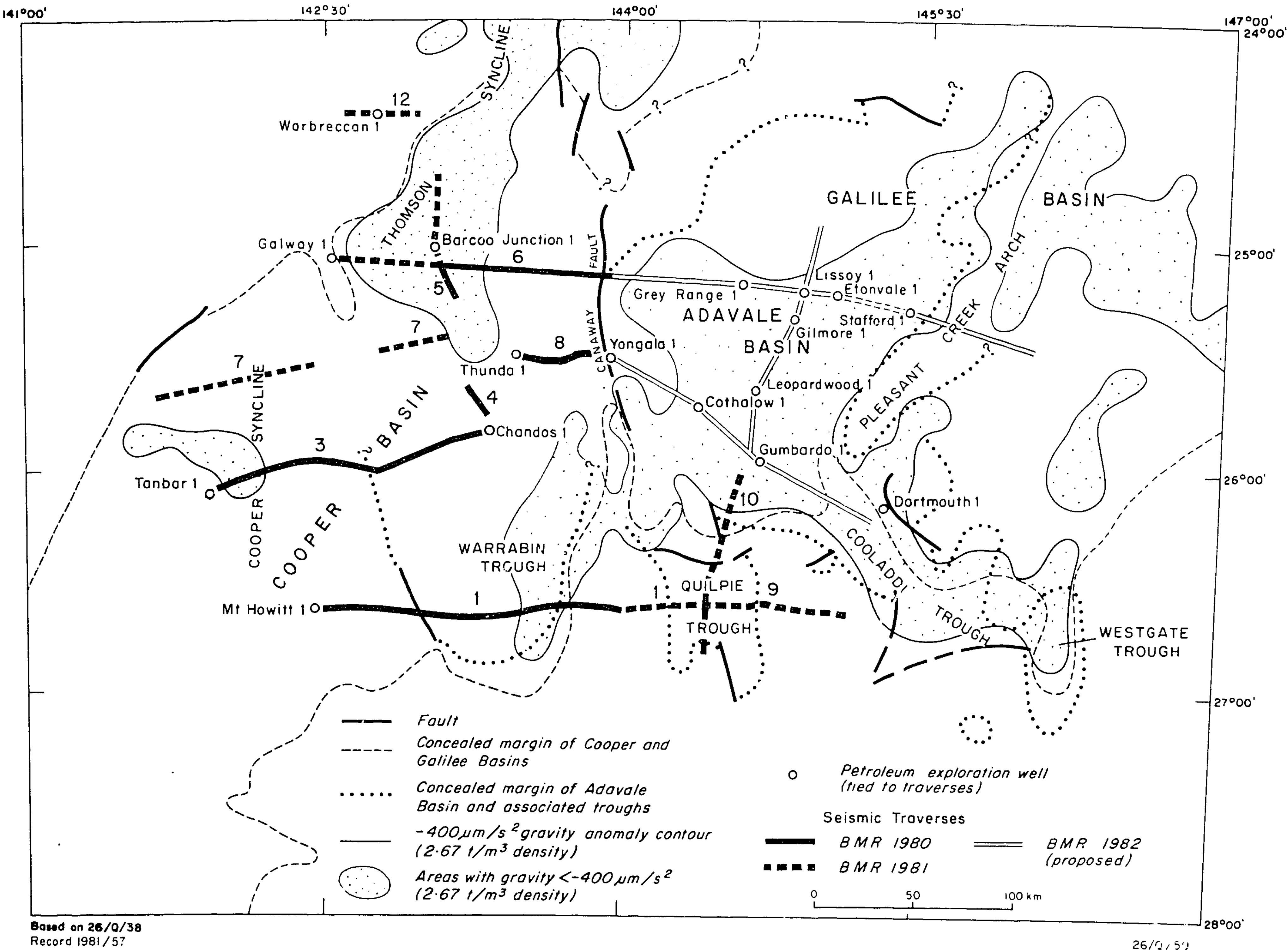
Approximately 450 km of seismic and gravity traversing was completed using 48-channel recording with 83-1/3 m geophone station spacing (Fig. SGM 2). Part of traverse 7 (35 km) about the Cooper Creek channels could not be completed because of lack of bulldozing, and insufficient time was available to



Record 1981/57

26/A/1

Fig. SGM 1. Areas covered by seismic and gravity reviews, reports and surveys



26/Q/59

Fig SGM 2. Central Eromanga Basin Project - main structural units, gravity low areas & BMR seismic traverses record the main east-west line through the Adavale Basin. Heavy rain causing boggy conditions at the start of the survey, extensive silcrete layers causing hard, slow drilling conditions in the Quilpie-Adavale area, and late rains causing flooding of the Thomson River and Cooper Creek channels, all contributed to slow survey progress and numerous changes of program. In addition, breakdown of arrangements for hiring a bulldozer and grader at the start of the survey and delays in making alternative arrangements caused further problems.

All reflection records were recorded to 20 s for deep crustal information. In addition, an 11-shot expanded spread with a maximum offset of 21 km was recorded on the main east-west traverse, near Quilpie, to provide velocity information on the deeper part of the section. The seismic party also drilled and loaded charges for large crustal refraction shots.

GSI, the data processing contractor, prepared final cross-section displays of work recorded during 1980. Selected sections with steeply dipping events and indications of faulting, were migrated. Deep crustal information was displayed to 16 s prior to arranging further detailed processing in the USA. Analogue to digital transcription and reprocessing of selected traverses from the Barcoo, Bulgroo, Quilpie, Trinidad, and Gumbardo subsidised seismic surveys was done to assist in interpretation projects. Brute stack sections were produced for the 1981 survey work.

The good quality seismic data (Fig. SGM 3) recorded over the Warrabin Trough west of the Canaway Ridge in 1980 enabled existing poorer quality pre-1971 seismic data to be re-interpreted, allowing the basic structural framework and margins of the Trough to be mapped. Sediments ranging in age from the lateral equivalents of the Devonian-Carboniferous Buckabie Formation and of the Middle Devonian Cooladdi Dolomite to possible early Devonian, possibly pre-dating sediments in the central part of the Adavale Basin in the east, were shown to be up to 3000 m thick along the axis of the Trough. The Warrabin Trough is folded and faulted by high-angle reverse faults which were active during the late Carboniferous. The Canaway Ridge, which is a fault-bounded basement horst, was uplifted at this time, and separates the Warrabin Trough from the main part of the Adavale Basin. Although suitable traps for hydrocarbons appear to be present, the petroleum potential of the Trough is unknown since exploration wells Bodalla 1 and Chandos 1, drilled on structural highs on the western flank of the Trough, penetrated only a small part of the sequence, and petroleum geochemical results from the wells were contradictory.

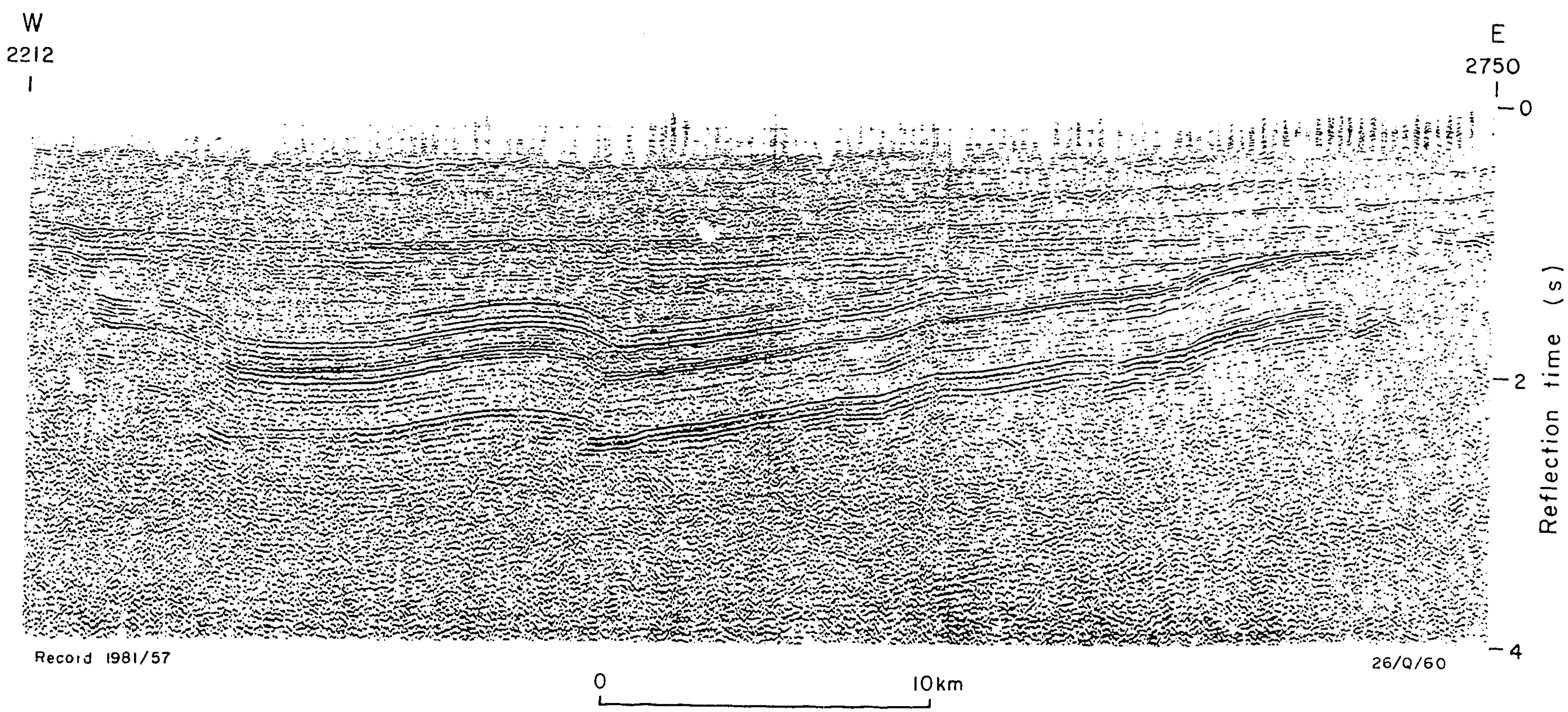


Fig. SGM3. Central Eromanga Basin, Traverse I, seismic section over Warrabin Trough

Another Devonian-Carboniferous trough, named the Barcoo Trough, which lies in the general area of the Thomson Syncline to the northwest of the Warrabin Trough, was only partly defined by the seismic and gravity work in 1980 but has been more clearly defined by the 1981 work. The Warrabin and Barcoo Troughs appear to be connected by a thin flat-lying to gently folded sequence of Devonian sediments.

The eastern extent of the Permian and Triassic sequences in the Cooper Basin is more clearly defined; the sequences do not extend as far eastwards over the southern part of the Warrabin Trough as previously interpreted. The seismic results show prograding within the Triassic near the basin margins. The Jurassic-Cretaceous Eromanga Basin sequence shows reflections which clearly illustrate the main structural features of the basin and its stratigraphy. Features such as shoaling and channelling which took place during deposition of the Toolebuc Formation are evident, and beds of coal and carbonaceous shale within the basal Winton Formation have a distinctive reflection character.

The Canaway Fault has been further investigated by the recent detailed seismic and gravity work which provides information on the nature and timing of the feature. The Canaway Fault is a normal, near-vertical, growth fault. The first major movement occurred in the mid-Carboniferous, splitting the western part of the Adavale Basin. The Adavale Basin sediments on the west of the fault were eroded significantly following the uplift. Smaller displacements continued during the Permian to Cretaceous, and a major movement took place in the middle of the Late Tertiary.

The seismic results from the 1981 survey will be processed and integrated with the results from previous seismic surveys and new seismic surveys done by the petroleum tenement holders, and interpreted to provide more information on the regional structure and stratigraphy of the area.

<u>LANDSAT and seismic reflection studies</u>. The surface expression of faults that displace the Warrabin Trough and younger basin sequences was sought through a study of LANDSAT imagery. The Central Eromanga Basin area has low relief, the exposed rocks are deeply weathered and mantled mainly by surficial sediments, and the weathered profiles have been warped and faulted. LANDSAT-interpreted lineaments have been compared with faults mapped from seismic reflection data in the Warrabin Trough area. Some faults are coincident with lineations. Some linear features are closely parallel to the faults. The studies were particularly useful in linking faults on widely-spaced seismic traverses. LANDSAT studies provided near-surface information on some faults which on

seismic reflection data appear to be confined to the deeper section. It was suggested that post-Cretaceous movements due to differential compaction or minor tectonic rejuvenation may have given surface expression to some of the deep-seated faults.

Deep crustal reflections. The deep reflection data recorded to 20 s were processed in USA using seismic computer systems at Cornell University and Virginia Polytechnic Institute. Using the COCORP's MEGASEIS system at Cornell University, brute stacks of traverses 1, 3, 6, and 8 were obtained, and several tests were carried out to determine the frequency content of the signal, vertical velocities from the wide-angle reflection data, and the effects of deconvolution, filtering, autostatics, and migration. Problems were encountered in migrating the 20 s data mainly because of the limited capacity of the MEGASEIS system. Further trials with velocity analysis and migration made using the DISCO system at Virginia Polytechnic Institute produced better results. A better selection of migration parameters, including the velocity function, is required to obtain good migrated sections. The brute stack of a section typical of the area is shown in Figure SGM 4. Below the zone of sedimentary reflections to about 2.0 s, the section shows a zone of sparse reflections, apart from the sedimentary multiples, in the upper part of the crust. On the other hand, the lower crust shows a zone of strong, but discontinuous and often intersecting reflections, between about 7 and 13 s (approximately 20 and 40 km). Below this zone, the section shows no reflections, but only some diffractions that originate in the lower crust. It is planned to publish these data in the journal 'Geophysics'.

Gravity interpretation. Gravity measurements made at 0.5 km intervals along seismic lines during the 1980 field season were interpreted to provide information on structures at various depths in the section. In particular, several deep troughs were indicated in areas where the quality of seismic reflection data is poor at depth. The presence or absence of Permian coal seams considerably affects seismic penetration, and where the coal is absent, seismic data reveal deep Devonian troughs coincident with gravity lows. Where the coal is present, the quality of deep reflections is poor; however such troughs are suggested in places by gravity lows alone.

The structure of the Canaway Fault was investigated along traverses 6 and 8. Gravity models based on seismic structure (Fig. SGM 5) show that the Canaway Fault has a close affiliation with a granite pluton which formed a topographic high prior to Devonian sedimentation.

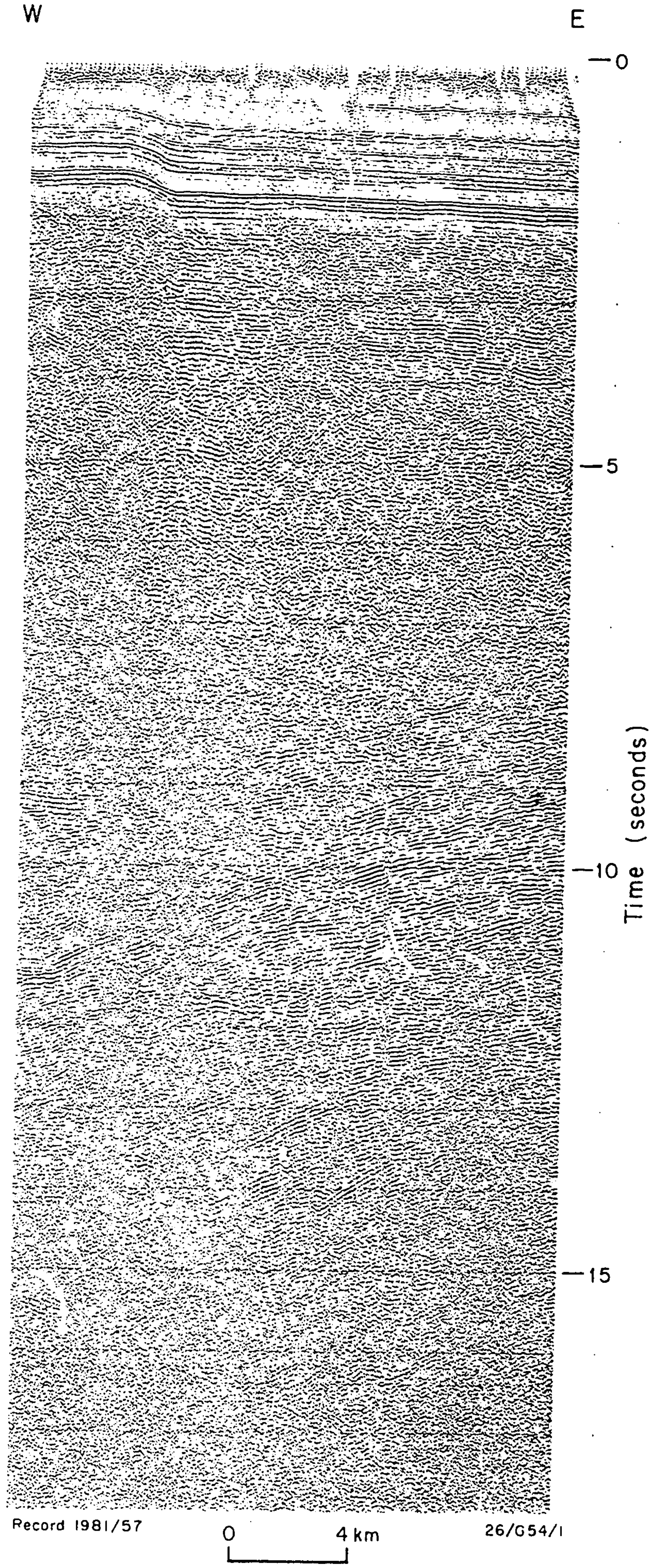


Fig. SGM 4. Central Eromanga Basin deep reflection section, Traverse I (West)

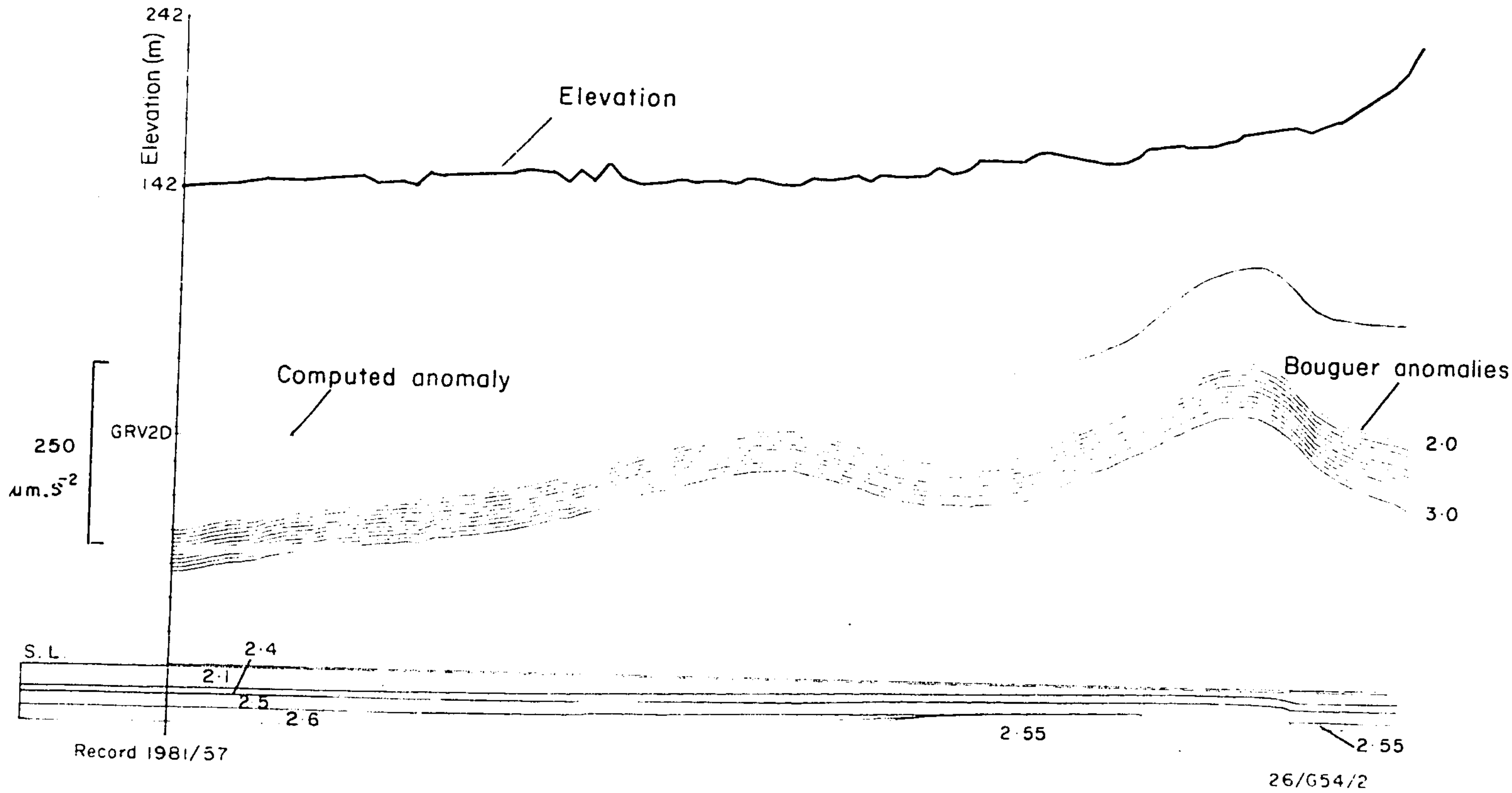


Fig. SGM 5. Central Eromanga Basin gravity profile and model Traverse 6 (East)

The basement block containing the granite was uplifted by movements across the Canaway Fault. Several kilometres of Devonian-Carboniferous sediments were cut off by this movement, and are now preserved on the eastern side of the fault.

Seismic reflection studies of the crust and upper mantle in NE Australia (S.P. Mathur)

A map has been prepared showing the type of basement rocks met in the deep exploration wells in NE Australia (136°30'-150°E, 20°-29°S). This is to assist in the interpretation of deep crustal reflections recorded during 1976-79 in the Galilee, Georgina, and Bowen (Denison Trough) Basins. A paper on the results is in preparation.

Geosutures and orogenic belts in the Australian continent (S.P. Mathur, R.D. Shaw (Geol. Branch))

The paper reviewing the geology and geophysics of the orogenic belts is being revised to submit to Earth Evolution Sciences for publication under the title 'Australian orogenic belts: evidence for evolving plate tectonics?'.

Denison Trough seismic and gravity surveys, Qld, 1978-1979 (J.A. Bauer, A. Nelson (Shell, ex-GSQ), O. Dixon (GSQ), W. Anfiloff, F.J. Moss)

Final reporting on the surveys, the results of which were discussed in the 1980 summary, was completed and a number of papers have been published or are in press. Discussions were held with petroleum tenement holders on results and interpretation for planning further company seismic surveys to follow up leads from the BMR seismic work.

Ngalia Basin, NT (F.J. Moss, A.T. Wells (Geol. Branch))

A number of editorial matters relating to the Bulletin on the structure and stratigraphy of the basin were attended to. The geophysical plate was amended to include new information. Illustrations for the Bulletin are being drafted.

Discussions have been held with the petroleum tenement holders on the petroleum prospectivity of the basin and particularly on structures seen from seismic work in the Davis Anticline and an area east of Mount Allen. A substantial section of Lower Palaeozoic sediments found in Davis 1 well had been predicted from BMR work. Further seismic and gravity work has been planned by the tenement holders to follow up BMR and previous company work.

Hillsborough Basin, Qld (F.J. Moss, J. Pinchin)

A brief review of geology and subsidised geophysical survey information in the Hillsborough Basin was made to determine the feasibility of a proposal for high resolution seismic work to assist in oil shale investigations in the area. It was concluded that high resolution seismic work would be very useful in investigating the structure and depositional history of the oil shale formations.

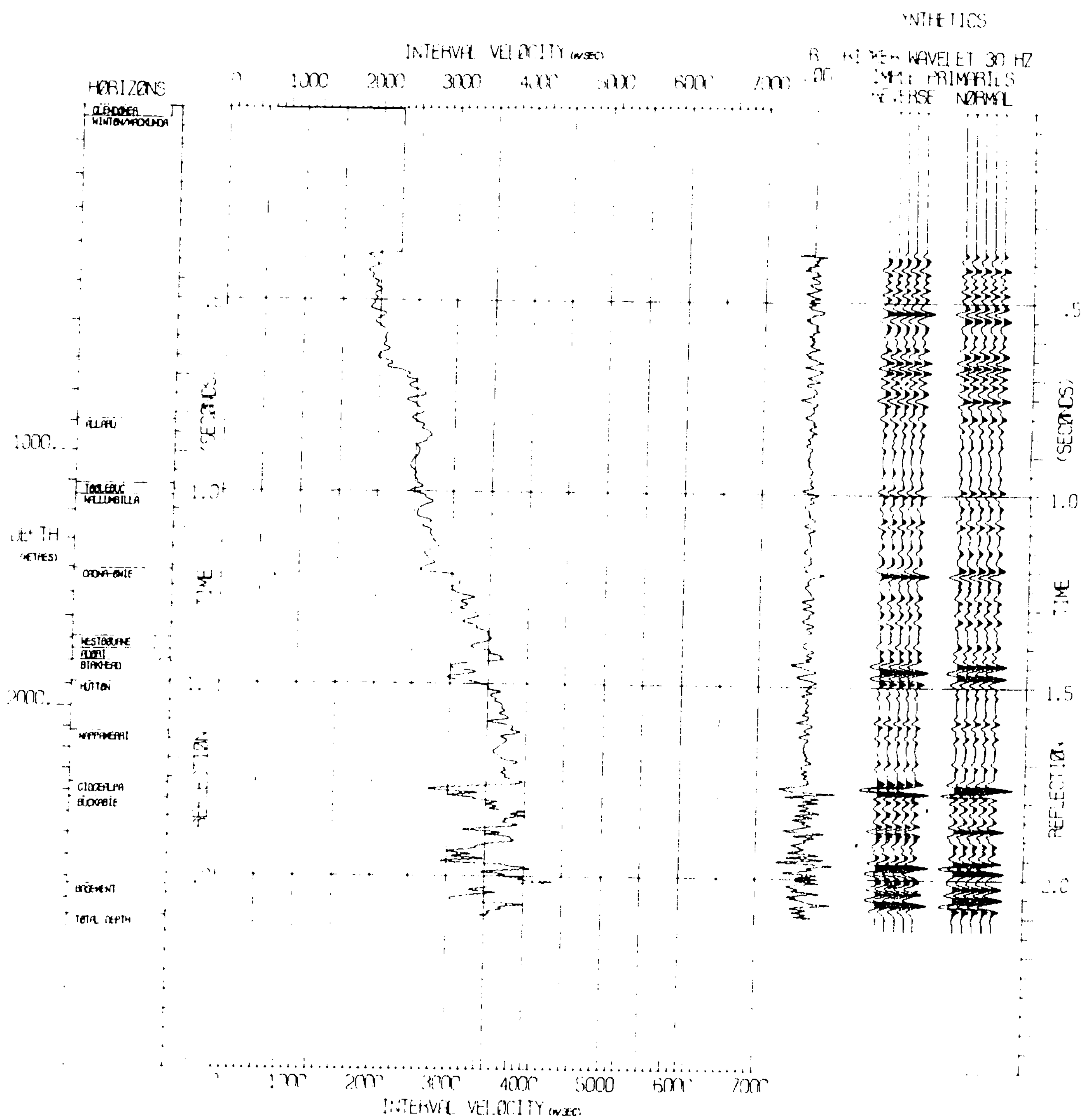
Production of synthetic seismograms (D. Pfister, K. Wake-Dyster, M. Sexton)

SEISSYN, a computer program for producing synthetic seismograms, was modified to improve the presentation of results as shown by an example in Figure SGM 6. In this presentation, the stratigraphy, velocity and reflection coefficient logs are displayed along with the synthetic seismogram at a vertical scale similar to that of the reduced seismic sections. The program was used for production of seismograms for Barcoo Junction 1, Buckabie 1, Chandos 1, Galway 1, Gilmore 1, Gumbardo 1, Leopardwood 1, Mount Howitt 1, Quilberry 1, Thunda 1, and Yongala 1 & 2 wells in the central Eromanga Basin, and Davis 1 in the Ngalia Basin.

Shotpoint and well location compilation (F. Brassil, D. Pfister, G. Price, M. Sexton)

Digitisation of SP locations from previous subsidised company as well as BMR surveys, checking for errors, and production of maps at several different scales continued. Although priority was given to the Central Eromanga Basin (141-147°E, 24-28°S), the area of current BMR projects, maps for some other areas were also produced in response to company requests. Preliminary location maps for several areas of the Central Eromanga Basin and Denison Trough, listed in the section on Reports, Maps, Lectures, Overseas Visits, Courses, are available from the Copy Service, Government Printer (Production), GPO Box 84, Canberra, 2600.

SYNTHETIC SEISMOGRAM



SCALE 100 MMS = 1 SECOND
30 MMS = 1000 M/S

NEAR SURFACE DATA

LAYER	THICKNESS	UPP VEL	LOW VEL
1	1.	610.	610.
[illegible]	422.	2250.	2250.

HØRIZØN	DEPTH	TIME
GLENDOWER	0	0.000
WINTON/MACKUNDA	4	0.000
ALLARU	812	.818
TOOLEBUC	1113	.986
WALLUMBILLA	1141	1.015
CADNA-OWIE	1408.	1.201
HOORAY		
WESTBOURNE	1684	1.396
ADORI	1750	1.418
BIRKHEAD	1780	1.442
HUTTON	1881	1.504
[illegible]	2124	1.631
[illegible]	2373	1.764
BUCKABIE	2436.	1.804
BASEMENT	2842.	2.028
TOTAL DEPTH	2878	

Record 1981/57

26/G54/3

Fig. SGM 6. Synthetic seismogram, Chandos I

Seismic technical services (J. Grace, D. Gardner, G. Jennings, K. Butterfield, D. Pfister, G. Price, R.D.E. Cherry, L. Rickardsson, A. Takken, D.K. McIntyre, D.W. Johnstone)

The main project between field surveys was to convert all strings of geophones from groups of 8 to groups of 16. This has reduced the occurrence of breakdowns in the field considerably and also greatly reduced the time required to lay geophone spreads.

The DFS IV digital seismic recording system was used between field surveys for the A/D conversion of analogue field tapes of the Bulgroo and Barcoo surveys within the Central Eromanga Basin. Both SIE and Techno-type analogue tapes were converted and sent to GSI for processing.

The DFS IV and seismic field recording system were free of major faults during 1981, and only minor delays to field recording occurred.

McArthur Basin gravity survey, 1980 (W. Anfiloff, R. Tracey)

During August, 1980, the gravity coverage established by BMR in 1978 and 1979 was extended westwards along the Carpentaria Highway, the Beetaloo Road, and a large section of the Stuart Highway. The survey produced 866 new observations, mainly at 0.5 km intervals (Fig. SGM 7).

Anomalies with amplitudes of up to 25 mGal (250 $\mu m.s^2$) were delineated (Fig. SGM 8). In some areas the anomalies are exceptionally broad and smooth, suggesting a thick cover of undeformed sediments. Elsewhere, fault anomalies and structural boundaries are evident. Overall, the gravity data give a good indication of deep structure and basement topography over a large area where geological exposure is very poor.

Galilee Basin (W. Anfiloff)

A paper dealing with a combined seismic and gravity interpretation over the Donnybrook Anticline, west of Clermont in central Queensland, was completed. The paper investigates the relation between reflection seismic and detailed gravity data over a complex structure near the boundary between the Galilee and Drummond Basins. The interpretation (Fig. SGM 9) suggests that the Donnybrook Gravity High is partly caused by a reverse density contrast

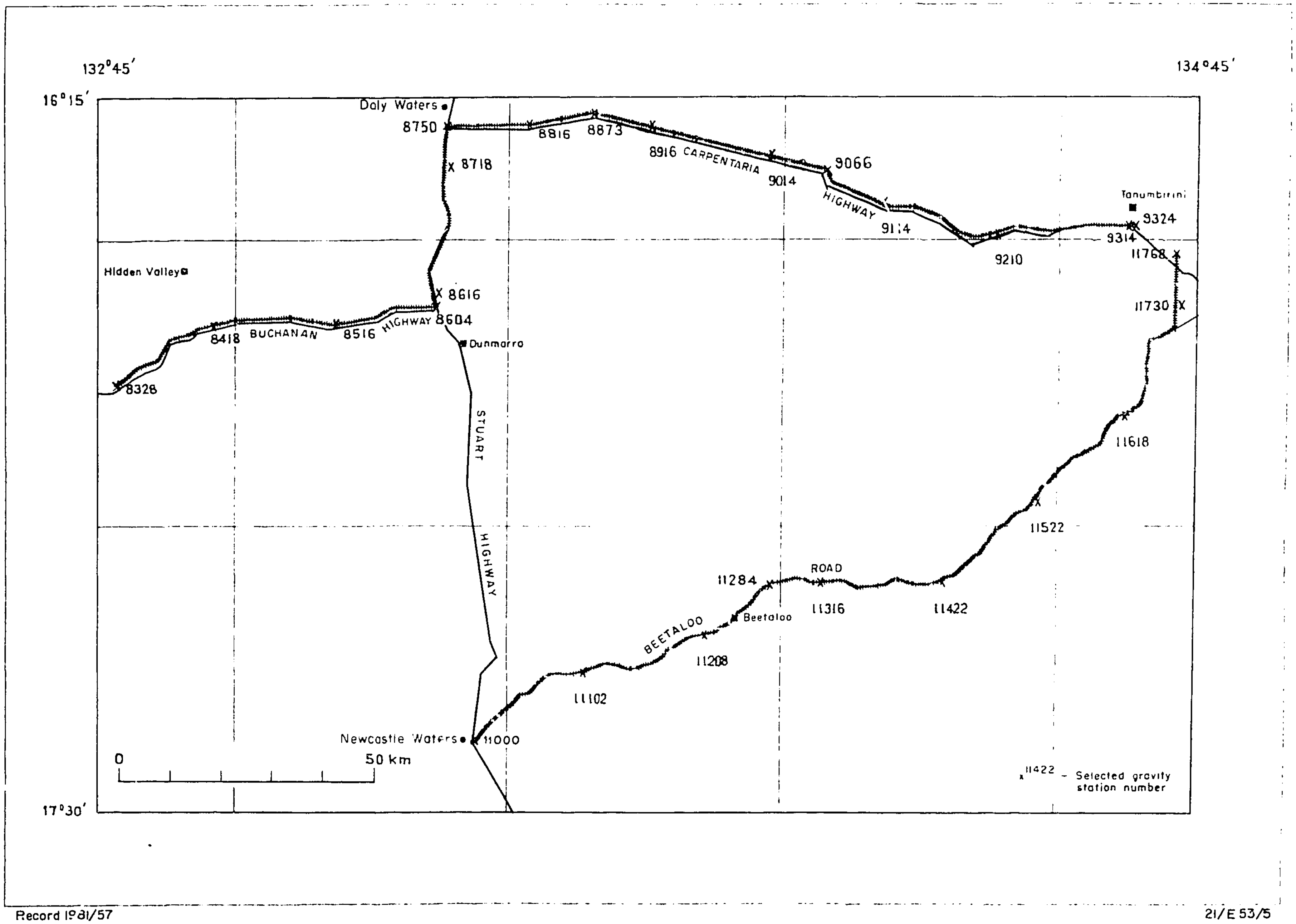
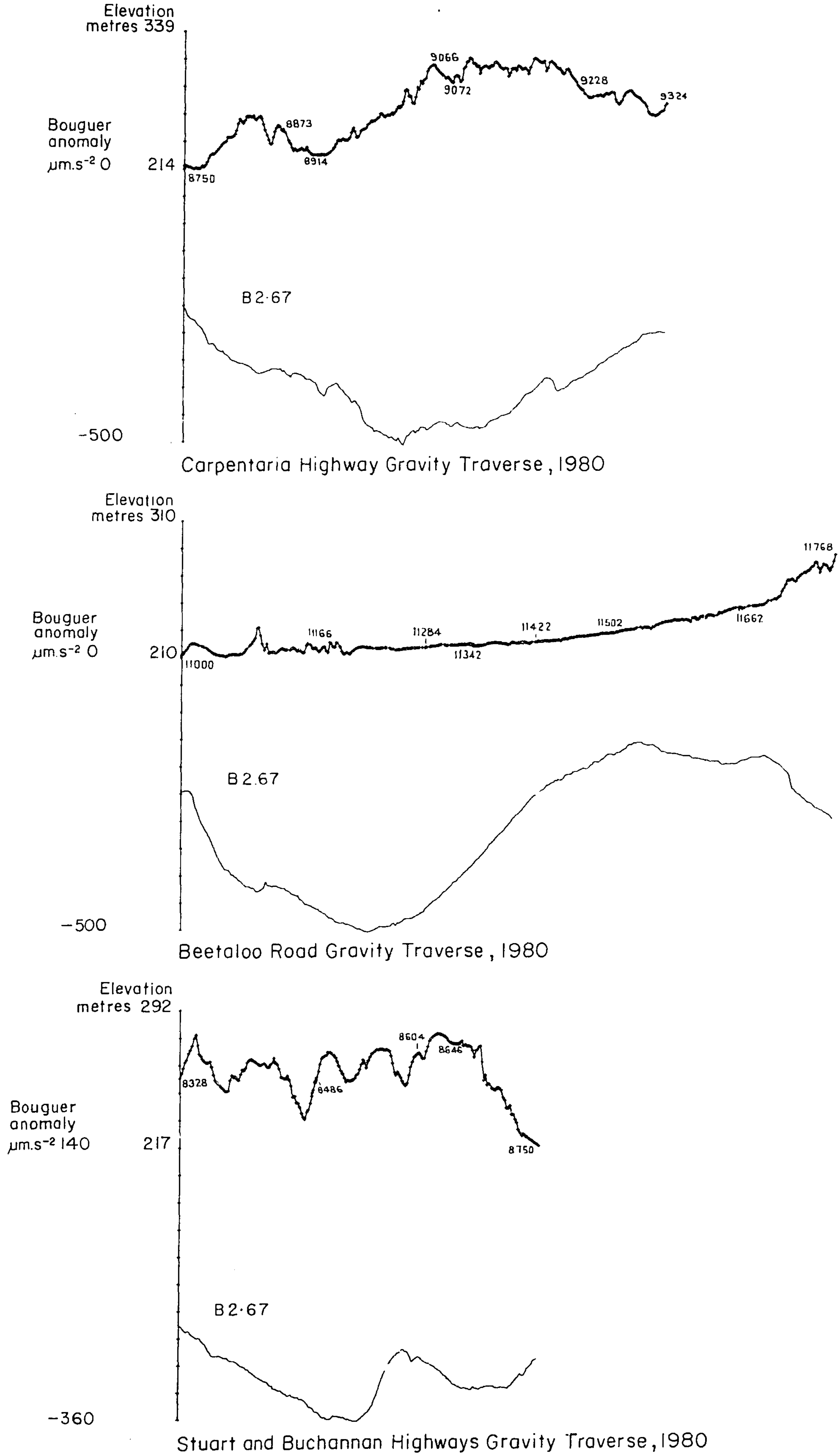


Fig. SGM 7. McArthur Basin gravity survey, gravity traverses 1980



Record 1981/57 21/E53/6

Fig. SGM 8. McArthur Basin gravity survey. Elevation and Bouguer anomaly profiles

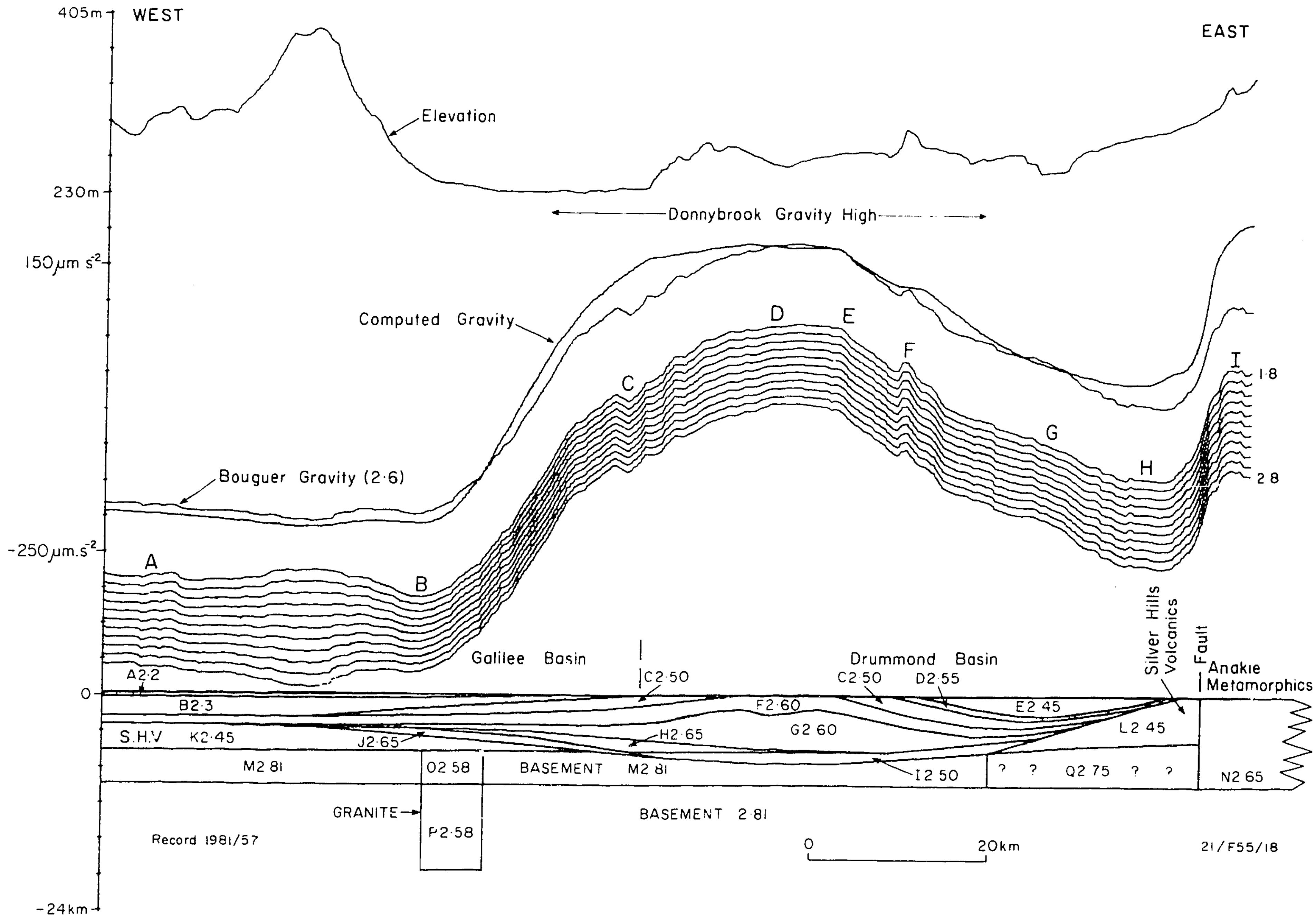


Fig. SGM 9. Galilee Basin, interpretation of Donnybrook Gravity High associated with a deep Permo-Carboniferous Trough situated within a thick layer of acid volcanics. The flanks of the high are considerably accentuated by the negative effects of an interpreted granite on the western side, and a thick body of acid volcanics on the eastern side.

<u>Agate Creek gravity survey</u> (W. Anfiloff)

A paper dealing with the interpretation of a detailed gravity survey across the Agate Pocket in northern Queensland was completed. The paper describes the processing of gravity data over abrupt topographic features and the integration of this processing with modelling to accommodate vertical continuation effects in the density profiling process.

<u>Elevation and gravity profiles across Australia</u> (W. Anfiloff)

Twenty sets of elevation and gravity profiles crossing the Australian continent and its margins were prepared by computer from a data bank of 260 000 observations, e.g. Figure SGM 10. The concise and accurate presentation enables crustal blocks to be identified from their elevation and surface character.

The profiles indicate that the continent consists of rigid crustal blocks containing the cratonised remnants of ancient mobile belts. Some blocks have been eroded to great depth, others are blanketed by sediments, and many are undergoing passive isostatic adjustment. Differential vertical movements between adjacent small blocks suggest that some are not in isostatic equilibrium, and differences in regional free-air anomaly levels over distances up to 6 degrees of arc confirm that complete isostasy does not prevail. Around the outer zone of the continent, the dominant direction of movement is downwards, presumably in response to subcrustal erosion. However, horizontal compression may be preventing some of the blocks from subsiding, resulting in topographic features, including the Australian Alps.

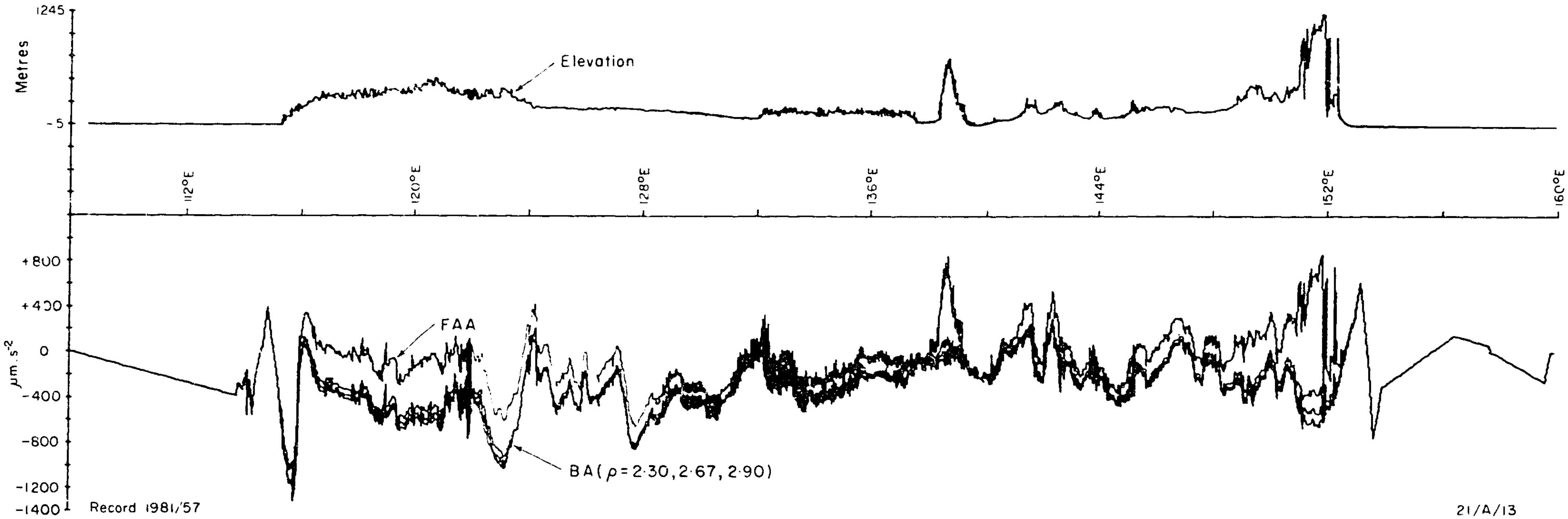


Fig. SGM 10. Elevation and gravity profiles across Australia along latitude 31°S

<u>MARINE SURVEYS</u> (R. Whitworth, F.W. Brown)

<u>Coral Sea Basin margin co-operative study with BGR</u> (P.A. Symonds, D.C. Ramsay)

The results of the 1978 co-operative BGR (Federal German Institute for Geosciences and Natural Resources)/BMR survey in the Coral Sea indicated that this region is ideal for research into the fundamental problems concerning the development of continental margins. Therefore, a follow-up survey using the R/V SONNE was carried out around the margins of the Coral Sea Basin during the period 29 November 1980 to 9 January 1981.

The main aims of the study were to determine the extent, nature, and development history of the rift grabens and the ocean/continent boundary around the Coral Sea Basin, and to obtain information on the lithofacies, age, and palaeo-environment of the Mesozoic and Cainozoic sediments in the area. Other specific objectives were to investigate the nature of possible fossil reefs beneath the slopes of the Queensland and Papuan Plateaus, and the structure and tectonic history of the Aure-Moresby Trough, the Osprey Embayment, and the Queensland Trough.

The 1980/81 survey, which involved co-operation between BGR and BMR under the auspices of the Australia/Federal Republic of Germany Science and Technology Agreement, and the Geological Survey of Papua New Guinea (GSPNG), was divided into a 21-day geophysical cruise (SO-16A) and a 12-day geological sampling cruise (SO-16B). The survey recorded about 7140 km of bathymetric and gravity data, 6950 km of magnetic data, 3150 km of multichannel seismic reflection profiles, 3530 km of analogue single-channel seismic profiles, 10 sonobuoy refraction profiles, and sampled 16 stations by dredging and 9 stations by coring (Fig. SGM 11).

Five seismic sequences have been mapped on the SO-16A seismic profiles, as well as on all the previously collected profiles in the region. Two major unconformities, which were tied to DSDP sites, have been given Miocene and Eocene/Oligocene ages; an older unconformity, which is often absent over basement highs beneath the plateaus, particularly the Queensland Plateau, and marks the top of the sediment fill between fault blocks, is assumed to be of Paleocene age. One of the major outcomes of the geophysical cruise is that it has significantly increased our knowledge of the nature of the change from continental to oceanic crust around the margins of the Coral Sea Basin. A major down-to-the-basin fault with a throw of 2 s or more of reflection time, usually defines the start of the change from continental to oceanic basement.

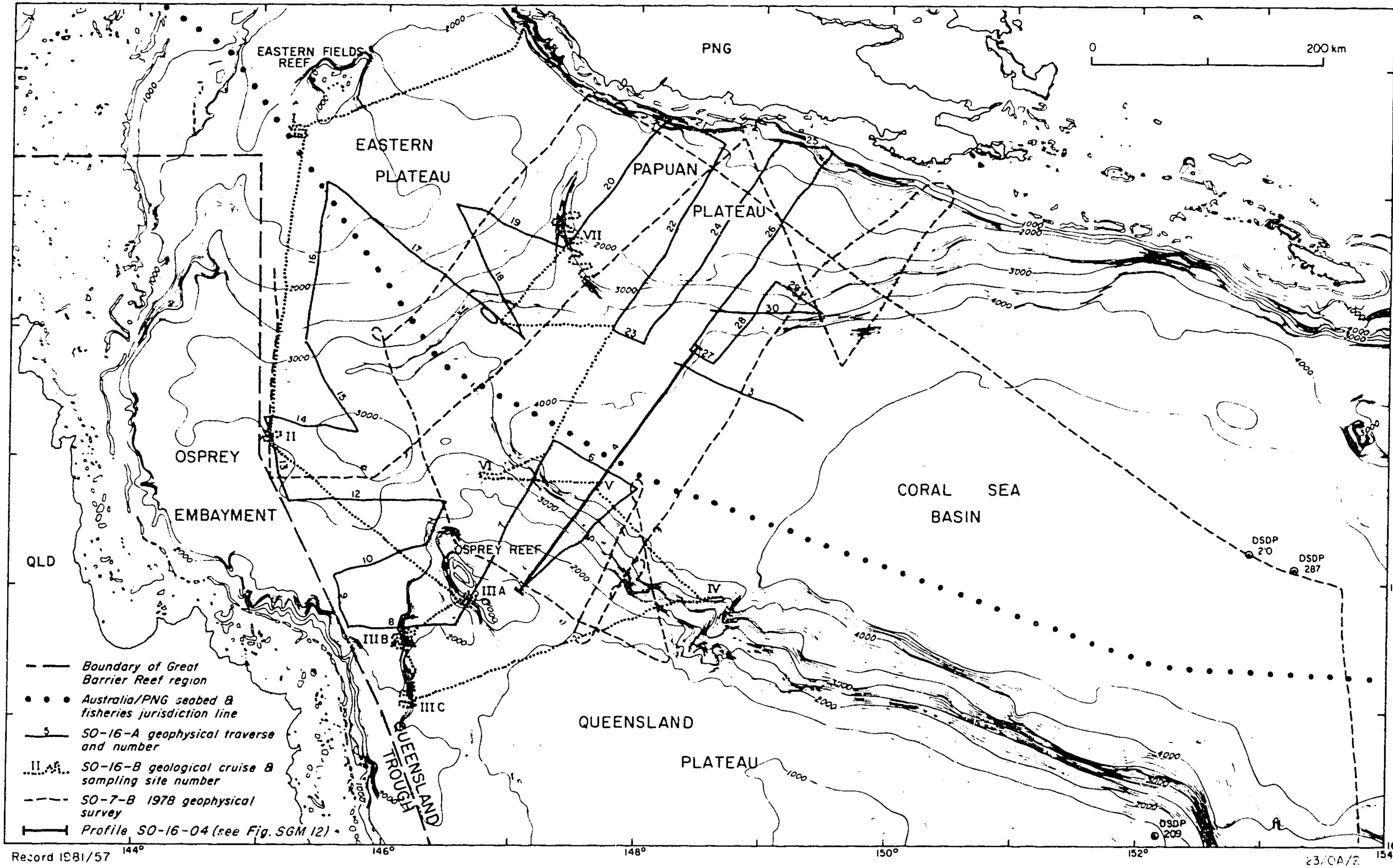


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Fig. SGM11. Bathymetry of the Coral Sea showing Sonne tracks

In some places oceanic basement abuts this fault and in other places deep basement blocks of assumed continental origin lie between the fault and oceanic basement. The ocean/continent boundary is generally very clear and can often be determined to within 5 km (Fig. SGM 12; location of profile shown in Fig. SGM 11).

During the SO-16B cruise 7 sites were sampled by either dredging or gravity coring at a total of 25 stations in water depths ranging from about 1000 to 4000 m (Fig. SGM 11). The range of water depths and site locations sampled, and the type and age of the lithofacies obtained, are shown in Figure SGM 13. One of the most significant finds was the conglomerate and breccia obtained from the eastern escarpment of the Queensland Trough - these rocks have given us the first direct information on the nature of basement rocks beneath the Queensland Plateau. The clasts within the conglomerate/breccia, which could only have been derived from the Queensland Plateau, indicate that this feature is underlain by Tasman Geosyncline rocks, as had been previously suggested.

The processing and interpretation of the 1980/81 and the 1978 SONNE data from the Coral Sea continued at both BGR, Hannover, and BMR, Canberra, throughout 1981. P. Symonds commenced a 6-month visit to Hannover in November 1981 to collaborate with BGR scientists in finalising the seismic processing and interpretation, and in the preparation of publications on the results of the study.

The preliminary results of the 1980/81 SONNE survey have been published in a BGR Report and in the CCOP Newsletter.

Bass Strait project (J.C. Branson, K. Lockwood, E. Nicholas, A.S. Scherl, S. Kravis, W.M. McAvoy)

Proposal. Improvement in our understanding of the origin and evolution of the Bass Strait region is essential to a better evaluation of its economic potential. The information required is from deep within the sedimentary section; from the Eastern View Coal Measures down to crystalline basement. Penetration beneath the Eastern View Coal Measures presents a considerable technical problem. Highly specialised seismic reflection techniques will be needed to give adequate stratigraphic and structural data. These will probably include long airgun arrays and spatial filtering using extended seismic cable active sections. In addition, gravity and magnetic data will be required to provide indirect evidence on sediment thickness, structural features, and faulting down to basement.

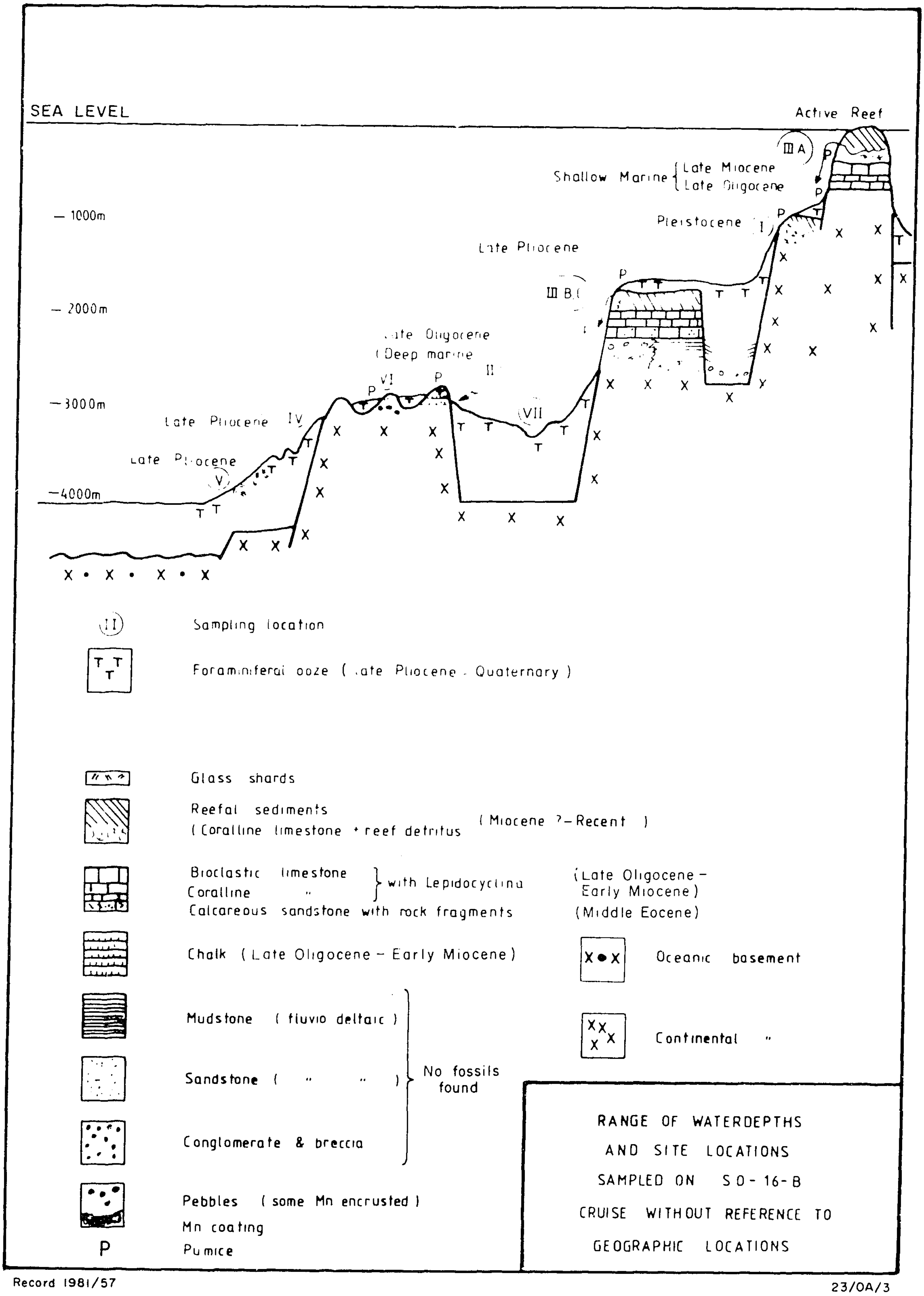

Fig. SGM 12. Conceptual diagram of Sonne sampling locations

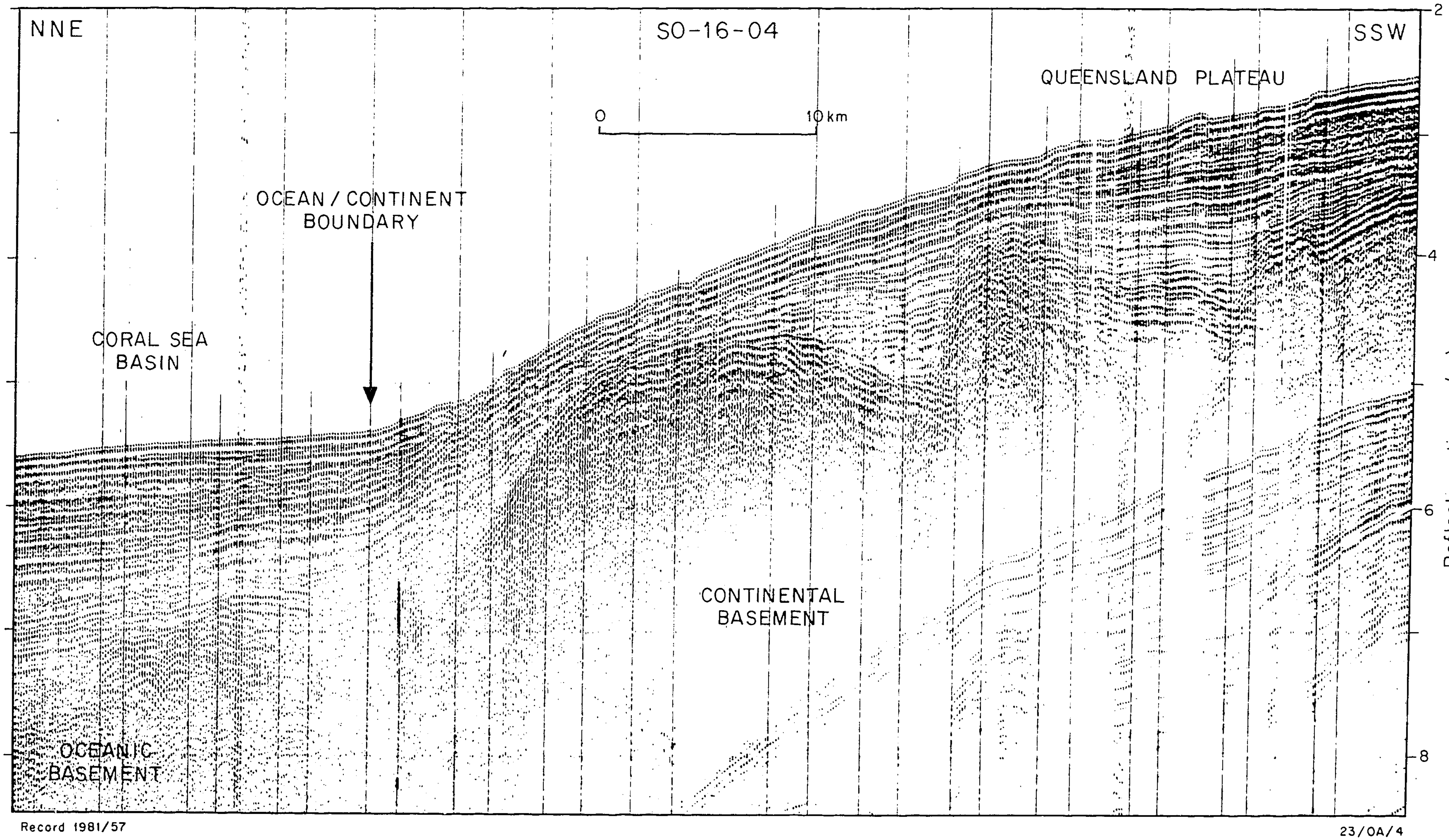

Fig. SGM 13. Single channel monitor record

In the August 1981 budget, $2.9 million was allocated to a contract for a marine geophysical program to be carried out in the Bass Strait region with the following objectives in mind:-

(a) the evolution of the southeast margin of Australia (the Bass Strait region)

(b) the origin and development of the Bass Basin and its relation to the Otway and Gippsland Basins (see Fig. SGM 14)

(c) recording of high quality seismic data at Eastern View, Otway, and basement levels in the Bass Basin

(d) the basement type and structure within the Bass Basin

(e) the structure within the Eastern View Coal Measures

It is proposed to carry out 4000 km of traversing in order to study the evolution of the southeastern margin of Australia (Bass Strait region) and, in particular, the geological history of the Bass Basin and its relation to the Gippsland and Otway Basins.

Progress during the latter half of 1981 can be summarised under the following headings:-

(i) <u>Data compilation</u>: The capability to display, at a specified scale, trackmaps of scientific surveys and company surveys in the Bass region has been achieved.

(ii) <u>Data reduction</u>: Some progress toward regional summaries of structure and geological history has been made. These consist of time-structure maps and structural-element maps in the Otway, Bass, and Gippsland Basins. Seismic-stratigraphic studies, and allied velocity studies, have been initiated in the Bass Basin. Factors governing optimum traverse location, including the distribution of submarine canyons and Tertiary channels, have been considered.

(iii) <u>Tectonic development</u>: Early consideration of the tectonic significance of faulting in the Bass Basin suggests that two episodes of deformation, tentatively correlated with Tasman Sea and Southern Ocean openings, can be identified.

(iv) <u>Resource prospectivity</u>: Based on a study of seismic stratigraphy in the vicinity of the Pelican Field, a new potential petroleum exploration ploy is being formulated.

(v) <u>Traverse location</u>: A geophysical program consisting of 3000 km of seismic, gravity, and magnetic surveying has been formulated for the Bass region.

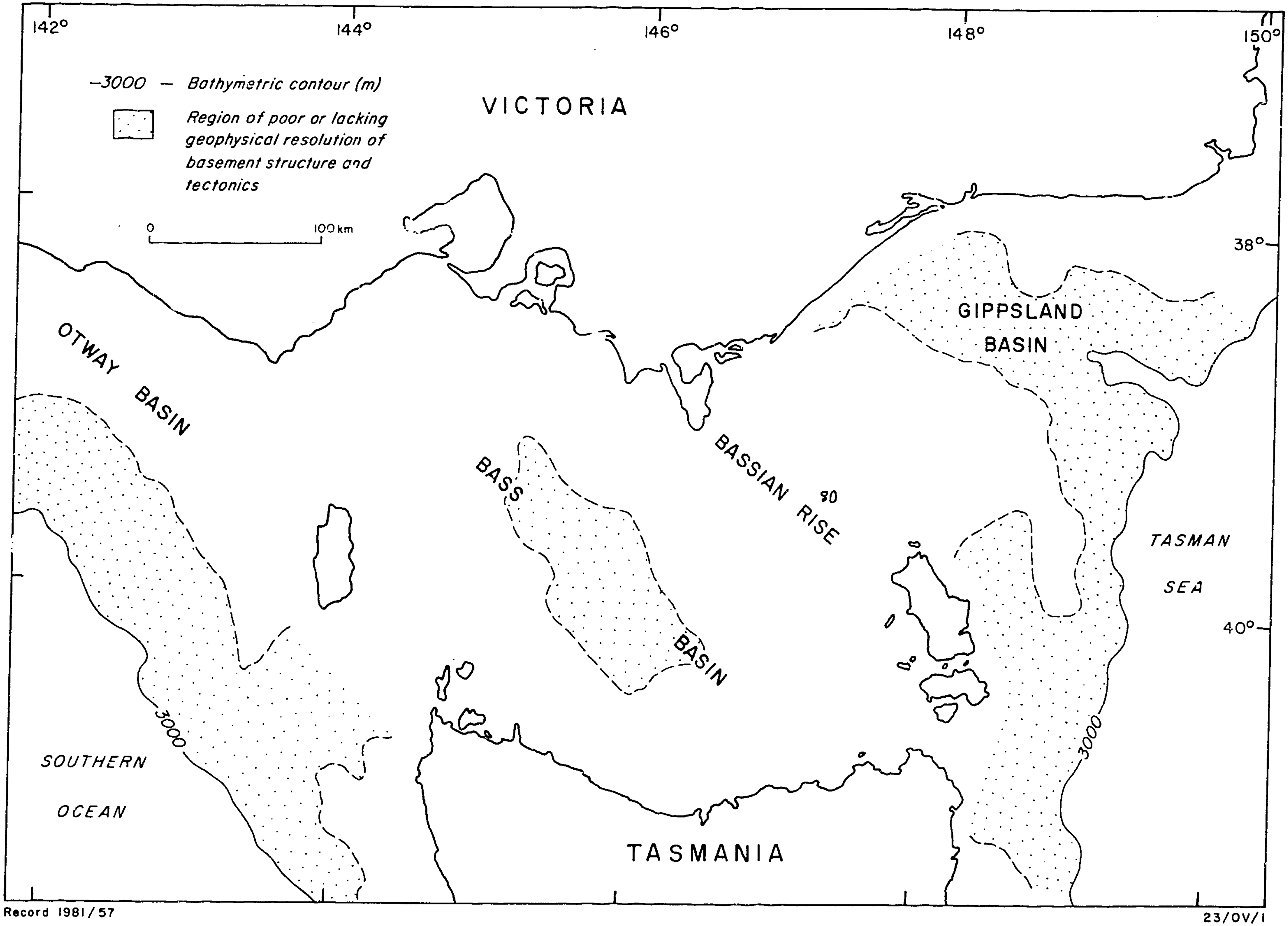

Fig. SGM 14. Bass Strait region

<u>Geophysical surveying in the central Great Barrier Reef</u> (R. Whitworth, F.W. Brown, P.A. Symonds, H.M.J. Stagg, D.C. Ramsay, A. Parisi, J.K.C. Grace, T.G. Hegvold, B. Jones, D. Pfister, L.W. Miller)

The main aim of the project is to establish the structure and stratigraphy of the inter-reef areas and thus extend ideas on reef growth developed from modern reef studies to encompass the whole reef province as it exists today and has developed during the Late Cainozoic. The study is required to place detailed local investigations into the regional framework and hence better determine what geological processes have controlled the evolution of the Great Barrier Reef. This will involve the integration of structural and seismic stratigraphic studies with a sampling program aimed at acquiring information on the nature and distribution of the relict and modern sediments.

This survey was the continuation of an on-going co-operative project started in 1980 with Division of National Mapping (NATMAP). On the 1981 survey magnetic, bathymetric, and navigation data were collected, as was done in 1980, and shallow seismic data were recorded for the first time by BMR in this region of Australia.

Although funding for a multi-channel streamer cable has been approved, the cable could not be delivered in time for use in 1981. Therefore, an old single-channel streamer was installed in the latter part of the survey to test the new seismic acquisition system, and to provide practical experience for the field staff.

For the 1981 season, NATMAP chartered the T.S.M.V. FEBRINA, a steel hulled boat about 22 m in overall length. Outfitting of the FEBRINA with containerised equipment and winches started at the beginning of June, and the ship commenced test cruises out of Townsville towards the end of the month. The seismic system was installed at the beginning of August and used until the end of the survey on 22 September. During this time about 3500 km of magnetic traversing, and about 1000 km of sparker traversing, were recorded between Townsville in the south and Dunk Island in the north.

The magnetic base-station, set up last year at Charters Towers, functioned throughout the survey period, providing diurnal variations in the magnetic field intensity in digital form.

Processing of data has started, but is still at a very early stage. Preliminary contouring of magnetic anomalies is shown in Figure SGM 15. This does not represent all the data collected in 1981, nor has it been integrated with the 1980 data. Figure SGM 15 also indicates the location of the seismic section shown in Figure SGM 16. The quality of the single-channel seismic sections varied dramatically throughout the survey area, undoubtedly as a result of variations in the nature of the seafloor. In places where the seafloor is relatively hard, and thus has a high reflectivity, the seismic sections in shallow water are masked by water-bottom multiples. In other places, where the sediments are unconsolidated and saturated with water, the reflectivity of the seafloor is low and thus any water-bottom multiples have a low amplitude and do not mask useful information. For example, on the on-board monitor record shown in Figure SGM 16A, a downfaulted basement surface deepening to the east, and onlapping sediments, can be seen down to 1.1 seconds of reflection time beneath the seafloor. Since the data have been digitally recorded, some enhancement of the deeper reflections is possible by carrying out simple processing to correct for spherical divergence and inelastic attenuation of the seismic energy (Fig. SGM 16B). This processed section was made using BMR's in-house seismic processing system, which is currently being developed.

<u>Joint cruises of scientific investigation by SOPAC, Australia, New Zealand, and USA</u> (A. Renwick, J.C. Branson)

Two separate studies using United States ships were proposed for 1982 by the United States Geological Survey and the Hawaii Institute of Geophysics. These studies arose from a review of the 1980 workshop meeting in Noumea, by the 9th Session of CCOP/SOPAC in Tarawa, Kiribati, and approaches to donor countries to undertake the academic and expensive parts of these programs. Support for these programs was also taken up by the Australian and New Zealand Governments in June 1981 with Australian funds up to $700 000 and New Zealand funds up to $100 000 for ship time, scientists' travel, training, and publication of survey results. The areas of study made during three legs of the two cruises are shown in Fig. SGM 17.

The Hawaii Institute of Geophysics vessel R/V KANA KEOKI will research three areas in the SOPAC region commencing with one leg of the cruise in a region west of Samoa along the rugged east-west trending topography of the Vitias Trench. Leg 2 will investigate the proposed spreading centres in the

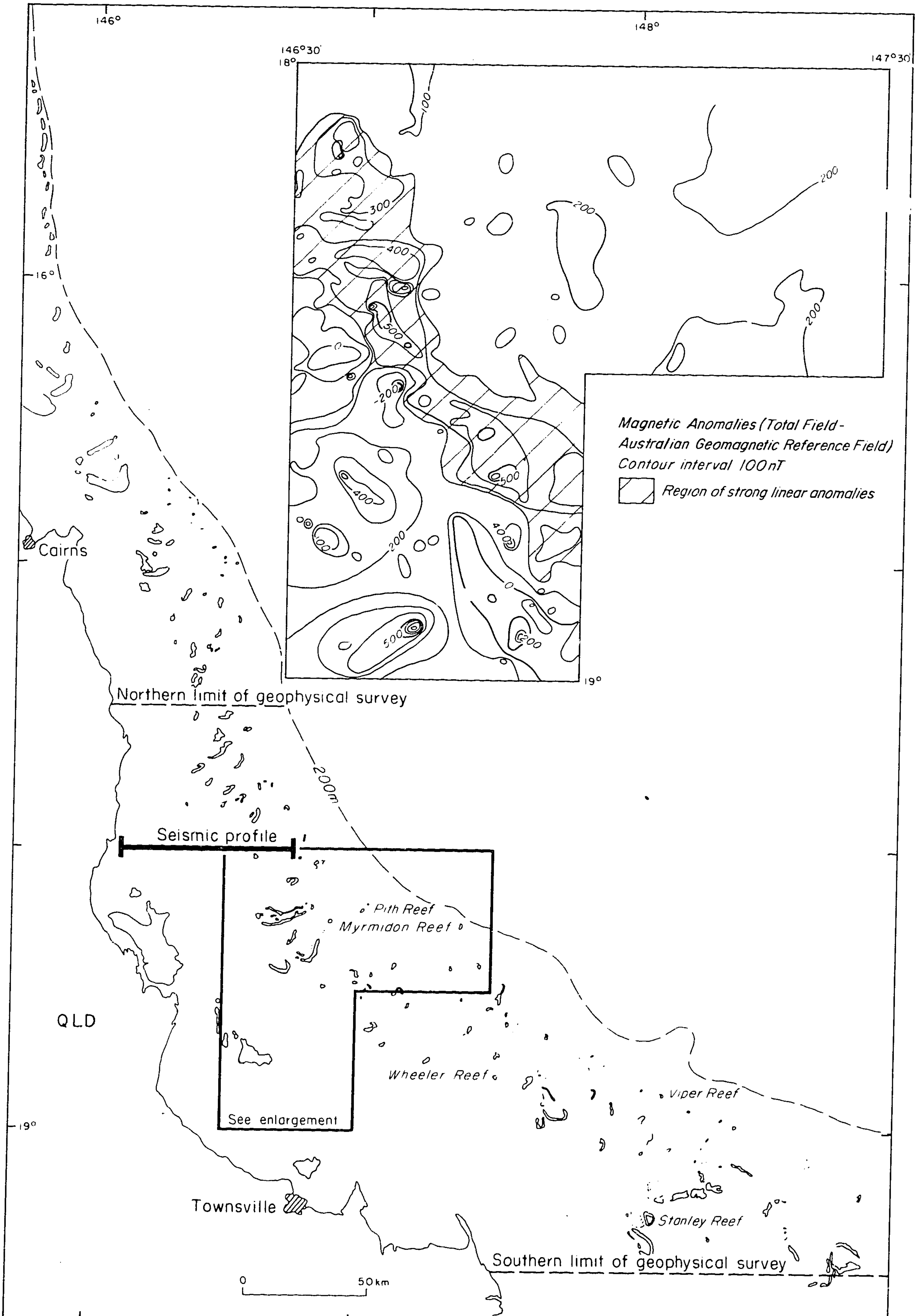

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Fig. SGM 15. Great Barrier Reef geophysical survey 1981

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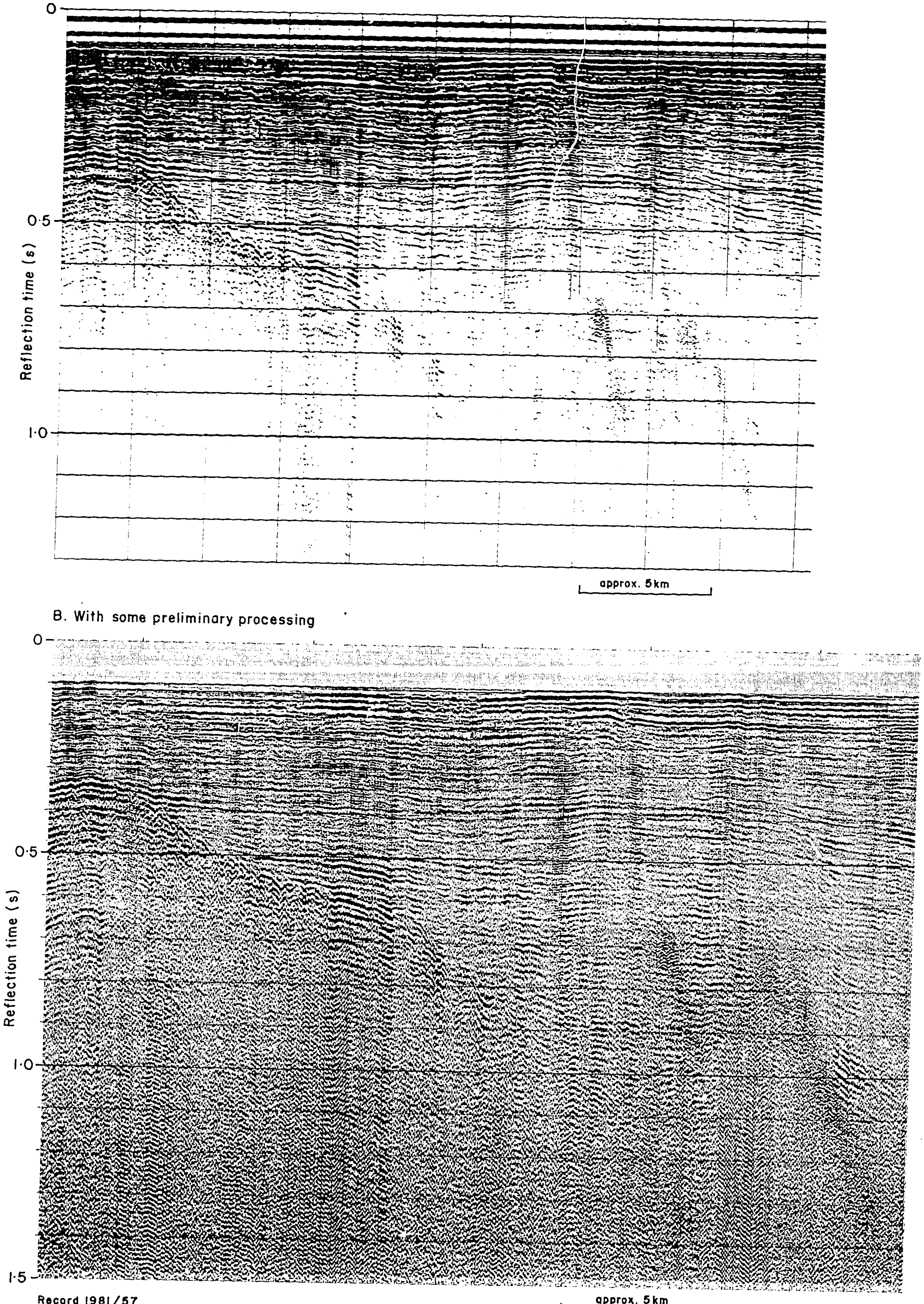

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Fig. SGM 16. Single channel seismic section, Great Barrier Reef

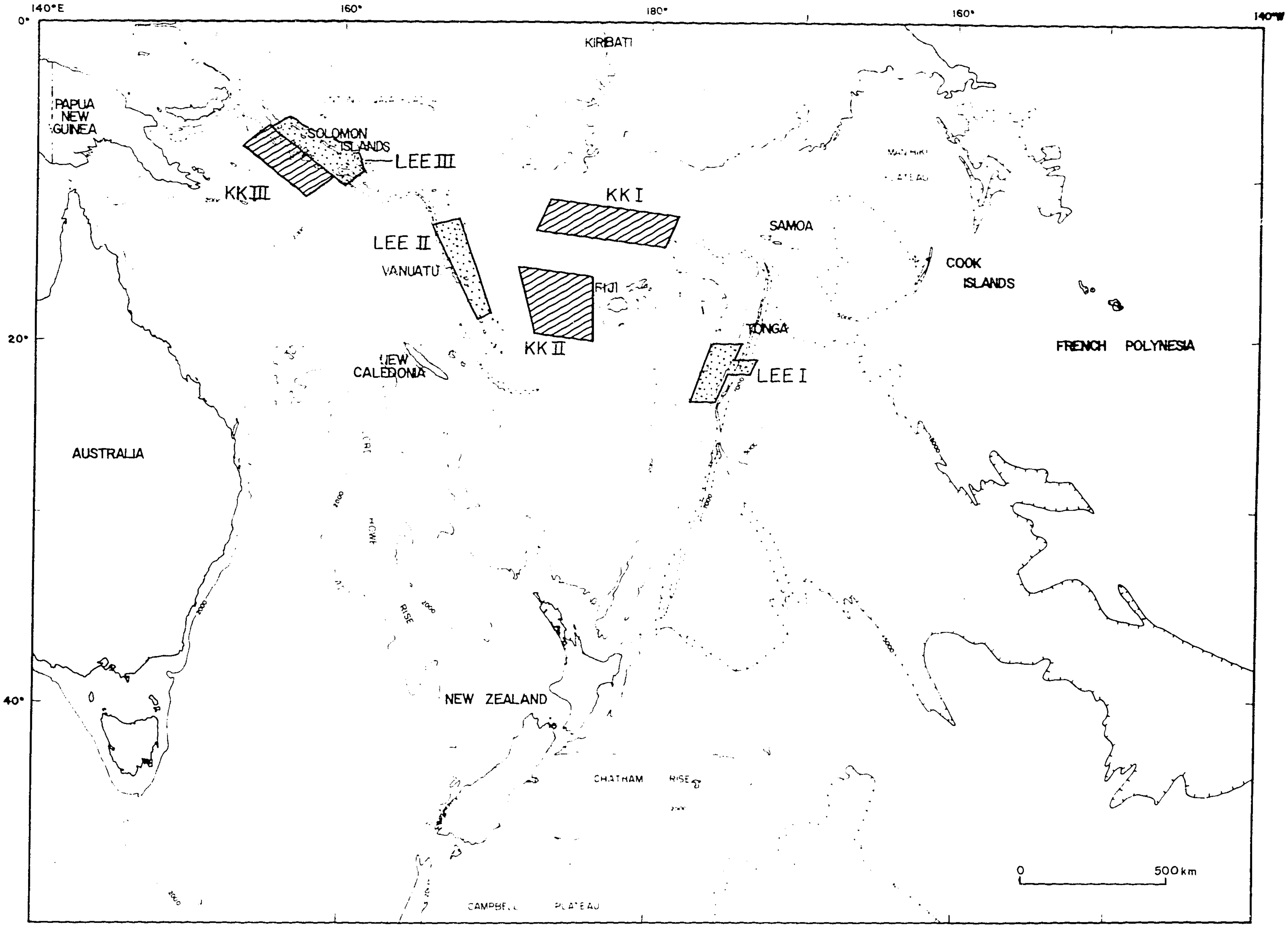

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Fig. SGM 17. Planned joint cruises SOPAC 1982 by reseach vessels Kana Keoki and S.P. Lee

North Fiji Basin over the Fiji Plateau and leg 3 will study head flow and subduction at the Solomon Trough in the eastern Woodlark Basin. There are six berths allocated to Australian scientists on the R/V KANA KEOKI and a further two Australian scientists will be representing Island Nations.

A cruise by the United States Geological Survey Vessel R/V S.P. LEE will investigate the hydrocarbon potential of southern Tonga, central Vanuatu, and central Solomon Islands. Four Australian scientists are to take part in these cruises and a fifth Australian will represent Island Nations. Several international and national meetings were held to co-ordinate the programs and to decide on participants.

CCOP/SOPAC 10th Session (J.C. Branson)

The 10th Session of CCOP/SOPAC was held in Port Vila, Vanuatu from 6th to 13th October 1981. The session was organised under a number of headings dealing with work carried out in surveys for hydrocarbons, manganese nodules, phosphates and phosphorites, sand and gravel, and coastal engineering and precious coral.

A final UNDP-funded cruise using the vessel MACHIAS completed a number of regional assessments, but SOPAC scientists identified a number of regions which could benefit by a further cruise in 1983/84.

A training course in bathymetric drafting carried out by an Australian draftsman, together with cruise training on the MACHIAS and geological training at the University of the South Pacific, were some of the important aspects of work of the SOPAC Technical Secretariat.

Although a shallow-water drill was identified in 1980 as an item for possible Australian assistance, an urgent need arose in late 1981 for a small drill for aggregate studies onshore as well as offshore. Australia is a donor country for this region with expertise in shallow drilling which could be used for training island nationals.

The Australian contribution to the bathymetric drafting training program is due to end in 1982, and new scientists are to be recruited for marine geology to replace staff returning to their sponsoring institutions.

Antarctic marine surveys 1979/80, 80/81, 81/82 (H.M.J. Stagg, R. Whitworth, L.A. Tilbury, D.C. Ramsey, A.B. Devenish, J.K.C. Grace, L.W. Miller, D.E. Pfister, T.R. Hegvold, B. Jones, S. Parker, G. Price, S. Scherl, U. Hammerling)

During 1981, the following activities took place on each of these surveys.

1979/80 Survey. Processing of the navigation data was completed and final track maps were produced. Filtering and resampling of the magnetic data have not yet been carried out.

1980/81 Survey. Magnetics and bathymetric data were acquired on the FIBEX cruise and during transits from Melbourne to Antarctica. These data, together with the data acquired on the two earlier cruises in the 1980/81 summer, have been transcribed to 9-track tape and reformatted on the CYBER-76 computers; processing is continuing. A preliminary track map has been compiled from the transcribed field data to assist planning for the 1981/82 surveys.

1981/82 Survey. A dedicated cruise of the NELLA DAN has been set aside for marine geoscience, with BMR as the principal operator. In addition to the navigation, bathymetry, and magnetic data acquisition of previous seasons, a digital seismic system is being installed on the NELLA DAN for the first time. The principal aim of the dedicated cruise is a reconnaissance survey of the Antarctic margin between Davis and Mawson; an alternative survey of the southern end of the Kerguelen-Gaussberg ridge may be undertaken if ice conditions close to Antarctica preclude operations.

For the 1981/82 summer, BMR digital data acquisition system (DAS) installed on the NELLA DAN has been upgraded to allow the interrogation of the Tracor satellite navigator for course, speed, and satellite fix information. Otherwise, the DAS will continue to acquire navigation, bathymetric, and magnetic data as recorded during last summer's cruises. The commitment of the Marine Geophysics Group to the dedicated geoscience cruise in 1982 has required a large preparatory effort by the group to acquire seismic data during NELLA DAN cruises. A digital seismic acquisition system (MUSIC) was installed in a container in the rear hold with seismic winches mounted on the after deck, and a site was prepared for a seismic source. For the initial cruise, to Macquarie Island, the single-channel Teledyne GEOTECH hydrostreamer was used; it will be replaced by the AMSTAC-funded multichannel streamer for the geoscience cruise. The seismic source will initially be a low-powered sparker; this should be replaced by a 500 cubic inch (8.2L) airgun for the geoscience cruise.

Southern Ocean magnetic lineations (L.A. Tilbury, H.M.J. Stagg)

By mid-1981, Marine Geophysics Group had acquired ten lines of magnetic data on the R/V NELLA DAN in the Southern Ocean in a direction oblique both to the strike of the magnetic lineations and to the direction of the majority of other ships' tracks. It is anticipated that this coverage will increase at the rate of four lines per year over the next few years. Periodic reappraisals of the spreading history of the Southern Ocean will be made in the light of the NELLA DAN and other data, as warranted. The first of these reappraisals is presently under way and will be the subject of a paper at the Fourth International Symposium on Antarctic Earth Sciences in Adelaide, August 1982.

Rift basins of the Australian continental margin - Circum-Pacific map project (P.A. Symonds)

This study follows on from work by Willcox and Symonds reported in the 1980 Summary of Activities (Record 1980/70). The aim is to determine the extent, age, structure, and tectonic significance of the rift grabens that lie within the zone of rifting associated with the Australian continental margin. The delineation of the rift-zone, and major structures within it, was initially carried out in response to a request from the Circum-Pacific Council for Energy and Mineral Resources, and was to be used in the preparation of their SW Quadrant Map, 1:10^6, Thematic Series.

Throughout the year, P.A. Symonds had discussions with H.F. Doutch, chairman of the SW Quadrant of the Circum-Pacific Map Project, on the best way to portray the rift zone information on the plate tectonic and structural elements maps.

A paper titled 'The rift zone of the Australian continental margin', is in the final stages of preparation.

Seismic processing system development (C.R. Johnston, F.M. Brassil, L.J. Allen)

Objectives. To develop a seismic data processing system capable of performing basic seismic data processing of large quantities of data at low cost.

Achievements. Hardware: A Tektronix 4014 interactive graphics terminal and a Hewlett-Packard asynchronous terminal multiplexer subsystem were installed. The hardware required to complete the development system is the Logic Science HSR-11 rasterer, delivery of which is well behind schedule.

Software: A set of interactive graphics software for the Tektronix terminal was developed. This software will be used to develop interactive seismic processing software.

The 'processing environment' design was completed. This is known as the SPOCK system and provides a software framework within which particular processes can be developed and executed efficiently.

The 'pre-processing' processes which were developed or enhanced were

- Land survey auxiliary data compilation
- CDP gathering
- SEG-B field tape demultiplexing
- Amplitude compensation
- IBM-HP floating point conversion

The display process was enhanced to allow more display capability.

Operating system configuration and development continued.

We were able to co-operate with another NERDDC-funded project at BHP Central Research Laboratories, to solve problems associated with reading seismic field tapes.

Data recorded by BMR in the Barrier Reef were amplitude corrected and displayed.

COGS/AMSTAC-FAP Workshop - Australia and deep sea drilling (J.C. Branson, P.A. Symonds)

The Consortium for Ocean Geosciences of Australian Universities (COGS) convened a workshop on Australian involvement in scientific ocean drilling, at the Research School of Earth Sciences in Canberra from March 10-12, 1981. Approximately fifty people attended from government, industry, and academia, including participants from New Zealand, United States, and a representative from the South Pacific (CCOP-SOPAC) countries. The main aims of the workshop were:

1. To acquaint Australian marine geoscientists with recent achievements of the International Program for Ocean Drilling (IPOD) and future plans for IPOD and the proposed Ocean Margins Drilling Program (OMD).

2. To establish which ocean drilling sites in the Australasian region might provide answers to important questions such as the development and history of continental margins and plate boundaries, and changes in patterns of ocean currents, the composition of the oceans and the climate.

3. To examine the question of whether or not Australia should seek greater involvement in an international program of scientific ocean drilling.

Four working groups met during the course of the workshop. The working groups on Passive Continental Margins, Palaeoenvironments, and Active Margins produced reports outlining research problems that could be confronted by drilling in the Australasian region, as well as proposals for specific ocean drilling sites. The fourth working group, which was concerned with the mechanisms for Australian involvement in IPOD-OMD, produced a proposal for Australian involvement in IPOD.

J.C. Branson and P.A. Symonds attended the workshop and were supporters for the working groups on mechanisms for Australian involvement in IPOD-OMD and passive continental margins, respectively. They prepared drill-site proposals for the Wallaby Plateau, Naturaliste Plateau, Naturaliste Fracture Zone, Diamantina Fracture Zone, Kerguelen Plateau, Australian-Antarctic Discordance, the southern continental margin of Australia and magnetic quiet zone, and the Coral Sea Basin region. They were also involved in editing a publication on the workshop titled 'The future of scientific ocean drilling in the Australasian region' (COGS Publication No. 1).

Development of a general-purpose data acquisition system (DAS) (R. Whitworth, H.M.J. Stagg, A. Parisi)

The main features of the DAS have been previously described in the 1979 Summary of Activities. Some enhancement of the software to cope better with hardware problems has been carried out this year, and the system is now essentially completed.

The improvements include:

(1) better handling of power failures to avoid the need to re-load the DAS program.

(2) the teletype terminals can be logically 'switched' within the program. Should any of the terminals fail, its messages can either be diverted to another teletype or eliminated while the program is running.

(3) The clock-driven acquisition routine ACQ has been generalised to better cope with special-purpose inputs such as aerial-character transmission from the HIFIX or display output from the TRACOR navigation systems.

The DAS has been used on two further surveys this year. On the T.S.M.V. FEBRINA in the Great Barrier Reef, the DAS has been used to acquire navigation, magnetic, and bathymetric data, while providing an on-line positioning system using any combination of range-range or hyperbolic range precision radio navigation systems. The system being used on the M.V. NELLA DAN during the 1981/82 summer has been extended. Position, course and speed, satellite fix positions and their quality are now acquired by interrogating the TRACOR satnavigator every 10 seconds.

The BCS-based acquisition system cannot usefully be extended further until funds are available to convert to an RTE operating system.

Data processing and compilation (L.A. Tilbury, R. Whitworth, B. Jones, T.R. Hegvold, A. Price, D. Pfister, U. Hammerling)

Work continued irregularly at a relatively low level, partially because of staff losses, and also because of heavy involvement in field surveys in the Great Barrier Reef, and on board the NELLA DAN during Antarctic trips.

Transcription and archiving of field data cassettes from BMR surveys continued as availability of the necessary equipment allowed.

Processing of the NELLA DAN 1979/80 navigation data was completed and a start made on data from 1980/81. Similarly for the Heard Island survey, navigation data processing has reached the stage of adjustment to satellite fixes.

Extension of the radio navigation data reduction programs was required for the co-operative surveys with the Division of National Mapping in the Great Barrier Reef.

Compilation of data from external organisations has come to a virtual halt because of the limited staff numbers.

Development of multi-channel digital seismic acquisition system (MUSIC) (H.M.J. Stagg)

The major objective of this project is to enable the Marine Geophysics Group to record seismic reflection data digitally in demultiplexed format. This will allow the efficient processing of marine data on the in-house seismic processing system. The recording format adopted is the internationally accepted SEG-Y data exchange format. This will make the data readily available to other users. The main features of the MUSIC system have been described in the 1979 and 1980 Summaries of Activity.

Substantial improvements have been made to the system as described in 1980. The most significant of these has been the increase in the number of data values that can be recorded in one shot from 18 000 to 32 000. This permits the recording of 24 channels of data for just over 5 seconds using a 4 millisecond sampling rate. Expansion to a greater capability is straightforward.

During 1980 the development of the BCS-based Stage I system was completed. The system was thoroughly field-tested on the Great Barrier Reef survey, and was used as a production system for the last month of the survey. The EPC monitor display system proved most effective; a variable-density record of each shot some millimetres wide can be obtained without any degradation in record quality.

The system will be used in substantially the same form on board the NELLA DAN during the 1981/82 summer.

ENGINEERING GEOPHYSICS GROUP (F.J. Taylor)

Norfolk Island groundwater (R.S. Abell (Geol. Branch), F.J. Taylor, P.J. Swan)

A short geophysical survey involving resistivity and magnetic work was carried out on Norfolk Island to assist with the selection of sites for deep water bores for future water supplies for the island. Field measurements of the total magnetic field over selected traverses show very large high frequency variations due to remanent magnetisation within the weathered basalt. The measurements were of little use in determining the location of faults or fracture zones owing to this large variation.

The resistivity measurements involved 12.5 km of Wenner profiling along valleys dissecting the plateaus. The objective was to locate regions of deeper weathering, possibly associated with fractures or surface lineaments, where groundwater could accumulate and penetrate to the deeper regions. Ten low-resistivity anomalies were indicated on the resulting profiles and five of these sites were recommended for drilling. A shallow bore drilled on one of these anomalies since the survey was completed has produced relatively good supplies of groundwater.

Vibration measurements, ACT (D.C. Ramsay, P.J. Swan)

Vibration levels at sites throughout the urban area were monitored following requests from various organisations. Sites monitored during the year included the Patents Office, Mugga Way water main, and the Papua New Guinea Embassy.

Resistivity interpretation (F.J. Taylor)

Resistivity data from Schlumberger and Wenner depth probes were interpreted for internal organisations. In particular, 43 depth probes from the Department of Housing and Construction's foreign aid program on Kiribati were interpreted using the forward and inverse modelling programs written for the BMR HP 2100 series computer. Documentation of these programs was completed during the year.

Well logging (G.S. Jennings)

Logging of boreholes continued to meet requirements from within BMR. The logging program for 1981 centred around logging the holes drilled for Geological Branch's oil shale methodology project, into the Toolebuc Formation in central and western Queensland, under a NERDDC grant. Five holes were logged around Charleville early in 1981 and further holes are being logged in October-November in the Boulia and Charleville regions.

The BMR workshops are currently building two down-hole geophone assemblies for use with twin-channel velocity shoots. The supply of a density tool was further delayed by the contractor and the delivery date is still not firm. Little progress has been made in obtaining digital recording for the logging system.

3. GEOMAGNETISM, SEISMOLOGY AND REGIONAL GEOPHYSICS SECTION

(D. Denham)

REGIONAL GEOPHYSICS (D.M. Finlayson)

Southeastern Australia seismic crustal investigations (D.M. Finlayson)

From 1976 to 1978 BMR conducted seismic investigations of crustal structure within the Lachlan Fold Belt and Sydney Basin using quarry blasts as seismic sources. These investigations have been interpreted and reported in the scientific literature (Fig. GSR 1 and 2).

Taken together with the results of other workers, a seismic P-wave velocity model for the upper 60 km of the lithosphere can now be constructed for the southeast Australian region, which includes Precambrian as well as Phanerozoic tectonic provinces (Fig. GSR 3).

Pilbara region crustal investigations (P.J. Drummond)

Interpretation of the seismic and gravity data collected in the Pilbara region of northwest Australia (Fig. GSR 4) in 1977 continued throughout 1981. The results of the seismic interpretation to date are summarised in Figure GSR 5, and the geological interpretation of the seismic profiles is shown in Figure GSR 4.

The crust of the Pilbara Craton is 28-33 km thick, and its boundary with the upper mantle dips south at slightly less than one degree. The southern edge of the craton is marked by a sharp increase in crustal thickness about 40 km south of the Sylvania Dome in the east and along the northern boundary of the Ashburton Trough in the west. Seismically, the crust has two layers, an upper one with P-wave velocity 6.0-6.1 km/s and a lower one of 6.4-6.6 km/s. The boundary between them is depressed beneath the deepest part of the Hamersley Basin, and rises along the southern part of the Basin and Craton. The velocities in the lower crustal layer are highest along the southern part of the Hamersley Basin, an area known to have been depressed during the formation and filling of the Basin, and then uplifted.

The crust of the northern Yilgarn Craton is at least 50 km thick and, seismically, has three layers. The uppermost layer has P-wave velocities of 6.1-6.2 km/s, the middle layer, at 10-16 km depth, 6.4 km/s, and the lowest, at 32 km depth, 6.7-7.0 km/s. A zone of crust about 50 km wide, along the northern

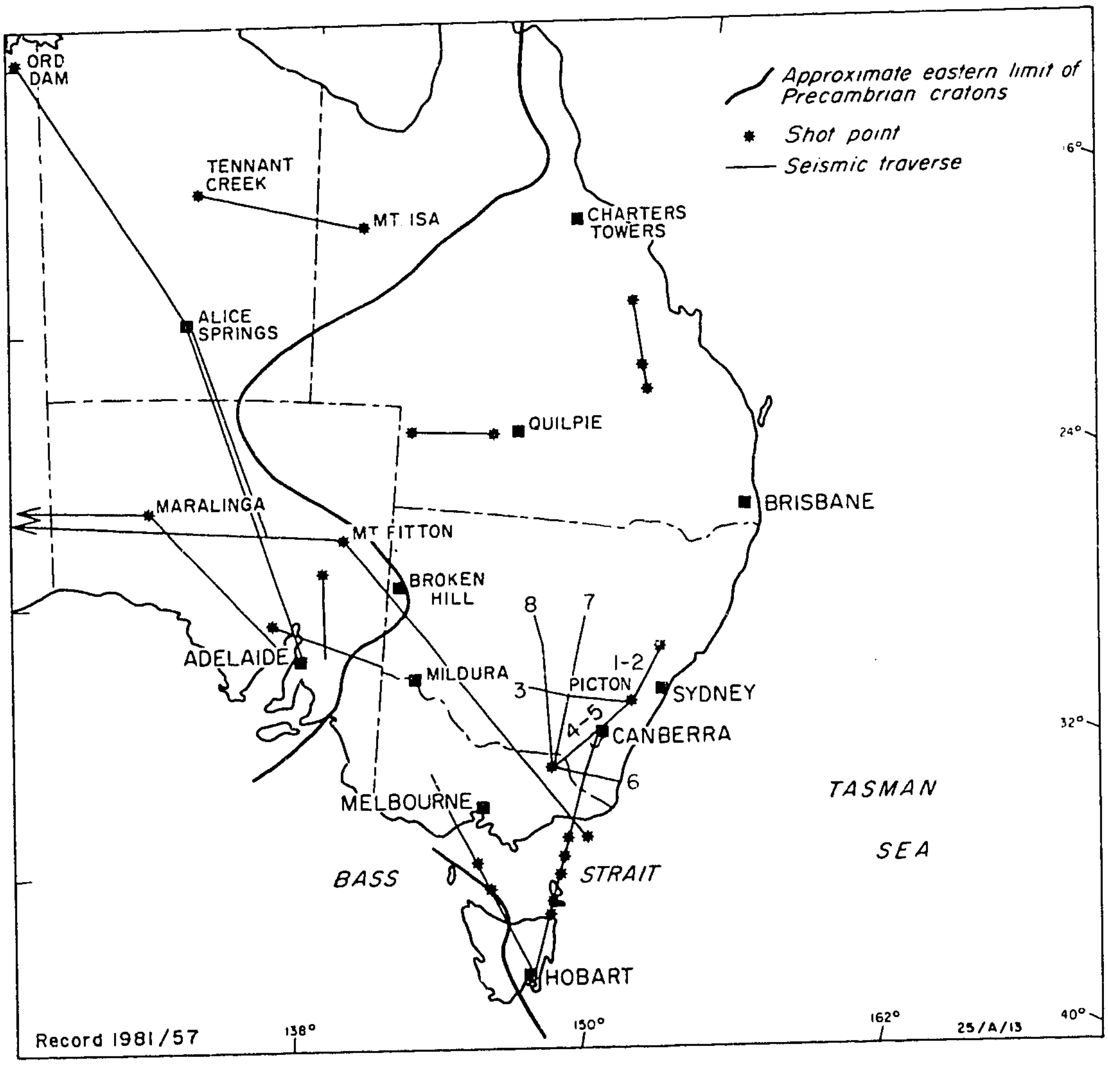

Fig. GSR 1. Seismic refraction traverses in eastern Australia. Velocity-depth models for traverses 1 to 8 are shown in Fig. GSR 2.

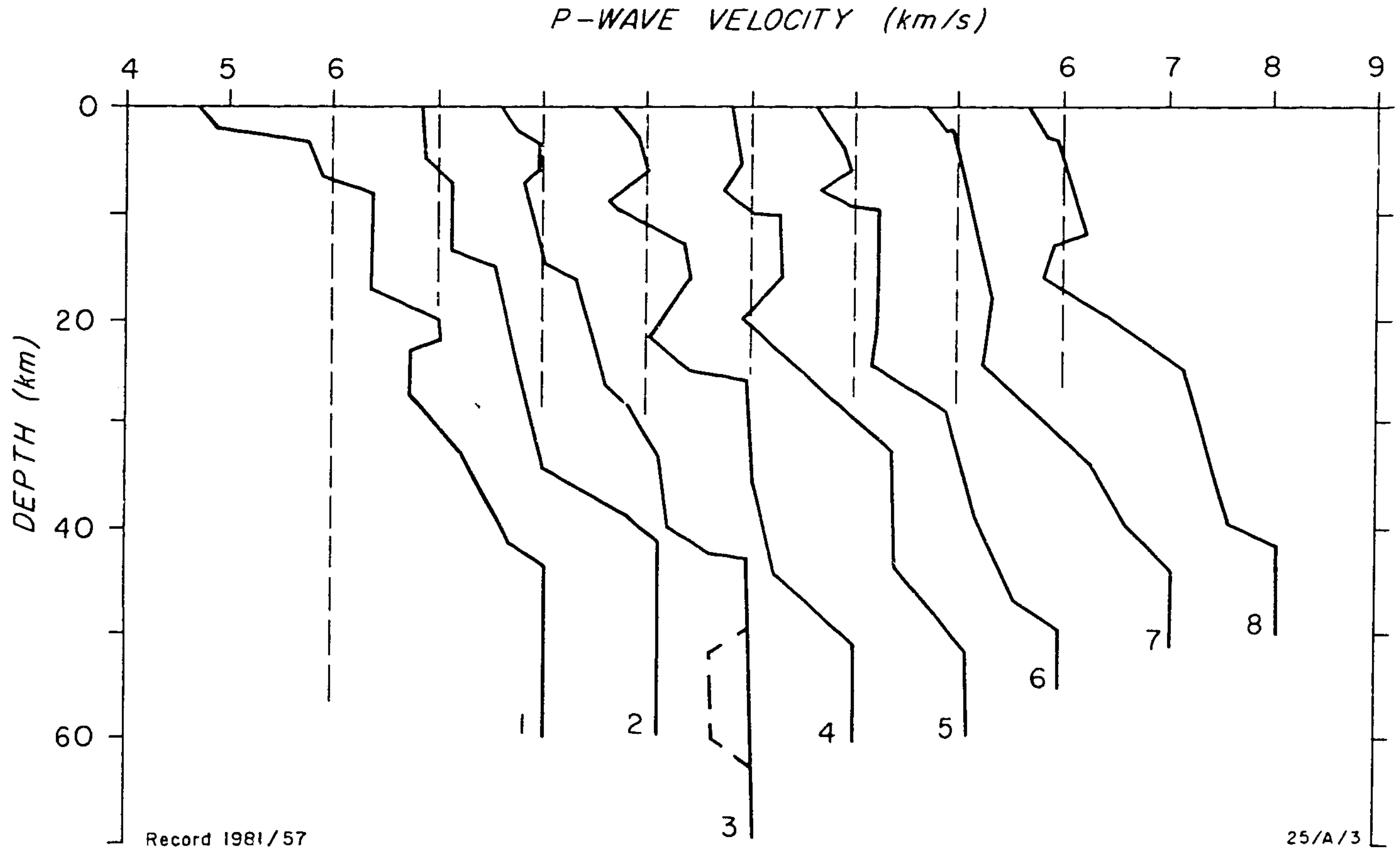

Fig. GSR 2. Velocity-depth profiles for traverses 1 to 8 shown in Fig. GSR 1.

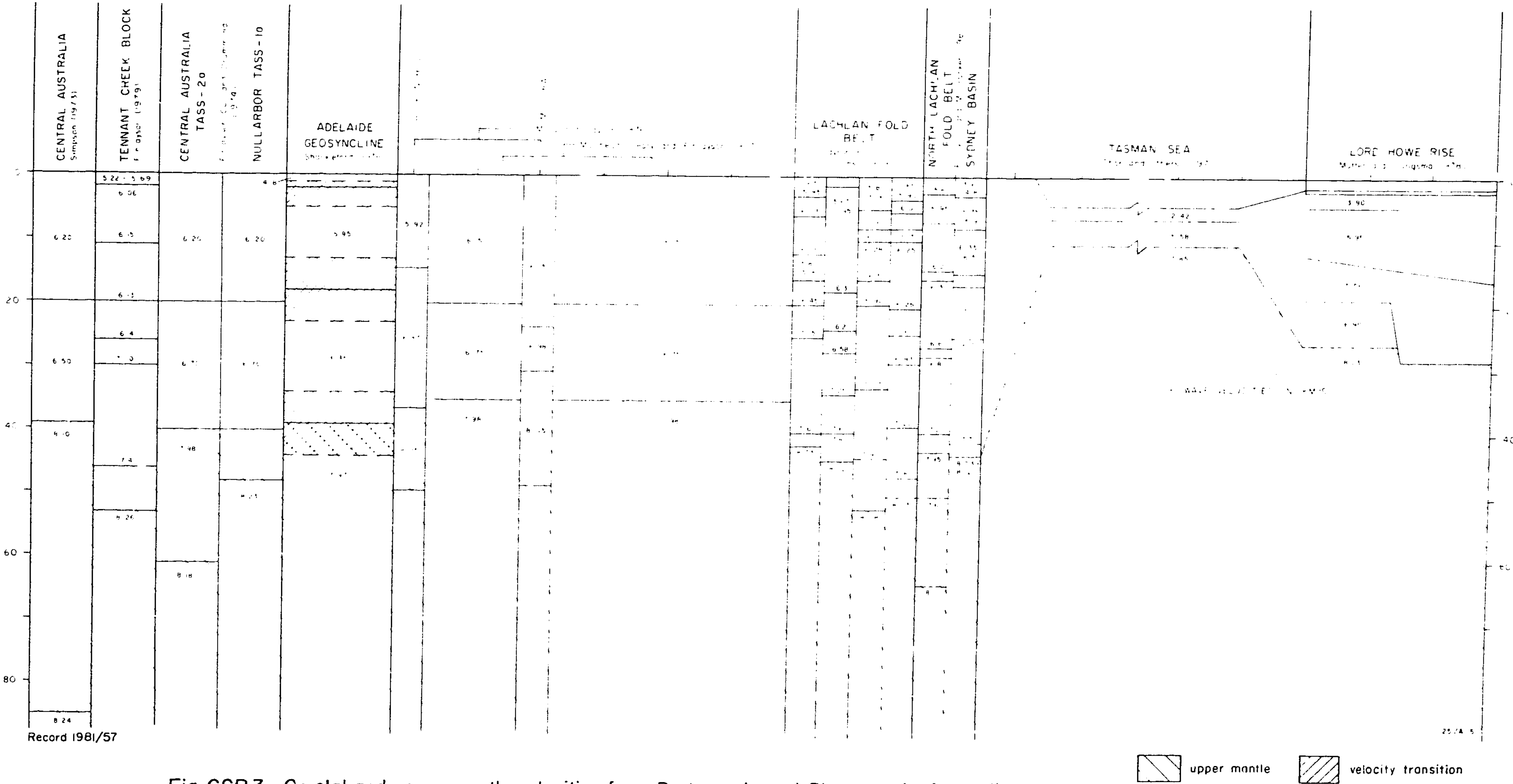

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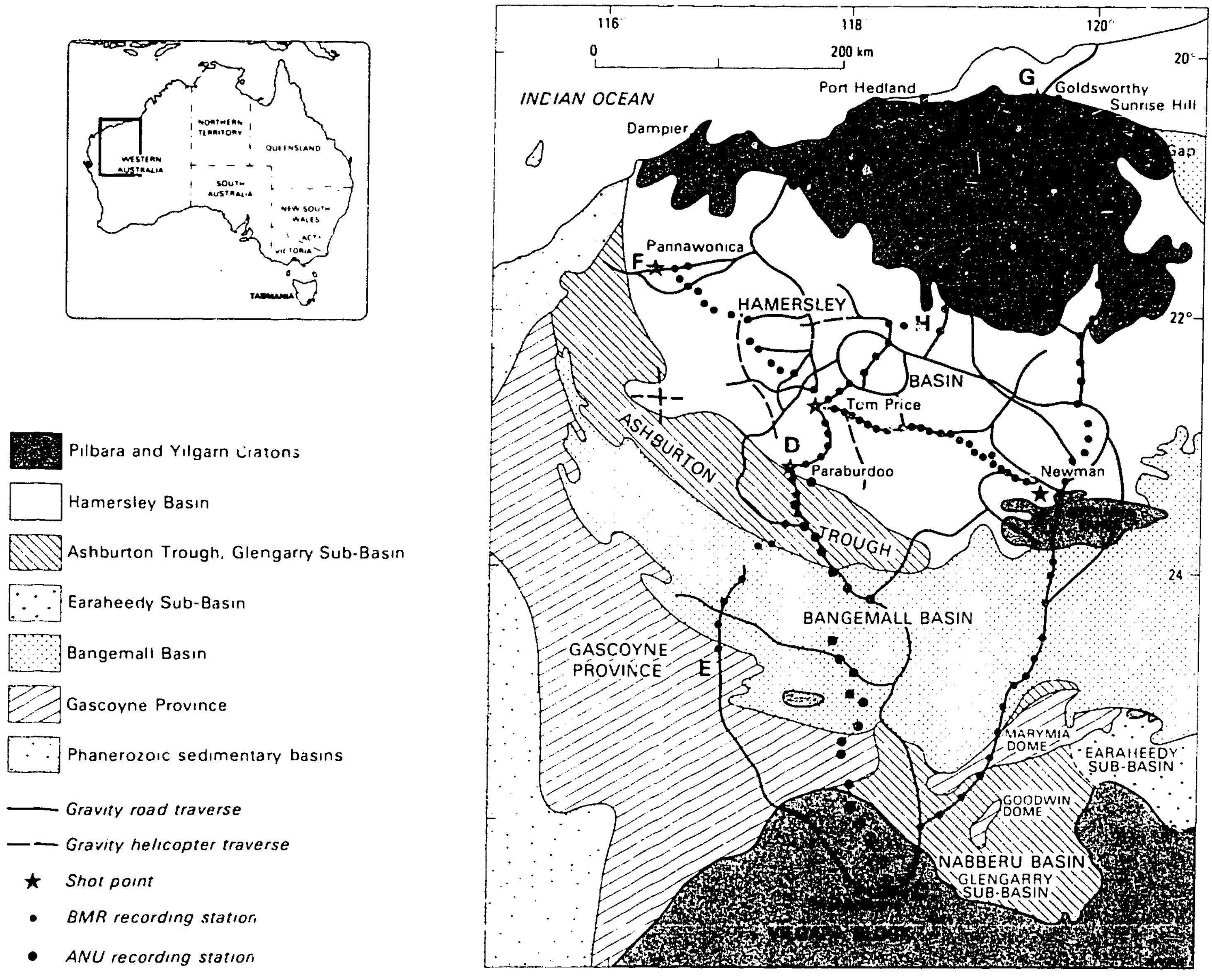
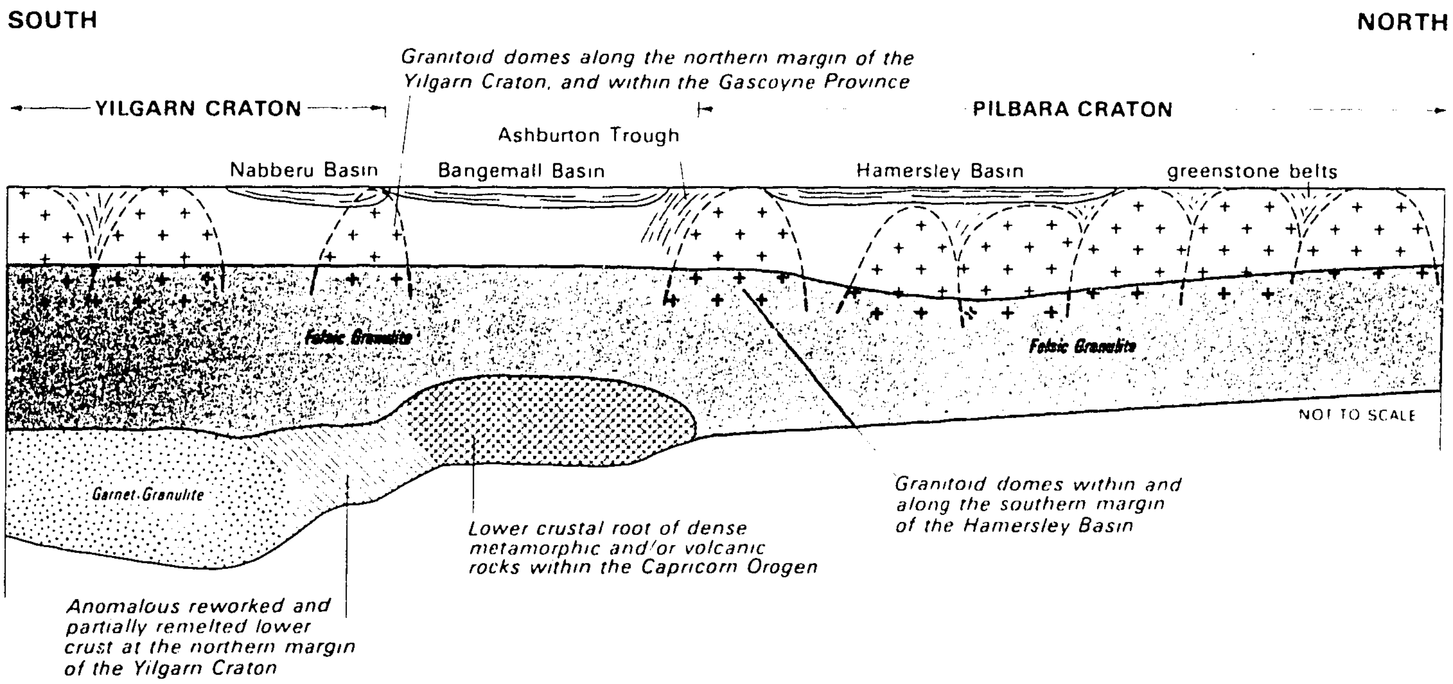
Fig. GSR 3. Crustal and upper mantle velocities from Proterozoic and Phanerozoic Australia

Fig. GSR 4.



Geology and survey design.



Cartoon sketch of a north/south section of crust through the survey area, in which the seismic models are interpreted in terms of the geology.

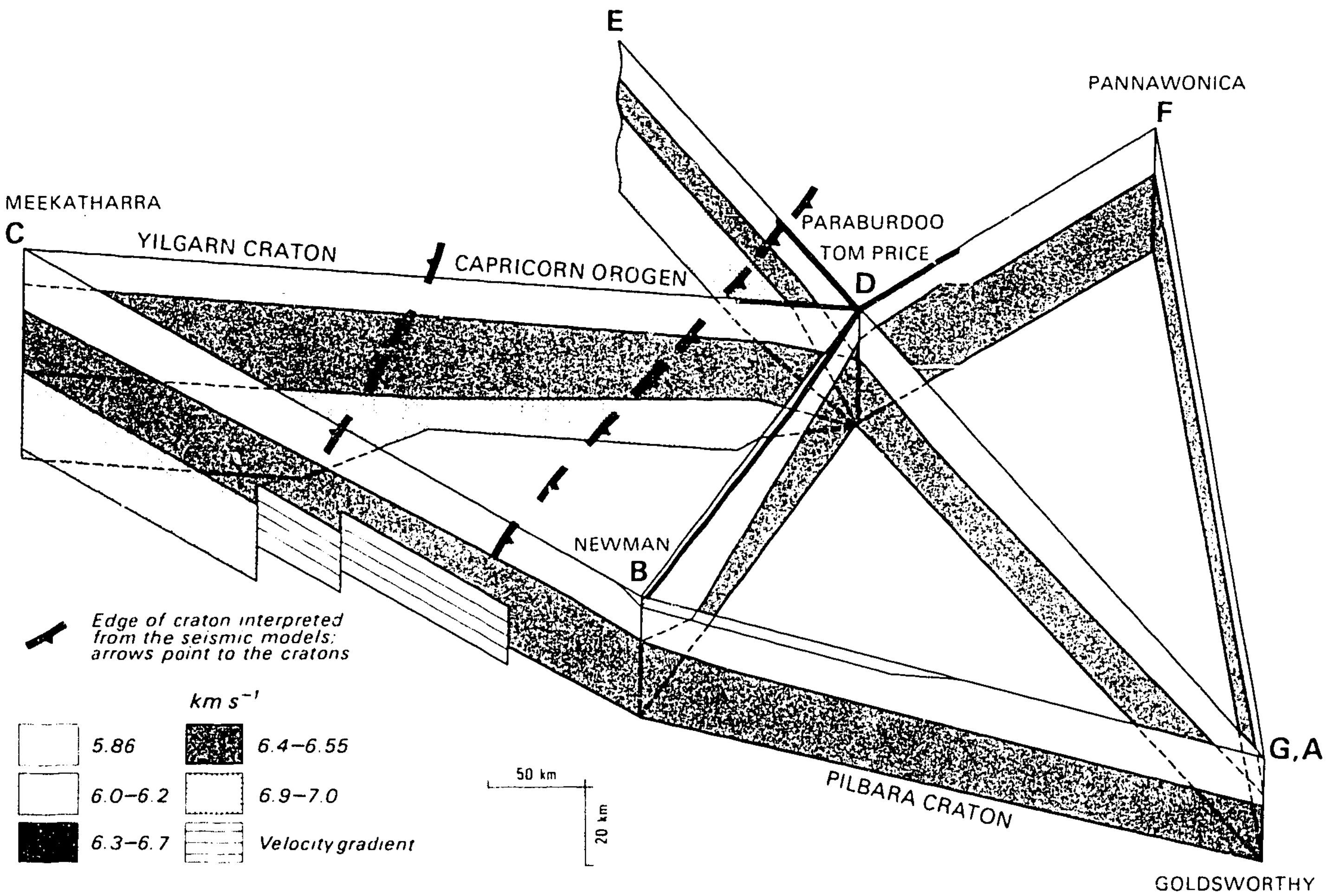


Fig. GSR 5.

Fence diagram of all of the seismic models from the Intercept Method interpretation of the data from the 1977 Pilbara Crustal Survey.

The interpreted margins of the cratons are based on crustal thicknesses. The edge of the Pilbara Craton corresponds to the southern margin of thin crust, and the northern edge of the Yilgarn Craton corresponds to the northern margin of thick crust. The Capricorn Orogen between the cratons has crust of intermediate thickness.

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margin of the craton, was extensively reworked during Proterozoic orogenesis, and is now characterised by thinner crust than the rest of the Yilgarn Craton, extensive granitoid emplacement, intense deformation and folding of the upper crustal rocks, and low gravity values.

The Capricorn Orogen between the cratons is marked by high velocities in the lower crust, probably caused by dense mafic intrusions or a higher metamorphic grade.

The seismic layering within the crust is most likely caused by increasing metamorphic grade with depth. The crust is probably of average acid to intermediate chemical composition, and has a low metamorphic grade at the surface. The velocity increases are attributed to metamorphic grade increasing to felsic granulite at 9-16 km depth, and garnet granulite at 32 km depth in the Yilgarn Craton.

However, these seismic models appear to be at variance with published isostatic models for the region. Two density models that attempt to explain the difference are shown in Fig. GSR 6.

In model A, the thick, low-density crust of the Yilgarn Craton is compensated at depth by high-density upper mantle rocks, and in model B the composition of the Yilgarn Craton is slightly more iron rich (either at the base of the crust or to a lesser extent throughout) than the crust of the Pilbara Craton. A compromise model is preferred in which the crust, particularly in the Yilgarn Craton, is chemically stratified with the denser, more basic rocks at the base. In this model, the upper mantle under the Yilgarn Craton is denser than that under the Pilbara Craton, and isostatic equilibrium is reached at depths greater than the base of the crust.

The differences in the crust or mantle throughout the region provide more evidence that the cratons have separate evolutionary histories. The upper mantle under the Pilbara Craton may be less dense than that under the Yilgarn Craton because of iron depletion, and may have been the source of iron for the basic volcanics and banded iron formations in the Hamersley Basin.

<u>Seismic investigations of the North Australian Craton between Tennant Creek and Mount Isa</u> (D.M. Finlayson)

During 1979 two seismic surveys were conducted to determine the gross crustal structure of the North Australian Craton between the Tennant Creek Block and the Mount Isa Geosyncline (Fig. GSR 7). The interpretation of the first survey along a 60 km traverse wholely on the Tennant Creek Inlier was reported in the 1980 Summary of Activities (Record 1980/70).

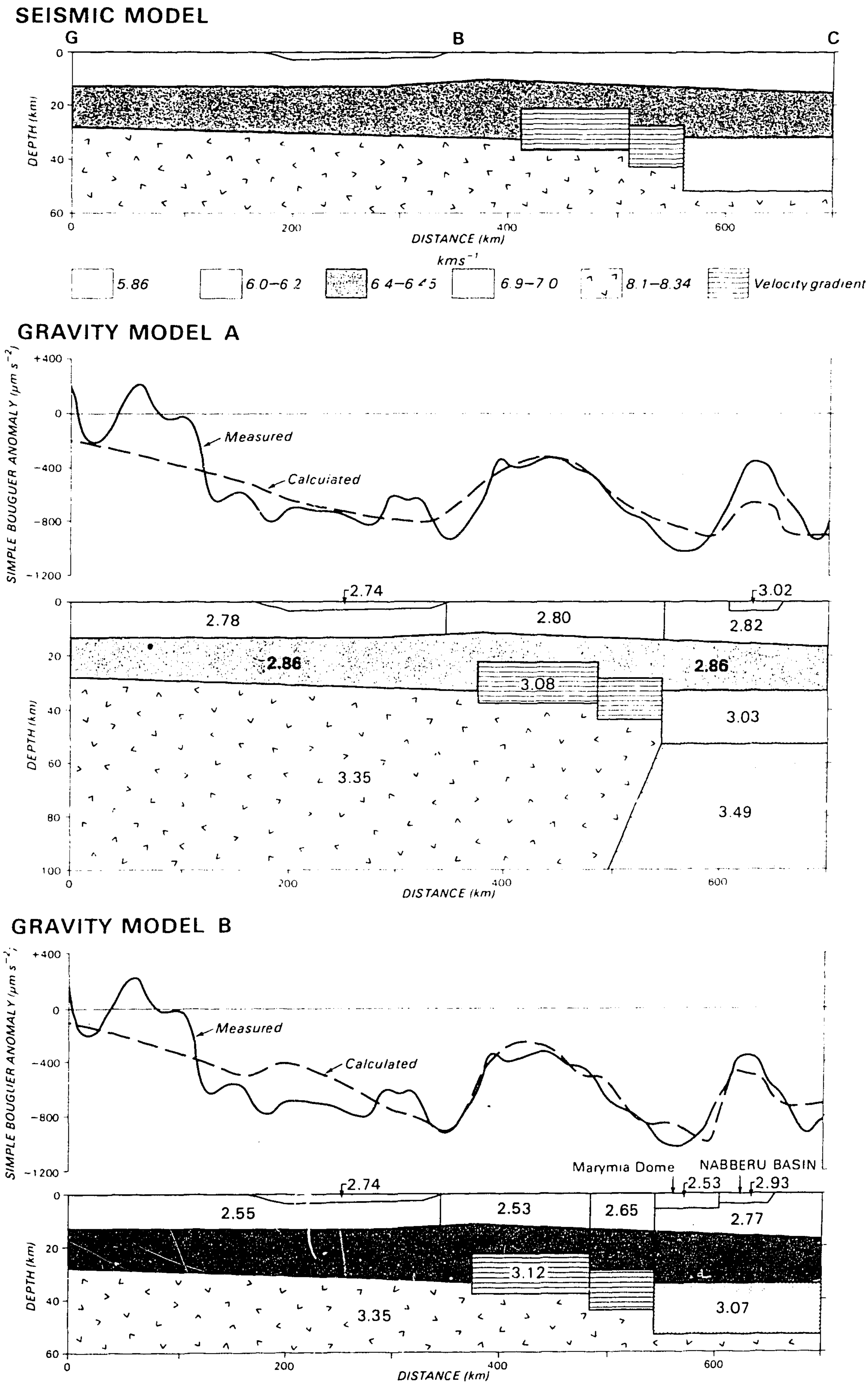

Fig.GSR6.

The seismic model (Drummond, 1979c) and two gravity models for line GBC. Model A has a root of high-density upper mantle compensating the effects of the thick crust under end C, and in model B different velocity/density functions (see text) were assumed for each end of the line. The calculated and measured curves agree in the principal features, but the short-wavelength effects were not modelled. Both models require a high-density slab representing the Nabberu Basin near end C, and model B requires a low-density prism to represent the Marymia Dome.

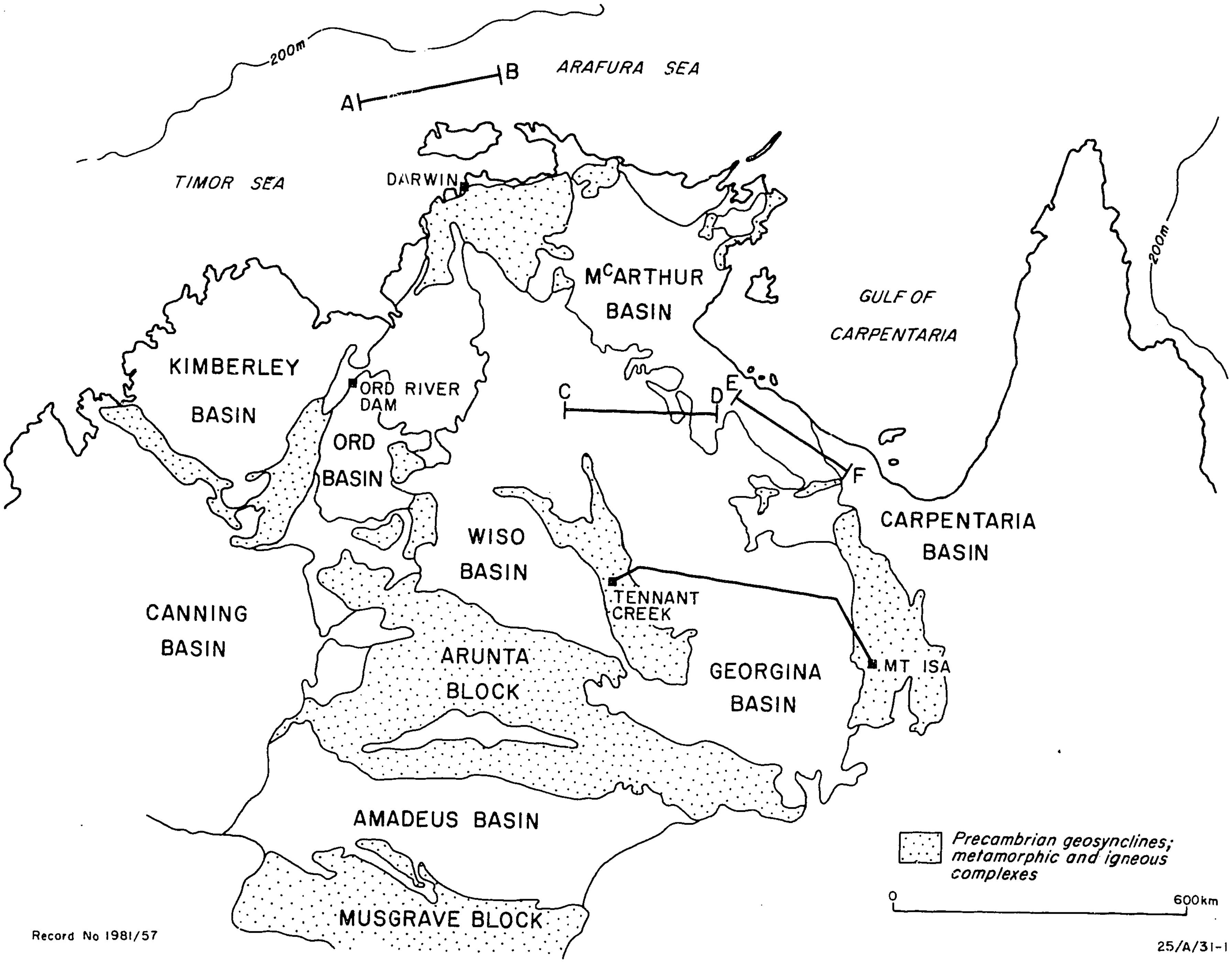

Fig. GSR 7. Seismic crustal investigations of the North Australian Craton. A-B, West Arafura Sea; C-D, E-F McArthur Basin

Seismic recording along a 600 km traverse across the southern part of the Proterozoic North Australian Craton between Tennant Creek and Mount Isa (Fig. GSR 8) indicates velocity-depth structures in the upper and middle crust which are different under the eastern and western portions of the traverse. The velocity structures near the surface are compatible with an assemblage of younger and older metamorphic rocks intruded by granites. Near surface (0-5 km) P-wave velocities on the Tennant Creek Block increase from 5.47 km/s at the surface to about 6.2 km/s and correspond to low grade metamorphics of the Warramunga Group interspersed with weathered granites overlying amphibolite facies rocks of older metamorphic domains. In the Mount Isa Geosyncline, velocities of 6.03-6.15 km/s correspond to the Leichhart Metamorphics interspersed with granites.

In the middle crust, P-wave velocities of 6.85 km/s are evident at a depth of 26 km near Tennant Creek, whereas such velocities are not evident until depths of about 37 km near Mount Isa. There is therefore a trend for mid-crust velocities to increase from east to west. The lower crust is characterised by velocities of 7.3-7.5 km/s, and the upper mantle velocities of 8.16-8.20 km/s are reached at depths of 51-44 km (Fig. GSR 9).

Exposed granulite facies rocks in central Australia were formed at mid-to-lower crustal depths; such rocks are low in heat-producing elements and therefore compatible with the low surface heat flow generally measured in Precambrian Australia. Laboratory measurements on world-wide samples indicate that the velocities of mid-lower crustal rocks in the North Australian Craton could result from an assemblage of granulite facies rocks varying from pyroxene granulite in the middle crust, through hornblende granulite, to garnet granulite in the lower crust.

Taken together with other seismic data from the North Australian Craton, there is evidence for mid-crustal velocities increasing from east to west and from south to north. These trends could result from a greater proportion of high-velocity granulites being emplaced at higher levels in the crust.

Structure of the Australian continental lithosphere (D.M. Finlayson)

Geophysical differences exist in the lithosphere between Phanerozoic and Precambrian Australia. Published material has been analysed to assess the depth extent of these differences and their contribution to the tectonic framework of the Australian continent.

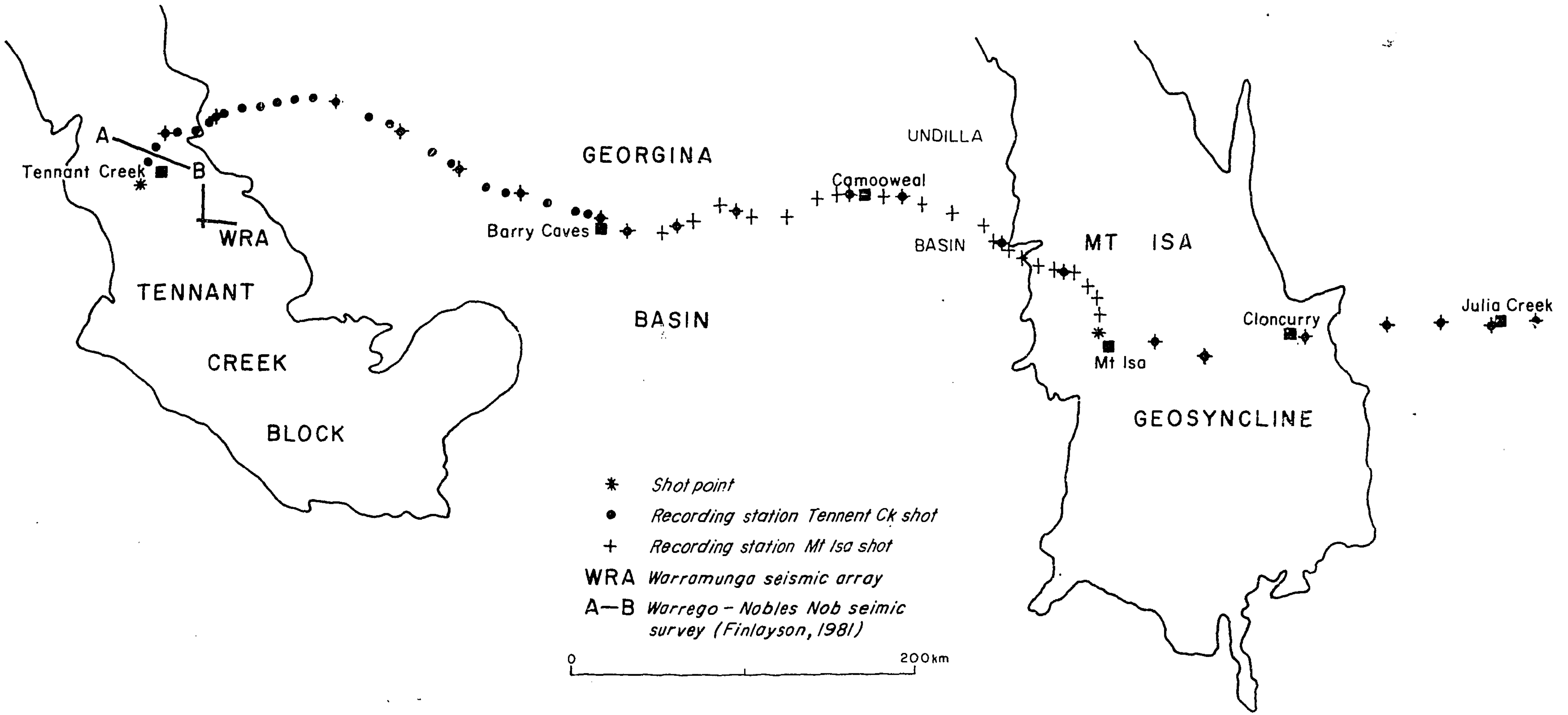

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Fig. GSR 8. Tennant Creek-Mount Isa seismic stations

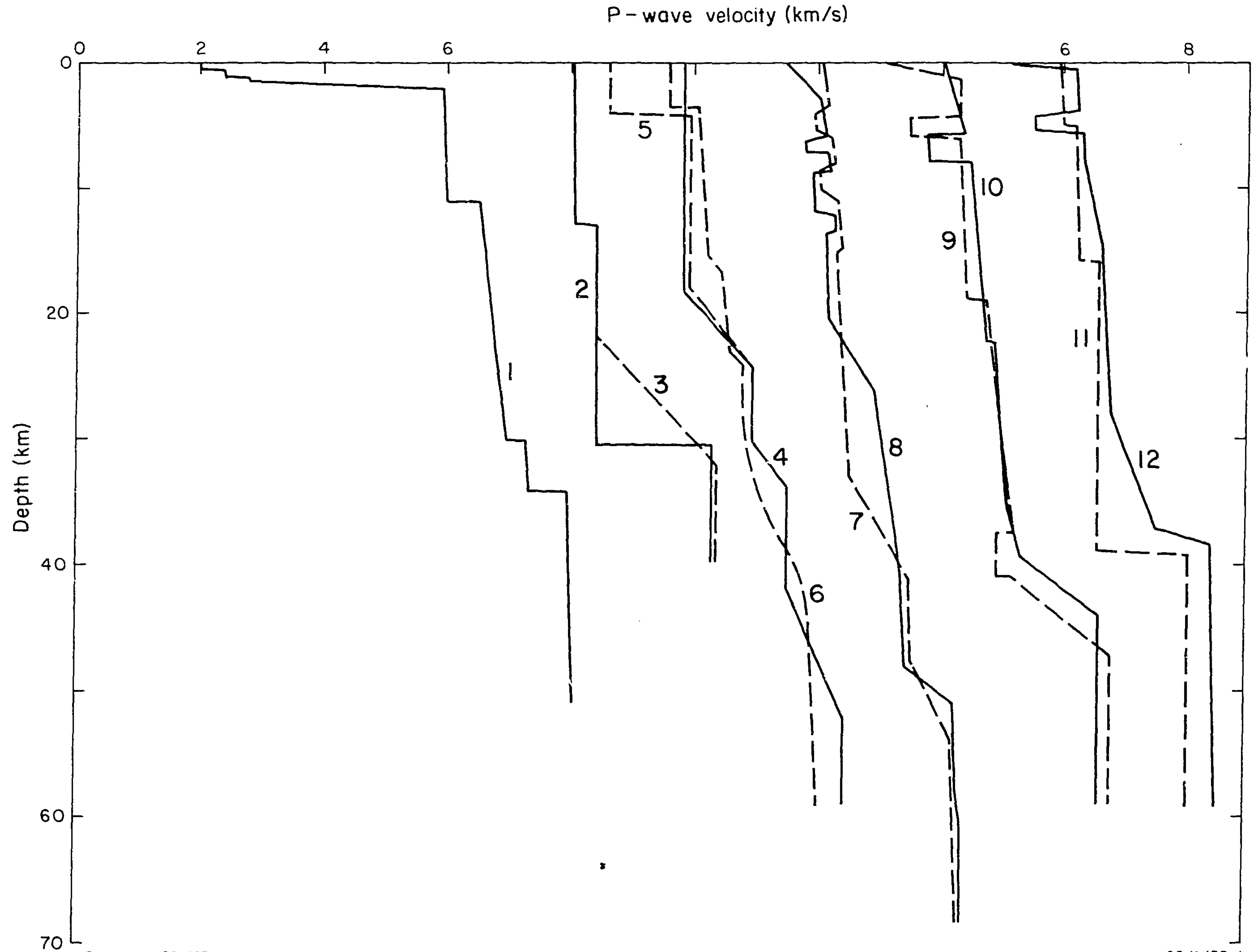

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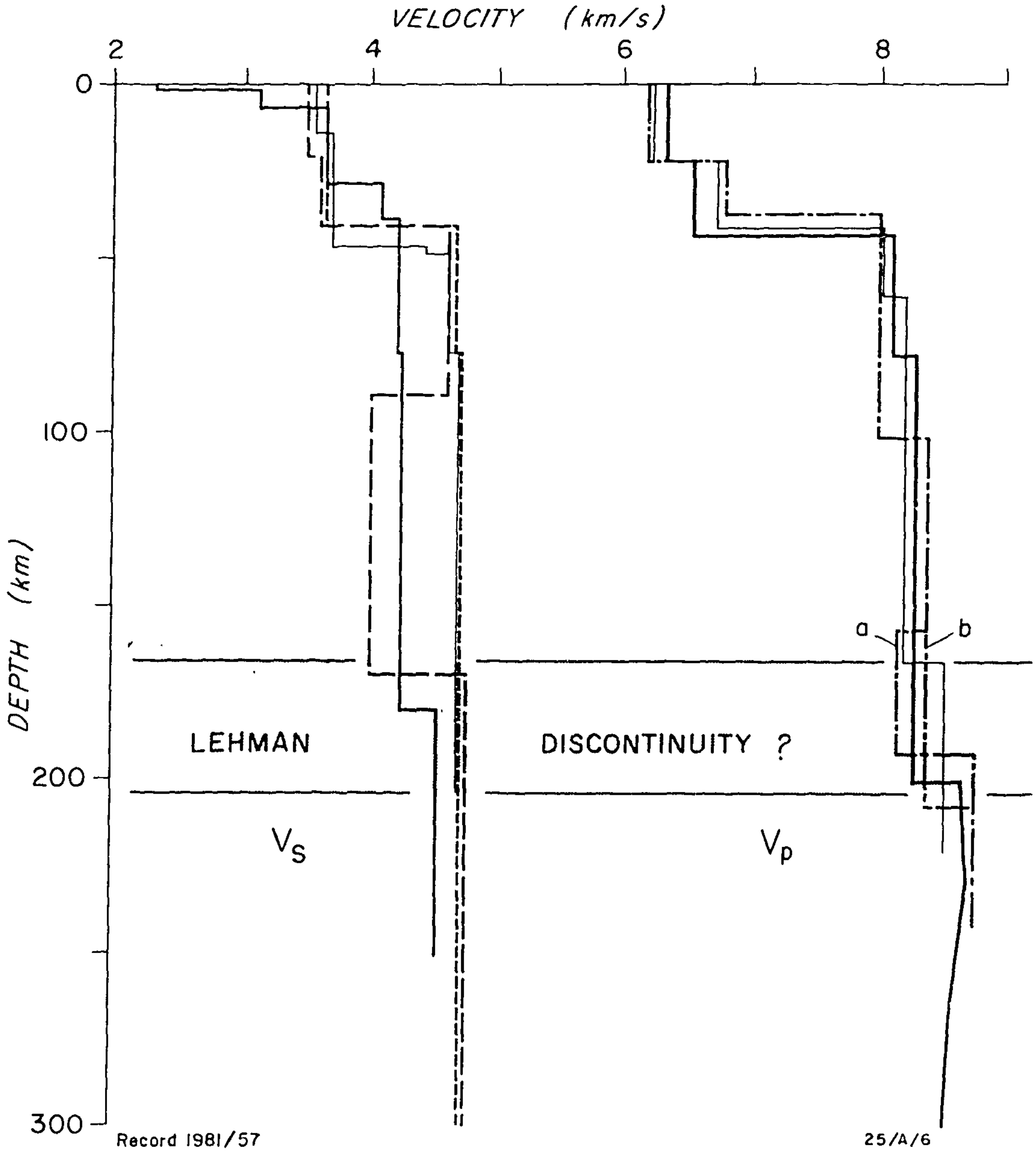
Fig. GSR 9. Velocity–depth profiles from Precambrian provinces. 1. West Arafura Sea; 2, 3. Pilbara Block; 4, 5. West McArthur Basin; 6. East McArthur Basin; 7, 8. Tennant Creek—Mount Isa; 9, 10. Grenville Province, Canada; 11, 12. Superior Province, Canada.

Cannikin atomic bomb recordings indicated differences in travel-times from the Aleutian Islands test site to Phanerozoic and Precambrian provinces in Australia of up to 1.1 s. Explosion seismic studies in central and southeastern Australia enable travel-time corrections for crustal and upper mantle structure to be made to recordings of such teleseismic events. Structure in the upper 60 km can account for, at most, about 0.2 s of the residual differences, but attempts to constrain the remaining residual time to the region above the Lehmann discontinuity, at about 200 km depth, are difficult to reconcile with explosion seismic models (Fig. GSR 10). Regional differences in seismic velocity structure between Phanerozoic and Precambrian Australia therefore appear to exist at depths greater than 200 km.

Electrical conductivities within the mantle have been investigated using two methods. Long-period electromagnetic depth sounding using magnetometer arrays demonstrates that conductivities increase at about 200 km under Phanerozoic Australia but not until about 500 km depth under Precambrian Australia. Shorter period magnetotelluric measurements can only resolve shallower structures; these too indicate a similar trend but with sub-crustal conductivities increasing at less than 100 km under Phanerozoic Australia. Magma at these depths and shallower may be the source for Cainozoic volcanism in eastern Australia. Under Precambrian central and northern Australia, magnetotelluric investigations indicate that pronounced conductivity increases do not occur until depths of 150-200 km are reached.

Ocean floor magnetic lineations indicate that the Australian lithospheric plate as a whole is separating from Antarctica at a rate of about 7 cm/yr. The seismic and conductivity structures under the continental region of this plate indicate that lateral inhomogeneities possibly extend to depths as great as 500 km and are probably caused by the passage of eastern Australia over a hot spot. Hawaiian studies indicate that hot spots are not local features but result from large-scale disturbances in the mantle. Conductivity increases commencing in the depth range 100-250 km may give an indication of uppermost zones within which the Palaeozoic lithosphere has been substantially modified, resulting in elevated surface heat flow, volcanism, and seismic travel-time anomalies.



Mills & Fitch (1977) Model CTA 2S1

Goncz & Cleary (1976) Model E1

Goncz & Cleary (1976) Model W1 *

Hales, Muirhead & Rynn (1980b) *

Muirhead, Cleary & Finlayson (1977)
a – with low velocity zone
b – without low velocity zone

Hales, Muirhead & Rynn (1980a) *

Finlayson, Cull & Drummond TASS 2a model (1974) *

* Surveys in Precambrian provinces

Fig. GSR 10. Lithospheric velocity-depth models for continental Australia

Northern Australia lithospheric studies (D.M. Finlayson)

During 1981 scme preliminary planning was done to design a seismic investigation aimed at determining the fine structure of the sub-crustal lithosphere under Northern Australia. This is a co-operative project between BMR, the Australian National University, and the Royal Australian Navy. It is expected that field work will be conducted during September-October 1982, and will involve recording marine shots and earthquakes off northern Australia at closely spaced stations along a line between Darwin and Alice Springs.

Seismic crustal studies instrumentation and programs (C.D.N. Collins, J. Whatman, D.M. Finlayson)

Instrumentation. Modifications were made to the twenty-one remote recording seismic tape recorders with a view to reducing the power consumption and battery requirements.

NCE-3 clocks were developed to replace the existing NCE-2 clocks. The NCE-3 clocks have low power requirements (10 mA at 12 V) and a low-powered liquid crystal display, instead of the LED display of the NCE-2 model. Thirty-seven of the new clocks have been built out of a total of forty. All NCE-2 clocks have now been replaced in the twenty-one recording systems.

New low-powered Phillips DC motors and gearboxes will be installed in the the fifteen XTA-2 systems, replacing the original stepper motors. Preliminary tests on two modified systems have proved satisfactory and they are being field tested in the Eromanga Basin. The 12-volt current requirement of the modified systems is approximately 270 mA when recording (compared with 790 mA using the original motor). Power consumption during standby is about 100 mA.

Twelve new recording systems are being built based on Tandberg tape decks. Apart from certain mechanical parts of the tape deck, most components will be the same as in the XTA-2 systems.

Testing of a Geotech amplifier and seismometer continued, and construction of new TMF-3 modulators commenced. Routine maintenance of equipment continued throughout 1981.

Programs. Minor improvements were made to the Group's computer programs during the year. Severalprograms have been transferred to the BMR HP computer from the CSIRO CYBER 76 and can now be run interactively. An extended version of the ray-tracing program SEISRAY is being adapted to the HP system to trace headwaves in complex models. An extremal inversion program by J.A. Orcutt was adapted to the CSIRO CYBER 76 systems. Requests for assistance with programs were received from the Universities of Queensland and Adelaide, and the Australian National University.

Central Eromanga Basin project - seismic refraction investigations (J. Lock)

In 1980, data were recorded on two overlapping E-W lines in the Quilpie area. Line 1 had a station spacing of 1.875 km and extended from the Windorah/Eromanga turn-off in the east to Mount Howitt No. 1 Well, 150 km to the west. This line coincided with reflection line 1. Line 2 had station spacing of 7.5 km and extended from Cheepie in the east to Terebooka Bore in the west (Fig. GSR 11). Line 1 was shot to determine the velocity structure of the Eromanga Basin, the buried Cooper Basin, the Warrabin Trough and the basement. Line 2 was shot to determine the velocity structure of the crust and upper mantle.

The 420 analogue field records from the 1980 survey have been digitised and time corrected. Forward and reversed record sections from all segments of lines 1 and 2 have been compiled. These showed the data to be of high quality, with clear first arrivals followed by a sequence of arrivals characterised by increasing amplitude with time. Breaks and delays in the travel-times were found to correspond to structure in the sedimentary sequence, also evident in the reflection profile along line 1. Interpretation of the record sections is continuing.

In 1981 field work is planned to extend line 1 from the Windorah/Eromanga turn-off 112.5 km eastward to Cheepie. This line will pass from the Warrabin Trough over the Thargomindah Shelf, the Quilpie Trough, and on to the Cheepie Shelf. Reflection line 1 has also been extended to the east. A 300 km N-S line from south of Blackall to south of Toompine, and intersecting the E-W lines just east of Quilpie, is also planned (Fig. GSR 11). The station spacing will be 7.5 km. Large offset shots south of Barcaldine and Thargomindah will extend this line to 400 km.

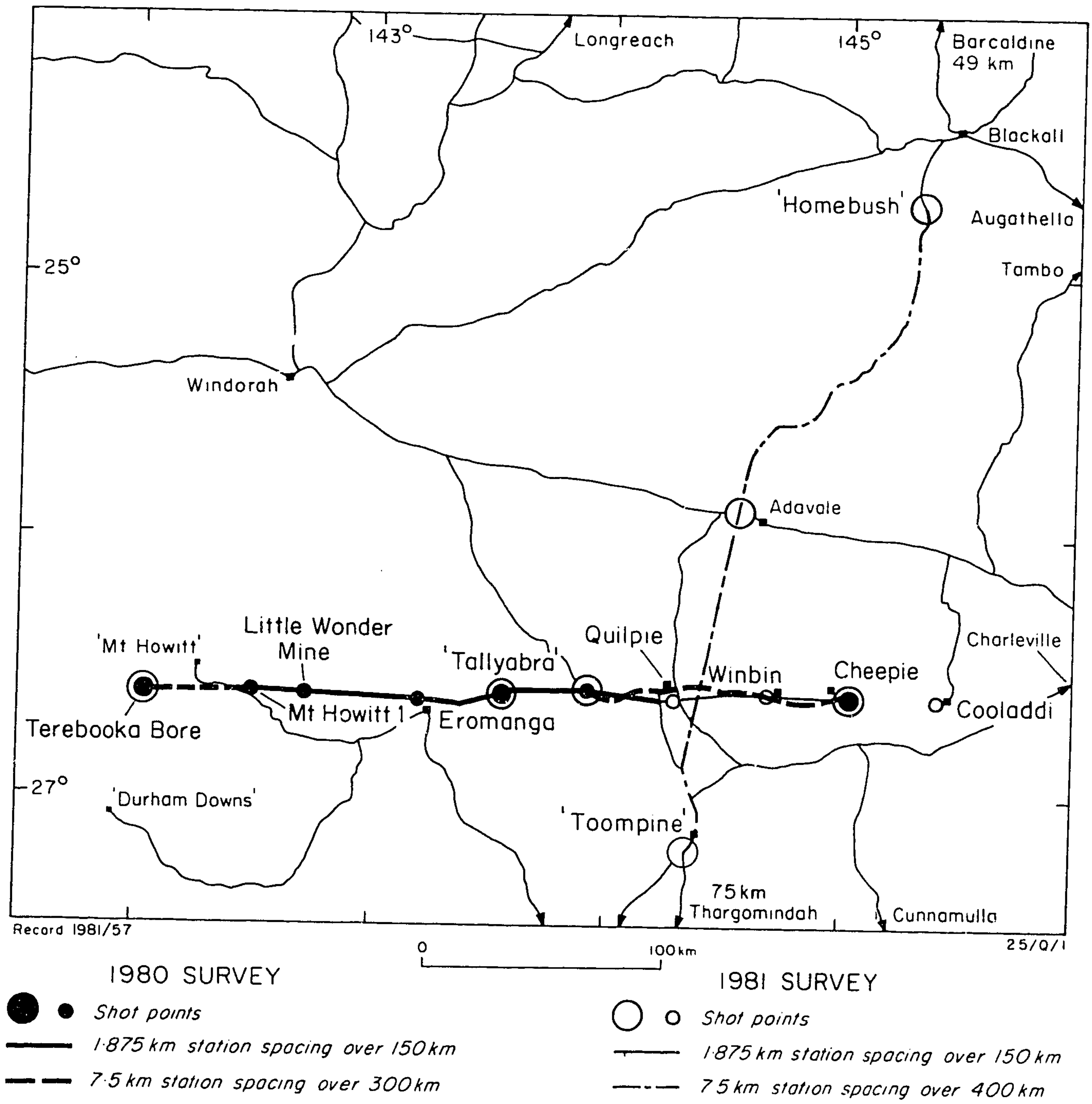


Fig. GSR 11. Seismic refraction recording traverses, Central Eromanga Basin

Eromanga Basin magnetotelluric (MT) investigations (A.G. Spence, J. Whatman)

During 1980, MT measurements were made at 12 sites spaced approximately 20 km apart along a traverse over the central part of the Eromanga Basin. This work was conducted as one of a series of geophysical investigations of the Basin. The main objective was to determine the electrical conductivity structure of the region. Crustal seismic recordings and continuous seismic reflection profiling were carried out along the same traverse, as shown in the location sketch (Fig. GSR 12).

The results of the study are presented in the form of profiles of average resistivity against depth below each site along the traverse, as seen by currents flowing along-strike and across-strike (Fig. GSR 13 and 14).

The uppermost zone on the profiles corresponds to the Eromanga sequence. Its low average resistivity (generally less than 5 ohm-m) reflects its high porosity. The base of the zone is well-resolved and its relief portrays the known structural features encountered along the traverse. Another feature of note is the occurrence of anomalously low average resistivities within this zone below sites 2, 6, 7 (along-strike), and site 8 (across-strike). These are regarded as being due to the presence of groundwater of increased salinity within the sediments below these sites. Furthermore, the locations of these sites appear to satisfy groundwater-study criteria for stagnation zones; they occur in down-gradient positions on large anticlines.

The second, deeper resistivity zone is generally not well resolved, because of the presence of the conductive Eromanga sequence immediately overlying it. One of the better resolved features is a deep zone of intermediate porosity below the Warrabin Trough. This is interpreted as a fracture zone resulting from the uplift of the Canaway Ridge. A similar but smaller zone appears further to the east, near site 11. Devonian-Carboniferous sediments fill the top sections of these troughs to depths which have not been resolved.

Permo-Triassic Cooper Basin sediments extend into the region at this level from the west. Though not well defined, their eastern limit occurs between sites 7 and 8. In the Coonavalla Syncline below the Cooper Basin sediments there is a well-resolved layer of fairly high porosity along strike. It is regarded as due to tight folding of sediments, probably Devonian-Carboniferous. The remaining feature of this zone is an unresolved thickness (probably 4-5 km) of intermediate porosity in the Cooper Syncline. It is regarded as being due to fracturing of the metamorphics that make up the lower part of the section.

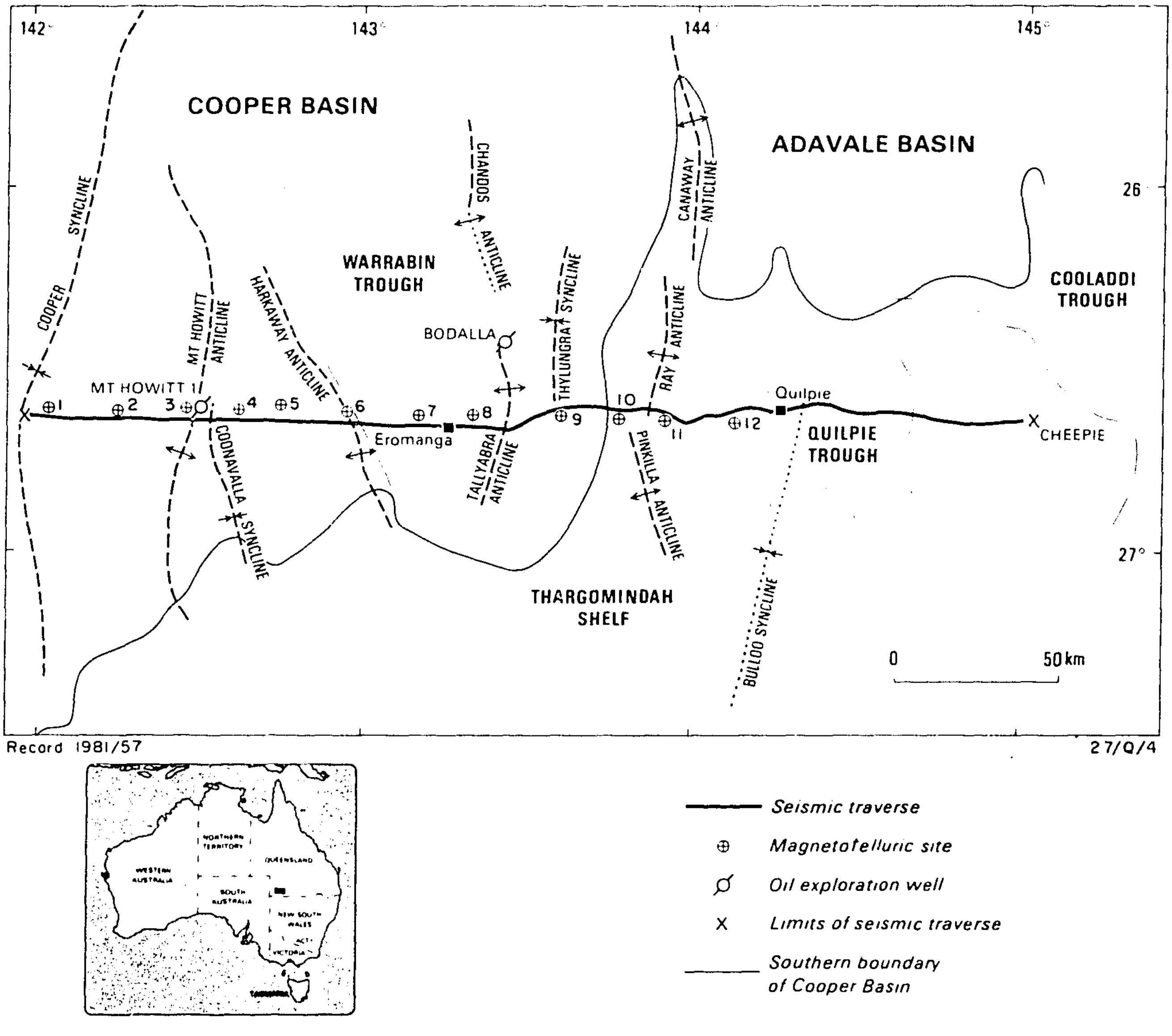


Fig. GSR 12. Magnetotelluric recording sites, Central Eromanga Basin

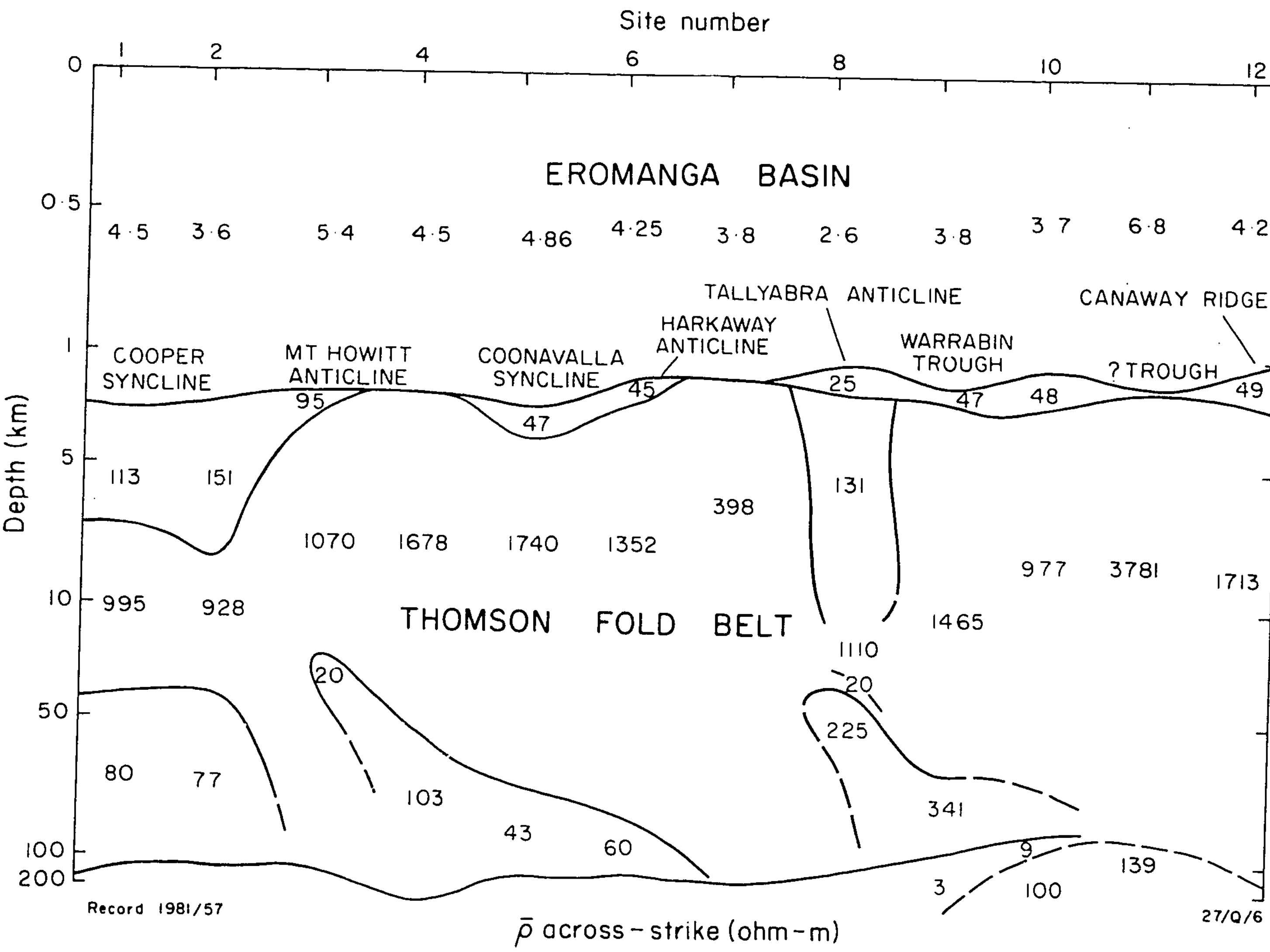


Fig. GSR 13. $\bar{\rho}$ across-strike Eromanga Basin schematic section-resistivity

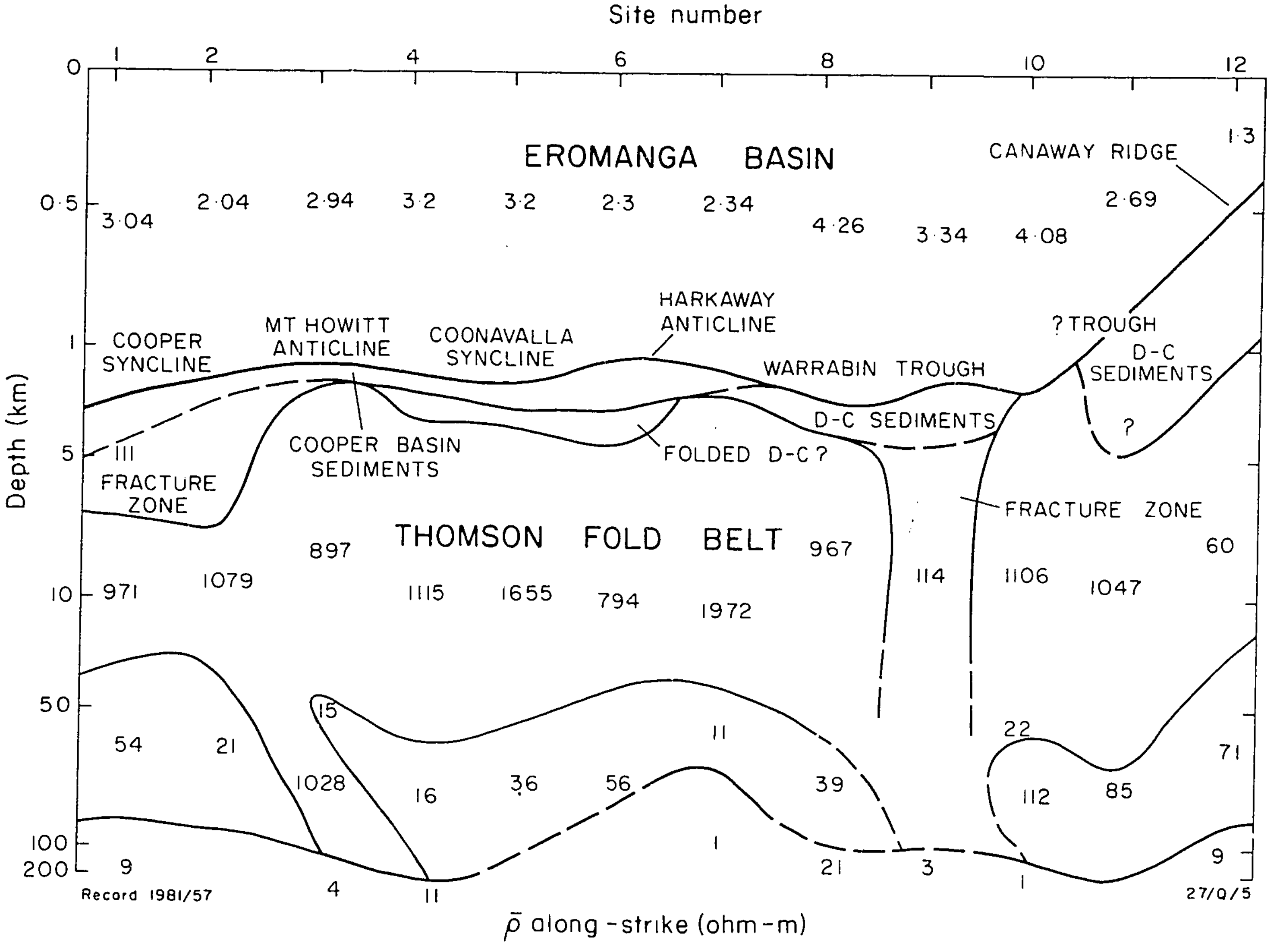


Fig. GSR 14. $\bar{\rho}$ along strike, Eromanga Basin schematic sections-resistivity

The next broad zone on the profiles consists of material of high average resistivity and is impervious except for the two fracture zones mentioned above. Its upper surface marks the base of the hydrocarbon prospective sequence. It is very thick (30-60 km), and is composed of long wavelength folds of low amplitude. It is identified with the metamorphic rocks of the Thomson Fold Belt and deeper crustal rocks.

The deepest zone is characterised by much lower resistivities and the presence of major lateral discontinuities below sites 2-3 and sites 8-9. It has been suggested elsewhere that the very low resistivities which occur here at depths of 90 km and greater could mark a zone of partial melting beneath the lithosphere.

The results of this broad reconnaissance survey have demonstrated the applicability of MT to the investigation of the Eromanga Basin. Proposed upgrading of the field instrumentation and refinements of interpretation procedures are expected to decrease noise and scatter, thus permitting the use of more refined models in interpretation.

Magnetotelluric (MT) systems development (J.P. Cull, A.G. Spence)

The BMR MT data acquisition and interpretation programs were developed over many years by several individuals. The system continues to evolve as new hardware is made available and further advances are made in MT theory. As a result the BMR system remains the most sophisticated in Australia and is one of the few used on a routine basis for regional surveys.

The original digital acquisition system (DAS) was based on a 21 MX computer with 32 k byte memory and a 7905 disc with 15 M byte capacity. A new computer (1000 E series), a new disc (7908), and a 3 M Cartridge are being commissioned for the new DAS. Consequently, revisions were required to the software operation system, involving conversion from the original RTE-2 system to that of the RTE-4 system.

Suitable modifications to software have been progressively implemented, and routine processing operations have been adopted. Software procedures have been implemented to reduce ambiguity resulting from random rotation angles generated by noise in marginal 2-D structures. Driver routines in the original acquisition programs remain to be modified to allow for different disc access time and track segment allocation.

Geothermal studies (J.P. Cull)

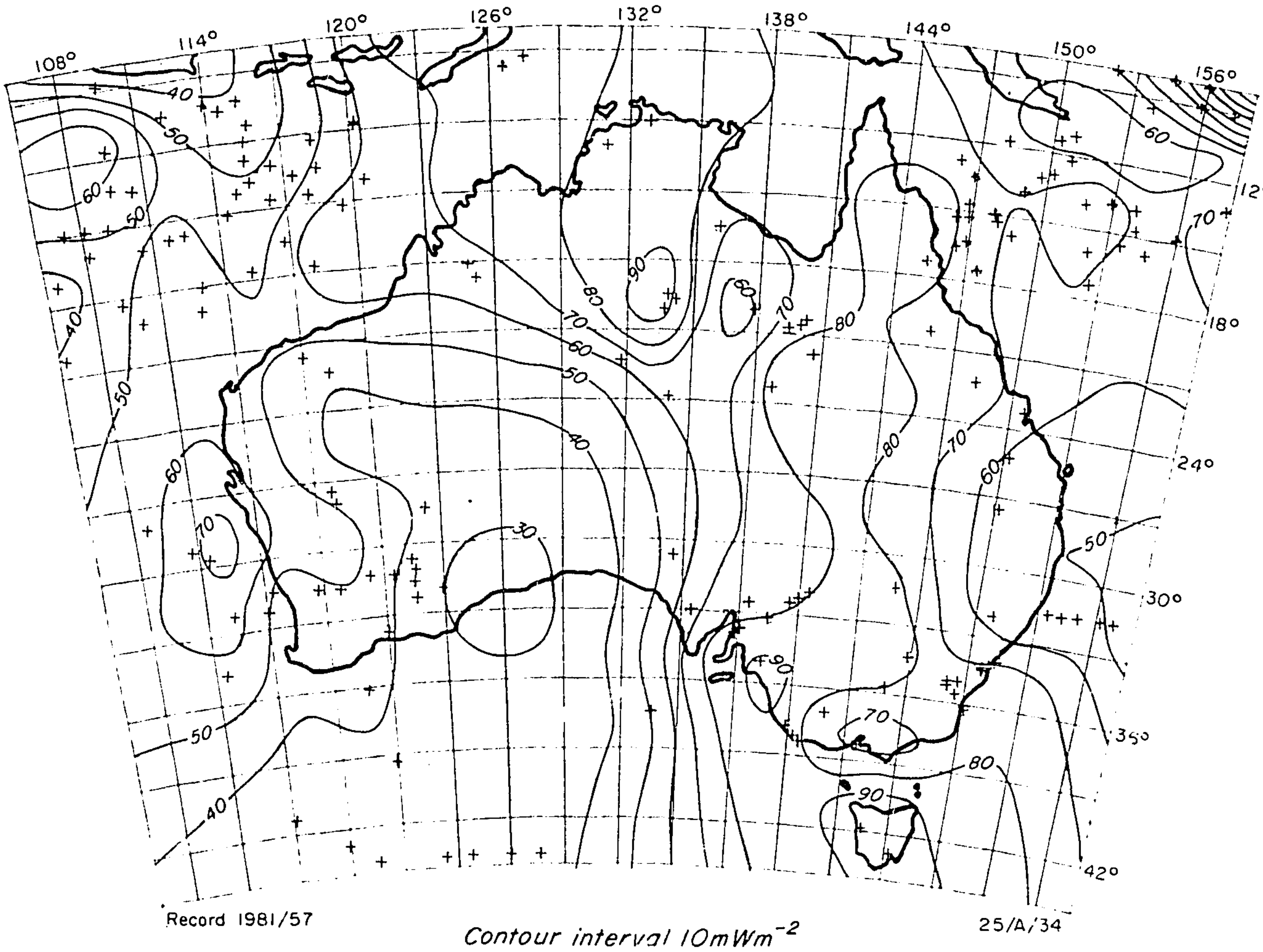
All heat flow data obtained in Australia have been compiled in a standard format which rates the principal facts of each determination. Quality has been assessed using a code that contains a summary of the sources of error. Estimates of precision vary according to the techniques used both in recording and processing the data, but less obvious systematic errors are generated by changes in equipment design, core sampling rates, and local site conditions. Each factor must be considered when comparing data from different sources. The rating system has been tested for consistency, and a calibration has been provided using multiple determinations of heat flow in regions of similar geology; consequently the subjective quality factors can also be used for numerical estimates of error associated with isolated determinations.

Data were considered in two groups according to quality. Errors at 10 percent (one standard deviation) were calculated for the group with better quality, but other data may contain errors of 20 percent. New determinations of heat flow have been presented according to the adopted format, and other data related to geothermal studies have been included to complement the existing data bank. Regional trends identified previously are preserved even when data of poor quality are rejected. A revised map showing regional geothermal flux is shown in Fig. GSR 15.

Gravity data base (A.S. Murray, P. Wellman, J. Williams, E.H. Smilek, R. Tracey)

Gravity data bank. The computer-based gravity data bank should ultimately hold all significant gravity data in the Australian region. Currently it contains information from approximately 560 000 gravity observations covering continental Australia, the continental margins, offshore islands, and parts of Antarctica. The contract recomputation of gravity data to the current height and gravity standards continued slowly during the year with nearly 20 000 new observations being added to the data bank. The contract nears completion.

Gravity maps. Two new series of gravity maps are currently being produced. Both show Bouguer anomaly contours based on the IGSN71 gravity datum and the GRS67 formula for normal gravity, and are calculated for a density of 2.67 t/m^3. One series is at 1:250 000 scale showing station positions identified by a survey number and annotated with a station number, elevation,



Contour interval 10 mWm^{-2}

+ *Data point*

Fig GSR 15 Heat flow in Australia. Contours derived from a 3° grid of values rated better than 333 and gravity anomaly. The other series at 1:1 000 000 shows only station positions in addition to the contours. The maps will be released in blocks of 1:1 000 000 sheet areas wherever possible. The first three blocks covering the Hamersley Range, Canberra, and Bourke Sheet areas were released in 1981; further releases will be made at intervals of a few months over the next five to eight years until the series are complete. The status of the various map sheets at October 1981 is shown in Fig. GSR 16.

Requests for gravity data. Outside data requests consisted of 2[illegible] enquiries for tie stations for gravity surveys, 16 for tables of predicted tidal gravity, 14 for computer listings of surveys as small areas, 9 requests for information on the data bank tape availability, and two on computer program availability. There were three BMR requests to produce special computer plotted maps. There were six loans of gravity meters for periods exceeding one day.

Computer programs. Several additional features were incorporated into the contouring programs to improve the quality of the machine-plotted maps. An automatic legend of sufficient standard for publication, and the optional drawing of coastlines and State boundaries were added to the program.

The grid data file manipulation program was modified to allow the interpolation of a fine grid from an input gridded file. The interpolated grid may have one-third or one-half the grid spacing of the input grid.

A three-dimensional modelling program was developed to calculate the gravity effect of a horizontal prism of arbitrary quadrilateral cross-section and finite length. The profile may be calculated along a line at any orientation with respect to the body. In principal, an n-sided polygon cross-section prism may be modelled by combining several quadrilateral prisms.

Gravity base station (Isogal) network

In late 1981, the Earth Physics Branch of the Canadian Department of Energy, Mines and Resources offered to reduce BMR 1980 survey observations using their least-squares adjustment program. Consequently the BMR data were put in the Canadian computer input format, checked for errors, and sent to Canada for adjustment.

Laboratory tests on LaCost & Romberg gravity meters to measure their temperature, pressure, and voltage sensitivity were completed, and a start was made on analysing the results.

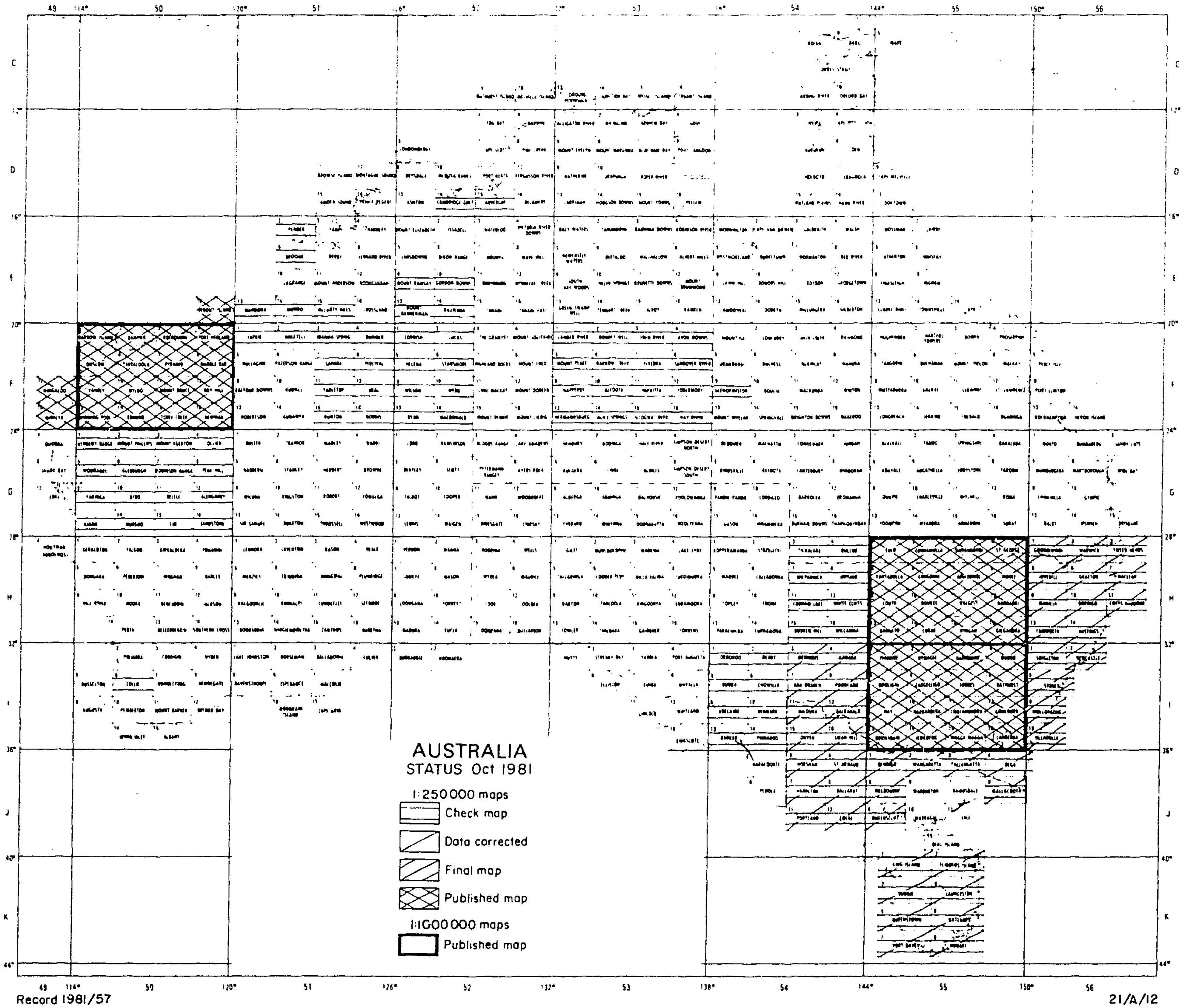


Fig. GSR 16. Status of new series gravity maps October 1981

Antarctica - aeromagnetic and gravity surveys (P. Wellman, J. Williams)

The aim of this project is to obtain aeromagnetic, ice radar, and gravity measurements over Australian East Antarctica and interpret the data to determine the regional geology and crustal structure. This work is designed to interpolate between rock outcrops to help the mineral search, and delineate sedimentary basins for oil search.

Antarctic field work, Princess Elizabeth Land. During the 1980-81 summer season in Antarctica, BMR conducted helicopter-supported geophysical and mapping surveys along the Ingrid Christensen Coast near Davis Base (Fig. GSR 17). Observations were made of ice surface height, ice thickness, gravity, and total magnetic field over a 140 x 170 km area of plateau ice on a 20 km grid. At some sites ice samples were collected for oxygen isotope analysis. Vertical coloured aerial photographs were taken of all rock outcrop between the Vestfold Hills and Landing Bluff using 70 mm colour film. Late Proterozoic basaltic dykes in the Vestfold Hills were sampled for palaeomagnetic analysis; 144 samples were collected from 47 sites. A BMR Record describes the operational details, and a draft paper has been written to outline the scientific results (Fig. GSR 18).

The gravity and magnetic results suggest that the Archaean rocks of the Vestfold Hills do not extend inland. They may, however, extend under Prydz Bay to the north, or, as a narrow coastal strip, under ice inland from the West Ice Shelf 150 km to the northeast of the Vestfold Hills. Late Proterozoic rocks probably underlie most of the ice cap along the coast. Gravity and magnetic anomalies indicate that there is no major change in crustal structure across the boundary between Archaean and Late Proterozoic rocks.

Antarctic aeromagnetic and gravity interpretation, McRobertson and Enderby Lands. In preparation for interpretation, ice radar and aeromagnetic records were picked at 15-second intervals from records obtained during the 1977 and 1980 seasons. Computer programs to plot the profiles, and so calculate apparent susceptibilities and depth to source were written. Australian and Soviet gravity data were put on IBM cards in preparation for a combined map of all data.

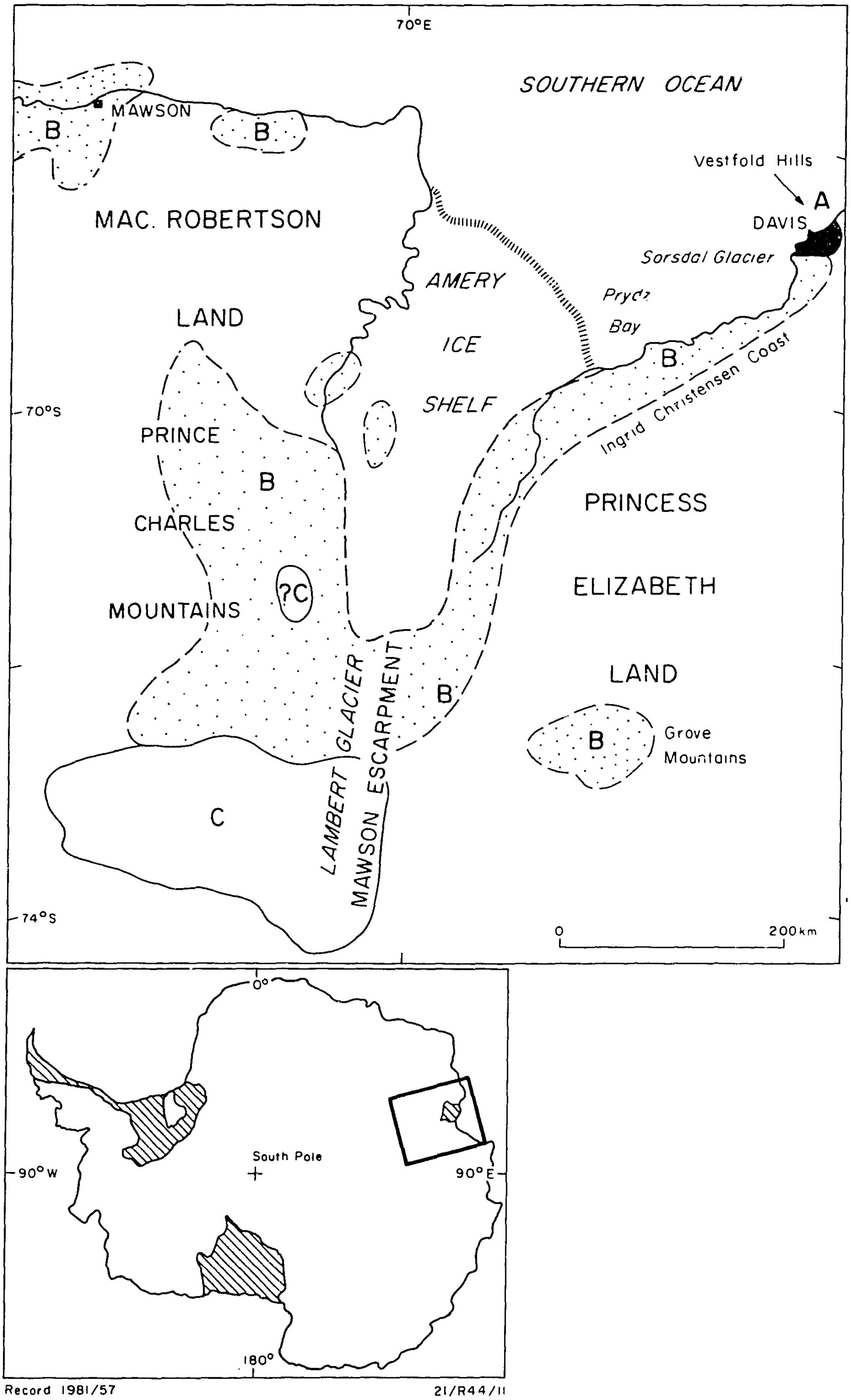


Fig. GSR 17. Antarctica field work, Princess Elizabeth Land, 1980–1981

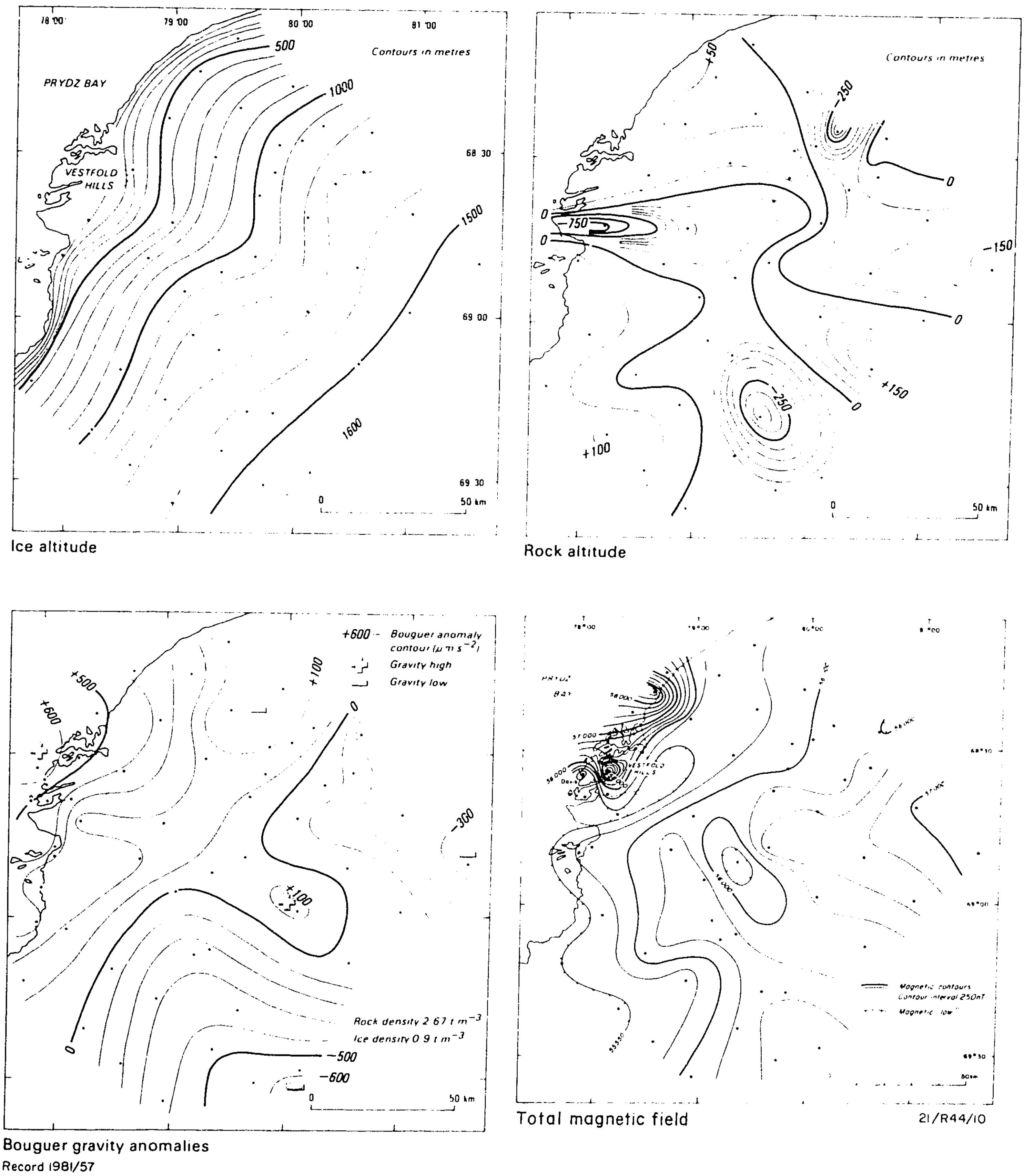


Fig. GSR 18 Geophysical results Princess Elizabeth Land

Crustal strain measurements (P. Wellman, R. Tracey)

The aim of this project is to define areas and rates of present day crustal movement (strain) on the Australian continent. The results will be used to define Cainozoic tectonics, recurrence intervals for damaging earthquakes, and, together with stress measurements, define areas with abnormally high short term earthquake risk.

A paper was written describing crustal movement from existing repeat surveying (Fig. GSR 19 and 20). A National Mapping re-survey of the region between Lake George and Sydney is expected to start in late 1981.

First order geodetic measurements show that strain rates in southeastern New South Wales are about $50 \times 10^{-9} yr^{-1}$, much greater than those suggested by seismicity. The direction of principal axis of compression (Fig. GSR 19) varies with position, but it is consistent with the compression axis directions of the earthquake focal mechanisms in the Bowning area, and with the pattern of late Cainozoic vertical displacements suggested by geomorphology. In southwestern Western Australia, strain identified from geodetic measurements is patchy in distribution, and is irregular in magnitude and direction (Fig. GSR 20). High levels of strain are found close to areas of historic faulting, in areas of high measured stress, and across the Darling Fault which separates the Perth Basin from the Yilgarn Craton.

In the SW seismic zone there is a co-operative program with the WA Geological Survey to determine crustal movement for earthquake prediction. Gravity observations were made during 1980 and middle 1981 by BMR at 370 bench marks using three gravity meters. Repeat second-order levelling by the Australian Survey Office continued so that by 1 August, 600 km had been completed. The area being investigated is the western two-thirds of Fig. GSR 20.

Geophysics and geology of eastern Australia (P. Wellman)

A paper was written describing the geological and environmental history of southeastern Australia during the last 100 million years. In order to define further the rifting and uplift model some samples of Cainozoic volcanic rock from Tasmania, NSW, and Queensland were dated by The Australian Mineral Development Laboratories (AMDEL) using the K-Ar whole rock technique.

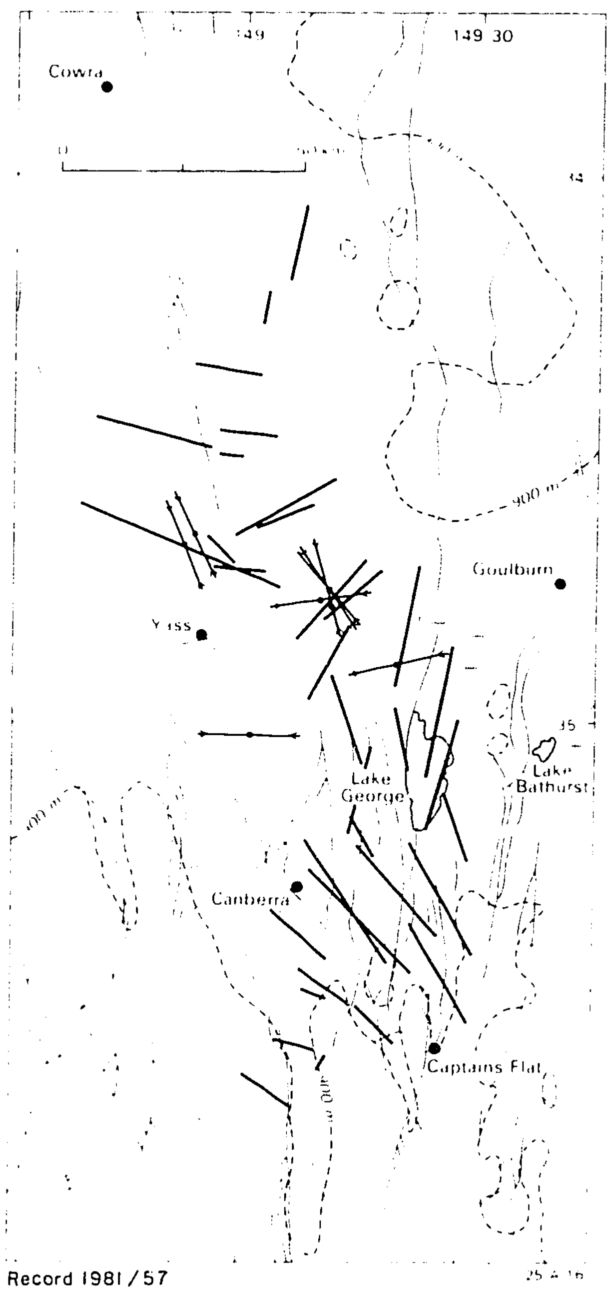
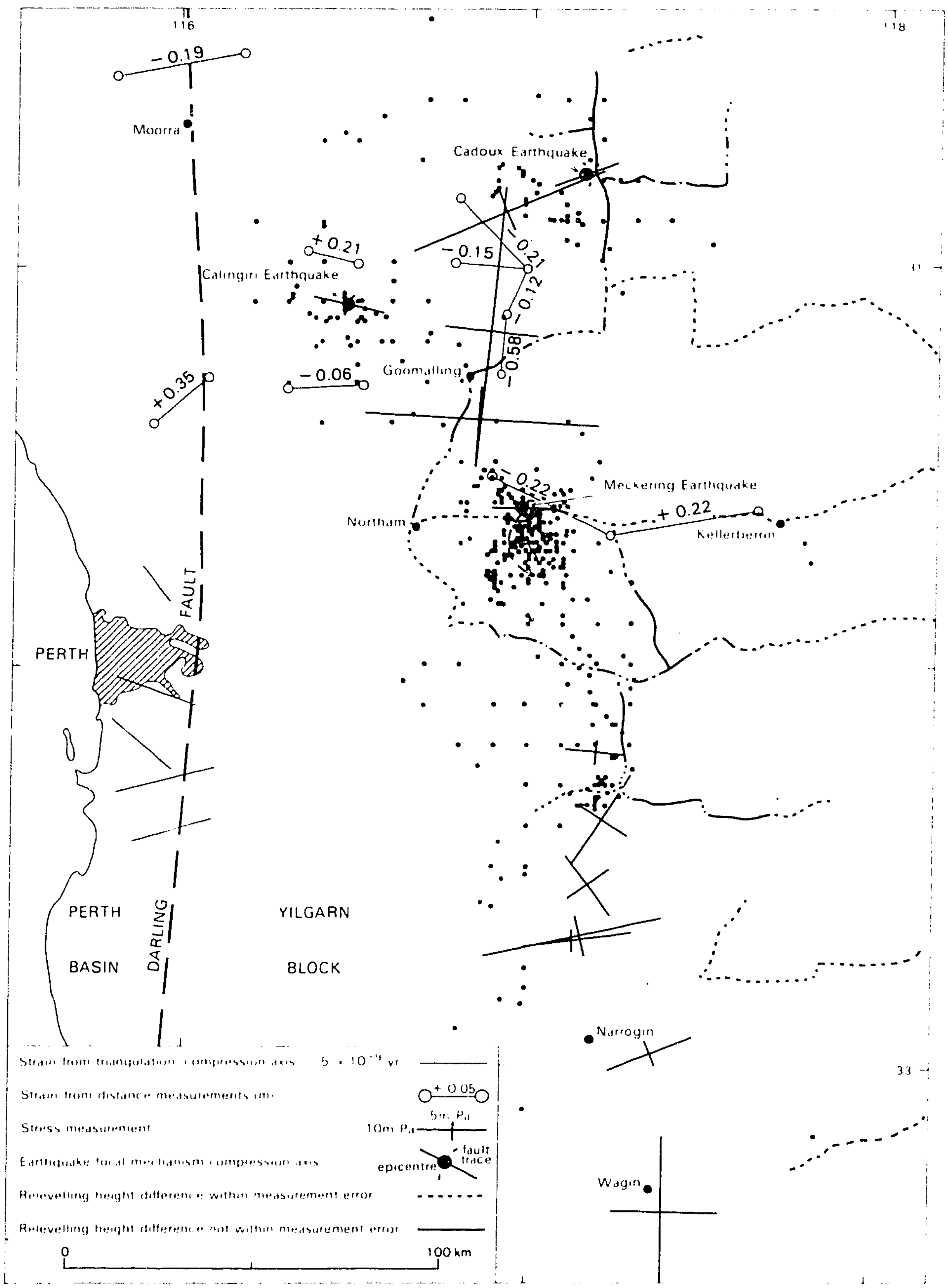


Fig. GSR 19. Southeastern NSW, showing the correlation between direction of principle axis of compression (thick lines), with land over 900m (dashed lines), lakes and swamps, and earthquake focal mechanism compression axes (arrows). Faults are shown as thin lines (from Pogson, 1972)



Record 1981/57

Fig. GSR 20. Southwestern WA, showing relation between seismicity and the results of measurements of stress and horizontal and vertical strain

Basin development (G. Karner)

Study continued during the year at Lamont-Doherty Geological Observatory of Columbia University. Course work on gravity and geodesy, and examinations for the degree of Master of Philosophy were successfully completed. Application has been made for an extension to a Commonwealth Public Service Board postgraduate scholarship until the end of 1982.

Research work at Lamont-Doherty Observatory included the compilation of a free-air gravity map of the southwest Pacific; the study of the gravity effect of axially symmetric bodies using a one-dimensional fast Fourier transform; the development of mechanical models of subsidence of foreland basins, lithospheric flexure, and the driving mechanism of sedimentary basin formation; the analysis of rheological properties of continental lithosphere; spectral representation of isostatic models including isostasy at Atlantic type continental margins; and thermal transients associated with sedimentary basin evolution.

Physical properties of rocks (M. Idnurm, J.W. Giddings, H. Hughes)

A total of 807 rock samples were measured in the laboratory during 1981. Unlike previous measurements, those in 1981 were restricted to magnetic and electrical properties only. They were undertaken principally to aid interpretation in metalliferous geophysical projects, by the project staff. The breakdown of measurements is shown in Table GSR 1.

Table GSR 1

	Number of measurements
Magnetic susceptibility	274
Remanence	748
Electrical resistivity	12
Induced polarisation	30

A new sonic velocity apparatus was purchased. This replaced 20 year old equipment that was beginning to deteriorate rapidly.

Tertiary weathered profiles (M. Idnurm)

The [illegible] project is to determine the chronology and geographic distribution of [illegible]iary chemical weathering on the Australian continent. The 1981 work aimed mainly at improving the quality of earlier results in order to give greater confidence to regional correlations.

Southern Queensland. Laboratory measurements were made on supplementary samples collected in 1980. These consolidate earlier results that suggested two ages of regional chemical weathering, one in the middle Tertiary and the other in late Tertiary. More precise age estimates for these weathering phases now await an improved time calibration for the Australian Cainozoic pole path, on which work is currently in progress.

A brief sampling program was carried out at Mount Canaway, Qld, the type locality of the Canaway profile, where a recent large mining cut has exposed fresh parts of the profile, and at several problematic sites in the Surat region, Qld.

Southern NSW. Laboratory measurements were completed on a supplementary suite of samples collected in 1980 from the Upper Shoalhaven Plain. Two tentative weathering ages that had been indicated by earlier results were confirmed. The new results show a juxtaposition of successive weathering effects at several sites.

Central Australia. Samples were collected in regions to the east and northeast of Alice Springs as a follow-up of the 1977 reconnaissance work. A total of 250 samples was obtained from weathered profiles developed on Archaean metamorphic complexes and Phanerozoic platform covers. Field observations indicate multi-cyclic weathering that is variously associated with ferruginous mottled zones, detrital laterite, and silcrete. Sampling was extended to the northwest of Tennant Creek.

Cainozoic apparent pole path (M. Idnurm)

This project seeks to improve palaeomagnetism as a tool for dating Tertiary rocks and, at the same time, to elucidate the history of northward drift of the Australian continent.

A brief pilot study was carried out on the feasibility of precise pole determinations from Otway Basin rocks. This was followed by one week of sampling along the coastal cliffs of western Victoria, the principal units being the Angahook Formation, the Glenample clay, and the Port Campbell Limestone. Specimens have been prepared from all samples and measurements are well under way.

Reconnaissance measurements were also carried out on a number of oil exploration and hydrogeological drillcores from the Tertiary sedimentary sequences of southeastern and northwestern Australia. Several of the drillcores showed good directional stability of remanence and more detailed measures are planned.

Antarctic palaeomagnetism (M. Idnurm, P. Wellman, J.W. Giddings, J.W. Williams, H. Hughes)

This project aims to determine Proterozoic pole positions of eastern Antarctica as constraints on the reconstruction of Gondwanaland.

Enderby Land mafic dykes. Approximately 15 percent of pilot measurements have been completed on the 1979/80 samples that supplement an earlier collection (already measured). A data base was created for this project.

Vestfold Hills mafic dykes. During the 1980/81 Antarctic field season, 143 samples were collected by J. Williams and K. Collerson (RSES*). Specimens were prepared from all samples and 10 percent of the pilot measurements were completed.

Irian Jaya project: palaeomagnetism (J. Giddings)

BMR palaeomagnetic group is involved in the Irian Jaya project, an Australian Government funded assistance program for the Republic of Indonesia, for three reasons:

(i) To assist geologists in unravelling the tectonic evolution of Irian Jaya; in particular, whether or not the Vogelkop region has undergone a large rotation.

(ii) To act as a source of advice and help in upgrading the palaeomagnetic laboratory that the Geological Research and Development Centre maintains in Bandung.

(iii) To assist in the program designed to train Indonesians in the skills and techniques of palaeomagnetism.

All aspects of the project involve a commitment to training Indonesian personnel in the practical and analytical techniques of palaeomagnetism. Progress in (i), (ii), and (iii) is therefore very dependent on the availability of Indonesian staff.

Unfortunately, in 1981, Indonesian personnel have not been forthcoming despite expectations for a 4-month visit. As a result, no further experimental work has been done on the collection of Irian Jaya rocks since the burst of activity in early 1980, when an Indonesian geologist spent 3½ months in BMR. The only progress made has been to add to the palaeomagnetic data base the 1530 measurements made in 1980 on rocks from 7 of the 9 formations sampled.

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* Research School of Earth Sciences, Australian National University.

Regarding the laboratory, the Schonstedt, tumbling-specimen, AF demagnetiser arrived mid-year from the USA. Checking-over of the instrument and its operation, a useful training exercise, will have to await arrival of an Indonesian. The equipment for a basic operational laboratory is now complete, except for a thermal demagnetiser. Although scheduled to be built in BMR by Indonesian staff under supervision, the uncertainty of the availability of Indonesian staff, and the delay since the plans were drawn up, are forcing the option of purchasing an off-the-shelf unit. The matter is currently under review.

At this stage, assuming Indonesian participation, there is no reason why all aspects of the project should not be completed during 1982.

Development of a comprehensive, palaeomagnetic data-processing system
(J. Giddings, F. Newman)

To cope efficiently and effectively with the large amounts of data generated by BMR's palaeomagnetic program, a comprehensive data-processing system is being developed to automate, as far as possible, the collection and analysis of palaeomagnetic measurements.

The system is designed around two elements:

(i) A 10 M byte data base PALMAG and a suite of accession and analysis programs, operating on BMR's in-house computer.

(ii) A computer-based facility for recording, displaying, and interrogating palaeomagnetic measurements at the joint ANU/BMR palaeomagnetic laboratory, Black Mountain.

Work in 1981, like that of 1980, has concentrated on the data base aspect. Completed in 1980, the data base is now fully operational. Early in 1981, sample orientation data for 3500 samples from 33 formations were added to the data base, followed later in the year by measurements recorded and stockpiled on 50 cassettes. To date, 8800 remanence measurements from 24 formations are stored on the data base; by the end of 1981, with the addition of data acquired prior to cassette or paper-tape recording, this figure will be close to 12 000. As a by-product of the updating process, the data are corrected for field and bedding, and the directions of remanence are plotted on stereograms and on a cartesian co-ordinate system. Additionally, plots of the decay of intensity of remanence and the change in susceptibility are produced for demagnetisation data sets.

Two new interactive processing programs are currently being developed to enable paper tapes from the Digico spinner magnetometers to be automatically handled. At present, disc files of these data, for use by the data base update program, are created manually from a console, wasting a lot of time. The programs should be ready by the end of 1981 and will form part of the suite of programs used to process and store data on the data base. To this end, the update and plotting program was expanded to accept Digico-derived data.

An interactive analysis-graphics package, for semi-automatic analysis of the remanence of rocks, using demagnetisation data on the data base and an HP2648A graphics terminal, could not be started in 1981. However, as an interim measure to speed up the analysis of palaeomagnetic data, the master plots from the data base update program have already made a significant impact, reducing contact time by a factor of ten.

Palaeomagnetism of Proterozoic igneous rocks of Australia (J. Giddings)

This project is designed to improve the first-order apparent polar wander (APW) path for Australia for the period 750 m.y. - 1800 m.y., by establishing well-defined, well-dated palaeomagnetic poles. To date, samples have been collected from the Stuart Dykes (Central Australia, 897 m.y.), Morawa Lavas (WA, about 1400 m.y.) and Edith River Volcanics (NT, about 1750 m.y.). During 1981, 800 measurements from the project were added to the palaeomagnetic data base.

Stuart Dykes. NRM directions for the 14 dykes collected are scattered. Early in 1981, 22 pilot specimens from 12 of the dykes were stepwise AF demagnetised to 120 nT to see whether the disturbing secondary magnetisations could be removed. Preliminary examination of those results shows that the directions of magnetisation of the dykes become well grouped around a direction with moderate to steep positive inclination, and westerly declination. The secondary magnetisations removed during pilot demagnetisation have yet to be examined; however, the well-grouped magnetisation of the dykes bears no relationship to directions that could be expected from geological events younger than the dykes e.g. Alice Springs Orogeny, and is therefore considered primary.

The preliminary pole is about 35 degrees beyond the published 750 m.y. Yilgarn dykes pole YB, and assists in defining an older part of the Late Precambrian APW path. In the context of Gondwanaland, the Stuart Dykes pole assumes greater significance. Instead of lying close to similar aged poles from Africa, it falls about 60 degrees away, bringing into question the concept of the continental integrity of Eastern Gondwanaland during the Late Precambrian.

Morawa Lavas. The Morawa Lavas crop out in the Billeranga Hills, about 300 km north of Perth, just inland of the Darling Fault. Thermal demagnetisation data from pilot specimens of these lavas, the underlying Neereno Sandstone, and the overlying Campbell Sandstone, show that all units have been magnetically overprinted by some younger event. The components of magnetisation, considered primary at this stage of the analysis, are negatively magnetised with shallow to moderate inclinations. Considered together, the units define a smooth shift in direction from easterly (Neereno Sandstone), through southeasterly (Morawa Lavas), to south-southeasterly (Campbell Sandstone) declinations.

Preliminary poles, based on these pilot data, define a 35 degree path segment. This segment is 40 degrees removed from the published path for this part of the Precambrian; furthermore, the sense of motion of the pole from old to young is opposite.

Little analysis has been done on the overprint directions of magnetisation. One set from one site of the lavas, where dykes cut the lavas, gives a pole very similar to the Yilgarn dykes pole YC (1500-750 m.y.) and could possibly represent a baked country rock phenomenon. However, since the direction is also similar to directions for the mid-Tertiary, a weathering origin is considered more likely in view of the considerable peneplanation of the Yilgarn Block in the Tertiary. A definite statement will need to await further analysis on a larger number of pilot specimens.

Edith River Volcanics. A preliminary analysis has been made of the thermal demagnetisation data that were obtained during 1980. In general, the volcanics have been heavily overprinted magnetically, with temperatures above 500°C being required to isolate the primary magnetisation. The pilot specimen directions of primary magnetisation are well grouped about an ESE direction with moderate positive inclination. The corresponding pole is some 35 degrees away from the commonly used result published over 20 years ago when demagnetisation techniques were not in general usage. The current study demonstrates that the earlier result includes considerable biassing by unremoved secondary magnetisation. Very heartening is the similarity of the new preliminary determination - some 25 degrees difference - to initial results from the overlying, somewhat younger, Kombolgie Sandstone - the subject of an in-depth magnetostratigraphic study by BMR.

McArthur Basin project (K.A. Plumb)

The McArthur Basin project is a long-term multidisciplinary project, whose basic aim is to elucidate the evolution of the McArthur Basin, using both geological and geophysical techniques, and to apply this information to the understanding of the genesis of ore deposits in the region and to the assessment of possible hydrocarbon potential of the basin.

Geophysical studies are of two types: (1) palaeomagnetic studies to assist stratigraphic analysis of the basin, and (2) subsurface structural investigations of the deep structure across the basin. Geological investigations are reported in the Annual Summary of the Geological Branch.

Emphasis during 1981 has been on the completion of the various subprojects, for which the major fieldwork was carried out during 1978-79. The only new initiative has been to commence interpretation of the aeromagnetic data, following completion of data processing and release of all the relevant aeromagnetic and radiometric contour and profile maps during 1981.

In essence, the main progress during 1981 has been to refine the preliminary interpretations reported in 1980 (Record 1980/70), and to prepare reports on these results.

There is excellent agreement between the seismic and magnetotelluric results. Techniques have been used in interpreting magnetotelluric data which enhance the 1-D models. These techniques, applied to the 1978 data, have further confirmed the geological models across the Emu Fault, as reported in 1980, while modelling of the 1979 data has clearly identified the major rock units in the western half of the basin predicted from surface geology.

The major new discovery during the year, from the combined seismic-magnetotelluric-gravity data, is the identification of previously unknown McArthur Basin rocks beneath Mesozoic cover, extending at least as far west as Daly Waters. A basin edge, a short distance to the west of Daly Waters, is indicated.

Preliminary modelling of depth to magnetic basement has failed to give geologically meaningful results; further analysis is planned for 1982. No significant new results have come from palaeomagnetism during the year because of commitments to other projects.

Objectives of the 1981 program. The main objectives of the 1981 program were:

1. Complete interpretation of deep seismic refraction and reflection data recorded across the southern McArthur Basin during 1979, and prepare reports for publication;

2. Complete interpretation of the magnetotelluric data recorded across the southern McArthur Basin during 1978-79, and prepare reports for publication;

3. Continue laboratory measurements and assessment of palaeomagnetic samples from the McArthur Basin;

4. Complete processing and analysis of gravity data recorded across the southern McArthur Basin during 1978-80, and prepare reports for publication;

5. Carry out preliminary interpretation of depth to aeromagnetic basement, from surveys flown during 1977-78.

Reporting of Results. Progress of research has been reported in half-yearly reports - Records 1981/20 and 1981/50.

Plumb, Collins, Cull, Pinchin, and Zadoroznyj summarised progress of the geophysical assessment of the deep structure beneath the McArthur Basin, in an abstract to the Joint Meeting on Mount Isa Geology in September.

Collins has produced an operational report on the 1979 crustal seismic investigations (Record 1981/2).

A Record describing the results and interpretation of the 1978 magnetotelluric survey, by Cull, Spence, Major, Kerr, and Plumb, is in press (Record 1981/1).

A Record (Record 1981/64) describing the results and interpretation of the 1979 magnetotelluric survey, by Cull, Spence, and Plumb, is being edited.

Collins is completing a Record on the results and interpretation of the 1979 crustal seismic survey,.

Anfiloff is revising his Record on the 1978-80 gravity survey, following editing.

McArthur Basin crustal investigations (C.D.N. Collins)

Deep seismic refraction data were recorded during 1979 between Daly Waters and H.Y.C., and between Borroloola and McArthur Basin (Fig. GSR 21). The recording scheme and other operational details are described in BMR Record 1981/27; the interpretation has been summarised in Records 1981/20 and 1981/50.

A detailed investigation was made to delineate the shallow structures where the data were adequate for the purpose. Substantial differences between the travel-time curves, from the two traverses recorded in 1979, are due mainly to lateral variations in these near-surface structures.

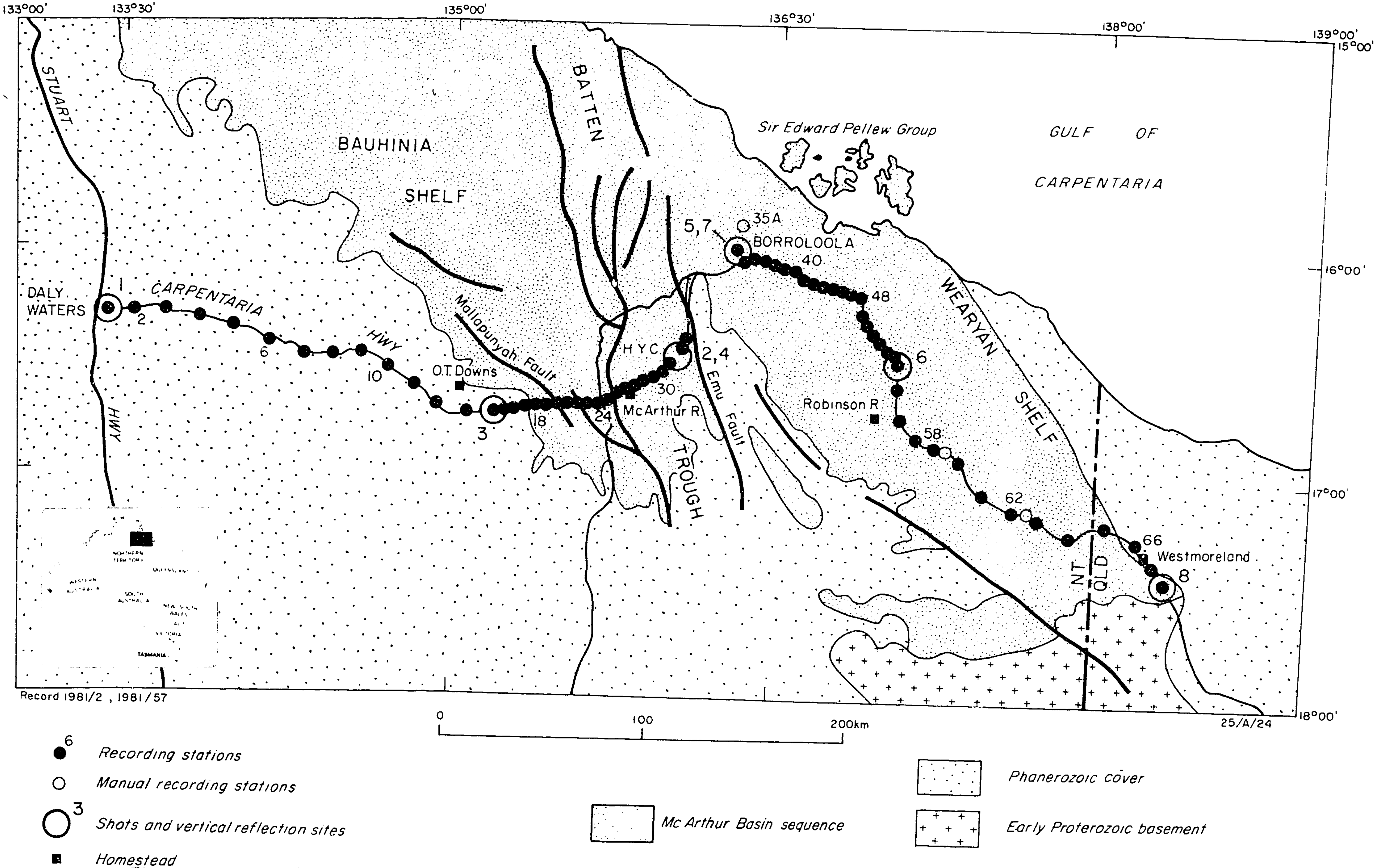


Fig. GSR 21. Locations of shots and recording stations and simplified geology, McArthur Basin.

At Daly Waters on the western traverse, a layer 4.1 km thick, with a velocity of 4.62 km/s, probably represents the combined Cretaceous cover plus the underlying Cambrian and Proterozoic sediments. The data are not sufficiently detailed to distinguish between them. The Proterozoic sediments may belong to the Roper Group. The Cambrian carbonates probably have a higher velocity, but are relatively thin, about 300 m; the Cretaceous sediments may be less than 100 m thick.

The basement at Daly Waters, at a depth of about 4.3 km, has an apparent velocity of 5.90 km/s. Farther east at OT Downs and H.Y.C., strong arrivals with a velocity of about 5.80 km/s were recorded. Assuming that the basement at Daly Waters has a similar velocity, the higher apparent velocity there shows that the boundary dips westwards; i.e. the 4.62 km/s layer thins towards the east. This is confirmed by much smaller delays in the basement travel-times at OT Downs, and by no delays at all at H.Y.C.

Below the surface alluvium and weathering at Borroloola, on the eastern traverse, a layer with a velocity of 3.58 km/s and 370 m thick is interpreted. At Robinson River the equivalent layer has a velocity of 4.81 km/s and a thickness of 650 m. From the surface geology and the observed gravity, it appears these layers are not continuous with each other along the traverse. Below these layers the velocity increases to 5.55 km/s at Borroloola, and to 5.44 km/s at Robinson River. The thickness of this layer is about 2.88 km, and does not vary significantly. Basement lies at a depth of 3.3 - 3.5 km, and has a velocity of 6.04 km/s.

The characteristic features of arrivals from the middle and deep crust, and from the upper mantle, are a lack of obvious wide-angle reflection branches, first arrivals with fairly uniform amplitudes, and a more or less continuous travel-time curve. These suggest gradients in the velocity-depth curve, rather than sharply-defined layering. Lateral variations in the upper crustal structure make it difficult to apply modelling techniques, such as synthetic seismograms, which require lateral homogeneity. The deeper layers are assumed to fulfil this requirement, at least within each traverse.

Layered models (models 4 & 5, Fig. GSR 9), for the traverse west of the Emu Fault, may be interpreted from the data. The basement velocity remains substantially constant, or with perhaps a slight increase to a depth of 18 km, where it increases gradually to 6.94 km/s at 24 km. A further increase takes place within a gradient zone between 30 and 34 km, to a velocity of 7.52 km/s, and again between 42 to 52 km, from 7.52 to 8.55 km/ This very high velocity is based on poor data, recorded only at the furthest recording sites.

The data quality is better on the eastern traverse, with some evidence of later arrivals. Below basement rocks with a velocity of 6.04 km/s, the velocity remains constant or increases slightly to a depth of 15 km, where it increases to reach 6.47 km/s at 16.5 km depth. It increases again within a gradient zone between 21 and 24 km, to 6.81 km/s, and increases from then on in a non-linear manner to about 7.4 km/s at 35 km depth. Below this, there is a gradual increase to 8.1 km/s at 52 km depth. Again the lower crust and upper mantle structures are not well defined, because they are recorded only at the furthest stations.

McArthur Basin magnetotellurics (J.P. Cull)

In 1979, seventeen magnetotelluric (MT) sites were occupied in the McArthur Basin; a 200 km traverse was completed across the Bauhinia Shelf to complement results obtained in 1978. The data were initially compiled as individual graphic representations of rotated tensor apparent resistivities and phase curves for each orthogonal component, together with tensor rotation angle versus frequency. The geological interpretations are based on these processed data.

A preliminary examination of the resistivity plots at each site reveals marked differences associated with the major structural units of the Bauhinia Shelf. A predominantly 2-D feature is indicated by diverging components of apparent resistivity. This observation is emphasised with data presented as 2-D pseudosections constructed from the individual plots, and severe limits must be imposed on 1-D inversions. Actual resistivities for each stratigraphic unit cannot be readily resolved because of anisotropy related to steeply dipping structures, and correlations must be based on relative values.

Isotropic data at each end of the traverse were inverted in a 1-D analysis revealing well-defined resistivity contrasts. The Roper Group appears to be characterised by values in the range 20-50 ohm-m. However, very low values (about 10 ohm-m) have been detected at shallow depth in the region of the Limmen Bight River. These values suggest the presence of an aquifer sequence (such as the Abren Sandstone) which tends to mask any response from deeper layers. Even so, there is some indication of high values (greater than 1000 ohm-m) at depths near 3 km. These values are attributed to McArthur Group rocks which are not detected further west.

Resistivity contrasts near Daly Waters are again approximately constant between sites, suggesting lateral uniformity. However they differ markedly from results near the Limmen Bight River. In particular, there is no indication of the low resistivity aquifer sequence and consequently deeper features can be resolved with greater precision. Basement resistivity values appear to be less than 1000 ohm-m with maximum depths of 9.5 km changing abruptly to 6.0 km at Daly Waters. There is no indication of more resistive layers at shallow depth and consequently the McArthur Group appears to be absent. The most significant resistivity contrast at shallow depth appears to correlate with the Roper/Tawallah Group boundaries at depths of 2 km near Daly Waters. A similar boundary has been detected by seismic refraction techniques and the major features are identical. There is an abrupt change in depth from 2.0 to 4.5 km at Daly Waters with a gradual return to shallow depths in the east.

Data from the central sites crossing complex structure are highly variable; orthogonal components diverge and continuity between sites cannot be readily detected. Consequently 1-D inversion may not be appropriate. However major features have been identified in models generated by 2-D inversion (Fig. GSR 22). An isolated resistive block has been identified again at shallow depth in the region of the Limmen Bight River. This block is attributed to McArthur Group rocks but the western extent remains obscure. Steeply dipping zones of high conductivity have been detected and these obscure details in other more resistive units.

Eastern McArthur Basin magnetostratigraphy (M. Idnurm, J.W. Giddings)

This project studies the feasibility of magnetostratigraphy in Carpentarian sequences, seeks to determine the Carpentarian apparent pole path, and applies palaeomagnetic techniques to understand the geological history of the Basin.

In 1981, work centred mainly on the origin of magnetisation in the Lower McArthur Group. Remanence directions were determined in the exploration drill core from Tawallah Pocket 1 (TP1). The drill hole is located approximately 100 km north of the Kilgour River palaeomagnetic sections, and the aim of the measurements was to confirm firstly that the remanence directions at Kilgour River hold basin-wide, and secondly, that the magnetisation is not due to surficial weathering processes. The drill hole penetrated 110 m of rock comprising the Lower Amelia Dolomite and Upper Mallapunyah Formation. The core
comprising the Lower Amelia Dolomite and Upper Mallapunyah Formation. The core

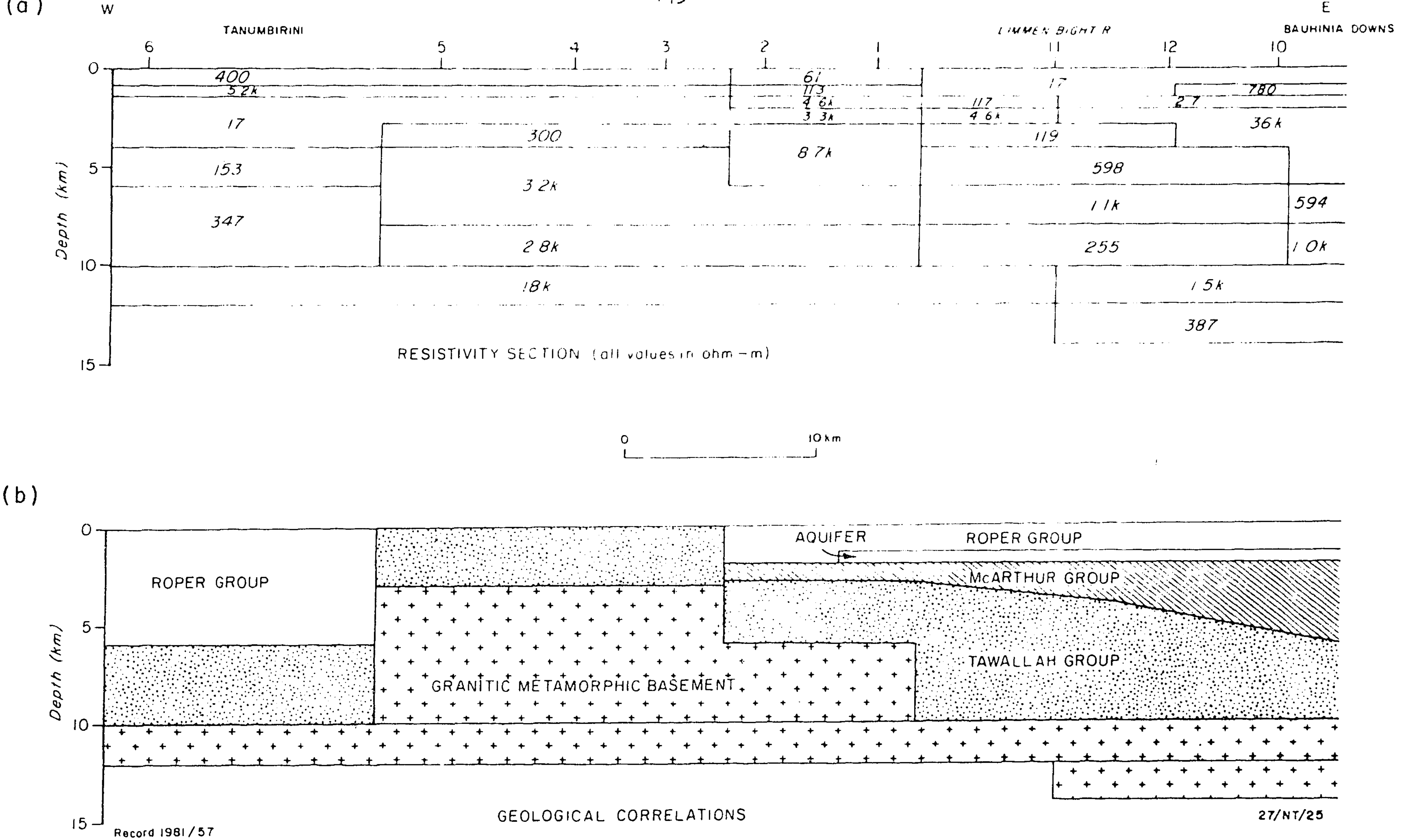


Fig. GSR 22. Resistivity cross section (a) with geological interpretation (b) based on 2D inversions segments were oriented by means of regional dip as defined by the core-bedding intersection. A source of error is the departure of the drill hole from vertical - such departure is indicated by a change of the core-bedding angle with depth, but the deviation appears to be relatively small and can be partly allowed for.

The remanence directions in TP1 fall into two well-separated groups. The main group, though scattered, agrees with the Kilgour River directions, thus eliminating the possibility that the magnetisation is due to local effects or surficial weathering. The second group, which is defined by a few directions only, represents a remanence acquired much later. These directions are from parts of the drill core associated with a colour change from red to green in dolomitic siltstones, and appear, therefore, to be caused by post-depositional reduction reactions. It is interesting to note that the magnetisation in the anomalous group appears to be somewhat younger than the Emmerugga Dolomite, suggesting the possibility that the reduction at TP1 and the mineralisation at the HYC deposit may be contemporaneous. This may have significance for exploration. The polarities in the measured intervals are consistent with those in the Kilgour River sequences. It is planned to extend the measurements to other parts of the TP1 drill core to obtain a comprehensive test of magnetostratigraphic correlation.

A week was spent in the Kilgour River region collecting samples for fold tests on the origin of remanence, and in order to define better some segments of the upper Tawallah-lower McArthur Group apparent pole path. Samples were also collected from the Abner Sandstone of the Roper Group, and from a weathered profile developed on the Mesozoic platform cover.

A computer data base was created for the project. All except the earliest measurements have been entered on to the data base.

Western McArthur Basin magnetostratigraphy (J. Giddings, M. Idnurm)

This project, in conjunction with its sister project, Eastern McArthur Basin magnetostratigraphy, aims at establishing a master magnetostratigraphic column for the Carpentarian, for use as a tool in the correlation of Carpentarian rock sequences. The formation chosen as the starting point in the Western McArthur Basin is the basal Kombolgie Sandstone.

The nature of the project requires sampling at closely spaced intervals resulting in large numbers of samples. To assist with efficient handling of the data generated by these samples, a data base was set up; most of the effort on the project in 1981 has therefore been spent on transferring all measurements made to date on to the data base. So far (October, 1981), about 3500 such measurements have been added; by the end of 1981, this figure will be close to 5000. New measurements have been made on 800 specimens prepared during 1981.

Because of the emphasis on organising the data into a readily accessible form, little time has been devoted to analysing the data closely, which is planned for 1982. However, a brief examination of some of the data is encouraging. It shows that the preliminary pole for the lower part of the Kombolgie in the Edith River section is close to that for the somewhat older underlying, Edith River Volcanics. Furthermore, going upsection, there is a shift in the pole position which is in the same sense as that found in the Eastern McArthur Basin study: the pole paths for each of the two areas, at this stage, therefore seem comparable.

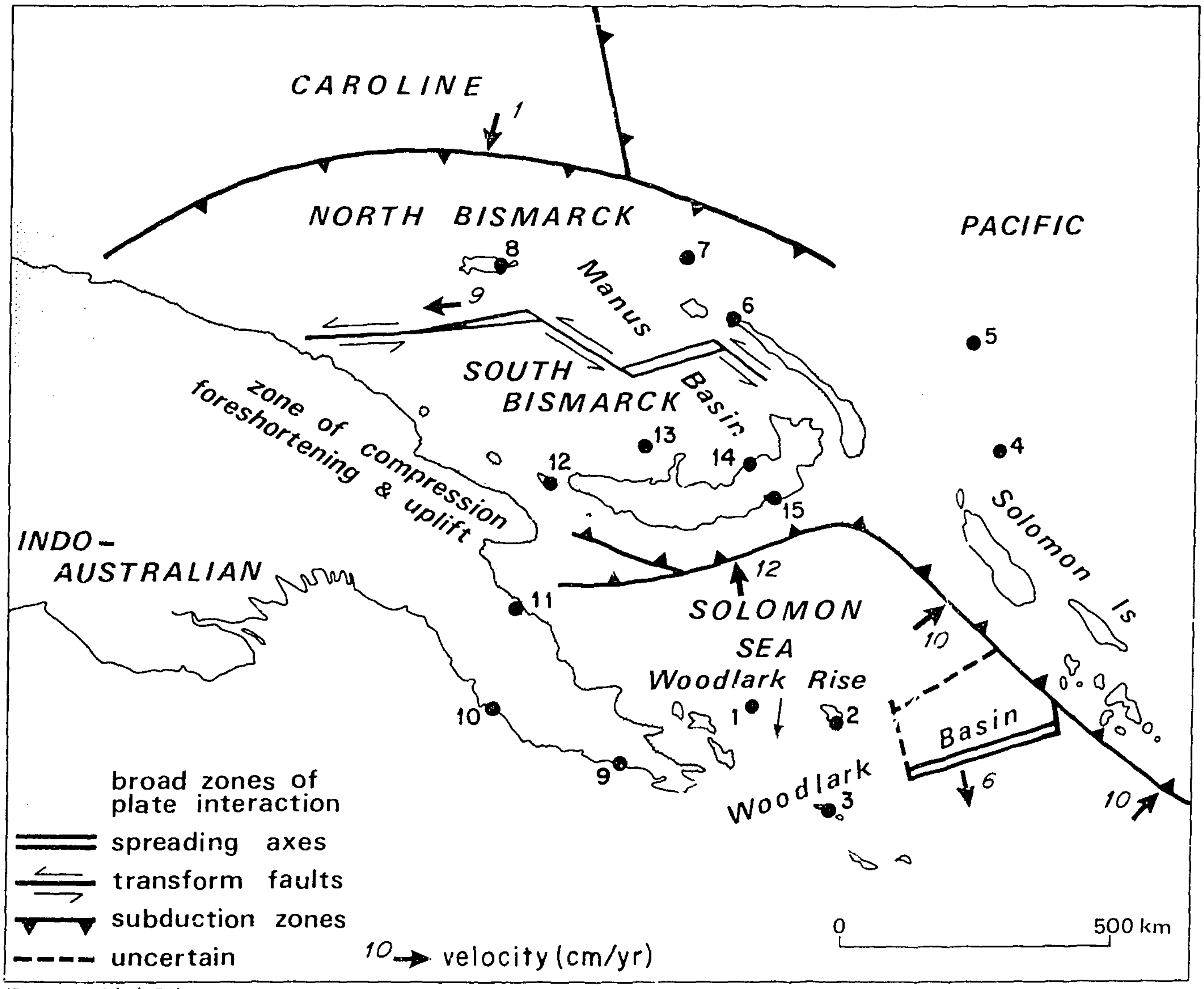
Plate tectonic movements - Papua New Guinea (D. Denham)

Two surveys in the Papua New Guinea region were planned for the first half of 1981. These were a re-measurement of station distances across St George Channel (between New Ireland and New Britain), and a set of Dopper satellite observations using JMR receivers to determine distances between specially selected sites located on main sub-plates in the region.

A shortage of funds restricted the operation to the JMR survey which was carried out at 15 sites on at least 5 sub-plates (see Fig. GSR 23). The observations are currently being analysed at the Massachusetts Institute of Technology, the University of New South Wales, and the Division of National Mapping.

GEOMAGNETISM AND SEISMOLOGY SUBSECTION (P.M. McGregor)

The operational groups in the Subsection are listed below. The Technical Support Group formally came into being in October 1981 when Mr J. Vahala, the new group's manager, was transferred from the Department of Housing and Construction.



(Based on P/A/739)
Record 1981/57

25/09/1

1	Trobriands	6	Kavieng	11	Morobe
2	Woodlark I.	7	Emira I.	12	Umboi I.
3	Misima I.	8	Manus I.	13	Witu I.
4	Carteret I.	9	Robinson River	14	Ulawun
5	Nuguria I.	10	Port Moresby	15	Pomio

Fig. GSR 23. JMR sites for BMR/Natmap crustal movement survey of PNG 1981

Achievements in the Subsection are mainly the result of team efforts and it is generally inappropriate to associate particular officers with particular projects. For example, the repeat magnetic survey for the production of epoch 1980 charts involved personnel from all groups at one time or another. This applies to most observatory functions, but projects carried out by individuals are specified.

The Subsection Groups comprise:

Antarctic and Special Projects: I.B. Everingham, V.F. Dent (part).
Mawson - B.A. Gaull (1980), A. Marks (1981), R.P. Silberstein (1982).
Macquarie Island - W. Williams (1981), I. Ferguson (1982).
Canberra Observatory Group - R.S. Smith, M. McMullan, V.F. Dent (part); W.K. Greenwood on secondment from IES Branch.
Mundaring Observatory Group - P.J. Gregson, E.P. Paull, G. Woad, B. Page, M. Bousfield.
Surveys, Data & Reductions Group - G.R. Small, A.J. McEwin, G.H. Thomas.
Technical Support Group - J. Vahala, M.K. Douch, J.F. Salib.

Vacancies existed of Science 1 at Mundaring, owing to Mr Gaull's duties at Mawson, and Science 2 in Canberra; the latter was occupied temporarily by Mr Dent, pending procedures for its permanent occupancy. Delays in recruiting a geophysicist for Macquarie Island necessitated Mr Thomas's operation of the observatory over the 1981/82 summer. It is fortunate that he volunteered for this duty and that a National Mapping survey vessel will visit the island in February 1982 (thereby enabling a changeover of personnel); it is imperative that future recruitment takes place in time to ensure adequate training of Antarctic observers.

Detection seismology

The eleventh (February) and twelfth (August) sessions of the Group of Scientific Experts (GSE) were attended at Geneva. Convenorship of Study Group 3 - on the use of the Global Telecommunications System (GTS) - involved the organisation of two global experiments (6 October-28 November 1980 and 2 November-11 December 1981), aimed at determining the usefulness of the GTS in a nuclear test-ban monitoring role. An operations manual for the use of the GTS was written (at the behest of the GSE) and distributed to all GSE countries.

IAGA and associated activities

The 4th Scientific Assembly of IAGA at Edinburgh in August required considerable correspondence as National Correspondent, Chairman of the Working Group on magnetic surveys and charts, and member of the Working Group concerned with MAGSAT. Part of the Assembly, and the preceding MAGSAT workshop were attended; at the former, Professor Denis Winch was given a preliminary assessment of global reference fields for Australia, for presentation at a subsequent session; at the latter a description of correlative geophysical data was presented jointly with Mr Dooley.

Geomagnetism

Observatories. Analogue magnetographs were operated continuously at Gnangara (WA), Toolangi (Vic), Macquarie Island, and Mawson (Antarctica), and a digital Automatic Magnetic Observatory (AMO) at Canberra. Control observations were made regularly at all observatories except Toolangi; at Casey and Davis (Antarctica), absolute observations were made by officers of the Antarctic Division, to provide estimates of the secular variation at those places.

Because the absolute hut at Davis was contaminated magnetically by new buildings it was shifted; station differences between the old and new locations were obtained.

At Canberra Magnetic Observatory, four azimuth pillars were erected and the azimuth of one of them from pier AW was determined. Three temporary reference marks were erected at Gnangara to supplement the single permanent mark; new lamp regulators were installed (June) to stabilise trace intensities.

Record losses at all observatories were minimal except for a protracted loss at Canberra in June, after the connection of a new chart recorder. Likewise, preliminary attempts to telemeter AMO data into the BMR office caused interference, so the project was deferred.

No progress was made on the second AMO for Gnangara because of staff commitments in other projects. Two EDA fluxgate magnetographs (FM 100C) were bought, tested, and found unsuitable. They were replaced by EDA with FM 100B models.

Data production and distribution. Magnetograms from analogue observatories were reduced to hourly and associated mean values and the results reported promptly to WDCA. A backlog of unreduced scalings (Port Moresby September 1975-August 1979, Gnangara January 1976-August 1979, and Toolang January 1976-June 1979) was eliminated and the results were sent to WDC-A on magnetic tape. No progress was made in transferring earlier scalings stored at CSIRO to the BMR computer.

The following programs were written or modified to manipulate AMO data:

(a) to create a computer file of minute values in IAGA format;

(b) to delete unacceptably noisy data from the AMO data file;

(c) to plot magnetograms for any of the components of the magnetic field;

(d) to scale and file magnetic storm parameters from the AMO data files.

A start was made on the automatic production of K indices from the AMO data but considerable effort is needed to determine if it will be feasible.

Magnetic field values at various locations, and copies of charts were supplied to several government departments, universities, companies, and individuals.

Monthly parts of the Geophysical Observatory report were issued about three months after the event; a new front cover was used for the 1981 volume.

Magnetic surveys. A first-order magnetic survey was carried out on Guadalcanal (Honiara), Nauru, and in PNG and Irian Jaya, starting in May and lasting for 11 weeks. The stations visited are shown in Figure GSR 24. Exact re-occupations were made at Manus Island, Wewak, and Daru, and close re-occupations at Honiara and Kavieng. New stations were established at Nauru (the old station was contaminated) and at Kieta and Gurney (where airports had been redesigned and previous stations lost). Four new stations were established in Irian Jaya.

Assistance with the survey was provided by staff from the Solomon Islands Geological Survey, the Nauru Department of Lands and Surveys, the PNG Geological Survey (Port Moresby Observatory), and the Irian Jaya Geological Mapping Project.

An EDA fluxgate magnetometer recording Z, D, H, & F, was operated continuously for two months from 22 December 1980 at Davis Base. Frequent sets of absolute measurements provided control so all standard observatory data are available for the two months. The fluxgate recordings also facilitated observations at several earlier stations at Davis, including the first station which was established in 1957 (close re-occupation).

During January, February 1981 third-order magnetic observations were carried out at six regional magnetic stations in the Davis-Amery Ice Shelf region (Landing Bluff, Mount Caroline Mikkelson, Dodd Island, Larsemann Hills, Horde Island, and Torckler Island).

In April, the magnetic station at Portland was shifted from the present airport to the new airport site. The old airport is to be used by ALCOA for its refinery. Station differences were determined thoroughly.

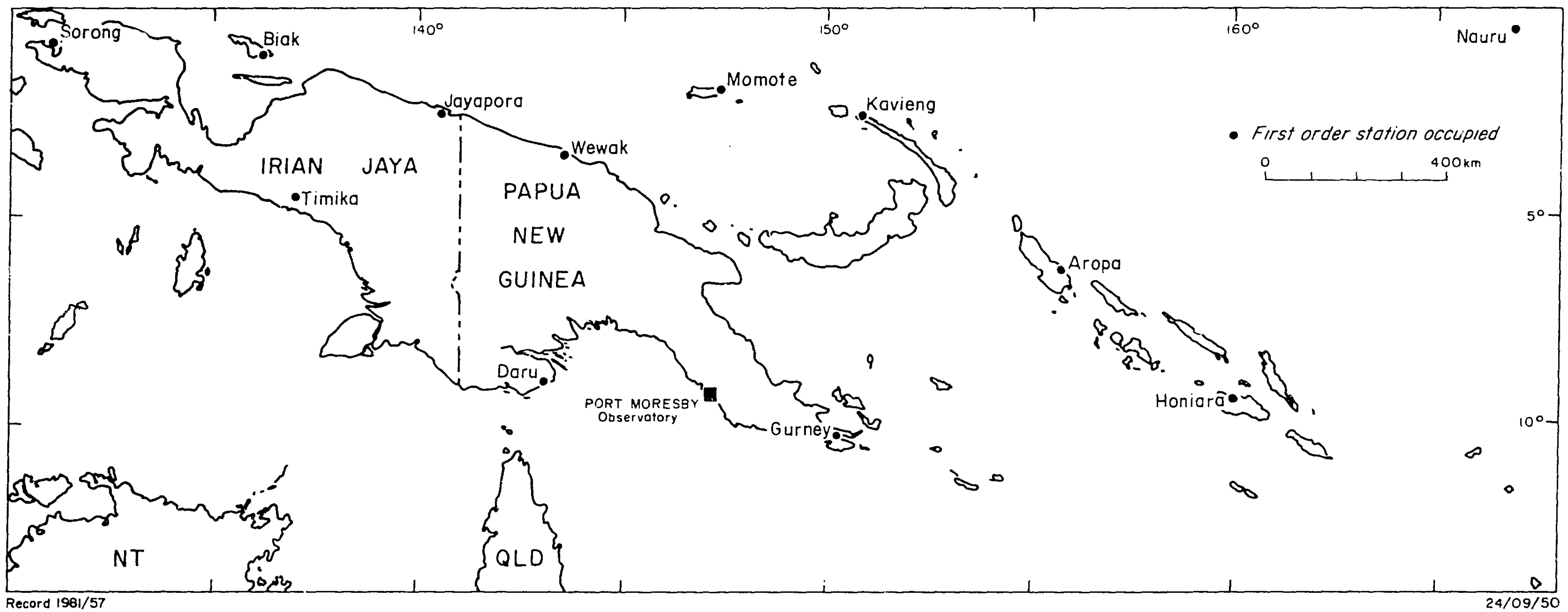


Fig.GSR 24. Regional magnetic survey 1981

Isomagnetic charts. Reduction of survey data for production of the 1980.0 isomagnetic charts continued. The 1980.0 declination (D) chart was completed and distributed. The isolines of D and its secular variation were derived by fitting fourth-degree polynomials to the results and were computer-drawn (Fig. GSR 25). A similar produced will be used for the other charts.

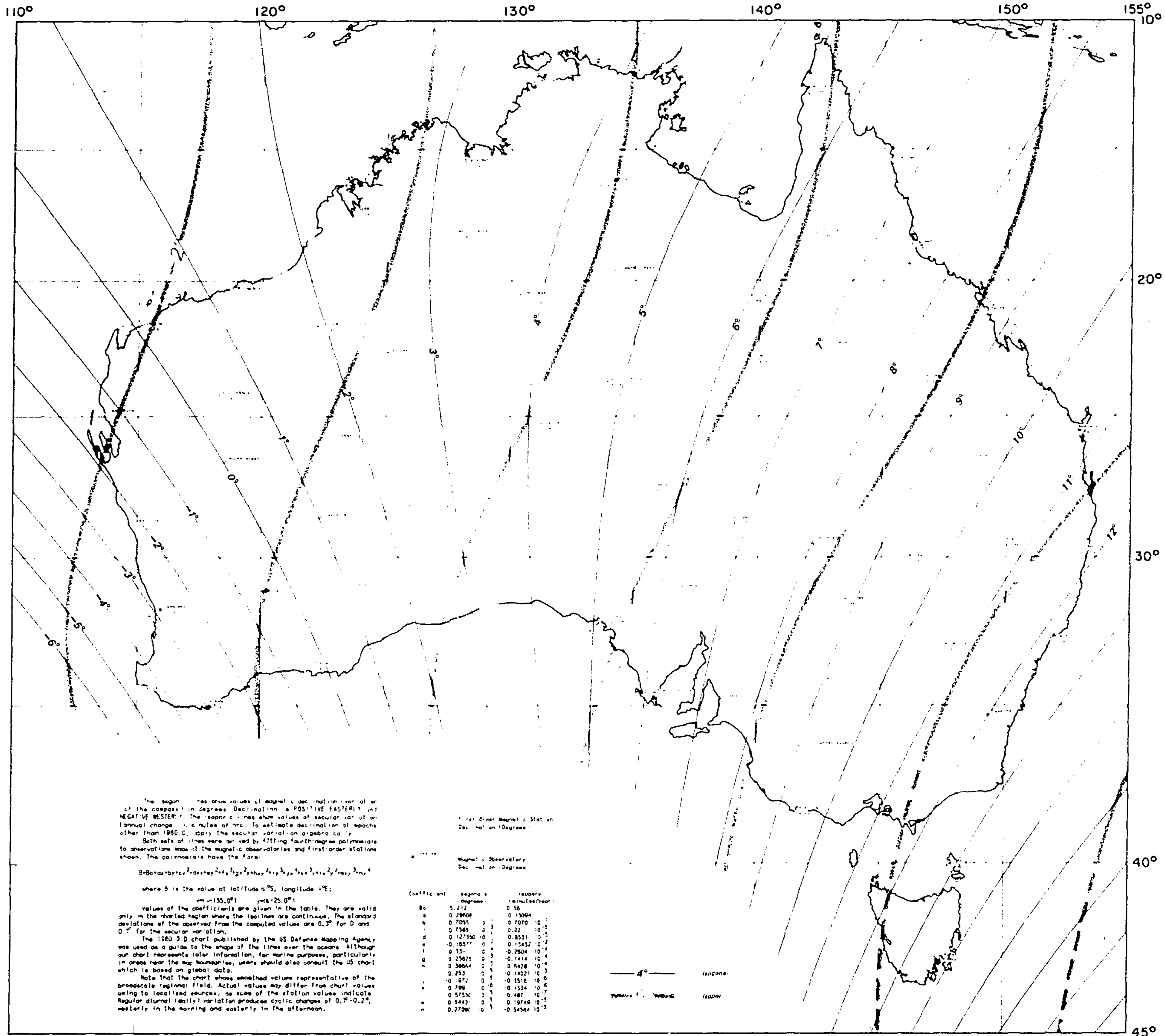
Using values of D secular variation, an assessment was made of the fit of three candidate models for the International Geomagnetic Reference Field 1980 in the Australian region; the results were presented at a working session of the International Association of Geomagnetism and Aeronomy by Professor D. Winch of Sydney University - a joint author. The preliminary conclusion is that the US models (NASA and USGS) give the best space-terms and the UK model (IGS) the best time-terms.

A data base was set up on the BMR computer comprising data from the first-order station network and Australasian observatory annual mean values. Software was developed to plot and list data to derive secular variation for the production of magnetic charts, and other studies.

Abrupt changes in D secular variation. Watheroo Magnetic Observatory continuously recorded the Earth's magnetic field from 1919 to 1958, and D recordings at Watheroo (and Gnangara since 1959) have been controlled accurately by declinometers which have not changed in design. During the period 1920-1959 abrupt changes in the rate of secular variation apparently occurred in 1928, 1929, 1940, and 1948. Their possible relation to large Australian earthquakes was investigated because it was considered that stress changes within the Earth's crust could cause sudden changes in the magnetic field. Toolangi results were also investigated but they are less accurate than Watheroo results and were discarded.

The abrupt changes are shown in Figure GSR 26. The largest earthquakes in Western Australia occured in 1929 and 1941 at times coinciding with rapid changes in the rate of secular variation. However, recent evidence suggests that the cause of the abrupt changes could be external to the Earth and the observed correlation is probably coincidental.

Results of this work clearly indicated that (a) the abrupt changes can take place within a period of one or two months and (b) it is essential to record the Earth's magnetic field with high accuracy and for long time intervals in order to provide the data necessary to study secular variation changes for such applications.



Record 1981/57

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Fig.GSR 25. Magnetic declination epoch 1980·0

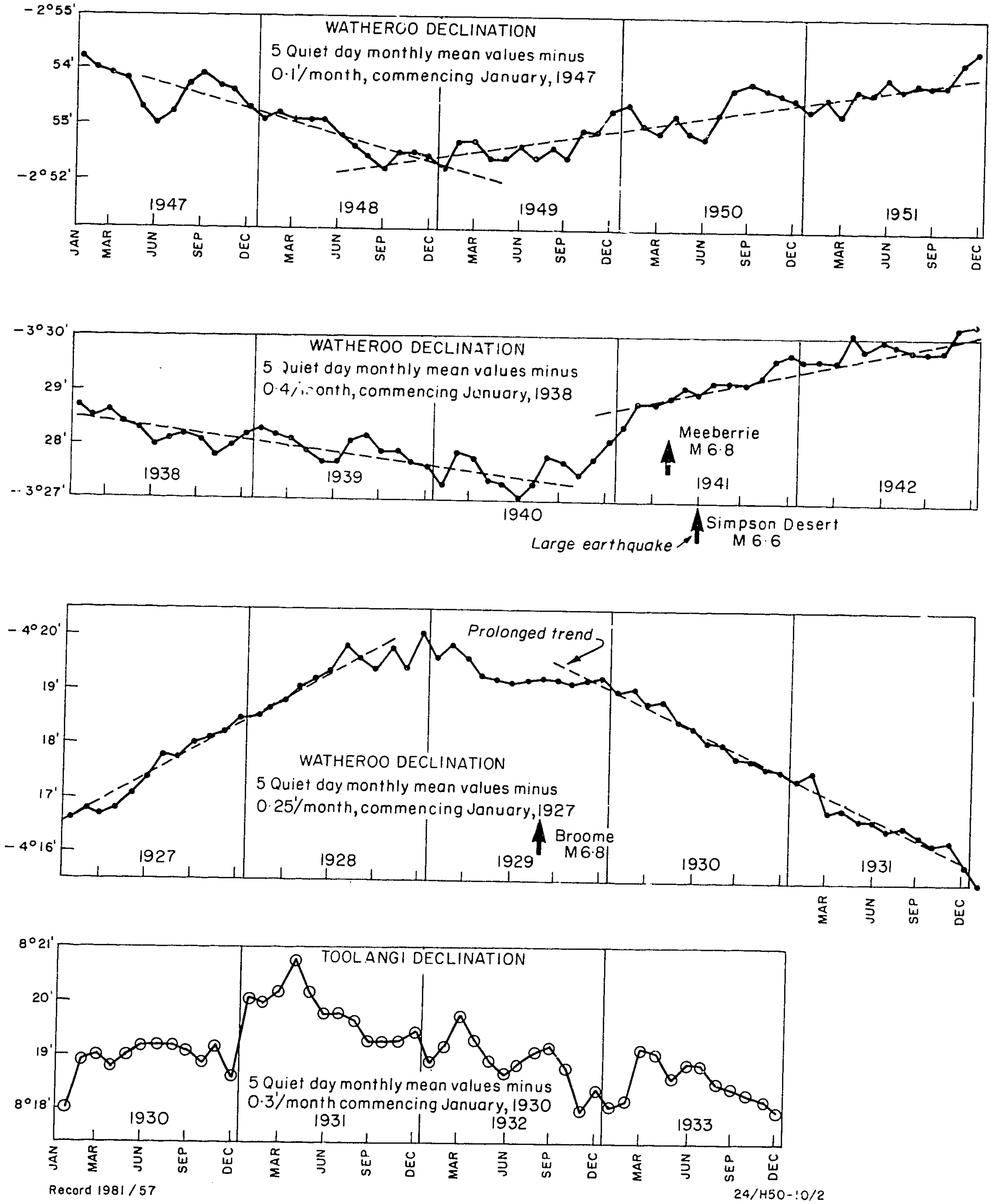

Fig. GSR 26. Abrupt changes in secular variation in declination at Watheroo

Co-operative programs. An IPS type 4B ionosonde was operated throughout the year at Mundaring with soundings made every 15 minutes. Six-hourly and the noon values of the F2 critical frequency were made at Mundaring. The ionograms were sent to IPS Sydney for the scaling of all other parameters.

Pulsation recording, in co-operation with the University of Newcastle, continued at Mundaring throughout the year except when both sensors were returned to Newcastle for servicing.

A fluxgate was operated at the Canberra Observatory for Dr F. Chamulaun of Flinders University (SA) so that it could be checked against the observatory records.

Seismology

Seismograph stations. Seismographs were operated at the following places, some jointly, with the co-operating agencies shown in parentheses: three or more components: Adelaide (University of Adelaide), Alice Springs (USAF), Charters Towers (University of Queensland), Kununurra (WA Public Works Department), Manton, Mawson, Mundaring, Narrogin, Hobart (University of Tasmania), Toolangi, Riverview (Riverview College Observatory). Stations underlined are part of the 'World Wide Standard Seismograph Network'. Narrogin is a 'Seismic Research Observatory' (SRO) and Charters Towers is an Abbreviated SRO. Single component: Ballidu, Bellfield, Canberra, Cooney, Kalgoorlie, Kellerberrin (from September 1981), Marble Bar, Macquarie Island, Meekatharra, Mount Isa, Nanutarra, Stephens Creek, Swanview, and Warburton.

Sprengnether MEQ800 seismographs were installed temporarily at Kellerberrin and Ballidu in December 1980 and August 1981. The seismograph at Swanview was closed in July 1981 and re-installed at Kellerberrin on 23 September 1981; signals are telemetered to the Mundaring office. The recording equipment at Darwin was moved into an office in the Tannadice Street building in October. All stations were visited at least once during the year for maintenance, repairs, calibration, or modifications.

Data production and distribution. A new system was introduced in January: phase data are keyed directly into the BMR computer from the preliminary phase data sheets and telex tapes for transmission of preliminary data to the USGS are prepared. The files also permit automatic conversion to Format 2, required by the International Seismological Centre. This saves manual re-writing of data and subsequent punching.

Final phase data from all agencies in Australia and PNG and the Solomon Islands were sent to the International Seismological Centre (ISC) on schedule. About 5000 phases were sent each month on average (Fig. GSR 27 shows the details for BMR stations); an average of 75 epicentral determinations by Australian agencies were also sent.

The regional Earthquake Data File (for the area 0-90°S and 75-165°E) was brought up to the end of 1980; 1490 events and a number of corrections to existing data were added to the file.

Accelerographs. The two accelerographs in the Dalton/Gunning district were not triggered.

Four MO2 accelerographs were operated in the Meckering area and two at the Ord River Dam (Kununurra). An accelerogram was obtained for one small tremor (ML = 2.3) on 11 October 1980. The epicentral distance was 6 km and peak accelerations recorded were Z 0.8 x 10^{-2}, N 2.6 x 10^{-2} and E 1.2 x 10^{-2} m/s^2.

Three SMA1 accelerographs were installed for Telecom in the Wellington Street telephone exchange in Perth.

Australian seismicity. Significant earthquakes that occurred during September 1980-September 1981 are listed in Table GSR 2.

1980 earthquakes with M greater than 2.9, which were added to the data file. are shown in Figure GSR 28. Most of the seismic activity was in Western Australia where two earthquakes with magnitude of ML 5.0 or more occurred. One of these (8 December 1980), occurred about 150 km west of Fremantle in a region which had previously been considered to be aseismic. A poorly controlled fault-plane solution obtained from stations to the east of the epicentre indicated that N-S tensional stress caused the earthquake; however, tectonic implications of the earthquake are speculative.

During June and July 1982, several tremors were felt at Errabiddy Station in the known zone of seismicity inland from Carnarvon. The Bass Strait earthquake (16 June 1981) did not cause damage. However, it occurred in an area where earthquakes have occurred in the past and draws attention to the necessity for seismic risk re-assessments for Geelong and Melbourne.

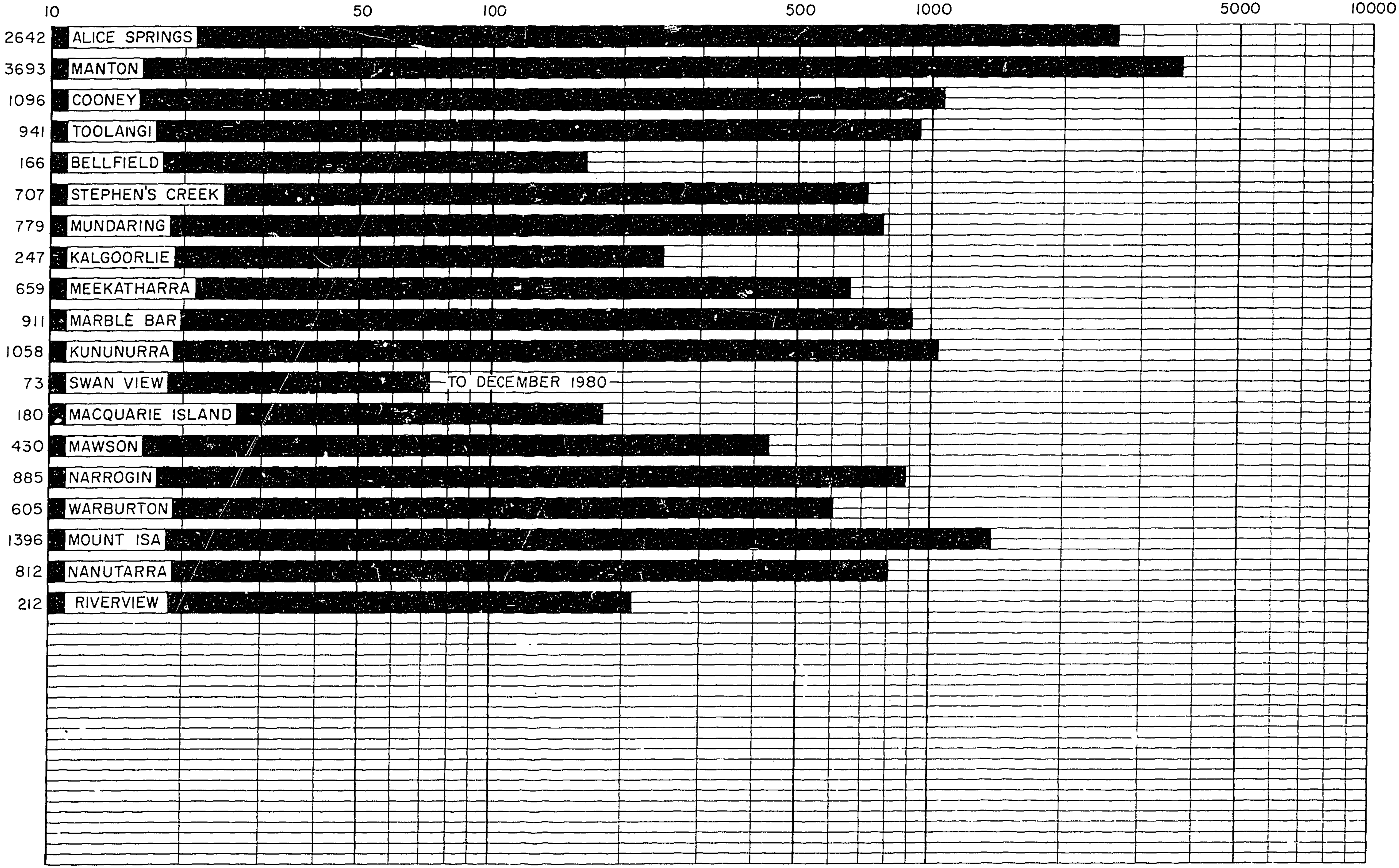

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Fig.GSR 27. *P* – Wave arrivals - BMR stations Sept. 1980 - Aug. 1981

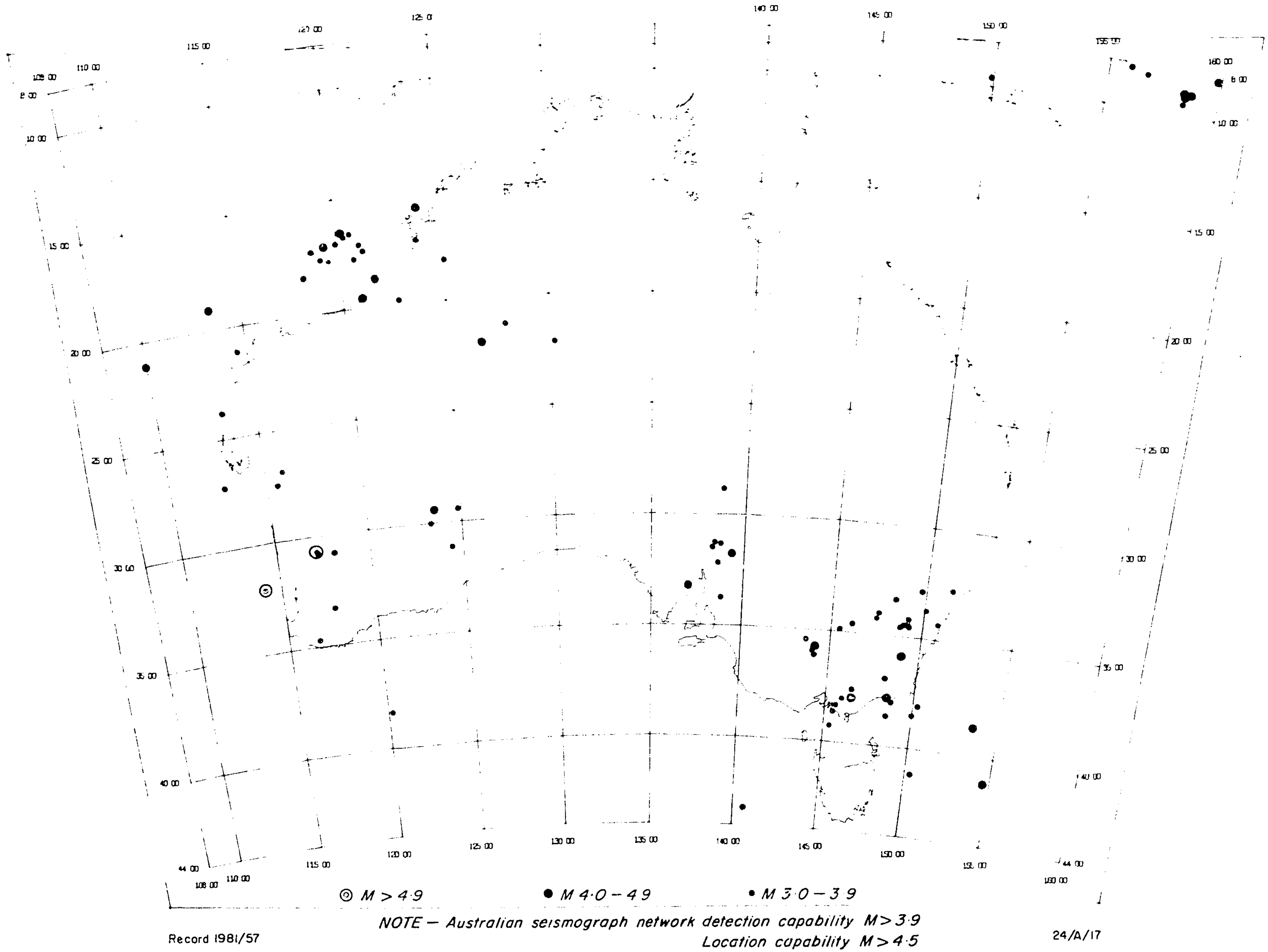

Fig. GSR 28. Seismicity of Australia 1980

TABLE GSR 2

SIGNIFICANT EARTHQUAKES IN THE AUSTRALIAN REGION

1 SEPTEMBER 1980 - 30 SEPTEMBER 1981

DATE	LOCALITY	MAGNITUDE ML	REMARKS
1980			
Sep 01	5 km E Cadoux	3.0	
Oct 05	Dumbleyung	3.0	
Nov 02	120 km NNW Carnarvon	3.3	
22	420 km SSE Albany	3.3	
23	200 km NE Kalgoorlie	3.5	
24	170 km N Derby	4.0	
29	55 km W Fitzroy Crossing	3.3	
Dec 02	Rowley Shoals	3.9	
08	150 km W Fremantle	5.2	Felt MM V at Fremantle
10	4 km NNE Cadoux	5.0	Felt max MM VI at Cadoux
19	Lake Tobin	3.9	
20	Lake Tobin	3.9	
21	Lake Tobin	4.0	
23	70 km NW Onslow	3.0	
24	30 km N Walpole	3.2	
1981			
Jan 01	80 km NE Broome	5.0	
12	160 km W Exmouth	4.0	
21	75 km NE Marble Bar	3.2	
22	2 km SE Cadoux	3.3	
Feb 07	240 km NNW Dampier	3.1	
21	40 km SSW Dongara	3.2	
23	45 km SW Landor	3.2	
26	10 km NW Badgebup	3.2	Felt MM IV
Mar 15	140 km SE Broome	3.9	
Apr 03	100 km ESE Broome	4.3	
07	8 km E Cadoux	4.5	
13	240 km NW Broome	3.5	
15	Lake Tobin	4.2	
16	90 km S Norseman	3.3	
21	20 km S Learmonth	3.0	
29	240 km NW Broome	4.4	

TABLE GSR 2 (continued)

1981			
May 05	120 km SSW Broome	4.0	
25	400 km NW Campbell Is	6.5	Felt Tasmania
Jun 02	100 km SW Broome	3.7	
07	150 km WNW Carnarvon	3.2	
16	35 km SE Lorne Vic	4.9	Max intensity MM V: Felt Melbourne & Geelong
20	Picton NSW	3.5	Felt
27	50 km NNE Broome	3.8	
28	10 km S Errabiddy Station	3.8	Felt MM IV
29	340 km SW Carnarvon	4.4	
Jul 01	10 km S Errabiddy Station	3.0	
01	10 km S Errabiddy Station	3.2	
01	10 km S Errabiddy Station	3.4	Felt MM IV
07	300 km W Shark Bay	3.2	
13	255 km SSE Esperance	4.2	
16	100 km N Exmouth	4.7	
30	150 km NNW Meekatharra	3.5	
Aug 15	280 km WNW Broome	4.0	
23	250 km NW Broome	4.2	
Sep 12	270 km E Kalgoorlie	3.0	
21	Echuca Vic	3.0	Felt

Isoseismal maps and atlas. Maps were drawn for the earthquakes of 8 December 1980 (Fremantle), 10 December 1980 (Cadoux), and 16 June 1981 (Bass Strait) - see Figure GSR 29. With the isoseismal maps for eight Queensland earthquakes (drawn by the University of Queensland), they were added to the Isoseismal Atlas, which now contains 77 maps and is being prepared for publication. For the Fremantle earthquake felt intensities in the Perth region were generally greater to the east of the Darling Fault even though the earthquake was to the west. The map for the Bass Strait earthquake was drawn using about 250 answered BMR questionnaires and results of field inspections by the Preston Institute of Technology Seismology Centre. The maximum intensity was MM V and the radius of the MM IV isoseismal approximately 100 km. A surface wave magnitude (MS) 4.2 was determined from six Australian stations.

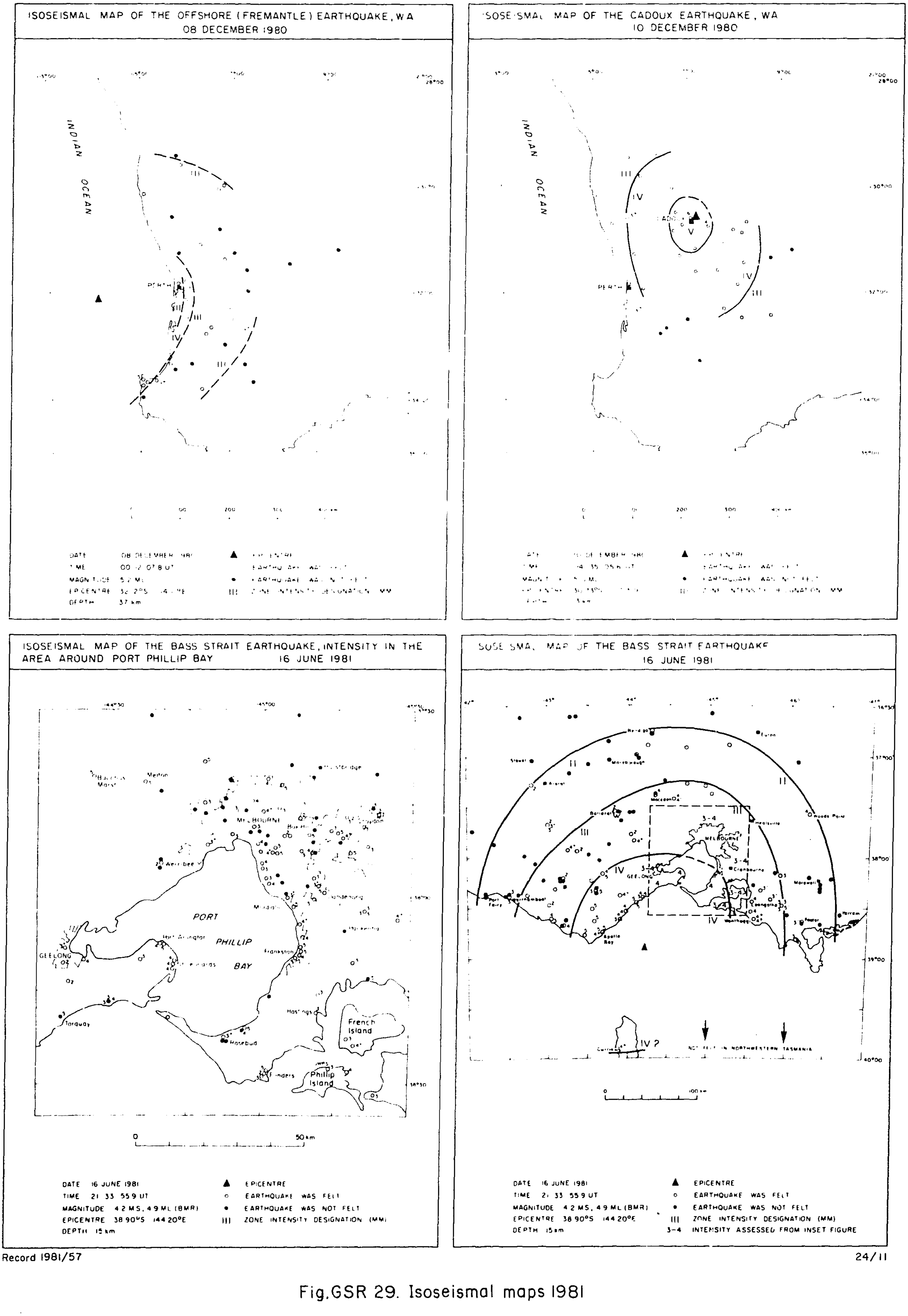

Fig.GSR 29. Isoseismal maps 1981

TABLE GSR 3

SURFACE WAVE (MS) MAGNITUDES FROM RIV, PER AND MEL SEISMOGRAMS(1913 - 1959)

YEAR	DATE D M	ORIGIN TIME (UT) h	m	s	AREA	MS	ML
1913	18 Dec	13	54		Townsville	4.6	
1918	6 June	18	14	24	Bundaberg	5.8	
1920	8 Feb	05	24	30	Off SW Aust	6.1*	
1922	10 Apr	10	47	39	E of Bass St.	5.1	
1929	16 Aug	21	28	22	Off NW Aust	6.6*	
1929	28 Dec	01	22	53	E of Bass St.	5.1	
1930	27 Oct	02	03	51	Boorawa	3.0	5.0
1932	2 Sep	18	22	32	Mornington	4.2	
1933	11 Jan	20	10	51	Gunning	4.0	4.8
1934	30 Jan	20	27	54	"	3.8	4.7
1934	12 Jul	14	24	27	Indian Ocean	5.9*	
1934	10 Nov	23	47	40	Gunning	4.2	4.8
1934	18 Nov	21	58	41	"	5.2	5.6
1935	12 Apr	01	32	24	Gayndah	5.4	
1937	28 Oct	98	34	43	Simpson Des.	5.3	
1937	20 Dec	22	35	02	"	5.6	
1938	24 Mar	20	03	33	Riverina	4.5	4.7
1938	17 Apr	08	56	22	Simpson Des.	5.8	
1939	26 Mar	03	56	05	L. Torrens	5.8	
1941	29 Apr	01	35	41	Meeberrie	6.8*	
1941	4 May	22	07	30	Simpson Des.	5.8	
1941	4 May	22	31	50	"	5.0	
1941	4 May	23	23	57	"	5.5	
1941	27 June	07	55	51	"	6.5	
1946	14 Sep	19	48	42	E of Bass St.	5.4	
1948	6 Aug	03	29	23	Robe	5.4	5.6
1949	10 Mar	22	30	33	Gunning	4.6	5.5
1952	24 June	01	46	00	Maryborough	4.4	
1952	7 Sep	05	41	14	Gunning	3.9	4.7
1952	19 Nov	01	59	16		3.6	4.9
1954	28 Feb	18	09	52	Adelaide	4.9	5.4
1954	19 Sep	10	37	13	Maryborough	4.0	
1959	18 May	11	28	46	Berridale	3.8	5.3

*MS using IASPEI formulae for epicentral distance greater than 20°.

Earthquake magnitude determination (1913-1959). To add to the limited amount of magnitude data for larger Australian earthquakes which occurred prior to 1960, surface wave magnitudes (MS) for 33 earthquakes were determined from Riverview, Melbourne, and Perth seismograms. Results are given in Table GSR 3.

Stress measurements and earthquake prediction (D. Denham)

A series of overcoring measurements was carried out in granites near Geelong, Anakie, Melbourne, and Lancefield (Victoria). These measurements were taken by members of the CSIRO Division of Applied Geomechanics - to date the results have not been obtained.

A hydraulic fracture test at Lancefield gave values for σ_1 and σ_2 of 16 and 7 MPa at a depth of about 5 m. The azimuth for σ_1 was about 58 degrees.

Earthquake source mechanisms (D. Denham)

A program to calculate synthetic seismograms for body waves in the far field was obtained from the California Institute of Technology.

This was adapted to the Cyber 76, and modelling was started on the 1979 Cadoux earthquake.

GSE experiments. Australia took part in the two trials in 1980. The first, on the exchange of routine seismic data bulletins via the Global Telecommunications System, involved the routing of messages from Canberra and Mundaring to the Melbourne GTS centre (Bureau of Meteorology). It provided all participants with useful practical experience of the GTS, and led to the formulation of a more complex and elaborate trial.

The second was the 'Data Base' experiment aimed at obtaining a comprehensive (Level 1 and Level 2) set of data for future assessment of global detection/identification capabilities. Australian contributions were SRO datatapes from Narrogin and Charters Towers, and Alice Springs array tapes. Foreign Affairs provided some funds for services and a part-time employee.

4. REPORTS, MAPS, LECTURES, CONFERENCES, OVERSEAS VISITS, COURSES

EXTERNAL PUBLICATIONS

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1981/1	CULL, J.P., SPENCE, A.G., MAJOR, J.A. KERR, D.W., & PLUMB, K.A.	The 1978 McArthur Basin magnetotelluric survey.
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	GREGSON, P.J.	Mundaring Geophysical Observatory annual report, 1980.
1981/66	SPIES, B.R.	Electrical geophysics in the USSR.
	WILLIAMS, J.W.	Geophysical and surveying work along the Ingrid Christensen Coast near Davis Base, Antarctica, 1980/1981 summer.

Maps issued

1:1 000 000 Bouguer gravity anomaly maps: Canberra, Bourke, Hamersley Range.

1:250 000 Bouguer gravity anomaly maps: EULO, CUNNAMULLA, DIRRANBANDI, ST GEORGE, YANTABULLA, ENNOGNIA, ANGLEDOOL, MOREE, LOUTH, BOURKE, WALGETT, NARRABRI, BARNATO, COBAR, NYNGAN, GILGANDRA, IVANHOE, NYMAGEE, NARROMINE, DUBBO, BOOLIGAL, CARGELLIGO, FORBES, BATHURST, HAY, NARRANDERA, COOTAMUNDRA, GOULBURN, DENILIQUIN, JERILDERIE, WAGGA WAGGA, CANBERRA, BEDOUT ISLAND, NINGALOO, MINILYA, BARROW ISLAND, DAMPIER, ROEBOURNE, PORT HEDLAND, ONSLOW, YARRALOOLA, PYRAMID, MARBLE BAR, YANREY, WYLOO, MOUNT BRUCE, ROY HILL, WINNING POOL, EDMUND, TUREE CREEK, NEWMAN.

Airborne maps - see Table MA 2.

Shotpoint location maps:

1:100 000: Keeroongooloo, Windorah, Springfield, Retreat, Jundah, Bulgroo, Budgerygar, Arno.

1:250 000: Canterbury, Windorah, Barrolka, Eromanga.

BMR Denison Trough 1978-79 survey, 1:250 000: Taroom, Eddystone, Baralaba, Springsure.

Seismic cross-sections released

BMR surveys:

Galilee Basin, 1976, traverses 1-4.
Georgina Basin, 1977, traverses 1-7, & 9-14.
Denison Trough, 1978-79, traverses 1-9.
Central Eromanga Basin, 1980, traverses, 1, 3-6, & 8.

Subsidised surveys:

Quilpie-Thargomindah-Charleville, 1959-60, lines 1, 4, 6, & 11.
Gumbardo, 1962, line 446.
Bulgroo, 1963, lines, 4, 8, 9 & 12.
Barcoo, 1964, lines 20B, 23B, & 24B.
Trinidad, 1964, line 1.
Thylungra, 1966 line NM1.
Welford, 1967, lines 645, 646, 647, & 648.

ADDRESSES TO MEETINGS AND CONFERENCES

DENHAM, D. — Earthquake evidence for compressive stress in the southeast Australian crust. Special Seminar on Stress and Seismicity in Eastern Australia, Melbourne, 12 November 1980.

DENHAM, D. — Crustal stress in southeast Australia. Symposium on the Cainozoic evolution of continental southeast Australia, Canberra, 26-27 November 1980.

DENHAM, D. — Can in-situ stress measurements be used to predict earthquakes? Some evidence from Western Australia. 21st General Assembly of IASPEI, London, Canada, 21-30 July 1981.

DOOLEY, J.C. — Arguing in circles about Earth expansion; a simple physical test of Earth expansion. Expanding Earth Symposium, Sydney, 11-14 February 1981.

DOOLEY, J.C. — Some lesser known aspects of BMR geophysical research. BMR Symposium, Canberra, 5-6 May 1981.

DOOLEY, J.C., & McGREGOR, P.M. — Correlative geophysical data in the Australian region for use in the MAGSAT project. MAGSAT Principal Investigators' Meeting, Edinburg, UK, 30-31 July 1981.

HONE, I.G. — Regional geophysics of the Mount Isa Inlier. Joint meeting on the geology of the Mount Isa region, Northwest Queensland Branch, AusIMM, and the Bureau of Mineral Resources. Mount Isa, 15-16 September 1981.

IDNURM, M. — Climate: Long term cycles of Milankovitch. Plasma Research Group Seminar series, RSES, Australia National University, Canberra, February 1981.

JOHNSTON, C.R. — The Timor enigma - continental collision or expanding Earth? Expanding Earth Symposium, Sydney, 11-14 February 1981.

KARNER, G.D. — A mechanical model for the subsidence of foreland basins. American Geophysical Union Spring Meeting, Baltimore, Maryland, USA, 25-29 May 1981.

KARNER, G.D. — Rheological properties of continental lithosphere. American Geophysical Union Meeting: with M.S. Steckler*.

MAJOR, J.A. — The response of down-hole TEM surveys in the presence of a conductive overburden. 2nd Biennial Conference, Australian Society of Exploration Geophysicists, Adelaide, 17-21 August 1981.

MOSS, F.J., PINCHIN, J., & SENIOR, B.R. — Regional geology, geophysics and petroleum potential of the central Eromanga Basin area. BMR Symposium, Canberra, 5-6 May 1981.

SHEARD, S.N. — National calibration sites for airborne spectrometer system in NSW. 2nd Biennial Conference, Australian Society of Exploration Geophysicists, Adelaide, 17-21 August 1981.

STUART, D.C. — The use of gamma-spectrometer and radon surveys for mapping and exploration in the Pine Creek Geosyncline. 2nd Biennial Conference, Australian Society of Exploration Geophysicists, Adelaide, 17-21 August 1981.

OVERSEAS VISITS AND CONFERENCES

BRANSON, J.C. — Tenth Session, CCOP/SOPAC, Port Vila, Vanuata, 6-13 October 1981.

BRANSON, J.C., & RENWICK, A. — SOPAC Joint Cruise Planning, Suva, Fiji, 8-17 August 1981.

DENHAM, D. — 21st General Assembly of the International Association of Seismology and Physics of the Earth's Interior, London, Canada, 21-30 July 1981.

DENHAM, D.	Geophysical Institute, University of Karlsruhe, West Germany, 5-7 October 1981.
DOOLEY, J.C., & McGREGOR, P.M.	MAGSAT Principal Investigators' Meeting, Edinburgh, UK, 30-31 July 1981.
DOOLEY, J C. & McGREGOR, P.M.	International Association of Geomagnetism and Aeronomy Scientific Assembly, Edinburgh, UK, 2-15 August 1981.
KARNER, G.D.	American Geophysical Union Spring Meeting, Baltimore, Maryland, USA, 25-29 May 1981.
MATHUR, S.P.	Cornell University, Ithaca, New York, USA, and Virginia Polytechnic Institute, Blacksburg, Va, U.S.A. 8 May - 4 September 1981.
MATHUR, S.P.	IASPEI Meeting on controlled source seismology, London, Ontario, Canada, 22-24 July 1981.

LOCAL CONFERENCES

BRANSON, J.C., DENHAM, D., & SYMONDS, P.A.	CCGS/IPOD Worksh[illegible] RSES, Canberra, 10-12 March 1981.
DENHAM, D.	5th Australian Geological Convention, Perth, 17-21 August 1981.
DOOLEY, J.C.	National Committee for Antarctic Research, Hobart, 20-21 May 1981.
DOOLEY, J.C., & JOHNSTON, C.R.	Expanding Earth Symposium, Sydney, 11-14 February 1981.

FINLAYSON, D.M., MAJOR, J.A., MOSS, F.J., STUART, D.C., & ANFILOFF, W. (private visit)	2nd Biennial Conference, Australian Society of Exploration Geophysicists, Adelaide, 17-21 August 1981.
HONE, I.G.	Joint meeting on the geology of the Mount Isa region, Northwest Queensland Branch, the AusIMM, and the Bureau of Mineral Resources, Mount Isa, 15-16 September 1981.
PINCHIN, J.	APEA Conference, Adelaide, March 1981.
STUART, D.C.	NEA/IAEA Workshop on research and development of borehole logging techniques in uranium exploration, Adelaide, 16 August 1981.

TRAINING COURSES

JOHNSTONE, D.W.	Shot firer's course. Telecom, Sydney, 15-29 June 1981.
MAJOR, J.A.	New developments in electromagnetic exploration. AMF Workshop Course, Macquarie University, 16-27 November 1981.
MATHUR, S.P.	Interpretive view of migration. Geo Quest International Inc., Houston, USA, 22-24 June 1981.
SEXTON, M.J.	Petroleum exploration in cratonic basins. AMF, Adelaide, 27-31 July 1981.
WOAD, G.	Introduction to microprocessors. Telecom, Perth, August 1981.