BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

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GEOPHYSICAL BRANCH SUMMARY OF ACTIVITIES 1979

DEPARTMENT OF NATIONAL DEVELOPMENT & ENERGY

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SUMMARY

METALLIFEROUS AND AIRBORNE SECTION

Consistent with the trend established over recent years, a reduced work program was planned for the Section for 1979 to adjust to the ever decreasing staffing and financial resources. It was planned to return the Aero Commander to survey operations in the second half of 1979, the aircraft having been taken out of service the previous year owing to funding problems. Unfortunately staff losses from the Section were so severe in the first half of 1979 that the proposed action could not be implemented. This resulted in the cancellation of the DOBBYN and east CAMOOWEAL airborne survey from 1979 field program, and three 1:250 000 Sheet areas foreshadowed for 1980 program. With the exception of the forementioned project, most other field and research projects went ahead with necessary redistribution of operational staff. Predictably this resulted in a major reduction in the rate of data processing and reporting in the second half of 1979. The effect of this will be felt in 1980 when little field activity, particularly for the Metalliferous Subsection, will be possible owing to priority being given to data handling and reporting backlogs. The locations of the field activities of the Section during 1979 are shown in Figure MA-1.

Staff from the Metalliferous Subsection were allocated to two basic program areas during 1979:

1. Methodological research in metalliferous geophysics.
2. The Lachlan Fold Belt geophysical project.

Methodological research concentrated on the application of magnetic, electrical (including EM), and nuclear methods to mineral exploration and regional geological studies. Work on magnetic projects was divided between development of a carborne magnetometer system and a downhole magnetometer, and research into data interpretation using spectral analysis techniques.

A considerable quantity of effort went into electrical and EM research with emphasis directed towards the application and interpretation of these methods. Specific work included transient EM modelling using the Macquarie University modelling facility (the most significant results being presented at the ASEG conference in Adelaide), development of interpretation aids for transient EM surveys over one-dimensional structures, investigation into the sensitivity of the Cole-Cole dispersion model for analysis of complex

resistivity work, a theoretical study of the use of magneto-resistivity and MIP methods to search for three-dimensional conductors under conductive overburden, and major participation in the AMF workshop on electrical methods with special reference to EM modelling in the design and interpretation of surveys. Research projects oriented more towards system development included the construction and field testing of a three-component downhole EM probe, experimental surveys in conjunction with CSIRO staff to study the performance of SIROTEM, and the design of a high-sensitivity analogue receiver applicable to complex resistivity studies. In keeping with the major interest the Subsection maintains in electrical geophysics research, B. Spies visited the USSR late in the year to exchange information on the use of electrical methods in mineral and petroleum exploration.

With regard to nuclear geophysics, work was primarily restricted to a continuation of a study into the use of alpha particle and gamma-ray detectors for radioelement exploration, with fieldwork principally confined to the Rum Jungle-Alligator Rivers region, and the development of dynamic test ranges at Dalgety and Dubbo, NSW, for the calibration of airborne gamma-ray spectrometers.

Approximately half the Subsection's staff were assigned to the Lachlan Fold Belt project at the start of 1979. Staff losses progressively reduced personnel on this project throughout the year. The principal objective is to establish an understanding of the geophysical response of the surface and crustal geology of the region at scales appropriate for regional, mining district, and mineral deposit studies. Both Subsections were involved in the first phase of this project during 1979, with effort concentrated on data gathering. This included airborne surveys of the DUBBO, GILGANDRA, and NYNGAN, 1:250 000 Sheet areas in NSW plus completion of similar work over the WARBURTON and MALLACOOTA in Victoria; airborne traverses flown along latitudes $31^{\circ}32'S$, $34^{\circ}3'S$, and $35^{\circ}5'S$ (as indicated in Figure MA-1), with data recorded at both high and low flight elevations to assist studies of crustal structure and near-surface geology respectively; and a substantial program of rock sampling, physical property measurement, geological observations, and ground magnetic and gamma spectrometer measurement over an area of twenty 1:250 000 Sheets. 900 sites were visited in the latter aspect of the project. The analyses of these

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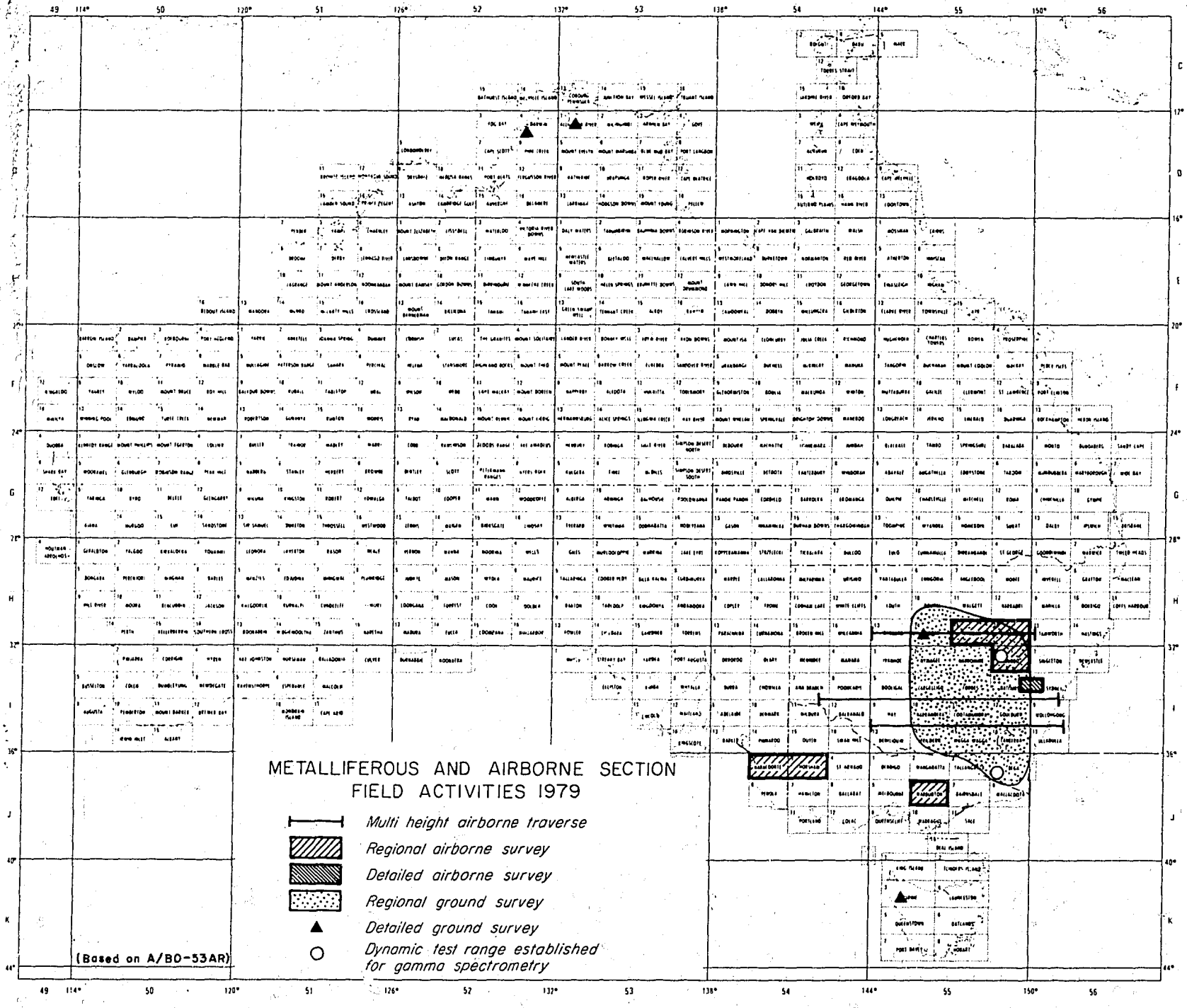


data, together with regional airborne and gravity information, now to hand, will demand major office studies in 1980 with little opportunity for additional fieldwork.

Specific studies undertaken over more restricted areas included an analysis of the geophysics of the Cobar area; geophysical modelling of the Cobar trough using magnetic and gravity data; EM model studies and specialised transient EM surveys of the Elura deposit (the latter in conjunction with CSIRO and Newmont Pty Ltd); magnetic studies of mineralised bodies and other surficial sources using airborne-carborne-in-hole magnetic surveys supplemented by rock-property measurements and modelling. Results of this work will become available progressively during 1980.

The Bureau's Twin Otter aircraft was operational for 750 hours in 1979, enabling 70 000 line-km to be surveyed. The year's survey work commenced with minor operations involving the completion of aeromagnetic surveys over the WARBURTON and MALLACOOTA 1:250 000 Sheet areas. Results from these surveys will become available in early 1980.

A small detailed aeromagnetic survey was flown in the Lithgow district over the Western Coalfield area in late February to early March. This was the first phase of a joint project with CSIRO to investigate the use of the aeromagnetic method in the resolution of fracture zones which affect mining operations.

The first major project of the year commenced in May with a program to survey 40 000 km in the Sheet areas of DUBBO, GILGANDRA, and NYNGAN as previously mentioned. Survey operations were completed in August and results of this work should become available progressively from April 1980.

The second, and last, major project of the year involved the surveying of the NARACOORTE, SA, and HARSHAM, Victoria, 1:250 000 Sheet areas. Flying commenced on this survey in mid-September and is expected to be completed by late November. Results from this work will not become available before the end of 1980.

Brief detailed gamma-spectrometer surveys were made at Dalgety and near Dubbo, NSW, as part of the project to establish dynamic calibration test facilities for airborne gamma spectrometers as mentioned previously. Results of this work supported by ground-truth data will become available in 1980.

As in 1978, most Airborne Subsection personnel contributed to work in the Airborne Reductions and Contract Group for long periods during the year. Processing was undertaken on 34 1:250 000 Sheet areas; this resulted in the production of 129 maps, of which 112 were released and the remainder retained for inspection at BMR. As a result of this work four major projects reached final mapping status in 1979, namely, Officer Basin 1975-1978, McArthur Basin South 1977, Albany-Fraser Block 1977, and Adelaide Geosyncline 1978.

During the year requests from 13 outside organisations, including exploration companies, were dealt with for the supply of digital geophysical data for 19 1:250 000 Sheet areas. In addition 14 requests to access analogue data were dealt with.

Subsection personnel were also involved in the development of computer programs to deal with specialised processing and interpretation of airborne geophysical data, upgrading of the gamma spectrometry instrumentation in the Twin Otter, and participation in a follow-up ADAE mission to the Philippines to develop a 5-year aid program in the field of uranium exploration training.

SEISMIC, GRAVITY, AND MARINE SECTION

Main field activities of the Seismic and Gravity Groups were in the Denison Trough and McArthur Basin surveys. Other activities comprised data processing, interpretation, and reporting on earlier surveys, and reviews of geophysical information in areas where further surveys may be required to solve stratigraphic and/or structural problems, particularly relating to petroleum search. Contributions were made to the studies of the Petroleum, Coal, and Oil Shale Task Groups set up by the Director.

Staff shortages have become more acute but there has been continual and somewhat more widespread involvement in co-operative projects, including the Georgina and McArthur Basin projects; Gundary Plains deep crustal reflection survey with the Regional Section; Central Eromanga Basins project with Geological and Petroleum Exploration Branches; Ngalia and Officer Basins Bulletins with Geological Branch; and Denison Trough project with the Geological Survey of Queensland.

The main objectives of the Denison Trough Survey were to delineate basement in the deep parts of the trough, to provide structural information, particularly on the Lower Permian section and at the margins of the basin, and to provide stratigraphic information along seismic lines tying petroleum exploration wells and stratigraphic holes drilled by GSQ. The results from the 1978 survey provided new information on the structural and depositional history of the basin; this in turn provided leads for a renewed petroleum exploration program. The 1979 survey completed the regional traverses across and along the southern part of the Trough. The results will be interpreted with drilling and other information.

Deep crustal reflection and gravity information from the McArthur Basin is being interpreted in conjunction with refraction information.

The Groups have become more heavily involved in study of the Central Eromanga and underlying basins, which were seen as having a high priority by the Petroleum Task Group. This study is expected to develop into a major project in future programs over the next few years.

The year saw the production of the 220 final track and profile maps from the Continental Margin Survey.

The Marine Group was again much occupied with interpretation and reporting projects. The major studies of the Carnarvon and Ceduna Terraces were continued at a reduced rate, and A.R. Fraser presented a paper at APEA on the Ceduna Terrace. The writing of a Bulletin on the Scott Plateau was completed. Studies of the Timor Sea area were continued, and C.R. Johnston presented papers at a SEATAR workshop and at the IUGG General Assembly. Other areas studied were the Naturaliste Plateau and the Woodlark Basin, and papers were presented at the IUGG by J.C. Branson and G. Karner respectively.

In all of these studies data from the Continental Margin Survey were combined with data from other sources.

Following on from the co-operation with BGR (Geological Survey of the Federal German Republic) on surveys of the Lord Howe Rise and the northeast Coral Sea in the R.V. Sonne at the end of 1978, J.B. Willcox and P.J. Cameron each spent six months at BGR in Hanover processing and interpreting the data. Willcox presented preliminary results of the Lord Howe Rise survey at the EAEG Meeting in Hamburg.

Magnetic measurements were continued in association with Division of National Mapping's bathymetric survey of the continental shelf. The survey on board the M.V. Cape Pillar lasted a month and about 7000 km in the Timor and Arafura Sea area were surveyed. An expanded data acquisition system designed to interface with the satellite/sonar Doppler navigation system was used successfully. Processing of the data collected on previous NATMAP surveys approached completion, much of the manpower being supplied by NATMAP and guidance and program development being supplied by BMR.

BMR has had a long standing intention, and in recent years there has been some pressure, to start geophysical surveying of the Antarctic continental margin, and adjacent areas of the Southern Ocean. This summer a start is being made with magnetic profiling on the M.V. Nella Dan during the four relief voyages. Data will be acquired in the Prydz Bay-Kerguelen Ridge region.

Considerable effort went into planning and preparations for future program. An AMSTAC workshop to examine priorities for future marine geoscience in Australia and to look at the problems of co-ordination was hosted by BMR early in the year.

Development of systems both for field and in-house use has achieved some significant progress this year. The non-seismic data acquisition system software was completed and tested on the Cape Pillar in the Timor Sea during August and September with satisfactory results. A start has been made on the on-board seismic acquisition system and the first stage sea-going system should be ready for testing by the end of the year.

Development of the seismic processing system, although hampered by difficulties, has made progress. A grant from NERDDC has been obtained for the purchase of an array processor and other peripheral equipment which will greatly enhance system performance in the long term. Unfortunately, although the grant was obtained in February, because of administrative difficulties it was not until September that orders were placed for the major items required. An experienced staff member from the project development group resigned and has not been replaced.

A seismic analogue-to-digital transcription system is close to routine operation in October, after a lengthy period of overhaul to somewhat aged analogue equipment. The obsolescence of the equipment is likely to cause further problems in the future. A preliminary test has indicated that the throughput rate of analogue marine tapes can be boosted by a factor of four by playing them back at four times real speed and increasing the sampling rate accordingly. This improvement should make the system a reasonable production unit with the limited manpower available.

Compilation and display of data in Australian waters from overseas institutions was restarted during the year, the main initial effort being on the Southern Ocean to aid forthcoming activities there.

R. Whitworth continued his work on the Geomagnetic Reference Field with a private visit to NOAA in Boulder, Colorado. He is presenting a paper on his work at the IUGG General Assembly in Canberra.

Activities of the Engineering Geophysics Group declined because of general financial restraints and a fall in major construction proposals within the ACT. The group has now become part of the Seismic, Gravity and Marine section. Staff changes during the year included the retirement of Dr E.J. Polak in August. G. Pettifer returned to the Bureau after a 2-year contract with the Papua New Guinea Geological Survey, and P. Hill left to join that Survey.

The 1979 program of the Group entailed engineering geophysical investigations throughout the ACT, borehole logging, blast vibration monitoring, assistance to foreign aid projects, and continued development of a shallow seismic reflection system. It also included: a joint project with the CSIRO to investigate slope stability at an open-cut coal mine in Queensland; experimental testing of an electromagnetic device for rapid, low-cost surveying of surface resistivity; and continued testing of devices which could be used for detecting buried explosive shells.

OBSERVATORIES AND REGIONAL SECTION

Staff in the Section were heavily involved in preparations for the XVII General Assembly of the International Union of Geodesy and Geophysics, held in Canberra in December 1979. Officers of the Section were authors or joint authors of twelve papers; also, eleven papers were contributed to BMR Journal of Australian Geology and Geophysics, Vol. 4 Nos 3 and 4, which are special issues for the Assembly. D. Denham, D. Finlayson, and J.P. Cull were conveners of symposia, and many of the staff were on the Organising Committee and various Sub-Committees.

A submission to National Aeronautics and Space Administration, USA, to participate in the MAGSAT (magnetic vector satellite) project was accepted with J.C. Dooley as Principal Investigator. The project will be tackled as four tasks with leaders as follows: regional mapping - P.M. McGregor; determination of Curie Point depth - P. Wellman; crustal magnetisation and structure - D. Denham; and Antarctica - P. Wellman. BMR will contribute "ground truth" data through its observatory and regional magnetic programs.

The normal seismological, magnetic, and ionospheric observatory programs were maintained. A new seismograph station was established at Mount Isa in August. Mr Howell Butler, of US Geological Survey, formally handed over a Certificate of Ownership for the Seismological Research Observatory (Narrogin) on 25 September.

Absolute observations ceased at Toolangi in June, 60 years after the transfer of the magnetic observatory from Melbourne; however recordings will continue through the next sunspot maximum.

Mr McGregor attended two further meetings of the Group of Scientific Experts of the Committee of Disarmament to advise on seismological detection of nuclear explosions, and visited related establishments at Stockholm and Blacknest (UK).

The date predicted last year for elimination of the backlog in magnetic mean hourly value scaling has now slipped to 1981, following experience with the scaling routines and delays due to computer breakdowns.

Reoccupation of regional magnetic first-order stations on the continent was completed, and observations were made at Lord Howe, Norfolk, Christmas, and Cocos Islands.

A major earthquake occurred at Cadoux, WA, on 2 June, in an area where high stress was measured in 1976. It is planned to repeat the stress measurements early in 1980. A Report on the seismic aspects of the earthquake was published in September.

A symposium on the Crust and Upper Mantle of Southeast Australia was held at Canberra on 12-14 February, sponsored by BMR, Australian National University (ANU), and the Geological Society of Australia; D. Denham was one of the conveners. About 150 attended, and over fifty papers were presented.

Deep crustal seismic refraction and reflection surveys were carried out in the McArthur Basin and between Tennant Creek and Mount Isa; the latter traverse was extended to Townsville by arrangement with ANU Research School of Earth Sciences. Interpretation of surveys from previous years continued; additional impetus was given in February by Dr C. Prodehl of University of Karlsruhe, who worked with the Group on southeast Australian data.

Stress measurements in southeast Australia continue to show horizontal compression, but the directions vary somewhat.

Heat flow measurements were made near Boulia, Georgetown, and Herberton (Qld), near Jabiluka and Batchelor (NT), Mt Gambier (Vic.), near Lake Torrens (SA), and Berrigan and Jugiong (NSW). The effect of climatic change on heat flow measurements was investigated.

Analysis of 1978 McArthur Basin magneto-telluric survey results shows a major feature near the Emu Fault, suggesting a throw of 3 or 4 km. Further fieldwork is in progress. Interpretation of the Officer Basin MT results confirms overthrusting at the boundary, but suggests a more complex picture than was believed previously from gravity and magnetic data.

Compilation of all available gravity data continued; some surveys were recomputed by contract and some by BMR personnel. Systematic checking of the gravity data in 1:250 000 Sheet areas continued, so numerous updated maps are almost ready for release.

Computer programs were modified so that computer-drawn maps are more acceptable for publication. The programs will now manipulate gridded data to remove regional effects, and to calculate first and second derivatives and upward and downward continuations.

As a co-operative project with the Soviet Academy of Sciences absolute gravity was measured to a precision of 0.06 $\mu m.s^{-2}$ and an accuracy of 0.15 $\mu m.s^{-2}$ at Sydney, Port Moresby, Hobart, Alice Springs, Darwin, and Perth.

A comparison was made of the results of quartz-mechanism gravity meter calibrations on tilt tables, hillside calibration ranges, and level calibration ranges. The effect of altitude on the gravity meter was found to be $(2.5 \pm 0.5) 10^{-3}$ $\mu m.s^{-2} m^{-1}$.

A study of the subsurface shape of granites was made using aeromagnetic and gravity data. In the preferred model the granites have steep sides, and the density changes with depth.

Maps of earthquake risk, plate tectonics, free-air anomalies, and Bouguer anomalies over Australia and surrounding regions were produced with explanatory notes for the BMR Earth Sciences Atlas.

The palaeomagnetic sampling program was restricted to the Morowa Lavas (WA) to allow time for measurements on samples collected in earlier years. These measurements, while not all complete yet, suggest a tentative correlation of sequences in the Georgetown Inlier, a new mid-Carboniferous pole position, three distinct periods of dyke intrusion in Enderby Land (Antarctica), and two weathering periods at 15 and 30 m.y. B.P. in southeast Queensland. The data acquisition system for the ANU-BMR co-operative laboratory at Black Mountain was completed.

1. METALLIFEROUS AND AIRBORNE SECTION

(G.A. Young)

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

METALLIFEROUS SUBSECTION (D Stuart, J. Gardener, D. Tucker)

During 1979 most of the subsection's staff were engaged in studies of the geophysical characteristics of the Lachlan Fold Belt in NSW. A description of these activities is included in the annual summary of the Lachlan Fold Belt Geophysical Project, which forms a separate section of this report. The remaining personnel were engaged in methodological research into the use of magnetic, electrical, and nuclear methods in mineral exploration, and in regional geological studies.

Owing to a further reduction in staff numbers during the year a large backlog of data processing and reporting has built up. To ensure that adequate reporting of this data is achieved only limited new field and office studies will be undertaken in 1980.

Magnetic methods (I. Hone, P. Gidley, R. Curtis-Nuthall)

Development of carborne magnetometer. With the assistance of staff from the Interim Engineering Services Branch, a carborne magnetometer and digital acquisition system was developed for use by the Metalliferous Subsection. The carborne magnetometer has been used to gather high-resolution data in surveys designed to investigate the signature of magnetic sources in the Cobar region (see Lachlan Project report). The system is designed to use a Geometrics G803 proton-precession magnetometer.

Spectral analysis techniques. The use of spectral techniques in the analyses of the characteristics of magnetic sources was investigated by modelling and airborne, carborne and downhole magnetic surveys in the Cobar area, of NSW. Preparation of a paper on the results of this work is in progress.

Development of downhole magnetometer. The carborne magnetometer system was adapted for use as a downhole magnetometer using a specially designed probe and the BMR developed MFS-7 fluxgate magnetometer. This instrument is being used to investigate the magnetic properties of mineral deposits and other magnetic sources in the Cobar area of NSW.

Electrical Methods (B. Spies, J. Major, R. Cobcroft, J. Silic, I. Hone, R. Curtis-Nuthall)

Transient EM modelling. The Macquarie University modelling facility which is currently on loan to BMR has been used during 1979 to study design criteria for TEM instruments and to study the response of TEM systems to different geological targets. Particular studies include: an investigation of the effects of loop configuration and transmitter pulse shape; the response of one- and two-loop TEM systems to overburden and lateral conductivity changes; and the response of a variety of exploration targets including Elura. The results of much of this work has been submitted for publication in the BMR Journal and presented in BMR Record 79/43. Further model studies are in progress.

Development of interpretation aids. To assist in quantitative interpretation of TEM surveys, an analysis of the response of one-dimensional structures using numerical modelling techniques was carried out jointly with Dr Raiche of CSIRO Mineral Physics. The results of this work are in the form of algorithims and curves and have been submitted for publication in "Geophysics".

Que River test survey. A short experimental field survey was undertaken by BMR at the Que River deposit in Tasmania during March. Dr Buselli of CSIRO assisted in this work, which was designed to study the performance of the SIROTEM instrument in an area where abnormal SIROTEM results had been obtained. The results indicate that strong negative transients observed at early delay times in this area are the result of large signals arising from zones of high conductivity. It appears that these spurious signals can be removed by increasing the input impedance of the receiver.

Development of 3-component downhole EM probe. Construction was completed of a prototype 3-component downhole probe designed to investigate the use of downhole EM methods in the exploration for deeply buried targets. Preliminary field tests were conducted in the Cobar area. Processing and analysis of the results is continuing.

Development of high-sensitivity receiver. To assist in experimental studies of the EM and electrical response of geological targets, a high-sensitivity analogue receiver has been designed around commercially available components. The receiver will have a phase and amplitude precision sufficient for complex resistivity measurements. Preliminary field surveys are expected to be conducted during 1980.

Magneto-resistivity. A theoretical study of the use of magneto-resistivity and MIP methods to search for three-dimensional conductors under a conductive overburden has been prepared for submission to the ASEG Bulletin. The results of this study indicate that the magneto-resistivity method has a limited effectiveness to detect small conductive targets.

USSR/Australia Science Agreement. During September to November, B. Spies visited geoscience institutes in the USSR as part of the USSR/Australia Science Agreement, to exchange information on the use of electrical methods in mineral and petroleum exploration.

AMF Workshop on Electrical Methods. J. Major prepared and presented a substantial quantity of course material dealing with the use of EM modelling in the interpretation and design of EM surveys at the AMF EM and Electrical Workshop in Adelaide during October. This work has been reproduced in volume 1 of the lecture notes for the workshop.

Nuclear Methods (A. Mutton, A. Warnes, S. Wilcox)

During 1979 work continued on a study of the use of alpha-particle and gamma-ray detectors in radioelement exploration. This work is still in progress.

Radon method study. Field studies of the radon concentration of rocks and soils were conducted in the Dalgety area of NSW and commenced in the Rum Jungle and Alligator Rivers areas of NT in July 1979. At Dalgety attention was directed towards a study of the sensitivity of various alpha detectors to the radioelement concentration of surface rocks and the effects of meterological changes. In the Rum Jungle and Alligator Rivers area attention was directed towards investigating the source and transport of radon anomalies using surface and downhole gamma-ray spectrometry. This work included a study of the radioelement and radon distribution around uranium mines and prospects.

Radioelement concentration of surface rocks in the Pine Creek Geosyncline. The radioelement concentration in bedrock and soils for various rock units in the Pine Creek Geosyncline was investigated by a program of surface and downhole gamma-spectrometry in the Rum Jungle and Alligator Rivers area. Preliminary results indicate a good correlation between the radioelement concentration in fresh bedrock and overlying weathered rocks and soils.

Downhole gamma-ray spectrometry. The use of downhole gamma-ray spectrometry in uranium exploration was investigated by a program of drilling and downhole and surface gamma-spectrometry in the Rum Jungle and Alligator Rivers area.

Calibration ranges for airborne gamma-spectrometry. A program of experimental flying, ground surveys, and sampling was conducted in the Dalgety and Dubbo areas of NSW with a view to establishing test ranges for the calibration of airborne gamma-ray spectrometers. This work is described in the annual summary of the Airborne Subsection.

Rock property measurements (I. Hone, V. Canberry, H. Reith)

With the assistance of the rock properties group of the Regional Subsection, a major program of rock property measurements was undertaken by metalliferous staff to assist various projects under way in the group. Principal measurements include wet and dry density, susceptibility, remanence, resistivity, and chargeability.

LACHLAN FOLD BELT GEOPHYSICAL PROJECT

Project Co-ordinator: D. Stuart

During 1979 a number of new and ongoing geophysical investigations in the Lachlan Fold Belt were drawn together into one project to study the geophysics of the region. The project aims are to establish a framework for understanding the geophysical response of the crustal and surface geology of the region, including its mineralised domains and mineral deposits. The establishment of this framework is intended to permit better use of the large BMR regional geophysical data bank covering this region and assist in the use of geophysics for exploration in the region.

In 1979 work was concentrated in the NSW section of the Fold Belt and employed personnel drawn from the Metalliferous, Airborne, Crustal, and Gravity groups of the Geophysical Branch, and personnel from the Geological Branch and the Geological Survey of NSW. The co-operation of many mining and exploration companies working in the Fold Belt is also acknowledged. Studies of the geophysical data in the NSW section of the Fold Belt are planned to conclude in mid 1981.

Owing to the scale of this project much of the work carried out during 1979 was of a data gathering nature, and processing and reporting on the work will not be well advanced until mid 1980. Additionally the continued loss of staff has resulted in a reduction in the rate of data processing and reporting. To ensure that adequate staff are available for the more regional aspects of the project, work on the mineralised domain and mineral deposit geophysics elements of the project will be scaled down in 1980.

REGIONAL GEOPHYSICAL MAPPING

Airborne surveys (B. Wyatt, N. Sheard, A. Mutton, S. Wilcox)

A program of regional airborne geophysics was undertaken during 1979 to assist in the completion of the airborne geophysical coverage of the region. In north-central NSW flying of the DUBBO, GILGANDRA, and NYNGAN 1:250 000 Sheet areas was completed in the period May to mid-August. Flying was at a nominal ground clearance of 150 m with east-west flight-lines spaced 1.5 km apart. Preliminary results of this work in the form of profiles will become progressively available from the end of 1979. Publication of the final results of this work as maps is expected after mid-1980. Other flying included the completion of the MALLACOOTA and WARBURTON 1:250 000 Sheet areas in Victoria. A further description of airborne surveys in the Lachlan Fold Belt is included in the Airborne Subsection annual summary.

Gravity traverses (J. Connelly)

A program of gravity traverses along roads and tracks in the southeast of NSW between Canberra, Cooma, and Merimbula, and along a traverse from Stockinbingal via Temora to Ardlethan, was undertaken to define better the gravity anomalies associated with granitoid structures in these areas. Station spacing was mostly 1 km, but was 2 km on some traverses. In all about 1100 new gravity stations were occupied. The results of this work will be included in the Australian gravity data net maintained by BMR. A further description of this program of gravity traversing is included in the Regional Geophysics Subsection annual summary.

CRUSTAL STUDIES (D. Denham, D. Finlayson)

Further investigation of the crustal structure of the region using seismic methods was undertaken this year. During November to December 1978, recordings were made of quarry blasts at South Marulan, Singleton, and Newcastle along lines joining these places. During April 1979, a seismic reflection survey was conducted at Gundary Plains near Goulburn to supplement data collected during 1978. Interpretation of these and previous seismic surveys of the fold belt continued during 1979. Papers were prepared on the results of crustal seismic investigations along lines from Dartmouth (Vic)-Marulan, Dartmouth-Condoblin, Dartmouth-Dubbo, and Dartmouth-Merimbula.

During February, BMR, in conjunction with the Geology Department of ANU and the Geological Society of Australia, sponsored a symposium on the Crust and Upper Mantle of SE Australia. The objectives of this symposium were to study the chemistry, structure, and tectonic development of the crust and upper mantle in southeast Australia.

Further details of the crustal studies program and results of investigations are discussed in the annual summary of activities for the Regional Geophysics Subsection.

FIELD INVESTIGATION OF REGIONAL GEOPHYSICS (D. Tucker, A. Yeates, B. Wyatt, V. Carberry, A. Retter, E. Chudyk)

In 1979 an investigation of the sources of regional geophysical anomalies in NSW was undertaken using airborne geophysical transects across the Fold Belt, field surveys, rock sampling, physical property measurements, and geological observations. During the course of this work, assistance was received from the New South Wales Geological Survey in carrying out some field work and providing geological information on the Fold Belt.

Airborne transects

Three multiple-height airborne geophysical traverses were flown across the Fold Belt along latitudes 31°32'S, 34°3'S, and 35°5.3'S (see Figure MA-1) as described in table MA-1. Total magnetic intensity data were recorded along all traverses and four-channel gamma-ray spectrometer data were recorded along the low-level traverses. Reduction of these data is in progress.

Latitude	Longitude	Distance (km)	Altitude
31°32'S	144°E to 150°E	570	150 agl 915 asl
34°31'S	142°E to 151°E	850	120 agl 1220 asl 3050 asl
35°5.3'S	144°E to 151°30'E	700	120 agl 915 asl 3050 asl

Table MA-1 - Description of Airborne Transects, Lachlan Fold Belt

The high-level magnetic data will be used in conjunction with Bouguer anomaly data to assist in the study of the crustal structure of the Fold Belt. The low-level magnetic and radiometric data will be used to investigate the geophysical characteristics of the near-surface geology of the region.

Geophysical surveys, rock sampling and physical property measurements

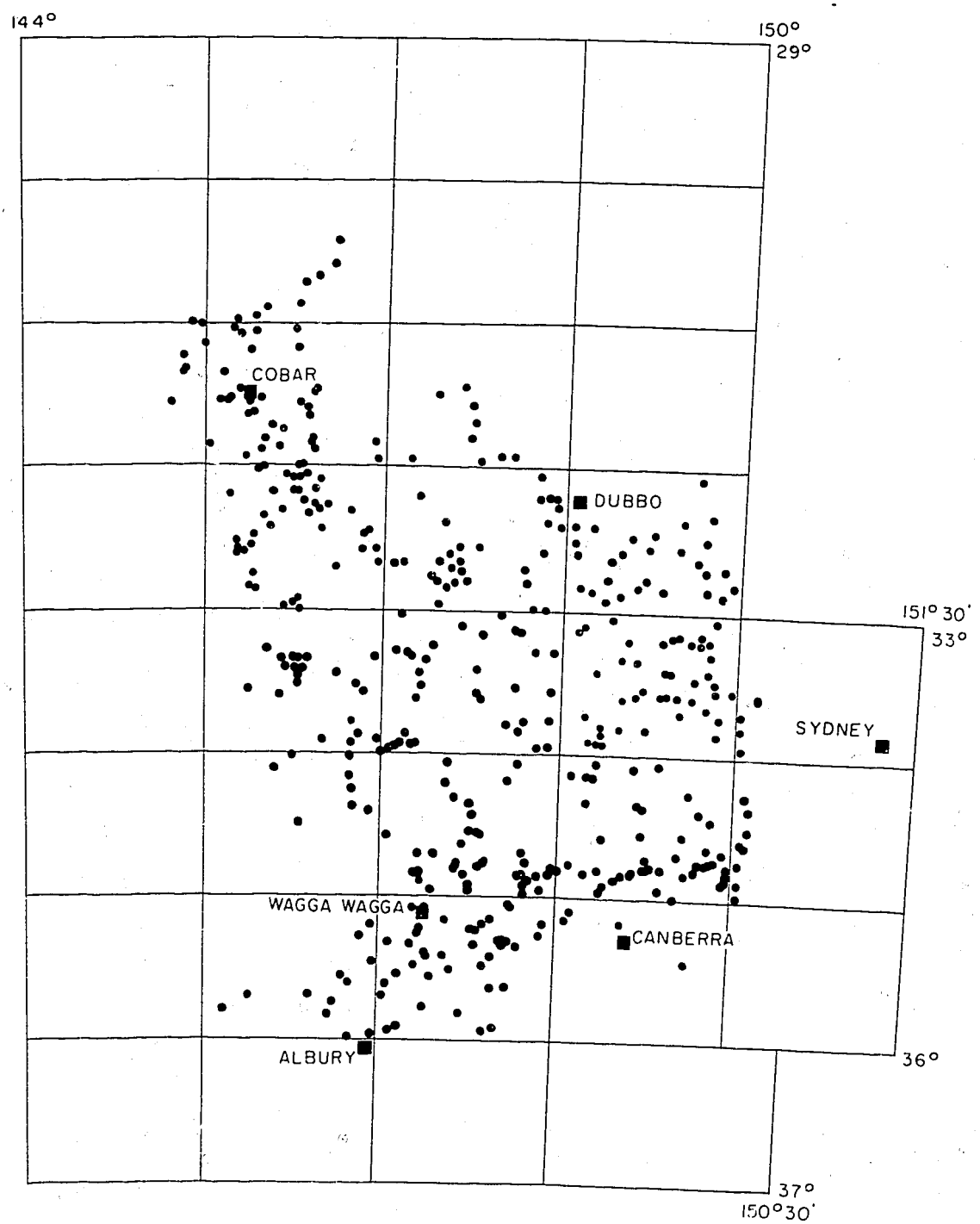
To assist in understanding the source of regional magnetic and gravity features, and to establish the geophysical characteristics of the rock units of the Fold Belt, a program of geophysical surveys, geological observation, and rock sampling was undertaken at selected sites throughout the Fold Belt in NSW.

Over 900 sites will be investigated during 1979 in a program involving helicopter and vehicle support. The location of the majority of these sites is indicated in Figure MA-2. At each site, in situ measurements of magnetic properties and radioelement concentration were made, and rock samples were collected for subsequent physical property measurements in the BMR laboratories and geological/mineragraphic analyses at AMDEL. Laboratory measurements include density, magnetic susceptibility, remanent magnetisation, grain density analyses, and transparent and opaque mineralogy.

REVIEW AND INTERPRETATION OF REGIONAL GEOPHYSICS (D. Tucker, A. Yeates, B. Wyatt)

A review of the geophysical and geological data from the Fold Belt in NSW reveals large-scale geophysical domains which can be correlated with features observed in the surface geology. On a more detailed scale individual magnetic and gravity features can frequently be associated with defined lithologies or structures. A detailed account of this study will be presented as a paper to the Annual Symposium of the Geological Society of Australia in Hobart, January 1980.

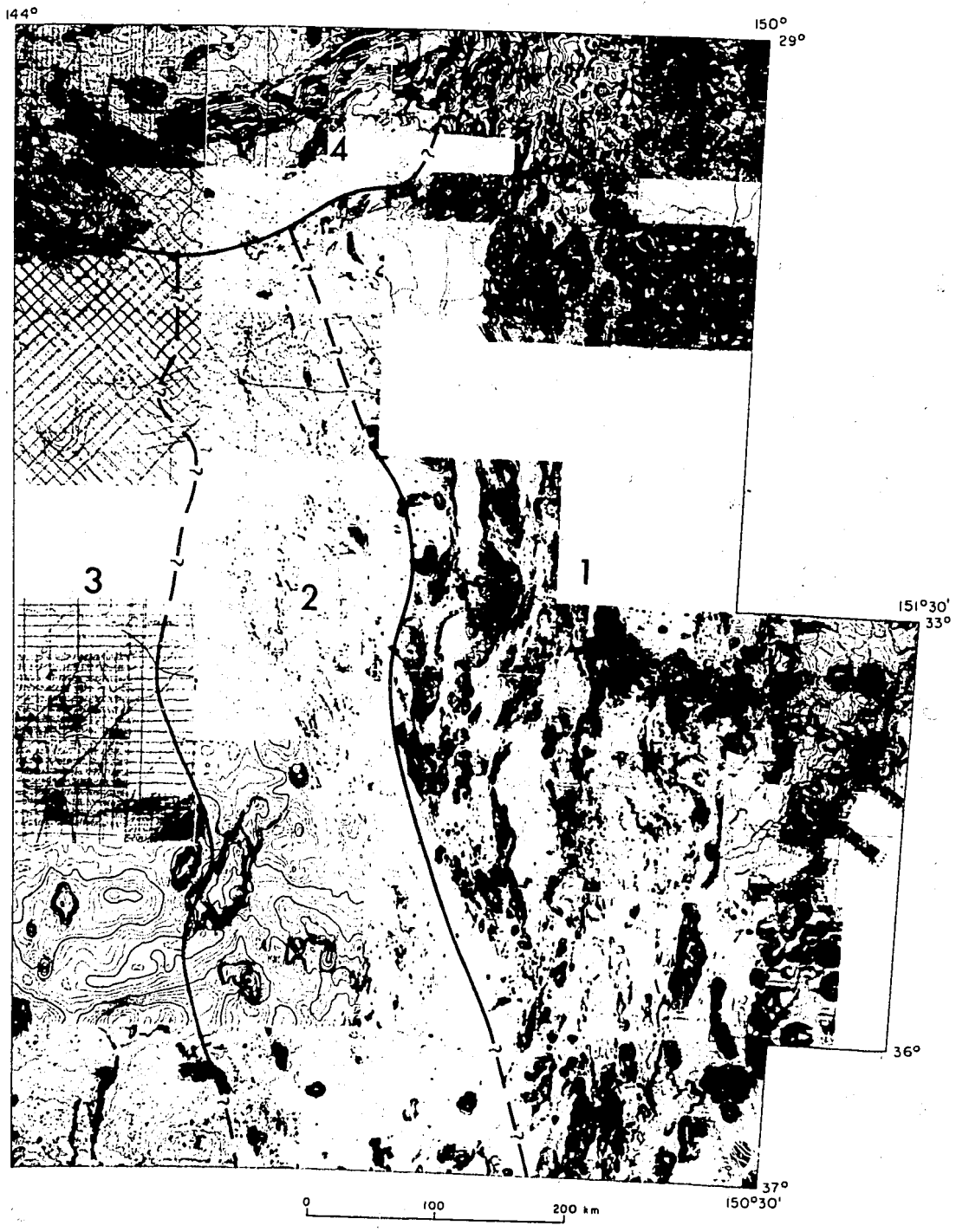
MA-2



Sample sites - Lachlan Fold Belt Geophysical Project

Record No. 1979/73

N/B7-1A



TOTAL MAGNETIC INTENSITY CONTOURS

GEOPHYSICAL DOMAINS IN THE LACHLAN FOLD BELT NSW

Record No 1979/73

N/81-5A

Geophysical domains

An examination of BMR regional magnetic and gravity data shows four broad geophysical domains defined on the basis of anomaly character. The outline of these domains is indicated in Figure MA-3.

Domain 1: Domain 1 covers the eastern part of the Fold Belt and is characterised by a complex pattern of curvilinear, predominantly north-trending Bouguer anomaly features, and intense, short-wavelength magnetic anomalies. Many of the magnetic anomalies and Bouguer anomaly features coincide.

As indicated in Figure MA-3 this domain extends beyond the area of outcrop of Lachlan Fold Belt rocks northwards into the Great Artesian Basin and eastwards into the Sydney Basin. The extensions of this domain to the east and north indicates Lachlan Fold Belt rocks to be the basement for these basins.

Domain 2: Domain 2 is a northwesterly trending zone lying between domain 1 and the western extent of Lachlan Fold Belt rocks to the west. Trend directions of magnetic and gravity features in this zone are more westerly than in domain 1 and the eastern margin of the domain is sharply defined in the magnetic data as a decrease in the amplitude, size, and frequency of anomalies. Similarly, gravity features are less complex than those in domain 2.

Domain 3: Domain 3 lies to the west of the area of outcrop of Lachlan Fold Belt rocks over sediments of the Murray-Darling Basin. The domain is characterised by a change in Bouguer anomaly trends to a markedly northeast direction. The magnetic pattern for this domain is not well defined owing to the limited amount and poor quality of the data. However, the few magnetic anomalies present are broad and suggest deep sources.

Domain 4: Domain 4 forms a boundary with the northern extent of domains 1, 2, and 3. It is characterised by arcuate, predominantly east-west magnetic and gravity features. The geological significance of this domain is not clear but it appears to indicate a change in basement geology.

Geological associations with geophysical domains

A comparison of magnetic and gravity data with the geology of the Fold Belt indicates that many of the geophysical features are related to geological sources which can be identified by surface mapping.

The boundary between the Darling Basin and the Lachlan Fold Belt is taken to approximate the onset of the considerable thickness of conformable fossiliferous and mainly marine, Lower to Upper Devonian, intercalated shales and quartzose sandstones. This boundary coincides fairly closely with the boundary between domains 2 and 3.

The boundary between domains 1 and 2 coincides with a marked geological change. East of this boundary is an area of closely spaced, shallow, marine to terrestial Silurian to Lower Devonian volcanic rises which constitute an abundance of lavas and pyroclastics, many of which are strongly magnetic. West of the boundary, rocks trend more westerly and are characterised by great thicknesses of non-magnetic tuffaceous sediments and a few, widely scattered volcanic rises.

A study of granitic plutons reveals wide variation in magnetic susceptibility, density, and radioelement concentration. This variation appears to be associated with observed changes in the texture and mineralogy of the plutons. On a broad scale granites in domain 2 are more potassic and aluminous than those in domain 1. A factor which seems to control the gravity response of the plutonic bodies is the different degrees of metamorphism of the sedimentary and volcanic rocks in domains 1 and 2. Sedimentary rocks in domain 2 appear to be more micaceous than those in the east and accordingly have a higher density.

Sources and characteristics of magnetic features

Ground magnetic traverses and in situ magnetic susceptibility measurements show that the sources of magnetic anomalies are mostly igneous rocks including andesites, ignimbrites, basalts, and granites. Many of these rocks crop out and are magnetic at the surface. Short-wavelength anomalies also occur over steeply dipping, particularly Ordovician, sediments but in general these sediments are not magnetic at the surface.

MINERALISED DOMAIN STUDIES (P. Wilkes, P. Gidley, I. Hone, V. Carberry)

This element of the project is intended to document the geophysical characteristics and physical properties of important mineral provinces in the Fold Belt. In 1979 work continued on a study of the geophysics of the Cobar area. Plans to extend this work to other mineral provinces of the Fold Belt have been deferred owing to loss of staff during the year. A review of this work was given in a paper presented at the 8th BMR Symposium in May 1979.

Physical properties of rocks in the Cobar area

A program of rock sampling and laboratory measurements was carried out to investigate the physical properties of rocks in the Cobar area. Analysis of samples is still continuing.

Although the number of samples measured to date is small and more drill-core samples are required, it appears that density increases with geological age. The magnetic data suggest that the susceptibility of rocks in the Cobar area is generally low, the maximum susceptibility reflects an apparent magnetite content of less than 0.1%. However, the data do suggest that the argillaceous sediments are generally more magnetic than the arenites.

The source of a magnetic anomaly associated with the CSA siltstone north of Cobar was drilled by BMR to investigate its magnetic properties. The results of magnetic measurements on samples from this hole are summarised in Table MA-2 and indicate the anomaly results from high intensity remanent magnetisation beneath the weathered zone.

Depth (m)	Susceptibility ($\times 10^{-6}$ cgs) range	Mean	Remanence ($\times 10^{-6}$ cgs) Range	Mean	Koenigsberger ratio Range	Mean	Comments
0-97	2-75	15 (749)	0.1-10.2	3.6 (18)	0.02-2.1	0.76 (18)	weathered zone
97-147.5	12-175	62 (409)	1.7-402.5	165.4 (13)	0.19-15.1	6.2 (13)	fresh zone

( ) = no. of samples

TABLE: MA-2 Magnetic properties of hole north of Cobar

Airborne surveys

To assist in the investigation of the structure and lithological characteristics of the Cobar region, a series of airborne magnetic and radiometric traverses up to 100 km long were made across the area at an altitude of 90 m and a line space of approximately 20 km. Interpretation of the magnetic results from this survey is still in progress.

Geophysical modelling of the Cobar Trough

An interpretation of the structure of the Cobar Trough using regional magnetic and gravity data is in progress. The interpretation is based on the rock property measurements which suggest a substantial density contrast between Ordovician basement and the sediments of the trough. Magnetic sources in the basement are being used as a depth control to calibrate the gravity modelling. Preliminary results of this modelling indicate two basins in the Cobar area. The most pronounced is centred 10 km west of Cobar and may be up to 5 km in depth. This basin strikes northeast, and has a steep slope on the east and a gentle slope on the west. A more gently sloping and symmetrical basin of about 2.5 km depth is indicated to be centred about 100 km west-southwest of Cobar. In between these basins the basement appears to be quite shallow forming local rises.

MINERAL DEPOSIT GEOPHYSICS (P. Wilkes, P. Gidley, I. Hone, B. Spies)

Work continued on a study of the geophysical characteristics of mineral deposits in the Cobar area. During 1979 further physical property measurements were made on material collected from mineral deposits and host rocks, and magnetic and electrical surveys were conducted at Elura. A review of the mineral deposit geophysics undertaken by BMR during 1978 was given in a paper presented at the 8th BMR Symposium in May 1979.

Physical property studies

The physical properties of the gossan and weathered zone at the Elura deposit were investigated by BMR drilling and logging, including downhole resistivity, EM, magnetics, and magneto-resistivity. The results of this work are still being processed. Further samples were collected from the Elura deposit and the CSA mine for electrical and magnetic physical property measurements.

EM model studies

A program of model studies was undertaken on the Macquarie University analogue modelling facility to investigate the EM response of mineral deposits and host rocks in the Cobar area.

The work indicates the high sensitivity of slingram configuration systems to changes in the conductance of the overburden and suggests that the conductive overburden in the Cobar area will strongly attenuate anomalies due to bedrock conductors. The modelling suggests that under optimum conditions a one-loop TEM system will detect an Elura type target as an anomaly of approximately 2 to 3 times background. The results of this work have been submitted for publication in the BMR Journal.

EM test surveys

Test surveys with different EM systems were conducted at Elura during 1979. This work included downhole EM surveys by BMR and by BMR in conjunction with CSIRO, and assistance to Newmont Pty Ltd in the planning and execution of an experimental EMP survey. The results of the EMP work will be reported on by Newmont with some assistance from BMR. The results of the downhole surveys are still being analysed.

RESEARCH AND DEVELOPMENT

A number of research projects were undertaken with a view to solving some particular problems facing the use of geophysics in the Fold Belt.

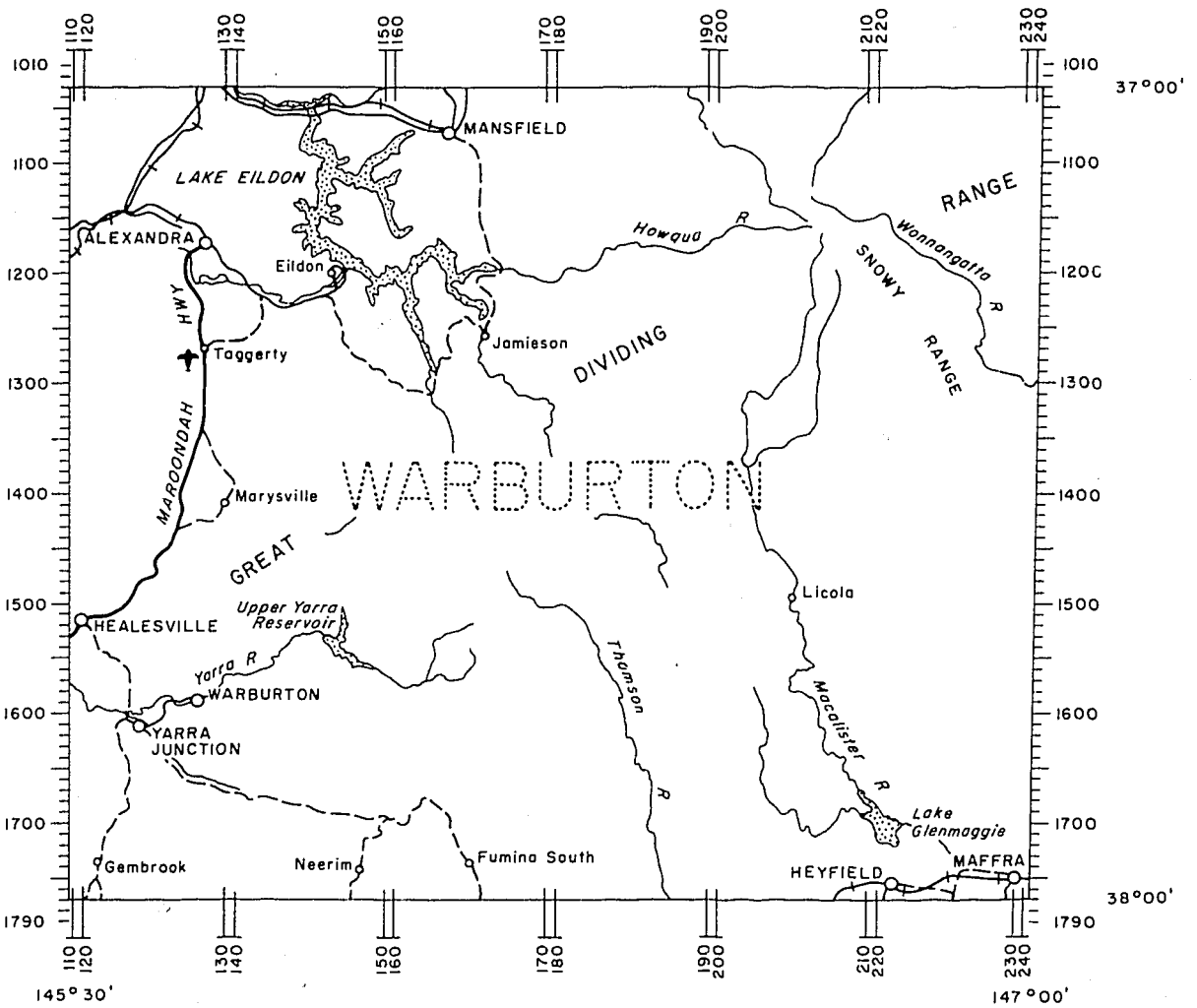
Discrimination of surficial and bedrock magnetic sources (P. Gidley, P. Wilkes)

The characteristics of magnetic sources in the Cobar area were investigated with a view to establishing survey and interpretation techniques to assist in the discrimination of surficial and bedrock magnetic sources. This work included detailed, high-resolution airborne, carborne and in-hole magnetic surveys, sampling, rock property measurements, and modelling. The results of this work show that remanent magnetisation is a major factor controlling the shape and amplitude of surficial sources, and suggest that spectral techniques of depth estimation can frequently discriminate between surficial and bedrock sources.

Electrical methods (B. Spies, J. Silic, J. Major, I. Hone)

A theoretical study of the application of complex resistivity and magnetometric resistivity methods to the search for bedrock conductors beneath a conductive overburden was undertaken during 1979. The results show that EM coupling problems will severely restrict the interpretation of complex resistivity surveys in areas of high-conductance overburden. The magnetometric-resistivity method has a capability for mapping purposes, but is very limited in its ability to detect small targets beneath a conductive cover.

Papers dealing with the research into complex resistivity and magneto-resistivity/MIP methods have been prepared for submission to "Geophysics" and the ASEG Bulletin.



AIRBORNE SURVEY, WARBURTON, VIC 1977

LOCALITY MAP

AND

FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60 KILOMETRES

LOCALITY DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

BENDIGO	WANGARATTA	TALLANGATTA
MELBOURNE	**WARBURTON**	BAIRNSDALE
QUEENSCLIFF	WARRAGUL	SALE

Record No. 1977/46, 1979/73

J55/B1-53-1A

Experimental airborne survey, Lithgow (J. Rees, J. Silic)

An experimental survey of the western coalfields district of the Sydney Basin was carried out jointly with CSIRO in March. The work was designed to investigate whether basement fracture patterns which are important for coalfield development can be detected by aeromagnetics. Maps have been prepared and interpretation is continuing. Further details are included in the Airborne Subsection annual summary.

AIRBORNE SUBSECTION (R. Wells, C. Leary, J. Rees, J. Mulder)

During 1979 Airborne Subsection flew approximately 70 000 line-km of survey traverse with the Twin Otter aircraft VH-BMG. The Bureau's other survey aircraft (Aero Commander VH-BMR) had been withdrawn from service in September 1978 because of a reduction in operational funding. It was planned that the Aero Commander would be returned to active service in mid 1979; however, staff losses in the first half of 1979 made this impracticable. Most of the Subsection's depleted staff were required for data processing during the year. This resulted in the release of 104 maps (Table MA-3).

Warburton-Mallacoota airborne magnetic surveys 1979 (S.N. Sheard, G. Green, E. Chudyk, S.J. Wilcox)

The airborne survey of WARBURTON 1:250 000 Sheet area (Figure MA-4) was commenced in October 1977 and was scheduled for completion in 1978. Owing to the withdrawal of the Aero Commander aircraft from service the survey was not completed until April 1979, when 6000 line-km was flown using the Twin Otter aircraft. The survey consisted of east-west lines flown 1.5 km apart at an altitude of 1800 m above sea level.

The airborne survey of MALLACOOTA 1:250 000 Sheet area was completed in 1977, but it was found that some fill-in and refly lines were required to complete the data processing satisfactorily. This survey flying was also undertaken in April 1979, when 1600 line-km was flown in an east-west configuration at 1650 m above sea level.

It is expected that final maps displaying the results of these surveys will be released through the Australian Government Printer (Copy Service) early in 1980.

Western coalfields project (J. Rees, J. Silic).

In early 1979, BMR in conjunction with CSIRO commenced a project to evaluate the use of airborne magnetic and remote sensing methods to delineate basement features and relate them to structures observed in the coal measures over portion of the Western Coalfields area in NSW.

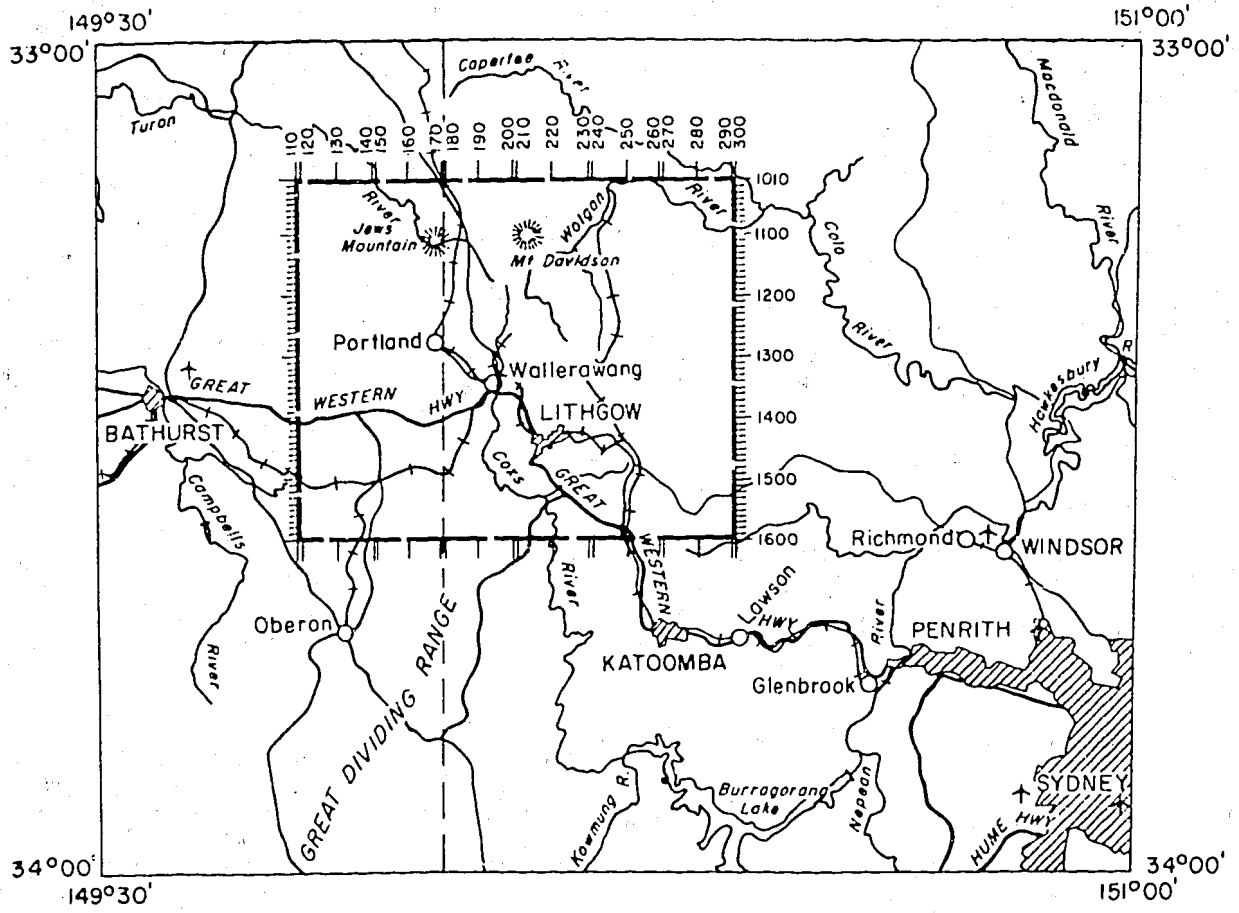
Phase 1 of the project constituted an aeromagnetic survey of 3500 line-km flown by BMR at 1450 m above sea level along E-W lines 1 km apart in the period 26 February to 12 March (Fig. MA-5). Phase 2 involved preliminary processing and mapping, which was completed by BMR in June. CSIRO attended to phase 3, which involved oriented sample collection for rock property determinations, drilling two holes through to basement, and ground work including magnetic traverses and geological mapping.

The final phase, involving staff from both organisations, commenced in October with aerial photography, satellite imagery, magnetic data, and surface and underground geology, analysed to determine to what extent bad roof areas in coal mines (which are related to linear fracture zones in basin sediments) correlate with underlying (magnetic) basement features. A report of the findings is expected to become available early in 1980.

Dubbo, Nyngan, Gilgandra airborne magnetic and spectrometer survey, NSW 1979 (S.N. Sheard, B. Wyatt, A. Mutton, G. Green, J. Eurell, S.J. Wilcox)

At the request of the NSW Geological Survey, a regional airborne magnetic and spectrometer survey totalling approximately 40 000 line-km was flown of the 1:250 000 Sheet areas GILGANDRA, DUBBO, and NYNGAN during the period May to mid-August (Figs. MA-6 to 8).

The survey was flown at 150 m above ground level along east-west flight-lines, 1.5 km apart. Double tie-lines were flown north-south every 15 minutes from the sheet boundaries.

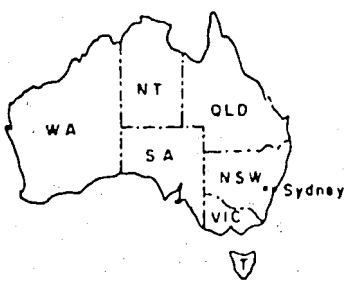


AIRBORNE SURVEY, LITHGOW, NSW 1979

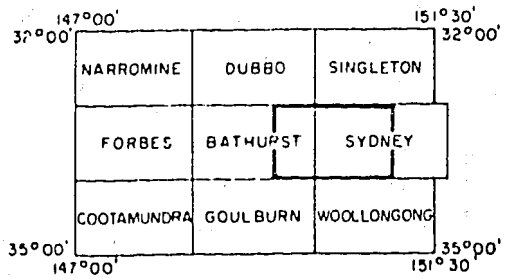
LOCALITY MAP
AND
FLIGHT – LINE SYSTEM

0 10 20 30 40 50 60 KILOMETRES

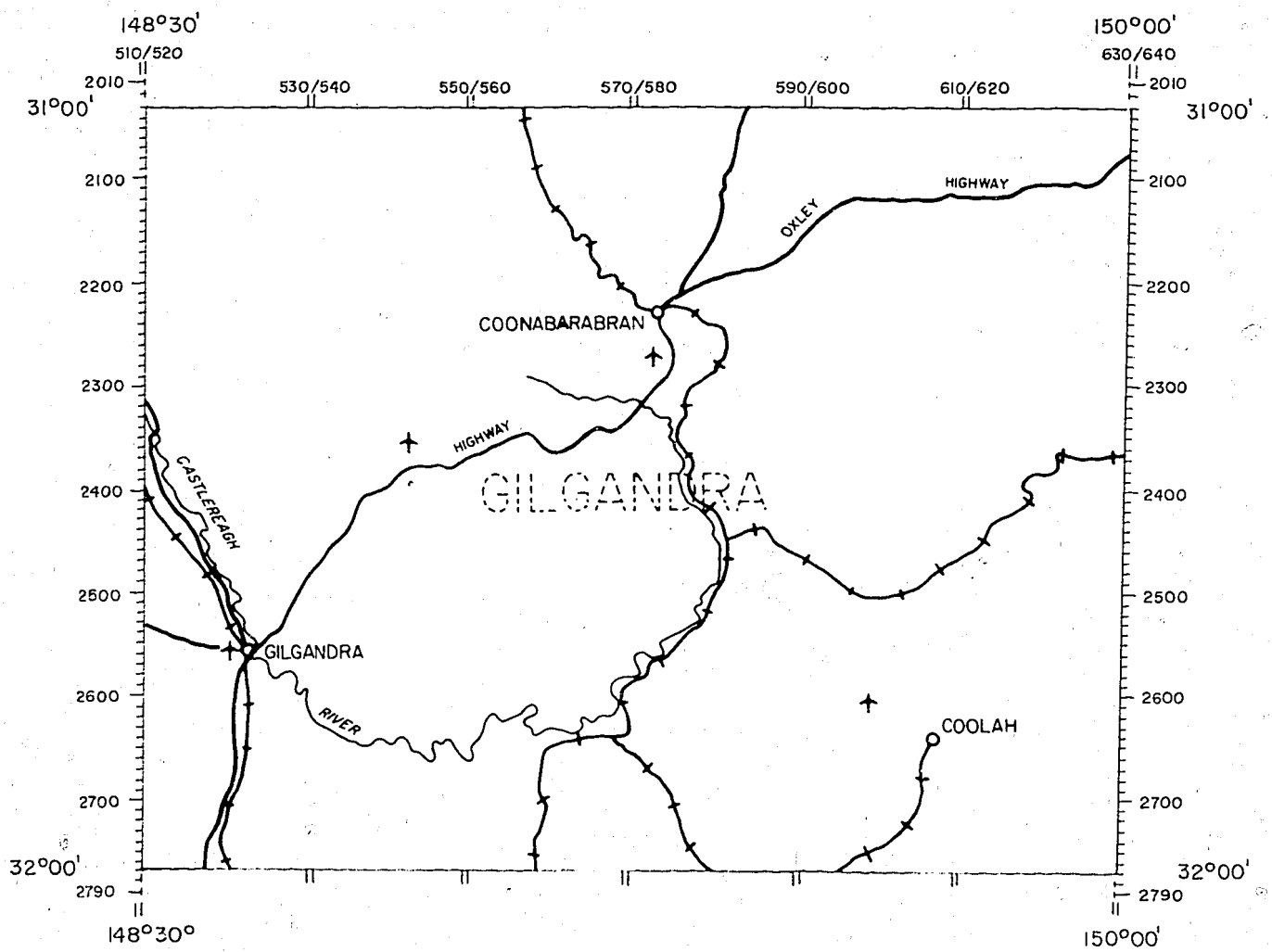
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES



MA 6



AIRBORNE SURVEY, GILGANDRA, NSW 1979

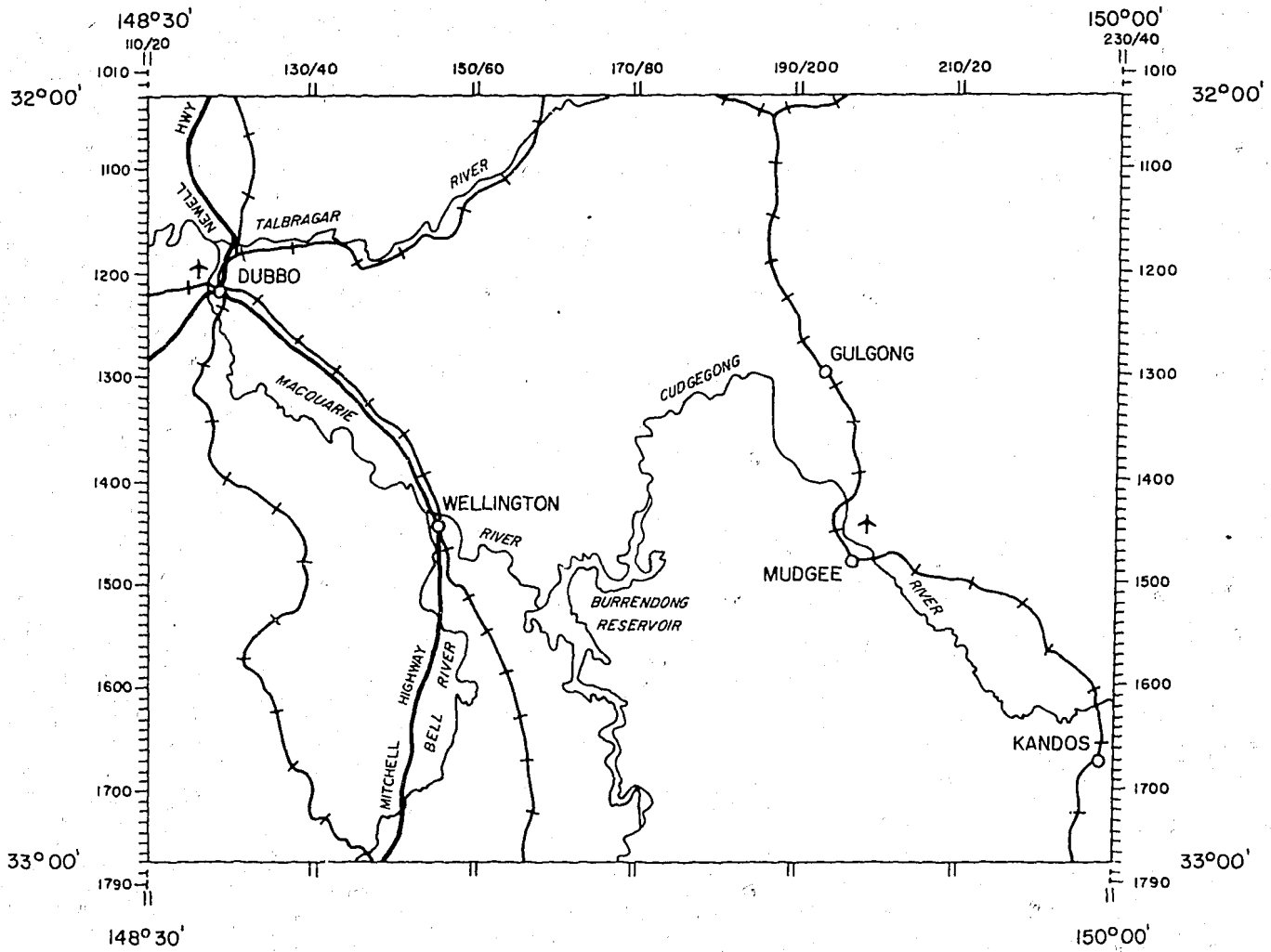
LOCALITY MAP AND FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60km

WALGETT	NARRABRI	MANILLA
NYNGAN	GILGANDRA	TAMWORTH
NARROMINE	DUBBO	SINGLETON

Record No. 1979/73

H55/BI-40A

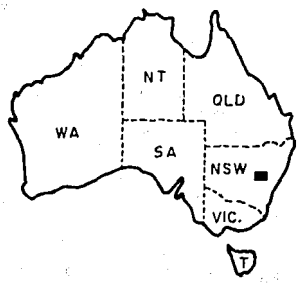


AIRBORNE SURVEY, DUBBO, N S W 1979

LOCALITY MAP
AND
FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60 km

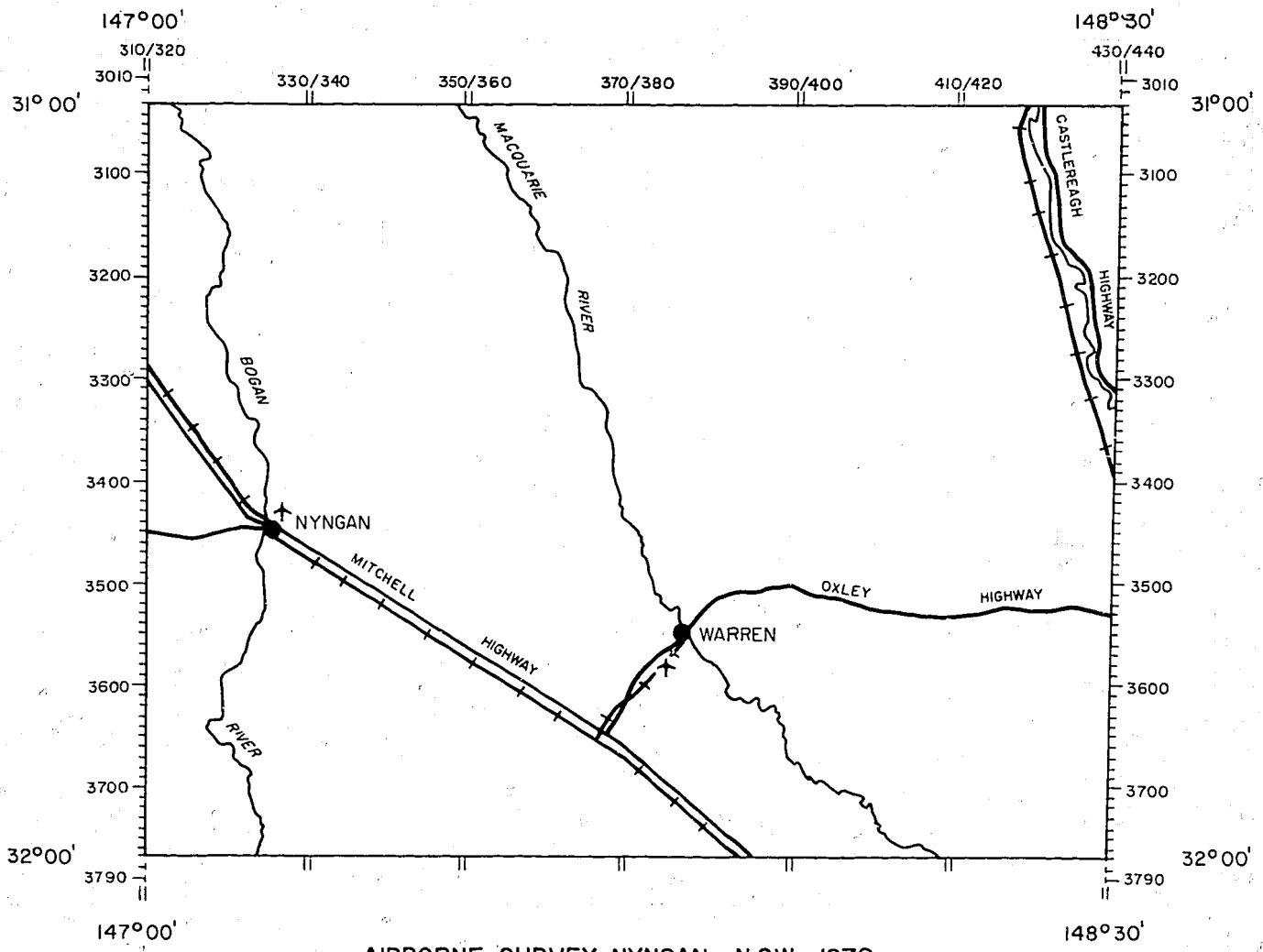
LOCATION DIAGRAM



REFERENCE TO 1:250000 MAP SERIES

NYNGAN	GILGANDRA	TAMWORTH
NARROMINE	DUBBO	SINGLETON
FORBES	BATHURST	SYDNEY

MA 8

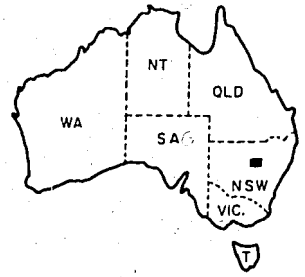


AIRBORNE SURVEY, NYNGAN, N S W 1979

LOCALITY MAP
AND
FLIGHT-LINE SYSTEM

10 0 10 20 30 40 50 60 km

LOCATION DIAGRAM

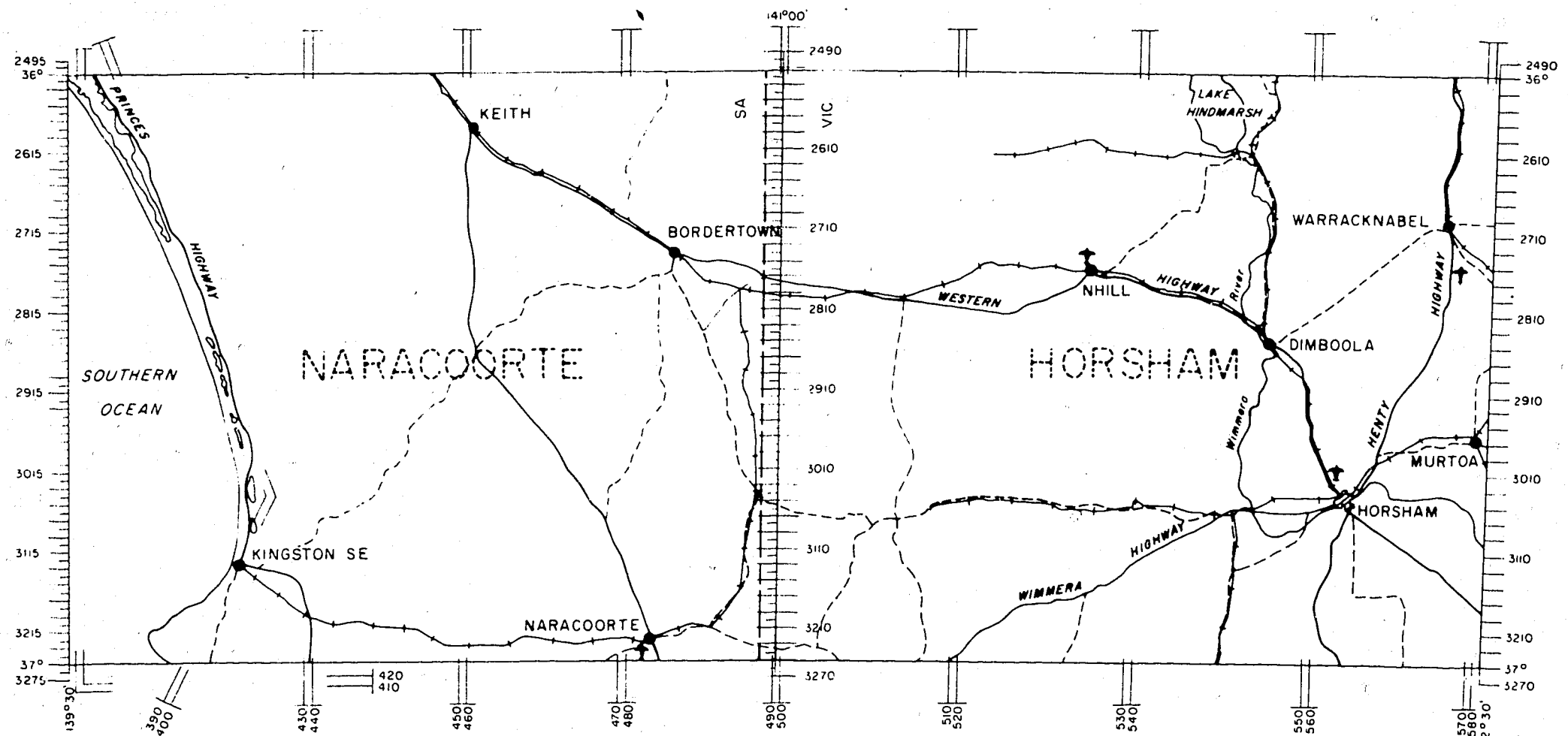


REFERENCE TO 1:250000 MAP SERIES

BOURKE	WALGETT	NARRABRI
COBAR	NYNGAN	GILGANDRA
NYMAGEE	NARROMINE	DUBBO

Record No 1979/73

H55/B1-39A



AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE

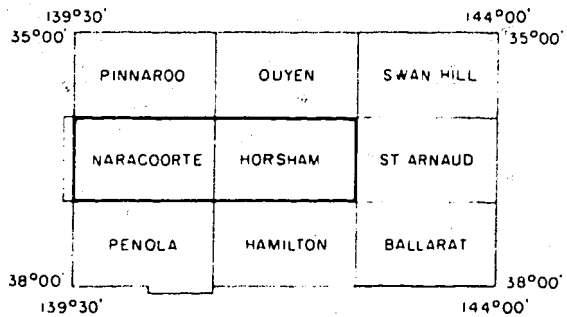
(NARACOORTE, HORSHAM) SA and Vic. 1979

LOCALITY MAP AND FLIGHT LINE SYSTEM

LOCALITY DIAGRAM

KILOMETRES 10 0 10 20 30 40 50

REFERENCE TO 1 250 000 MAP SERIES



MA 9

The Twin Otter aircraft, VH-BMG, equipped with a fluxgate magnetometer, a 4-channel spectrometer system, a digital acquisition system, and a Doppler navigation system, was used for the survey. The gamma-ray spectrometer detector assembly of four 6" x 4" cylindrical sodium iodide crystals (7410 cm^3) was replaced after completion of the GILGANDRA Sheet in early June by a new crystal slab (17 000 cm^3).

Processing of survey data commenced in late 1979, and preliminary release of survey results is programmed for the latter half of 1980. The data will be used to assist in determining the characteristics of the geological formations of the Lachlan Geosyncline.

Adelaide Geosyncline airborne magnetic and spectrometer survey, Vic.-SA 1979 (K. Horsfall, N. Sampath, G. Green, E. Chudyk)

At the request of the South Australian Department of Mines and the Victorian Department of Mines and Energy a regional airborne magnetic and spectrometer survey totalling approximately 19 000 line-km was flown of the HORSHAM and NARACOORTE 1:250 000 Sheet areas from Horsham during the period September to November (Fig. MA-9).

The Twin Otter aircraft, VH-BMG, which is equipped with a fluxgate magnetometer and a 4-channel spectrometer system, was used on the survey. It was flown at an average height of 150 m above ground level along flight-lines bearing east-west. These lines were spread 3.0 km apart in the HORSHAM Sheet area and 1.5 km apart in the NARACOORTE Sheet area. A Doppler system was used to aid navigation and flight path recovery. All data were digitally recorded.

Processing of the survey data will commence in 1980 and preliminary release of survey results will be made as they become available.

Airborne gamma-ray spectrometer calibration facilities (J. Rees, A. Mutton, J. Mulder, B. Warnes, B. Wyatt, N. Shear).

BMR has continued its program to establish dynamic test range facilities for the calibration and testing of airborne gamma-ray spectrometer (radiometric) equipment.

The Dalgety test area, south of Dalgety, NSW, was surveyed on the ground in 1978 using spectrometer and radon techniques. Rock and soil samples from the Dalgety dynamic calibration strip were analysed for potassium, uranium, and thorium at AMDEL. Detailed airborne spectrometer surveying at various heights was completed in 1979. A report will be prepared in early 1980 providing all information pertinent to this calibration strip.

Traverses were flown over 30 small trachyte outcrops located approximately 20 km south of Dubbo, NSW. These outcrops exhibit anomalous radioactivity and variations in the relative proportion of K, U, and Th from outcrop to outcrop. A detailed airborne survey of Plenns Deposit, south of Dubbo, has been completed. Soil and rock sampling will be completed in 1979.

Calibration of dynamic test lines at survey bases was completed for Gove and Renmark and commenced for Dubbo and Horsham. It is intended to set up and document such test lines in most areas surveyed by BMR in the next few years.

A complete set of calibration sources was purchased to assist quality control procedures in survey operations.

Officer Basin aeromagnetic survey, WA, 1975-1978 (N. Sheard)

This project, which covered seventeen 1:250 000 Sheet areas in the far east of Western Australia, was flown under contract to BMR in the period late 1975 to mid 1978. BMR's final processing of data provided by the contractor to the map production stage has been under way systematically since 1976. This has enabled data displays in profile and contour form at 1:250 000 scale to be released progressively through the Australian Government Printer (Copy Service) throughout the period of the project, with the last map FORREST released in October 1979. A complete series of the contour maps at 1:1 million scale is shown in Figures MA-10 to MA-26.

The area surveyed included the entire Western Australian part of the Officer Basin, and parts of the Yilgarn Block in the west, Musgrave Block in the northeast, and Eucla Basin in the south.

A high-amplitude high-frequency magnetic pattern is associated with the Archaean granites on the eastern edge of the Yilgarn Block in both ROBERT (Fig. MA-10) and THROSSELL (Fig. MA-11). This pattern is generally curvilinear, although some northwest-trending lineaments, which extend into the Officer Basin region, are evident.

The complex magnetic pattern over the Musgrave Block dominates the northeast of the survey area. The boundary, marked by several narrow curvilinear anomalies, sweeps in a northwesterly direction from South Australia through COOPER (Fig. MA-22), TALBOT (Fig. MA-17) and BENTLEY (Fig. MA-16). Further into the Musgrave Block the magnetic features are complex.

Between the two igneous and metamorphic basement areas, the magnetic pattern exhibits low-frequency, broad anomalies of the Officer and Eucla Basins. The magnetic basement dips east into WESTWOOD (Fig. MA-14) and YOWALGA (Fig. MA-13) to a depth of about 4000 m below sea level. In this zone most magnetic trends are northwesterly and extend into BROWNE (Fig. MA-12). The Westwood fault zone is apparent in the western half of WESTWOOD (Figure MA-14), striking north-south.

The magnetic basement rises to the south, becoming shallowest in MASON (Fig. MA-25) and JUBILEE (Fig. MA-20) and remaining relatively flat at about 1000 m below sea level through FORREST (Fig. MA-26).

The geologically mapped boundary of the Officer Basin and Eucla Basin runs through MASON and JUBILEE, but is not marked by definite magnetic features. However, a linear feature originating in COOK in South Australia trends northwest, cutting across a large circular anomaly in MASON (Fig. MA-25). Its linearity suggests a dyke-intruded fault zone, terminating at the Gawler block in South Australia and lying approximately over the boundary of the Officer and Eucla Basins in the region of the survey.

Prominent features in the southern part of the survey area are circular anomalies ranging in diameter and intensity (10-50 km diameter and 100-1200 nT). These anomalies suggest very deep intrabasement sources.

Curvilinear features extend from well south of the area into the southwestern region. These trend northeasterly through PLUMRIDGE (no plate) into NEALE (Fig. MA-15), and terminate in VERNON (Fig. MA-19). The source of these anomalies is probably folded, faulted Proterozoic metasediments dipping gently to the northeast.

The completion of aeromagnetic mapping in this area has made possible a more detailed geological study. The new data will aid in establishing basin boundaries and delineating the complex structures which have no surface expression.

McArthur Basin airborne survey, 1977 - data processing and preliminary interpretation (I. Zadoroznyj, S.N. Sheard).

During 1979 the main effort for this project was directed at the production of maps for preliminary release (refer Table MA-3). The Sub-section is currently processing the 1978 data for release in 1980.

Magnetic data. The total magnetic intensity contour maps of the 1977 McArthur Basin Airborne Survey area (Figs. MA-27 to 46) show a range in magnetic disturbance from short-wavelength, high-amplitude features (about 2 km and 600 nT) to broad flat features varying by only a few tens of nanoteslas over 50 km. Overall the field is relatively flat, as is expected from a sedimentary region with deep crystalline basement. There is a weak overall northwesterly trend in the anomaly pattern. The area can be divided into broad zones, one having magnetic anomalies due to shallow sources, and another the flatter field areas, having deep sources.

Interestingly the higher-amplitude anomalies form linear and curvilinear belts, particularly in URAPUNGA (Fig. MA-27), suggesting a particular type of structural control in the placement of the magnetic rocks. The high-amplitude anomalies in URAPUNGA correlate well with dolerite sills of Proterozoic age. Dolerites also appear to be the cause of other anomalies in the northern part of the survey area.

In the southern part of the survey area magnetically disturbed zones are correlated with basalts. Similar volcanics, beneath cover, area probably the cause of magnetic disturbance in areas far removed from outcrop. The variation in magnetic response of mapped basalts indicates a variation in lithology of similarly grouped units and suggests that further studies of these units is required.

Two major faults, the Emu Fault in BAUHINIA DOWNS (Fig. MA-39) and the Calvery Fault in CALVERT HILLS (Fig. MA-45), have magnetic expression but of different types. The expression of the former is a magnetic gradient and of the latter is a chain of high-amplitude anomalies. Similar magnetic features in other parts of the area are possibly magnetic expressions of fault zones. For example a major west-trending fault is suggested in the souther part of HODGSON DOWNS (Fig. MA-31).

An interesting feature in the northwest corner of HODGSON DOWNS is a partial ring of magnetic anomalies around the rim of a circular structure known as the Strangways Structure. This structure is thought to be the result of the impact of an extra terrestrial body.

Radiometric data. In the north of the area no major trends are evident. The northern coastal region as expected has low broad anomalous features indicative of water covered areas. The dolerite sills in URAPUNGA (Fig. MA-28) and HODGSON DOWNS (Fig. MA-32) have no radiometric expression. The alluvial cover which extends from southern URAPUNGA across western HODGSON DOWNS and most of TANUMBIRINI (Fig. MA-38) shields most gamma-radiation and localised low counts are evident.

The trends of the faulted Proterozoic sediments are evidenced by high-frequency and high-count anomalies. The anomalous zone extends from CALVERT HILLS (Fig. MA-46) in a northwesterly direction through WALLHALLOW (Fig. MA-44), north through BAUHINIA DOWNS (Fig. MA-40) and ROBINSON RIVER (figure MA-41) into MOUNT YOUNG (Figure MA-33) and PELLEW (Fig. MA-42), where it broadens into HODGSON DOWNS. The zone terminates in HODGSON DOWNS and MOUNT YOUNG. An interesting feature of this zone is the very high-count radiometric anomalies associated with the Scrutton Volcanics.

The good correlation between the Lower Proterozoic volcanics and high radiometric activity is noticeable in the south of CALVERT HILLS. The near-surface extent of the Peters Creek Volcanics might be far more extensive along its boundary with the Westmoreland Conglomerates than suggested by the mapped geology of the area. Considerable interest has been shown in the CALVERT HILLS spectrometer data, especially in a very intense uranium anomaly known as the Fish River Anomaly.

The spectrometer data of the McArthur Basin has already proved to be of valuable assistance to exploration companies. Closer and more detailed analysis of both the magnetic data and spectrometer data is therefore warranted. During the latter half of 1980 a multidisciplinary assessment of these data will commence.

Albany-Fraser Block airborne magnetic and radiometric survey WA 1977 (I. Zadoroznyj).

The survey, which covered MOUNT BARKER and parts of the PEMBERTON and BREMER BAY 1:250 000 Sheet areas, was flown in late 1977. The processing of survey data for map production commenced in late 1978; it was completed, and maps were progressively released through the Australian Government Printer (Copy Service) up till October 1979. The magnetic data were displayed in profile and contour form at a map scale of 1:250 000. Reductions of these maps at 1:1 million scale are shown in Figures MA-47 to 52.

The major feature evident in the magnetic results is a band of high-amplitude anomalies which extends right across the three sheet areas covered. This undoubtedly marks the boundary between the Archaean Yilgarn Block to the north and the Proterozoic Albany Fraser Block to the south. In BREMER BAY (Fig. MA-49) the band coincides with the Bremer Fault, and similar faults apparently extend right across the area. In MOUNT BARKER (Fig. MA-51) a strong magnetic lineament, most probably indicating another fault, cuts across the major band of anomalies and possibly marks a major boundary subdividing the Albany Fraser Block.

The anomalies in the northern parts of the area form discontinuous patterns similar to those found over other parts of the southwest Yilgarn Block. In the northwestern corner of MOUNT BARKER a strong northwest trend is evident in the anomalies. Both the areas of high-amplitude anomalies and the magnetically quiet areas in the southern parts of the area are of interest, as they point to significantly different lithologies.

The most interesting feature of the radiometric data is the fairly large area of intense radioactivity in southeast PEMBERTON (Fig. MA-48).

Adelaide Geosyncline airborne magnetic and radiometric survey, 1978
(K. Horsfall)

This survey, which covered the RENMARK, PINNAROO, ADELAIDE (part), and BARKER (part) 1:250 000 Sheet areas, was flown in late 1978. The processing of the data to the map production stage commenced early this year; it was completed, and maps were progressively released through the Australian Government Printer (Copy Service) up till October 1979. The magnetic and radiometric data were displayed in profile and contour form at a map scale of 1:250 000, reductions of which at 1:1 million scale are shown in (Figures MA-53 to 60). The magnetic character in the survey area is fairly flat in the northeast and central east, with some small isolated anomalies of up to several hundred nanoteslas and some NNW-trending linear features.

In the west of the area, the magnetic features are up to several thousand nanoteslas in amplitude, trending north in the north of the area and swinging to northwest in the south. These features outline the eastern border of the Adelaide Fold Belt. Correlations between the geology and magnetic data are difficult, owing to the Cainozoic cover in all but the northwestern part of the area.

The radiometric data are generally very flat except over the exposures of granites and metasediments in the west of the area. These anomalies are due to potassium and thorium.

The remainder of the area shows little or no radiometric activity except for a small increase in counts along the river flats of some of the major water courses. These are mainly attributed to thorium in the clays. There is no indication of high uranium counts in the area.

Airborne data conversion project. (R. Wells)

This project was mounted to convert airborne magnetic data recorded during the 1960s on 5-hole paper tape to the format currently used in our aircraft, and to transfer these data to magnetic tape so that they can be accessed by the ARGUS processing system.

An S.C.M. Paper tape reader was interfaced to the HP 2114 computer in use by the Observatory Section. This enabled the 5-hole paper-tape data to be copied to magnetic cassette, whence it can be accessed by the HP 2100 computer in BMR and stored as a disc file.

Owing to staff losses labour has not been available to write the format conversion and error checking softward. It is hoped that this final stage will be completed during 1980, and 1960 vintage digital data will be progressively added to the data bank.

Airborne gamma-ray spectrometry development

During 1979 action was initiated to upgrade progressively the quality of gamma spectrometry produced by BMR's survey aircraft, principally by a re-equipping program as funds permit.

Instrumentation (J. Rees, G. Green, D. Downie)

To upgrade basic airborne instrumentation, a new 17 000 cm^3 sodium iodide detector package and controller were purchased in May. After extensive testing and evaluation this equipment was installed in VH-BMG in June. It is planned to add a further 17 000 cm^3 detector package in 1980 when funds permit.

A high-performance analogue to digital converter module was purchased in June for development of a multi-channel analyser for the aircraft digital data acquisition system. Progress on this project has been delayed by lack of staff, but it is expected to have this facility developed during 1980.

Airborne A.D.P. Applications Group (J. Rees, J. Silic)

The group continued to support interpretation and analysis requirements of projects such as Lachlan and Georgina Basin. Programs for the interpretation of magnetic anomalies due to dykes, sloping steps, inclined plates, and dipping prisms were developed for both forward and inverse modelling. Inversion methods included critical point, least-squares and non-linear least-squares with error and sensitivity analysis.

A package for fast Fourier transformation and power spectral analysis was also implemented.

ADAB - Foreign Affairs - consulting (J. Rees)

J. Rees's secondment to ADAB to develop the Philippines Uranium Exploration Training Program continued during the year. Negotiations on a technical package were held in Manila in August and a report on a proposed 5-year programme was prepared in September.

AIRBORNE REDUCTIONS AND CONTRACTS GROUP (C. Leary, N. Sheard, A. Luyendyk, K. Horsfall, I. Zadoroznyj, J. Sampath, D. Souter, P. O'Rourke, P. Black)

Airborne data processing

The status of data processing, mapping, and mapping release for 1979 is shown in Table MA-3. During the year work commenced or continued on data sets for 34 1:250 000 SSeet areas; 17 of these were processed to completion. The total output was 129 geophysical maps, of which 112 were released through the Australian Government Printer Copy Service. The 17 radiometric ratio maps are available from BMR on application. Data processing on 17 sheets will continue into 1980, and data for 8 areas will be stockpiled, awaiting processing commencement late in 1980.

Supply of information and data to outside users

As at the end of October 1979, 19 requests for information about and copies of digital data were received from 13 organisations. These were from 10 exploration companies, CSIRO, Adelaide University, and NT Department of Mines and Energy. The data requested were from MacArthur Basin, Pine Creek-Darwin, Eucla Basin, Yilgarn Block, Arunta Block, Albany-Fraser Block, and Adelaide Geosyncline. There were also 14 requests from 6 exploration companies and 3 universities, for access to analogue data. The data requested were for Carnarvon Basin, Eromanga Basin, Yilgarn Block, Halls Creek, Woodlark Basin, and Lennard Shelf.

Two maps have been produced which display the availability of digital magnetic and radiometric data for Australia (Fig. MA-61 and 62).

Airborne ADP system development

Major program developments were in the following areas:

1. A program to generate infill data between flight-lines by linear interpolation was developed.

2. A program was written for the HP 2100 system to interface total count gridded data with the existing LANDSAT processing and display system. The geophysical data can now be displayed as grey-scale pictures.

3. A generalised program to allow entry of data from outside sources into the Airborne system has been produced.

4. The facility to process the magnetics at 0.2 s from the 0.2 s field data has been provided.

5. An option which allows the user to specify data not required for profiling or contouring by fiducial limits without the data actually being removed from the data base.

6. The program control for profile plots has been simplified for standard map production.

7. Group discussions led to standardisation of the general approach to the processing of survey data and the production of a detailed flow char illustrating the same.

8. The manuals describing the Airborne system have been updated and will be published as a microfiche Record.

No inroads were made during 1979 into the backlog of fully documenting, at the user level, the programs available in the Airborne system. However, those programs developed during 1979 were fully documented, so the situation has not deteriorated.

User training

New personnel in the section (P. Black, N. Sampath, L. Duke and D. Souter) were instructed in the various aspects of the system that pertain to them. Assistance has also been provided to F. Simonis and R. Rietsma from the Drawing Office in the computerised aspects fo flight-path recovery.

Several users within the Bureau have made use of various parts of the airborne system, requiring assistance and in some cases program modifications. These included P. Wilkes, P. Gidley (Metals), P. Scott (Geochemistry), J. Connelly (Regional Gravity) and G. Lamberts (Drawing Office).

AIRBORNE DATA PROCESSING/MAPPING/RELEASES 1979 TABLE MA-3

R - MAPS AND DATA RELEASED

C - PROCESSING COMPLETED P - PROCESSING IN PROGRESS S - DATA STOCKPILE

STATES	SHEETS	SURVEY CONFIGURATION				PROCESSING		MAPPING			
		MAG	RAD	SPACING Km	ALT m	DATA STATUS	SCALE	No MAPS	CONTOUR	PROFILES	
N.S.W.	CANBERRA	x		1.5	1750	R	1:250 000	1		MAGNETIC	FLIGHT PATHS
	WAGGA WAGGA	x	x	1.5	150/ 1750	R	1:250 000	1		MAGNETIC	PREVIOUSLY RELEASED
	GILGANDRA	x	x	1.5	150	P	1:250 000				
	DUBBO	x	x	1.5	150	P	1:250 000				
	NYNGAN	x	x	1.5	150	P	1:250 000				
N.S.W./VIC.	MALLACOOTA	x			1650	P	1:250 000	1		MAGNETIC	
	"					R	"	1		FLIGHT PATH	
VICTORIA	WARBURTON	x		1.5	1800	R	1:250 000	1	MAGNETIC		
	"					R	"	1		MAGNETIC	
	"					R	"	1		FLIGHT PATH	
	HORSHAM	x	x	3.0	150	S	1:250 000				
NORTHERN TERRITORY	EHRENBERG-RANGE	x	x	1.5	100	R	1:100 000	1	MAGNETIC		SPECIAL
	"					R	"	1		MAGNETIC	
	"					R	"	5		RADIOMETRIC	
	"					R	"	1		FLIGHT PATH	
	DARWIN	x	x	1.5	150	R	1:250 000	1		MAGNETIC	100nT/cm
	"					R	"	1		MAGNETIC	500nT/cm
	"					C	1:50 000	1		MAGNETIC	SPECIAL
	"					C	"	1		FLIGHT PATH	
	ROPER RIVER	x	x	3.0	150	P/R	1:250 000	1		MAGNETIC	
	"					P/R	"	5		RADIOMETRIC	
	"					R	"	1		FLIGHT PATH	
	CAPE BEATRICE	x	x	3.0	150	P/R	1:250 000	1		MAGNETIC	
						P/R	"	5		RADIOMETRIC	
						R	"	1		FLIGHT PATH	
	MT MARUMBA	x	x	3.0	150	P	1:250 000				
	BLUE MUD BAY	x	x	3.0	150	P	1:250 000				
	PORT LANGDON	x	x	3.0	150	P	1:250 000				
	MILINGIMBI	x	x	3.0	150	S	1:250 000				
	ARNHEMBAY	x	x	3.0	150	S	1:250 000				
	GOVE	x	x	3.0	150	S	1:250 000				
	JUNCTION BAY	x	x	3.0	150	S	1:250 000				
	WESSEL ISLAND	x	x	3.0	150	S	1:250 000				
	TRUANT ISLAND	x	x	3.0	150	S	1:250 000				
	FORREST	x		3.0	500	R	1:250 000	1	MAGNETIC		
	"					R	"	1		MAGNETIC	
	"					R	"	1		FLIGHT PATH	

AIRBORNE DATA PROCESSING/MAPPING/RELEASES 1979 TABLE MA-3

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STATES	SHEETS	SURVEY CONFIGURATION				PROCESSING		MAPPING		
		MAG	RAD	SPACING Km	ALT m	DATA STATUS	SCALE	No MAPS	CONTOUR	PROFILES
				1.5						
SOUTH	ADELAIDE-	x	x	/3.0	150	R	1:250 000	1	MAGNETIC	3 km SPACING
AUSTRALIA	RENMARK					R	"	1	MAGNETIC	1.5 km SPACING
	"					R	"	1	RADIOMETRIC	3 km SPACING
	"					R	"	1	RADIOMETRIC	1.5 km SPACING
	"					R	"	1		MAGNETIC 200nT/cm
	"					R	"	1		MAGNETIC 500nT/cm
	"					R	"	5		RADIOMETRIC
	"					R	"	1		FLIGHT PATH
	"					C	"	3		RAD. RATIOS
	BARKER-	x	x	1.5						
				/3.0	150	R	1:250 000	1	MAGNETIC	3 km SPACING
	PINNAROO					R	"	1	MAGNETIC	1.5 km SPACING
	"					R	"	1	RADIOMETRIC	3 km SPACING
	"					R	"	1	RADIOMETRIC	1.5 km SPACING
	"					R	"	1		MAGNETIC 200nT/cm
	"					R	"	1		MAGNETIC 500nT/cm
	"					R	"	5		RADIOMETRIC
	"					R	"	1		FLIGHT PATH
	"					C	"	3		RAD. RATIOS
	NULLARBOR	x	x	1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	COOMPANA	x	x	1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	FOWLER-	x	x	1.5	150	R	1:250 000	1		MAGNETIC
	NUYTS					R	"	1		FLIGHT PATH
	NARACOORTE	x	x	1.5	150	S	1:250 000			
QUEENSLAND	CAPE MELVILLE	x	x	3.0						
				/6.0	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	EBAGOOLA	x	x	1.5						
				/6.0	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	HOLROYD	x	x	3.0						
				/6.0	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
WESTERN	PEMBERTON	x	x	1.5	150	R	"	1	MAGNETIC	
AUSTRALIA	"					R	"	1	RADIOMETRIC	
	"					R	"	1		MAGNETIC
	"					R	"	5		RADIOMETRIC
	"					R	"	1		FLIGHT PATH
	"					C	"	3		RAD. RATIOS

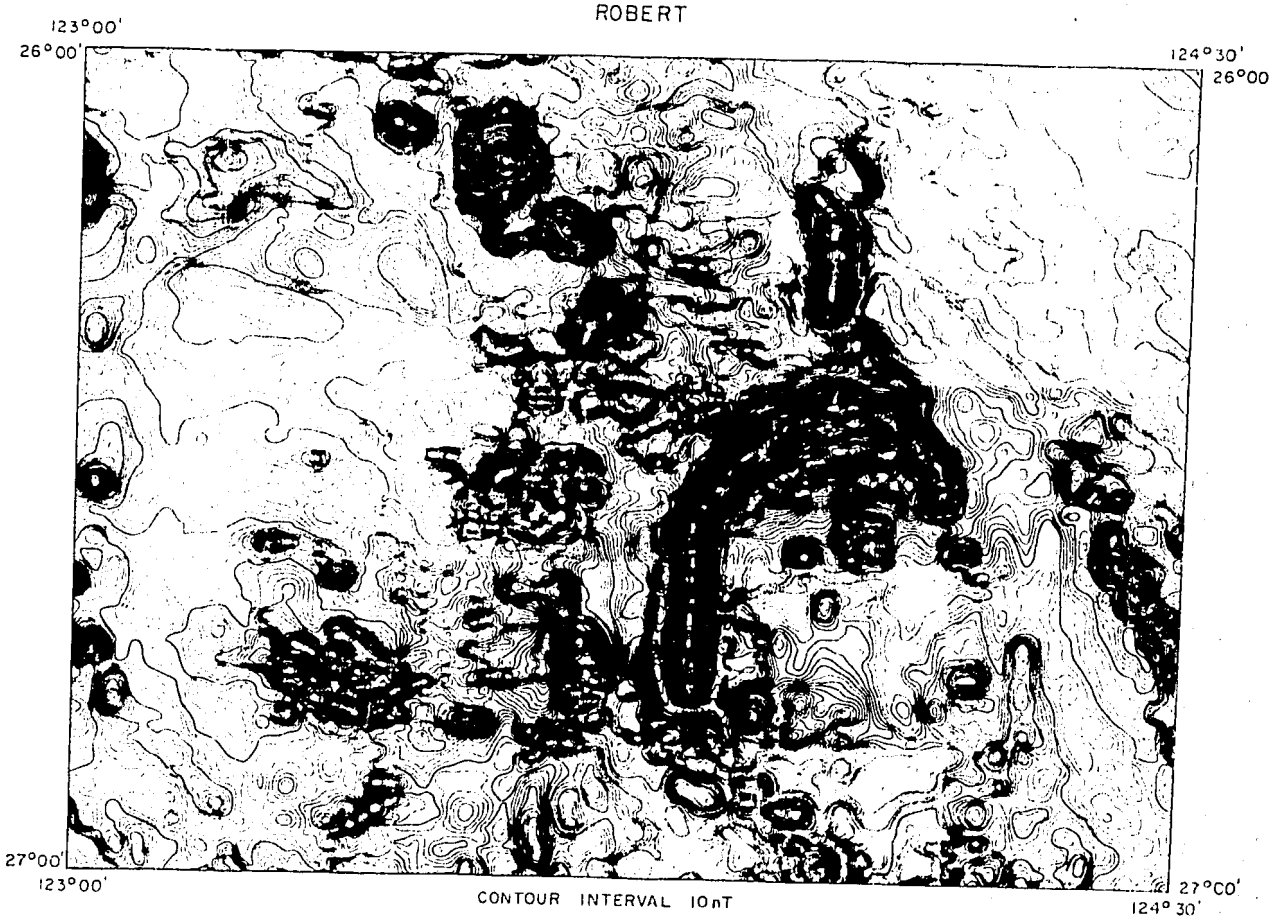
AIRBORNE DATA PROCESSING/MAPPING/RELEASES 1979 TABLE MA-3

R - MAPS AND DATA RELEASED

C - PROCESSING COMPLETED P - PROCESSING IN PROGRESS S - DATA STOCKPILE

STATES	SHEETS	SURVEY CONFIGURATION				PROCESSING		MAPPING		
		MAG	RAD	SPACING Km	ALT m	DATA STATUS	SCALE	No MAPS	CONTOUR	PROFILES
	BREMER BAY	x	x	1.5	150	R	1:250 000	1	MAGNETIC	
	"					R	"	1	RADIOMETRIC	
	"					R	"	1		MAGNETIC
	"					R	"	5		RADIOMETRIC
	"					R	"	1		FLIGHT PATH
	"					C	"	3		RAD. RATIOS
	MT BARKER	x	x	1.5	150	R	1:250 000	1	MAGNETIC	
	"					R	"	1	RADIOMETRIC	
	"					R	"	1		MAGNETIC
	"					R	"	5		RADIOMETRIC
	"					R	"	1		FLIGHT PATH
	"					C	"	3		RAD. RATIOS
	CORRIGIN	x		1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	PINJARRA	x		1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	PERTH	x		1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	KELLERBERRIN	x		1.5	150	R	1:250 000	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	JUBILEE	x		3.0	500	R	1:250 000	1	MAGNETIC	
	"					R	"	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	MASON	x		3.0	500	R	1:250 000	1	MAGNETIC	
	"					R	"	1		MAGNETIC
	"					R	"	1		FLIGHT PATH
	FORREST	x		3.0	500	R	1:250 000	1	MAGNETIC	
						R	"	1		MAGNETIC
						R	"	1		FLIGHT PATH

ROBERT



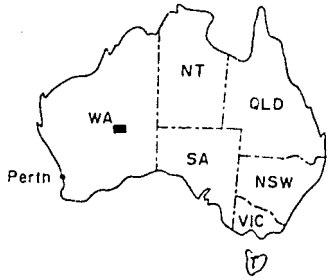
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



REFERENCE TO 1:250000 MAP SERIES

STANLEY	HERBERT	BROWNE
KINGSTON	ROBERT	YOWALGA
DUKETON	THROSSELL	WESTWOOD

THROSSELL

CONTOUR INTERVAL 10nT

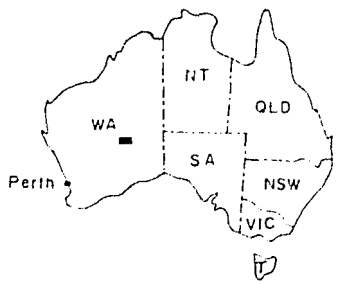
AIRBORNE SURVEY, OFFICER BASIN , WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 KILOMETRES

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

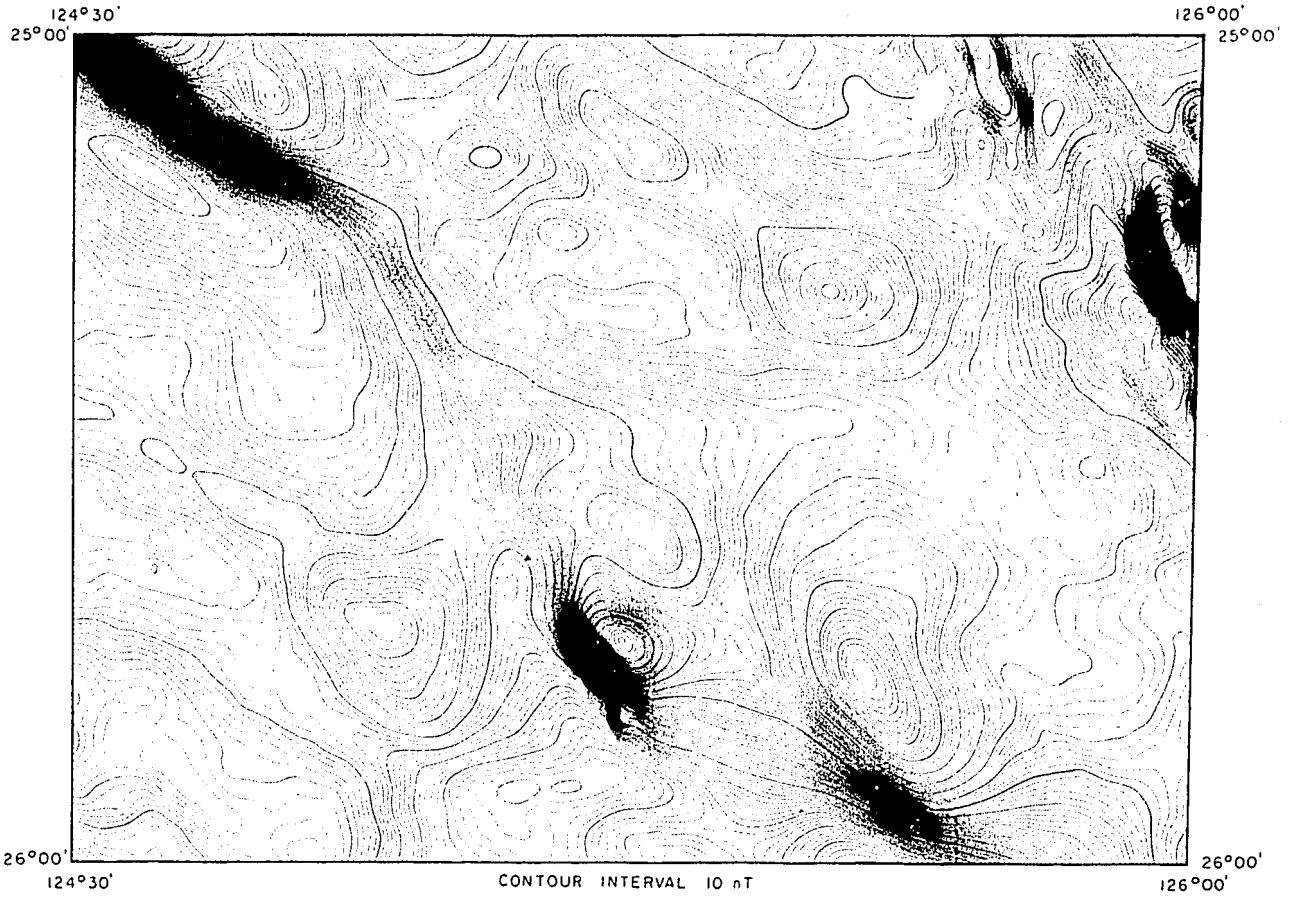
KINGSTON	ROBERT	YOWALGA
DUKETON	THROSSELL	WESTWOOD
LAVERTON	RASON	NEALE

G51/BI-67A

Record No. 1976/91, 1979/73

MA 12

BROWNE



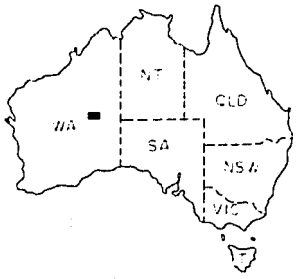
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-76

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



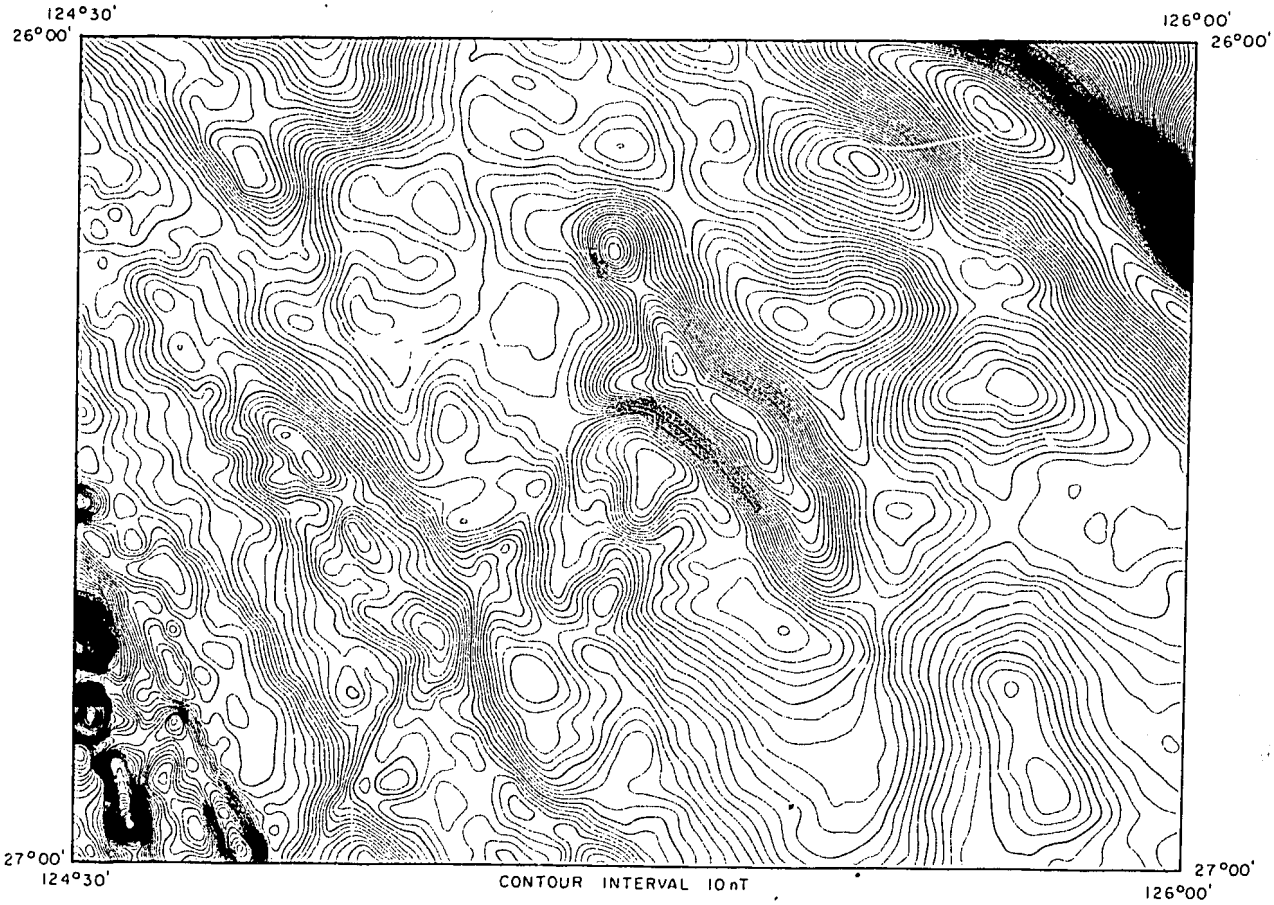
REFERENCE TO 1:250 000 MAP SERIES

MADLEY	WARRI	COBB
HERBERT	BROWNE	BENTLEY
ROBERT	YOWALGA	TALBOT

Record No 1979/73

MA 13

YOWALGA



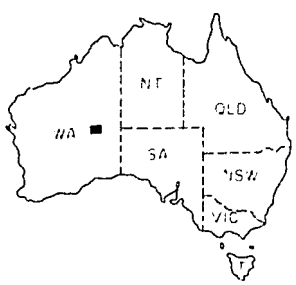
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

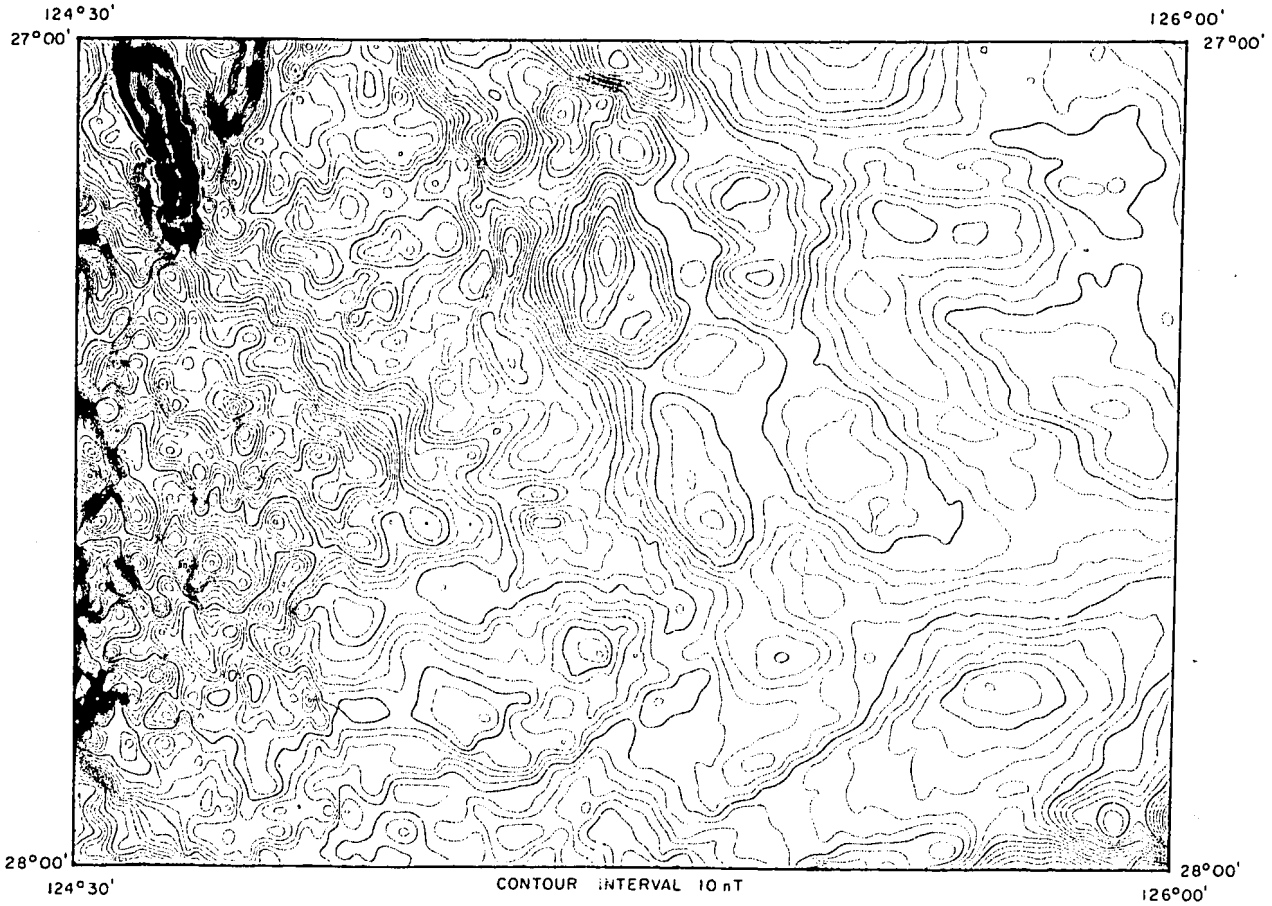
HERBERT	BROWNE	BENTLEY
ROBERT	YOWALGA	TALBOT
THROSSELL	WESTWOOD	LENNIS

Record No. 1978/97, 1979/73 & Report 213

G51/B1-78AR

MA 14

WESTWOOD



AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

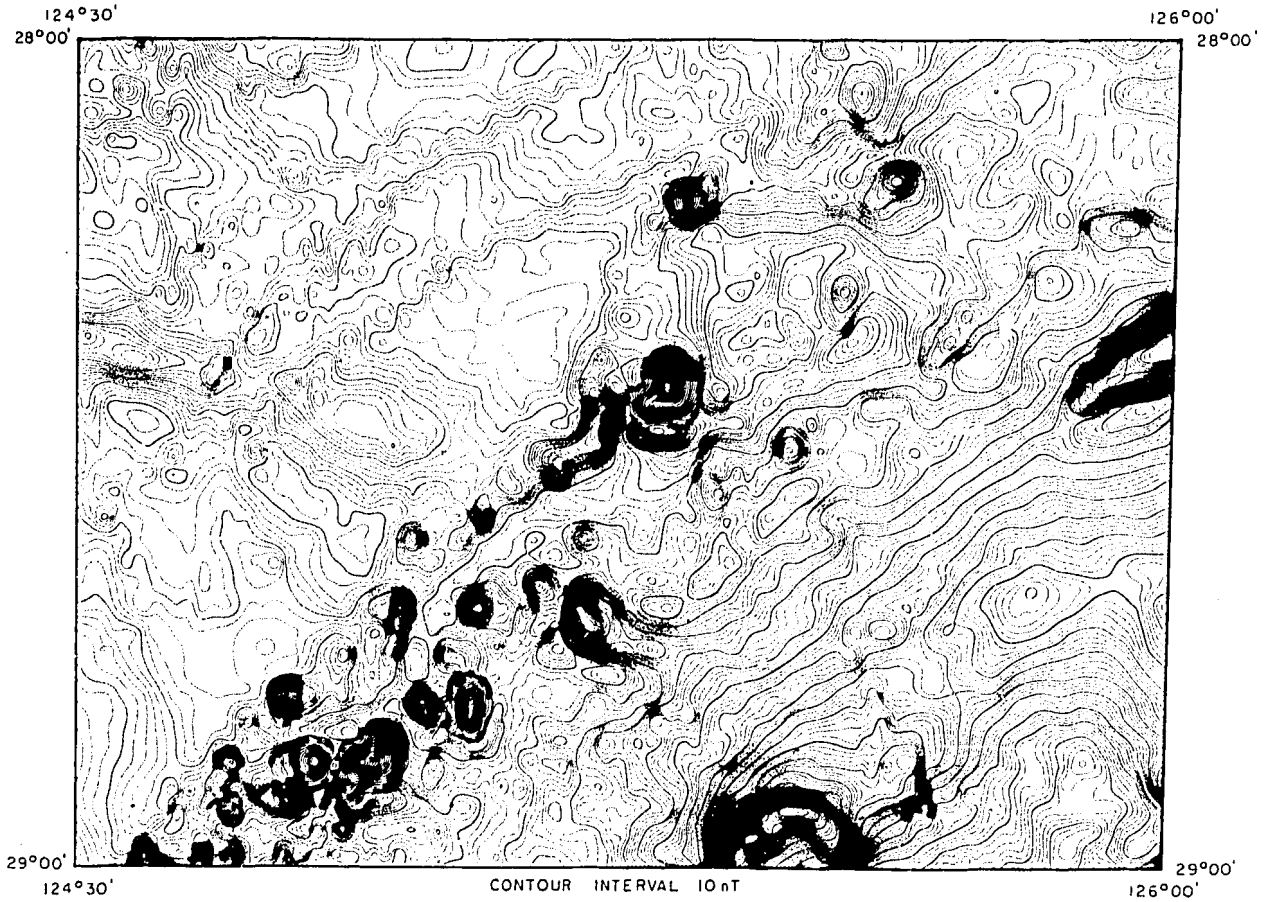
ROBERT	YOWALGA	TALBOT
THROSSELL	WESTWOOD	LENNIS
RASON	NEALE	VERNON

Record No. 1978/97, 1979/73 & Report 213

G 51/B1-81AR

MA 15

NEALE



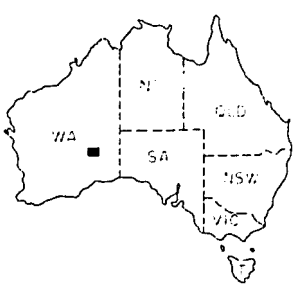
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

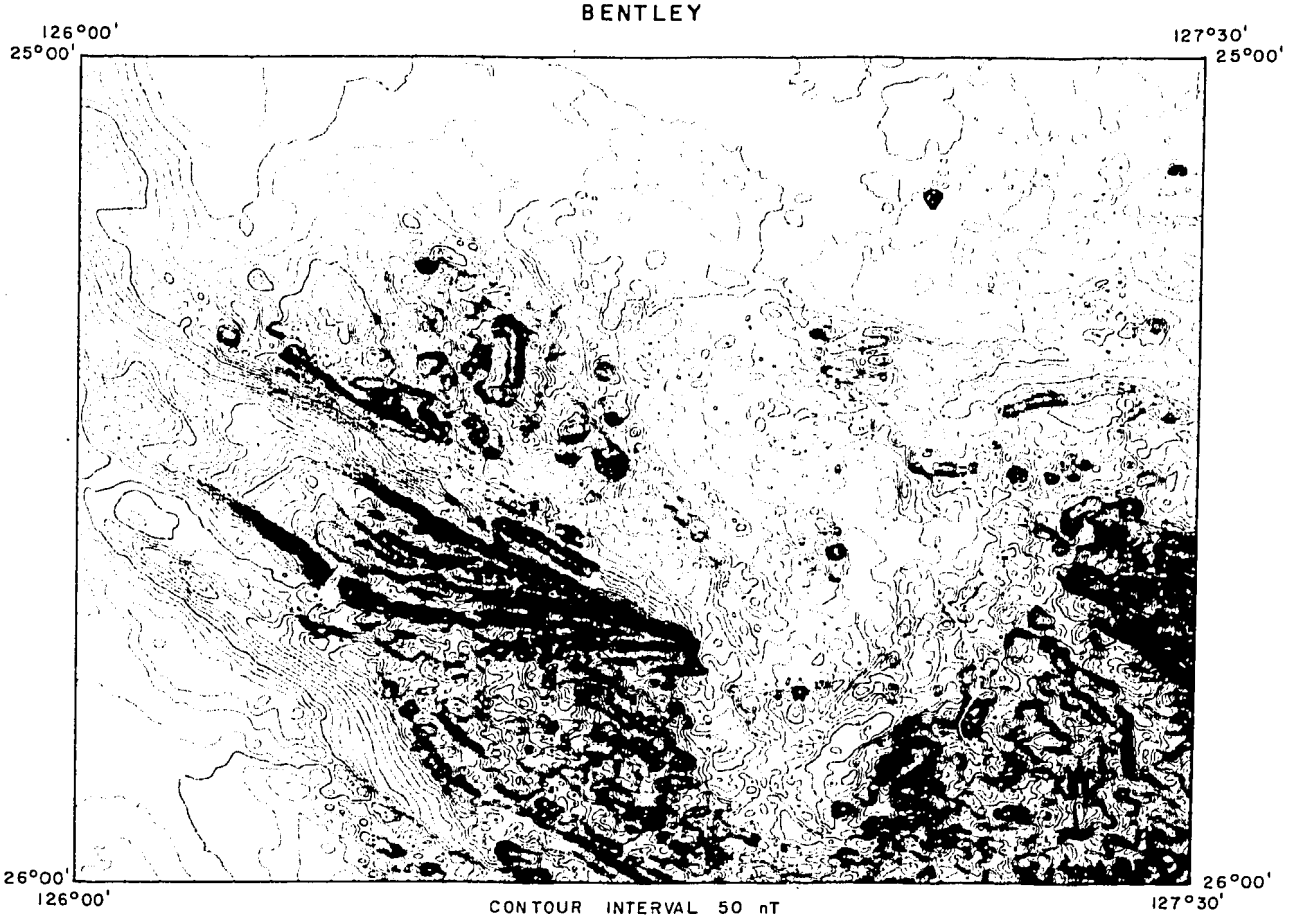
THROSSELL	WESTWOOD	LENNIS
RASON	NEALE	VERNON
MINIGWAL	PLUMRIDGE	JUBILEE

Record No. 1978/97, 1979/73 & Report 213

H51/BI-145AR

MA 16

BENTLEY



AIRBORNE SURVEY,
OFFICER BASIN, WA 1975-77

TOTAL MAGNETIC INTENSITY

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

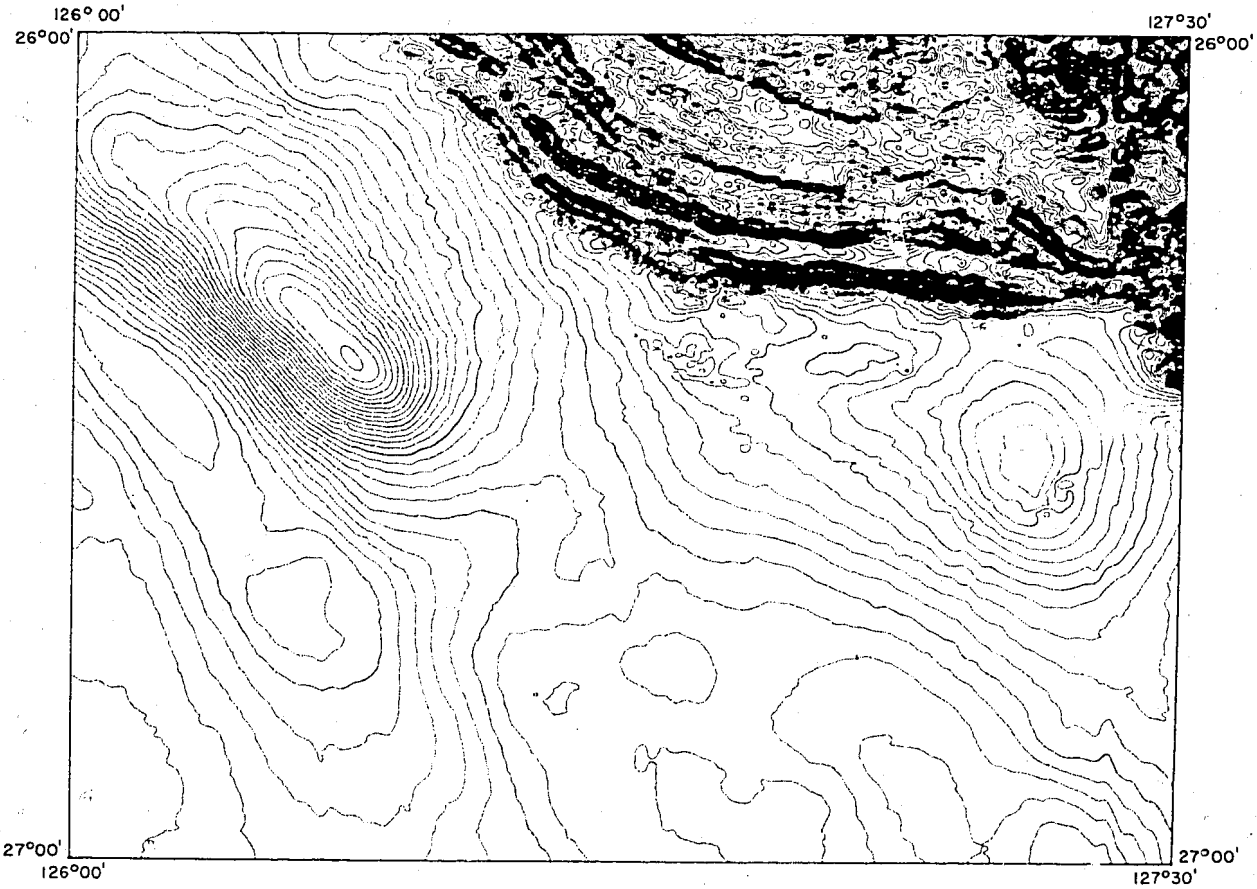
WARRI	COBB	RAWLINSON
BROWNE	BENTLEY	SCOTT
YOWALGA	TALBOT	COOPER

Record No. 1977/46, 1979/73

G52/BI-78 AR

MA 17

TALBOT



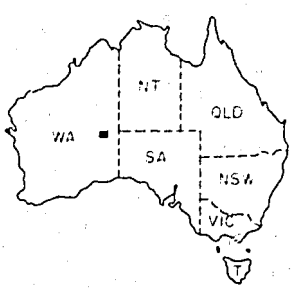
CONTOUR INTERVAL 50nT

AIRBORNE SURVEY, OFFICER BASIN, WA 1975-77

TOTAL MAGNETIC INTENSITY

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

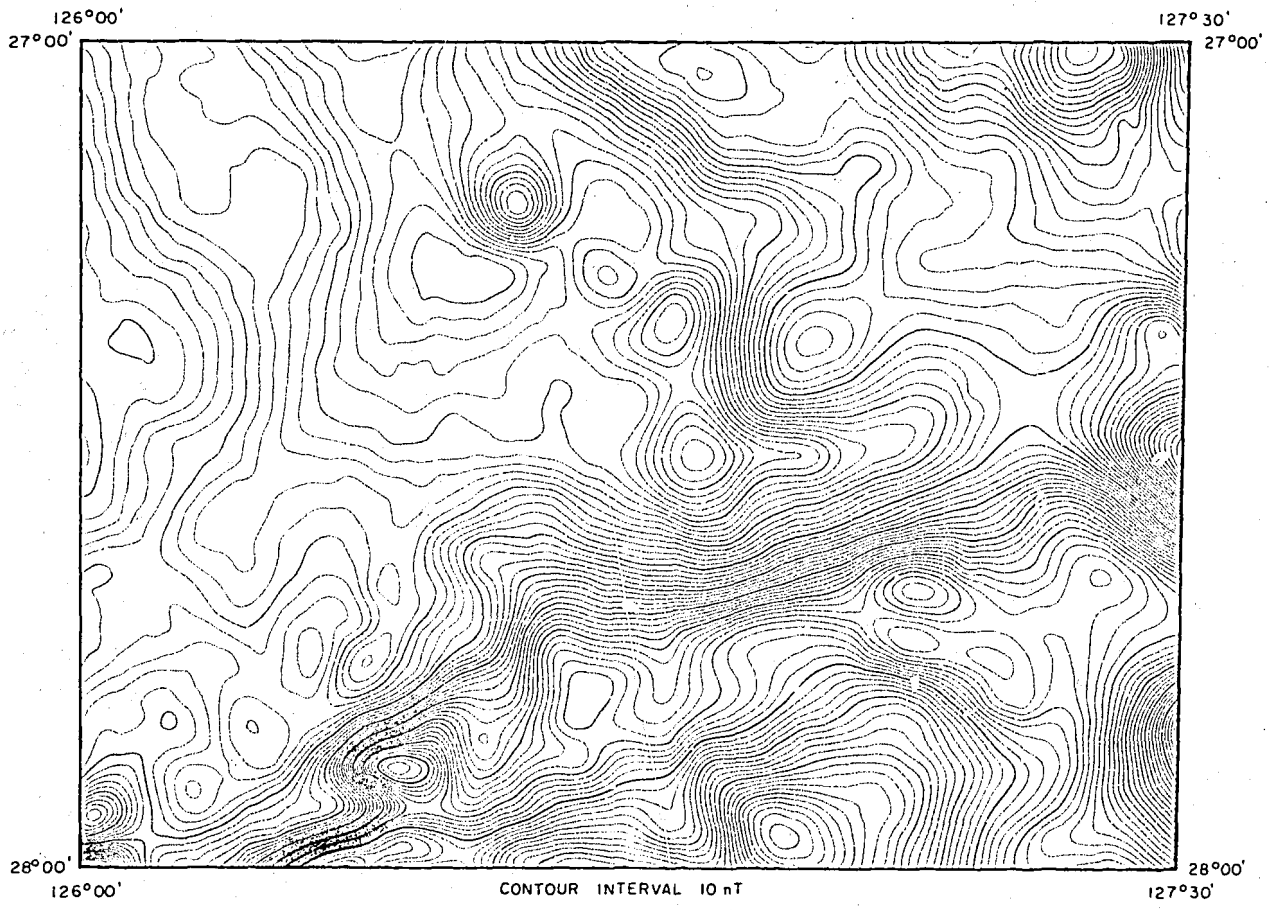
BROWNE	BENTLEY	SCOTT
YOWALGA	TALBOT	COOPER
WESTWOOD	LENNIS	WAIGEN

Record No. 1977/46, 1979/73

G52/BI-84AR

MA-18

LENNIS



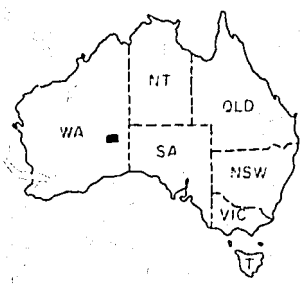
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-73

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

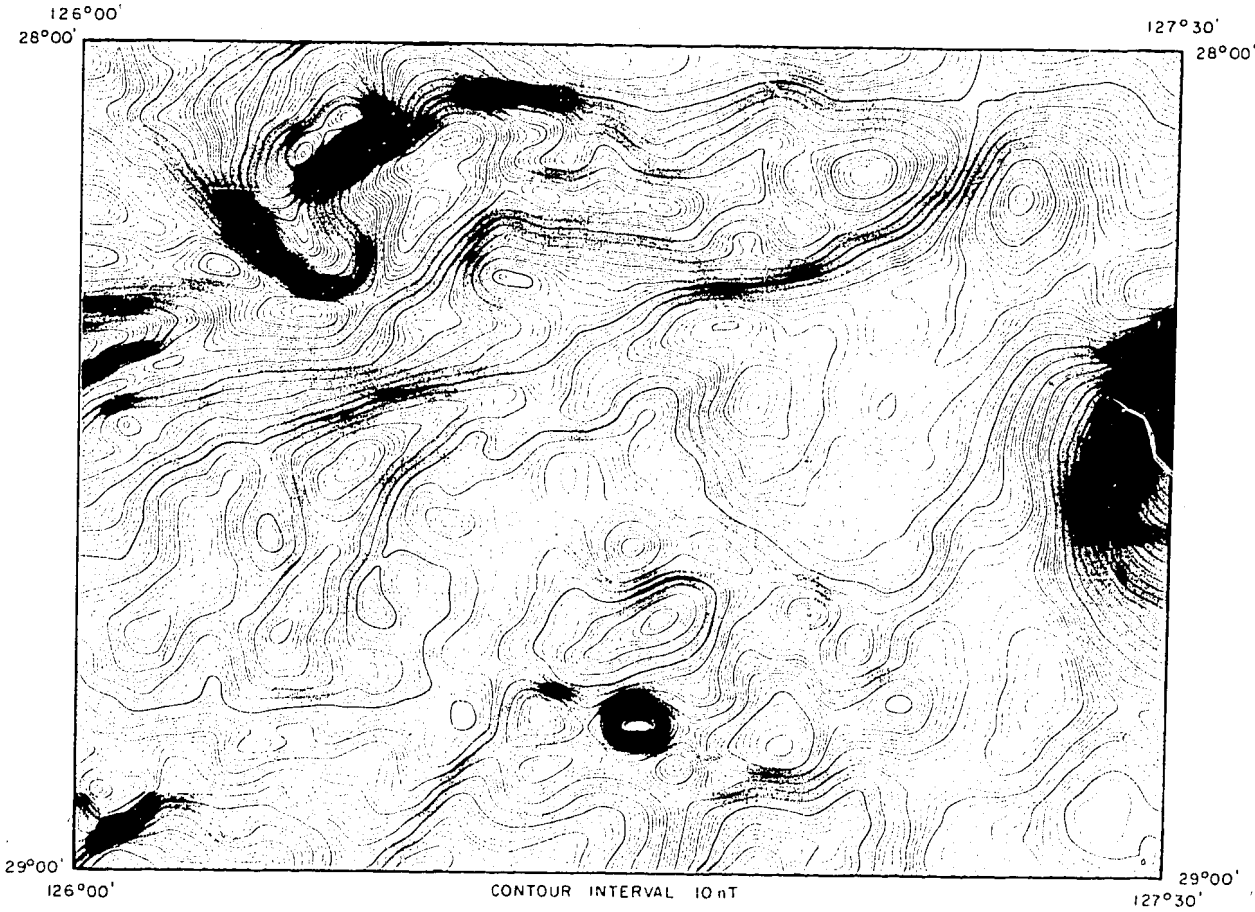
YOWALGA	TALBOT	COOPER
WESTWOOD	LENNIS	WAIGEN
NEALE	VERNON	WANNA

Record No. 1978/97, 1979/73 & Report 213

G52/BI-90AR

MA 19

VERNON

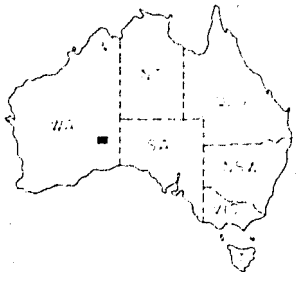


AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

LOCATION DIAGRAM

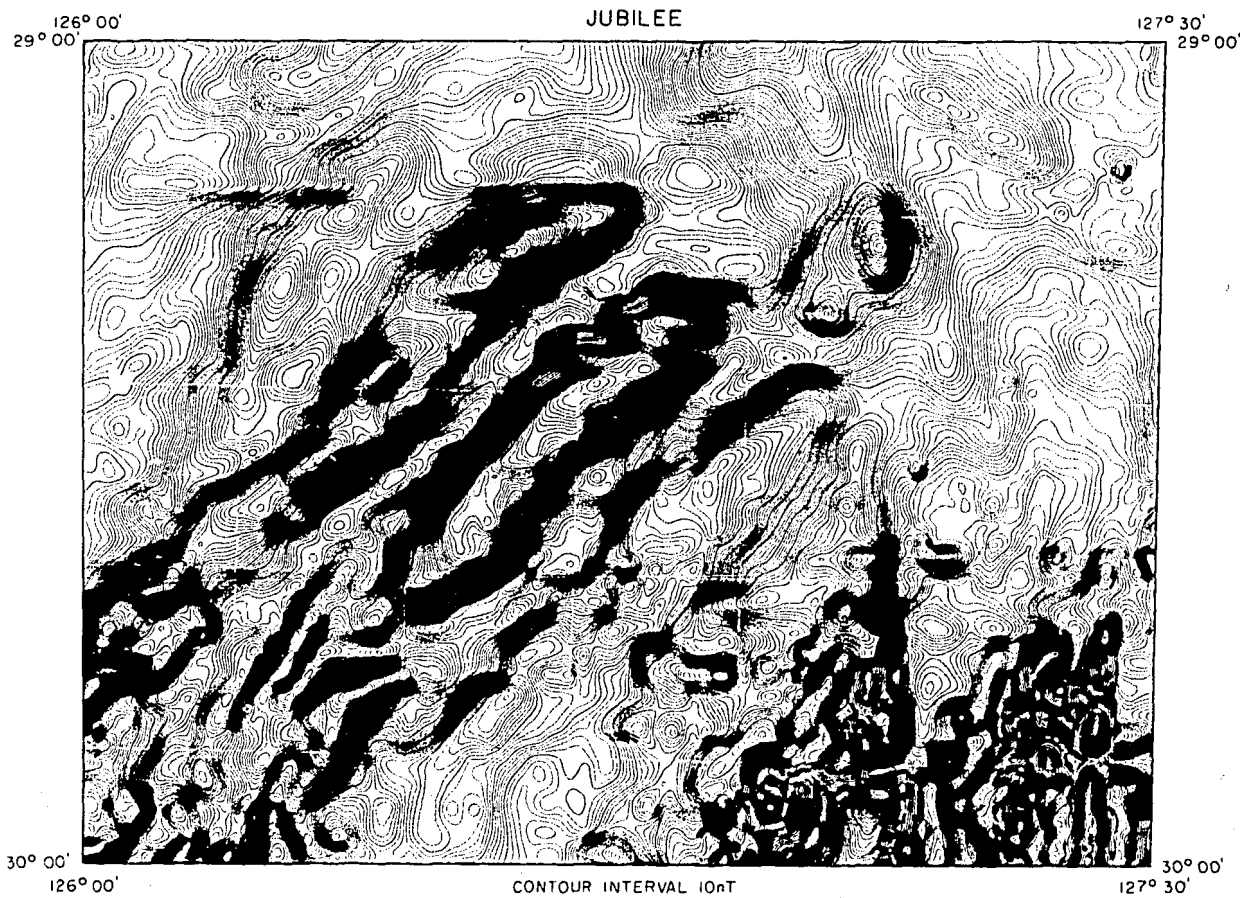


REFERENCE TO 1:250 000 MAP SERIES

WESTWOOD	LENNIS	WAIGEN
NEALE	VERNON	WANNA
PLUMRIDGE	JUBILEE	MASON

Record No. 1978/97, 1979/73 & Report 213

MA 20



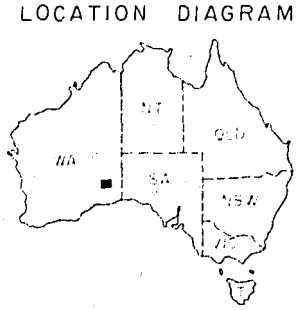
AIRBORNE SURVEY, OFFICER BASIN, WA 1976

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

0 5 10 20 30 40 50 KM

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

NEALE	VERNON	WANNA
PLUMRIDGE	JUBILEE	MASON
SEEMORE	LOONGANA	FORREST

MA 21

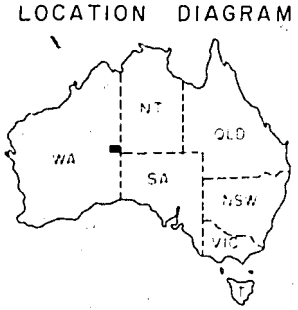
SCOTT

AIRBORNE SURVEY,
OFFICER BASIN, WA 1975-77

TOTAL MAGNETIC INTENSITY

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

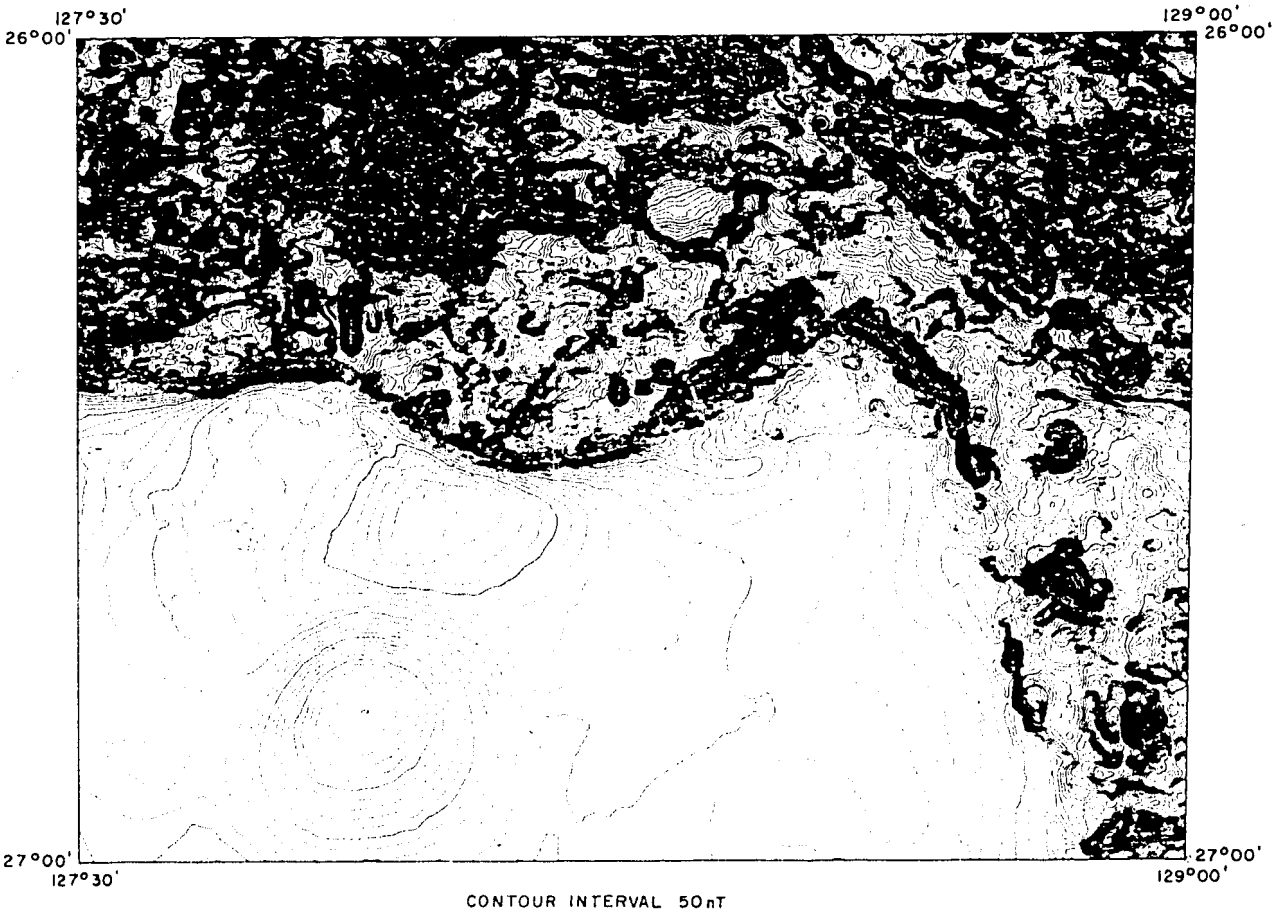
COBB	RAWLINSON	BLOODS RANGE
BENTLEY	SCOTT	PETERMANN RANGES
TALBOT	COOPER	MANN

Record No. 1977/46, 1979/73

G52/B1-81AR

MA 22

COOPER



CONTOUR INTERVAL 50nT

AIRBORNE SURVEY, OFFICER BASIN, WA 1975-77

TOTAL MAGNETIC INTENSITY

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

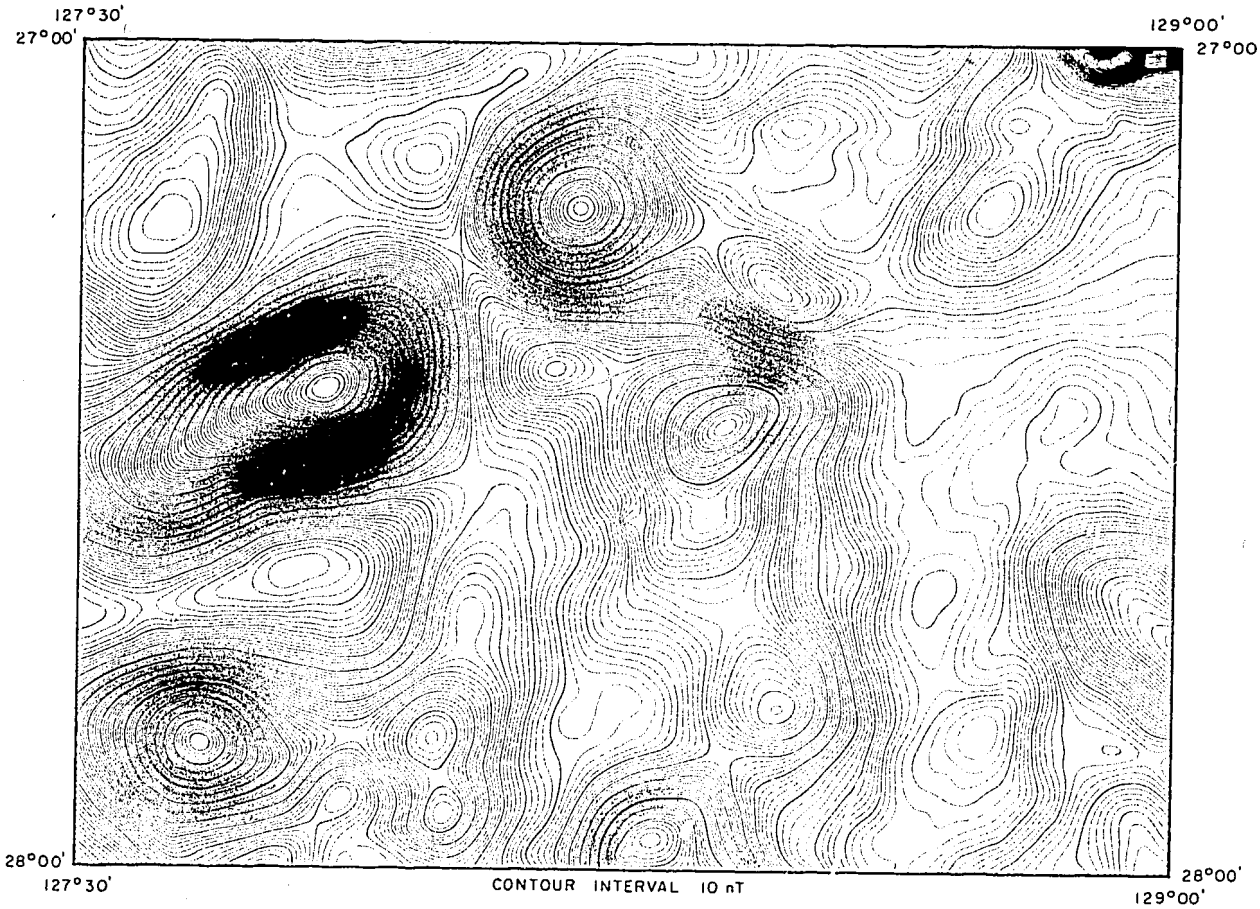
BENTLEY	SCOTT	PETERMANN RANGES
TALBOT	COOPER	MANN
LENNIS	WAIGEN	BIRKSGATE

Record No. 1977/46, 1979/73

G52/BI-87AR

MA 23

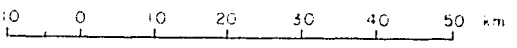
WAIGEN



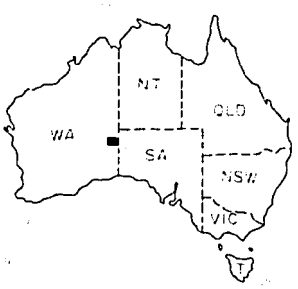
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000



LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

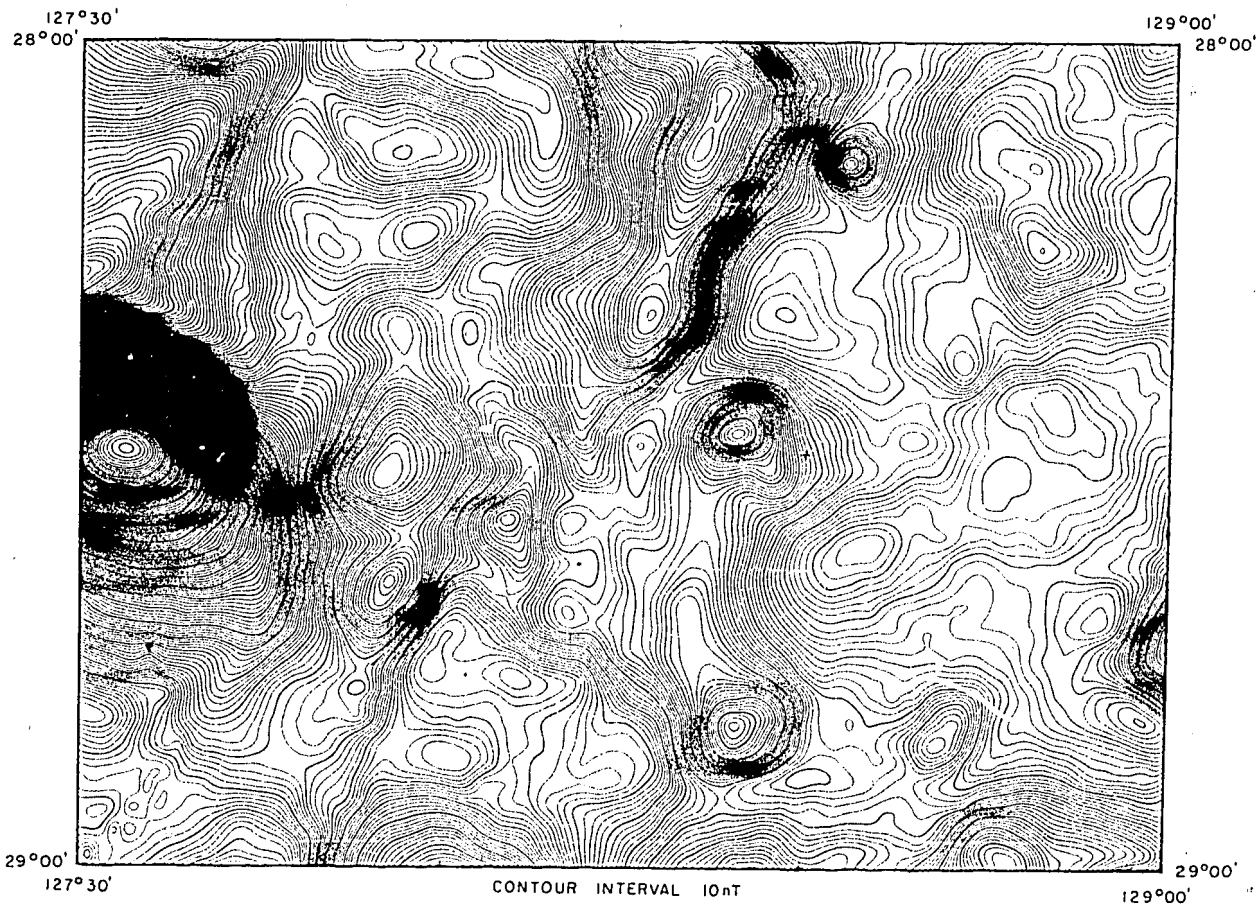
TALBOT	COOPER	MANN
LENNIS	WAIGEN	BIRKSGATE
VERNON	WANNA	NOORINA

Record No. 1978/97, 1979/73 & Report 213

G52/81-93 AR

MA 24

WANNA



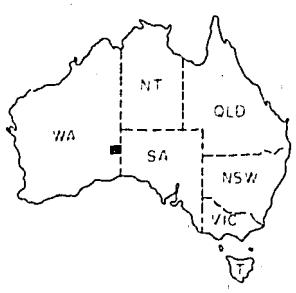
AIRBORNE SURVEY, OFFICER BASIN, WA 1975-78

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



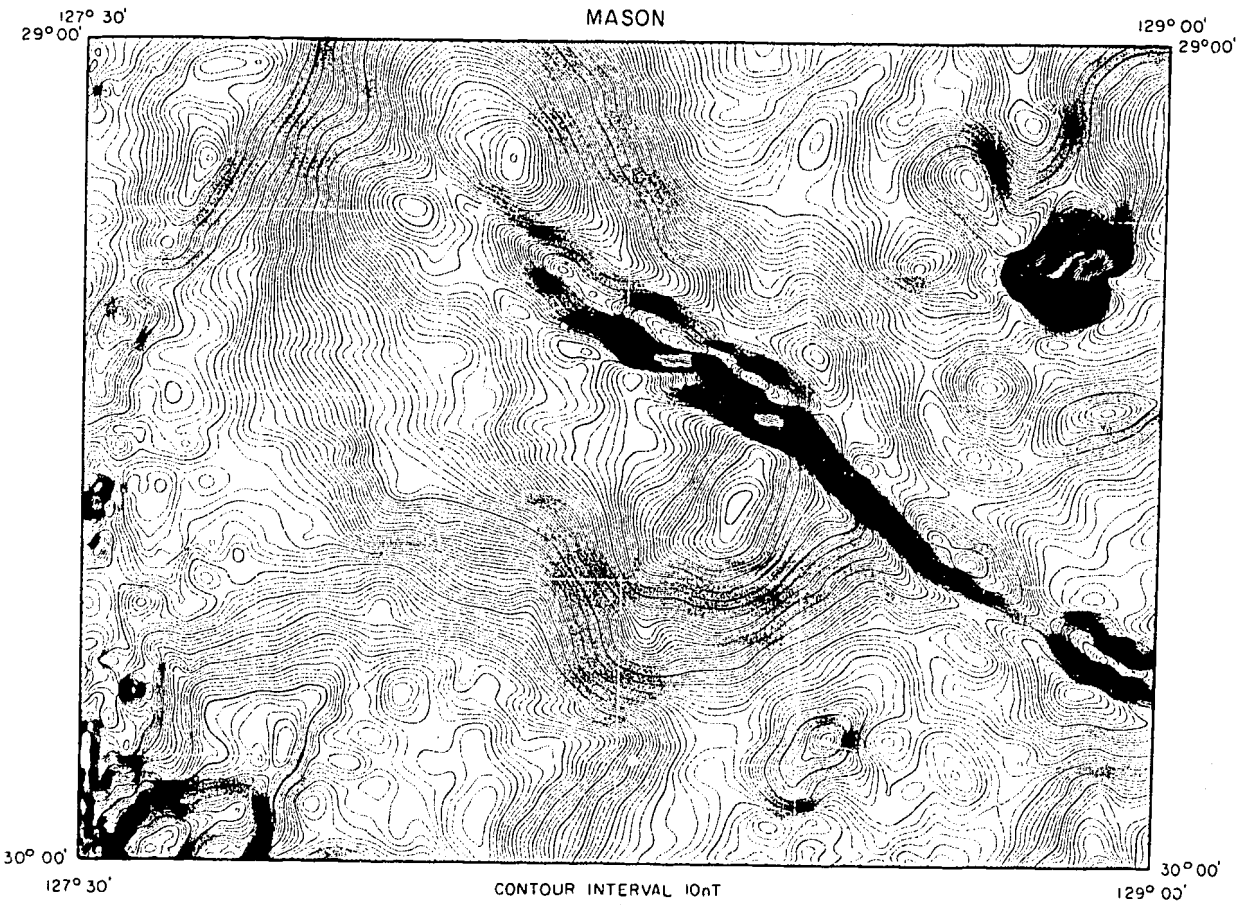
REFERENCE TO 1:250 000 MAP SERIES

LENNIS	WAIGEN	BIRKSGATE
VERNON	WANNA	NOORINA
JUBILEE	MASON	WYOLA

Record No. 1978/97, 1979/73 & Report 213

H52/BI-49AR

MA 25



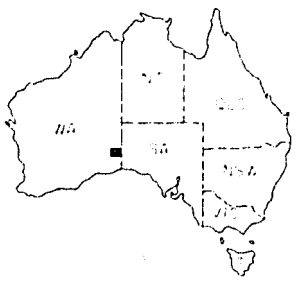
AIRBORNE SURVEY, OFFICER BASIN, WA 1977

TOTAL MAGNETIC INTENSITY

SCALE 1 : 1 000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM



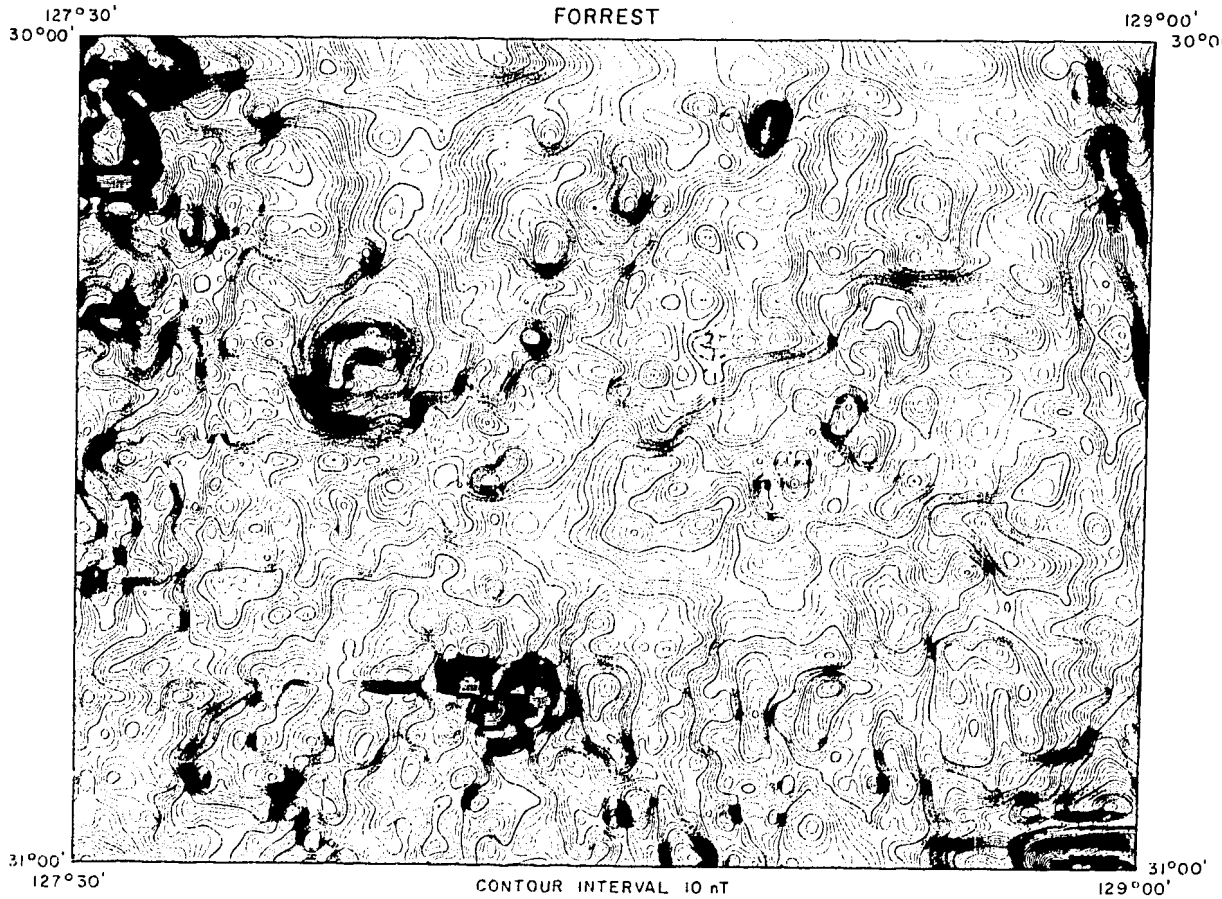
REFERENCE TO 1:250 000 MAP SERIES

VERNON	WANNA	NOORINA
JUBILEE	MASON	WYOLA
LOONGANA	FORREST	COOK

Record No 1979/73

H52/BI-55AR

MA 26



AIRBORNE SURVEY, OFFICER BASIN, WA 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

LOCATION DIAGRAM

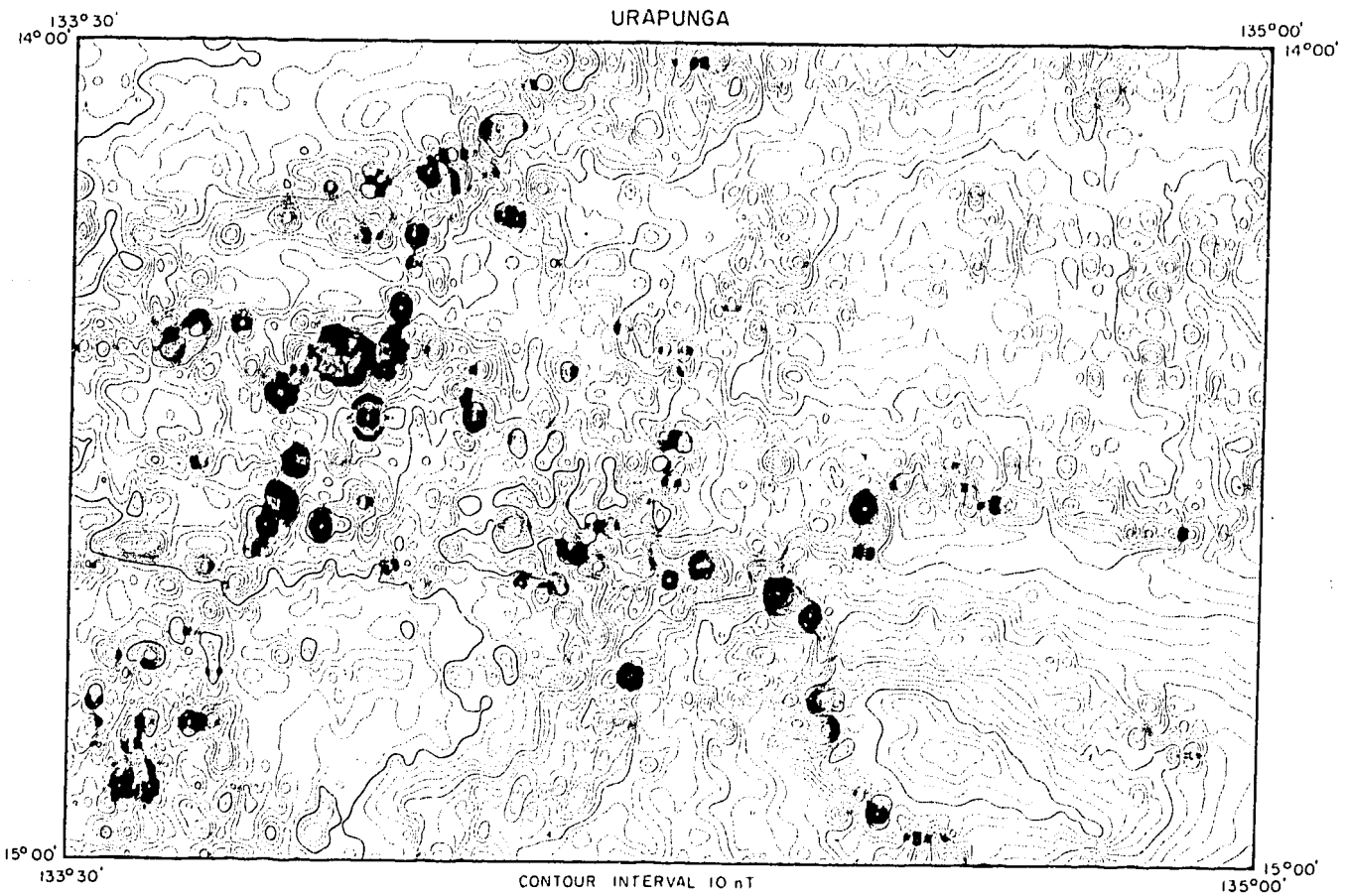
REFERENCE TO 1:250 000 MAP SERIES

JUBILEE	MASON	WYOLA
LOONGANA	FORREST	COOK
MADURA	EUCLA	COOMPANA

Record No 1979/73

H52/BI-58 AR

MA 27



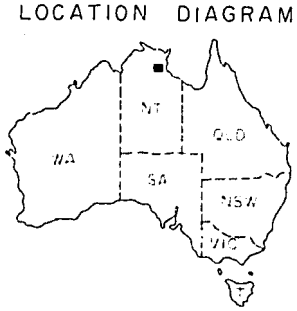
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



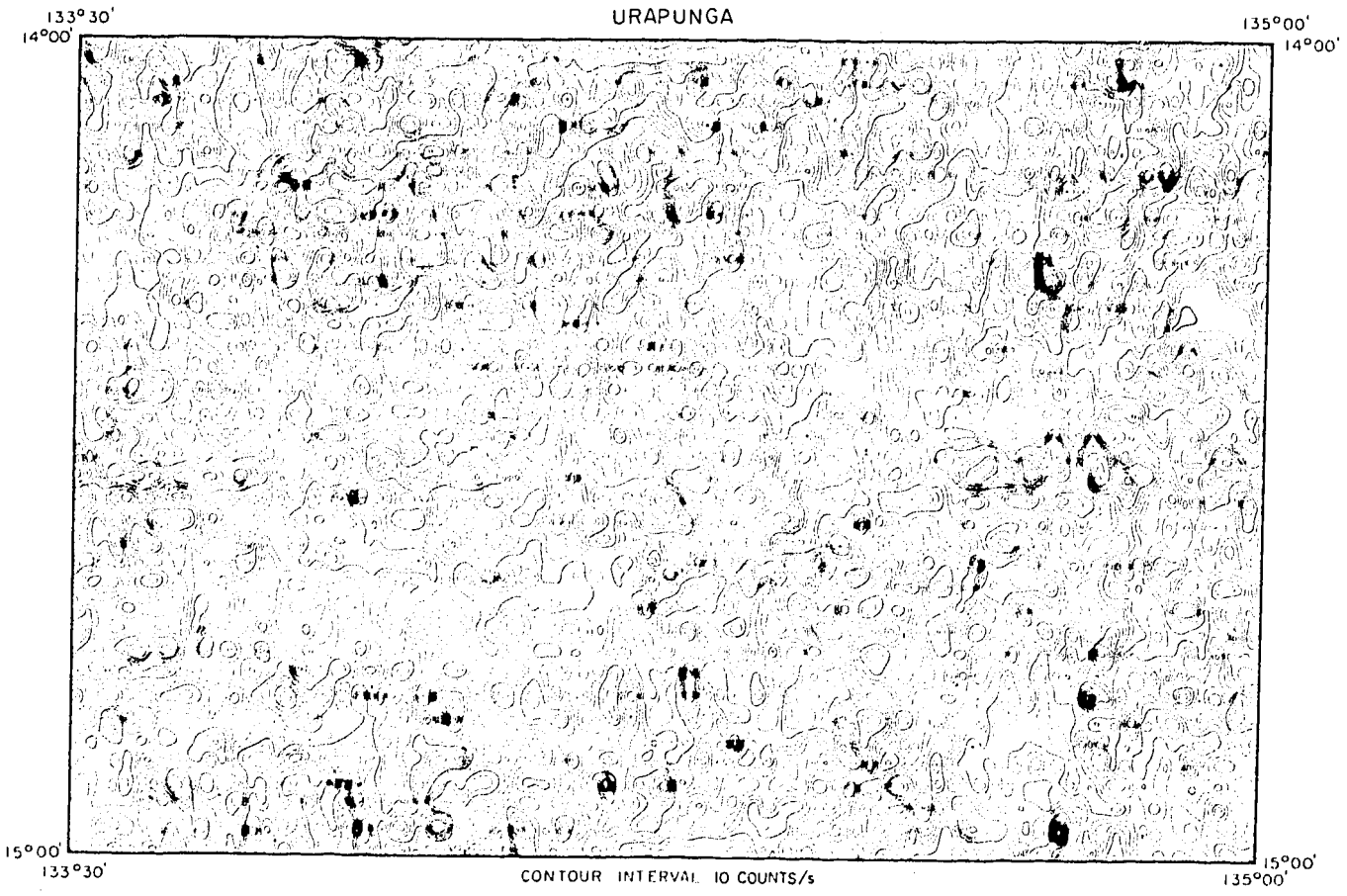
REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1978/97, 1979/73 & Report 213

D53/B1-96AR

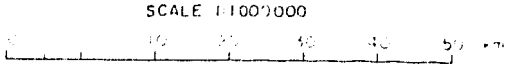
MA 28



AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:100'000



LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

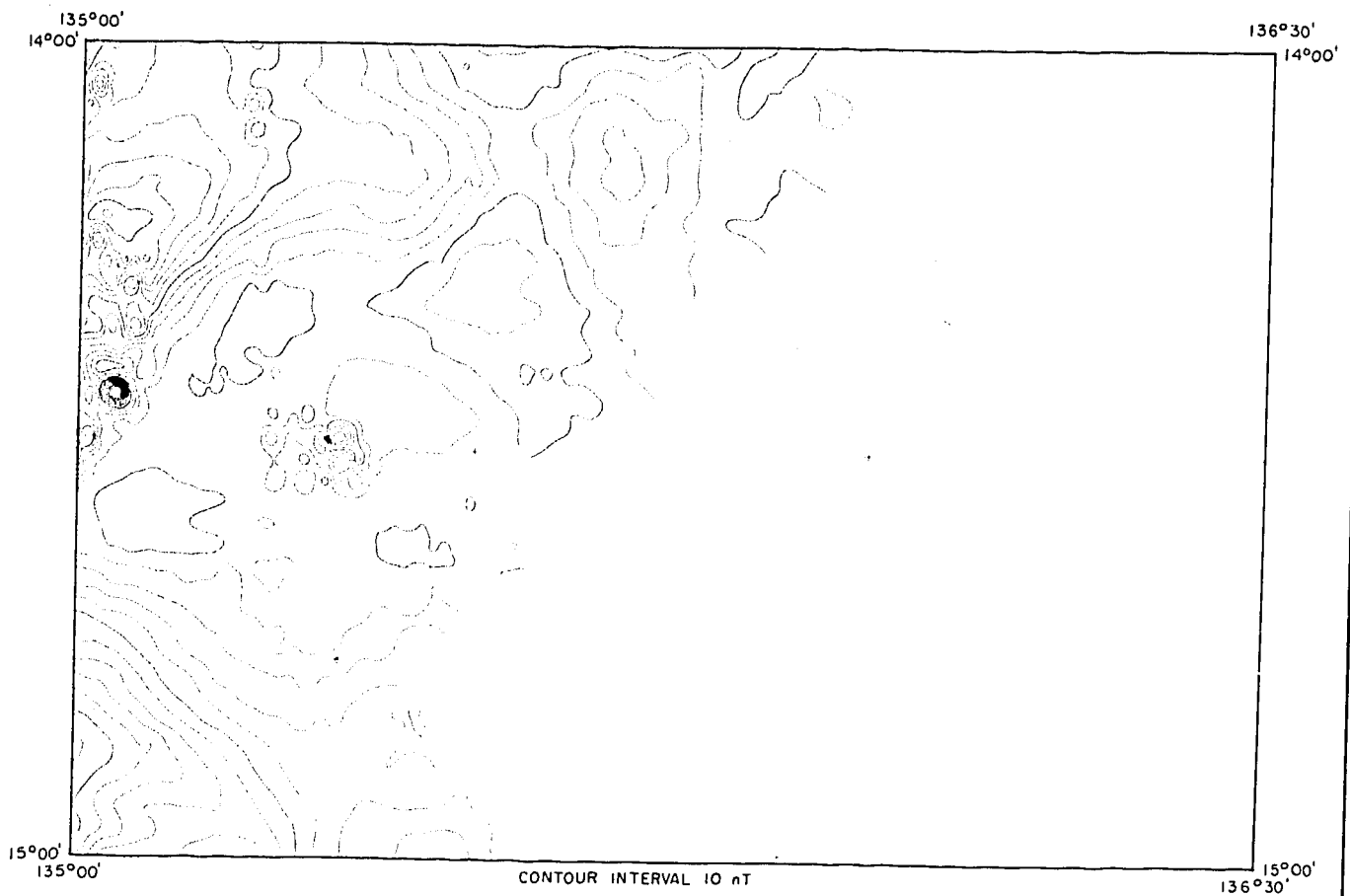
MT EVELYN	MT MARUMBA	BLUE MUD BAY
KATHERINE	URAPUNGA	ROPER RIVER
LARRIMAH	HODGSON DOWNS	MT YOUNG

Record No. 1978/97, 1979/73 & Report 213

D53/B1-103AR

MA 29

ROPER RIVER



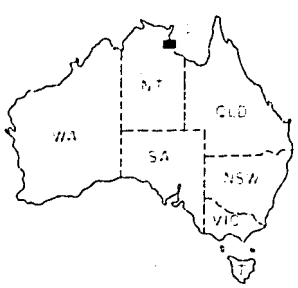
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

40 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

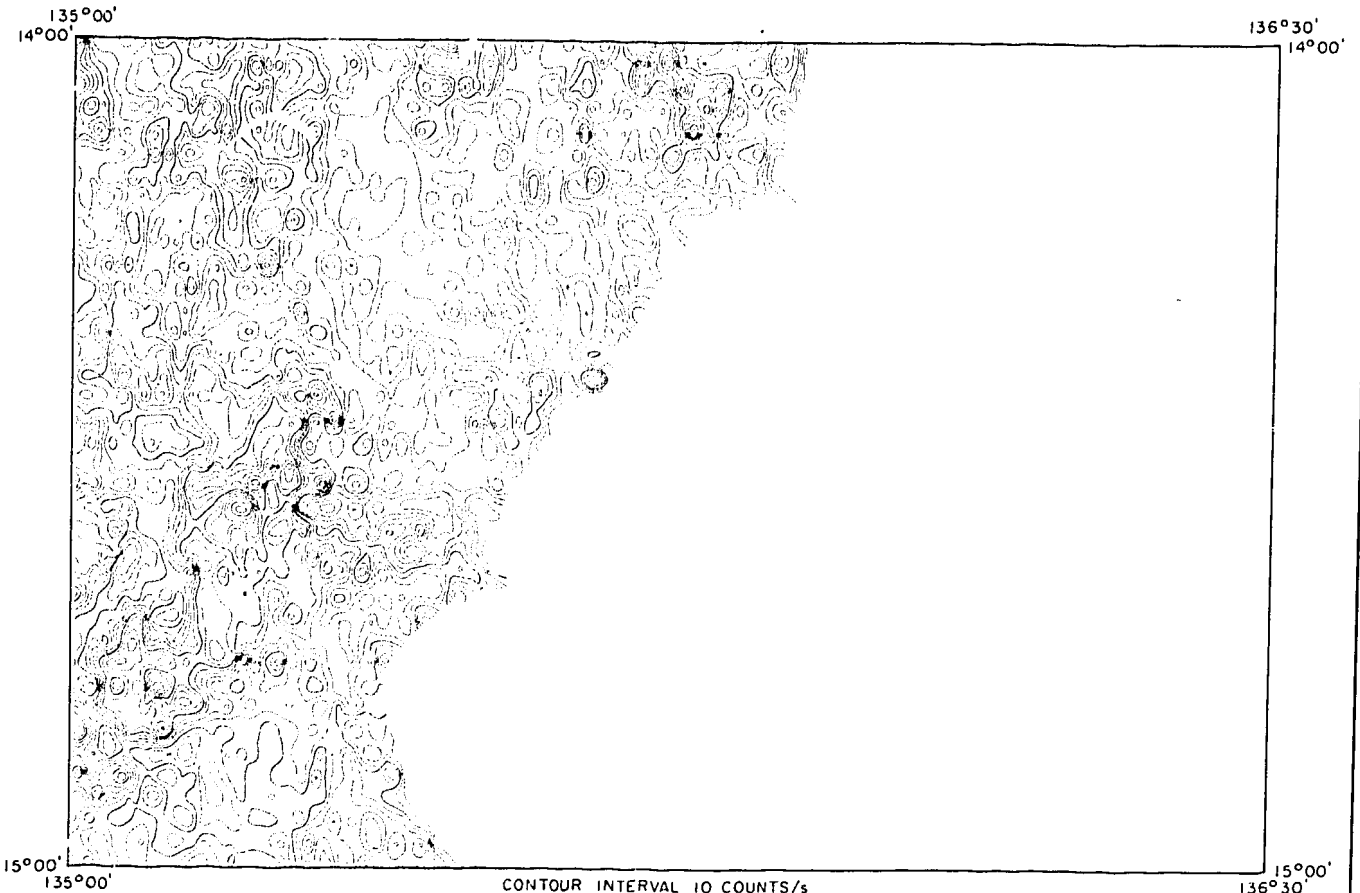
MOUNT MARUMBA	BLUE MUD BAY	PORT LANGDON
URAPUNGA	ROPER RIVER	CAPE BEATRICE
HODGSON DOWNS	MOUNT YOUNG	PELLEW

Record No. 1978/97, 1979/73 & Report 213

D53/BI-108AR

MA 30

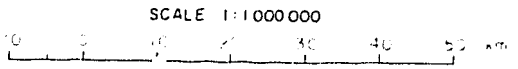
ROPER RIVER



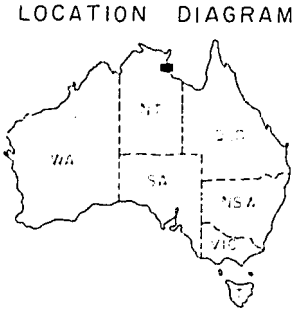
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000



LOCATION DIAGRAM



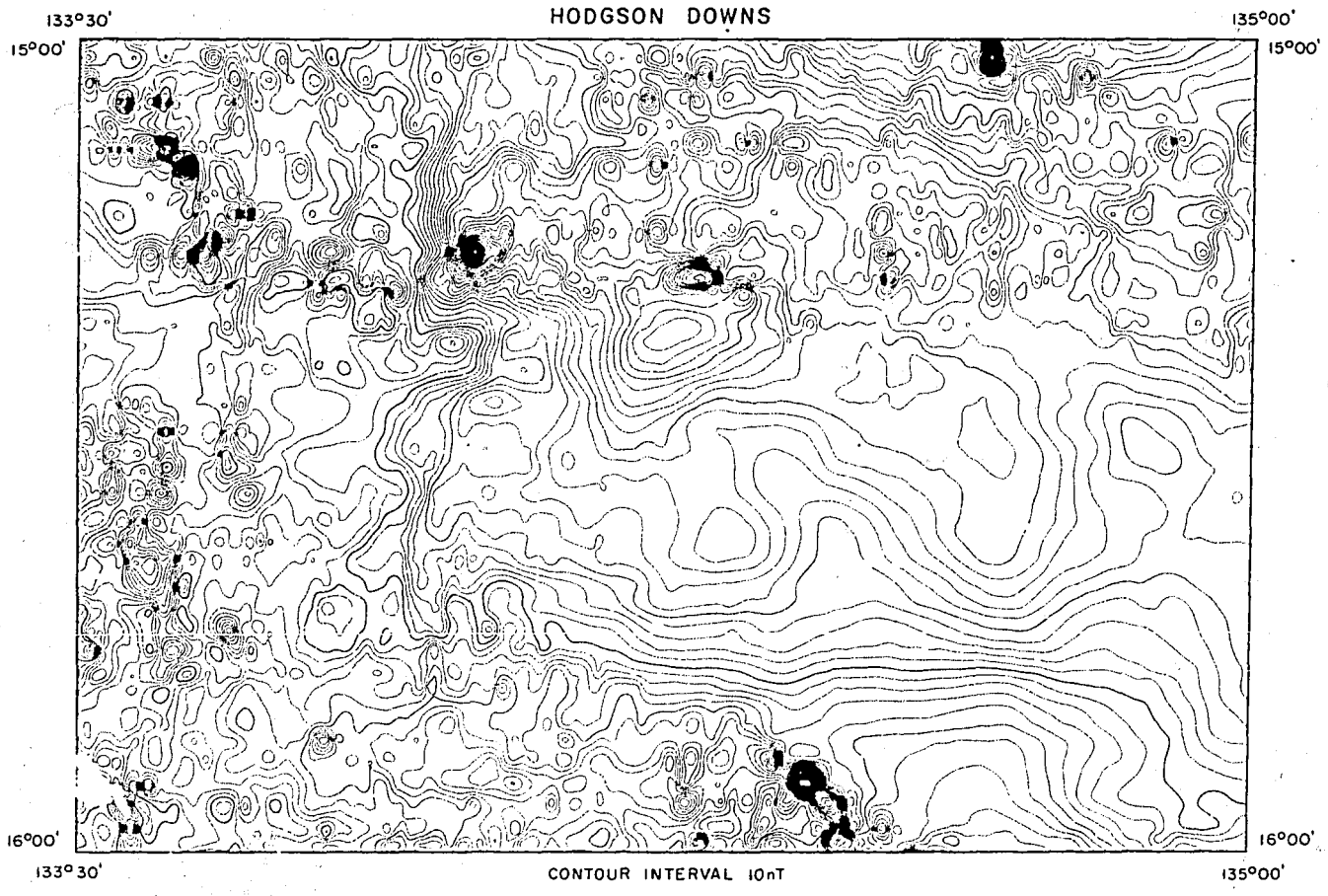
REFERENCE TO 1:250 000 MAP SERIES

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

Record No. 1978/97, 1979/73 & Report 213

D53/B1-115AR

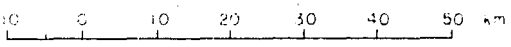
MA 31



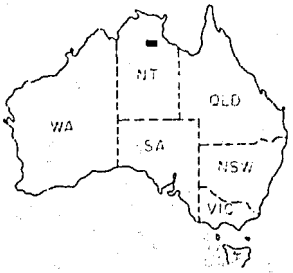
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000



LOCATION DIAGRAM

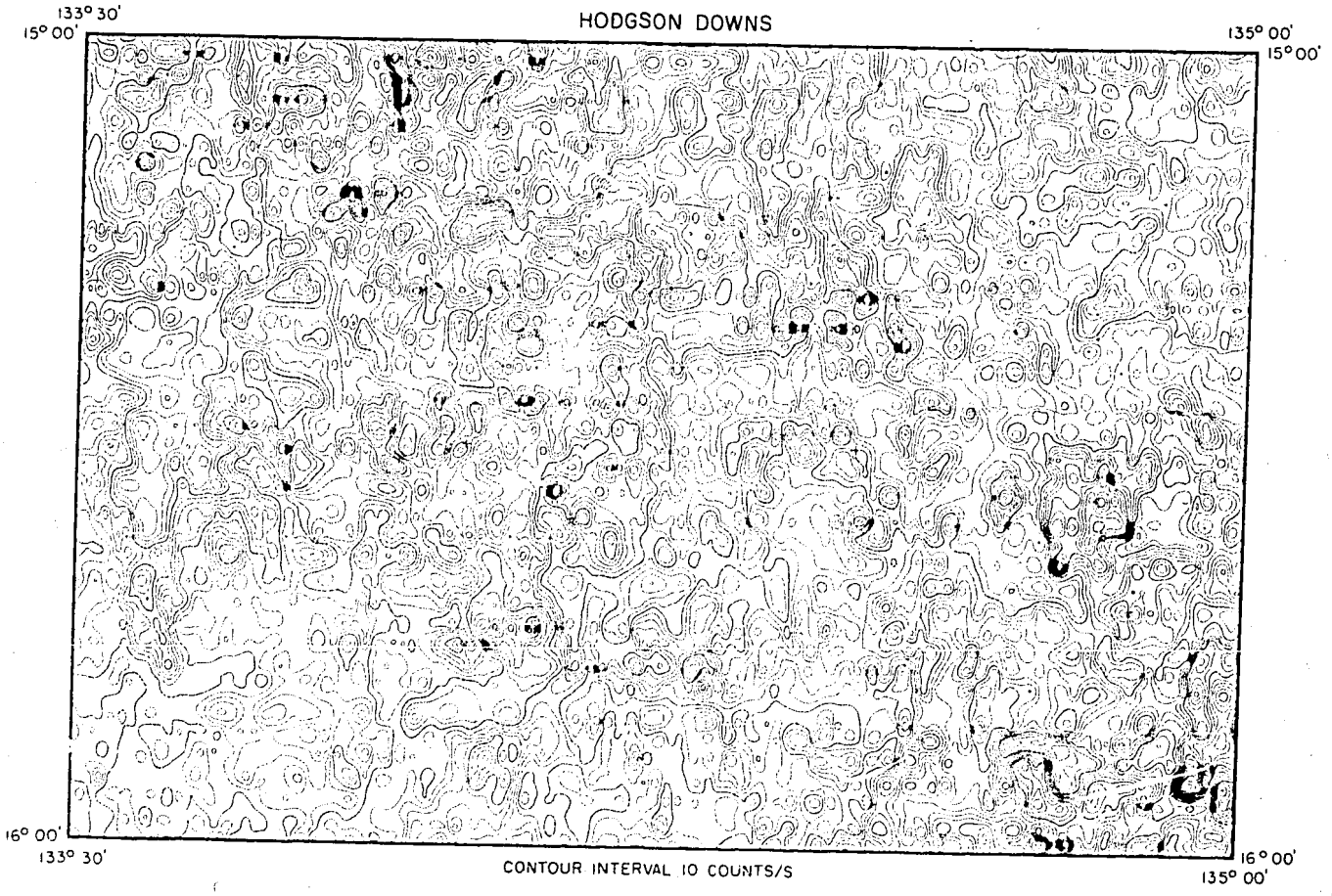


REFERENCE TO 1:250 000 MAP SERIES

KATHERINE	URAPUNGA	ROPER RIVER
LARRIMAH	HODGSON DOWNS	MOUNT YOUNG
DALY WATERS	TANUMBIRINI	BAUHINIA DOWNS

Record No 1979/73

MA 32



AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

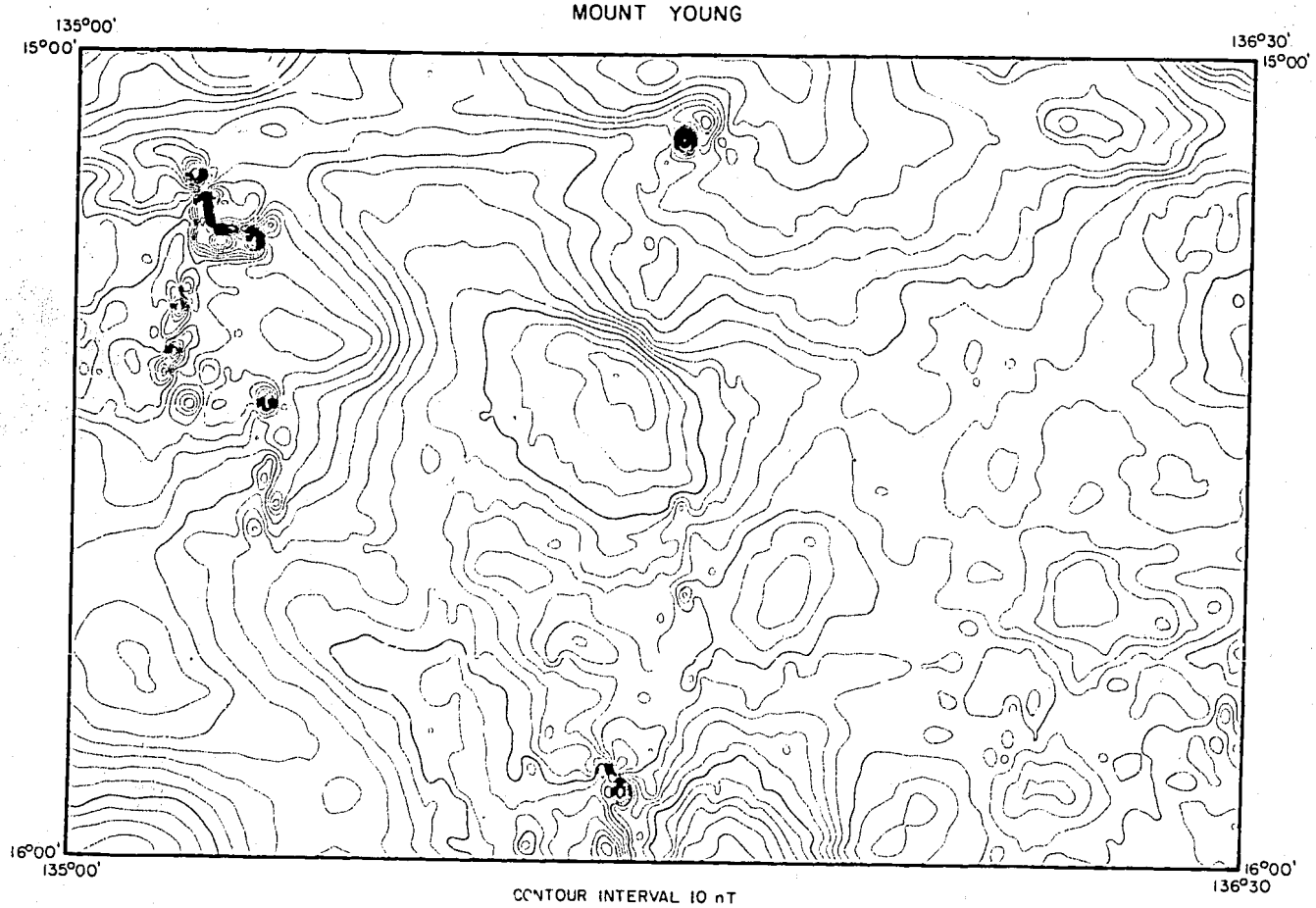
KATHERINE	URAPUNGA	ROPER RIVER
LARRIMAH	HODGSON DOWNS	MOUNT YOUNG
DALY WATERS	TANUMBIRINI	BAUHINIA DOWNS

Record No 1979/73

D53/BI-127AR

MA 33

MOUNT YOUNG



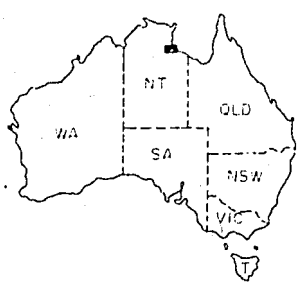
AIRBORNE SURVEY, Mc ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



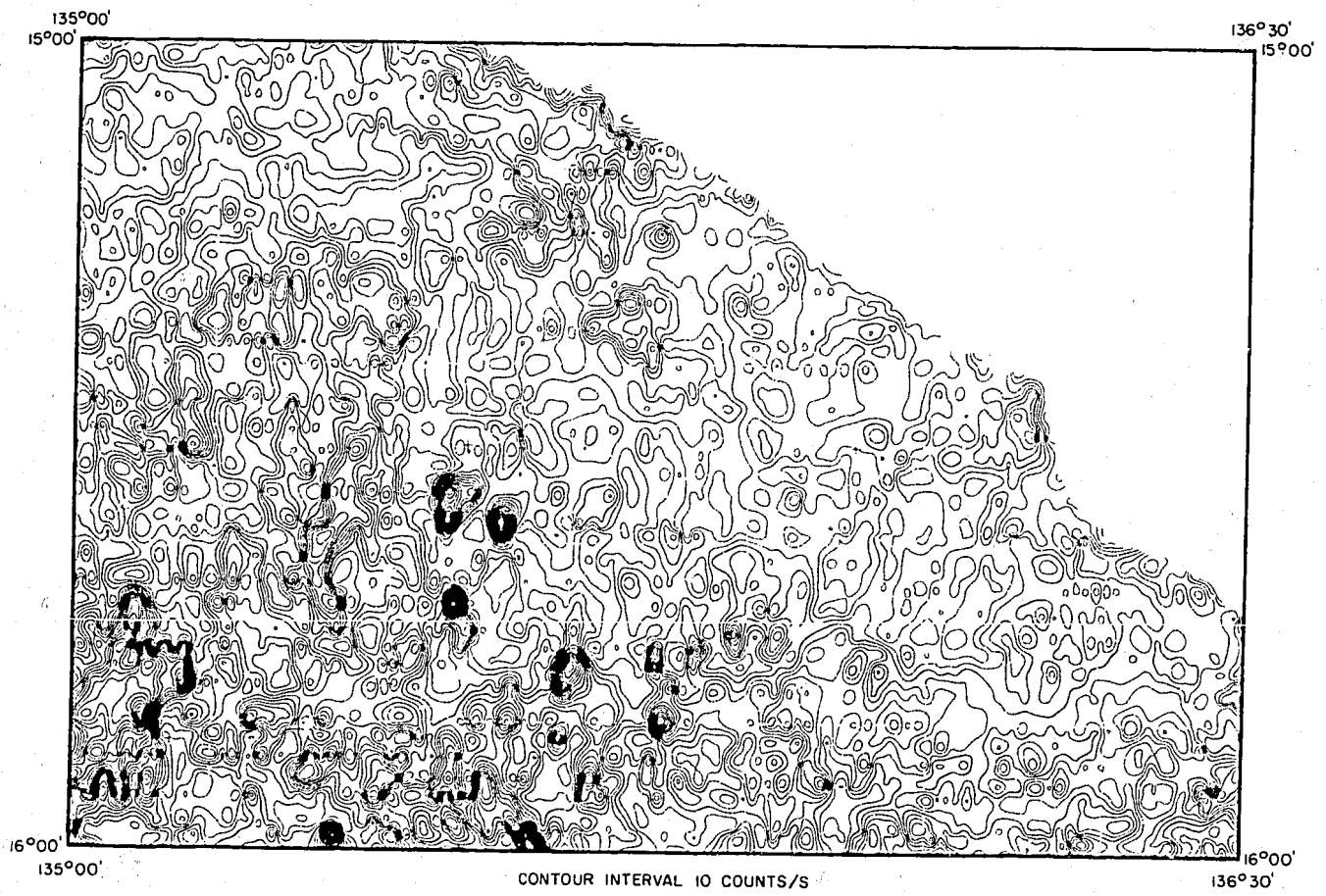
REFERENCE TO 1:250 000 MAP SERIES

URAPUNGA	ROPER RIVER	CAPE BEATRICE
HODGSON DOWNS	MOUNT YOUNG	PELLEW
TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER

Record No 1979/73

MA 34

MOUNT YOUNG



AIRBORNE SURVEY, Mc ARTHUR BASIN, NT 1977

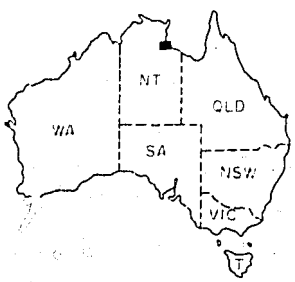
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

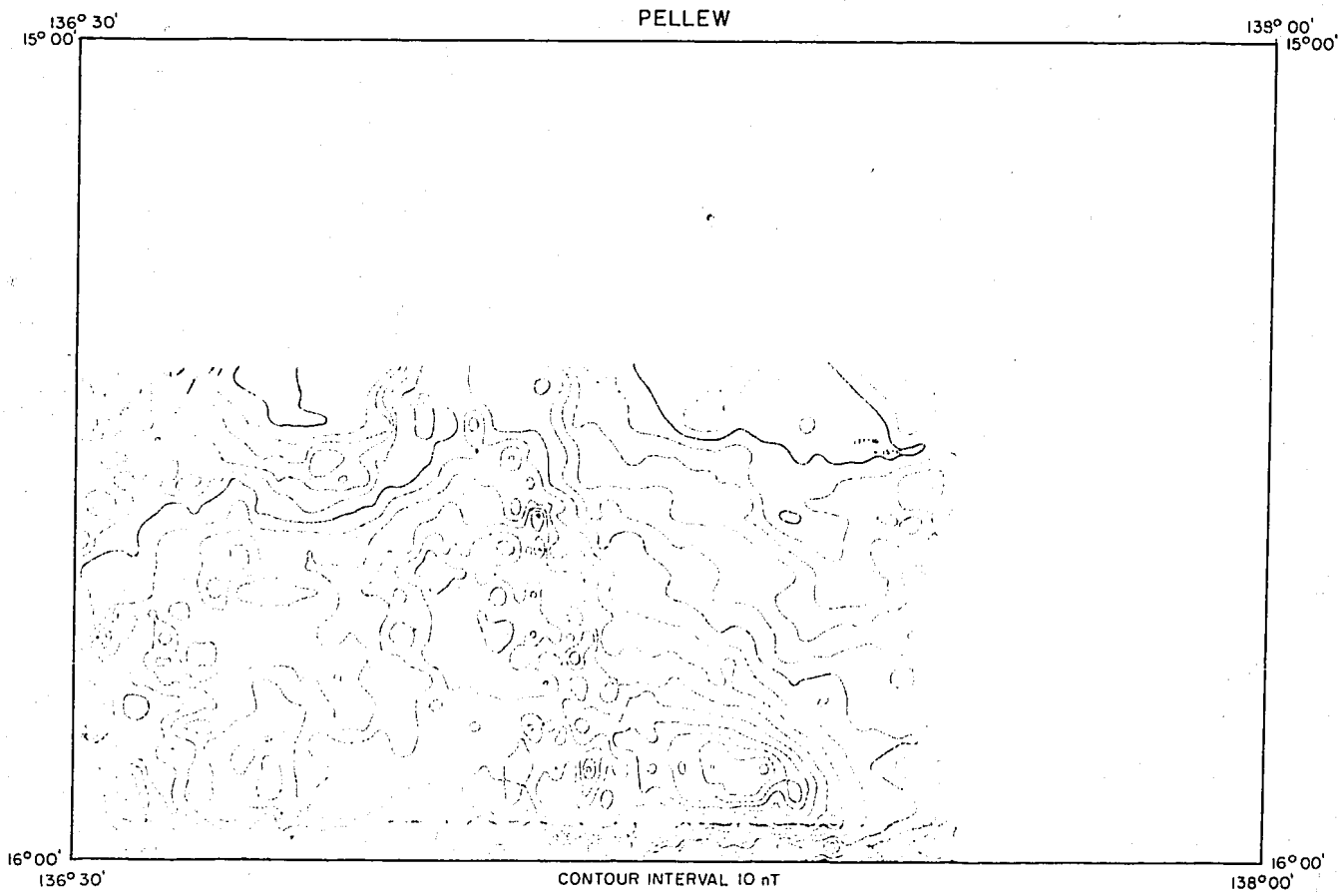


REFERENCE TO 1:250 000 MAP SERIES

URAPUNGA	ROPER RIVER	CAPE BEATRICE
HODGSON DOWNS	MOUNT YOUNG	PELLEW
TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER

Record No 1979/73

MA 35



AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

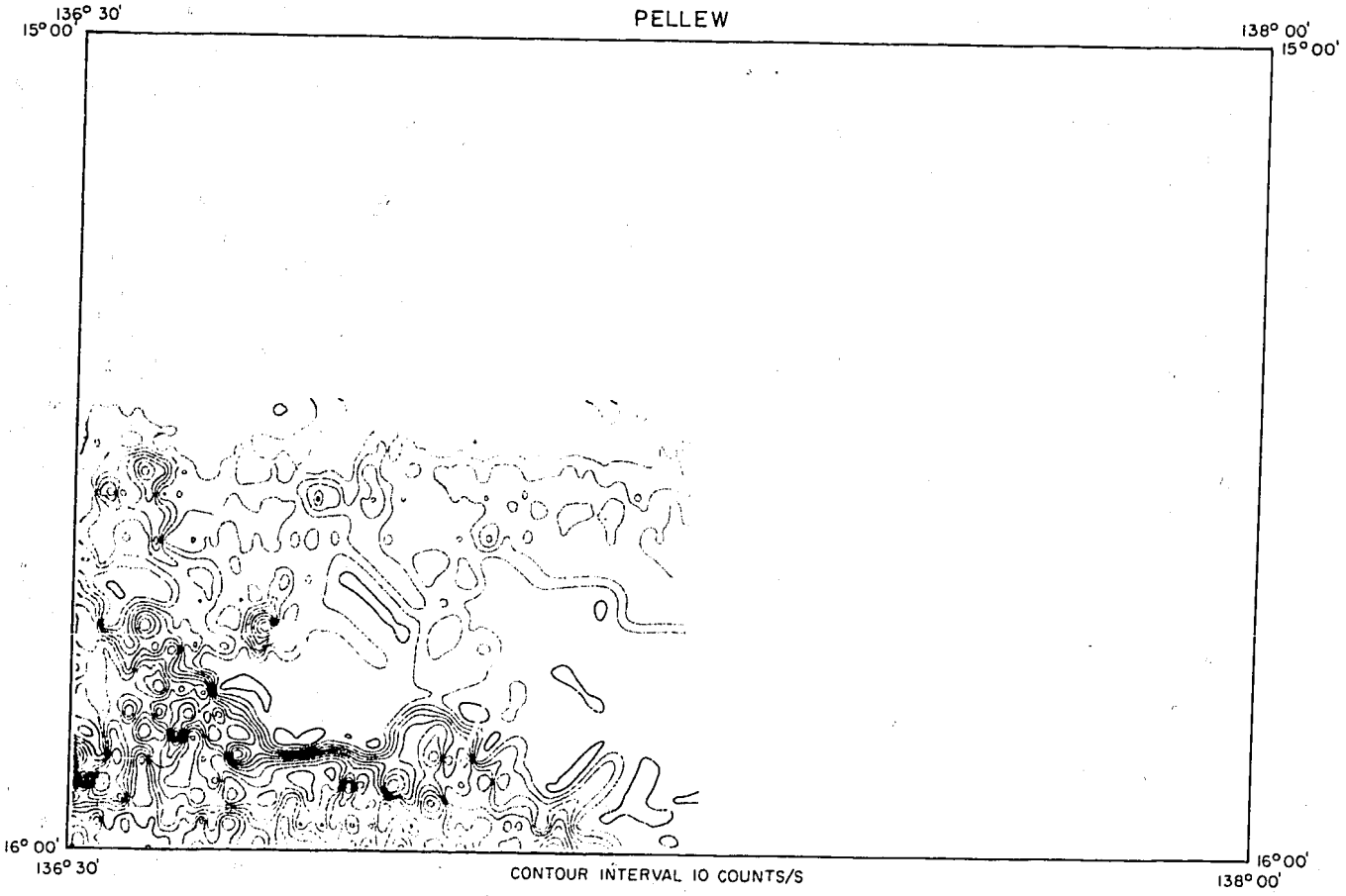
LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

ROPER RIVER	CAPE BEATRICE	
MOUNT YOUNG	PELLEW	
BAUHINIA DOWNS	ROBINSON RIVER	

Record No 1979/73

MA 36



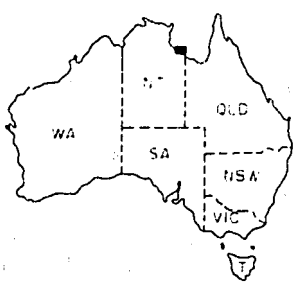
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM



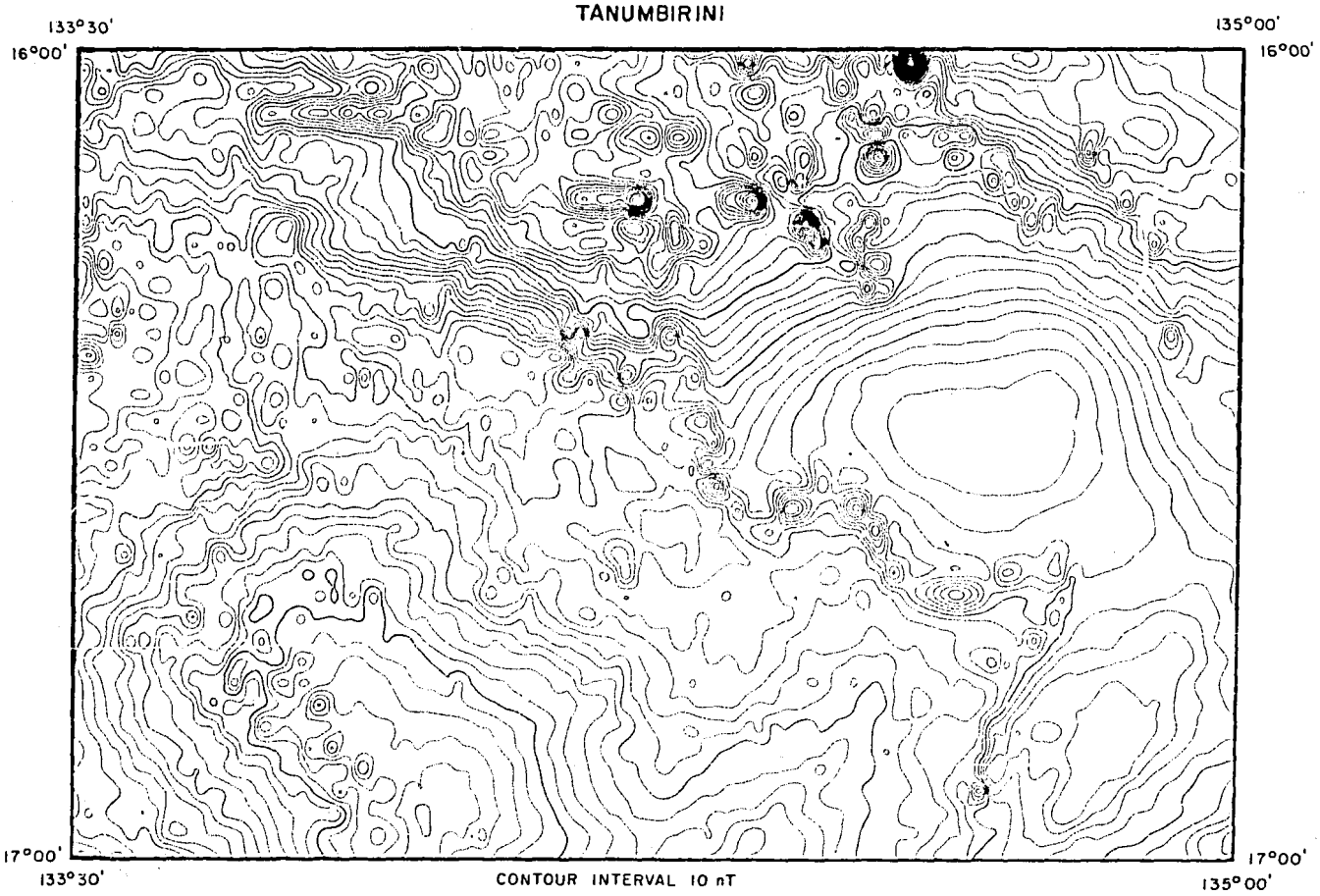
REFERENCE TO 1:250 000 MAP SERIES

ROPER RIVER	CAPE BEATRICE	
MOUNT YOUNG	PELLEW	
BAUHINIA DOWNS	ROBINSON RIVER	

Record No 1979/73

MA 37

TANUMBIRINI



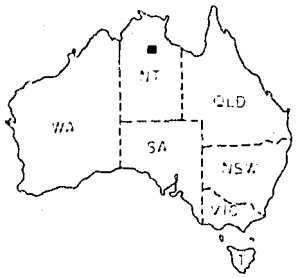
AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



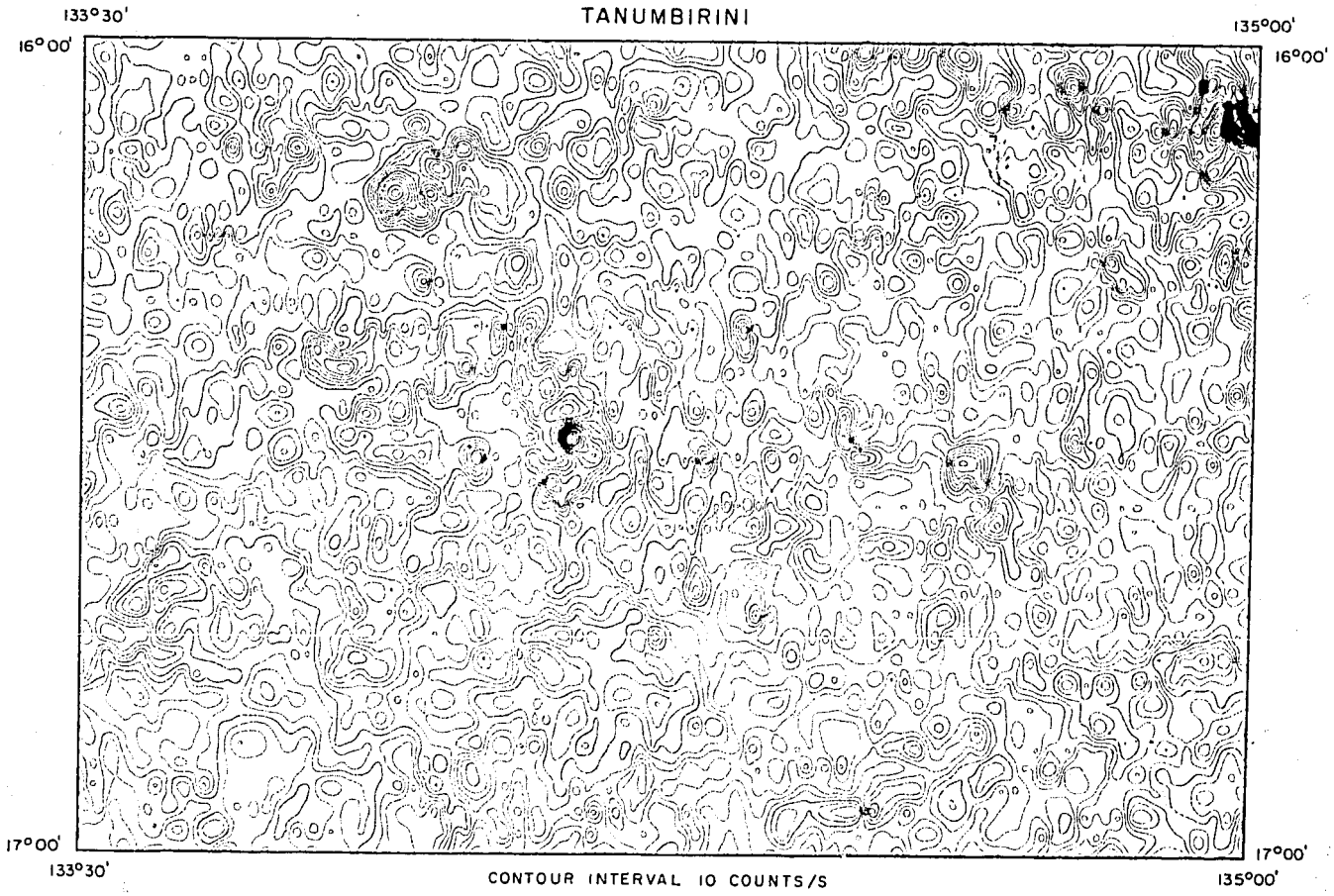
REFERENCE TO 1:250 000 MAP SERIES

LARRIMAH	HODGSON DOWNS	MOUNT YOUNG
DALY WATERS	TANUMBIRINI	BAUHINIA DOWNS
NEWCASTLE WATERS	BEETALOO	WALLHALLOW

Record No 1979/73

E53/B1-86AR

MA 38



AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

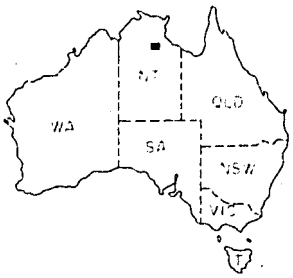
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



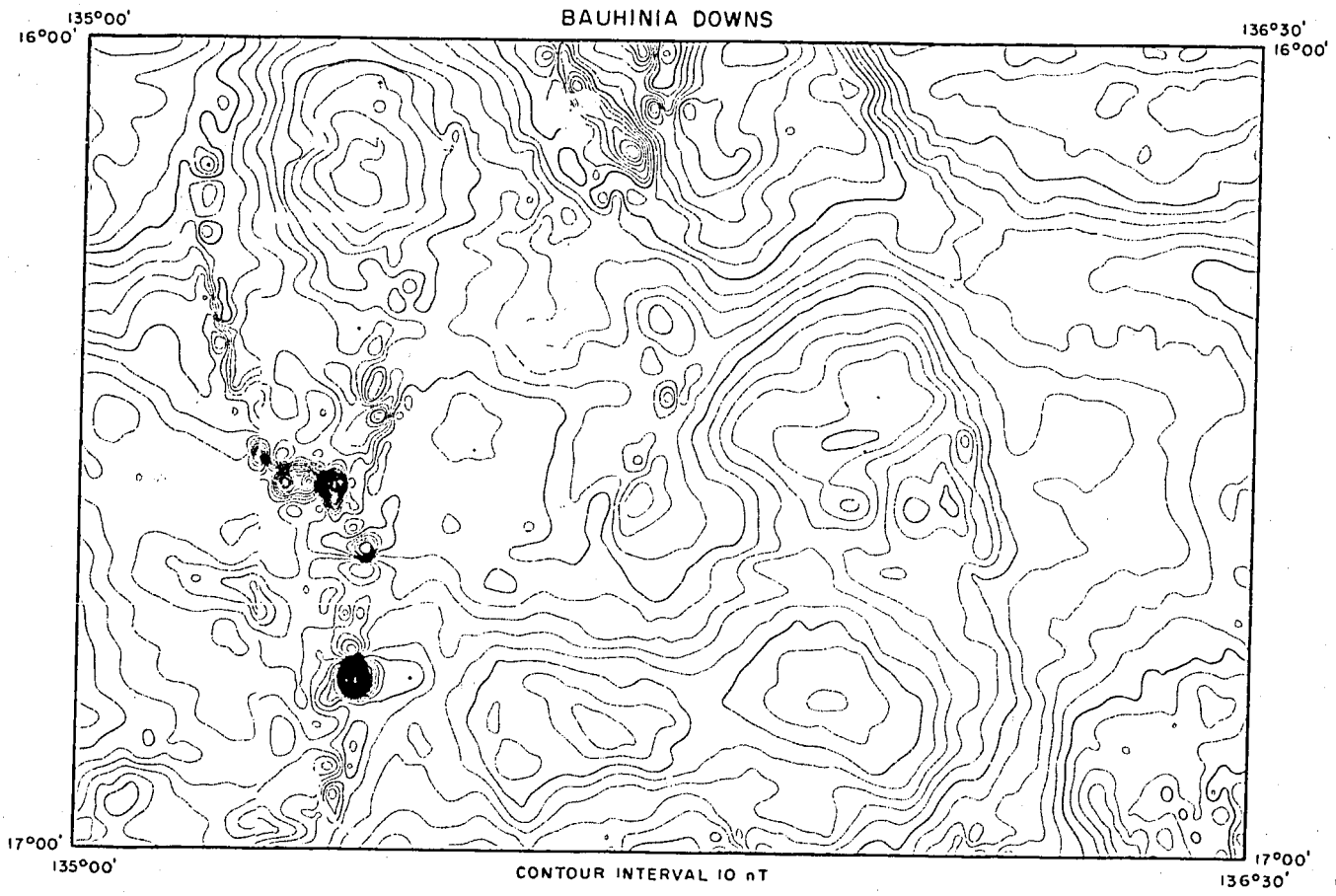
REFERENCE TO 1:250 000 MAP SERIES

LARRIMAH	HODGSON DOWNS	MOUNT YOUNG
DALY WATERS	TANUMBIRINI	BAUHINIA DOWNS
NEWCASTLE WATERS	BEETALOO	WALLHALLOW

Record No 1979/73

E53/B1-93 AR

MA 39



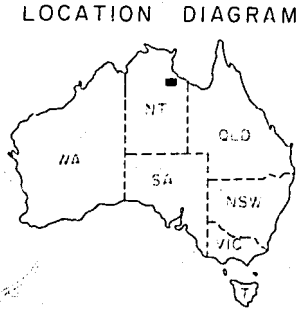
AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



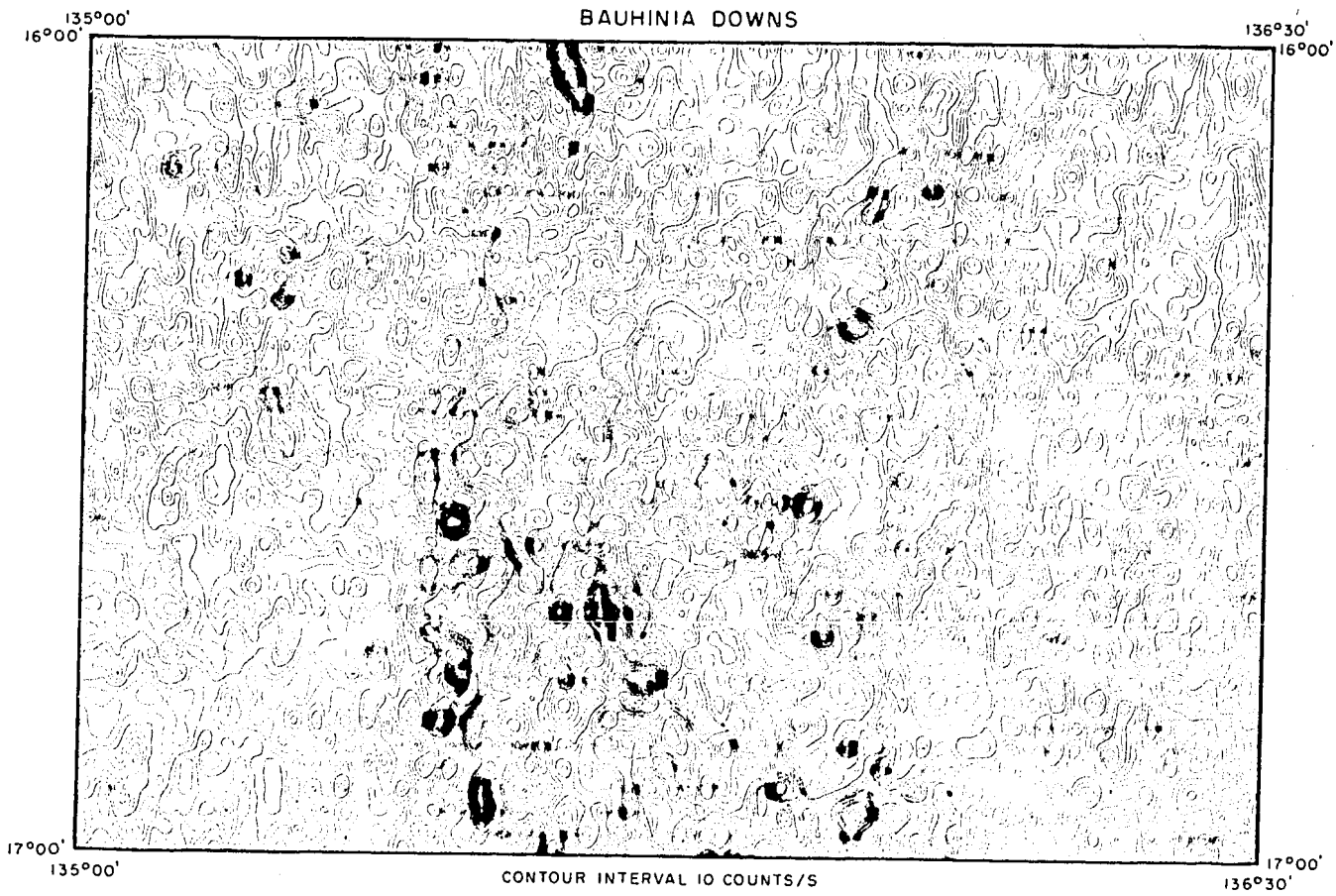
REFERENCE TO 1:250 000 MAP SERIES

HODGSON DOWNS	MOUNT YOUNG	PELLEW
TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER
BEETALOO	WALLHALLOW	CALVERT HILLS

Record No 1979/73

E53/81-98AR

MA 40



AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM

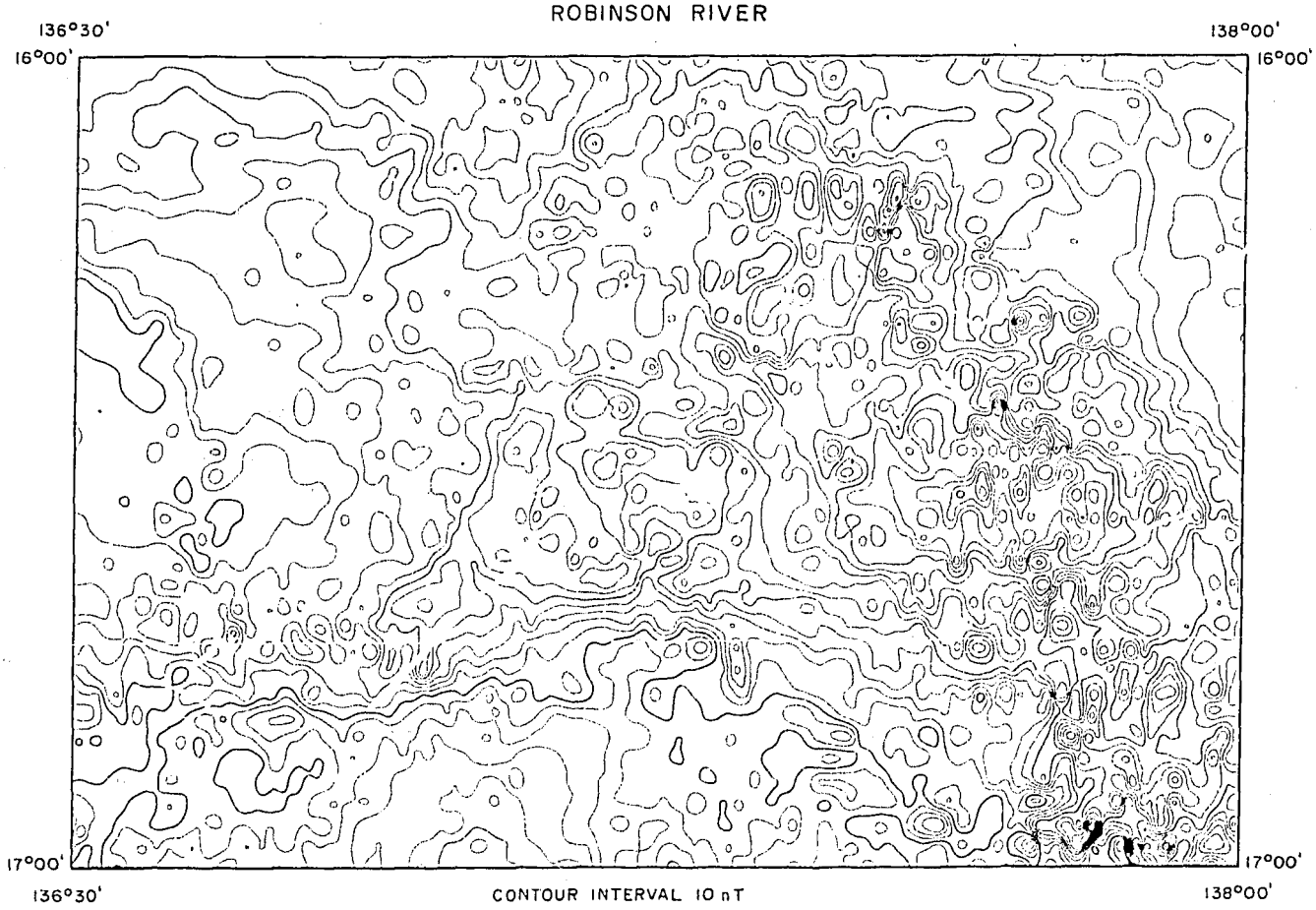
REFERENCE TO 1:250 000 MAP SERIES

HODGSON DOWNS	MOUNT YOUNG	PELLEW
TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER
BEETALOO	WALLHALLOW	CALVERT HILLS

Record No 1979/73

MA 41

ROBINSON RIVER



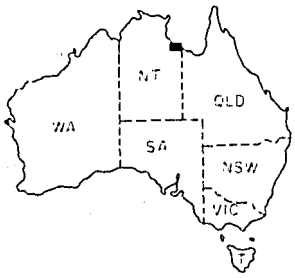
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



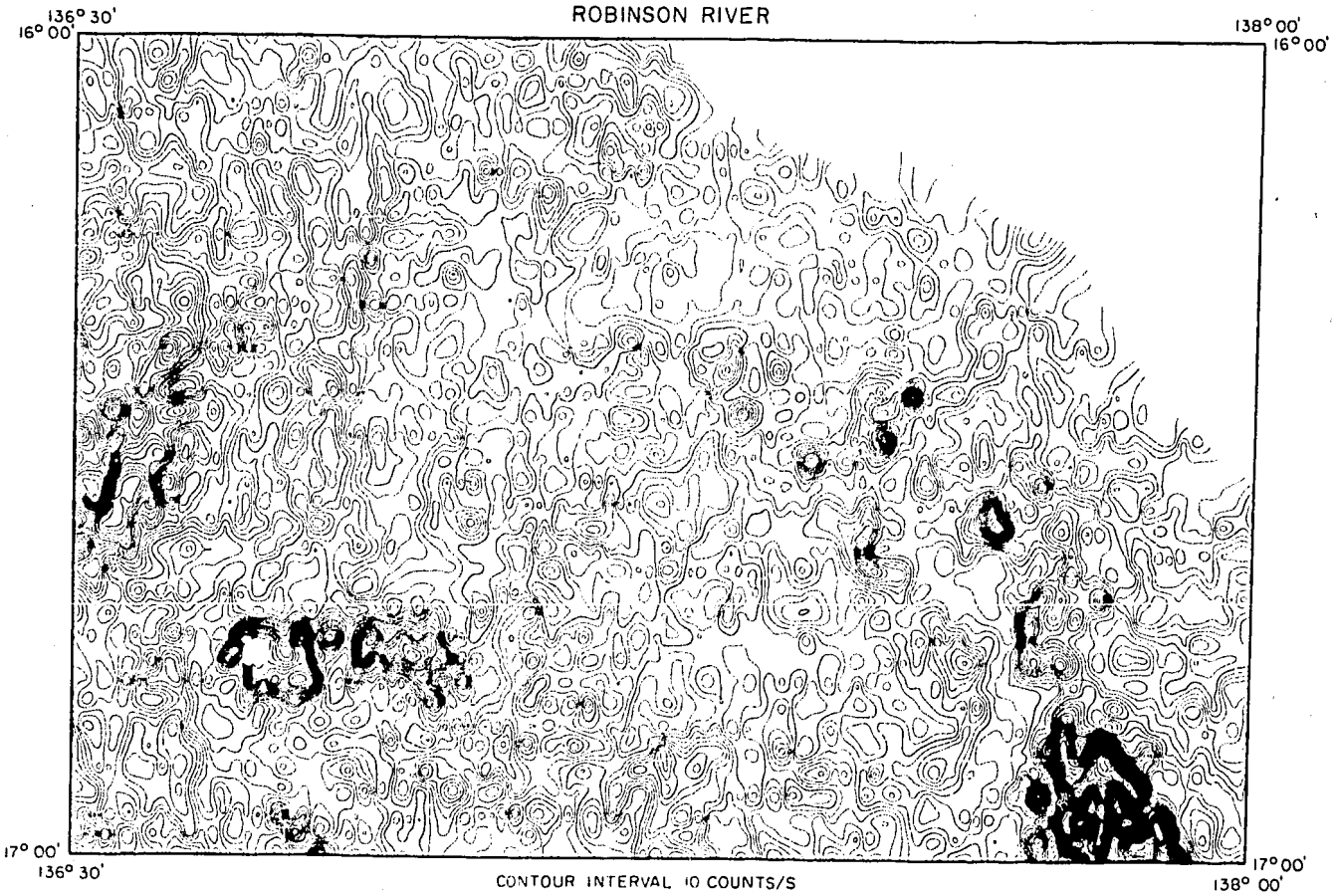
REFERENCE TO 1:250 000 MAP SERIES

MOUNT YOUNG	PELLEW	
BAUHINIA DOWNS	ROBINSON RIVER	MORNINGTON
WALLHALLOW	CALVERT HILLS	WEST-MORELAND

Record No 1979/73

E53/81-122 AR

MA 42



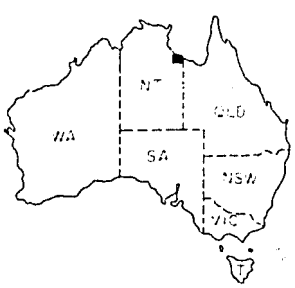
AIRBORNE SURVEY, McARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



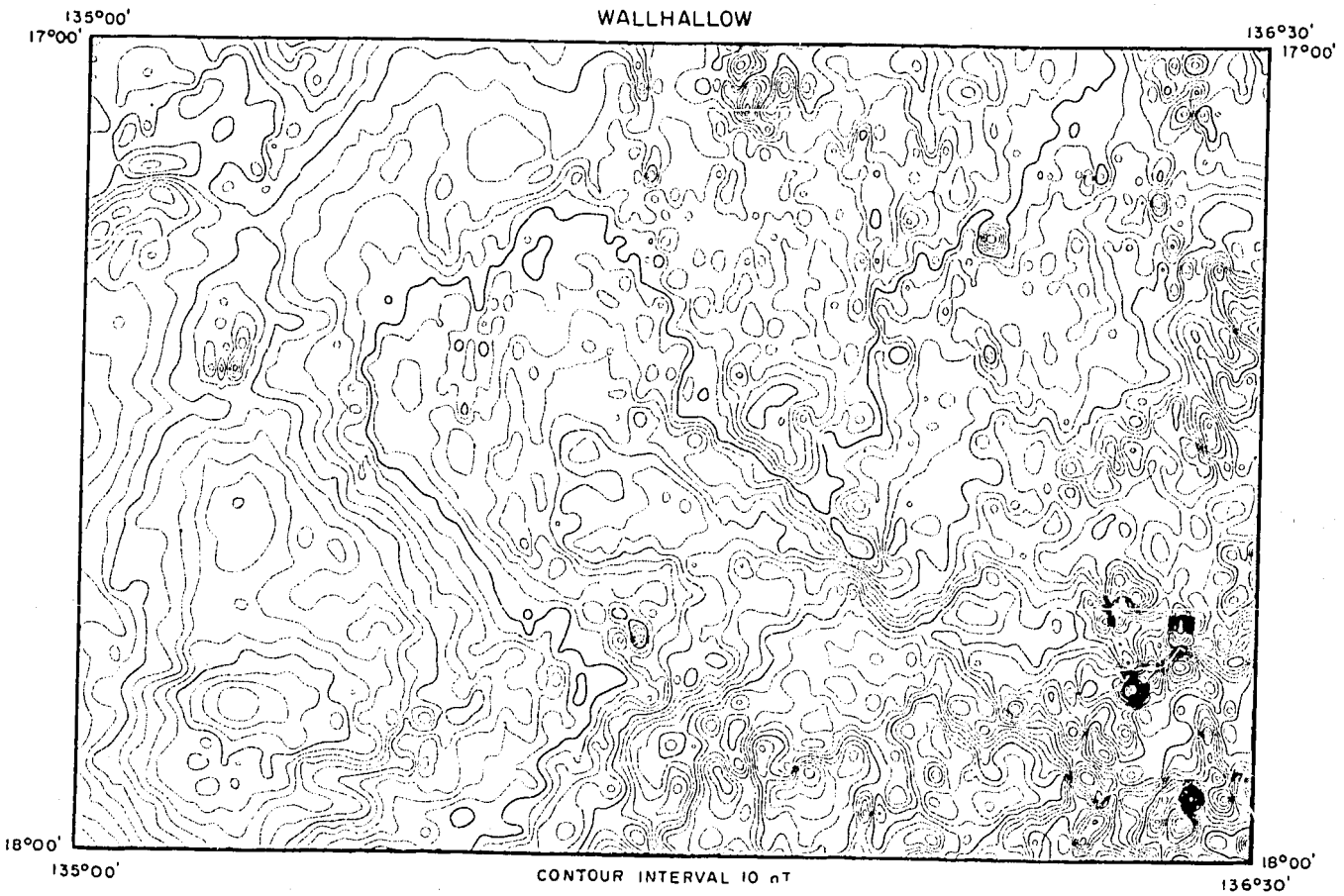
REFERENCE TO 1:250 000 MAP SERIES

MOUNT YOUNG	PELLEW	
BAUHINIA DOWNS	ROBINSON RIVER	MORNINGTON
WALLHALLOW	CALVERT HILLS	WESTMORELAND

Record No 1979/73

E53/81-120AR

MA 43



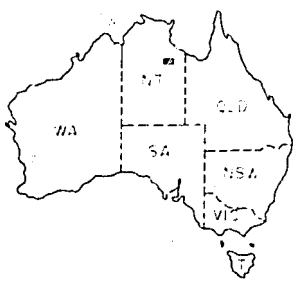
AIRBORNE SURVEY, MCARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM



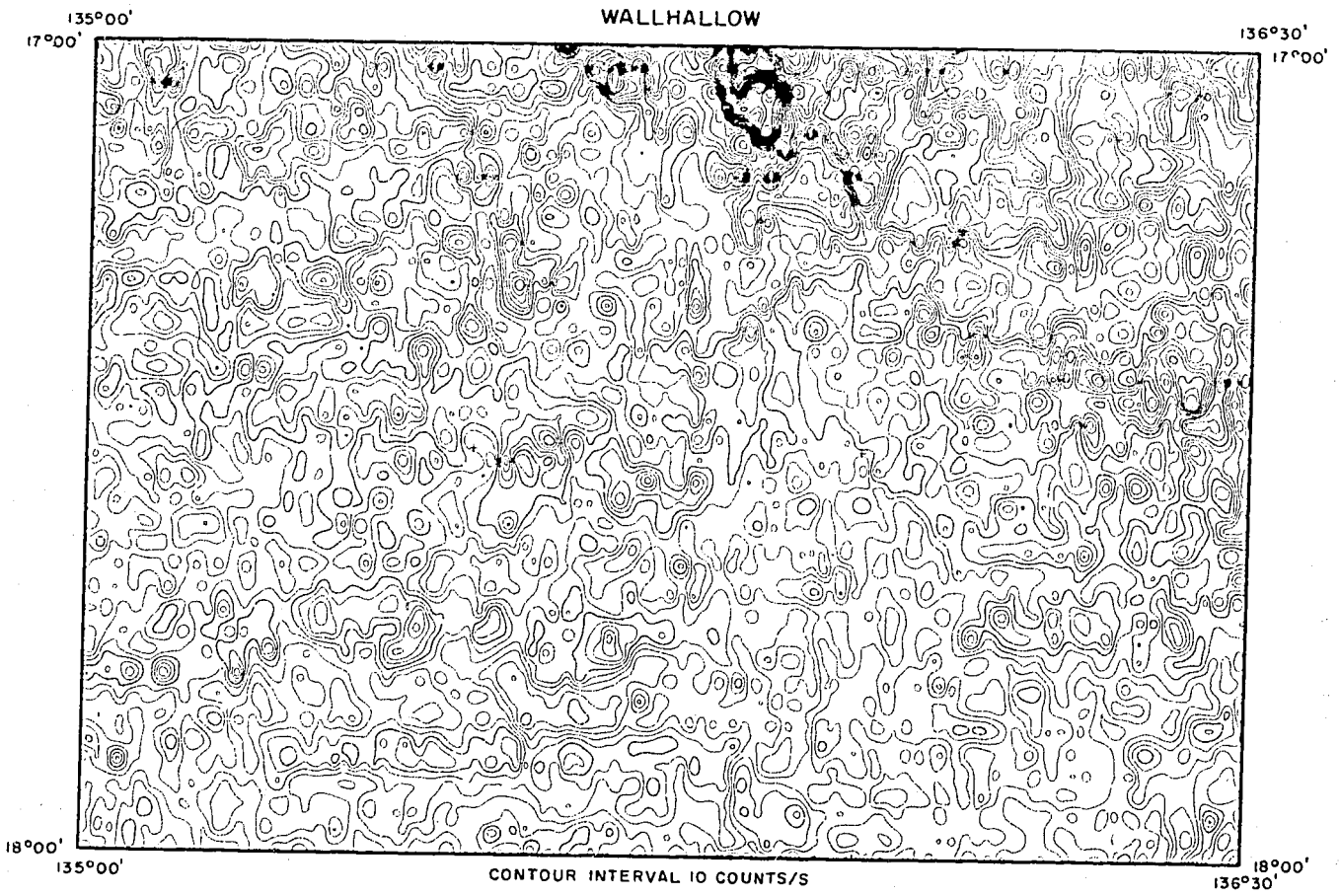
REFERENCE TO 1:250 000 MAP SERIES

TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER
BEETALOO	WALLHALLOW	CALVERT HILLS
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND

Record No 1979/73

E 53/BI-110 AR

MA 44



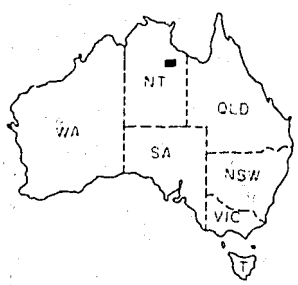
AIRBORNE SURVEY, MC ARTHUR BASIN, NT 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



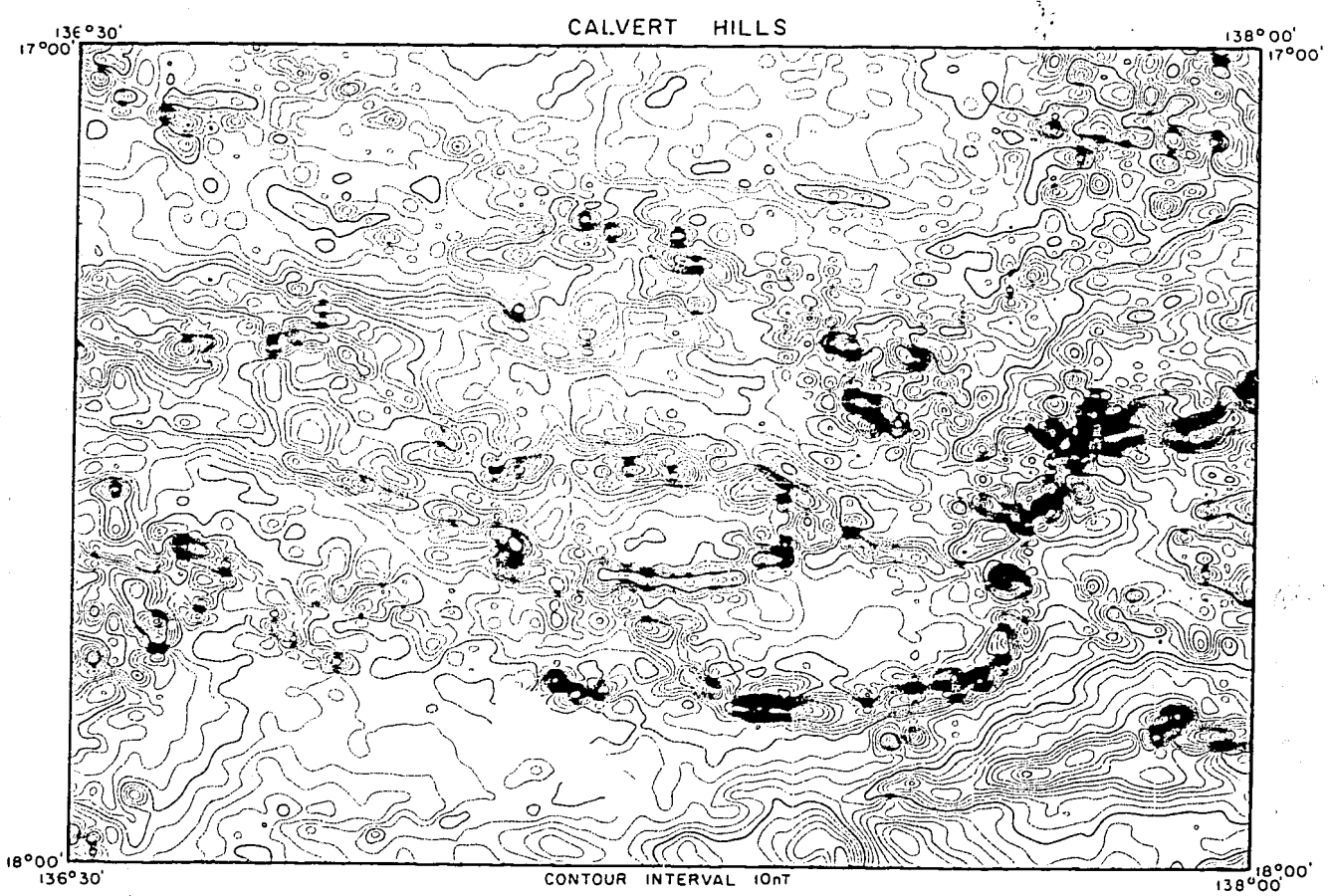
REFERENCE TO 1:250 000 MAP SERIES

TANUMBIRINI	BAUHINIA DOWNS	ROBINSON RIVER
BEETALOO	WALLHALLOW	CALVERT HILLS
HELEN SPRINGS	BRUNETTE DOWNS	MOUNT DRUMMOND

Record No 1979/73

E53/81-117 AR

MA 45



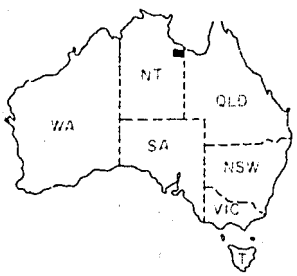
AIRBORNE SURVEY, Mc ARTHUR BASIN, NT 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



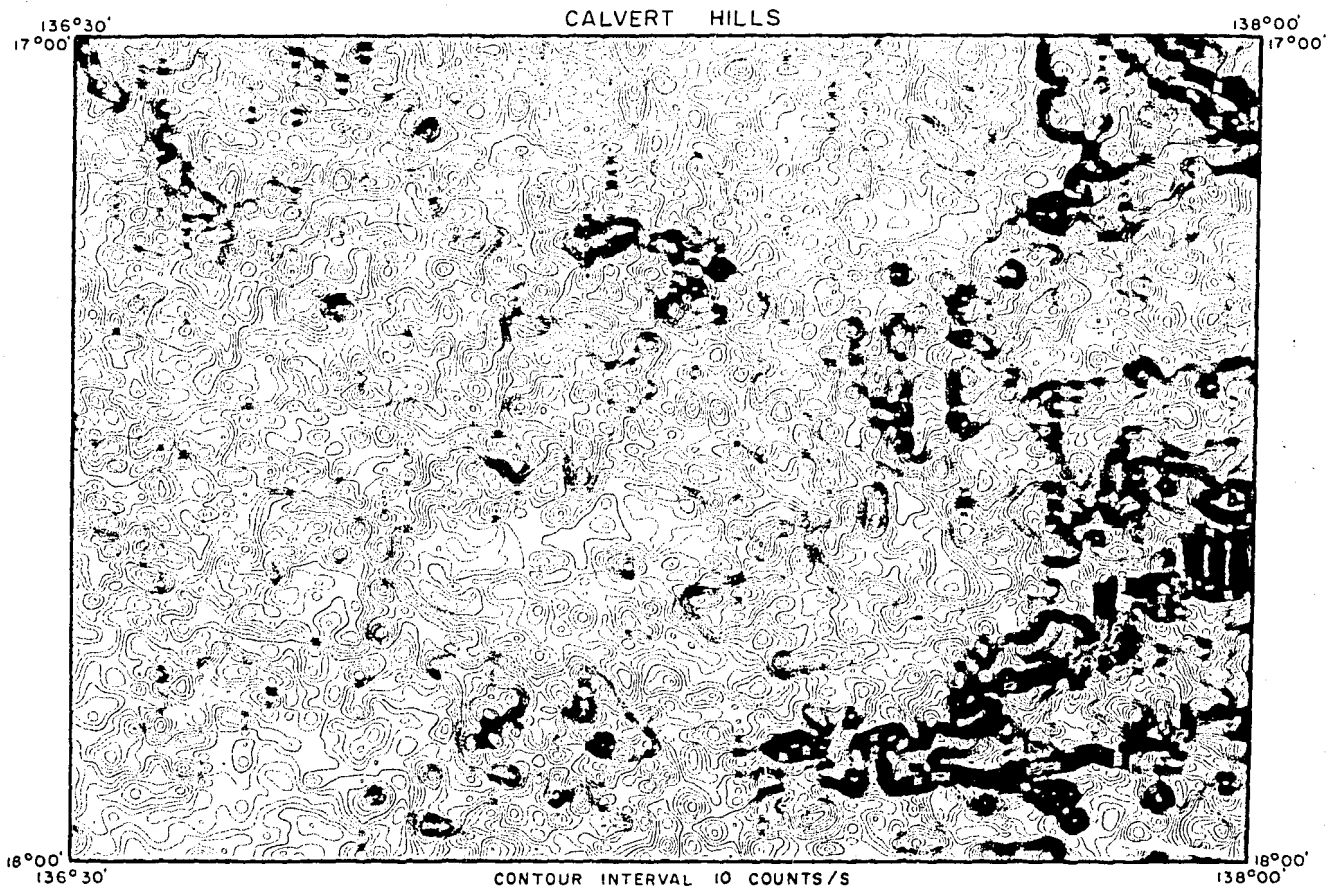
REFERENCE TO 1:250 000 MAP SERIES

BAUHINIA DOWNS	ROBINSON RIVER	MORNINGTON
WALLHALLOW	CALVERT HILLS	WEST-MORELAND
BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL

Record No 1979/73

E53/81-74AR

MA 46



AIRBORNE SURVEY, Mc ARTHUR BASIN, NT 1977

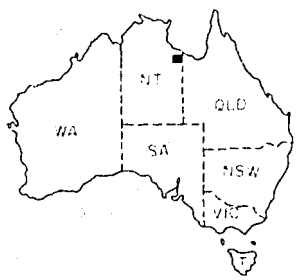
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

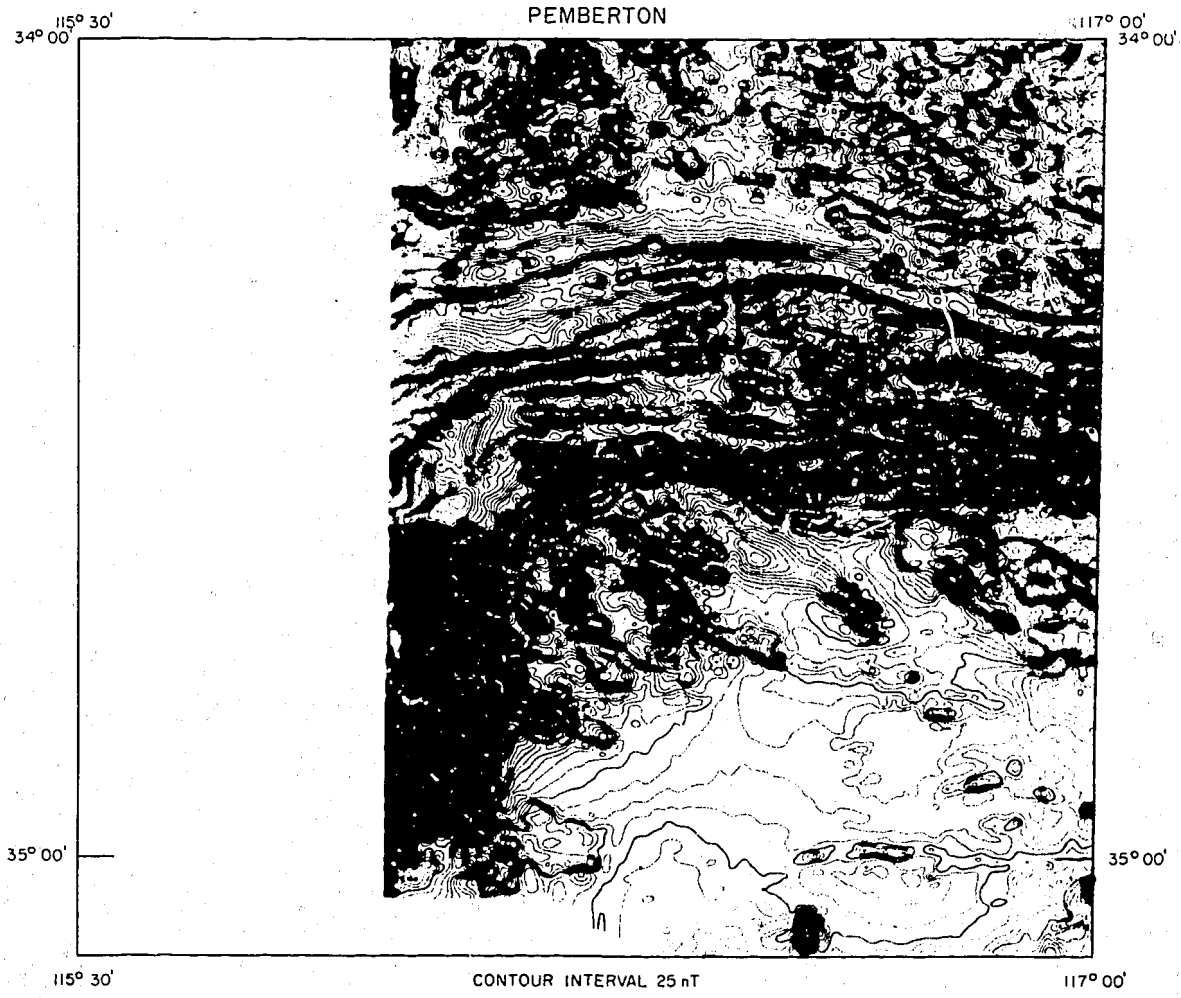
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

BAUHINIA DOWNS	ROBINSON RIVER	MORNINGTON
WALLHALLOW	CALVERT HILLS	WEST-MORELAND
BRUNETTE DOWNS	MOUNT DRUMMOND	LAWN HILL

MA 47



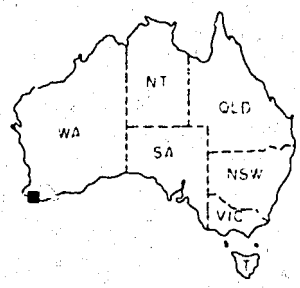
AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

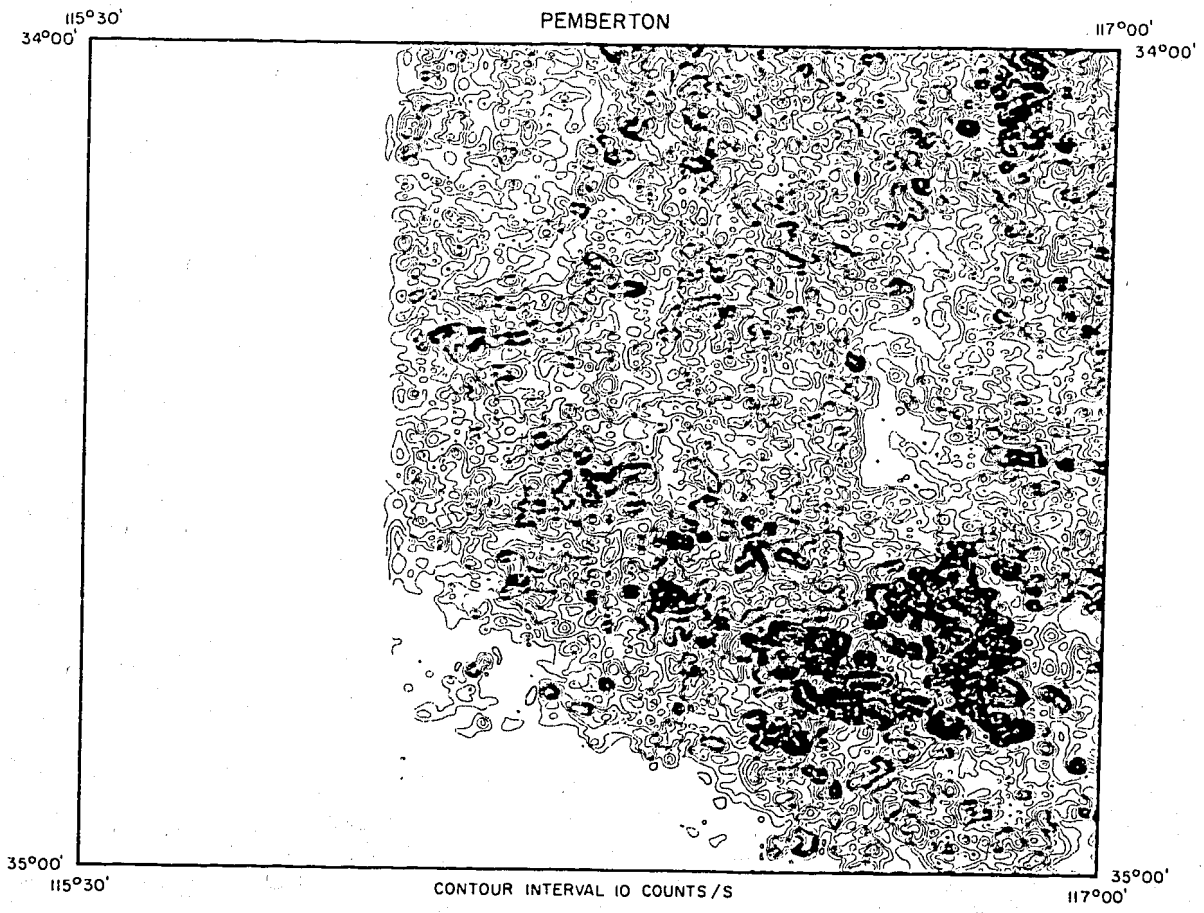
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

BUSSELTON	COLLIE	DUMBLEYUNG
AUGUSTA	PEMBERTON	MOUNT BARKER
	IRWIN INLET	ALBANY

MA 48



AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

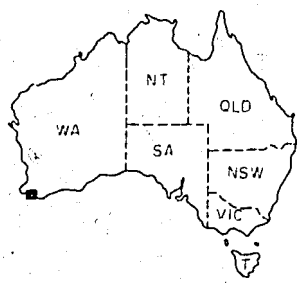
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

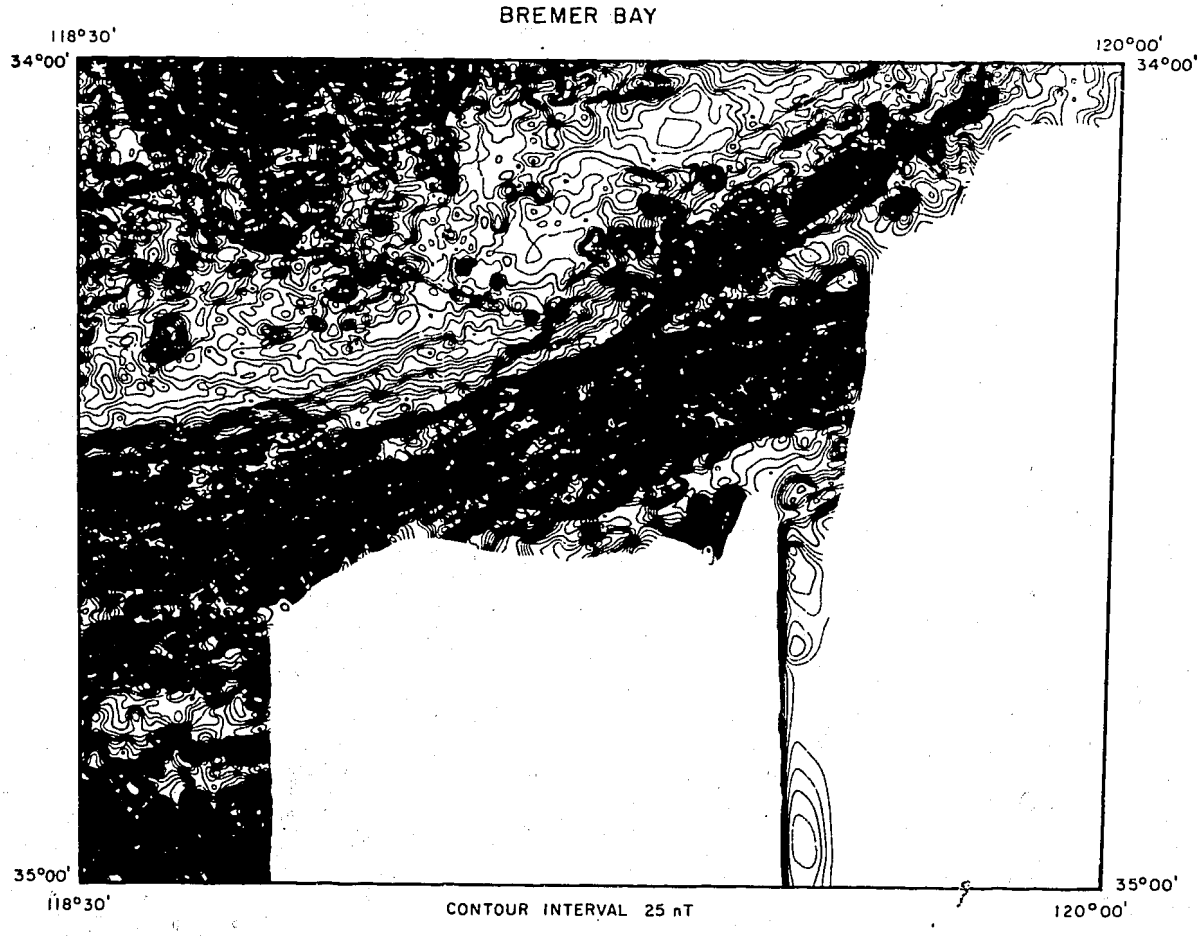
BUSSELTON	COLLIE	DUMBLEYUNG
AUGUSTA	PEMBERTON	MOUNT BARKER
	IRWIN INLET	ALBANY

Record No 1979/73

I50/BI-62AR

MA 49

BREMER BAY



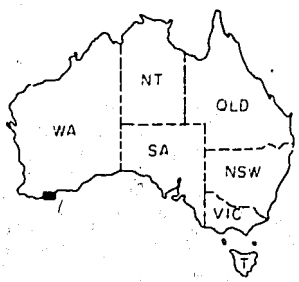
AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



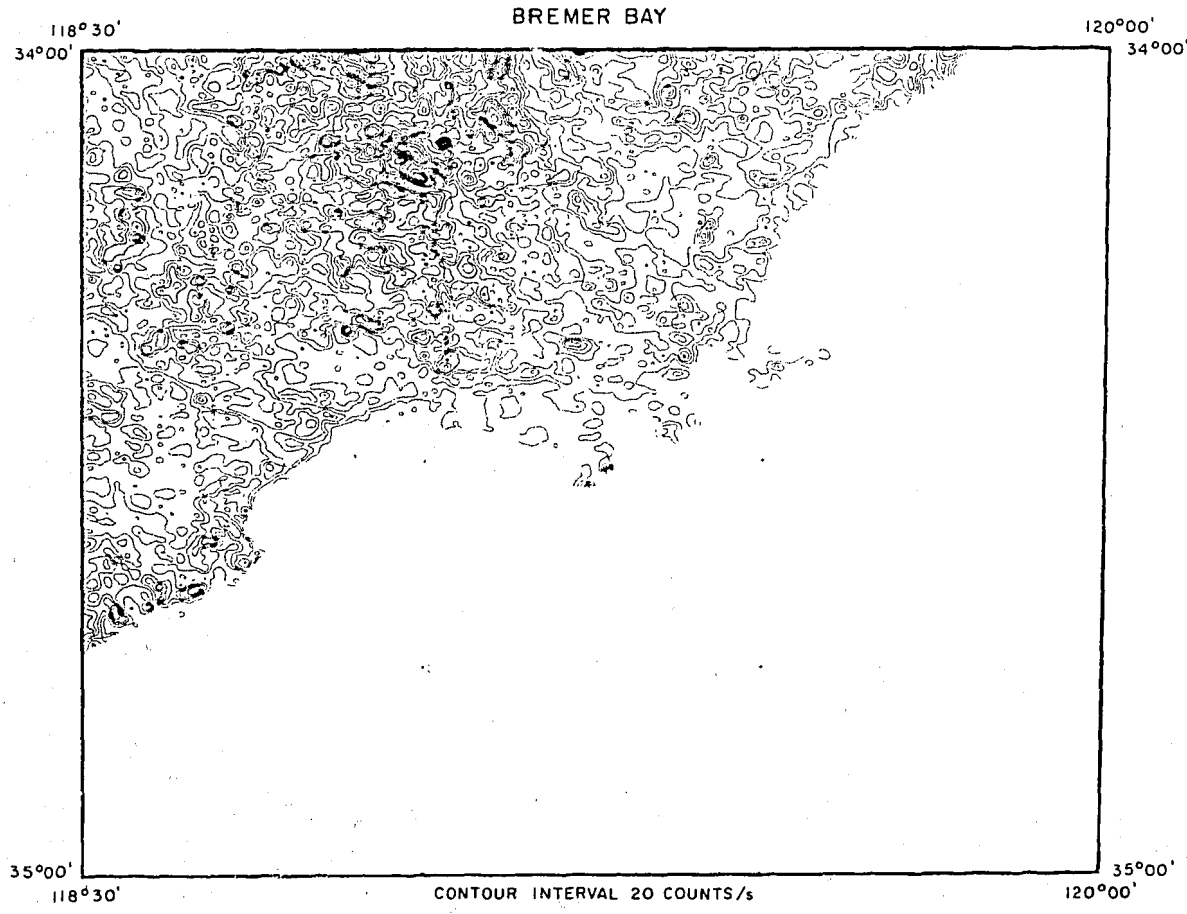
REFERENCE TO 1:250 000 MAP SERIES

DUMBLEYUNG	NEWDEGATE	RAVENSTHORPE
MOUNT BARKER	BREMER BAY	
ALBANY		

Record No. 1979/73

I50/BI-73AR

MA 50



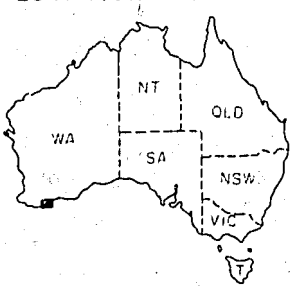
AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



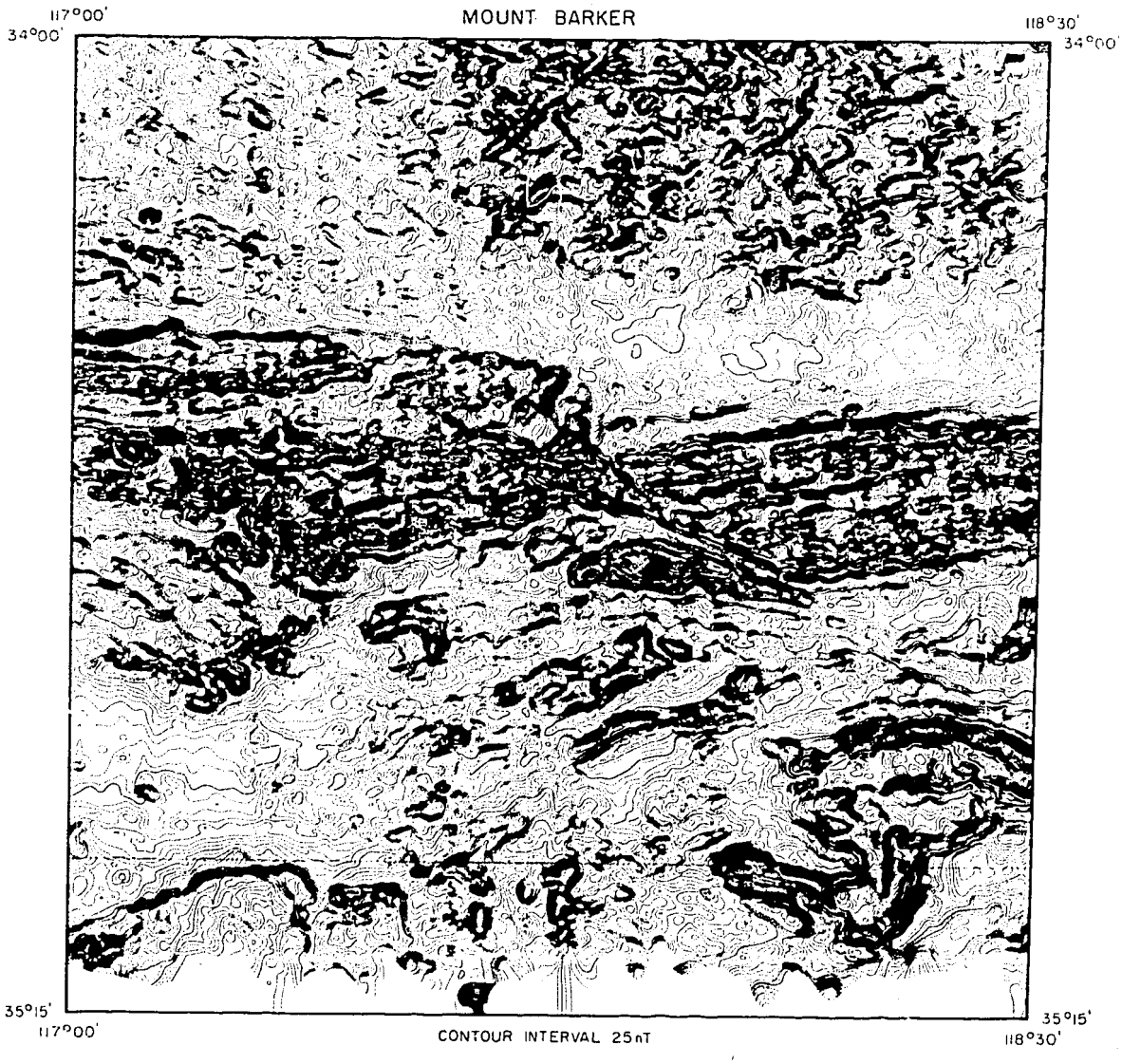
REFERENCE TO 1:250 000 MAP SERIES

DUMBLEYUNG	NEWDEGATE	RAVENSTHORPE
MOUNT BARKER	BREMER BAY	
ALBANY		

Record No 1979/73

I50/BI-80AR

MA 51



AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

0 10 20 30 40 50 km

LOCATION DIAGRAM

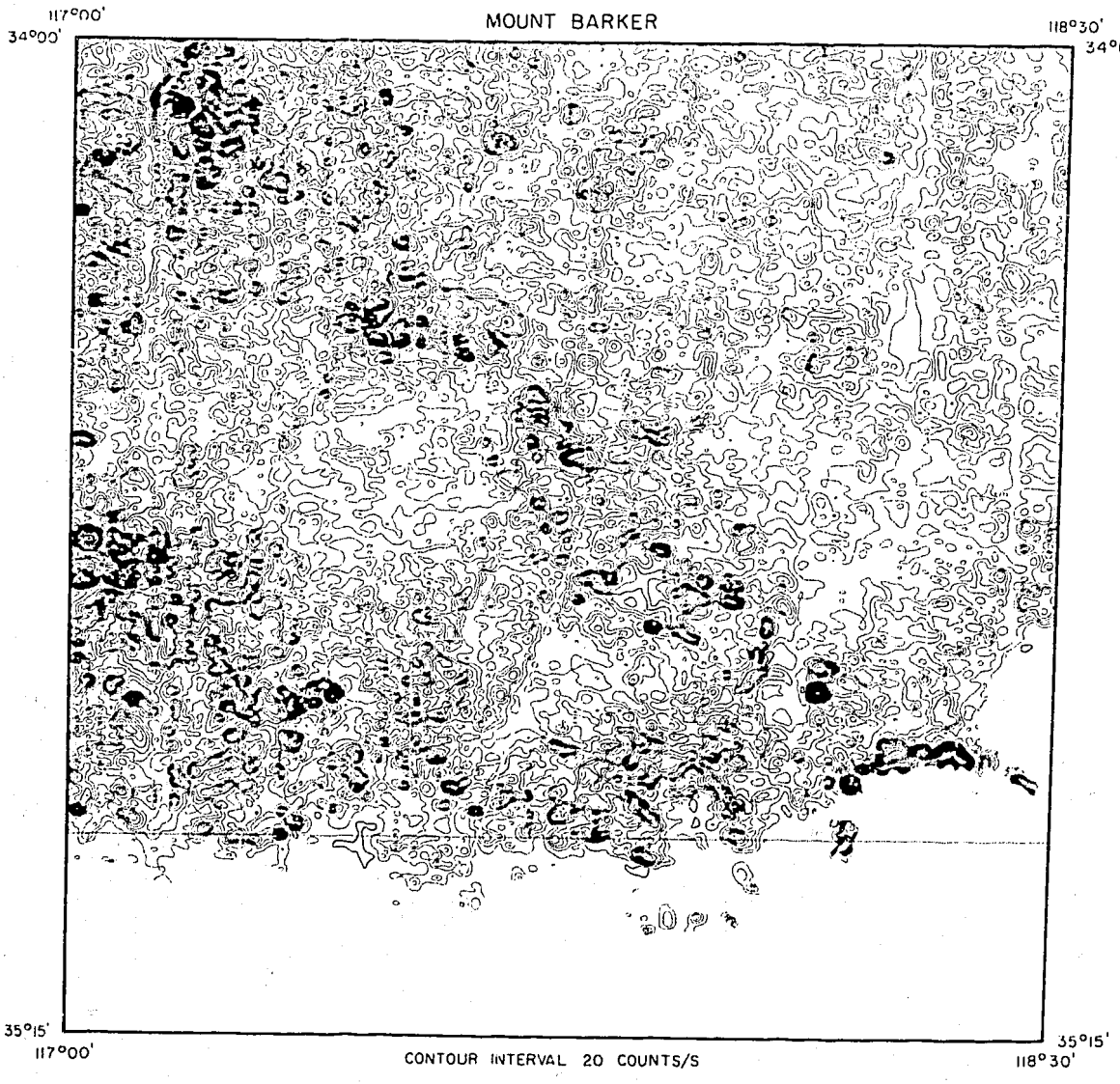
REFERENCE TO 1:250 000 MAP SERIES

COLLIE	DUMBLEYUNG	NEWDEGATE
PEMBERTON	MOUNT BARKER	BREMER BAY
IRWIN INLET	ALBANY	

Record No 1979/73

I50/BI-64AR

MA 52



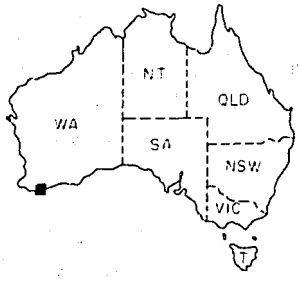
AIRBORNE SURVEY, ALBANY FRASER BLOCK, WA 1977

RADIOMETRIC CONTOURS, TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

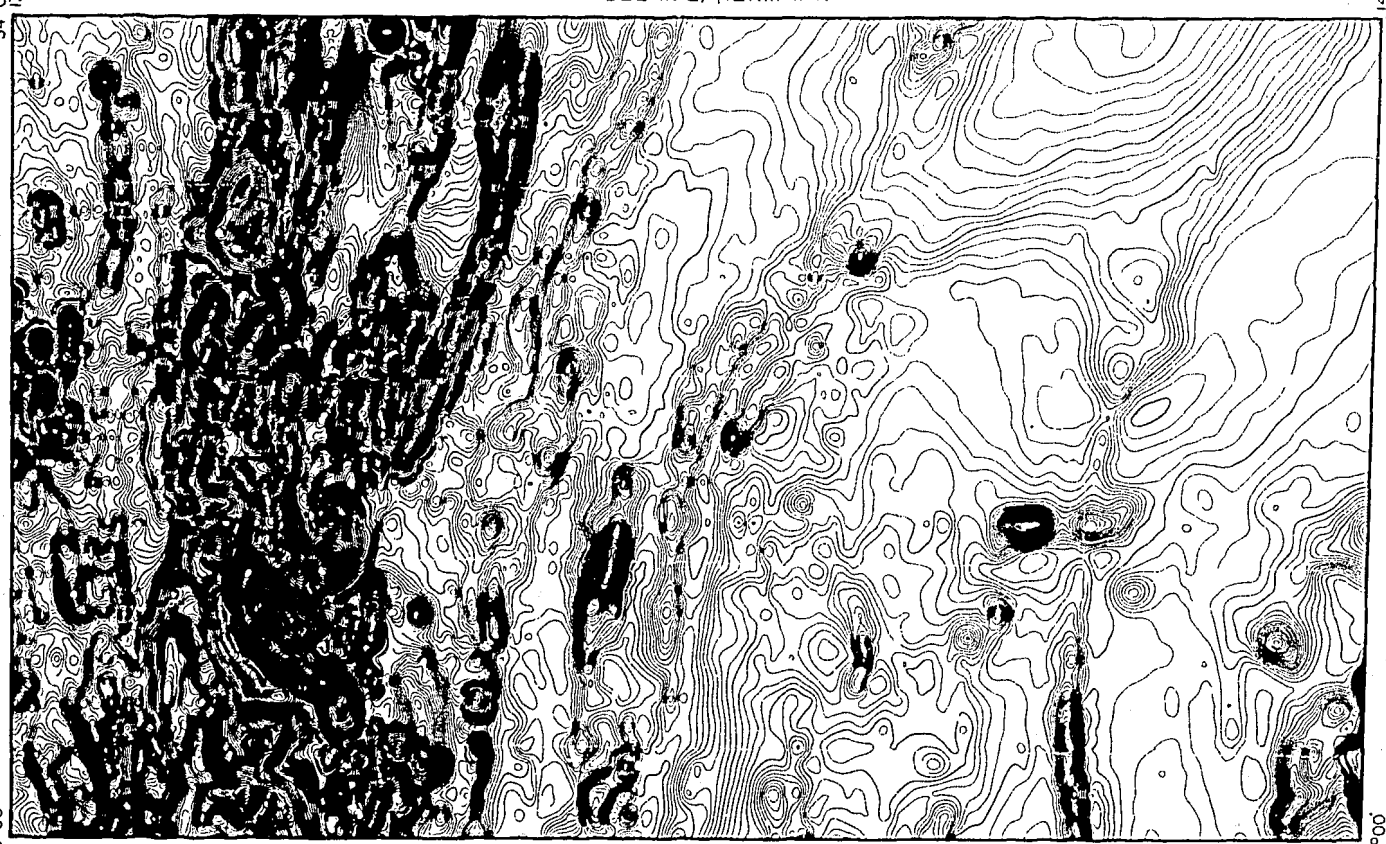
COLLIE	DUMBLEYUNG	NEWDEGATE
PEMBERTON	MOUNT BARKER	BREMER BAY
IRWIN INLET	ALBANY	

Record No 1979/73

150/81-71AR

MA 53

ADELAIDE/RENMARK



CONTOUR INTERVAL 10nT

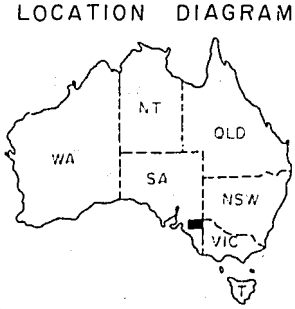
AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

TOTAL MAGNETIC INTENSITY

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

BURRA	CHOWILLA	ANA BRANCH
ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN

Record No 1979/73

154/BI-67AR

MA 54

AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

REFERENCE TO 1:250 000 MAP SERIES

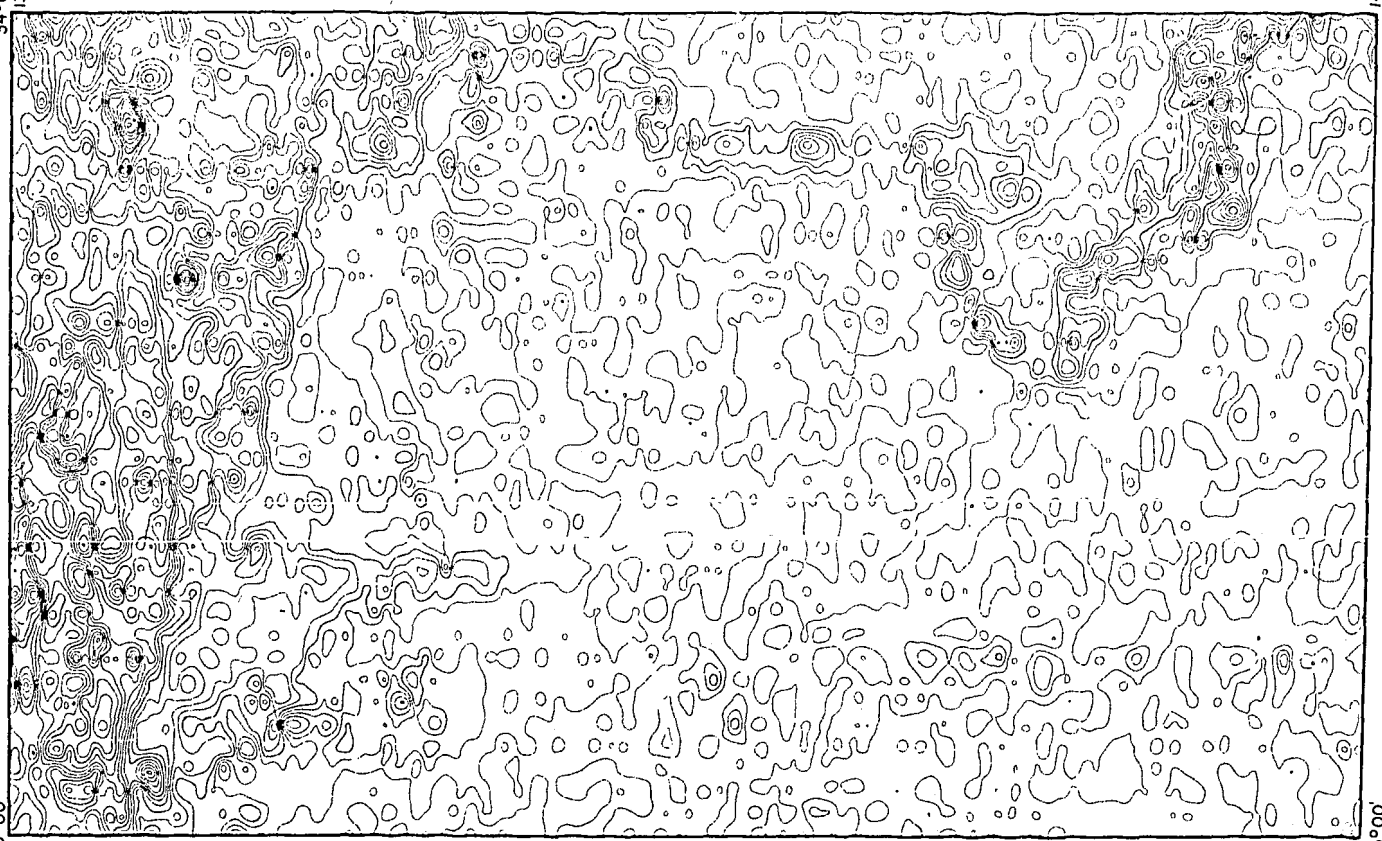
WHYALLA	BURRA	CHOWILLA
MAITLAND	ADELAIDE	RENMARK
KINGSCOTE	BARKER	PINNAROO

Record No 1979/73

154/BI-68AR

MA 55

ADELAIDE/RENMARK



CONTOUR INTERVAL 10 COUNTS/S

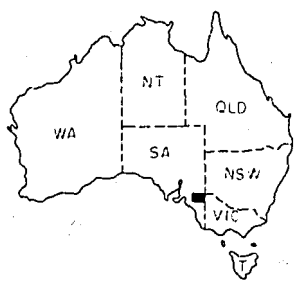
AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM

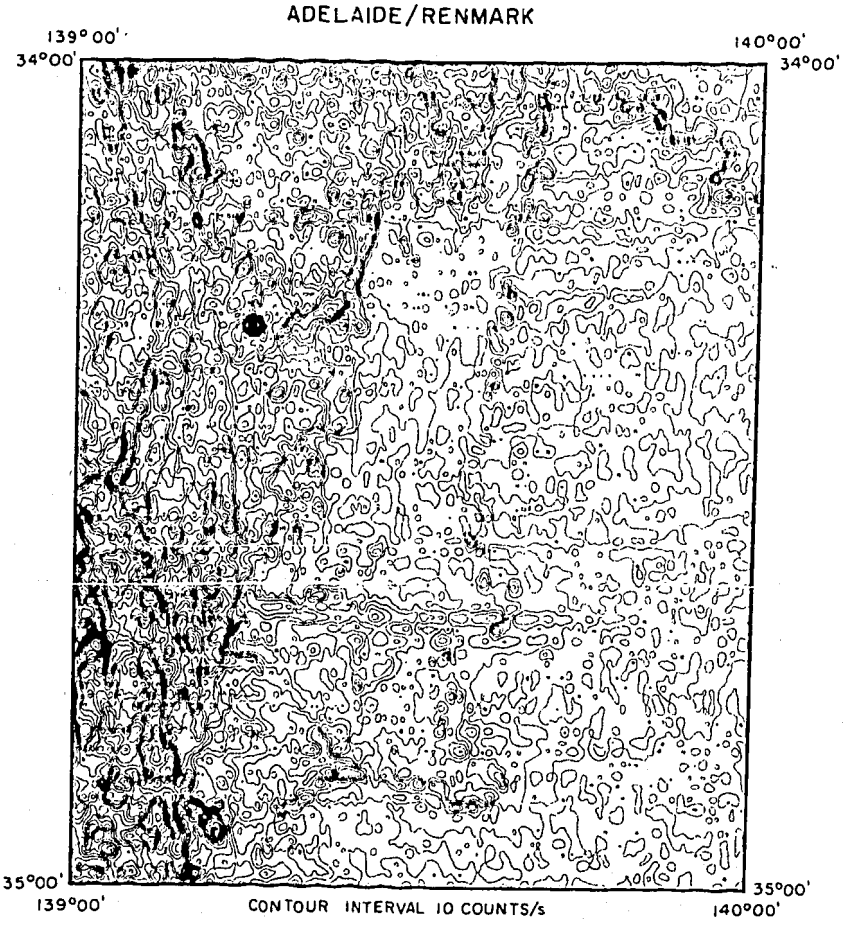


REFERENCE TO 1:250 000 MAP SERIES

BURRA	CHOWILLA	ANA BRANCH
ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN

MA 56

ADELAIDE/RENMARK



AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

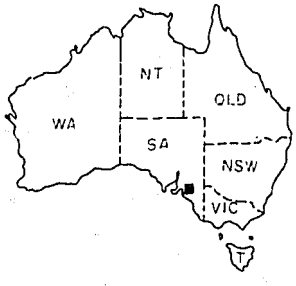
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1000000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



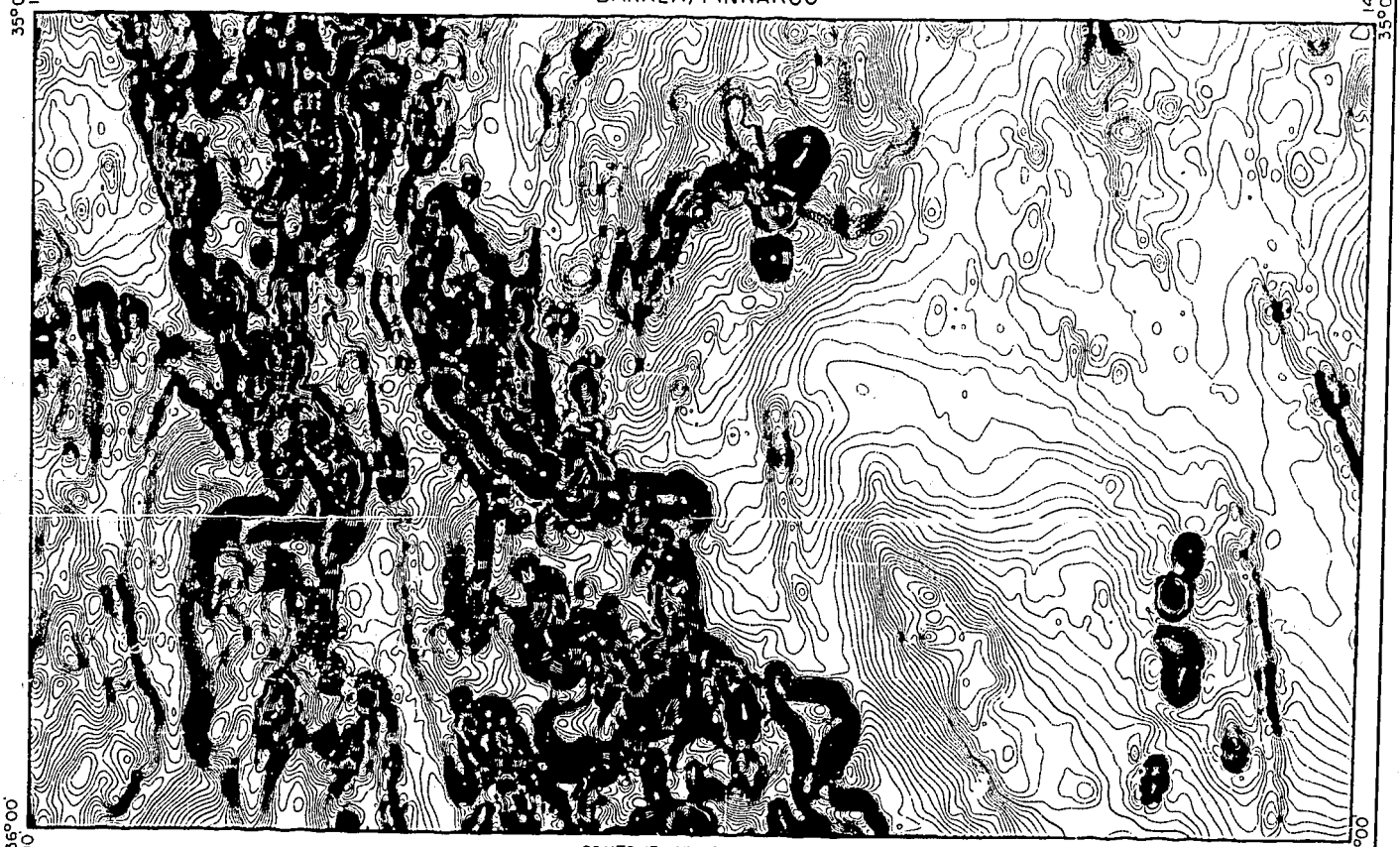
REFERENCE TO 1:250 000 MAP SERIES

WHYALLA	BURRA	CHOWILLA
MAITLAND	ADELAIDE	RENMARK
KINGSCOTE	BARKER	PINNAROO

Record No 1979/73

MA 57

BARKER/PINNAROO



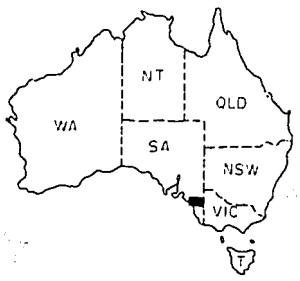
AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

TOTAL MAGNETIC INTENSITY

SCALE 1:1000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN
	NARRACOORTE	HORSHAM

Record No 1979/73

I54/BI-53AR

MA 58

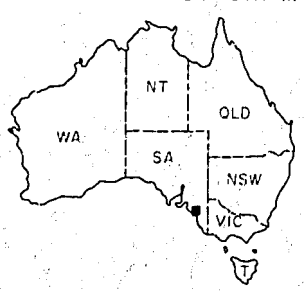
AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

TOTAL MAGNETIC INTENSITY

SCALE 1 : 1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

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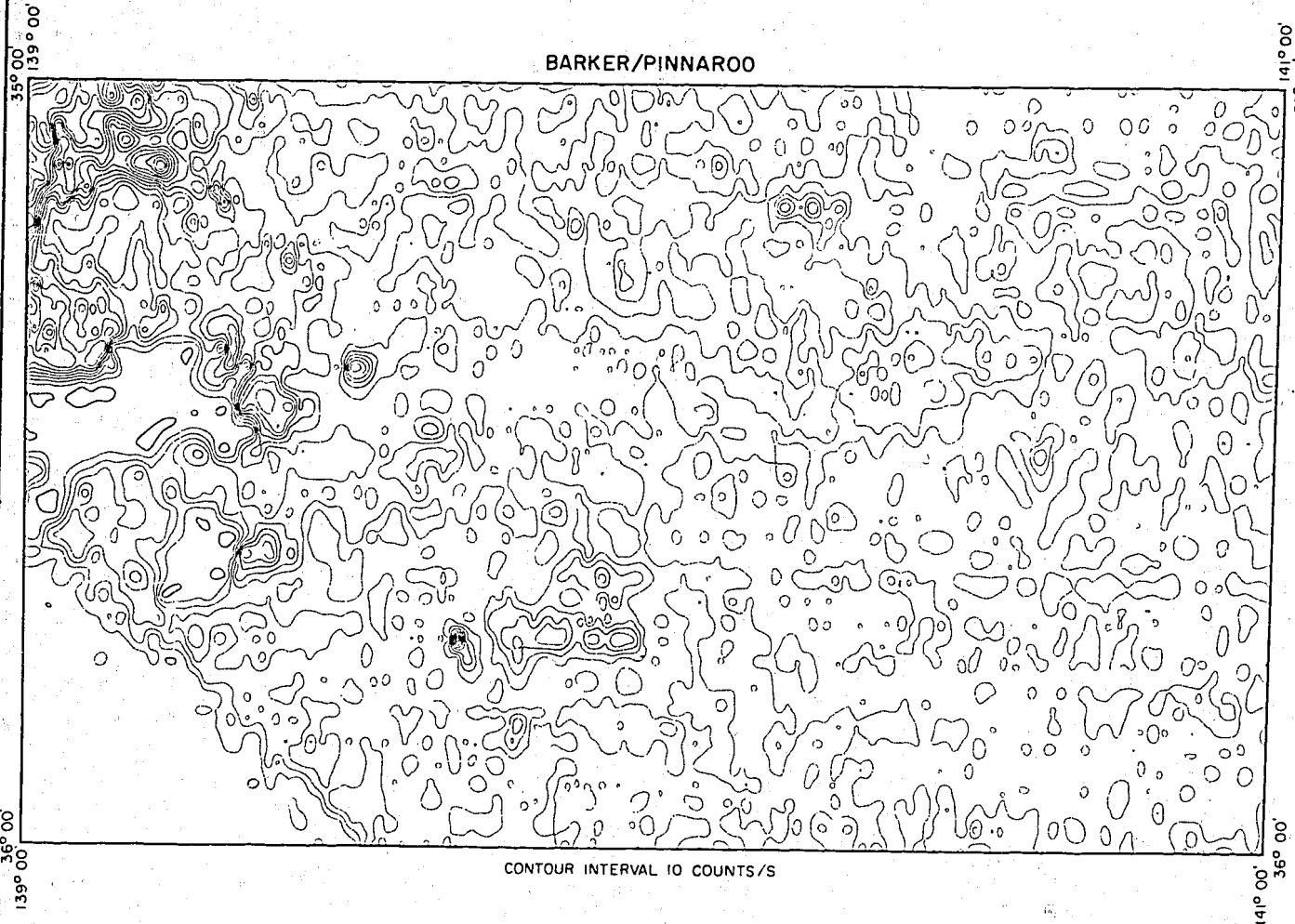
BARKER	PINNAROO	OUYEN
	NARRACOORTE	HORSHAM

Record No 1979/73

I54/BI-54AR

MA 59



AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

RADIOMETRIC CONTOURS
TOTAL COUNT

SCALE 1:1 000 000

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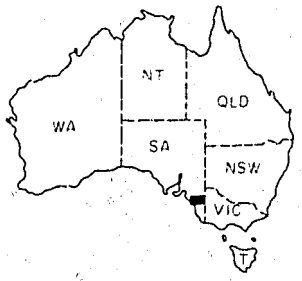
LOCATION DIAGRAM



REFERENCE TO 1:250 000 MAP SERIES

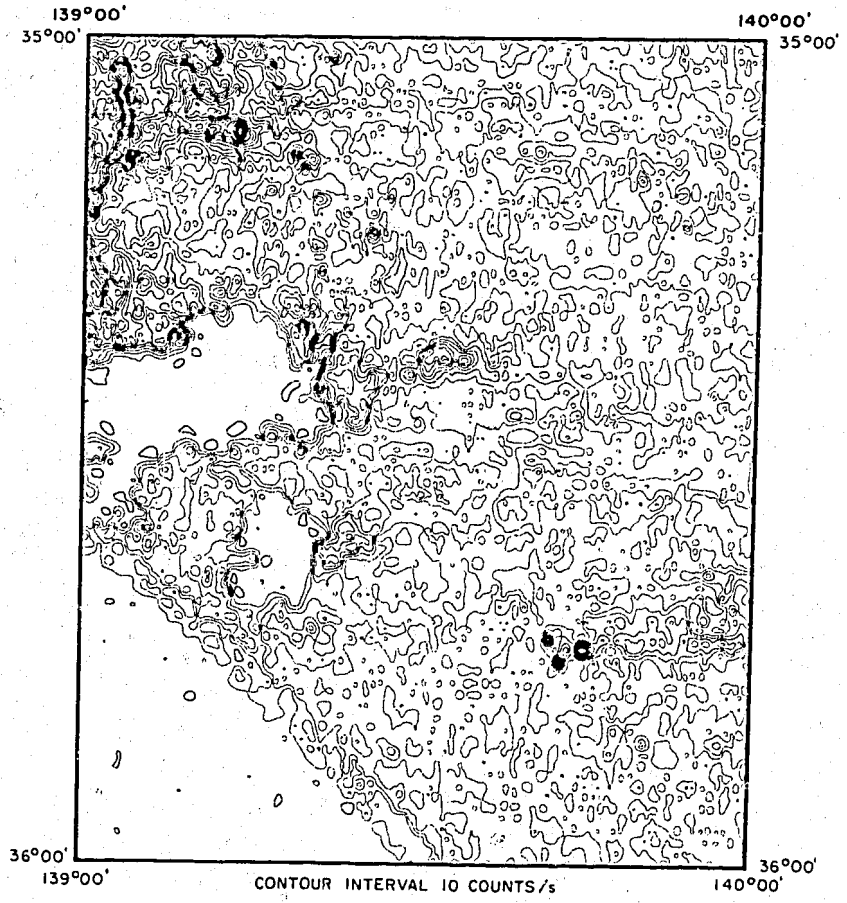
ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN
	NARRACOORTE	HORSHAM

Record No 1979/73

I54/BI-6IAR

MA 60

BARKER/PINNAROO



AIRBORNE SURVEY, ADELAIDE GEOSYNCLINE, SA 1978

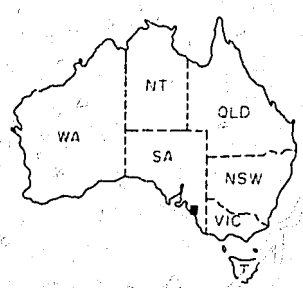
RADIOMETRIC CONTOURS

TOTAL COUNT

SCALE 1:1 000 000

10 0 10 20 30 40 50 km

LOCATION DIAGRAM



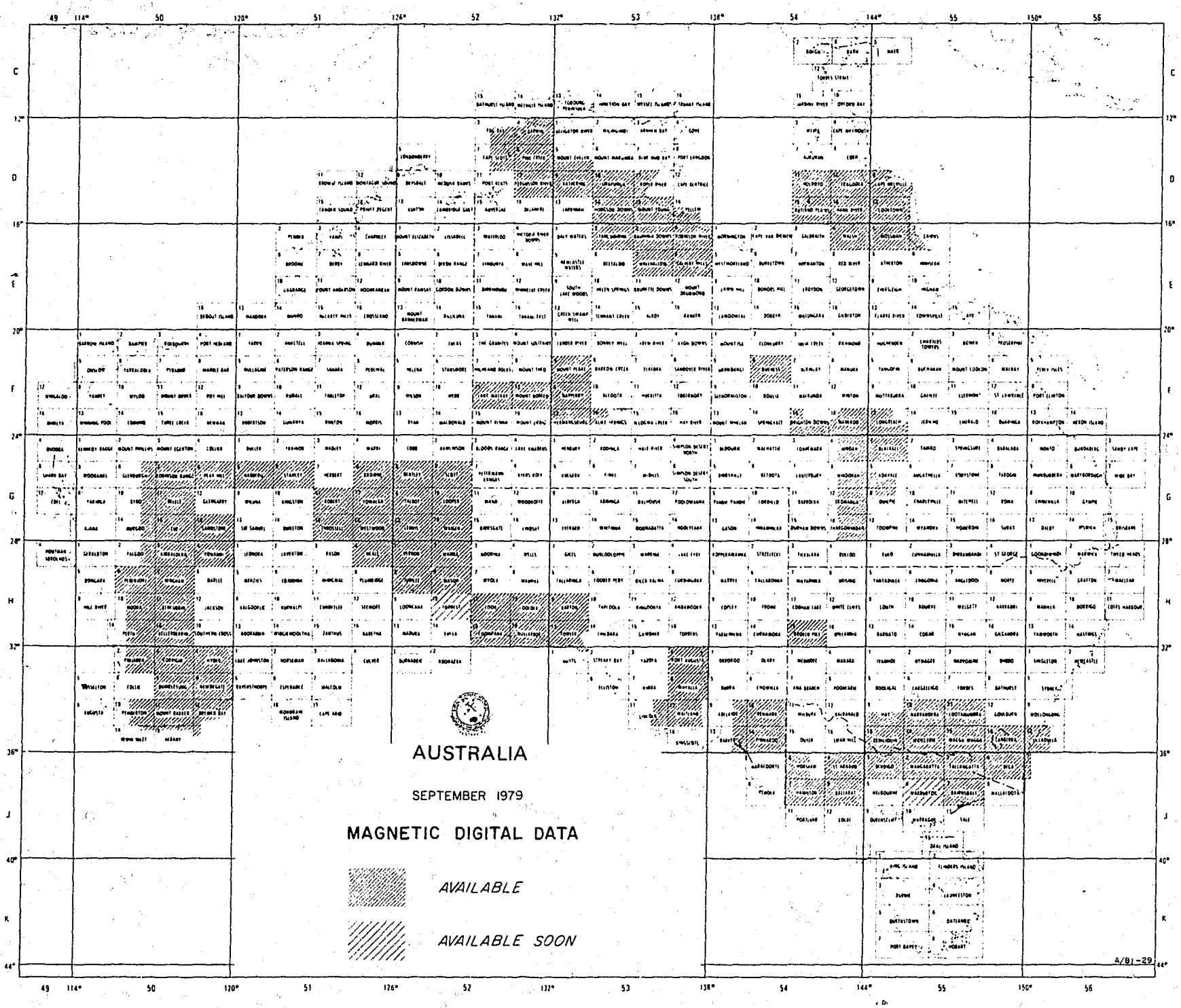
REFERENCE TO 1:250 000 MAP SERIES

ADELAIDE	RENMARK	MILDURA
BARKER	PINNAROO	OUYEN
	NARACOORTE	HORSHAM

Record No 1979/73

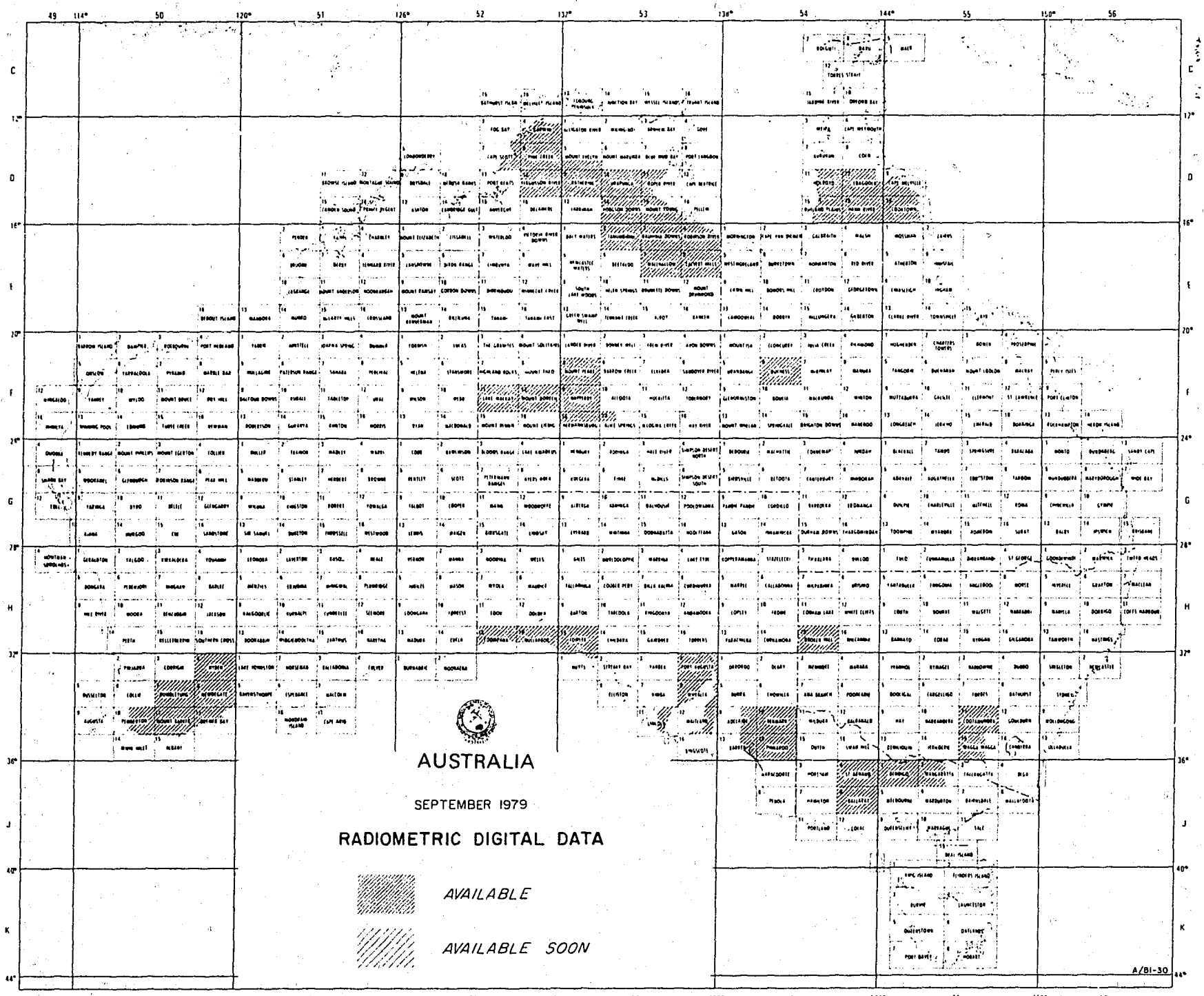
I54/B1-62 AR

Record No 1979/73



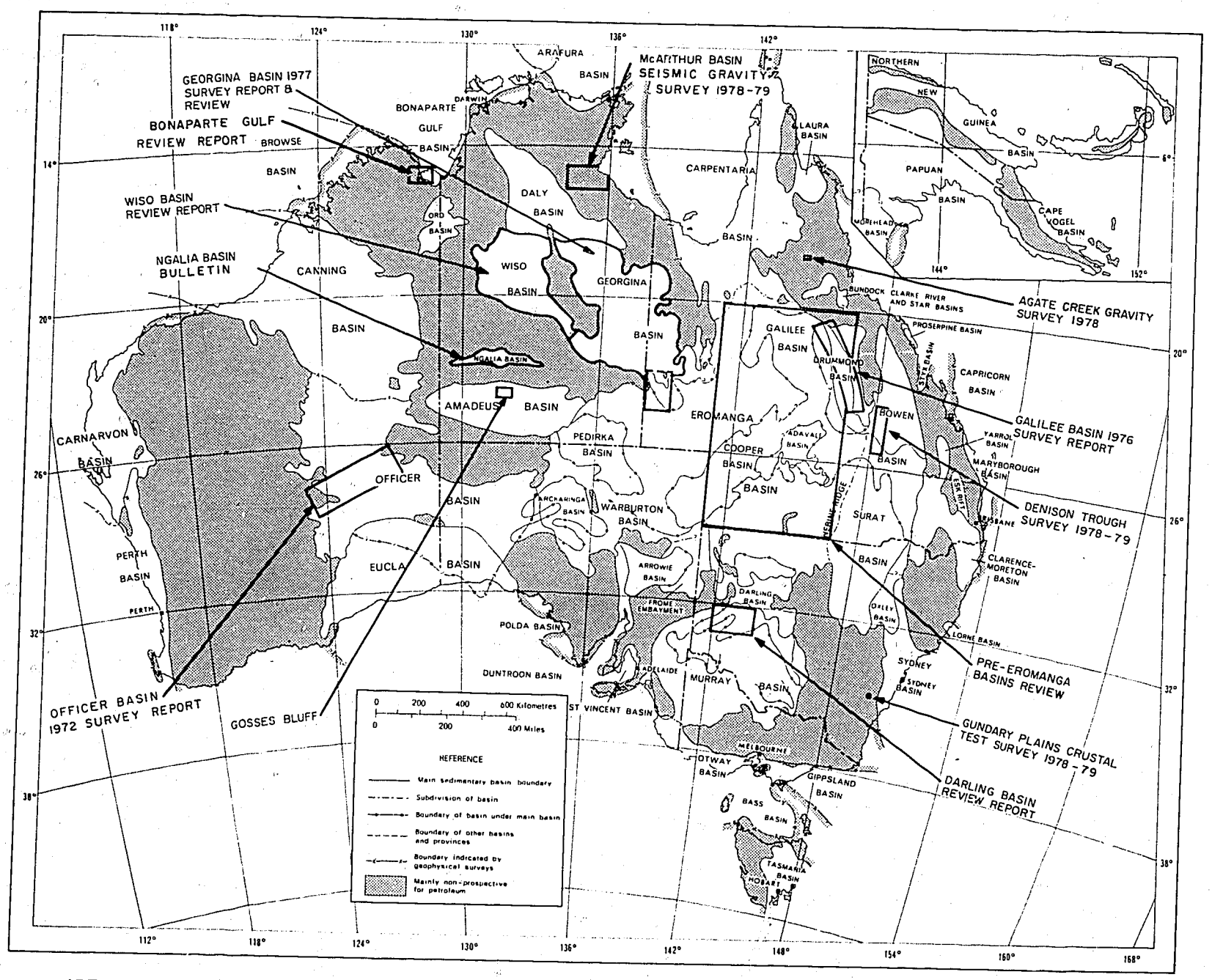
MA 61

Record No 1979/73



A/81-30

MA 62



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

SEISMIC, GRAVITY AND MARINE SECTION

(A. Turpie)

SEISMIC AND GRAVITY SURVEYS (F.J. Moss)

The areas concerned in the work of the seismic and gravity groups are shown in Figure SGM-1.

Denison Trough seismic and gravity survey, Bowen Basin, Qld 1978-79 (J.A. Bauer, W. Anfiloff, A. Nelson (GSQ), O. Dixon (GSQ), J.K.C. Grace, D. Gardner, D. Pfister, G. Price, R. DeNardi, R.D.E. Cherry, L.A. Rickardsson, D.K. McIntyre, A.C. Takken, B. Pedvin, J.A. Somerville, F.J. Moss, J. Pinchin)

A seismic survey of the Denison Trough, started in 1978 but not completed owing to the prevalence of wet weather that year, was completed in 1979. The seismic traverses are shown in Figure SGM-2. Gravity measurements also were made on these traverses.

The main objectives of the regional survey were to delineate the configuration of the trough, particularly at Lower Permian and basement levels, and to provide stratigraphic information from the entire Permian sequence. The stratigraphic information will be used in conjunction with that from petroleum exploration and other wells, and from current Geological Survey of Queensland stratigraphic studies, to provide reliable correlations throughout the Trough.

During the three month survey in 1979 265 km of traverse were shot to provide mainly 6-fold CDP reflection data, and gravity measurements were made at 500 m intervals. This compares with a total of 192 km of CDP coverage in 4 1/2 months' operations in 1978. Field work in 1979 generally progressed satisfactorily, in fine weather. The main factor determining program was drilling, which in places was slowed down by problems with near-surface gravels and basalt boulders. The recording equipment performed satisfactorily, and with full sets of 48-channel cables and geophones recently acquired, the party could progress up to 8 km per day.

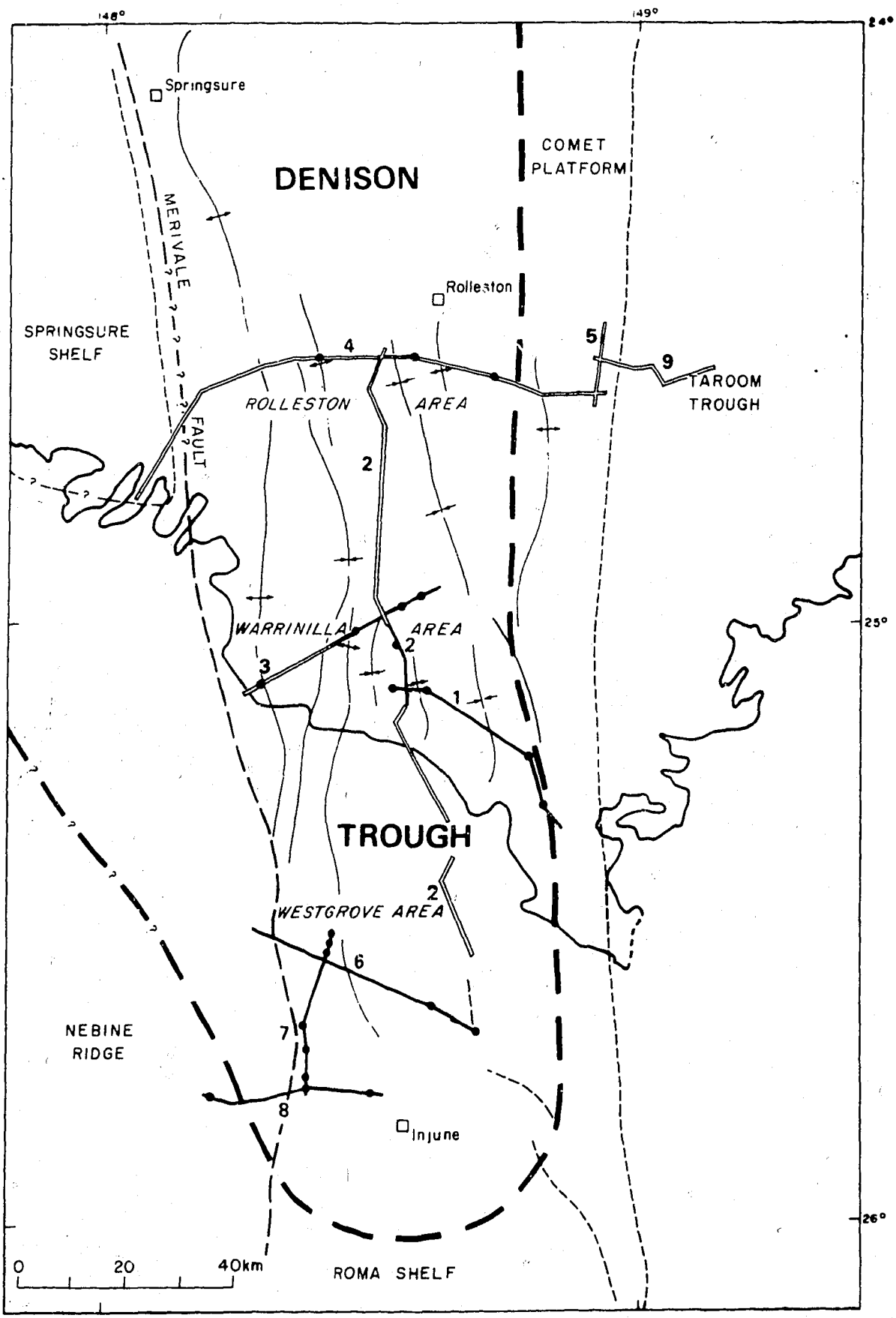
The quality of the data has varied from poor to very good. In most areas the data from the Upper Permian are excellent, enabling reliable detailed stratigraphic correlations. In the deeper parts of the basin with a thick section of Reids Dome Beds it is difficult to define basement reliably. Seismic energy penetration is hampered by the presence of highly reflective coal beds throughout this part of the sequence. Basement is seen more clearly in areas where the Reids Dome Beds are thinner.

Seismic interpretations have been made in the Westgrove area, and papers on the structural and stratigraphic significance of the results and their implication in the current search for hydrocarbons in the Denison Trough have been prepared for publication. The interpretation of all the BMR seismic and gravity results in the Trough and the results obtained by the tenement holders in the area will be made in 1980. BMR and the Geological Survey will be mainly concerned with the regional aspects providing the structural and stratigraphic framework for the Trough; Associated Australian Resources, the main tenement holder active in the area, will be mainly concerned with the detailed interpretation of data relating to specific petroleum prospects.

The work in the Westgrove area enabled three major phases of folding to be identified, together with minor phases which affected depositional patterns towards the end of the early Permian. The Merivale Fault, shown on the seismic section in Figure SGM-3, is probably a hinged fault which has been active and influenced deposition throughout Permian and Triassic times. Recognition of faults and stratigraphic relations previously unknown, has suggested that more complex structures and stratigraphy are present than suspected previously. The new seismic data are proving to be very useful in providing leads to renewed petroleum exploration activity in the Trough.

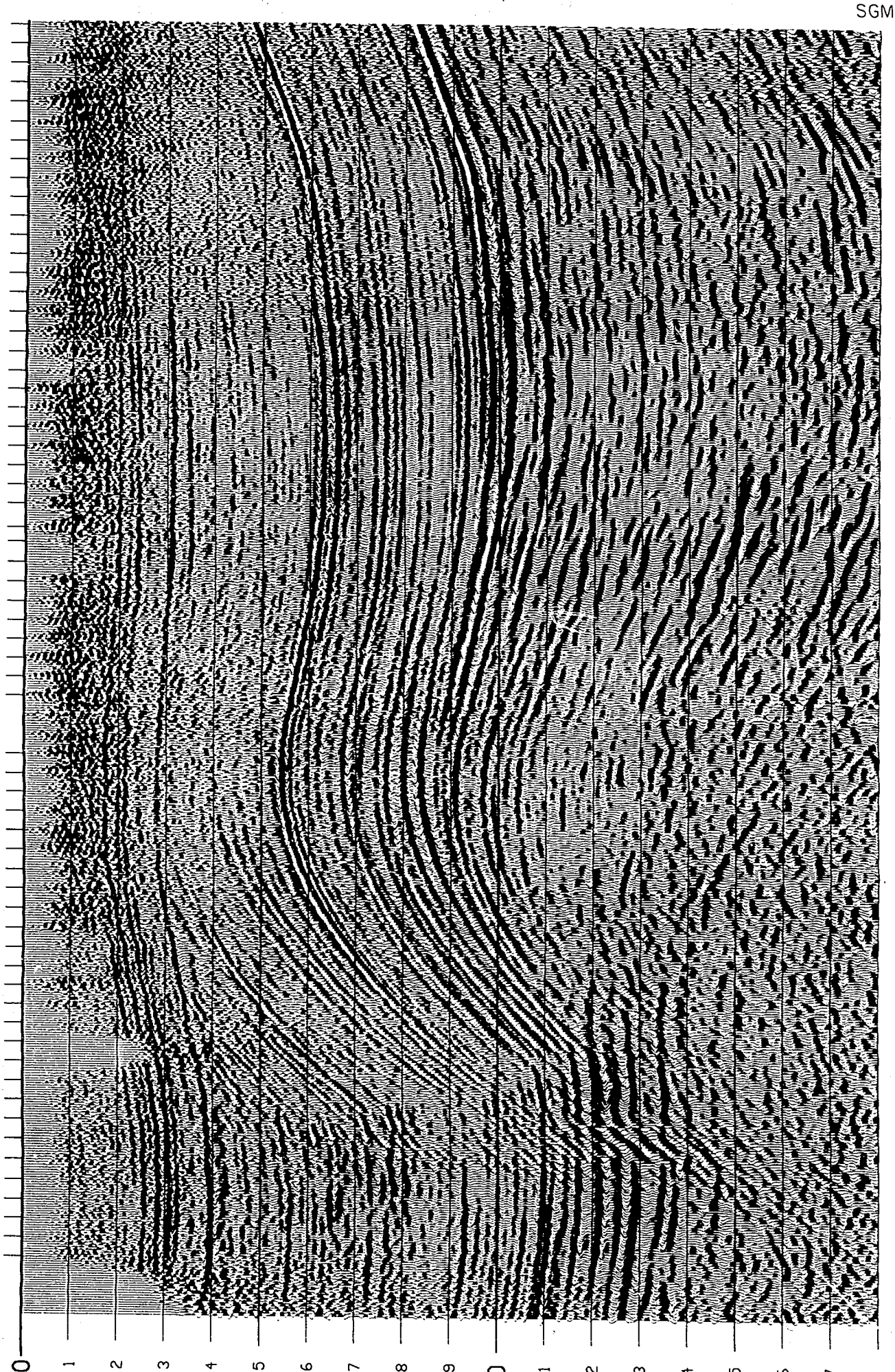
Galilee Basin seismic survey, 1976 (J. Pinchin, F.J. Moss)

The final report on the survey was amended to be issued as a BMR Record. The report includes a detailed account of all aspects of the field survey, data processing, and interpretation.



DENISON TROUGH SEISMIC SURVEY, QLD 1978-79
REGIONAL SETTING AND SEISMIC TRAVERSES

SGM-3



Denison Trough, Qld — seismic section across Merivale Fault (unmigrated)

Record No 1979/73

G55/B3-165A

Officer Basin seismic survey, WA 1972 (P.L. Harrison)

The seismic results on the THROSSELL 1:250 000 Sheet area were reinterpreted taking into account the results of subsequent aeromagnetic coverage and stratigraphic drilling.

BMR aeromagnetic coverage, obtained in 1976, suggested magnetic sources at less than 400 m depth near the seismic traverses on THROSSELL. Shallow stratigraphic drilling some distance northeast of the seismic traverses encountered granite and gneiss, thus supporting the magnetic interpretation. Reflections recorded to depths of 12.5 km over distances up to 4 km are now interpreted as being from layered metamorphic and crystalline rocks, possibly metasediments with basic intrusives, rather than from Proterozoic sediments as interpreted previously.

The reinterpretation has been included in the final report of the survey, which was published during the year.

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

A number of editorial matters relating to the Bulletin on the structure and stratigraphy of the basin were attended to. A contribution was made to BMR 78.

The seismic data were again briefly reviewed in the area about the Davis Anticline in the northern part of the basin on receipt of stratigraphic information from a drill hole on the surface crest of the anticline. Although planned to penetrate the entire Mount Eclipse Sandstone sequence, the hole stopped short by an estimated 10 m from the base of the Mount Eclipse Sandstone. Selection of the drill site did not take into account the south dip of the axial plane of the Anticline and thus the Mount Eclipse Sandstone was penetrated on the flank of the structure.

The estimate of the position of near-base Mount Eclipse Sandstone strongly supports the interpretation of a substantial thickness of Lower Palaeozoics being present below the Mount Eclipse Sandstone in the area.

Southeast Georgina Basin seismic and gravity survey, Qld 1977
(P.L. Harrison, S.P. Mathur)

The main results of the survey and related review of the structure, stratigraphy, and petroleum prospects of the Toko Syncline in the SE Georgina Basin were presented to the 1979 APEA Conference.

Seismic and other pertinent information were studied to provide a better understanding of the nature of the Toomba Fault and its relation to the syncline. The fault was found to be a high-angle reverse fault with a dip varying between 40° W and 70° W. There are significant differences in the geometry of the deformed strata adjacent to the fault in different places and along the fault. There is no uniform relation between the attitude of the fault and the geometry of the deformed strata, suggesting that there have been several movements or that stresses had been realigned locally by basement irregularities.

The structural results are consistent with general northeasterly compression, two stages of deformation having been identified. The analysis also provided information on shallow Cretaceous sediments near the fault, and on thick Adelaidean strata in areas covered by sand and alluvium.

Georgina Basin crustal interpretation (S.P. Mathur, P.L. Harrison)

In collaboration with other members of the Georgina Basin project team, several subsurface geological model cross-sections across the basin were prepared incorporating all available magnetic, gravity, seismic, and exploratory well information. Using these data isopach maps of the Palaeozoic (excluding the Lower Cambrian) and Adelaidean/Lower Cambrian sediments were prepared.

The results of the review were published in the BMR Journal Vol. 4 No. 3.

McArthur Basin gravity survey 1978-79 (W. Anfiloff)

Detailed information on the gravity investigations is included in the Project Branch progress reports, BMR Records 79/15, 79/16, 79/44, 79/57.

Gravity observations made in 1978 were processed, and a preliminary qualitative interpretation along the main east-west traverse was made. The results suggest a broadly undulating basement generally and a broad syncline east of the Emu Fault.

The absence of a regional change in gravity level across the Emu Fault suggests that either the fault has no major vertical displacement or that there is no density contrast between the sediments and basement rocks in that area. The results of further gravity work in 1979 over a major syncline west of the Emu Fault indicate that there must be a distinct density contrast. Gravity anomalies associated with other faults, including the Tawallah Fault, imply that these faults have vertical displacement. Therefore the first of the alternative interpretations appears to be the more likely.

A short-wavelength gravity high of 3 mGal amplitude, in the vicinity of the Emu Fault on the main traverse, has been interpreted as the expression of a shallow dense body, possibly similar in nature to the HYC orebody zone, which lies close to the fault some distance to the south of the main traverse.

The gravity coverage of the McArthur Basin was also extended over a number of roads, principally to provide detail on anomalous gravity features and on the extent of the Batten Trough. The 1979 work gave gravity observations, mainly at 0.5 km intervals, over about 450 km of traverse.

The results of the gravity investigations will be analysed with those of other geophysical and geological investigations during 1980 to provide an integrated interpretation.

McArthur Basin deep crustal reflection seismic survey 1979

(J. Pinchin, D. Pfister, R.D.E. Cherry, L.A. Rickardsson, D.K. McIntyre, D.W. Johnstone)

A deep crustal reflection survey was carried out in the McArthur Basin in conjunction with a refraction survey to investigate the crustal structure of the basin and, in particular, to investigate the differences in structure on both sides of the Emu Fault. The locations of the traverses and reflection shot-points are shown in Figure SGM-4.

Seismic reflection recordings were made from 2000 kg shots at Daly Waters, HYC mine, Borroloola, and Westmoreland, and from 400 kg shots at OT Downs, HYC mine, Borroloola, and Robinson River on the main refraction traverses and from 50 kg shots at Batten Creek and Starvation Hill. Recording spreads were 3 km long with a 1 km cross traverse.

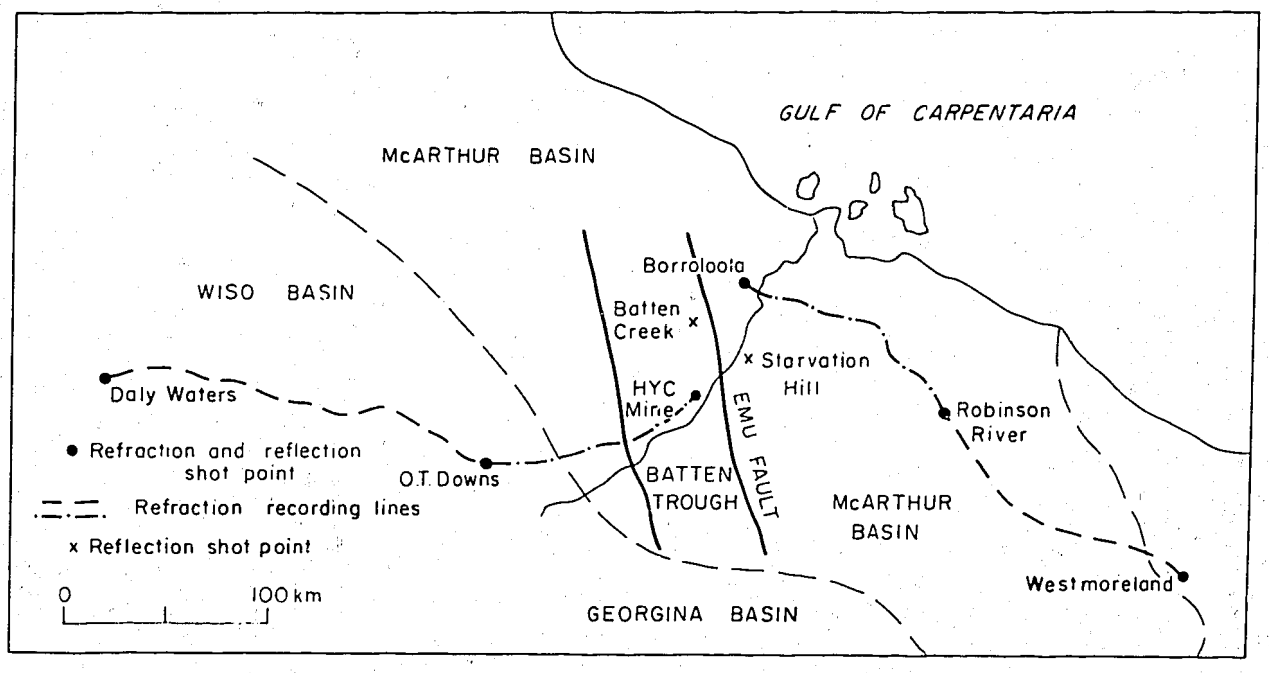
Good-quality reflections were recorded at all locations except Daly Waters and OT Downs; the estimated depths of the reflections range from 2 km to 45 km. The reflection data are being digitally processed by Geophysical Services International, Sydney. The data will be interpreted together with the refraction information.

Seismic reflection studies of the crust and upper mantle in NE Australia

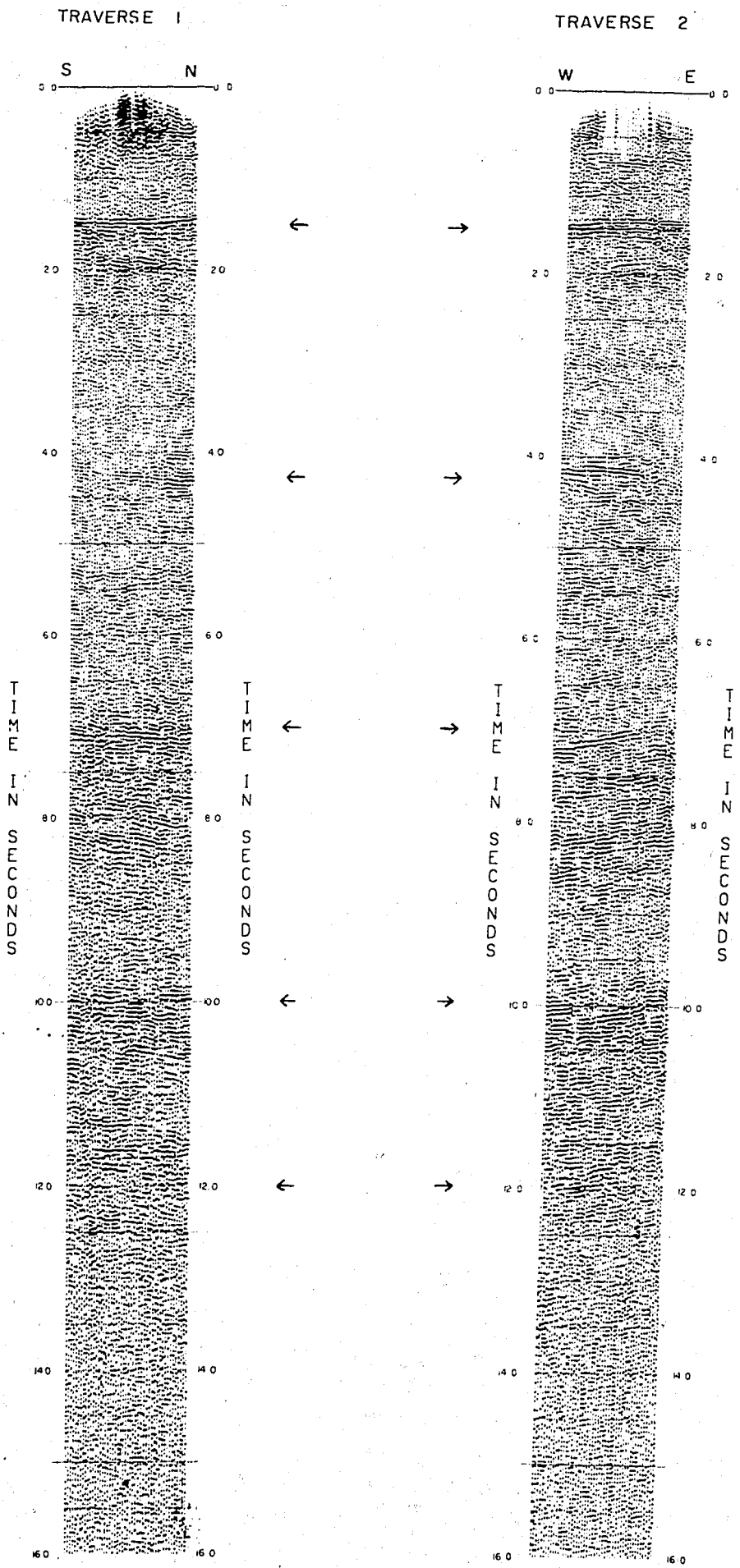
(S.P. Mathur)

Deep crustal reflection data in the Galilee, Georgina, and Bowen basins have been studied. These data were digitally recorded to 20 s reflection time during BMR's normal program of basin seismic surveys during 1975 to 1978, and have been digitally processed by GSI in attempts to improve the quality of the deep reflections.

Below shallow reflections, which correlate with the sedimentary section, the records show reflection events with variable dip, continuity, and spatial density. Most of the section shows strong events at about 12 s, forming a band or bands of relatively short and discontinuous reflections rather than a single continuous reflection.



McArthur Basin seismic location sketch map



Record No 1979/73 Gundary Plains 1978. Deep crustal reflections G55/83-164A

These events, which appear to originate from the deeper part of the crust, suggest that in northeastern Australia the transition from crust to mantle occurs in short steps over a broad vertical zone and not over a sharp boundary. This is consistent with data obtained elsewhere in Australia. The variations in character and spatial density of the reflections may be interpreted in terms of crustal features, including faults, unconformities, intrusive bodies, and boundaries between different rock bodies. A paper on the work was presented at the IUGG Conference in Canberra.

Gundary Plains deep crustal reflection test survey, NSW 1978-79 (J. Pinchin, J.K.C. Grace, D. Pfister, L.A. Rickardsson)

Seismic recording equipment being prepared for the 1979 Denison Trough seismic survey was again field tested on a deep crustal reflection test survey in the Gundary Plains, south of Goulburn, NSW, during April 1979.

The 1979 recordings used small charges, 100 kg as against 370 kg per shot in 1978, for 13 shots on a traverse parallel to the 1978 north-south traverse. The data are being processed to obtain more reliable vertical velocity information than previously and to provide a 13-fold CDP section. The 1979 work complemented that carried out in 1978, when recordings were also made on two cross-traverses from these shots on each traverse, with a maximum shot-to-geophone offset of 6 km.

The 1978 results were digitally processed by Geophysical Service International, Sydney. Static and dynamic corrections and time-variant filters were applied and 3-fold CDP sections were produced. Fair-quality reflections were recorded down to 12 s reflection time (Fig. SGM-5); this corresponds to a depth of approximately 41 km. The results were interpreted with the refraction results obtained on the Dartmouth-Marulan deep crustal refraction survey line and presented at the CUMSEA Symposium.

Gosses Bluff impact structure (F.J. Moss)

Assistance was given to B.C. Barlow in the preparation of a major paper on the interpretation of detailed gravity information about Gosses Bluff. The interpretation was reviewed and discussed in relation to the preliminary interpretation of seismic results in the area. In the absence of B.C. Barlow, F.J. Moss amended the paper after comments by referees.

Information was assembled to start reinterpreting the seismic data prior to compiling the geological and geophysical information together for a proposed Bulletin.

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

Further amendments were made to the draft report reviewing the geology and geophysics of the Darling Basin. The report recommends a 3-month CDP seismic survey to investigate the presence of shallow Lower Devonian sediments on the flanks of the Blantyre and Menindee Troughs.

The report was produced as a BMR Record. It proved to be a useful contribution to a study undertaken by the NSW Mines Department to investigate the possible prospectivity of the Darling Basin.

Any proposed seismic survey in the basin would follow completion of source rock drilling and studies undertaken in the latter part of 1979 by the Petroleum Exploration Branch.

Bonaparte Gulf Basin review (S.P. Mathur)

A brief report was prepared on a proposal for a 4-month seismic survey in the area between the Bonaparte No. 1 and No. 2 wells and the western margin of the onshore part of the basin. A survey using multiple coverage and digital recording and processing is considered necessary to define the structure of the margin. The area is considered to have fair hydrocarbon potential since a significant amount of gas was discovered some time ago in the Bonaparte No. 2 well.

However, a new petroleum exploration permit has now been granted over the area generally covered by the review, and since it is anticipated that the companies involved will carry out an active exploration program aimed, in part, at defining the western margin, a possible BMR seismic survey in the area has now only a low priority.

Pre-Eromanga Basins review (S.P. Mathur, F.M. Brassil, J. Pinchin, F.J. Moss)

Compilation of well locations and depths to the deepest formation penetrated in the Queensland area continued as time permitted. The object of the compilation is to provide a data base for studying the geophysics and geology of the basins underlying the Eromanga Basin.

Work on this project attained higher priority when the "Petroleum Task Group" recommended that a major effort should be made to review the prospectivity of the Central Eromanga Basin and underlying basins. As a result a team, consisting of S.P. Mathur and J. Pinchin, P.L. Harrison of Petroleum Exploration Branch, and B. Senior of Geological Branch, was formed with the objective of reviewing the information from the area to identify geological/geophysical problems remaining to be solved and to formulate a proposal for systematic study of the problem areas.

The recommendations of the group could lead to detailed studies and surveys as the Central Eromanga Basin Project.

Coal geophysics (F.J. Moss)

Information on the applications and current use of high-resolution seismic techniques in coal exploration in Australia was supplied in response to requests by the Coal Branch, Department of National Development, and by the Alberta Research Council, Canada. The possible resolution attainable in defining the depths to and thickness of coal layers was discussed in response to a request regarding exploration for coal in Bangladesh.

F.J. Moss was a member of the Coal Task Group, and provided an input on the future application of high-resolution seismic and other geophysical methods to coal exploration.

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

Work continued on assessing possible seismic survey proposals, in consultation with other BMR officers and with State Government Geological Surveys and industry. The reporting on recent seismic surveys in the Galilee, Georgina, and Bowen Basins, and particularly review work on the pre-Eromanga Basins, have led to recommendations for future seismic surveys.

The effort being made to obtain up-to-date shot-point and well-location maps, together with computer printouts of key information from seismic surveys and wells, is aimed at assisting industry and BMR in determining where future surveys may be required.

Recent digital multiple-coverage seismic surveys and associated digital processing have provided much better data than previously. In many areas now being resurveyed, previously unknown significant structural and stratigraphic relations are becoming apparent, which will in turn lead to more effective petroleum exploration programs.

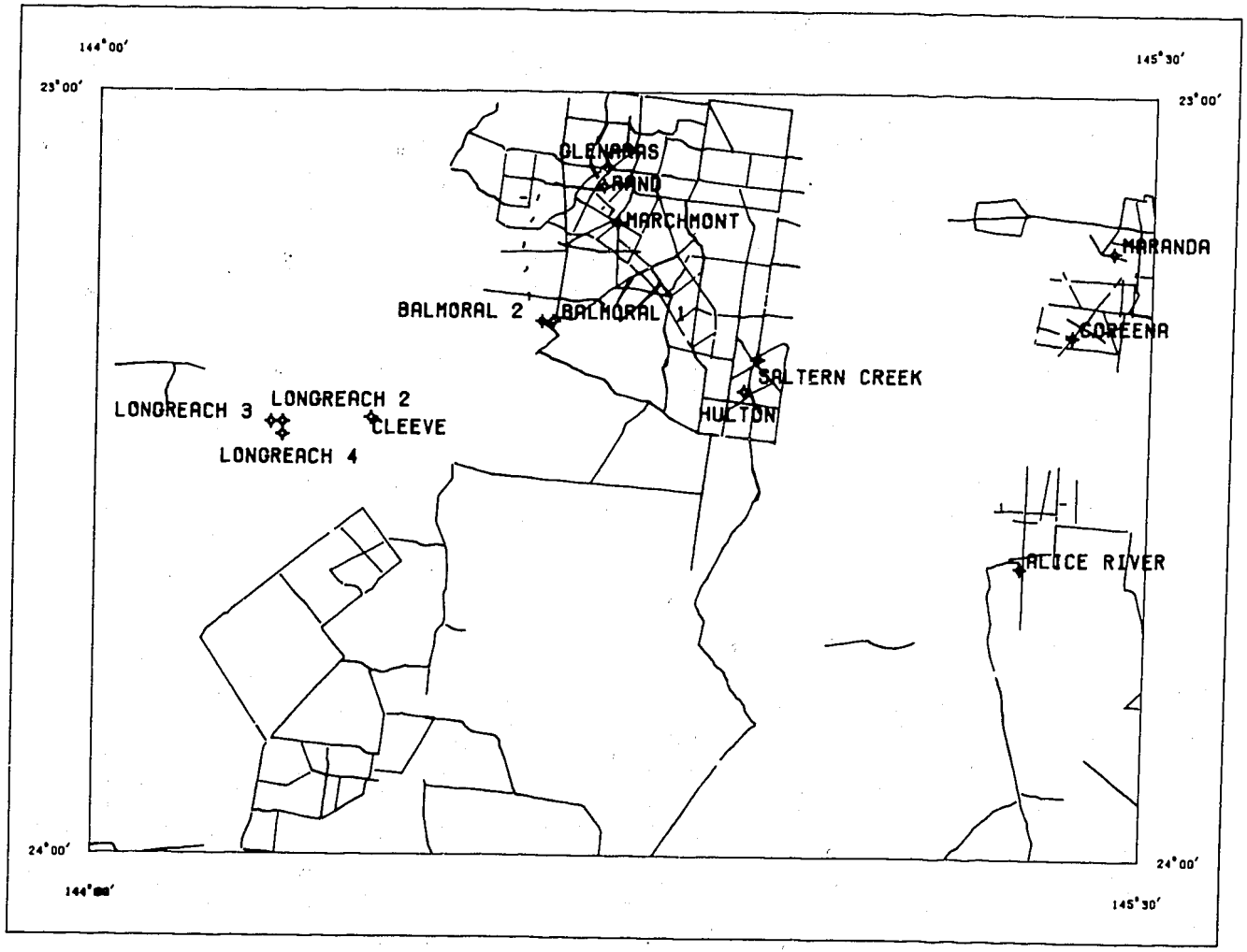
Compilation and plotting of shot-point and well locations (F.M. Brassil)

During 1979 a major revision and ordering of the shot-point and well data system was undertaken. The software was expanded and its efficiency improved. A full set of programs is now available to input, edit, and display data in a variety of presentations. Fully annotated shot-point and well-location maps can be produced at any desired scale and projection (Figure SGM-6).

A report documenting the software data structure and means of expanding and editing the data bank is nearly complete. A start has been made on checking and editing available digitised data; however, shortage of manpower has delayed completion of the task. A system for incorporating new shot-point and well-location data into the data bank is under examination.

SCALE 1:1000000

EDITION OF 1979/09/20



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

Example of computer-plotted seismic traverses and exploration wells

Information on all exploration wells in Australia has now been coded and will be added to the well-location data bank. Seismic shot-point data from the Bonaparte Gulf surveys have been digitised, and preliminary maps have been produced. Tests have been made to find the most suitable formats for both shot-point and well-location maps at 1:250 000 and 1:1 million scales. The co-operation of all petroleum exploration companies and State Mines Departments is sought in providing BMR with information to update these maps.

Production of synthetic seismograms (S.P. Mathur, D. Pfister)

The program SEISSYN, developed originally for use on the CDC 3600 for producing synthetic reflection seismograms from well sonic logs, and modified for use on the Cyber 76 in 1978, was checked for operational errors. Minor errors were corrected and several test runs of the program were made using the sonic log from Richmond No. 3 well in the Surat Basin, which had been digitised at 1 ft and 5 ft intervals. Comparison of the new results with those obtained using the original program indicated no significant differences.

The program SONLOG, which converts the digitised x-y co-ordinates of a sonic log into depth versus 1/V values, was adapted for use with the BMR in-house HP 2100 computer.

Synthetic seismograms were produced for the Westgrove No. 1, Kia Ora No. 1, Warrinilla No. 1, and other wells in the Denison Trough to provide control for stratigraphic correlations using CDP seismic sections.

Seismic technical services (J. Pinchin, J.K.C. Grace, D. Gardner, D. Pfister, R.D.E. Cherry, L.A. Rickardsson, D.K. McIntyre).

The DFSIV and associated field recording equipment continued to function satisfactorily. The DFSIV was completely tested to manufacturer's specifications, a new set of read/write heads was installed in the tape transport, and the recording format was changed to 48 channel, 1600 b.p.i., phase encoded, SEG B format, to enable the data to be handled in the BMR processing system.

All geophone strings were tested on the shake table and revised and repaired as necessary. Spread cables were fitted with AMPHIB connectors to replace the RUFNEK connectors, which had proved to be awkward and unreliable to use in the field. Purchase of more 539-m spread cables and sufficient new strings of geophones to lay geophone spreads at 96 stations improved the efficiency of field operations for 6-fold CDP recordings to between 6 to 8 km per day.

A new recording cab input panel and new interconnecting plugs were made. The remote-firing unit and all Philips FM10 radio transceivers were overhauled and tested. Three International C1300 trucks used in lieu of Landrovers to provide carrying capacity for the heavy 48-channel spread cables were fitted with geophone racks.

Additional equipment received and put into use during the year included: Geophone and cable field test units, high-sensitivity geophones for uphole measurements, and a new 32.5 kVa generator. The performance of the generator, which provides power for the seismic field camp operations, proved to be excellent.

Further details of the work carried out on the seismic technical services is given in the report of the Interim Engineering Services Branch.

Agate Creek gravity survey 1978 (W. Anfiloff)

Results from the Agate Creek survey indicate that the basalt flow of the pocket of Agate Creek Volcanics is not underlain by a major tensional structure through which the basalts could have been extruded. A 25 mGal low is associated with the pocket; the low is attributed to granodiorite underlying the basalt. The boundary between the granodiorite and the Etheridge Group is defined by the flank of this gravity low. A smaller gravity low within the pocket coincides with a major ridge of rhyolite. A draft report is being prepared as a contribution to reporting on the Georgetown project.

Gravity interpretation methodology (W. Anfiloff)

Work continued on papers dealing with the gravity effects of topography, and gravity exploration methods in areas of non-flat topography.

Computer processing of the gravity effects associated with topography is ideally suited to the 2-dimensional case where traverses are run across elongate topographic features such as ridges, ranges, or escarpments. Multiple density profiling techniques were successfully applied to process data from the Agate Creek and McArthur Basin surveys, where traverses were laid in the above manner.

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

Continental Margin Survey

A regional geophysical survey of most of the Australian continental margin and New Guinea waters was completed by BMR in January 1973. Survey lines spaced 20 to 30 n. miles apart extended from near the coast out to the base of the continental slope at a water depth of about 4000 metres, about 100 000 line miles being surveyed in a period of two and a half years. Areas on the north-west shelf and in the Timor Sea and Bonaparte Gulf surveyed earlier by BMR were not resurveyed, but coverage was extended into deeper water. Main areas not included in this survey were the Arafura Sea, the Gulf of Carpentaria, the Great Barrier Reef, and Bass Strait.

Seismic, gravity, magnetic, and depth recordings were made. The seismic system comprised a 120-kilojoule sparker source and a six-channel streamer. The first hydrophone group was 300 m from the ship with subsequent channels at 220 m intervals. Navigation was by a satellite Doppler and sonar Doppler combination. Ship speed was about 9 knots.

This was the Continental Margin Survey. The results were made available immediately in preliminary form and have been widely used by industry, government, universities, and other institutions both in Australia and overseas from 1970 onwards.

The Marine Geophysics Group has continued to process and interpret the data in the intervening period and a history of these activities can be followed in the sequence of Annual Summaries of Activities. Many individual reports and papers on particular topics have been written and these will be found listed there; also brochures have been regularly issued listing the data and other material available. A new and comprehensive brochure has been prepared.

A proportion of the six-channel analogue seismic data in the areas of highest interest has been processed for industry and for BMR, mostly by Geophysical Services International of Sydney. It is anticipated that further seismic data will be processed as required.

The Marine Group has developed a whole package of computer routines for processing and displaying the navigation, bathymetric, gravity, and magnetic data, and 1979 has seen the production of 220 final track and profile maps. The completion of this task in some ways marks the end of an epoch for the Marine Group.

The results of the Continental Margin Survey have been particularly useful in obtaining an initial regional understanding and evaluation of the Australian continental slope and its marginal plateaus. They have helped BMR to advise government on matters related to Law of the Sea and international boundary negotiations.

The final bathymetric results from the Survey were provided to the RAN Hydrographer who has incorporated them into his Ocean Sounding Charts towards the end of 1978 through into 1979.

The survey remains the largest ever carried out in Australia and is one of the longest continuous surveys ever done throughout the world. Processing of the results has spanned approximately seven years, and it has taken over six months time to scribe the final maps on the flat-bed plotter. BMR staff involvement has ranged from 3 at the start to a peak of about 10 and reduced to 2 in the current year. Some selected statistics are given in the following table:

Statistics of Continental Margin Survey

(including survey of Gulf of Papua and Bismarck Sea)

Cost	$3 500 678
Length of survey	863 days
Operational days	575 days
No. of cruises	36
Total length of traversing	186 170 km
No. of data values (ten-second non-seismic)	158 976 000
No. of seismic shot-points	7 000 000
Length of analogue charts collected	19 km
No. of seismic analogue tapes of 700 m each	1 282
Total length of seismic monitor records	12 km
No. of man-years field work (BMR)	7
No. of man-years field work (CGG*)	43
No. of man-years data processing (BMR)	28
No. of man-years data processing (CGG*)	10
No. of man-years development	15

* Compagnie Generale de Geophysique, Paris, France, which was contractor to BMR for the continental margin survey.

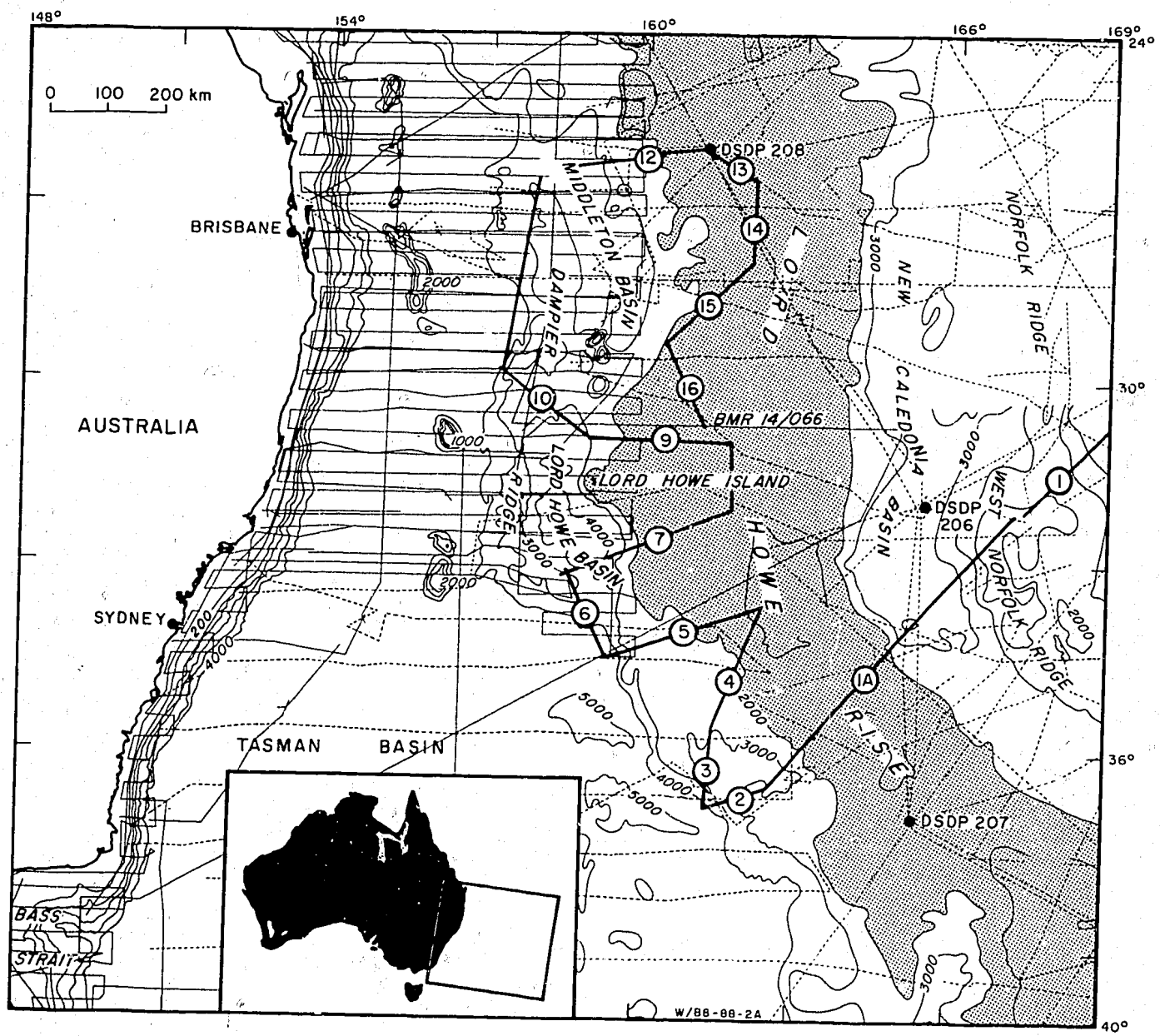
Lord Howe Rise - co-operative project with BGR (J.B. Willcox, P.A. Symonds, L.A. Tilbury, A.R. Fraser)

During the period from 19 October to 15 November 1978 the Bundesanstalt fur Geowissenschaften und Rohstoffe (Federal German Geological Survey) (BGR) and the Bureau of Mineral Resources conducted a co-operative survey aboard R.V. Sonne over the central Lord Howe Rise area, under the auspices of the FRG/Australia Science Agreement which is administered for Australia by the Department of Science, which provided the Australian component of funding. Scientist from BGR, BMR and the New Zealand Department of Scientific and Industrial Research (DSIR) took part in the cruise.

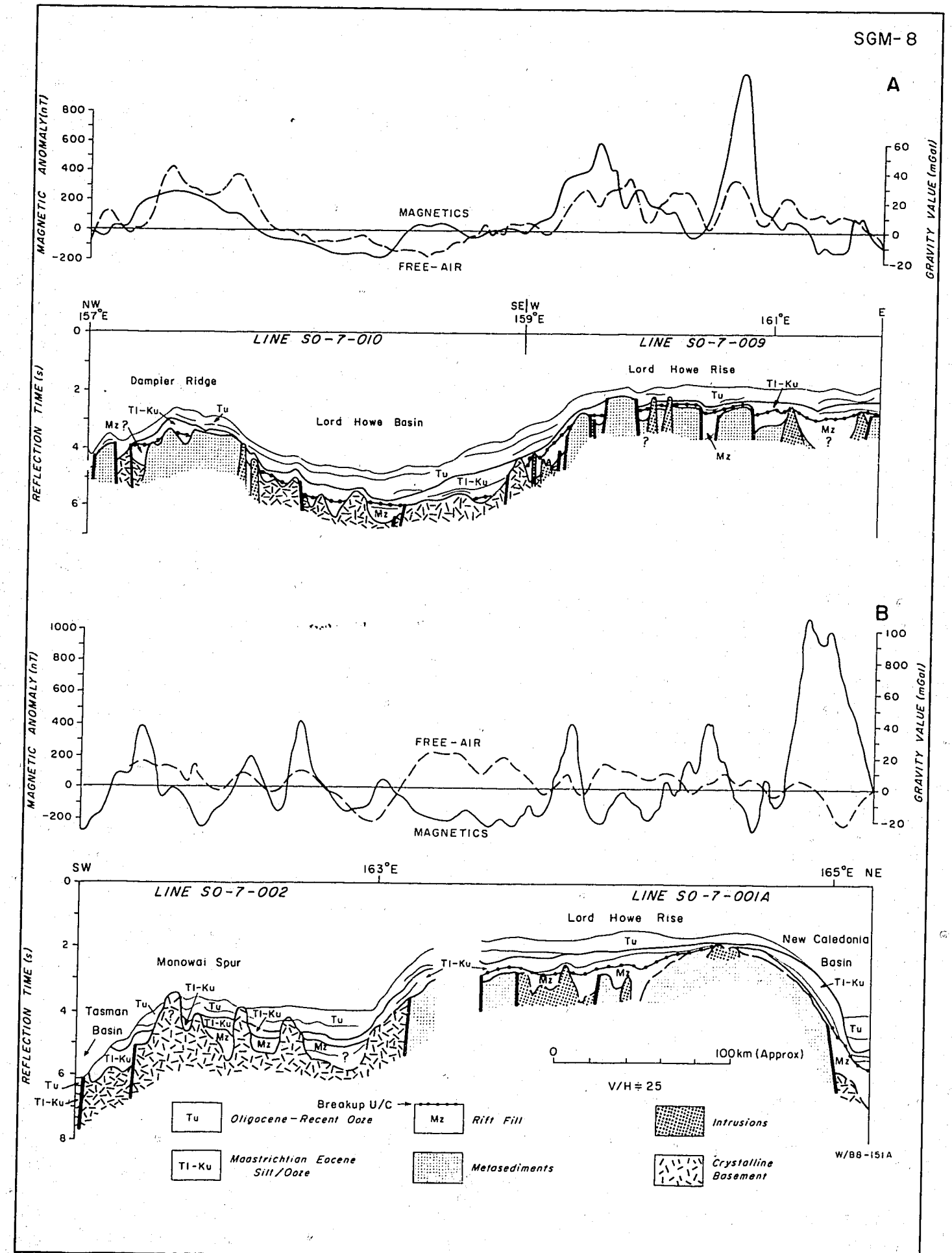
The main objectives were to examine the structure, geological evolution, and petroleum potential of the Lord Howe Rise. The survey extended primarily over the western half of the Rise, between 25° and 37°S latitude, but included crossings of other nearby features. (Figure SGM-7). About 4000 line-kilometres of 24-channel digital seismic, gravity, magnetic, and bathymetric data was recorded, as well as 14 sonobuoy refraction seismic profiles. Ship's positions were determined by a 'Magnavox' integrated satellite/sonar Doppler navigation system.

The Lord Howe Rise is a major submarine feature in the Tasman Sea; it extends northwest from the New Zealand continental margin and lies about 600 km off the east coast of Australia. It is about 2000 km long and 300 km wide, and its crest lies in water ranging from 750 to 1200 m deep. Previous studies have indicated that it has a continental crustal structure. The general absence of rift-valley or pull-apart basins along the eastern seaboard of Australia has led to speculation that when breakup took place in the Tasman Basin, the rift-valley was breached along its western boundary fault, and that any associated sedimentary basins remained wholly attached to the 'Lord Howe Plate'.

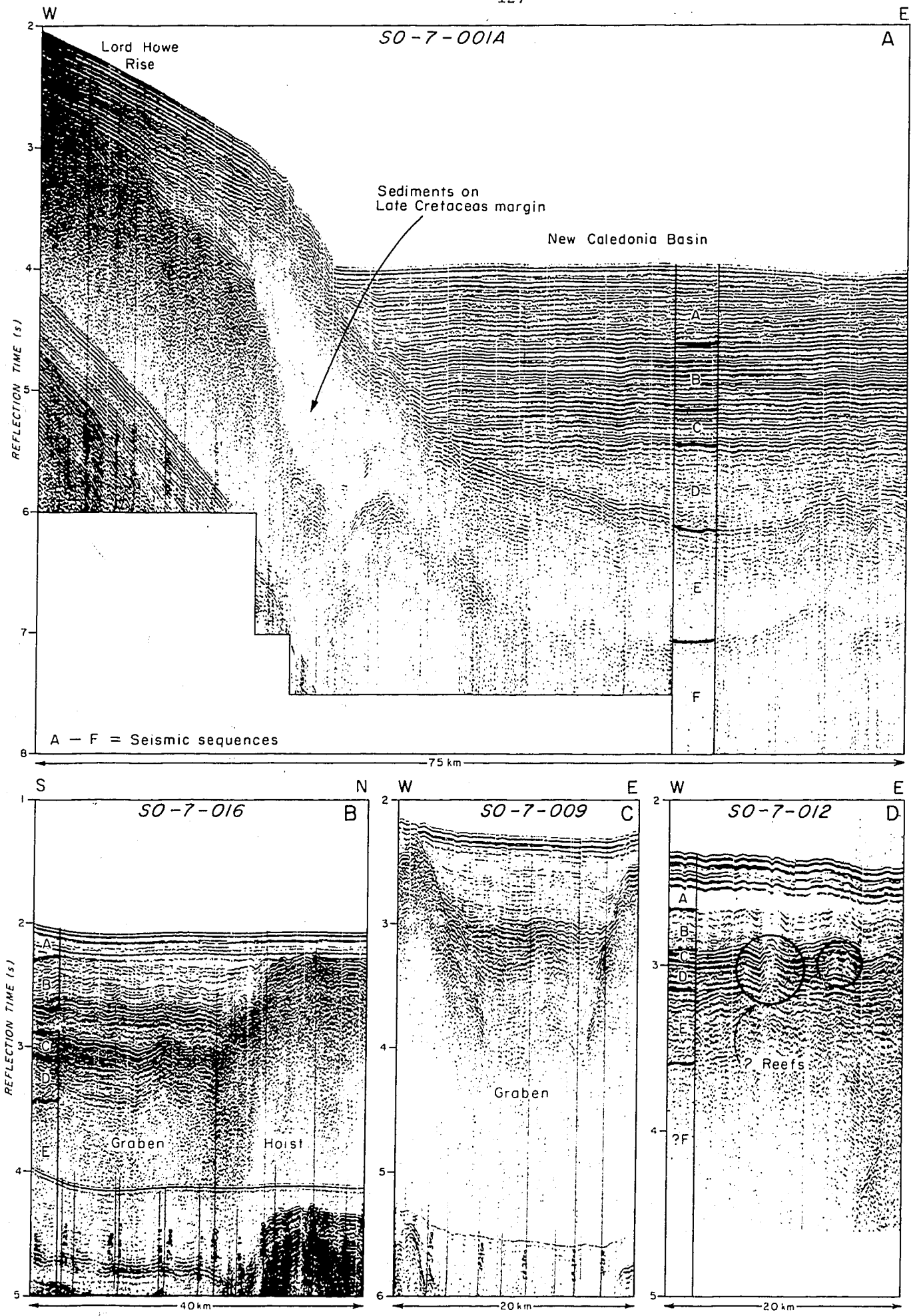
Seismic monitor data from the survey show that sediment-filled grabens make up much of western Lord Howe Rise (Figure SGM-8), but that there is no single sediment-filled depression resulting from rifting or pullapart tectonics,



Bathymetry of the Tasman Sea showing 'Sonne' lines



Structural profiles in the Lord Howe Rise region



Examples of single-fold monitor records

such as occurs on the southern "Atlantic type" margin of Australia as exemplified in the Bremer, Great Australian Bight, and Otway Basins. This preliminary interpretation indicates that wave-base erosion was taking place on Lord Howe Rise in the Late Cretaceous, and implies that a shallow marine environment was present prior to seafloor spreading in the Tasman Basin. Shallow marine silts and clays penetrated in DSDP Site 207, and palaeogeographical reconstructions, which juxtapose central Lord Howe Rise and the Gippsland Basin, indicate that marine petroleum source rocks may be present. Possible petroleum traps appear to exist against the boundary faults of the grabens (Band C, Fig. SGM-9) and in structures interpreted as reefs of Late Cretaceous and Paleocene age (D, Fig. SGM-9). A seal may be provided by pelagic oozes.

The eastern flank of Lord Howe Rise was probably the ancient (Pre-Maastrichtian) continental margin of the 'Australian-Antarctic super-continent'. Lying along that flank a wedge of Late Cretaceous or older sediment, up to 2000 m thick, (A, Fig. SGM-9) may also be prospective for petroleum.

A BMR Report and a paper, to be published in 'Geophysical Prospecting', were prepared from the preliminary results of the survey.

Overseas visit by J.B. Willcox

As a follow-up to the co-operative survey, Mr Willcox visited BGR in Hanover from May to October 1979, with funding provided by the Department of Science under the Science Agreement. With BGR Scientists he processed the seismic data and commenced detailed interpretation of the results. He also attended the 41st Meeting of the European Association of Exploration Geophysicists in Hamburg from 29 May to 1 June and presented a paper titled 'Lord Howe Rise, offshore Australia - preliminary results of a recent survey'.

Coral Sea Basin margin co-operative project with BGR (P.J. Cameron, G.D. Karner, W.J. Meyer, J.K. Grace, R.A. Dulski)

During November 1978, the northwest Coral Sea region was surveyed under the FRG/Australia Science Agreement which is administered for Australia by the Department of Science. The ship's tracks are shown in Figure SGM-10. This survey followed immediately after that of the Lord Howe Rise and received similar funding support. Scientists from BGR, BMR, and both Queensland and Papua New Guinea Geological Surveys participated.

The objective of the cruise was to search for marginal graben zones off the Queensland and Papuan Plateaus associated with the initial rifting of the northwest Coral Sea basin and to examine the subsequent evolution of the margin.

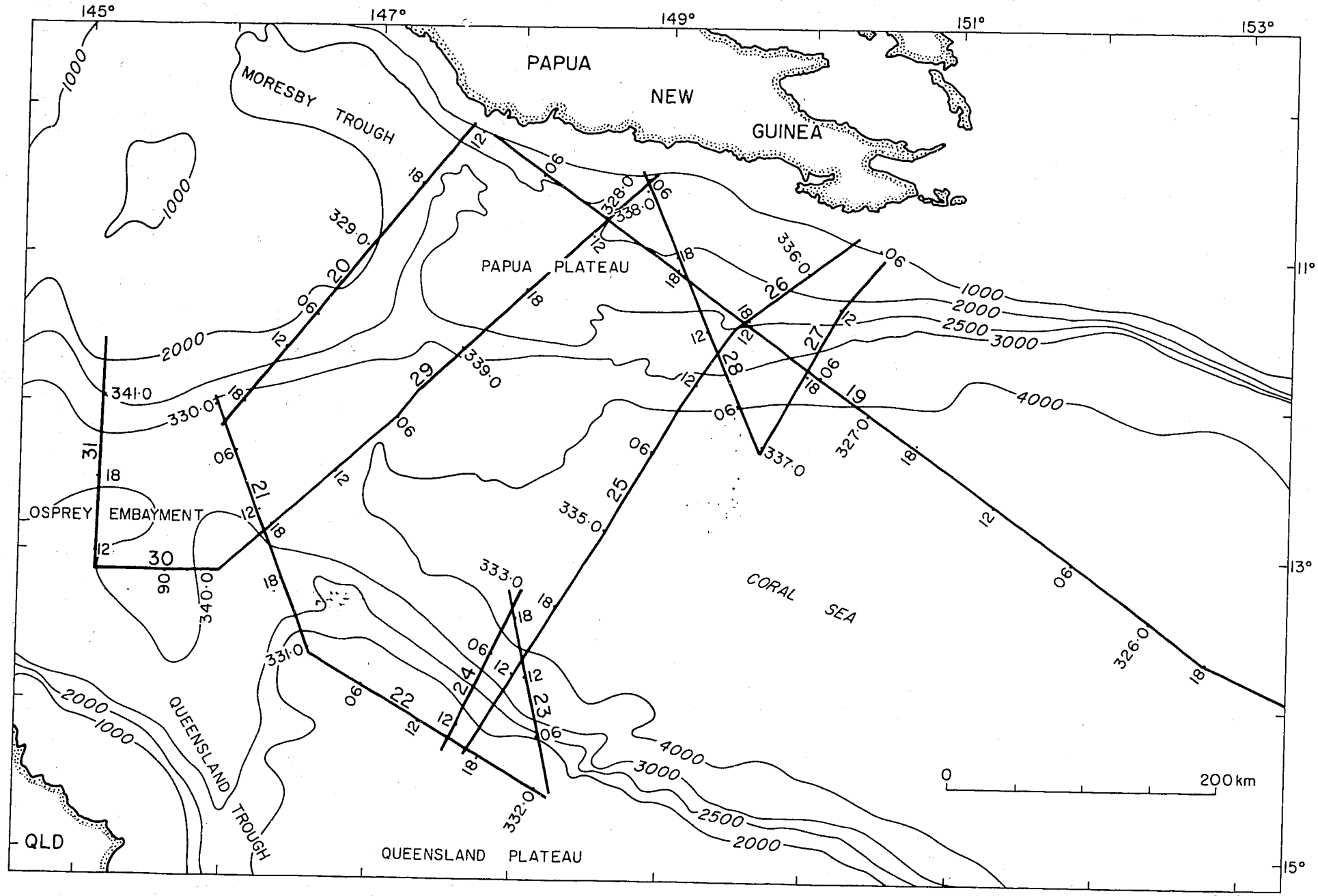
The basic method used was one of mapping the unconformities interpreted from reflection seismic records. The age of the regional unconformities was established by a tie line to DSDP sites 210 and 287 and hence the tectonic setting of the northwest Coral Sea basin and margin evolution could be deduced.

The transition from oceanic crust of the Coral Sea Basin to continental crust of the Queensland and Papuan Plateaus occurs in the surveyed area over a narrow (less than 50 km) zone and is associated with a sediment filled graben. The graben-zones contain more than 4 seconds (2-way reflection time) of sediments of pre-Oligocene/Eocene age.

At least two regional unconformities are recognisable over the surveyed area, representing periods of erosion during the Oligocene/Eocene and Miocene respectively. A third, older unconformity exists in block faulted regions of the Queensland and Papuan Plateaus.

The major discovery from the cruise was that both the Queensland and Papuan Plateaus contain major drowned fossil reefs on their outer slopes. All observed drowned reefs lie beneath the Oligocene/Eocene unconformity, indicating that these present deep-water areas were at shallow depths in pre-Eocene times. The Papuan Plateau shows clear evidence for reef migration in pre-Eocene times. Subsidence of both plateaus, therefore, apparently proceeded rapidly to completion by the Oligocene/Eocene.

Record No 1978/73



'Sonne' cruise, Coral Sea Basin, ships tracks (SO7B, 1978)

Q/B8-118-1A

Following the survey Mr Cameron compiled data, maps, and literature from other marine surveys in the region and in July 1979 went on a 5 month visit to BGR in Hanover. With BGR scientists he is processing seismic, gravity, and magnetic data from the Sonne cruise and is compiling, modelling, and interpreting the combined data. His visit was financed by the Department of Science under the Science Agreement.

Co-operative project with National Mapping - Survey 29 (H.M.J. Stagg, R.A. Dulski, T.R. Hegvold)

The Marine Geophysics Group continued its association with the Division of National Mapping's bathymetric survey of the continental shelf. We have provided a Geometrics proton-precession magnetometer, and since 1977 a Digitrak digital depth converter, a digital data acquisition system (DAS) for recording the data, and staff to run them. The DAS has also provided National Mapping with an on-line navigation system that has been improved and adapted from survey to survey as different navigation systems were used. From 3 August to 2 September 1979, Survey 29 was conducted in the Timor and Arafura Seas using the M.V. Cape Pillar. This is the first time that BMR has operated on board this vessel, which uses a Magnavox satellite/sonar Doppler navigation system.

The survey consisted of two cruises, the first of which was a National Mapping charter with surveying concentrated near Browse Island, north of Broome. In addition long east-west lines were run between Darwin and the survey area. The first week of this cruise was used by the BMR survey staff of three to install and test the system. This included debugging a new facility which interrogates the Magnavox satellite navigation computer to obtain the navigation data. During this period, 5-minute values of position, water depth, and magnetic intensity were hand-recorded on coding sheets. For the remaining two weeks of the cruise, data were recorded on cassette tape.

The second cruise was primarily a joint surveillance operation by Department of Health and Fisheries Division of Department of Primary Industry. BMR staff participated, partly to determine the feasibility of co-operation on cruises of this type. National Mapping supplied BMR with technical assistance

to run the navigation system. This cruise was more successful than originally expected. About 3000 km of magnetic and bathymetric data was acquired in the Arafura Sea from the Wessel Islands to west of Melville Island.

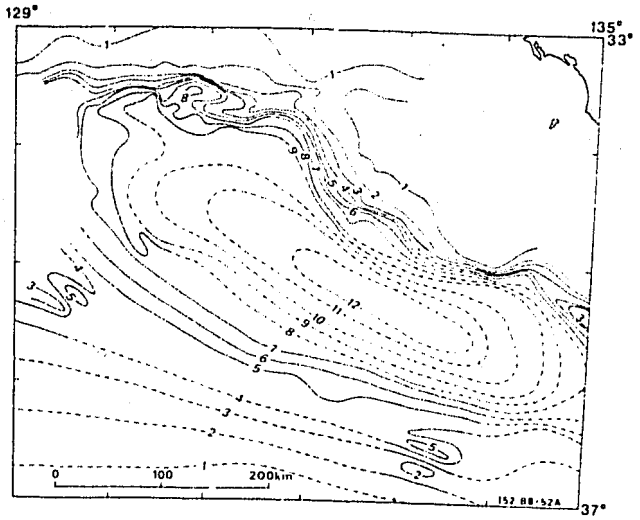
A magnetometer shore station was operated at East Point, Darwin, by a staff member of the BMR Darwin office during the second cruise only; a suitable site was not found by the survey team in time for the first cruise.

Magnetic measurements in the Southern Ocean on the M.V. Nella Dan (H.M.J. Stagg)

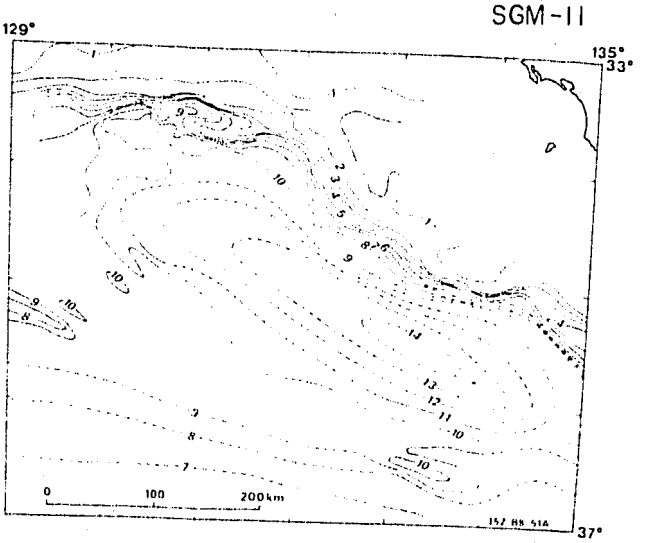
BMR has started the systematic collection of magnetic data on the M.V. Nella Dan during its ANARE relief voyages, using a computer-based data acquisition system (DAS). Because of the limited space and power available on the Nella Dan and other demands upon available hardware, a simplified version of the DAS used on the Cape Pillar has been implemented.

The Marine Geophysics Group DAS software is in modular form, and only two weeks was needed to put together the simplified system and test it under simulated field conditions. The peripheral devices included are NCE clock, Facit cassette tape recorder, Geometrics G803 proton-precession magnetometer and strip-chart recorder, and a KSR43 teletype for communication with the system. Time and magnetic data are acquired at 10-second intervals, and written to cassette tape in blocks every two minutes.

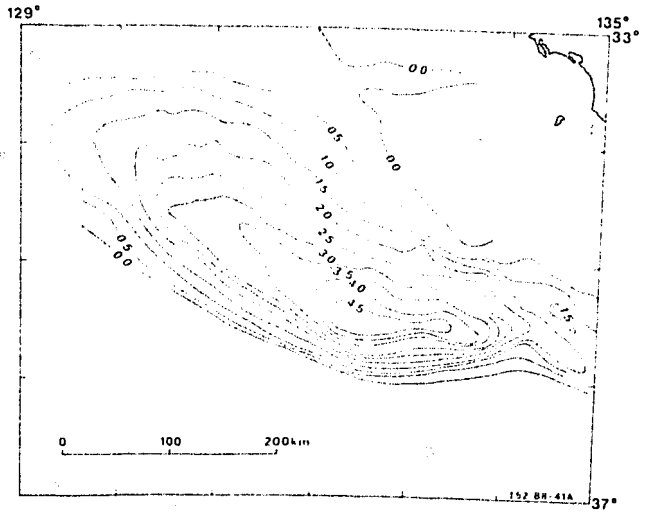
Because of the remoteness of the area of operations, the limited availability of trained manpower and the lack of maintenance and back-up facilities, "fail-safe" procedures have been adopted. If the Facit cassette recorder breaks down, the system will continue to operate dumping the last 10 one-minute digital values of the magnetic field to the teletype every 10 minutes. If a tape write operation is rejected for any reason (e.g. end-of-tape reached and a new cassette not inserted, or continuing parity errors) data will continue to be acquired. If no action is taken to rectify the problem, then after roughly four hours the cassette drive will be logically "turned off" within the software. If a new cassette is inserted or other appropriate action taken before this time limit is reached, all the accumulated data will then be saved on tape.



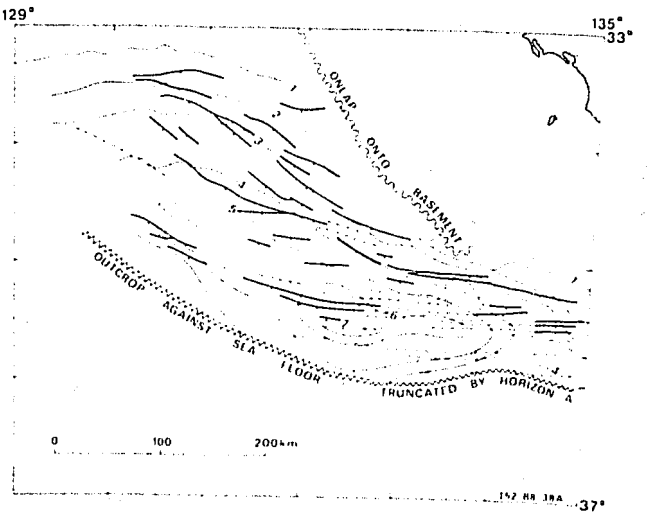
Total sediment thickness (km)



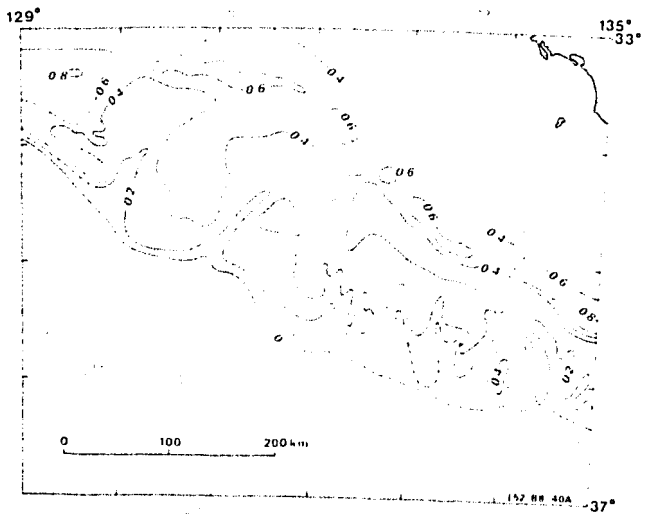
Basement contours (km)



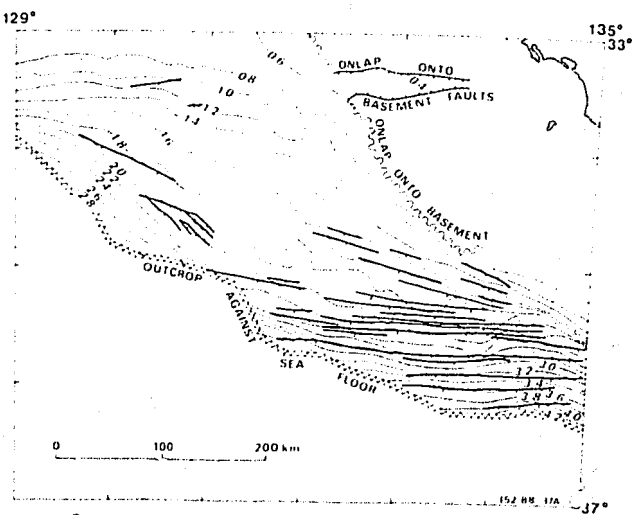
Thickness of late Cretaceous-early Tertiary sequence (km)



Contours of mid-Cretaceous unconformity (km)



Thickness of Tertiary post-break-up sequence (km)



Contours of break-up unconformity (km)

Isopach and structure contour maps, Ceduna Terrace

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

This is a continuation of the project described in the 1978 Summary of Activities.

Work in the early part of the year was directed towards the production of a paper for the 1979 APEA Journal and on oral presentation for the APEA Conference in Perth. Since then, the interpretation of BMR and Shell seismic data has continued to completion, horizon data have been digitised, and the production of final geophysical maps is in the final stages. A BMR Record to accompany the full suite of geophysical maps is in preparation. Some of the isopach, structure contour, and profile maps from the APEA paper are reproduced in Figures SGM-11 and SGM-12 to illustrate the extent and depth of detailed investigation.

Interpretative work in the past year has led to several conclusions relating to the tectonic development of the southern margin, and the depositional history, gross lithology, distribution, and petroleum potential of sediments in the Ceduna Terrace region.

The interpretation supports a previous view that rifting on the southern margin began in the late Jurassic, about 100 m.y. before break-up. The margins of the rift valley appear to have been controlled by boundary faults which remained fixed throughout the history of rifting; there is no evidence for outward migration of boundary faults as proposed in some generalised models of rift margin development. The axis of the rift valley may have been topographically high during the late Cretaceous, as evidenced by the common lack of sediments of this age in the southern part of the Ceduna Terrace. However, there is no indication of a basement ridge in the south, and gravity modelling studies suggest that the basement shallows gradually from about 12 km beneath the Ceduna Terrace to about 7 km beneath the abyssal plain.

The Ceduna Terrace area appears to have been subjected to two main cycles of transgression and regression during the Cretaceous. The first transgression occurred in Aptian times, probably as a result of the incursion of an epicontinental sea from the north via the Arckaringa and Eucla Basins. Depositional environments probably graded from restricted marine, on the margin of the rift valley, to more fully marine in the area to the south, which lay within the rift valley proper.

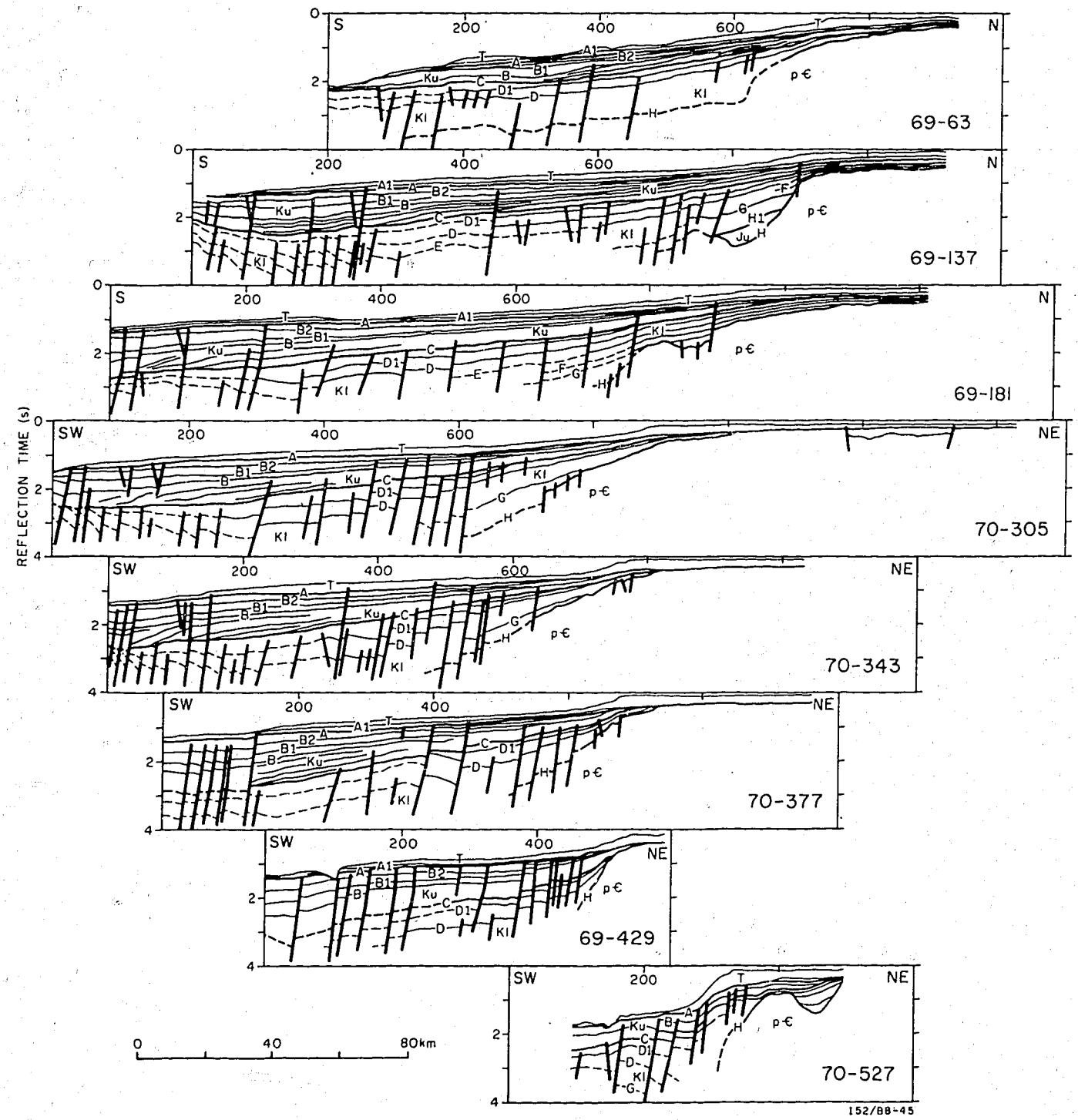
The second transgression was probably caused by the encroachment of the sea from the west along the floor of the rift valley. Large-scale foreset bedding in the western Ceduna Terrace, the presence of marine indicators in Potoroo-1 well, and the marginal marine nature of the Belfast Mudstone in the Otway Basin are interpreted as consequences of this transgression.

The petroleum potential of the Ceduna Terrace is rated as fair to good, although it is untested by drilling. The best prospects appear to be associated with the faulted Lower to mid-Cretaceous section, where structural entrapment of hydrocarbons may occur in tilted blocks by a combination of dip closure and faulting. The fault blocks are believed to contain marine source beds, and to be sealed by an overlying impervious sequence, but the presence of abundant reservoir rocks is doubtful. Stratigraphic traps may exist in the sand-rich Upper Cretaceous deltaic sequence, which directly overlies an interval thought to have good source potential.

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

During 1979 the time spent on finalisation of the Carnarvon Terrace study was restricted by demands from other projects. The Early and Late Cretaceous structure maps and the Late Cretaceous to Recent isopach map were contoured; the map of stacked profiles from the BMR Continental Margin Survey was prepared, showing seismic data in depth, overlain by gravity, free-air, and magnetic profiles.

All that remains is to complete the contouring of the Early to Late Cretaceous (Winning Group) and Early Cretaceous to Recent isopach maps, and revise the draft text of a BMR Report, "Geophysical Maps of the Carnarvon Terrace and Wallaby Plateau", which will accompany the maps. The report will contain about 15 reduced versions of contour and profile maps; about another 36 maps at 1:2.5 million and 1:1 million scales will be made available through the Australian Government Printing Office.



Line drawings based on computer-drawn profiles for eight interpreted seismic sections crossing the Ceduna Terrace

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

Geological interpretation of the geophysical data and a few bottom samples from Scott Plateau off northwestern Australia has been a continuing project reported extensively in previous annual summaries.

During 1979 a draft BMR Bulletin on the area was finalised and edited within Geophysical Branch between March and September and passed to the Publications Section late in the year.

A short article was published in the August 1979 edition of the Geological Society of America Bulletin. It was in response to a paper by Veevers & Cotterill (1978) in which they proposed that the Plateau is underlain by oceanic crust. This is at variance with the conclusion of Exon and Stagg that it had a continental origin.

Timor collision study (C.R. Johnston, C.O. Bowin (Woods Hole Oceanographic Institution))

Following the 1976 Woods Hole marine survey of the Timor Sea/Banda Sea area Mr Johnston has been associated with Dr Bowin and other in a co-operative interpretation of data from the region. A paper is in preparation for presentation at the December 1979 IUGG meeting in Canberra dealing with crustal reactions that have occurred during the Plio-Pleistocene continent/island collision in the Timor region. It proposes that the influx of vast quantities of sediment from the Australian continental margin into the Indonesian subduction zone initially resulted in the development of a large wedge of margin sediments lying immediately to the south of the superimposed Indonesian plate and extending up the Australian continental slope. In the vicinity of the subduction zone it was deformed, and continuing convergence between the plates compressed, thickened, and uplifted both the deformed sediment wedge and the leading edge of the superposed plate. It also resulted in the development of molasse basins along the southern side of Timor.

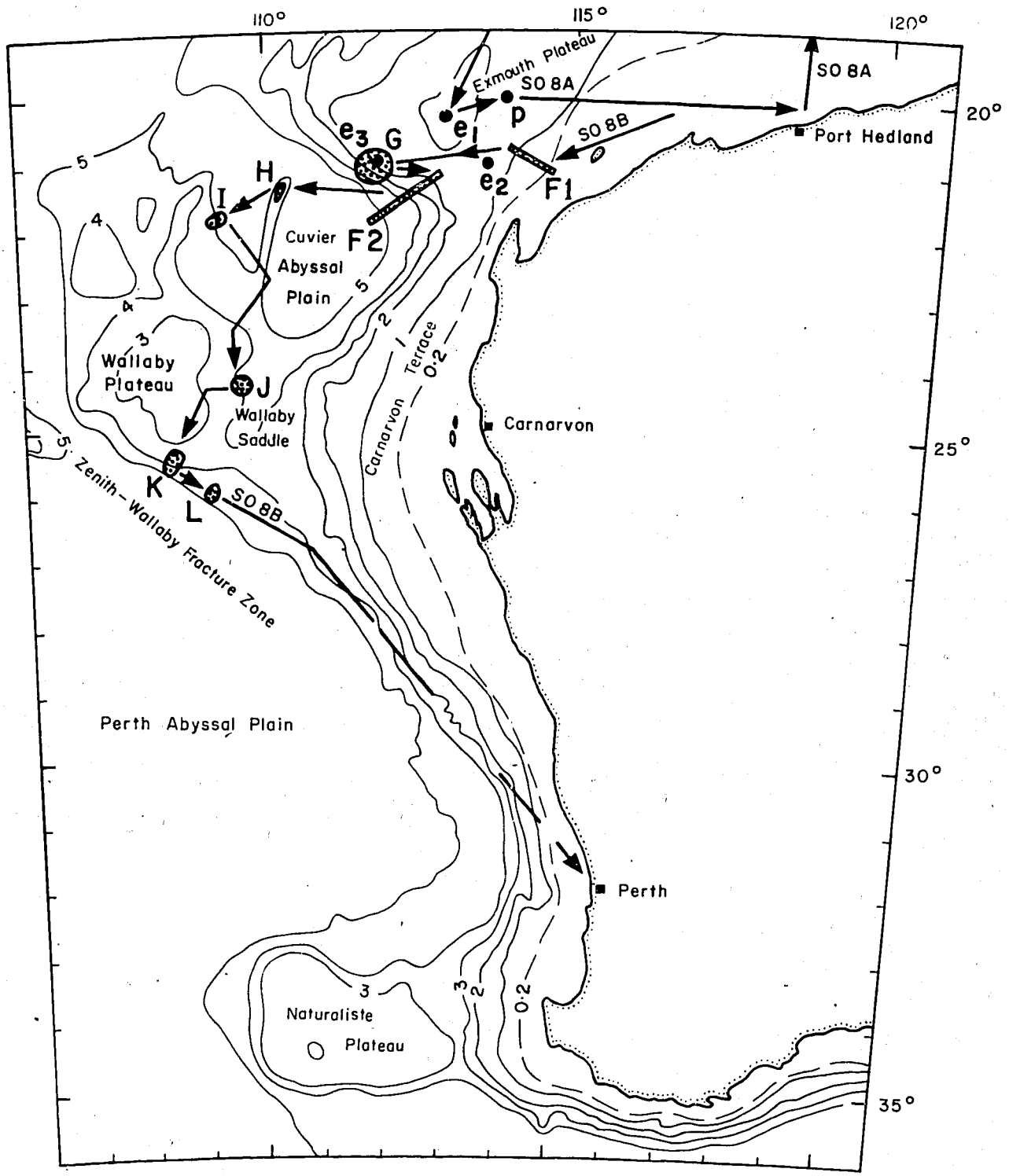
Naturaliste Plateau region (J.C. Branson, J.B. Colwell)

Mr Branson made a study of the structural elements in the oceanic and continental crust from 100° to 120° E longitude and 30° to 40° S latitude. For 4 weeks he was assisted by J.B. Colwell seconded from the Marine Geology Group. The study concentrates on the relation between and possible modes of formation of several major bathymetric and geophysical features which include the Magnetic Quiet Zone south of Albany, the Naturaliste Plateau and Fracture Zone, and the Diamantina Fracture Zone, which have been subjects of individual study respectively by J.C. Mutter (BMR), P. Petkovic (BMR), and R. Markl (Lamont-Doherty Geological Observatory). The main data sources for the study were the BMR Continental Margin Survey and Lamont-Doherty surveys on R.V. Vanin and R.V. Vema.

Survey profiles and magnetic records show that the Diamantina Fracture Zone is atypical of features normally termed 'fracture zones' because there is no evidence of wrench fault or transform motions across the lineament. An alternative proposal for this zone as a 'hot-spot' trace is also speculative. The Diamantina Fracture Zone does not correlate with plotted plate movements in the same manner as 'hot-spot' traces recorded in the Pacific Ocean. North of the DFZ the major magnetic lineation may be reinterpreted as part of the continental margin anomaly, rather than anomaly 22 as some authors suggest, and a new proposal can then be entertained for the presence of pre-Tertiary crust in the Magnetic Quiet Zone.

Linear trends within the basement of the Naturaliste Plateau and in its margins are considered significant elements in the formation of the Plateau and in the early history of seafloor spreading in the region.

Mr Branson has prepared a paper for presentation in the 1979 I.U.G.G. symposium in Canberra on margins of the Indian Ocean, in which he considered evidence for the Veevers & Cotterill 'epilith' growth of the Plateau and continental fragment theories of its origin. He prepared models of its crustal structure along with magnetic, gravity, and topographic compilation maps of the region.



Locality map showing Wallaby Plateau with Dredging sites

—2— Isobaths in kilometres

Sediment sampling area

● Gas sampling area

Wallaby Plateau project (P.A. Symonds)

This study was undertaken to complete the interpretation of the data from the offshore Carnarvon region of the Continental Margin Survey.

The Wallaby Plateau lies at a water depth of about 3000 metres off the central West Australian coast and is linked to the rest of the continental margin by the Wallaby Saddle (Figure SGM-13). To the northeast it is separated from the Cuvier Abyssal Plain by a low scarp and to the southwest it is separated from the Perth Abyssal Plain by the Zenith-Wallaby Fracture Zone. These abyssal plains were formed by an Early Cretaceous seafloor spreading system that was initiated 122 m.y. B.P.

In the past it has generally been accepted that the Wallaby Plateau is a thinned continental fragment; however, recently it has been suggested that it is an oceanic upgrowth of 'epilith' formed after the start of spreading in the Cuvier Abyssal Plain. Recent dredging on the margins of the plateau obtained a variety of volcanic and volcaniclastic rocks of unknown age. Although these results are consistent with an 'epilithic origin', there is some seismic stratigraphic and structural evidence to support a continental origin for at least part of the plateau. Analysis of gravity and magnetic data now in progress is intended to test the 'epilithic' and continental modes of origin by determining the nature of its margins and any associated crustal boundaries.

Woodlark Basin study (G. Karner)

A co-operative study of the Woodlark basin by scientists of Lamont-Doherty Geological Observatory and Mr Karner of BMR was completed during 1979. The results will be presented by Dr J. Weissel (LDGO) at the IUGG Symposium on the tectonics of the SW Pacific margin in Canberra during December 1979.

The previously known seafloor spreading magnetic lineations were traced into the western part of the basin using BMR data not previously available during the initial investigations of the basin. Magnetic spreading anomalies to anomaly 2' are symmetrical about a well-defined central anomaly, suggesting that the basin has been opening for the past 3.5 m.y.

Earthquake activity associated with the Woodlark plate boundary continues into the Papuan peninsula. Unlike the Mariana Trough, there is little evidence that the Woodlark basin opened behind an island arc-trench system.

Northwest Australia and Timor region review (P.R. Temple, C.R. Johnston)

Offshore and International Division requested a review of the geology of the Timor region and the resources potential of portions of Australia's northwest shelf. C.R. Johnston collaborated with Mr P.R. Temple of Petroleum Exploration Branch in providing the required information during the latter part of 1978.

AMSTAC workshop on the marine geosciences

A workshop on the marine geosciences was held at BMR in Canberra, on 22 and 23 February, as one of a series of workshops on the marine sciences organised by the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC), in accordance with the recommendations of the Australian Science and Technology Council (ASTEC) to examine means of co-ordination and to set priorities within the respective disciplines.

In preparation for this workshop members of the BMR Marine Geophysics and Marine Geology Groups drafted a working paper outlining a proposal for a national marine geoscience program.

The first day of this workshop was devoted to review of the submarine areas around Australia; amongst the speakers were Willcox (Continental Margin Survey), Cameron (Coral Sea) Johnston (Heard-Kerguelen), Symonds (Lord Howe Rise), and Exon (Exmouth and Wallaby plateaus) from BMR.

A report on the workshop has been prepared by AMSTAC. The summary and conclusions are given below.

Summary and Conclusions - Participants in the workshop divided into four working groups on the basis of regions, for morning sessions. The convener of each group presented their priorities to the assembly for discussion in order to arrive at two or three projects with top priority.

Much of the discussion was initially centred around acquisition of geoscience vessels and areas where these vessels might be used. Sir Rutherford Robertson reminded the participants that if a request was to be made then the case would need to be supported or justified on two grounds:

i) Outstanding scientific merit, and/or
ii) Economic advantage to the nation.

Further discussion took place during which the strong feeling was expressed that funds should be made available to allow studies of the continental shelf to recommence and to enable collaborative work to be undertaken in overseas research vessels while they are in or near Australian waters. After further discussion concerning the need for large geoscience vessels, the meeting agreed to two proposals:

1. That $500 000 be made available in 1979-80 for studies in the Great Barrier Reef area and for developing collaborative marine geoscience studies of a national and international nature, particularly in the region of the Heard-Kerguelen Plateau and/or the Lord Howe Rise.

2. That a well-documented case be developed during the year for provision of a large deep-water geoscience vessel to be operated as a National Facility. In addition, that the need for smaller multi-disciplinary vessels for continental shelf and upper continental slope studies be investigated.

Sir Rutherford commented on the success of the workshop in its having clearly focused on the immediate priority areas and, in closing, thanked the Bureau for providing facilities and assistance to the workshop.

Law of the Sea (P.A. Symonds)

This continuing commitment involved attending to requests from the Oil and Gas Division of the Department of National Development for information and advice relating to the Law of the Sea negotiations. It generally involved determining the effect that changes and additions to the definition of the legal 'continental shelf' would have around Australia and its territories and assessment of the petroleum prospectivity of the areas in question. During the middle part of the year many requests for information came out of the second session of the 8th Law of the Sea Conference in New York. They mainly concerned oceanic ridges and the proposition that purely oceanic features not forming part of the natural prolongation of a coastal state's landmass should not be treated as part of the continental margin.

Towards the end of 1979 officers of the Marine Group joined an inter-departmental Continental Shelf working group which was involved in preparations for Australia's participation in the 9th Law of the Sea Conference in 1980.

During the last year and a half the Marine Group has prepared about 20 special purpose maps and several Professional Opinions and minutes relating to questions concerning the Law of the Sea negotiations.

SEATAR workshop on the geology and tectonics of eastern Indonesia (C.R. Johnston)

Mr Johnston has been involved since 1976 in a co-operative BMR/Woods Hole Oceanographic Institution project dealing with the geology of eastern Indonesia and the northwest Australian continental margin. As a result he was invited to attend the SEATAR workshop held in Bandung, Indonesia during July. Funding was provided by IOC UNESCO. At the workshop Mr Johnston presented a paper which reviewed a number of suggested explanations for the geology of the Timor region and discussed implications arising from his studies on the development of the Banda Arc region. His paper will be included in the conference proceedings to be published early in 1980.

Proposal to use HMAS COOK in 1980 (H.M.J. Stagg)

Advice was received from the RAN hydrographer that the new hydrographic vessel HMAS Cook will be available for some civilian use during working-up trials out of Melbourne in 1980. A proposal was prepared, requesting the use of the Cook for two of the two-week cruises.

Australian Geomagnetic Reference Field (R. Whitworth)

R. Whitworth spent ten weeks in Boulder, Colorado, at his own expense, as a guest worker at the Data Studies Division of the National Oceanic and Atmospheric Administration. The visit was to further the study of secular variation in the Earth's magnetic field that the Marine Geophysics Group has been pursuing over the past few years.

Much of the time was spent in upgrading the observatory annual means file as several undefined datum jumps were detected. In parallel the computer programs used were rewritten to incorporate datum jumps and to make manipulation of the data more flexible for both the data manager and the user. A start was made to incorporating notes on data quality and sources of information in ancillary files, so that the user could be supplied with pertinent facts relating to the data.

Seismic processing system development (C.R. Johnston, A.P. Hogan, F.M. Brassil)

Early in 1979 support was received from the National Energy Research, Development and Demonstration Program (NERDDP) administered by the Department of National Development, for the purchase of equipment for accelerated development of an in-house seismic processing system to permit digital processing of both land and marine seismic data at high speed and low cost. The system will be developed in stages of increasing capability throughout the next 2 to 3 years and will have the effect of reducing progressively future contract processing requirements. The stages foreseen are:

1. Development of a pre-processing package to perform demultiplexing, anti-alias filtering and resample, true amplitude recovery, and trace annotation.

2. Development of a display package to encompass a variety of display types complete with timing lines, position annotation, processing information, and potential field data if available.

3. Development of a package to perform such tasks as common-depth-point gathering, low-precision interactive velocity analyses, stacking, and bandpass filtering.

4. Development of improved velocity analysis techniques and additional processes such as dereverberation and deconvolution.

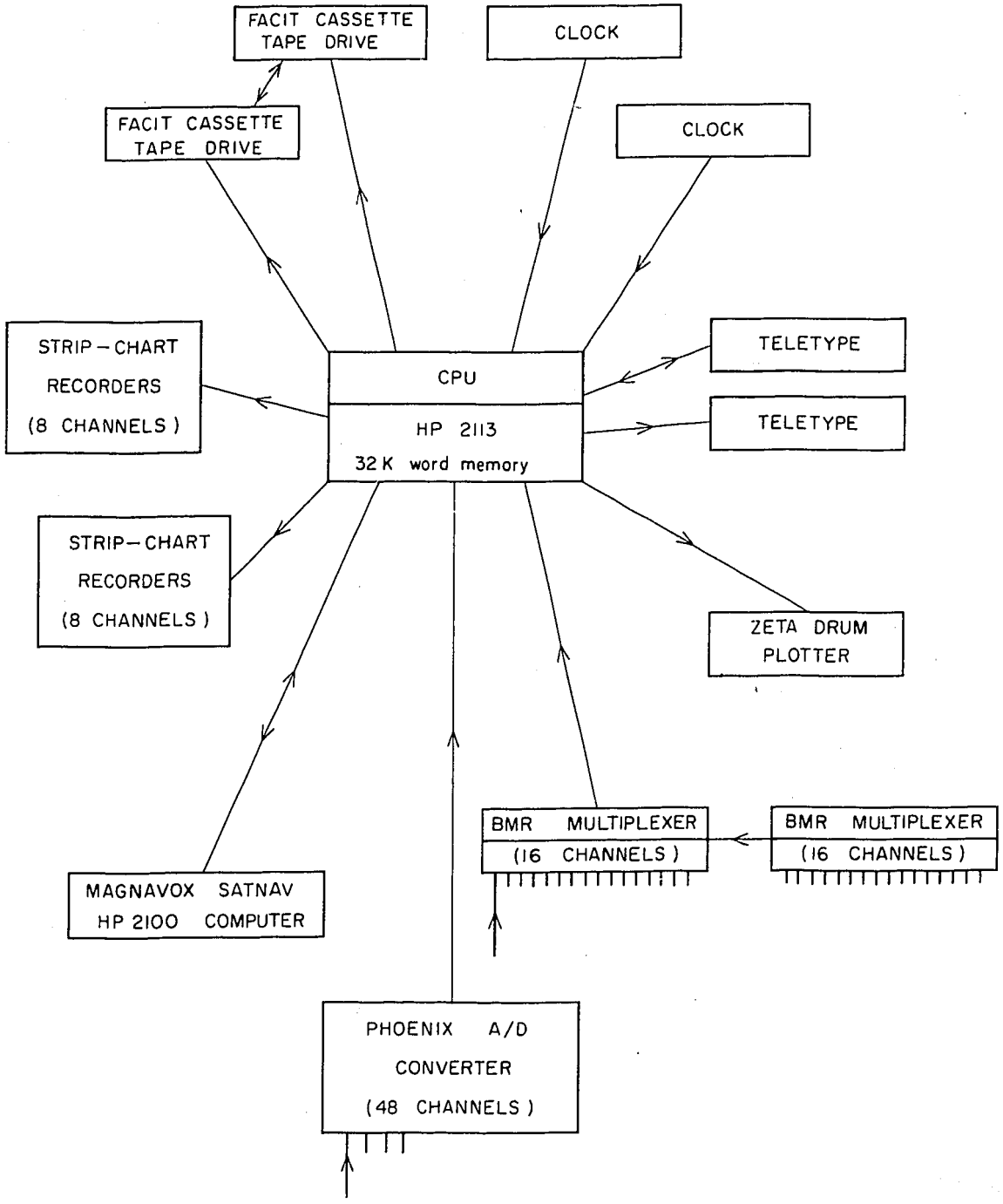
5. Development of more advanced techniques in accordance with needs; to include a real-time seismic processing system with continuous overlapping interactive velocity analyses for the specific requirement of handling large quantities of marine data.

The pre-processing and an initial display package have been written and have undergone limited testing, but they will both require modification to take advantage of high-speed equipment to be delivered late in 1979 or early 1980.

Seismic analogue-to-digital transcription development (C.R. Johnston, F.M. Brassil, J.K. Grace, P.J. Fowler, B. Devenish)

This project started in 1977 with the construction of a system that would convert BMR marine analogue data from an Ampex tape recorder into a digital format suitable for input to the seismic processing system at Woods Hole Oceanographic Institution. In 1978 the system was modified to convert the marine data to standard SEG-Y format to be compatible with commercial processing systems. The system was modified during 1979 to transcribe data at four times real speed. In addition, the analogue-to-digital controlling interface was modified to accept and send control signals between the computer and the MS42 seismic analogue playback system. This will enable development of a transcription facility for most other formats of analogue seismic tapes. The controlling interface was also modified to produce a range of sampling intervals.

By the end of 1979 it is intended to digitise approximately 10 000 km of marine seismic data, representing 10% of the data collected during the Continental Margin Survey.



Data acquisition system peripherals (existing capability)

Development of a data acquisition system (H.M.J. Stagg, R. Whitworth)

The generalised BCS-based marine data acquisition system (DAS), on which work was begun in 1978, was finalised during the first half of 1979 and tested successfully on board M.V. Cape Pillar in August. The present capability of the system is illustrated in Figure SGM-14.

The software for the DAS is modular in design, with many routines deliberately written in general form. Though somewhat less efficient in both space requirements and speed of execution, the added flexibility allows the system to be rapidly adapted to a variety of tasks and hardware configurations; for example, the DAS for the M.V. Nella Dan was put together in two weeks. The primary variation required to adapt the system to each new shipboard situation is that needed to acquire the relevant navigation data.

Briefly the main features of the DAS as it now stands are:

(1) User selected acquisition rate for all data channels of either 2, 5, 10, 30, or 60 seconds. The acquisition rate determines the number of data which may then be recorded.

(2) Incorporation of two clocks, to allow time checking and backup in case of failure. Either clock can provide the acquisition interrupts, and either clock may be logically "turned off" within the software by the operator.

(3) Two Facit cassette tape recorders are incorporated, primarily for backup in case of failure but also to simplify cleaning procedures necessary to minimise parity errors on tape. Again either cassette drive may be logically "turned off" by the operator.

(4) All digital data other than times are input through a BMR-designed sixteen-channel 16-bit multiplexer. Provision exists for "daisy-chaining" a second multiplexer should input equivalent to more than sixty-four 4-bit characters be required.

(5) Analogue data are input through a Phoenix analogue-to-digital converter that presently has a capability of 48 channels. This part of the system has not been extensively field tested.

(6) A Zeta digital X-Y plotter incorporated in the system can be used to plot up to 10 data channels. Options exist for plotting raw, time-differenced, or time-summed data, and for inverting any trace. The data channel being displayed is identified on the plot. This is one of the most powerful methods of plotting varying numbers of data channels, the requirements for which change from time to time.

(7) Two 8-channel digital-to-analogue interface cards can be installed, allowing up to 16 channels of data to be plotted on strip-chart recorders. While somewhat less flexible than the digital plotter, the multi-pen, multi-colour display is a more effective way of evaluating primary data channels for which continuous monitoring is considered essential.

(8) Magnetic values corrected for variations in the regional field using the Australian Geomagnetic Reference Field can be provided for on-board evaluation and plotting in map form.

A special feature of the system developed for and installed on the Cape Pillar was the way in which the DAS obtained navigation data from the Magnavox satellite navigation system. The DAS computer interrogated the Magnavox computer every acquisition cycle and received back the latest position, speed, and course information. This was achieved by installing a small (15-word) interrupt program in the navigation computer that returned to our computer the contents of any word of memory called for. Some care had to be taken to avoid monopolising the Magnavox computer processor time during time-critical periods such as during reception of satellite data.

Development of a digital on-board seismic acquisition system (H.M.J. Stagg, R. Whitworth)

High penetration marine seismic data are recorded using commerically available digital seismic recording systems built around an instantaneous floating point amplifier with a dynamic range in excess of 130 dB. It is difficult to justify the purchase of such expensive equipment for use with a low-power energy source such as a 20 kilojoule sparker when the maximum signal

level is unlikely to exceed the cable tow noise by more than 40 dB. A reasonable dynamic range requirement under such circumstances would be 60 dB. Such a capability can be achieved at significantly lower cost using a computer coupled to commercially available analogue-to-digital multiplexers.

Because of an impending requirement for such a high-resolution and low-power seismic system for geological studies it was decided to construct a system around an available Hewlett-Packard 21MX series computer and Phoenix A/D multiverter giving a dynamic range of 80 dB. It can also be used as a medium-resolution system for regional geophysical studies by simply changing the sampling rate.

The system is being built in two stages. The first is a solely computer-based acquisition system in which data are recorded in real time on magnetic tape. This minimum system can be more readily implemented and also provides a useful "fail-safe" backup in case of hardware failure in the second stage system. Design capability is for up to 12 channels of data to be sampled at 1-millisecond intervals for a record length of 1.5 s. About 90% of the basic software was ready by the end of September, and it is expected that the system will be functioning on a test basis by the end of the year.

The second stage will incorporate a moving-head disc as a large buffer area. Use of the 5 Mb disc presently available will permit the provision of sufficient data buffer time for operator intervention such as tape rewinding and tape drive cleaning without any loss of data while using only a single tape drive.

Digital enhancement of seismic monitor records (R. Whitworth, R.A. Pulski)

Monitor recorders (such as the EPC) that display seismic data in variable density form, are very useful in producing hard copy "pictures" of seismic data; however, they are very limited in their capability of producing a high-quality display for sections with several seconds' penetration. The root cause of the problem is the very narrow individual record trace width.

If a slow paper speed (down to 3 inches per hour) is used to give a presentable picture by eliminating the gap between traces, the vertical-to-horizontal scale distortion of up to 30 to 1 results in such a biased display that all but the regional structures can easily be misinterpreted. On the other hand a high paper speed (up to 24 inches per hour) results in such a poor picture, with almost total loss of reflector continuity across the wide gaps

between traces, that it is difficult to follow the reflection events. Loss of optical continuity between traces occurs for a paper speed between 6 and 12 inches per hour, depending on the shot interval.

What is required is a monitor recorder that will give an adequate optical display regardless of paper speed; the user can then freely choose the optimum sweep rate and paper speed for his purposes. A computer-based enhancement system has been developed that achieves this objective for paper speeds up to 48 inches per hour. The shot interval does not need to be a multiple of the sweep time of the recorder, neither do unpredictable major changes in shot interval produce significant changes in record quality.

The basic principles are simple. The shot pulse triggers conversion to digital form and storage within the computer of a given recording interval of seismic data digitised at a specified sampling rate. This data record is then output repetitively to an EPC recorder running continuously at high speed. When the next shot record is stored within the computer, output is recommenced with the new data. To maintain the equivalent time scale in the enhanced display, the ratio of data output rate to input rate is kept the same as that of input record length to EPC sweep period. The shot instant and recorder sweep start do not need to be synchronised in any way.

In the tests used to check the system, input record length was 5 s and sampling rate 2 ms; the EPC sweep period was 0.5 s and data output rate 0.2 ms. This gave ten sweeps of the recorder per shot as compared to the original single sweep, and hence totally eliminated gaps between traces at even quite high paper speeds. A very satisfactory record quality was attained for paper speeds of 12 to 24 inches per hour.

Visit to G.S.I. survey vessel EUGENE McDERMOTT II (H.M.J. Stagg)

During June 1979, BMR was invited to send an observer on board the GSI survey vessel Eugene McDermott II while it was operating in the Coral Sea. Mr Stagg subsequently spent 7 days on the vessel closely studying the techniques and equipment used by GSI, one of the major geophysical contractors. The principal objective was to observe a state-of-the-art survey vessel in action and evaluate the methods that might be used in future marine surveys by BMR.

Co-ordinate projections available in the mapping system (R. Whitworth, J.C. Branson)

Various map projections are used to produce the standard maps in the Marine Geophysics Group transverse Mercator at 1:250 000, Lambert conformal at 1:1 million simple conic with two standard parallels at 1:2 million and Mercator at 1:10 million; still other projections are used to produce specialised maps. All of the co-ordinate projections are maintained as subroutines of the mapping system within the Marine Program Library.

A new subroutine was added during 1979 to produce maps identical to those used by the Australian Navy Hydrographic Office for their Ocean Soundings Charts at 1:1 million. This routine is a spheroidal version of the standard Mercator projection.

Projection routines presently available in the Marine Program Library are:

simple rectangular
Lambert conformal conic
simple conic
transverse Mercator
standard Mercator
Miller's modified Mercator
spheroidal Mercator

Projection routines currently being added to the system are:

zenithal equal area
zenithal equidistant
oblique orthographic
oblique stereographic
gnomonic
Bonne's projection
Sanson-Flamsteed

Development of automated map legends
(R. Whitworth, L.A. Tilbury, G. Lamberts)

A surprising amount of manual effort is needed to prepare a standard map legend by hand. Considering the large number of maps that would be the final output of the Continental Margin Survey, it was decided to automate production of the legend (Geophysical Branch Summary of Activities, 1977). Figure SGM-15 shows an example of the final product for the Tasmania 1:1 million sheet.

The upper section of the legend (projection, profile information, title, map name etc.) is produced automatically when any map is generated. The lower section (BMR symbol, note, distance, scale, locality, picture, index to adjoining sheets, etc) is drawn under the user's control using the LEGEND program library routine.

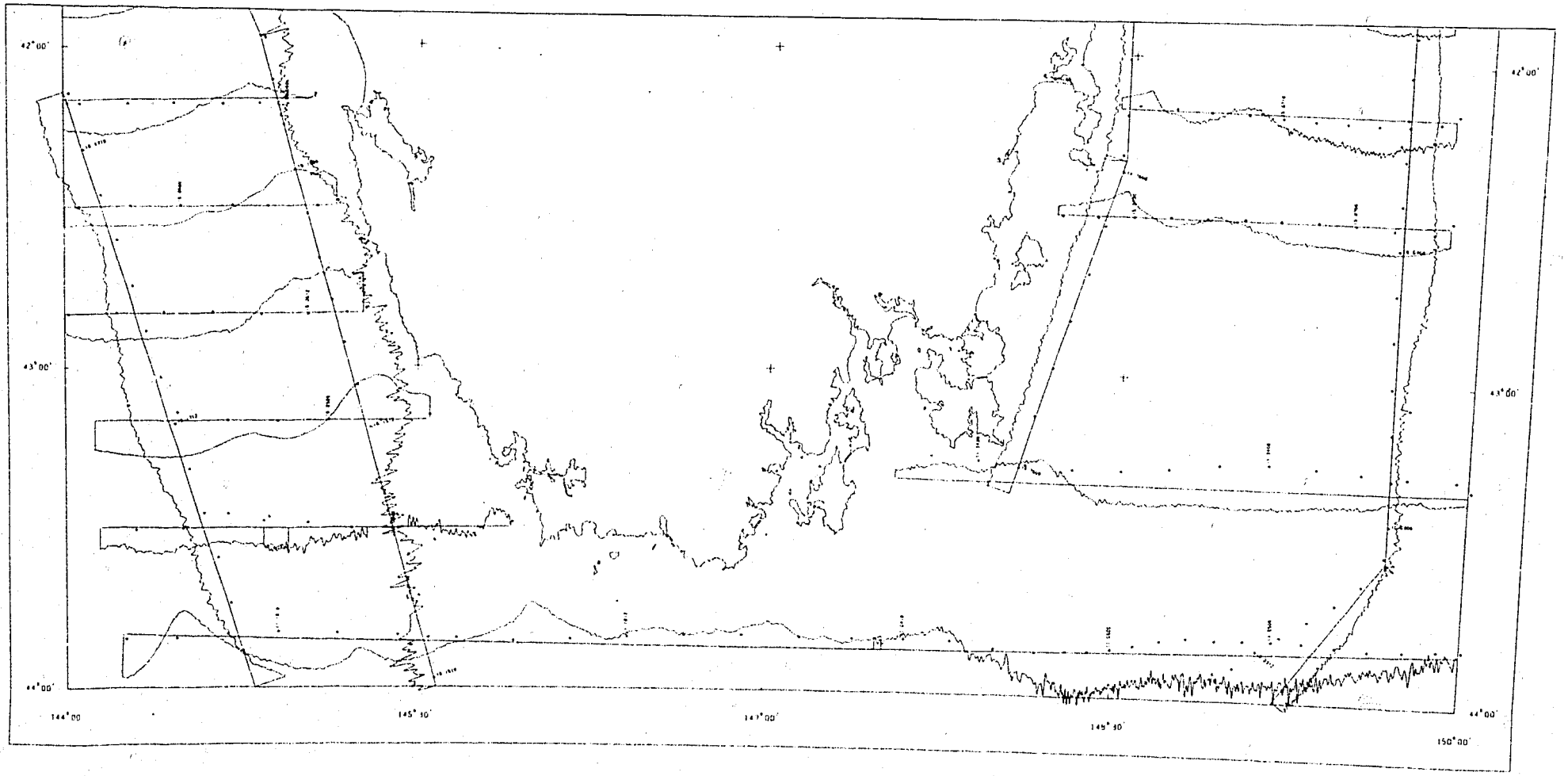
Each of the blocks that make up the legend can be individually placed wherever the user desires by specifying the X, Y position to be used. In this way individualised legend can be produced for any map with only minor effort by the user. In automatic mode the blocks are positioned in a pre-defined order and scaled to the width of the map, and the only information that needs to be provided by the user is the note to be drawn.

Certain parts of the legend are automatically made consistent with the map being produced. The distance scale is adjusted to give round number distances appropriate to the scale of the map (see Fig. SGM-11, Summary of Activities, 1977). On the locality picture the map limits are shown down to a minimum size of 0.1 inches, and below this a fixed size of 0.1 inches is used, centred at the correct locality. At small scales (1:2.5 and 1:10 million) the solid box is replaced by a frame to prevent obliteration of the underlying details. Similarly the actual map limits are outlined in the index to adjoining sheets. It is possible with this system to show the correct location of a 1:150 000 map relative to the standard 1:250 000 map sheets, for example.

At present the legend file contains pictures of the Indian and Pacific Ocean region, the Australian Region, the standard 1:2.5 million areas, and the individual States; indexes of the standard sheets for 1:250 000, 1:1 million, 1:2.5 million and 1:10 million scale series covering appropriate areas; and a variety of notes giving details of the data reduction techniques used in preparing the maps. Extension of the file to accommodate further requirements is straightforward.

Continental Margin Survey: map production (L.A. Tilbury, T.R. Hegvold, G.B. Price, J.C. Branson, W.J. Meyer)

This year saw completion of processing of the non-seismic data from the Continental Margin Survey. Most of the effort was spent on production of the final track maps and profile maps at 1:1 million representing final release



B.M.R. MARINE SURVEYS, 1970–1973
FREE AIR ANOMALY PROFILES

TASMANIA
SK55

G.R.S. SPHEROID
LAMBERT CONFORMAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 40°40' AND 43°20' SOUTH

PROFILE SCALE: 1 cm = 50 mGal
PROFILE BASELINE VALUE: 0 mGal

positive direction of profile generally to north and west

adjusted position of the ship on Survey 37 Day 92 at 0400h GMT

COMPUTER DRAWN AT BMR CANBERRA, AUSTRALIA

Further copies of this map may be purchased from:
Sales Service
Assistant Government Printer
(Production)
P.O. Box 84
CANBERRA, A.C.T. 2600

The free air anomaly values are based upon gravity measurements made with Lacoste and Romberg sea gravity meter S24, mounted on a gyro-stabilised platform. In low to moderate sea states, cross loops run from 3 to 10 mGal peak-to-peak, but above Beaufort scale 6 ranges to 30. Performance of the meter determined sharply, all data are purchased regardless of quality.

After resampling at one minute intervals, corrections have been made for the Eötvös effect. No adjustments have been made for misfits at track crossings. Using track made during port calls, the gravity data have been adjusted to the Australian tiegold 1969 datum (Barlow, B.C., 1970. National report on gravity in Australia, July 1965 to June 1970. Bureau Mineral Resources Australia Record 1970/67). This datum is consistent with that of Finlayson. The correction of gravity with latitude has been removed using the 1930 International Gravity Formula.

The map areas shows the ship's position at regular intervals of time, based upon dead-reckoning navigation adjusted to agree with satellite position fixes. Fix is estimated to be best than 0.2 n mile on the shelf, and 0.5 n mile in deep water.

Note: 1 mGal = 10 micrometres per second squared

KILOMETRES
-20 0 20 40 60 80 100
10 0 10 20 30 40 50
NAUTICAL MILES

The information contained in this map has been compiled by the Bureau of Mineral Resources, Geology and Geophysics as part of the policy of the Australian Government to assist in the exploration for and development of mineral resources. Persons purchasing transparencies of this map may reproduce it for their own use or that of their staffs, but not for any other purpose except with the permission in writing of the Director, BMR, P.O. Box 378, CANBERRA CITY, A.C.T. 2601.

The data used in this compilation were collected for BMR by Compagnie Generale de Geophysique during the period 1970 to 1973.

LOCALITY WITHIN AUSTRALIAN REGION

INDEX TO ADJOINING 1:1000000 MAP AREAS

HAMILTON	MELBOURNE	BOOALLA
STOPES	TASMANIA	SK56
SI54	SI55	SI56

Example of 1:1 000 000 map legend

of the data. In all, 220 maps have been scribed on BMR's Calcomp 745 flatbed plotter, positives have been produced and transparencies distributed to the relevant State authorities and the Australian Government Publishing Service. This has contributed to a heavy workload on the plotter and it has taken almost six months to scribe the maps despite sole use of the plotter for long periods of time. An example of the final product is shown in the free-air anomaly map of Tasmania (Figure SGM-15).

Processing of data from National Mapping surveys (R. Whitworth, T.R. Hegvold, G.B. Price, J.C. Branson, G. Karner, National Mapping staff)

This year saw considerable effort put into improving data cleaning programs to cope with the several types of error found in the Mini-Ranger navigation data from Surveys 26 to 28. The major difficulty has been in coping with spurious range variations (as distinct from random noise) that are only a small fraction of the change in range between consecutive samples. A two-pass process using program FIXDATA has been developed that first cleans the range differences, and then re-integrates the differences and compares the integrated value with the observed range. If they differ by more than a specified amount, the observed value is rejected.

Program NAVRHO which computes positions using the range-range technique has been streamlined and extended to allow the use of multiple range pairs. Detection of rapid variations in speed and heading, of invalid range data and invalid transmitter codes has been improved.

Much of the effort in running the data cleaning and navigation programs has been provided by National Mapping staff. Digital water depths are currently being checked and corrected and should be finalised by the end of the year. The mapping programs have been extended to plot data at 10-second intervals, and the first maps have been drawn with satisfactory results.

Project Investigator (L. Tilbury, F.W. Brown)

Project Investigator-I was an aeromagnetic survey of the Australian-Antarctic Discordance, carried out jointly by the US Navy Oceanographic Office and the Royal Australian Air Force during August and September 1978.

In all, 93 000 km of total magnetic intensity data was collected along north-south traverses spaced about 20 km apart. The aircraft flew at an altitude of 300 metres. Navigation was based upon an inertial system which gave positions at approximately 5-minute intervals. Traverses extended about 600 km north and south of the Southeast Indian Ocean Ridge. In the north they reached magnetic anomaly 6B (22.5 m.y. B.P.) and in the south, anomalies 5B to 6 (14.5 to 19.5 m.y. B.P.). BMR officers from the Airborne and ADP Sections visited the operation, which was based in South Australia. The Observatories Section provided magnetic data for diurnal and storm control.

Digital magnetic tapes of the original data were supplid to BMR. ADP Section prepared a conversion to standard ASCII format and supplied a set of tapes to the Aircraft Research and Development Unit in South Australia. Since then the data have been plotted as stacked profiles and are in the process of being contoured by the Marine Geophysics Group. The data show remarkable lineations over several hundred kilometres and delineate many fracture zones previously unrecognised.

Compilation of external marine data (R. Whitworth, J.C. Branson, L.A. Tilbury, W. Meyer).

In areas of deeper water around Australia geophysical data collected by overseas oceanographic institutes can form a significant input to an interpretation. BMR has been obtaining data from such institutes, but the workload associated with Continental Margin Survey processing precluded much effort on conversion to the marine data bank until towards the end of this year.

From September onwards work has been done on data from Lamont Doherty Geological Observatory (LDGO) Eltanin and Vema cruises. The Eltanin data were obtained on digital magnetic tape by Garry Karner during his study visit in 1978. The navigation, bathymetry, gravity, and magnetic data have been converted from all of the cruises obtained. Some further work is required to produce integrated data files that can be more efficiently handled by the Group's computer programs.

Most of the Vema data were obtained during co-operative cruises with LDGO and were in the form of printouts of individual parameters. Data from cruise V33, legs 1 to 5, 8, 13 and 14, have been laboriously converted into punched cards and processed through to the same stage as the Eltanin data. Only data from cruise V34 leg 5 are still to be converted.

Data storage indexes (L. Tilbury, U. Hammerling)

Several indexes are kept by the Marine Group, including an ITEM INDEX of micellaneous maps, microfilms, seismic sections, etc., some of which are confidential, and an ACCESSION INDEX of papers, pre-prints, brochures, etc. on marine equipment, techniques, and interpretation. An improved program has been written using the SORT/MERGE package on CSIRO's Cyber 76, to provide cross-indexed reference lists.

For the ITEM INDEX sorted reference lists have been produced according to data type, organisation, storage area (within Marine), keyword, and area (of the world) versus the title/description of the item. The ACCESSION INDEX has an author, journal, and keyword sort.

Archiving of marine digital tapes (L. Tilbury, W. Meyer, G. Price)

In order to save data for permanent retention and to save tape storage costs at CSIRO, certain processing phases of the Continental Margin Survey data will be archived using long-life tapes and the ADP Group's tape copy system. Those tapes archived so far include the navigation reduction phase, and the one-minute unadjusted geophysical data. This has enabled the Marine Group to release over 100 magnetic tapes previously held for them by CSIRO, with a consequent saving of over $4200 per year in tape storage costs.

Marine equipment overhaul (J.K.G. Grace, R.A. Dulski, P. Fowler)

Significant effort has been put into overhaul of equipment during the year. The major effort has been on units of the E.G. & G. sparker system. The triggered capacitor units, capacitor banks, and power supplies have been progressively overhauled and tested throughout the year. We now have available

an energy source capable of delivering 10 kilojoules, which will be more than adequate for high-resolution seismic work. On completion of the overhaul we anticipate having a capacity of about 15 kilojoules.

The major items of equipment used in the seismic analogue-to-digital system (Ampex analogue tape recorder and SIE PT700 amplifiers) were sent to the manufacturers for overhaul. The increasing obsolescence of these units, and the resultant disinterest of the manufacturers in their maintenance, present difficulties. BMR will probably need to accept full responsibility for maintenance in the future if they are to be kept operational.

Items of equipment used on the co-operative surveys with National Mapping have been overhauled as necessary; these include Geometrics G803 and G813 proton-precession magnetometers, Moseley and Texas Instruments strip-chart recorders, Edo DIGITRAK depth digitiser and Facit cassette tape recorders.

ENGINEERING GEOPHYSICS GROUP

E.J. Polak, F.J. Taylor, P.J. Hill, D.C. Ramsay, D.G. Bennett, G.S. Jennings, P.J. Swan, D.H. Francis, L.W. Miller, R.J. Wilson, G.R. Pettifer.

ACT engineering surveys

Geophysical surveys throughout the ACT using seismic, magnetic, and electrical methods continued during 1979 but the level of activity declined compared with previous years. These surveys were carried out on development sites in order to obtain information on rippability and foundations. Work of this nature was carried out for Narrabundah water pipeline, Limestone Avenue water pipeline, Capital Hill Parliament House site, Tennant damsite, Pialligo refuse tip, and the Health Services building site at Mitchell.

Investigation of a small sedimentary basin near Hoskinstown, NSW

As part of a geological investigation of a small sedimentary basin flanked by the Lake George Fault, the group conducted geophysical tests using the seismic refraction and electrical resistivity methods. The object was to determine the thicknesses of the unconsolidated sediment and weathered bedrock, to interpolate between cored holes drilled across the valley. Neither geophysical method proved to be very effective because of the lack of contrast of properties measured between the different rock units.

Vibration monitoring

Vibration measurements were taken in Campbell, Weston Creek, and Red Hill, to monitor vibration levels from blasting associated with excavations for water pipelines and roads.

Logging

Maintenance of the logging equipment continued throughout the year. Tenders for a density tool were considered but no firm order has been placed. Boreholes logged during the year included three shallow holes at Hoskinstown near the ACT, and two deep holes and six shallow holes in oil-shale basins near Rockhampton in Queensland. Gamma, neutron, electric, and temperature logs are not capable of resolving oil shale beds, and there is a need for different tools, e.g. density and sonic.

Digital seismic system for shallow investigations

An experimental shallow reflection survey was conducted in a coal basin near Gloucester, NSW. The digital recording system is oriented around an HP 2100 computer and uses a stacking procedure with a low-energy source to produce a record. One kilometre of 12-fold CDP data was collected using a Talisker rock breaker as an energy source. This machine drops a 600 kg weight from 5 m onto a

steel foot. Similar records were also obtained using a 75 kg weight dropped from 1 m. Results show shallow reflections from a coal bed for about one-third of the traverse length. Further work is continuing on processing the data in order to improve the signal-to-noise ratio in this area of high refraction noise. A grant under the Coal Research Assistance Act was applied for to purchase equipment which will allow uninterrupted research into these problems.

Testing of electromagnetic equipment

Two EM instruments (EM31 and EM34) were compared with standard resistivity equipment. They are capable of measuring near-surface conductivity without using ground electrodes. Comparison tests were carried out in different geological environments along traverses previously recorded using conventional resistivity dipole-dipole techniques. The results showed good agreement with the known profiles, and the EM instruments were found to be much simpler and quicker to use than the conventional resistivity equipment. Figure SGM-16 shows a comparison of the results along a traverse near Wodonga, Victoria. The operation of the EM31 in particular allows field operations to be speeded up by a factor of four even with fewer field personnel.

Location of unexploded shells

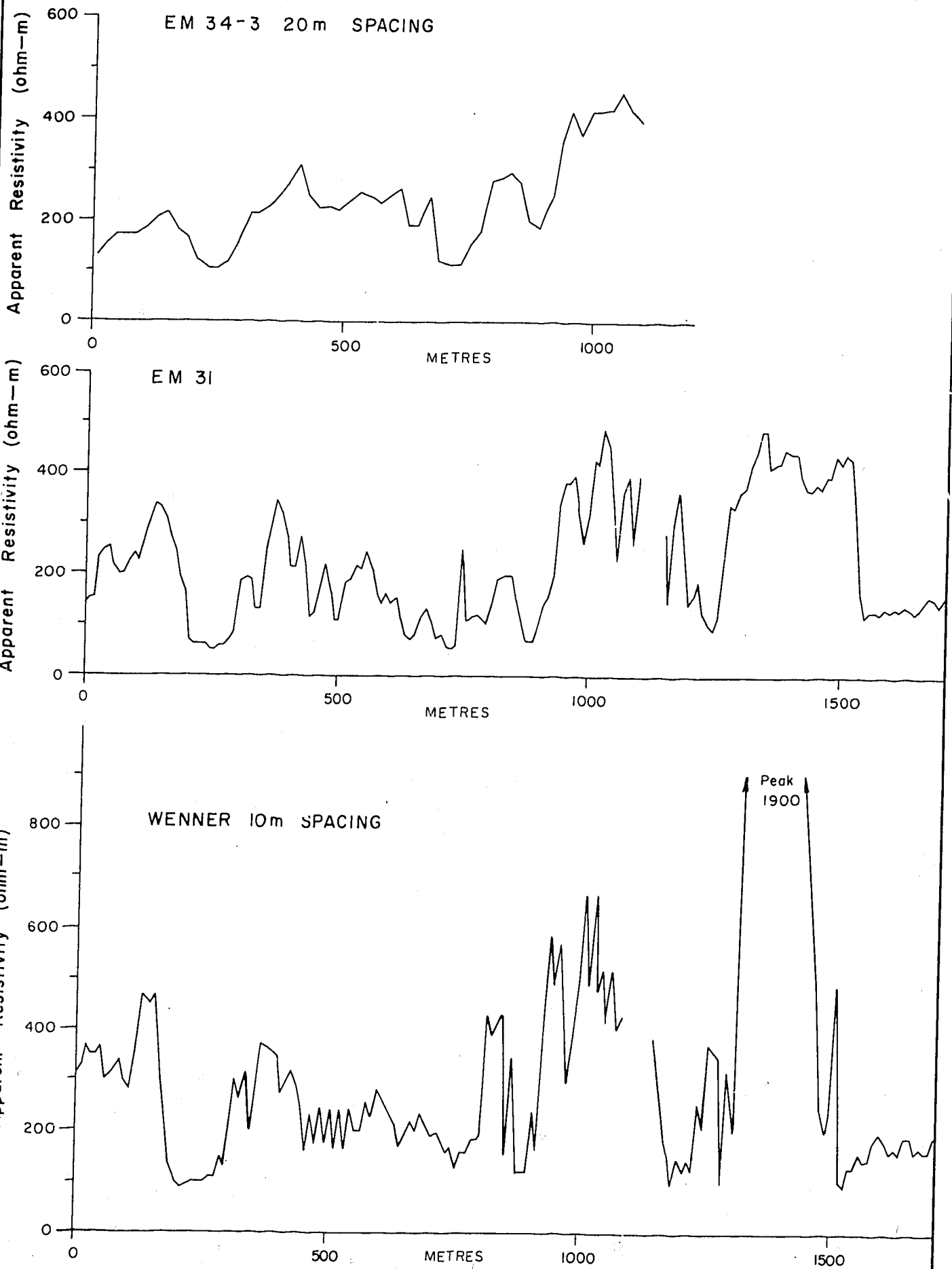
Further testing of instruments for detecting unexploded shells was carried out during the year. Tests with a differential fluxgate magnetometer showed that this instrument was not suitable. Literature is being searched on the suitability of the more recently developed metal detectors.

Slope stability, Blackwater QLD

A joint project with the CSIRO to investigate slope stability at an open-cut coal mine at Blackwater was instigated in the latter part of the year. The project involves among other things the measurement of uphole and cross-hole times for P and S seismic waves in a series of boreholes spaced about 60 m back from the existing high wall. Measurements will be taken before and after a large overburden blast to determine the effect of the blast.

STOCK ROUTE TRAVERSE

SGM-16



MURRAY FLOOD PLAINS, WODONGA, VIC.
COMPARISON OF EM WITH RESISTIVITY PROFILES

Record No. 1979/73

J55/85-162-1A

Overseas assistance

A groundwater study was conducted on Nive Island by the Engineering Geology and Engineering Geophysics groups on behalf of the Australian Development Assistance Bureau. Resistivity, gravity, and magnetic surveys were conducted together with geological mapping and borehole testing.

3. OBSERVATORIES AND REGIONAL SECTION

(J.C. Dooley)

OBSERVATORIES SUBSECTION (P.M. McGregor)

The Observatories Subsection deals with basic investigations ir geomagnetism and seismology.

As a result of the transfer of the Toolangi Observatory Group to Canberra and the handover of the Port Moresby Observatory to the PNG Government a reorganisation of the subsection was proposed as follows:

1. Data and Reductions Group: G. Small, A.J. McEwin
2. Canberra Observatory Group: R.S. Smith, M.W. McMullan, G.H. Thomas V. Dent.
3. Special Projects Group: I.B. Everingham.
4. Technical Support Group: G.H. Thomas, E. Smilek, J. Salib

The proposal has not been approved formally and until staff vacancies are filled it will not be possible to implement the reorganisation fully. Currently the first group provides data services for the entire Subsection and attends to magnetic surveys. The second group operates all permanent BMR observatories and seismograph stations outside Western Australia. It is also responsible for BMR personnel engaged in Antarctic observatory operations, namely K. Wake-Dyster (Macquarie Is) and M. Sexton (Mawson). I.B. Everingham (Group 3) has provided specialist seismological services and assisted in the general administration of the Subsection, and members of Group 4 have been assigned to work with other groups.

The Mundaring group maintained its previous functions with staff comprising : P.J. Gregson, E.P. Paull, B.A. Gaull (to 27 August), G. Woad, B.J. Page, Y. Moiler, and T. Creaser (retired 6 July).

Members of the Subsection assisted in preparations for the XVII General Assembly of the IUGG held in Canberra 2-15 December, and prepared papers for presentation at the Assembly and for the related special issue of the BMR Journal.

The following summary covers the interval October 1978 to September 1979. The locality map (Figure OR-1) shows the disposition of the magnetographs and seismographs operated solely or jointly by the Subsection.

Nuclear explosion detection and discrimination

Late in 1978 the UN reorganised its former Conference of the Committee on Disamarment, and Australia (and several other countries) was given a seat on the new Committee on Disarmament (CD). The CD maintained previous arrangements made for the Ad Hoc Group of Scientific Experts (GSE), which had been given a mandate to study the technical problems and procedures likely to arise in a global seismological system aimed at detecting violations of a nuclear test ban treaty. Mr McGregor continued to serve (for Department of Foreign Affairs) as Australian scientific expert to the GSE. At the seventh and eighth sessions in March and July he was assisted by diplomatic officers from the Permanent Mission at Geneva. As an adjunct to the eighth session he visited the UK Ministry of Defence seismic centre (Blacknest) and a demonstration of a global seismic data centre in Stockholm established by the Swedish Defence Research Institute.

Geomagnetism

Observatories. Standard magnetic observatories were operated continuously at Gnangara (WA), Macquarie Island, and Mawson, and until 30 June at Toolangi (Vic). They provided geomagnetic disturbance indices and data on other transient phenomena; preliminary monthly values; and 20 mm/hour analogue recordings of the three components declination (D), horizontal intensity (H), and vertical intensity (Z). The automatic digital magnetograph (ADM) at Canberra was operated continuously, but only preliminary monthly mean values were derived from it, pending development of computer programs for the production of other records and data. Monthly values were derived from absolute measurements of D,H,Z, and (after January) total intensity F, made by officers of the Antarctic Division at Casey and Davis (Antarctica). The observations at Davis recommenced in January after a break of 12 months. These data suffice to give approximate estimates of the geomagnetic field and its secular change.

Routine absolute observations at Toolangi ceased in June 1979, so closing an important era in Australian geomagnetism. It is planned to continue variation recordings until after the next maximum of solar magnetic disturbance, expected in the early 1980s. However, absolute control will need to be resumed periodically for such projects as MAGSAT - the orbiting 3-component vector magnetometer satellite scheduled launched late in 1979.

The overlap in controlled recording will link the results from Toolangi since 1858 with those from Canberra.

Proton vector magnetometers (PVM) were used at mainland stations to make absolute observations of H and Z. The Elsec proton magnetometers were replaced by MNS-2 magnetometers (BMR construction) during the year, and the Ruska declinometer was recommissioned for use at Canberra. The latter was a step towards establishing the Australian D magnetic standard.

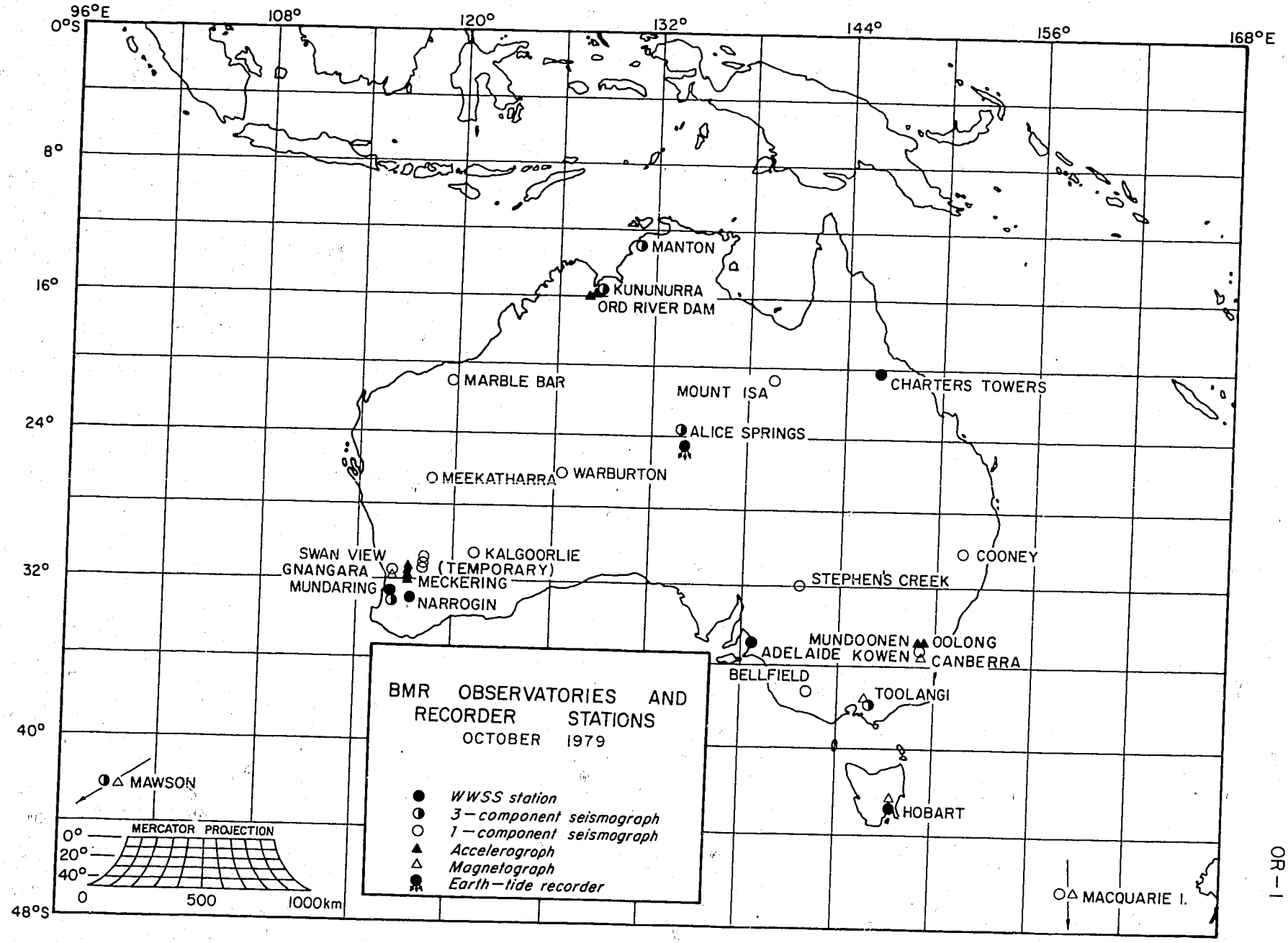
The ADM was improved by modifying the power supply (to reduce noise interference). Two sensors failed owing to corrosion in the water bath; finally satisfactory recording was restored by placing a water sample in a glass bottle in the sensor solenoid and reducing the polarising current to prevent over-heating.

A second Elsec ADM for Gnangara was delivered in April, and is being fitted with a tape recorder, strip printer, and controller.

Development recommenced of a 'photo-electronic-magnetograph' in which a photocell, servo-loop and Helmholtz coils are fitted to a classical suspended-magnet variometer used as a null detector. It is intended to use these magnetographs at Canberra as a back-up to the AMO, and to provide long-term digital recording in Antarctica.

Pulsation recording, in co-operation with the University of Newcastle, continued throughout the year at Mundaring.

A study of long-wavelength magnetic anomalies using results from trans-Australia aeromagnetic traverses was continued, and the possibility was investigated of maintaining Antarctic magnetic observations by only annual visits to the stations.



Record No. 1979/73
(BASED ON A/BO-83A)
A/89-68-6A
OR-1

Data reduction. Magnetograms from the observatories are reduced to absolute mean values (hourly, daily, monthly, annually) by the reductions group. The semi-automatic digitiser based on a mini-computer was in use for most of the year; about 13 observatory-years of magnetograms were converted to hourly ordinates in millimetres. The ADP section helped scale the magnetograms and wrote the reduction programs to derive absolute mean values. At the current rate the backlog of scaling should be eliminated by the end of 1981.

The basic programs for the reduction of the digital data from the Canberra ADM were completed. One-minute values from the ADM are stored on a computer file from which conventional analogue magnetograms (for K-index scaling) and mean values can be produced.

First-order survey. Reoccupation of the set of 59 first-order stations begun last year was completed. The 20 remaining stations in WA, SA, NSW, and Tasmania were occupied during the interval October 1978 to March 1979 (see Figure OR-2). In addition the island stations Lord Howe (January), Norfolk (February), Christmas and Cocos (June) were occupied. A new station was established at Warburton Mission in August. At each station, graphic records were made for at least 48 hours of D,H, and F and the temperature of the fluxgate sensor; the records were calibrated by frequent absolute measurements, and accuracies approaching observatory standards were usually attained. Computer programs to produce mean hourly ordinates were written. The digitising of records and the production of calibration data progressed slowly. The production of the isomagnetic charts for 1980.0 was delayed by staff shortages and is not expected to be completed before mid-1980. Personnel from all groups took part in this survey as follows: central WA - E.P. Paull; southern WA, western SA, Cocos and Christmas Islands - B.A. Gaull; central SA, M.J. Sexton; Tasmania, Lord Howe Island and Norfold Island - G.R. Small; field hand D. Morrison assisted throughout (except at the island stations).

Ionospherics. An IPS type IIIE ionosonde was operated until 16 January 1979, when it was replaced with a type 4B ionosonde. The latter is a mostly solid-state, swept-frequency, pulse instrument designed for routine vertical incidence sounding of the ionosphere. It uses a digital frequency synthesiser and digital programming, control, signal processing and display techniques. Recording is on 16-mm film.

Apart from the 6-hourly values of the F2 critical frequency scaling of hourly values by observatory staff ceased from 1 January 1979 because of staff shortages. Scaling of all other values was taken over by Ionospheric Prediction Service, Sydney. This closed a chapter in geophysics in Western Australia: the derivation of ionospheric data began at Watheroo Observatory (predecessor to Mundaring) in 1937 when the first automatic multi-frequency ionosonde in Australia was installed there by the Carnegie Institution of Washington.

Seismology

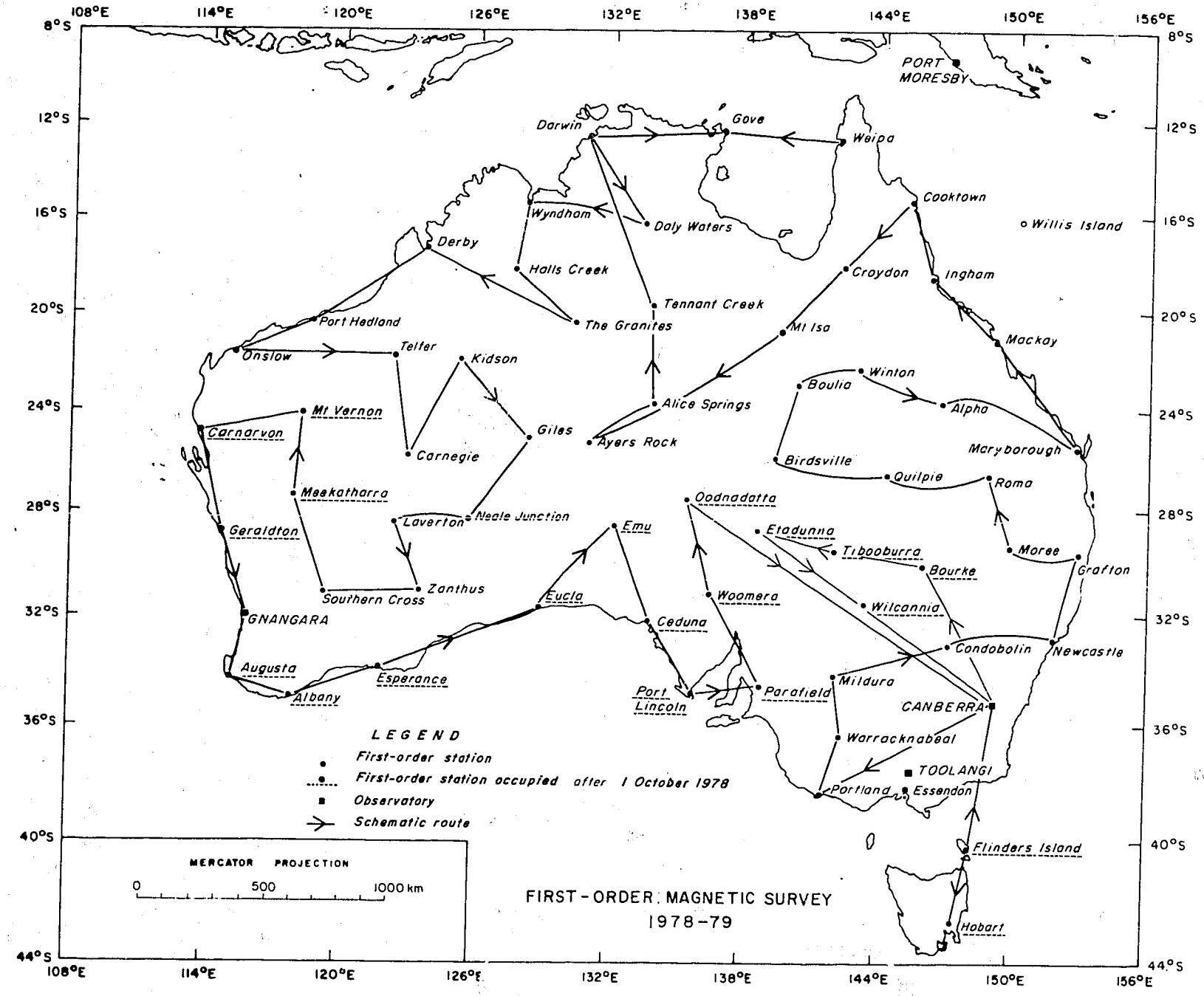
Seismograph stations. Seismographs were operated at the following places; some jointly, with the co-operating agencies shown in parentheses: THREE OR MORE COMPONENTS: Adelaide (University of Adelaide), Alice Springs (USAF), Charters Towers (University of Queensland), Kununurra (WA Public Works Dept), Manton, Mawson, Mundaring, Narrogin, Hobart (University of Tasmania), Toolangi. 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: Bellfield, Cooney, Kalgoorlie, Kowen, Marble Bar, Macquarie Island, Meekatharra, Mount Isa (from August) Stephens Creek, Swanview, and Warburton.

The single-component seismograph at Mount Isa was installed at a Telecom microwave relay station 6 km east of Mount Isa and has a magnification of 55 k at 1 s and a peak magnification of 100 k at 0.4 s.

The seismograph at Warburton was plagued with instrumental, operator, and communication problems. It was non-operational for about 30% of the time. Maintenance and modifications to the equipment, and instructions to the operator in August 1979 seemed to improve the reliability of the station.

Record losses and deterioration increased at Manton owing to deferment of servicing through shortage of funds. A thorough overhaul and recalibration in August restored proper performance.

Arrangements were made for long-period seismograms produced by the Australian/USA array station at Alice Springs to be sent to BMR for analysis and retention; they began arriving in June.



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A/B9-138-1A

OR-2

Two visits (January and August 1979) were made by maintenance teams from Albuquerque Seismological Laboratory to the Seismic Research Observatory. Maintenance included repairs to the remote system controller, remote inverter, and tape recording control. New anti-aliasing filters and radio for time signals were installed.

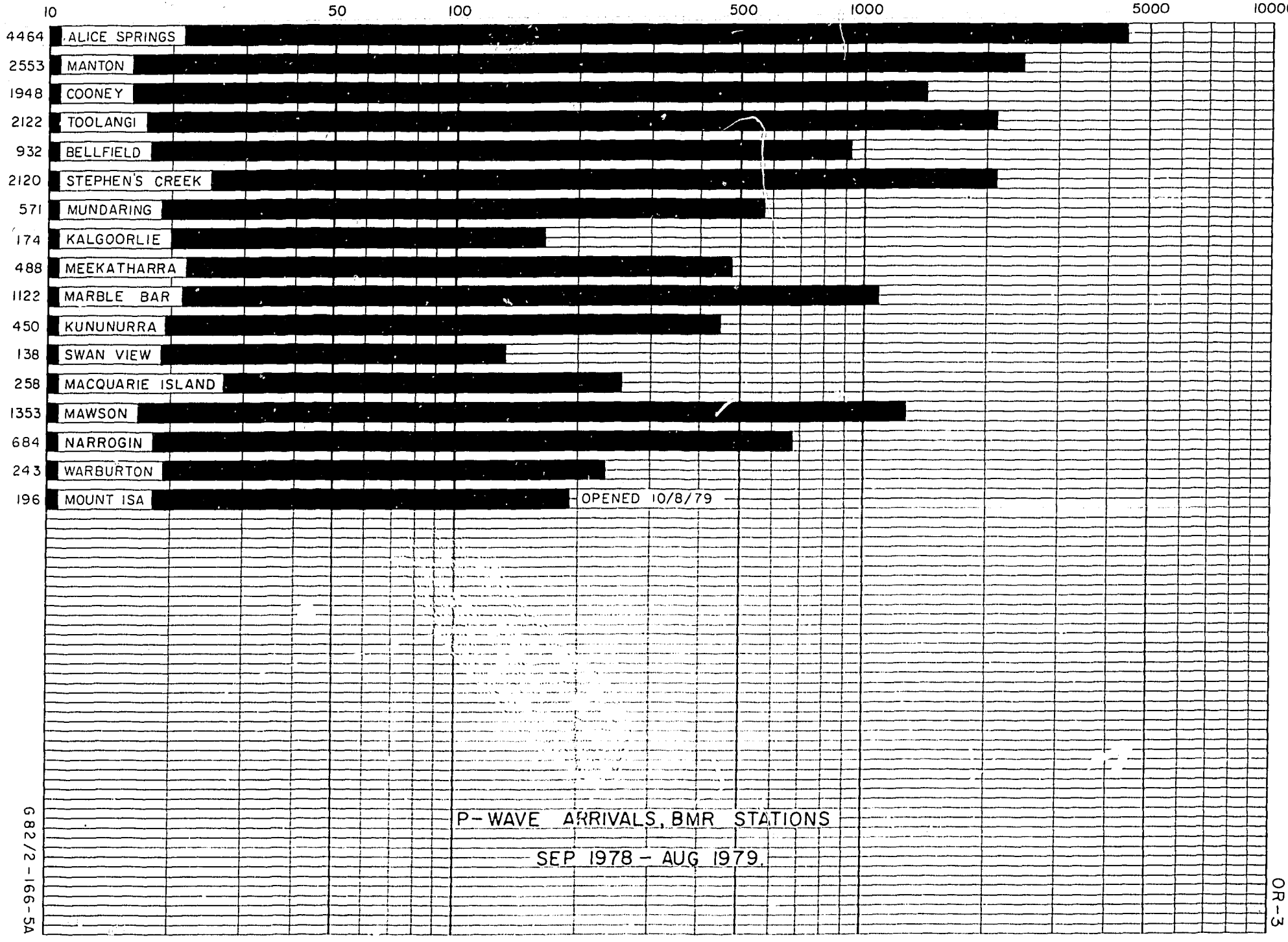
Three field seismographs were operated in the Meckering area during the year to record minor activity and to monitor any changes in P-wave velocities from a quarry in the Meckering area. Insufficient time-control and resolution degraded the results from the latter project.

Negotiations were started to include Riverview College Observatory in the BMR-assisted network; seismograms from Riverview were analysed at BMR after January.

Australian earthquakes. All significant earthquakes that occurred in Australia during the report period are listed below:

DATE (1978)	LOCALITY	MAGNITUDE	REMARKS
Oct 08	26 km NW Meeberrie Station, W.A.	3.5	Felt MM IV
28	20 km N Wongan Hills, WA	3.4	
Nov 16	17 km NW Pingrup, WA	3.7	Felt MM IV
24	70 km ENE Ravensthorpe, WA	4.3	
24	14 km S Meckering, WA	3.1	
25	Simpson Desert, NT	4.7	
28	300 km E Kalgoorlie, WA	3.0	
28	300 km E Rockhampton, Qld	4.0	
28	300 km E Rockhampton, Qld	5.0	Felt MM IV
Dec 12	200 km W Lake McKay, WA	4.7	
15	160 km W Dirk Hartog I, WA	4.6	
(1979)			
Jan 17	120 km SW Exmouth, WA	3.4	
18	Dalton, NSW	3.5	
20	500 km E Bass Strait	4.7	
24	550 km SW Albany, WA	4.5	
Feb 03	Oolong, NSW	3.0	Felt MM IV
Mar 13	24 km SSE Cadoux, WA	4.0	Felt MM IV
14	24 km SSE Cadoux, WA	3.8	Felt MM IV
14	24 km SSE Cadoux, WA	3.2	Felt MM IV
Apr 15	24 km SSE Cadoux, WA	3.1	Felt MM III
16	25 km SE Melbourne, Vic.	2.6	Felt MM IV
22	260 km WNW Broome, WA	6.0	
23	260 km WNW Broome, WA	7.0	Felt MM IV
24	120 km E Warburton, WA	4.3	
25	30 km SE Dumbleyung, WA	3.0	
25	260 km WNW Broome, WA	6.2	
29	230 km W Margaret River, WA	2.9	
May 10	16 SSE Cadoux, WA	3.2	
Jun 01	7 km SE Cadoux, WA	5.2	Felt MM VI
02	7 km SE Cadoux, WA	6.2	Felt MM IX
03	4 km E Cadoux, WA	5.3	Felt MM VI
07	5 km E Cadoux, WA	5.5	Felt MM VI
10	6 km E Cadoux, WA	4.3	Felt MM V
Jul 11	17 km SSW Meckering, WA	3.3	Felt MM IV
11	Tasman Sea	4.0	
12	Dalton, NSW	4.0	
14	80 km ESE Broome, WA	5.7	Felt MM IV

Record No. 1979/73
(Based on G441-39-1A)



G 82/2-166-5A

OR-3

The major earthquake on 2 June near the small town of Cadoux, Western Australia, injured only one person, but damage in the town and surrounding district could exceed $1.5 million.

Preliminary results showed that the earthquake had a Richter magnitude of 6.2, and occurred at 09h 48m 01s UT at latitude 30.83°S, longitude 117.5°E, depth 15 km. It is the third earthquake of magnitude 6 or greater which has occurred in the southwest seismic zone in eleven years. The maximum Modified Mercalli intensity observed was IX.

The earth fractured in a zone 14 km long. Three scarps were formed: the largest was 10 km long with overthrusting up to 1.1 m, vertical uplift up to 0.6 m, and some right-hand strike slippage. The general direction of movement (70°-80°) conformed roughly with the axis of major stress measured in the area in 1976.

Fault-plane solutions and hypocentres for earthquakes which occurred in Western Australia (6 May 1978, 23 April 1979, 2 June 1979) central Australia (25 November 1978) and eastern Australia (4 July 1977) were studied. Work on Papua New Guinea seismicity included an annual seismicity report, a list of earthquake intensity data for 1953-1959 and a study of swarms of tremors beneath the Bismarck Sea.

Accelerographs were operated in WA and NSW. One modified to lower the trigger-threshold was added near Yass. Accelerograms were obtained from the earthquake at Oolong in February, and at Meckering (WA) from the Cadoux earthquake in June.

Data files. Preliminary phase data from all the three-component stations and several of the single-component (regional) stations were sent a few times a week to the USGS centre for 'Preliminary Determination of Epicentres'. Final phase data from all agencies in Australia, PNG and the Solomon Islands for the interval January 1977 to November 1977 were sent to the International Seismological Centre (ISC) in accordance with the Centre's schedule; data on about 5300 P-phases and 40 hypocentres were sent monthly (Fig. OR-3 shows the details for BMR stations). The data were also produced in time-sorted bulletins and distributed to co-operating agencies.

The regional Earthquake Data File (for the area 0-90°S and 75°-165°E) was not updated during the year as the USGS fell behind in the production of hypocentral data. The file contains about 25 400 hypocentres from 1873 to December 1977. About 50 calls were made on the file, from inside and outside BMR. The calls included requests for information on felt earthquakes from the public and insurance companies, and plots and lists of regional seismicity for numerous purposes. Lists from the file and all bulletins are available optionally on either microfiche or paper.

Magnetic tapes of world seismicity were obtained from the USGS for the years 538 to 1977 and from ISC for the years 1971 to 1976.

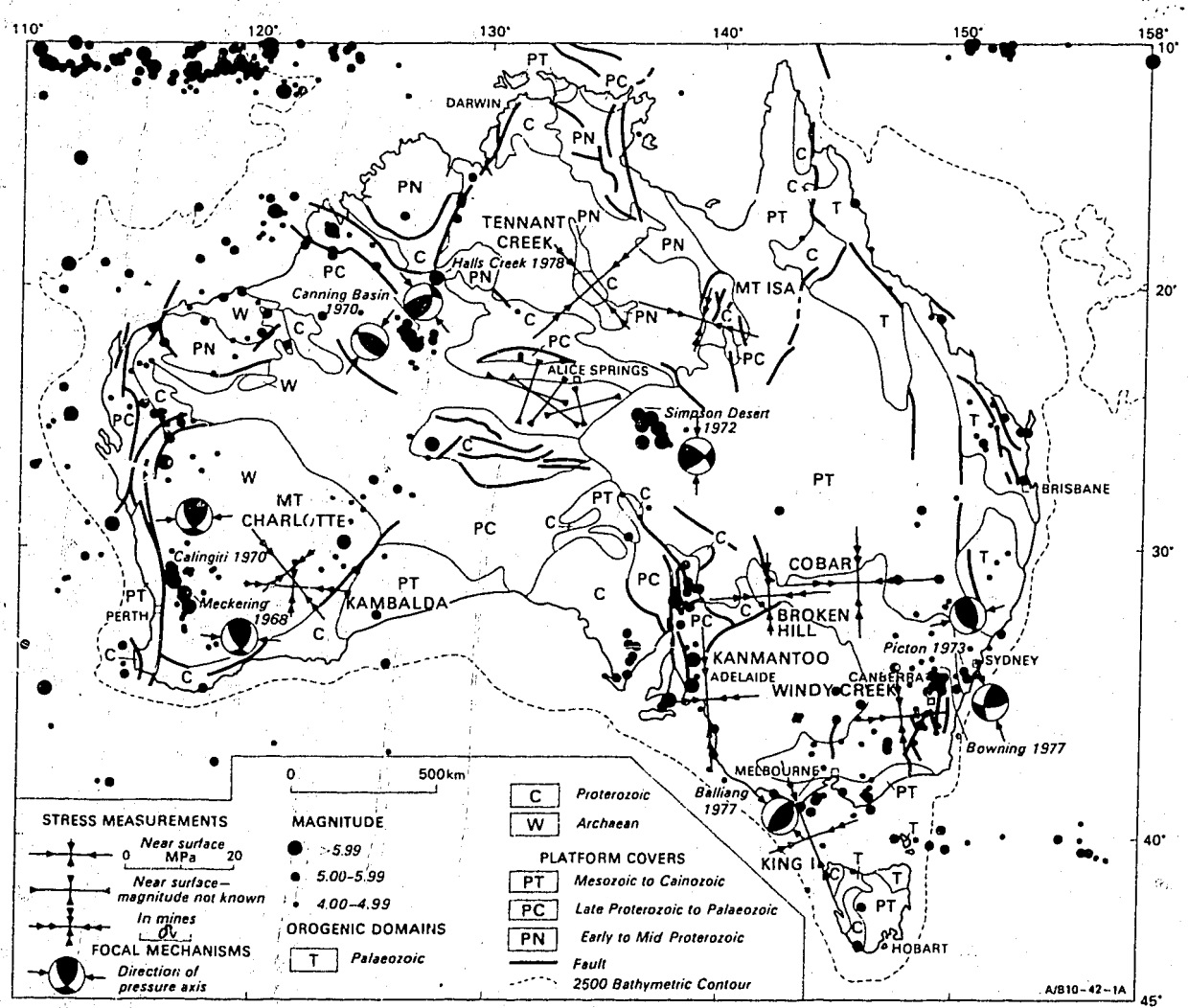
REGIONAL SUBSECTION

REGIONAL STRUCTURAL STUDIES GROUP

Stresses in the Australian crust: evidence from earthquakes and in situ stress measurements (D. Denham)

During 1979 BMR continued its program of stress measurements in the Lachlan Fold Belt in co-operation with the CSIRO Division of Applied Geomechanics. These results were combined with 1978 observations in SE Australia together with earlier results from Western Australia and South Australia; interpretations have been reported in several journals and symposia proceedings.

Evidence from earthquake focal mechanisms, in situ stress measurements, and surface deformations indicate that the Australian continent is in a state of substantial horizontal compression. Reliable focal mechanism determinations are now available from sight earthquakes that have occurred in several parts of the continent since 1967. Each of these mechanisms indicates that the faulting associated with the earthquakes was caused by compressive stress acting close to horizontal. In situ measurements made in mines and tunnels, and close to the surface in quarry floors or on rock outcrops, also indicate horizontal compressive stress in all areas.



Distribution of earthquakes greater than magnitude 4, 1873–1977; earthquake focal mechanisms - lower focal hemisphere displayed, black represents compression; in situ stress measurments made before 1976. δv represents the vertical stress due to overburden.

During 1978 and 1979 several sites in NSW were tested at depths ranging from 3 to 9 m. At each site the stress measured was compressive. In the eastern part of the State at Buckleys Lake, Jindabyne, Milton, and Moruya the axes of maximum compression were north-south, but in the west at Ardlethan, Mirrool, Berrigan, and Tocumwal the stresses are close to east-west, agreeing with the earlier results at Broken hill and Cobar. The highest values of about 20 MPa were obtained in Silurian granite at Tocumwal.

The results give principal stress orientation in different directions for different regions of the continent; it is therefore clear that simple models derived from plate tectonic concepts cannot be applied directly to explain the high observed stresses or their directions.

The results of observations to date are illustrated in Figures OR-4 to OR-6. An earthquake of Richter magnitude 6.2 at Cadoux in Western Australia on 2 June 1979 (see under 'Observatories') occurred in the area where stress measurements were made in 1976 (Fig. OR-5); preparations are being made to remeasure the stress in the area to determine the effect of the earthquake.

Tennant Creek-Mount Isa seismic survey (D.M. Finlayson, C.D.N. Collins, J.W. Williams, D. Pownall, H. Hughes)

During July, seismic refraction recordings were made along the Barkly Highway between Tennant Creek and Mount Isa (Fig. OR-7). Recordings were also made between Noble's Nob open-cut gold mine southeast of Tennant Creek, and Warrego underground gold/copper mine northwest of the town.

At Tennant Creek, 5 tonnes of explosive was detonated 40 metres deep in the abandoned Skinner Extended gold mine. Recordings were made from Tennant Creek to Barry Caves a distance of about 290 km using 21 BMR automatic remote-recording seismic tape recorders. In addition, the Australian National University deployed 20 automatic seismic tape recorders between Tennant Creek and Julia Creek at intervals of about 40 km, and recordings were therefore made beyond Barry Caves.

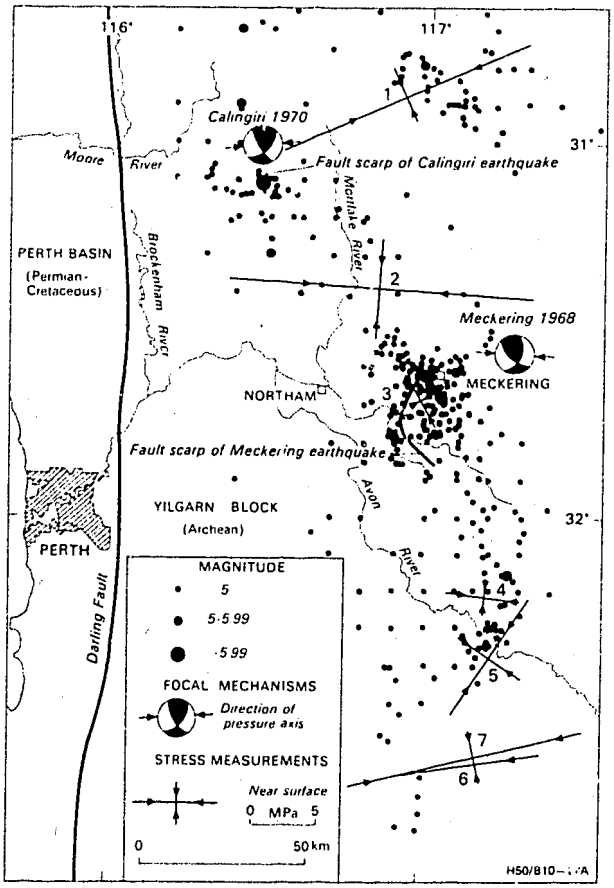
At Mount Isa, a routine quarry blast of 40 tonnes (at the Kennedy Siltstone open cut) was recorded using BMR equipment between Mount Isa and Barry Caves, a distance of 290 km; the line was extended further west, and to the east of Mount Isa using ANU recorders. Routine blasts at Boble's Nob and Warrego, of 2 and 0.7 tonnes respectively, were recorded at 21 stations between the two mines, which are 57 km apart. Playback of the Tennant Creek-Mount Isa recordings has commenced, and record sections have been drawn (Fig. OR-8); interpretation will follow after further processing of the data.

Tennant Creek-Townsville upper mantle studies (D.M. Finlayson, C.D.N. Collins, J.W. Williams, H. Hughes)

Seismic refraction data recorded by the Australian National University during BMR's Tennant Creek-Mount Isa seismic survey will be incorporated in the BMR interpretation. In exchange, ANU will have access to data from the Indian Ocean, Fiji-Tonga, and Banda Sea earthquakes recorded during the course of the BMR survey (Fig. OR-7).

As part of this data exchange, BMR deployed 21 remote-recording seismic stations between Julia Creek and Ayr, on the coast; 20 ANU stations were deployed between Julia Creek and Tennant Creek. Thus there was a continuous recording line of about 1350 km between the coast and Tennant Creek comprising 41 automatic seismic recorders. Recordings were also made at the ANU Warramunga Seismic Array at Tennant Creek, the BMR permanent seismic station at Mount Isa, and the Queensland University World Wide Standard Seismograph Station at Charters Towers. BMR recorders were run continuously from 15 to 30 of August. Several earthquakes from the relevant areas were detected during the recording period; BMR recording examples are shown in Figure OR-9.

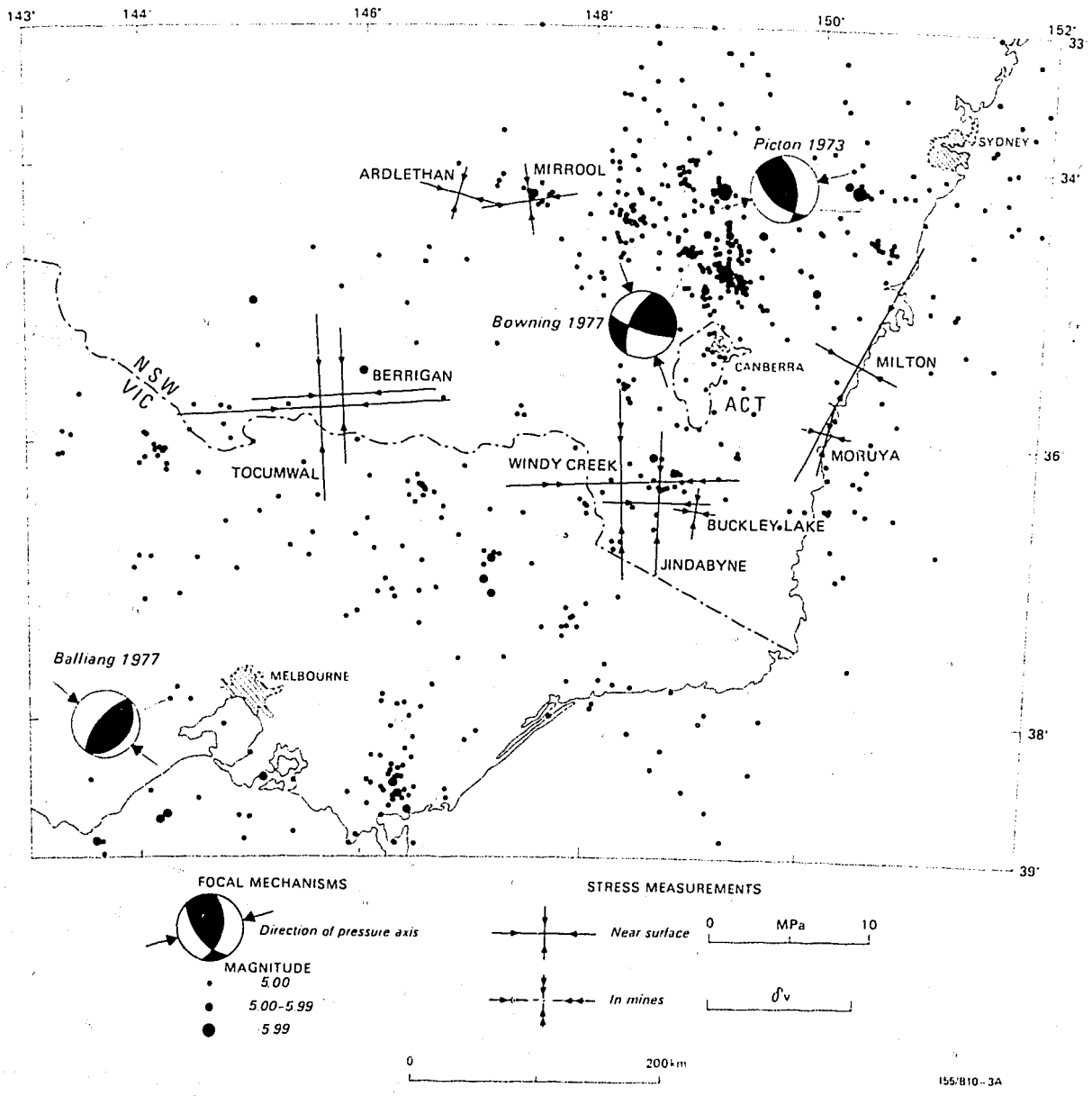
Routine mine and quarry blasts in the area were also recorded during this period; shots were timed at Greenvale nickel mine, Collinsville coal mine, Calcium limestone quarry, and quarries in the Townsville area. This information will be used to investigate local crustal structure.



Stress measurements near Meckering; the earthquake distribution before 1978 and the fault scarps from the Calingiri and Meckering earthquakes are also shown.

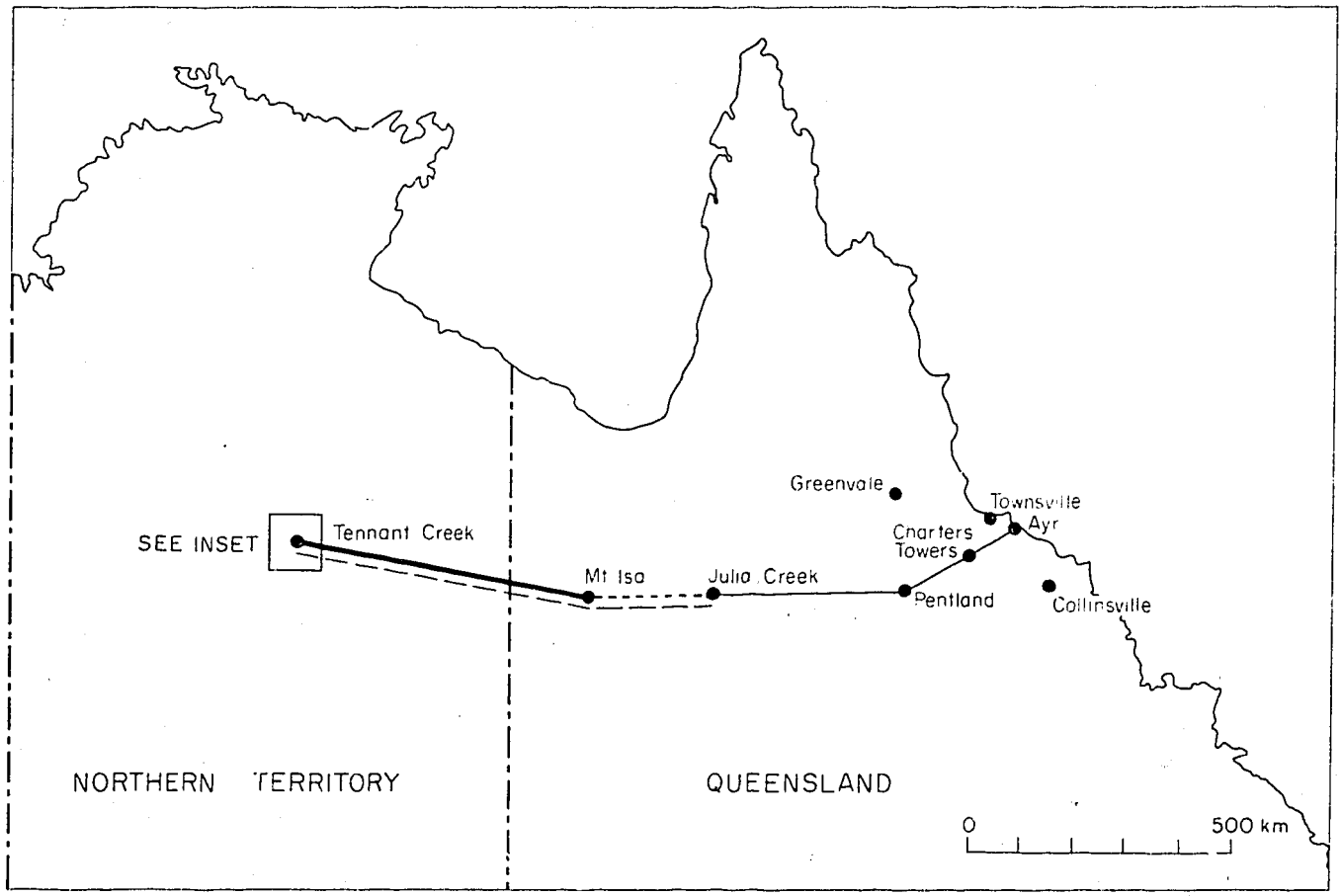
Record No. 1979/73

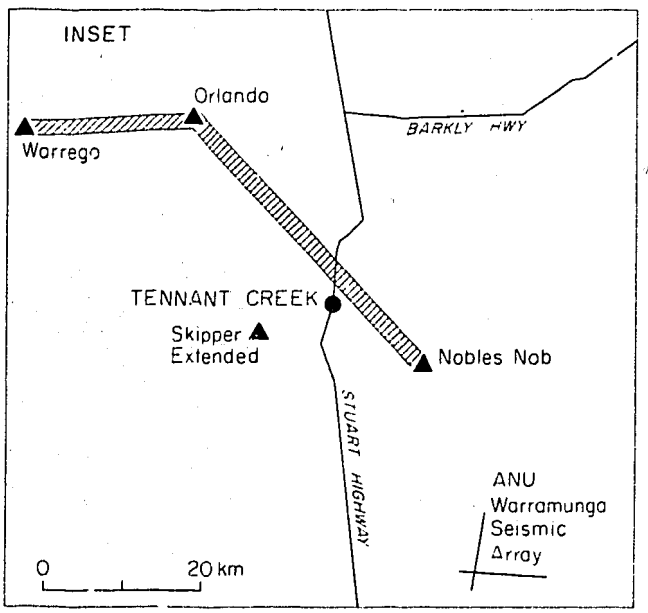
OR-6



Stress measurements in Lachlan Fold Belt

Record No. 1979/73





(a) Tennant Creek – Mt Isa Seismic Survey

BMR and ANU recording stations

ANU recording stations only

(b) Tennant Creek – Townsville Upper Mantle Studies

BMR recording stations

ANU recording stations

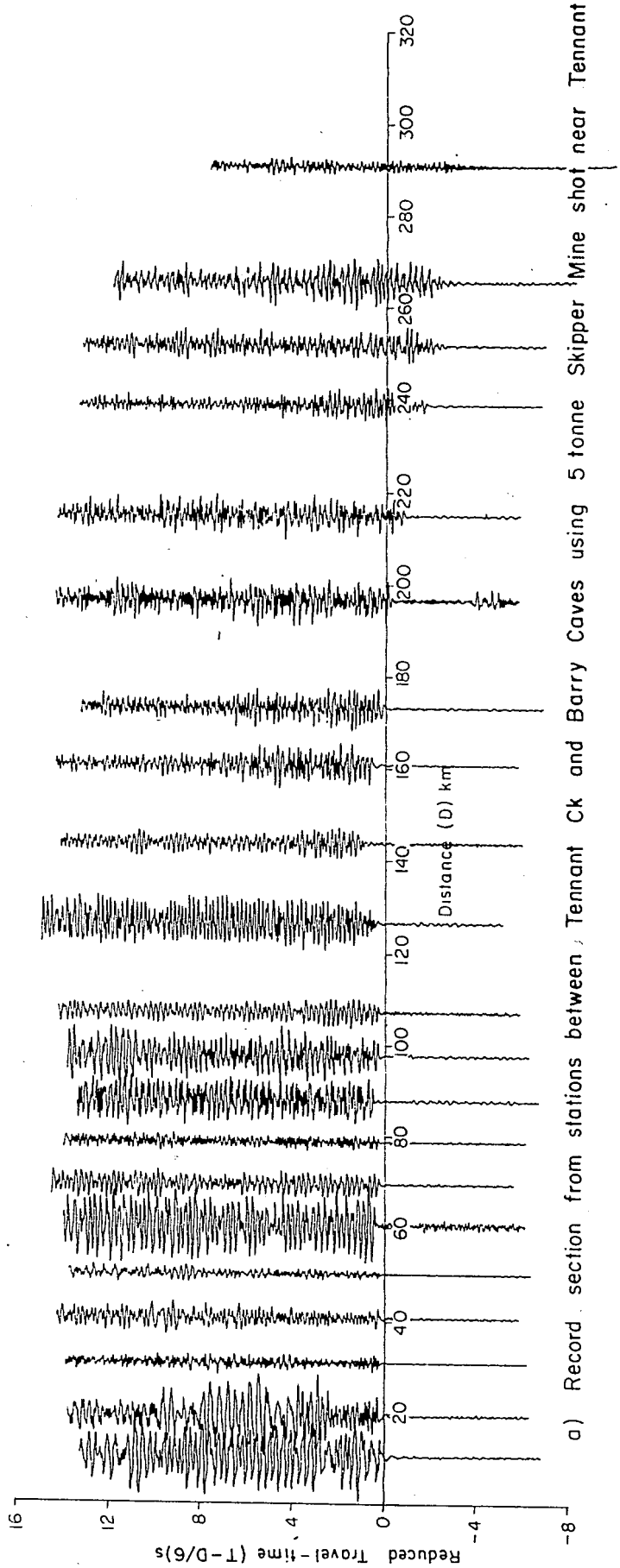
BMR Seismic recording line

Mine

Location diagram of Tennant Creek – Mt Isa Seismic Survey and Tennant Creek – Townsville Upper Mantle Studies.

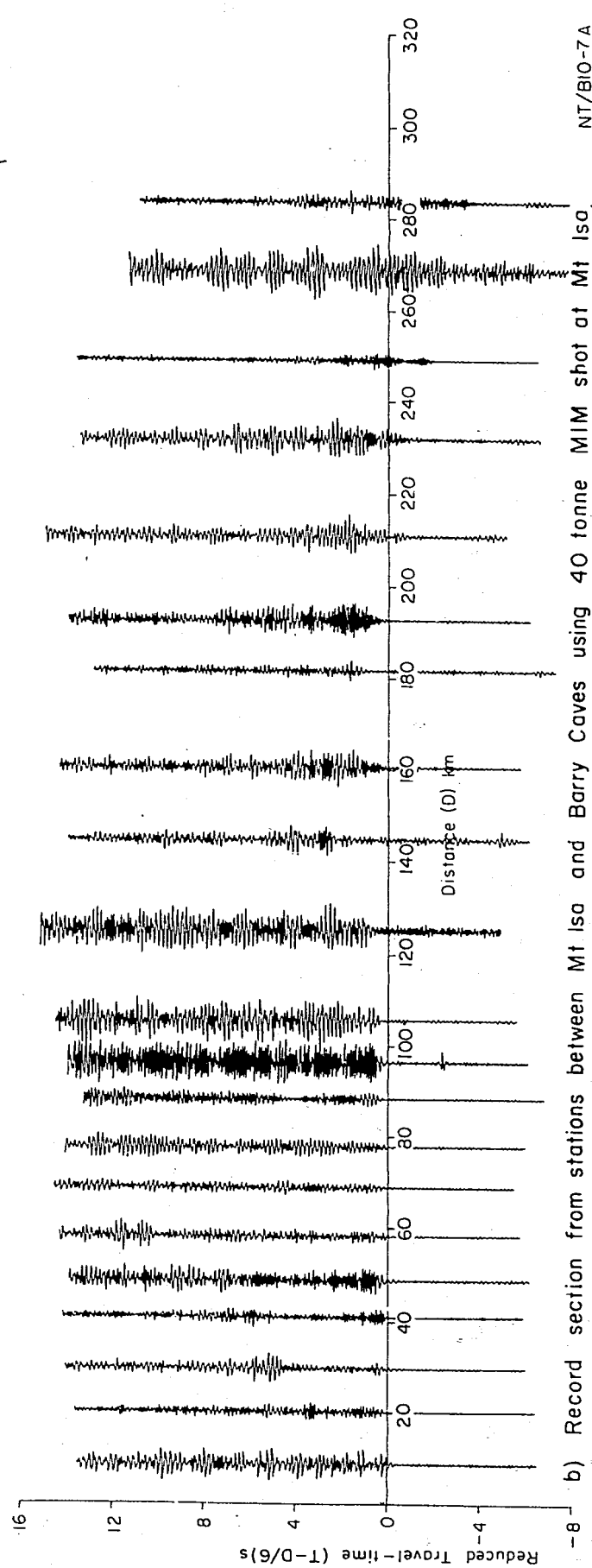
NT/B10-8A

Record No. 1979/73

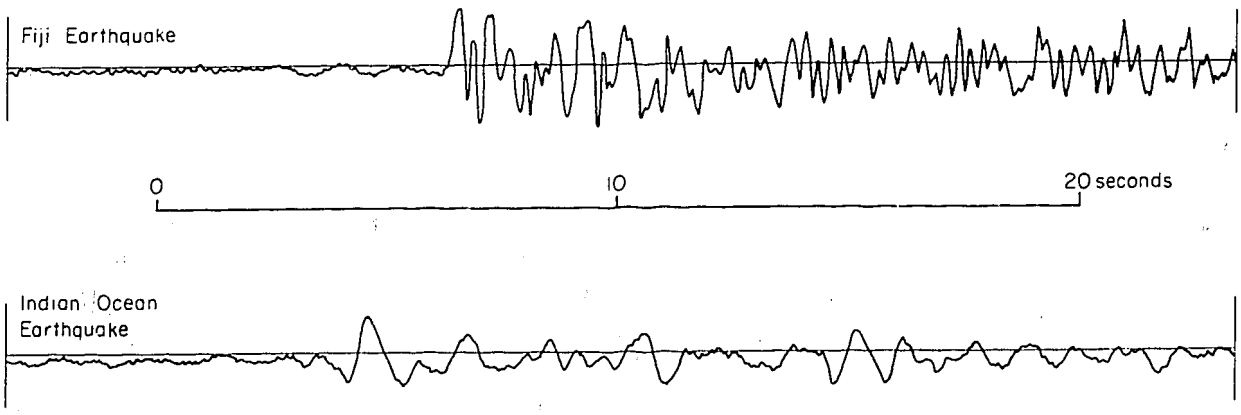


a) Record section from stations between Tennant Ck and Barry Caves using 5 tonne Skipper Mine shot near Tennant Ck.

Record No. 1979/73



b) Record section from stations between Mt Isa and Barry Caves using 40 tonne MIM shot at Mt Isa

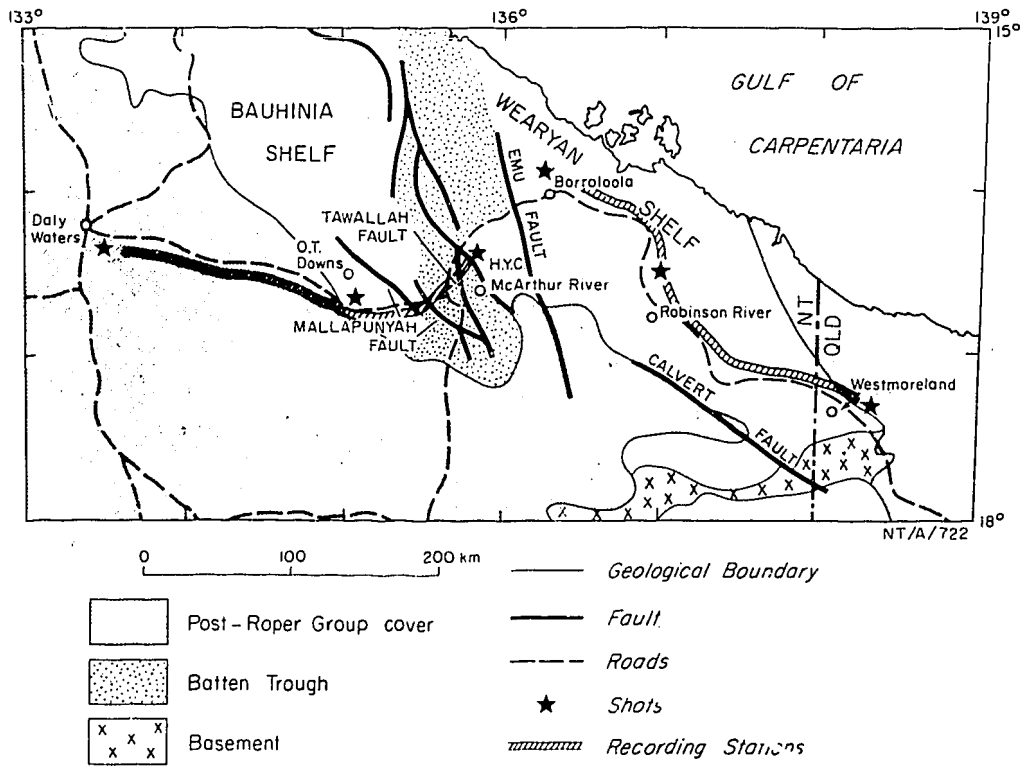


Recordings made at Homesteads, N. Qld.

Record No. 1979/73

F55/B10-16A

OR-10



McArthur Basin Seismic Crustal Survey - Location of shots and recording stations.

McArthur Basin seismic survey (C.D.N. Collins, J.W. Williams, D. Pownall)

As part of a study of the tectonics of the McArthur Basin, a series of long-range seismic refraction and vertical seismic reflection recordings were made during June and July. The aim of the seismic work was to define the deep crustal structure beneath the Bauhinia Shelf, Batten Trough and Wearyan Shelf, and relate the structure to surface features such as the Emu Fault Zone. A particular objective was to delineate any gross differences in structure east and west of the Emu Fault, in the vicinity of the HYC mineral deposit.

The refraction recordings were made along two traverses, each about 300 km long: along the Daly Waters to Borroloola road between Daly Waters and the HYC mine, and along the Borroloola to Burketown road between Borroloola and Westmoreland (Fig. OR-10).

On the first traverse, two large shots each of 2000 kg were fired; they were located at each end of the line near Daly Waters and the HYC mine. The explosive was detonated in a pattern of 20 holes drilled to a depth of 27 metres. Twenty-one recording stations were occupied along the traverse by automatic remote-recording seismic tape recorders. Two smaller 400 kg shots were fired to give greater detail near the Emu Fault end of the line, one near the HYC mine and one 100 km west near OT Downs. The recording stations were concentrated within 100 km and 200 km of the HYC mine respectively for these two shots.

The second traverse was a mirror-image of the first, with the large shots near Borroloola and Westmoreland and the small shots near Borroloola and Robinson River. Althogether, 68 sites were occupied on the two traverses, as well as 3 sites which were occupied by manual recorders. These manual recorder sites showed that the 2000 kg shots were well recorded at the farthest station from the shot. They were also used for shot-timing purposes.

Vertical reflection recordings were made at each shot-point. The eight refraction shots were used as the seismic sources and the geophone spreads extended for 1 1/2 km on either side of the shot, with a short cross-spread at one end.

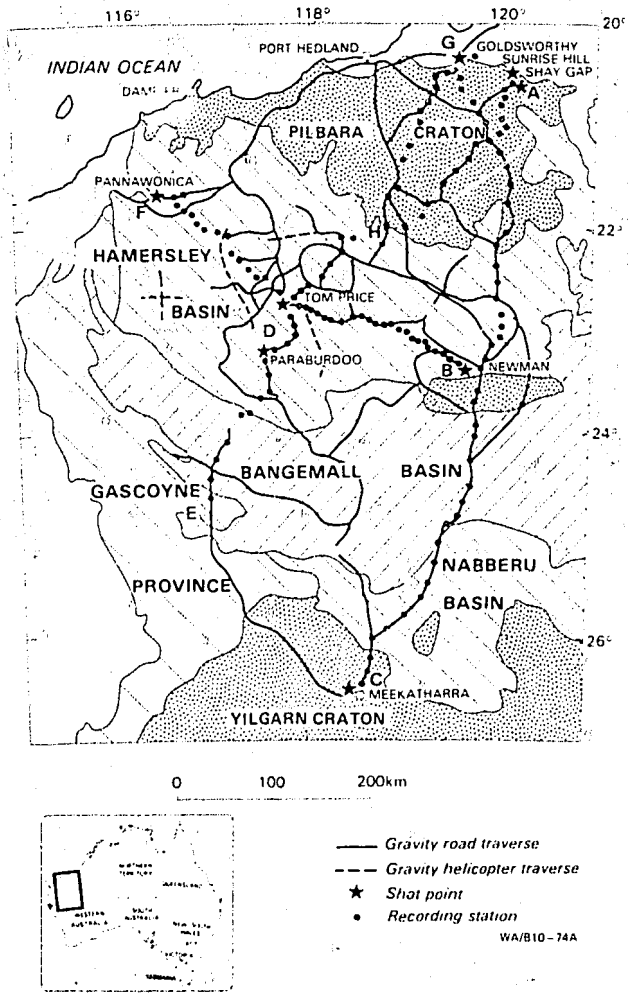
Preliminary playback of the magnetic tapes has shown that good recordings of refracted arrivals were made along the entire lengths of each traverse. However, the field playback system did not allow any reduction of the data beyond establishing that Moho arrivals were recorded at distances greater than about 200 km, and probably three main crustal velocities were recorded. No prominent difference between the two traverses could be established from these preliminary records. The data will be digitised and then processed before any interpretation commences. The vertical reflection data also require processing, but real-time analogue records show good deep reflections at some sites. It is hoped to correlate the seismic results with magneto-telluric and gravity results in the area.

Pilbara crustal survey - seismic interpretation (B.J. Drummond)

Interpretation of the seismic data from the traverse between Goldsworthy and Meekatharra continued (Fig. OR-11), and a two-dimensional model was derived (Fig. OR-12). The crust in the Pilbara Block appears to be two-layered, consisting of a granitic upper part (velocity 6.0 km s^{-1}) and a granulitic lower part (6.4 km s^{-1}). The base of the crust dips southwards by about 1 degree - starting at a depth of about 28 km under Goldsworthy and grading to 33 km at a point 80 km south of Newman. The crust under the northern Yilgarn Block is much thicker (about 50 km) and is three-layered. The top two layers are similar to the crustal layers of the Pilbara Block and are underlain by a denser layer with a seismic velocity of about 7 km s^{-1}. The crust between the two blocks has dense material at its base and is marked by steep velocity gradients.

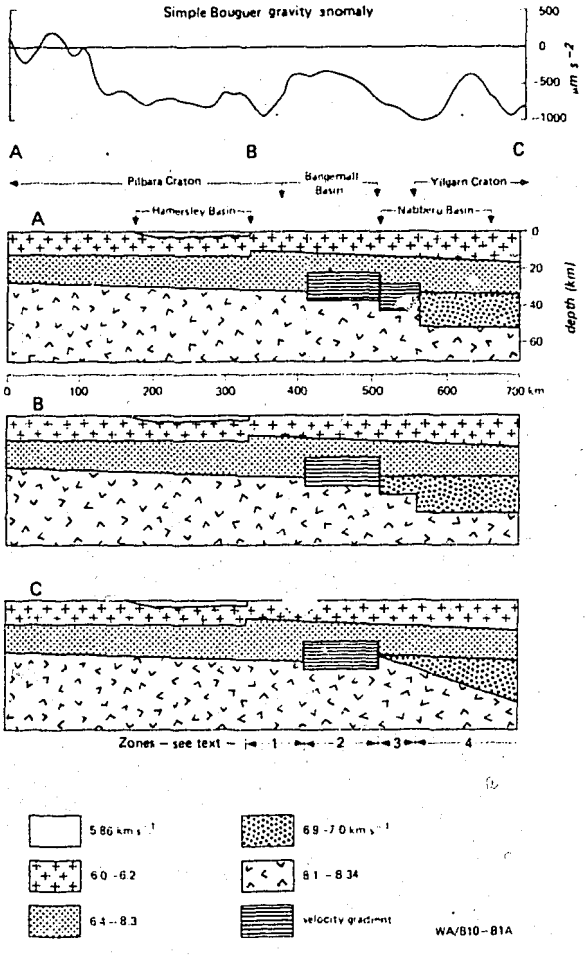
Processing of the seismic data from the other lines continued. Recordings of shots along the line from Goldsworthy to Tom Price and Paraburdoo were digitised and record sections produced. A start was made on interpreting detailed velocity/depth functions along all profiles to examine the nature of the intracrustal and crust/mantle boundaries.

OR-11



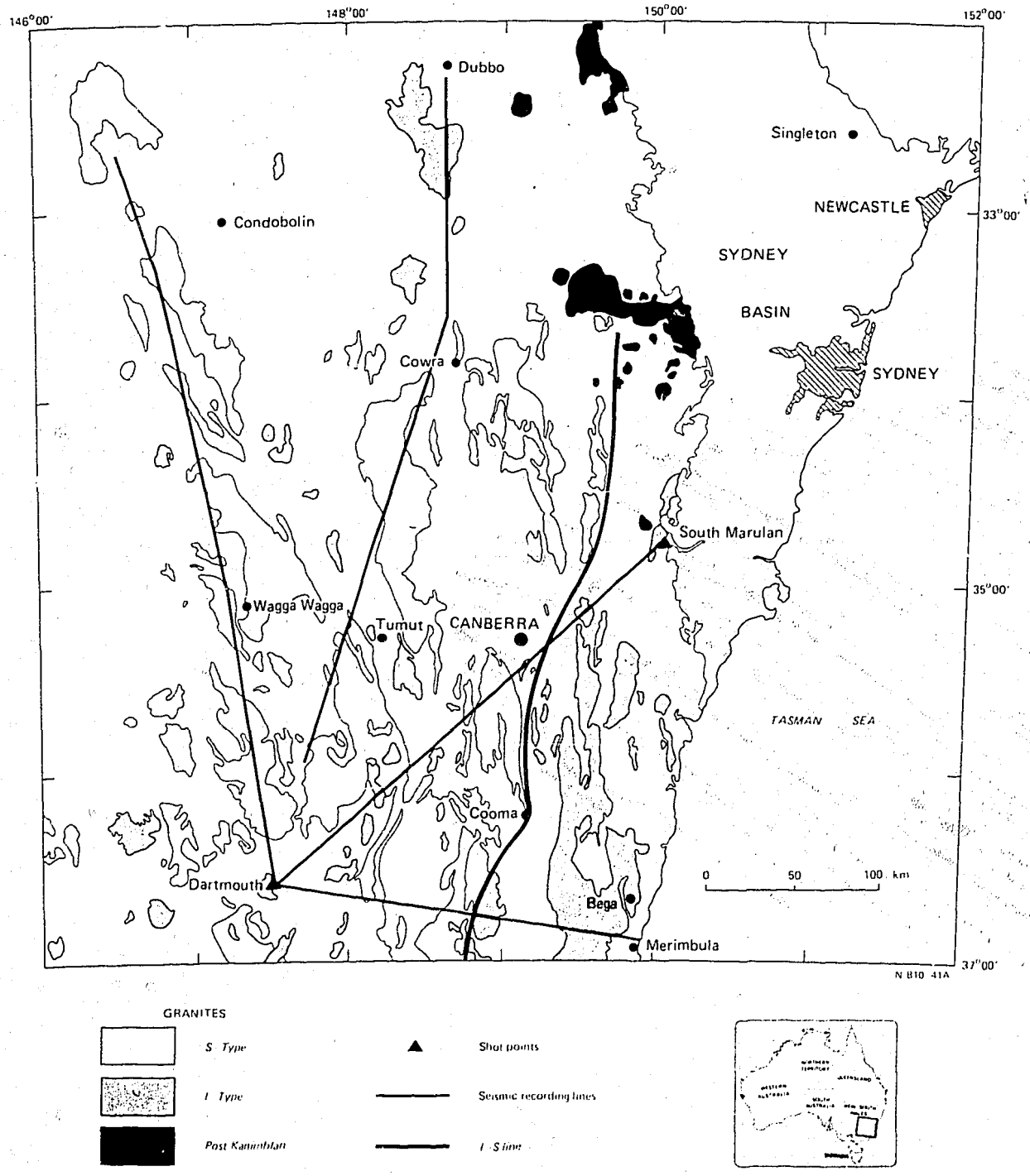
Pilbara Crustal Survey; geology and survey design

Record No. 1979/73



Pilbara crustal interpretation; gravity profile and seismic crustal models along line ABC

Record No 1979/73



Location of seismic traverses and granitoids in southeastern Australia

Record No. 1979/73

Southeastern Australia seismic investigations (D.M. Finlayson, D. Denham, C.D.N. Collins, H.M. McCracken)

Play-back, digitising, and interpretation of seismic recordings made in southeastern Australia during 1976-78 continued. Further field recordings were made at Gundary Plains near Goulburn in April.

Four main traverses (shown in Fig. OR-13) across the Lachlan Fold Belt were studied: Dartmouth to Condobolin, Dartmouth to Dubbo, Dartmouth to Merimbula, and Marulan to Ardlethan. The seismic record section and proposed model for the Dartmouth-Condobolin traverses are shown in Fig. OR-14 and for Dartmouth-Merimbula in Fig. OR-15. The results indicate: (1) the existence of vertical velocity gradients rather than discontinuous velocity changes, and (2) lateral variations in the velocity-depth relations across the region. The crust may contain one or more low-velocity zones of varying prominence throughout the region, and crustal thickness exceeds 50 km beneath the higher mountains. Velocities in the upper crust range from 5.6-6.3 km/s grading to 6.3-7 km/s in the middle crust and 8.02-8.05 km/s in the upper mantle. The seismic record sections from southeastern Australia are characteristic of old orogenic provinces. The velocity-depth structures are probably the result of geochemical mixing and/or compositional inhomogenei.

Preliminary interpretation along the line between Marulan and Singleton across the Sydney Basin suggests that the Basin contains low-density sediments dipping northwards, and that the Moho is shallower than under the Lachlan Fold Belt. There is no evidence of a low-velocity zone.

Coral Sea (C.D.N. Collins, B.J. Drummond)

Structural models have been derived using seismic refraction data from along the southwestern coast of the Papuan peninsula and the northwest Coral Sea (Fig. OR-16). Several inversion methods have been used giving consistent results. Sediments over the Papuan Plateau appear to be 5 km thick. To the west and southwest, they thicken to 10 km along the axes of the Moresby and

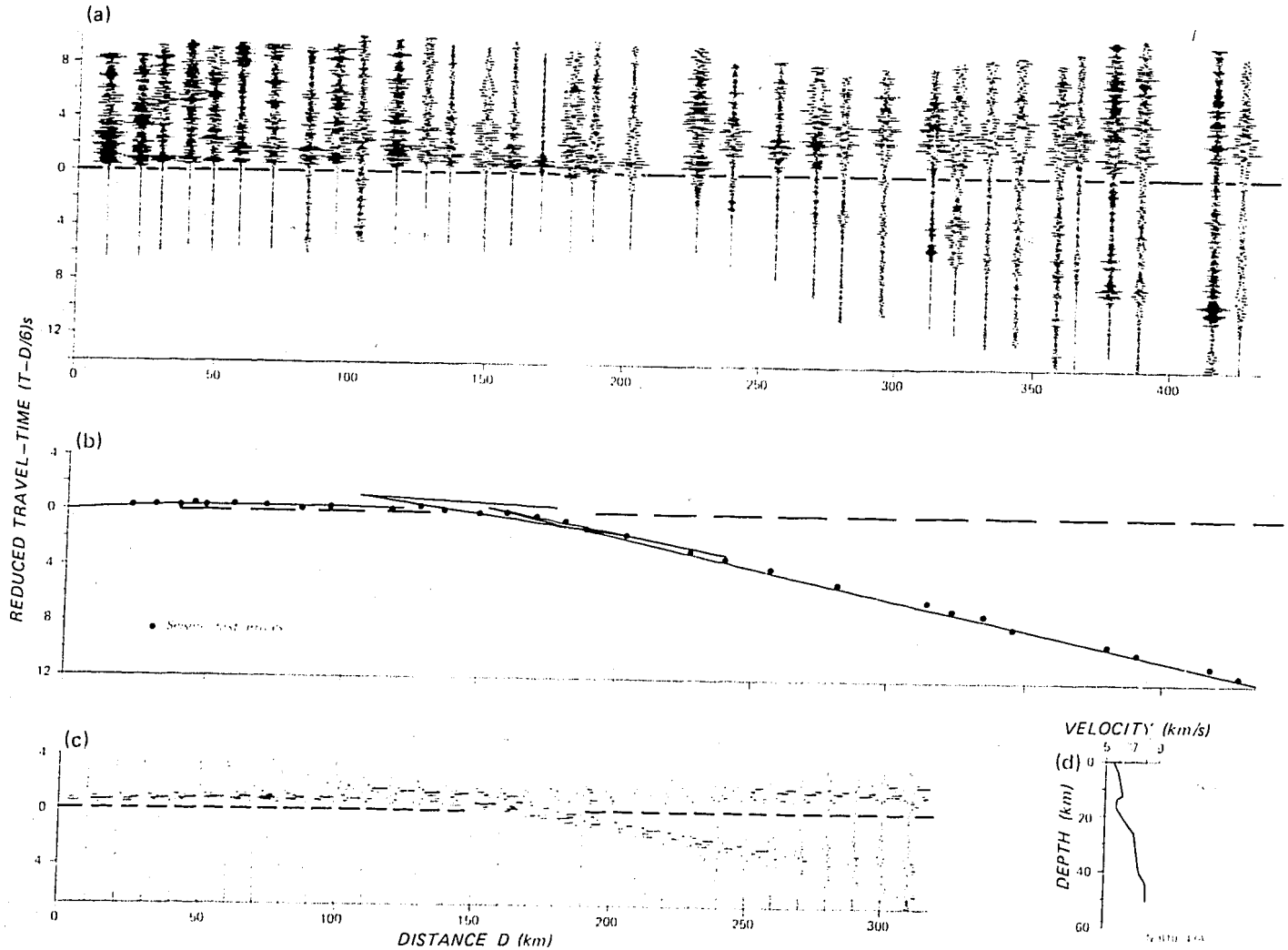
southern Aure Troughs. Farther out into the Coral Sea, over the Eastern Plateau, they are 1 to 2 km thick. Beneath these sediments, there is a layer in the upper crust with a P-wave velocity of 6.07 km/s. This in turn is underlain along the southern coastline of the peninsula by a lower crustal layer with velocity 6.9 km/s; this layer is probably also present under the Eastern Plateau. There are insufficient data to establish whether the lower crustal layer also occurs offshore under the Moresby Trough, but it is not present under the Aure Trough in the north. Intervals where the velocity increases with depth are likely to occur in the lower crust (below 17 km) under the peninsula, but again, there are insufficient data to say whether similar gradients are present offshore.

The Moho is 27 to 29 km deep along the southwestern coast of the peninsula. It shallows to 19 km under the Moresby Trough and deepens again to 25 km under the Eastern Plateau. The crust is therefore characterised as continental under the Papuan peninsula and Eastern Plateau and, excluding sediments, as oceanic under the Moresby Trough. It seems likely that northern Australia, the Eastern Plateau and the Papua Plateau once formed a continuous continental crust. During the rifting that formed the Coral Sea Basin, crustal thinning progressed northwestwards along the axes of the Moresby and Aure Troughs.

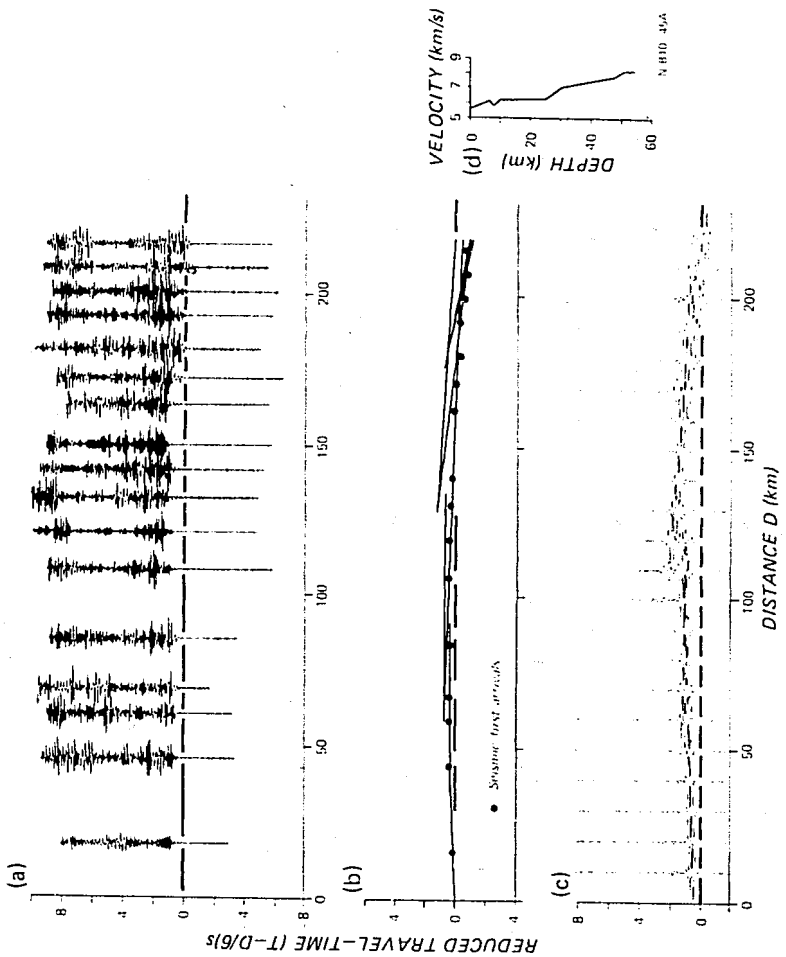
Equipment maintenance and development (J.W. Williams)

Several programs were started late in 1978 to improve the performance and reliability of the XTA-2 and P.I. seismic recording equipment (Fig. OR-17). All systems will benefit from the development of the NCE-3 digital clock with greatly reduced power consumption. Motor drive investigations continued in an attempt to find a suitable low-power drive for the XTA-2 system. 6 P.I. recorders were repackaged to improve handling and reliability.

Some work was done on constructing the new light-weight seismic tape recorders; radio receivers and tape heads have been ordered for these systems. A commercial stereo radio cassette tape recorder has been purchased for shot recording, but some modifications are required for BMR use.



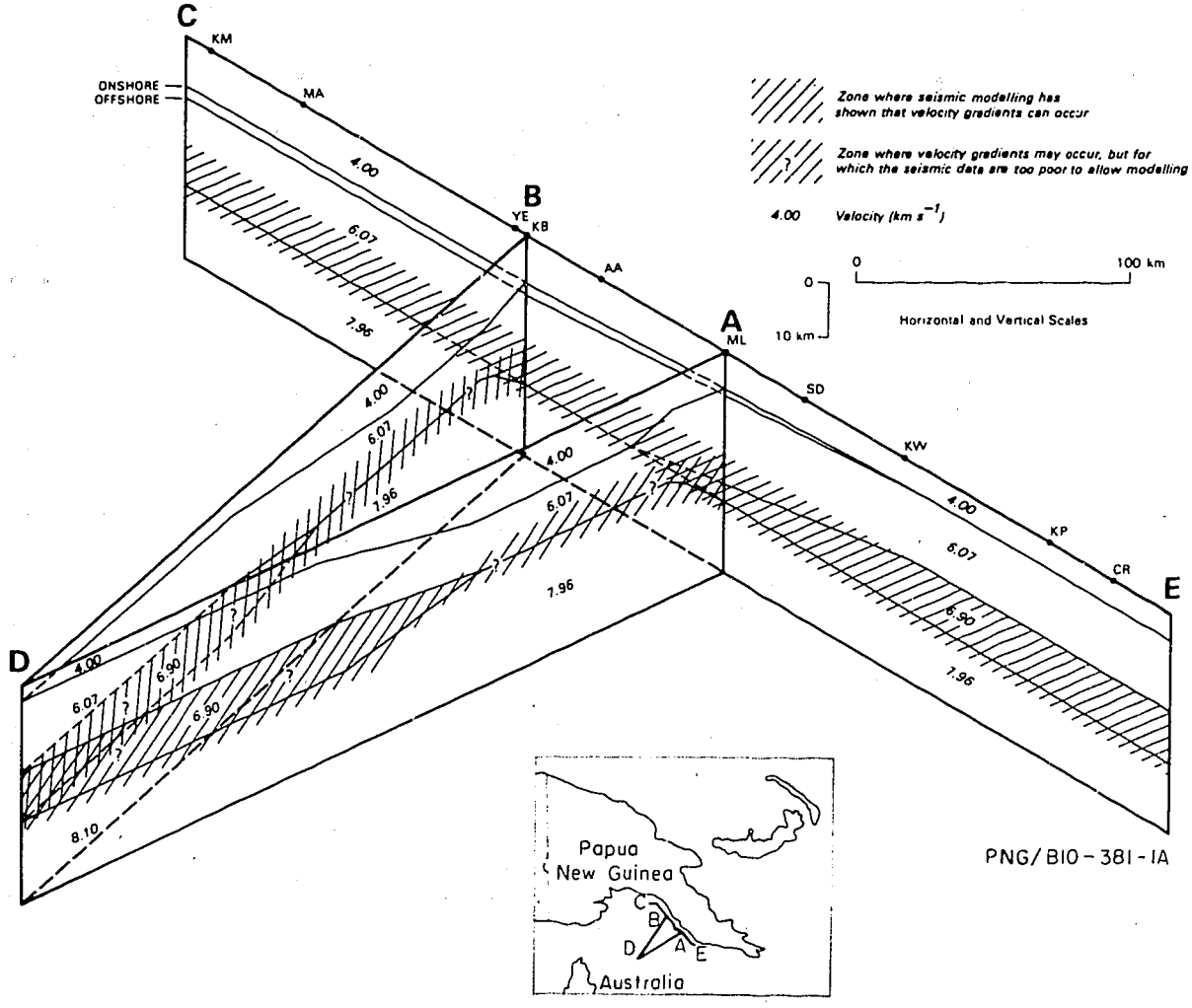
"(a) Dartmouth to Condobolin seismic record section, (b) DCN-1 model travel-time curves, (c) synthetic seismograms and (d) velocity-depth model DCN-1



Record No. 1979/73

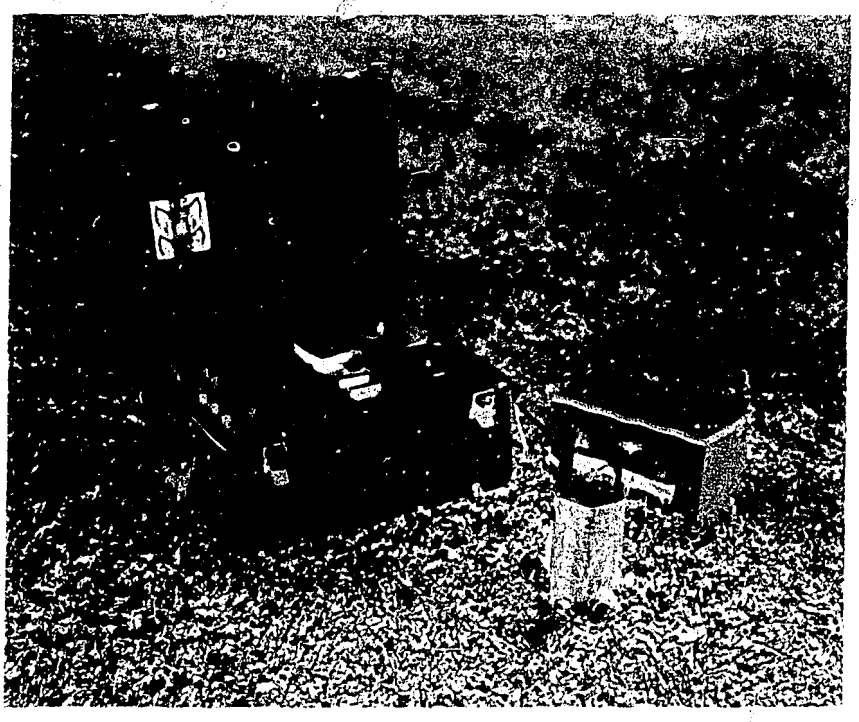
(a) Dartmouth to Merimbula seismic record section.
(b) DMA-1 model travel-time curves
(c) synthetic seismograms
(d) velocity depth model DMA-1

OR-16

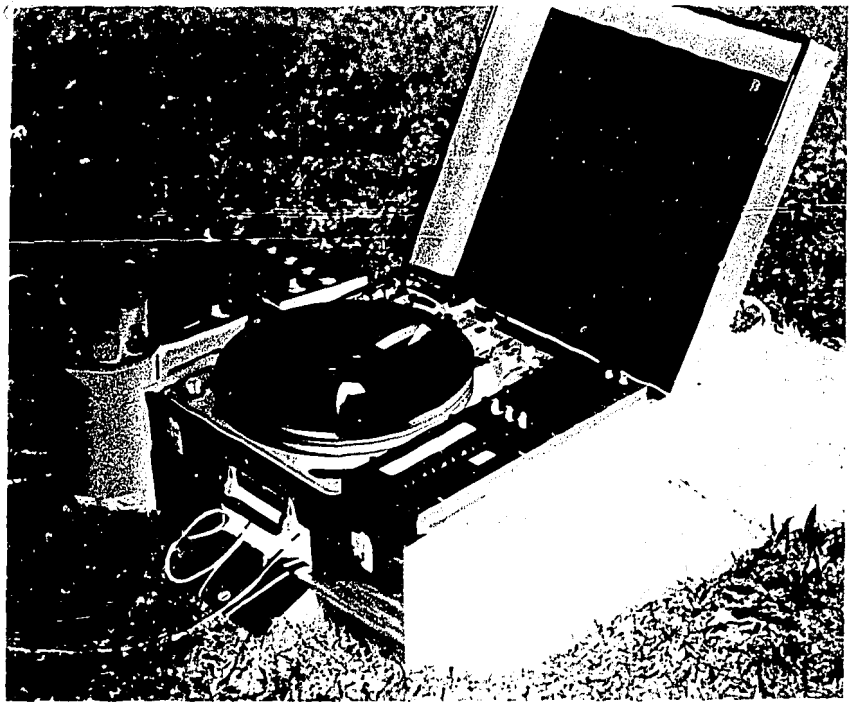


Crustal structure of the Northwest Coral Sea and Gulf of Papua – fence diagram of seismic and gravity profiles

Record No. 1979/73



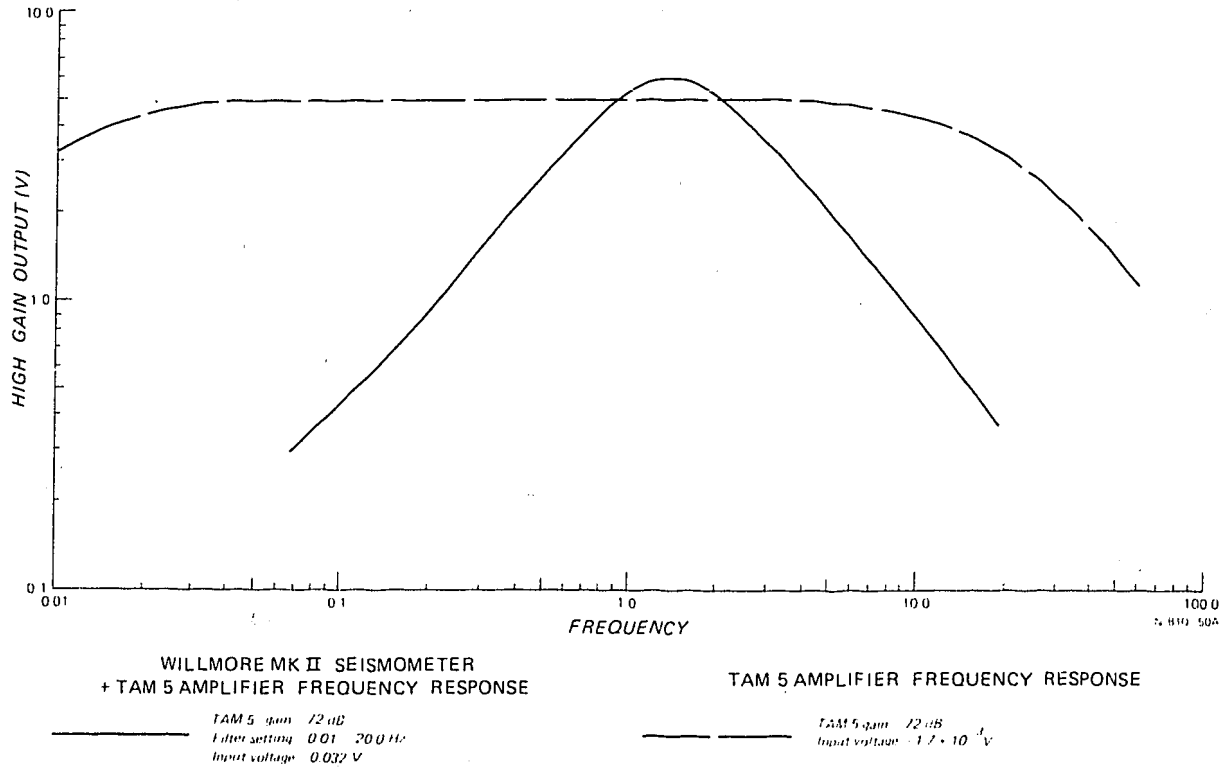
a) ¼ inch tape system



b) ½ inch tape system

BMR portable seismic tape recorders

Record No. 1979/73



a) Response of BMR seismic amplifier (type TAM-5) at a bandpass filter setting 0·01-20·0 Hz, with respect to frequency

b) Response of amplifier and Willmore Mk II seismometer with respect to frequency

A brief description of the XTA-2 and P.I. seismic tape recording systems was submitted for outside publication. The frequency response and magnification characteristics of the systems is shown in Figs OR-18 and OR-19.

Computer development (H.M. McCracken, A.S. Murray, B.J. Drummond)

A program developed by G. Müller of the University of Karlsruhe to compute and plot travel-time curves was adapted to the CSIRO CYBER 76 computer. Given a velocity-depth function, the travel time curves are plotted in reduced form for either a spherical or a flat model of the Earth.

Minor modifications were made to other programs in the crustal program Library.

Technical specialist visitor

Dr C. Prodehl, University of Karlsruhe, Germany, visited BMR as a technical specialist in seismic crustal investigations between 14 January and 21 February 1979. He worked closely with Regional Structural Surveys staff on the interpretation of southeastern Australia seismic data. He introduced to the Group several computer programs for use in seismic interpretation. He gave two lectures at BMR titled "Crustal structures in Europe and western USA" and "The structure of the lithosphere from explosion seismology".

He also led a geophysical workshop on seismic interpretation techniques, which ANU and University of Queensland staff attended.

BMR Atlas (H.M. McCracken, P. Wellman)

A map showing the tectonic effects of present-day plate motions and the age of the sea-floor in the Australian region was prepared for publication. The map is constituted from plates in the immediate region designated as: Australian, Pacific, Antarctic, Asian, Caroline, Philippine, Solomon Sea, and

North and South Bismarck Sea. Features noted on the map include: earthquake epicentres, depth to Benioff zone, active volcanoes, transform faults, spreading axes, continent/ocean boundaries, areas of continental margin rifting, and ocean sediment thickness. Explanatory notes to accompany the map have now been completed.

Heat flow (J.P. Cull)

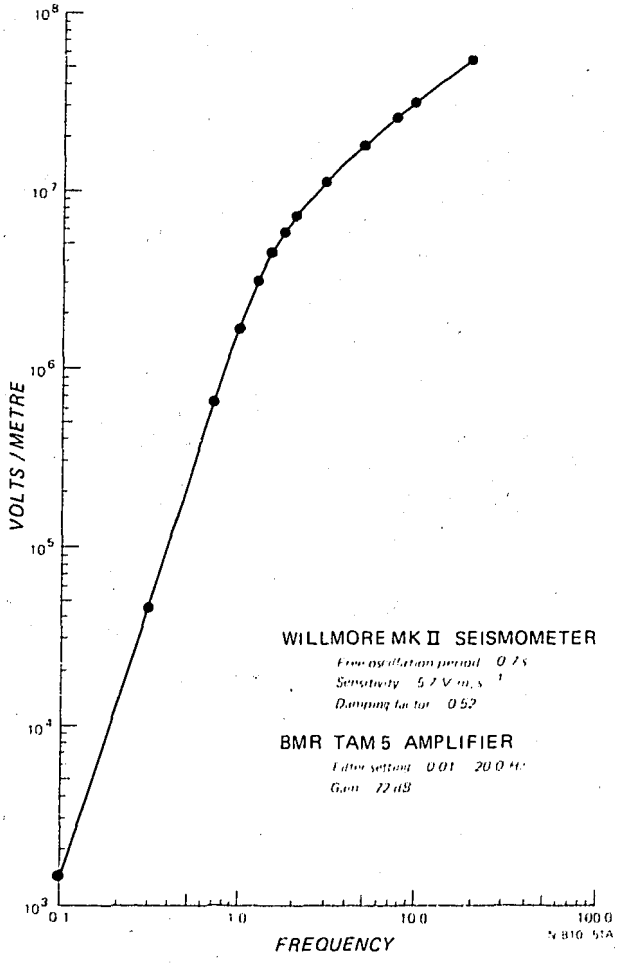
During 1978 temperatures were measured in boreholes drilled for mineral exploration near Boulia, Georgetown, and Herberton, Qld. Thermal conductivities were determined for core samples from each location. Heat flow is estimated to be 82.1, 72.4, and 120.2 mW m^{-2} respectively. The results for Boulia and Georgetown are consistent with regional trends (Fig. OR-20) but the very high value for Herberton appears to be a local anomaly, possibly caused by recent volcanism in the Atherton area.

Temperature gradients were also measured in five boreholes at the Jabiluka uranium prospect 200 km east of Darwin. Detailed geothermal studies were requested by Pancontinental to assist planning of underground mining. Temperature gradients reflect changes in thermal conductivity but are generally near 25 ^{o}C/km. The extrapolated surface temperatures are near 31 ^{o}C compared to mean annual air temperatures near 29 ^{o}C. Thermal condductivities were determined for 33 core samples from 3 boreholes, allowing detailed estimates of heat flow. Values range from, 71.6 to 84.9 mW m^{-2} with vertical and lateral variations consistent with uranium concentrations. The results of the survey have been documented as a professional opinion and a copy has been sent to Pancontinental.

A similar detailed heat flow survey was conducted near Lake Torrens. Two boreholes were logged to depths of 700 m and core was extracted for measurements of thermal conductivity. These measurements are not yet complete but preliminary estimates of heat flow are consistent with regional trends.

Temperatures have also been measured in boreholes near Canberra, Mount Gambier, Batchelor, and Jugiong. Data from the first two confirm previous results but the Batchelor data appear to conflict with high values previously reported for Rum Jungle. However, these results are not complete; further analysis is required including topographic modelling for Jugiong.

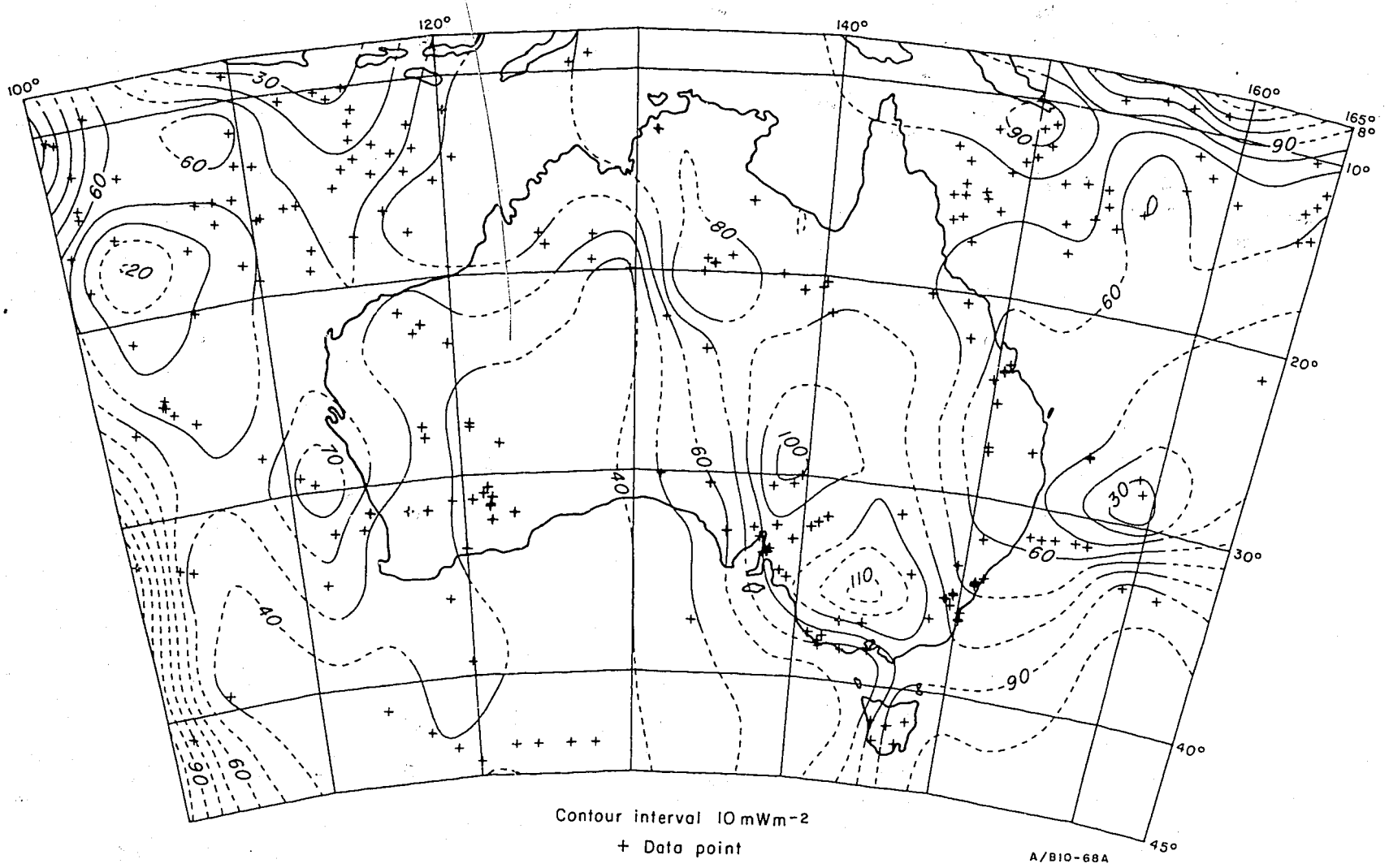
OR-19



Displacement magnification of BMR seismic tape recording systems, with respect to frequency

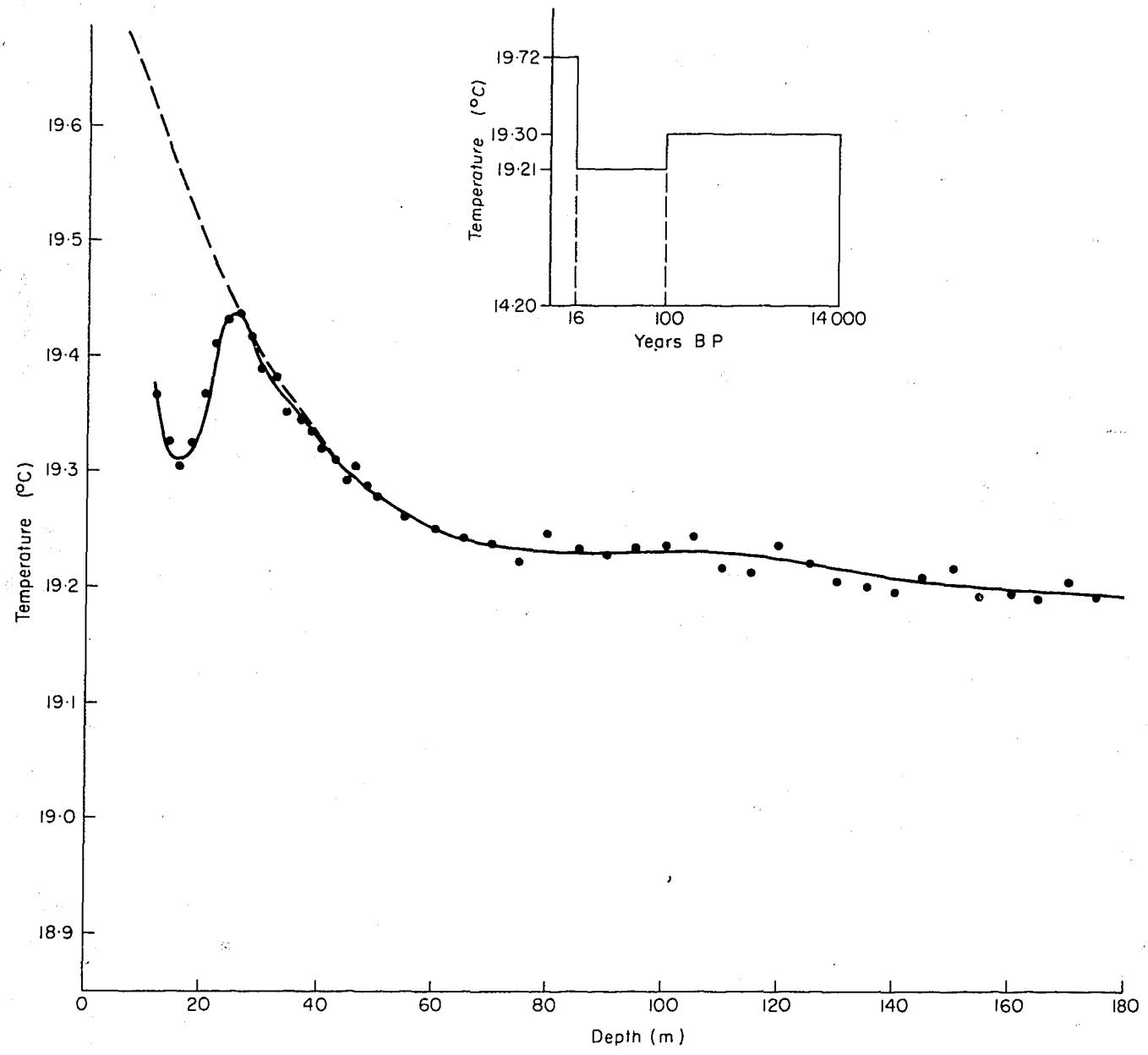
Record No. 1979/73

Record No. 1979/73



Heat flow contours, 3°grid

A/BIO-68A



Record No. 1979/73

Geothermal studies at Berrigan

155/B10-9A

Thermal modelling (J.P. Cull)

Geothermal gradients have been measured in the Berrigan (NSW) granite to depths of 200 m (Fig. OR-21). These data are non-linear even though thermal conductivities are highly uniform. Climatic perturbations are indicated by such curvature. The observed temperatures are broadly consistent with surface temperatures increasing by $5^{o}C$ at 15 000 years B.P. (corresponding to glacier retreat in the Snowy Mountains). However, other curvature is evident in the Berrigan data suggesting a decrease in surface temperature by $0.1^{o}C$ at 100 years B.P. A cultural perturbation caused by quarry operations at 16 years B.P. is also evident in the data providing internal constraints on climatic modelling. Data at depths less than 30 m reflect seasonal periodicity in solar heating. The wavelength of the propagated perturbation indicates a thermal diffusivity of 0.86 $\mu m^{2} s^{-1}$.

Geothermal energy (J.P. Cull)

Low enthalpy geothermal resources have been identified in the Otway Basin (Vic). Water at temperatures of $52^{o}C$ can be obtained at depths of 1400 m with bore flow rates of 70 l/s. Regional heat flow exceeds 80 mW m^{-2} at Mount Gambier may indicate high enthalpy prospects. A paper detailing the results of recent surveys in the region has been prepared for the journal Search.

Papers submitted to the geothermal energy symposium of IUGG were collated and edited prior to the publication of abstracts.

Thermal parameters (J.P. Cull, H. Hughes)

Thermal conductivities were measured on about 200 core samples taken from boreholes previously logged for temperature. Cylindrical plugs were cut and their end faces were lapped to reduce thermal resistance at the contact points of a standard divided bar apparatus. Values have been compared with results from ANU, and the data are in close agreement.

Heat capacity measurements were attempted using full core samples. However, the results are erratic because of excessive heat losses during the period of equilibrium. A modified Angstrom method is therefore adopted for determinations of thermal diffusivity. Heat capacity data can subsequently be calculated using independent measurements of thermal conductivity and density.

Magneto-tellurics (D. Kerr, A. Spence, R.F. Moore)

Processing of data from the 1978 McArthur Basin survey was substantially completed using 2-dimensional inversion analysis. A major feature corresponding with the Emu Fault has been detected but because of limited computer space there are still insufficient blocks to fully define the model. As a result, large RMS errors are generated near this feature. East of the fault the thickness of the McArthur-Tawallah Group is about 4000-5000 m with considerable lateral variation in the conductivity of the sediments. West of the fault a relatively high conductivity zone commences at a depth of about 4500 m and this is tentatively correlated with the Tawallah Group indicating a vertical displacement of 3000-4000 m. The high resistivity section from 2000-4500 m is correlated with the McArthur Group. A total of 10 iterations was required to define block boundaries adequately.

Further field work was undertaken in the McArthur Basin in the second half of 1979. All sites occupied were west of the Emu Fault. The principal area investigated was the Batten Trough. Equipment problems early in the survey delayed progress for several weeks. The data for this survey will be integrated with those from the 1978 survey and the combined results will be interpreted during 1979.

A paper detailing the results of an MT survey in the Officer Basin was completed for presentation by Professor K. Vozoff at the 48th Annual Meeting of the SEG and at the 1st Biennial Conference of the ASEG. Professor Vozoff spoke as joint author with officers of the SA Mines Department and BMR. The data confirm that the sediments are overthrust but the throw appears to be about 15 km rather than 50 km as inferred from gravity and magnetic data. Additional conductive material may exist within the highly resistive overthrust at a depth

of several kilometres (i.e. it is not a simple overthrust). The depth to basement south of the contact is probably nearer 3 km than the 4-6 km interpreted from gravity, magnetic, and seismic information. The 3 km horizon may well be the Proterozoic (Adelaidean)/Palaeozoic boundary, and reflections from below 3 km are probably from within the Adelaidean (700 ohm-metres), i.e. MT may have resolved the high-resistivity contrast between Adelaidean and younger sediments.

Six different methods for determining impedance have been tested with BMR's MT system using typical data; it has been found in practice that the technique described by Vozoff is by far the best. A number of other MT programs have been written in an attempt to improve the signal-to-noise ratio of the MT data.

REGIONAL GRAVITY GROUP

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

Contract recomputation of data (A.S. Murray, P. Wellman)

Progress on the recomputation was slow owing to the lack of experienced staff working on the project. Less than 20 surveys have been finished during the year although work is still progressing on most of the remaining surveys. The contract is expected to be completed early in 1980.

Gravity maps (A.S. Murray)

Corrected data were assembled for the Canberra, Sydney, Rowley Shoals, Cloates, and Hamersley Range 1:1 million map areas. Trial maps using ink pens of various sizes and scribed sheets were produced in an effort to find the most acceptable style for production and reproduction. Final gravity maps were produced for the Gosses Bluff paper in the BMR Journal; these consisted of: Bouguer anomaly maps at three different scales, a polynomial regional map, and residual anomaly maps at the three scales. Several experimental maps were produced of the Pine Creek area including two second-derivative maps using small and large grid intervals, a polynomial regional map obtained by the least-squares method, and a residual anomaly map.

Computer programs (A.S. Murray)

All obvious errors were removed from the contouring programs and several improvements were made allowing more flexibility of data input and presentation.

A program was written to find a polynomial surface which best fits the observed data by the least-squares method. The polynomial may be of degree 0 to 9 in latitude and longitude relative to a specified origin.

Program REGRID, which manipulates gridded data, was expanded to include the application of grid operators. It is now possible to produce first and second vertical or horizontal derivatives, upward and downward continuations of the observed or derivative fields, and a wide range of filtered data. The grids can be mathematically combined to give residuals, regionals and convolutions; the grids can be contoured at any stage.

Checking of gravity data to produce 1:250 000 Bouguer anomaly maps (J. Connelly, H. McCracken, A.S. Murray)

Maps for the Canberra, Sydney, Rowley Shoals (WA), Cloates (WA), and Hamersley Range (WA) 1:1 M areas have been completed, and maps for the Melbourne, Meekatharra, Tasmania and Hamilton areas are underway. Before producing the maps the data bank for that area is thoroughly checked for errors. The main types of error removed which will have been present in all 1:250 000 maps are:

1) Anomalies defined by a single station. All single point anomalies were checked and many were found to be the result of errors.

2) Position out by whole number of minutes. A number of position errors of the order of 10' or 15' were found.

3) Whole surveys slightly out of position owing to having originally been positioned on inaccurate maps.

4) Systematic height errors of up to 40 metres in regional helicopter surveys in rugged terrain.

The new series of 1:250 000 sheets should be free of significant errors. However, for most surveys no terrain corrections have been applied, and in rugged areas terrain effects will constitute the most significant source of error remaining.

Soviet-Australian absolute gravity project (G.D. Karner, P. Wellman)

In response to an invitation from BMR to the Soviet Academy of Sciences, a team of five Soviet scientists visited Australia and Papua New Guinea during April and May 1979 to determine the absolute value of gravity at Sydney, Hobart, Alice Springs, Darwin, Perth, and Port Moresby.

Absolute gravity was measured using an apparatus developed at the Institute of Automation and Electrometry of the Siberian Branch of the Soviet Academy of Sciences in Novosibirsk. It measures the acceleration of a dropped object in a partial vacuum. The time intervals and dropped distances that are necessary to determine the acceleration are measured using a rubidium frequency-standard and a helium-neon laser interferometer respectively. At each site about 2500 drops were made in groups of 120 drops lasting 30 minutes. The raw determination of gravity for each group must be corrected for systematic effects, including air resistance, laser wavelength variations, the vertical gradient of gravity at the site, microseismic activity, and most importantly, the variation in gravity caused by the solid-earth tide.

The absolute gravity measurements made at the above sites had a precision of 0.06μm s^{-2} and an accuracy of 0.15μm s^{-2} and are considered to be the most accurate made in the Australian region. Gravity ties to earlier established stations allowed comparisons with the new absolute gravity estimates. The gravity differences at individual sites were not significant.

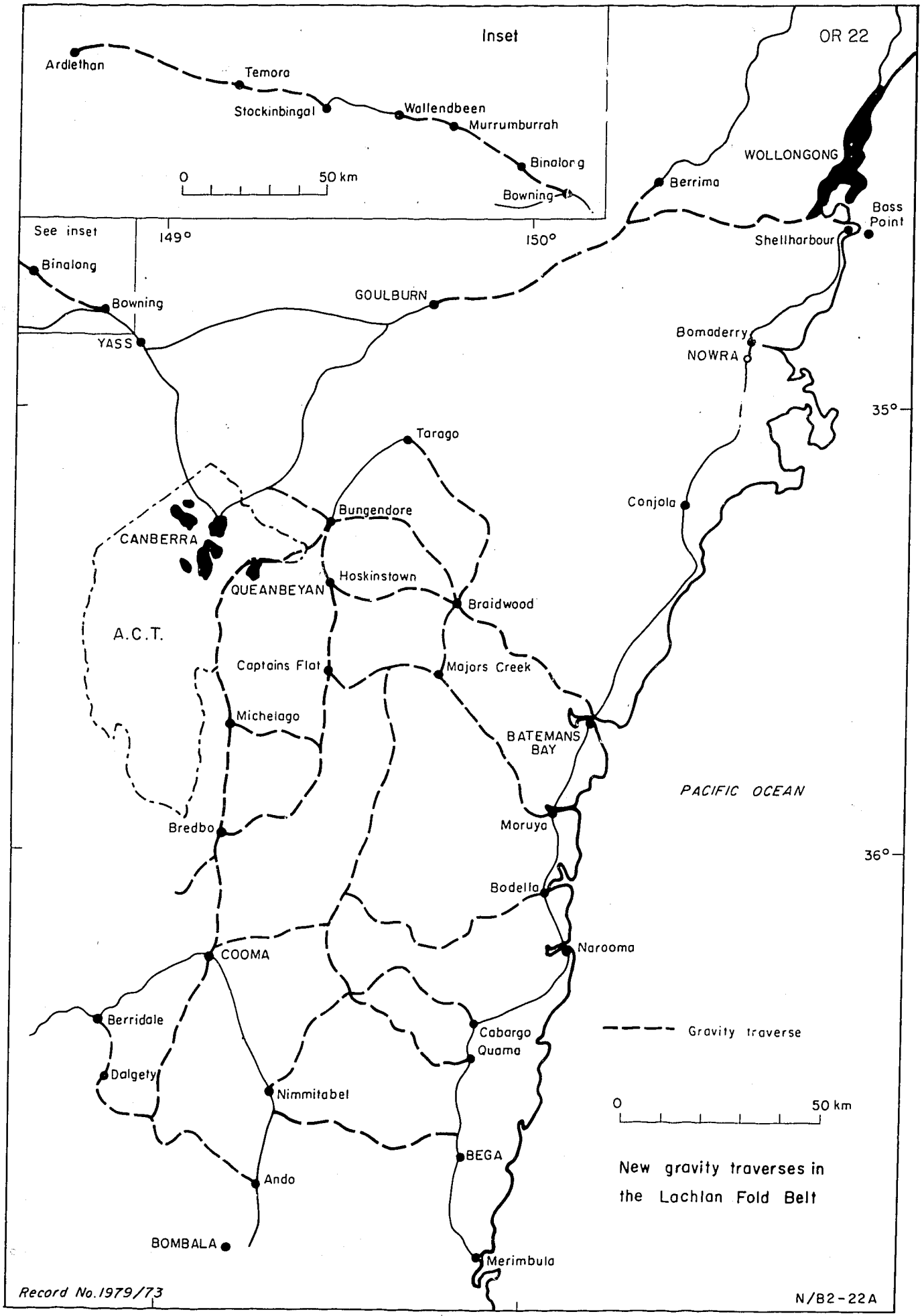
The mean difference for all the sites, however, could be interpreted as having a component of secular variation of $+0.033 \pm 0.012$μm s^{-2} per year.

Calibration of gravity meters with a quartz mechanism (P. Wellman)

Gravity meters with a quartz mechanism can be calibrated on tilt tables, on hillside calibration ranges with stations at different altitudes, or on level calibration ranges with stations at the same altitude. Twenty Worden, Sharpe, and Scintrex gravity meters were calibrated in Canberra in the period 1974 to 1977 by D.A. Coutts using a PEG-1 tilt table borrowed from the Soviet Academy of Sciences.

These BMR tilt calibrations agree to within experimental error with the calibrations by the manufacturers in North America, and calibrations using sea-level stations along the Australian Calibration line. Calibrations on hillside calibration ranges differ systematically from other calibrations, and indicate a mean altitude effect of $(2.5 \pm 0.5) \times 10^{-3}$ μm s^{-2} m^{-1}. This altitude effect is higher than the mean of $(1.5 \pm 0.3) \times 10^{-3}$ μm s^{-2} m^{-1} found by pressure chamber studies in North America and Europe.

If quartz-mechanism gravity meters are used either in base-station gravity networks, or for field stations in areas with over 500 m of relief, then a correction should be made for this altitude effect, particularly if the anomalies are used for geodetic purposes.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Berridale
Cabargo
Quama
Dalgety
Nimmitabel
BEGA
Ando
BOMBALA
Merimbula
Gravity traverse
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50 km
New gravity traverses in the Lachlan Fold Belt
Record No.1979/73
N/B2-22A

Lachlan Fold Belt regional studies (Aeromagnetics and gravity, Canberra-Bega region) (J. Connelly, J. van Son, R. Tracey)

A number of regional studies of the Lachlan Fold Belt are at present being undertaken by BMR. The aim is to provide an overall view of the tectonic history of the area, and thus a better understanding of the origin of mineralisation. The present study involves the interpretation of aeromagnetic and gravity data to determine the subsurface slope of granites in the Canberra and Bega 1:250 000 Sheet area. Aeromagnetic coverage consists of east-west flight-lines 1.6 km apart at a uniform height of 1750 m. Gravity data consist of regional observations on an 11 km grid and isolated road traverses. To improve the gravity coverage 1100 new gravity stations were read along traverses across most of the granites in the area; station spacing along these traverses was mainly 1 km (Fig. OR-22).

The granites of the Lachlan Fold Belt have been grouped on chemical criteria into I-type and S-type (Chappell & White, 1974). The I-type is thought to be of purely igneous origin, and the S-type derived from the partial melting of sedimentary rocks. Comparison of aeromagnetic and geological maps of the Canberra and Bega 1:250 000 Sheet areas indicates that most of the I-type granites have an associated magnetic anomaly. Susceptibility measurements on hard samples confirm that the I-type granites are magnetic, both susceptibility values varying from 0.001 to 0.05 SI units. S-type granites are only poorly delineated on the magnetic maps.

Interpretation of the slope of the I-type granites was made by two-dimensional modelling of magnetic and gravity data. Models with shallow outward sloping sides and a thickness of about 3 km were found to be consistent with both the magnetic and gravity data (Connelly, 1979). However, steep-sided bodies of much greater depth extent are consistent with the aeromagnetic data and also with the gravity data if the density contrast of the granites with surrounding rocks decreases with depth. Spectral analysis of the aeromagnetic data indicates that the steep-sided model is probably the correct interpretation. Work on the spectral analysis of aeromagnetic data is continuing.

An investigation of the stress regime which prevailed during the intrusion of the I-type granites was started. The direction of the principal stress can be inferred from fault directions, from the strike of dykes, and from the strike of the granitic intrusions themselves. A published computer program which calculates the magnitude and direction of stresses in any two-dimensional body under any given set of applied loads was adapted to run in the CSIRO CYBER 76. Modelling of the applied tectonic forces using the program was started.

Recent crustal movement in Papua New Guinea (D. Denham, P. Wellman)

The co-operative project with National Mapping was discussed. The preferred model of movement between lithospheric plates being on well defined faults was replaced by a model where the movement was on broad zones several hundred kilometres wide. The measurements planned for 1981 will comprise remeasurement of the St Georges Channel markers that were established in 1975 with laser geodimeters, using Doppler satellite receivers in a single network straddling Papua New Guinea and extending from the Pacific to the Australian plate across the Solomon Sea.

Requests for information (P. Wellman, J. van Son, A.S. Murray, J. Connelly)

Gravity meter requests consisted of four loans, two requests for information on malfunctions, two requests for information on purchases, and the testing of two malfunctioning gravity meters. Seven organisations requested base station data, and there have been numerous requests for tidal gravity predictions. Requests for large amounts of gravity data have been received from thirteen organisations; six of these requests entailed the preparation of new data tapes.

Earth tides

A co-operative project between BMR and the International Centre for Earth Tides in Belgium was completed in January when BMR packed up the recording gravity meter and transported it to Sydney for recalibration in Belgium. This gravity meter had made a continuous record of earth tides in Alice Springs during 1978; it had been attended to in Alice Springs by Mr Braybrook of NT Department of Transport and Works.

Antarctica

The aeromagnetic/ice-radar work planned for Enderby Land in the 1978/79 field season was postponed and is now expected to be carried out in the 1979/80 field season. Aeromagnetics and ice-radar records from 1976/77 have now been picked; analysis of the profiles awaits further work.

McArthur Basin

In association with the Seismic, Gravity and Marine Section, gravity traverses along roads were observed at 0.5 to 1 km spacing at levelled points. The observations should help interpretation of seismic refraction work in the area, and define major structural changes.

Admittance computer program (G.D. Karner)

During 1978, Karner was posted at the Lamong-Doherty Geological Observatory, New York, for a co-operative study of the type(s) of isostatic compensation operating at passive continental margins, using free-air gravity and bathymetry profile data. From this study emerged a suite of programs, the main one of which is called ADMIT, dealing with the cross-spectral analysis of gravity and bathymetry data. This suite of programs has been rewritten and generalised for the Cyber 76 computer. Features of the new package include its modular design, dynamic memory allocation (which optimises core usage), internal projection of the data about any azimuth on to a baseline which intersects the geologic feature of interest, an extraction routine which resamples the projected data symmetrically about the geologic feature being analysed, and an image routine which prepares asymmetric data for Fourier Transforming.

PALAEOMAGNETISM AND PHYSICAL PROPERTIES (M. Idnurm, J. Giddings and H. Hughes)

Physical properties

Some 400 rock samples were measured in the laboratory during 1979. The principal measurements were magnetic susceptibilities and remanences, and thermal conductivities. Most requests were received from within BMR and were concerned with the interpretation of geophysical field data. The laboratory relied heavily on assistance from the various client groups for these measurements. External requests were received from a number of mining companies and from the Geological Survey of PNG. The breakdown of measurements is as follows:

Sonic velocity	15
Point load strengths	15
Thermal conductivity	300
Magnetic susceptibility	238
Remanence	218
Electrical conductivity	79
Induced polarisation	71
Porosity	156
Specific gravity	365
Density	138

Palaeomagnetism of the Georgetown Inlier

This project is concerned with correlation by magnetic polarity of two sequences of the Newcastle Range Volcanics occurring in the main and eastern parts of the Ranges, separated by a fault zone. So far definite correlations have not proved possible by other means.

The samples for this work were collected in mid 1978 and the measurements were completed in early 1979. Despite considerable scatter in the remanence directions in some of the units, polarities can be assigned to all units and a tentative correlation scheme has been proposed.

As a side-issue the measurements have provided a new mid-Carboniferous pole position for Australia supplementing an earlier, rather poorly defined, pole. The new results confirm the rapid pole movement for the continent in the Carboniferous Period.

Palaeomagnetism in Enderby Land, Antarctica

This project is concerned with setting palaeomagnetic constraints on the Proterozoic and Early Palaeozoic reconstructions of Eastern Antarctica relative to the other Gondwana continents, and with the classification according to age (or alternatively, the definition of later heating events) of the various mafic and pegmatite dykes in Enderby Land. The sampling was carried out by P. Wellman and R.J. Tingey during the 1977 field season, and the measurements were completed in 1979. The final remanence directions, after demagnetisation, form three distinct groups, one of the groups being possibly further subdivisible on a finer scale. Two of the groups however need to be better defined, and a small program of supplementary palaeomagnetic sampling is planned for the 1979-80 Antarctic summer for that purpose.

Palaeomagnetism of weathered profiles in SE Qld

This is a co-operative project between BMR and the CSIRO Division of Soils on the dating of weathered profiles developed in the dissected tablelands of the Toowoomba-Roma region. The project is concerned with provision of age data for the geomorphic history of the region, and is at the same time part of a larger program of establishing a framework of weathering ages in Australia.

The samples were collected in mid 1977 and the measurements were completed in early 1979. Two groups of remanence directions, corresponding to two ages of weathering, were found. The first group, of approximate age 15 m.y. comes from localities in the eastern part of the region, and the second group, corresponding to approximately 30 m.y., comes mainly from the western part with an isolated, topographically high-level occurrence in the east.

The 30 m.y. age appears to represent a continent-wide mid-Tertiary weathering period, previously found in the adjacent Eromanga Basin as well as in South Australia and Western Australia. No counterparts are so far known for the 15 m.y. event, and it is possible that this event represents more localised weathering.

Palaeomagnetism in the McArthur Basin

Approximately one-third of the specimens from the 1978 collection of magnetostratigraphic samples were prepared. This includes material from the McArthur Group, Wollogorang Formation, Packsaddle Microgranite, Hobblechain Rhyolite, and Westmoreland Conglomerate. A series of pilot thermal demagnetisations was carried out on the new material. The main program of measurements has however been delayed by the late arrival of commercial demagnetisation equipment from USA.

The Packsaddle Microgranite and Hobblechain Rhyolite pilots give directions similar to those found in the Masterton and basal Mallapunyah Formations in 1978. The consistency of directions between well separated sites (the volcanics were sampled at Wollogorang Station approximately 200 km away from the Mallapunyah/Masterton sites), and for different lithologies for roughly time equivalent units, is encouraging, though not conclusive evidence that the remanence directions are primary.

Palaeomagnetism in the Pine Creek Geosyncline

Specimens have been prepared from about half the 1978 collection of samples from the Kombolgie Formation and the Depot Creek Sandstone. A series of pilot measurements has been completed on the new samples. Both units show large scatters in the remanence directions. The cause of the scatter is being investigated.

Palaeomagnetism of the Yilgarn Block

Some 200 oriented drill cores and hand samples were collected in July from the Morowa Lavas and the immediately underlying and overlying sedimentary sequences. This project aims to provide a refined Lower Carpentarian pole position for the Yilgarn Block. A large proportion of the specimens have been prepared, and thermal demagnetisation of the pilot specimens is in progress.

Equipment and systems

The palaeomagnetic data acquisition system for the Black Mountain Laboratory cryogenic magnetometer based on an HP2116 computer was completed. The system has been in operation since April and has proved very successful, reducing measurement times and leading to a considerable increase in efficiency. This project was carried out in conjunction with the ADP Section, which wrote the software, and with the Electronic Design and Development Subsection, which developed the hardware used in the link-up.

Development of data-processing software to complement the data acquisition system has also commenced. In the first instance all data processing is planned for BMR's Hewlett-Packard system. As an interim measure, several data-processing programs were written for an HP desk calculator.

Two pieces of equipment were manufactured for the laboratory in 1979: a divided-bar thermal conductivity apparatus, and a portable diamond coring drill (Irian Jaya project).

A thermal demagnetiser with rapid heating was purchased from the Schonstedt Instrument Co. in USA.

4. MULTIDISCIPLINARY PROJECTS

The Georgina Basin and McArthur Basin Multidisciplinary Projects are described and reported in The Geological Branch - Summary of Activities 1979 on pages 53-86.

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" 79.001	P.J. Hill	Capital Hill Parliament House Site - Seismic Refraction Survey
" 79.002	D.G. Bennett R. Evans	Mugga - Narrabundah pipeline
" 79.007	D.G. Bennett	Limestone Ave pipeline - Seismic refraction Survey
" 79.005	D.G. Bennett	Tests with Elsec Gradiometer for detection of unexploded shells.

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Tracks)
Water depth profiles) 55 sheets of each type
Free air gravity profiles)
Residual total magnetic intensity)

Gravity map of Melanesia 1:5 000 000.

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KARNER, G.D. Isostatic processes at passive continental margins. IUGG Assembly, Canberra, December 1979.

MAJOR, J.A. Modelling aids to TEM interpretation. AMF Workshop Course on modern EM and IP exploration techniques, Adelaide, October 1979.

MATHUR, S.P. Deep crustal and upper mantle reflection studies in N.E. Australia, 1975-78. International Union of Geodesy and Geophysics, General Assembly, Canberra, 2-15 December 1979.

PAULL, E.P. The Cadoux earthquake, W.A., 2.6.79. IUGG General Assembly Canberra, December 1979.

PAULL, E.P. Mt Helena Primary School on 'Earthquakes', November 1978.

PAULL, E.P. Roleystone Ratepayers' Association on 'Earthquakes', June 1979.

PINCHIN, J. Deep crustal seismic reflections at Boundary Plains, N.S.W. Crust and upper mantle of SE Australia Symposium, Canberra, 12-14 February 1979.

POLAK, E.J. Geothermal gradients in the Great Artesian Basin. Search for groundwater on Christmas Island. Annual Meeting of the Australian Institute of Physics, Perth, January 1979.

SILIC, J. Applications of magnetometric resistivity (MMR) and magnetic induced polarization (MIP) methods in deeply weathered terrains. SEG 29th Annual Meeting, New Orleans, November 1979.

SMITH, R.S. Implications of recently determined fault-plane solutions for Australian earthquakes. IUGG General Assembly, Canberra, December 1979.

SPIES, B.R. Interpretation and design of time-domain EM surveys in areas of conductive overburden. ASEG First Biennial Conference, Adelaide, August 1979.

SPIES, B.R. Experience with time domain EM methods in Australia. SEG 29th Annual Meeting, New Orleans, November 1979.

SYMONDS, P.A. The Lord Howe Rise. AMSTAC workshop on marine geosciences, Canberra, 22-23 February 1979.

TUCKER, D.H. The characteristics and interpretation of regional gravity, magnetic and radiometric surveys in the Pine Creek Geosyncline, Northern Territory. IUS, Sydney, June 1979.

WELLMAN, P. Antarctic aeromagnetic and palaeomagnetic work. Workshop on Antarctic Geology, Melbourne, 17-18 May 1979.

WELLMAN, P. Eastern Antarctic gravity surveys in the sector 30^{o}-80^{o}E. Workshop on Antarctic Geology, Belbourne, 17-18 May 1979.

WELLMAN, P. The timing of the late Mesozoic-Cainozoic uplift of the southeast Australia highlands. CUMSEA Symposium.

WELLMAN, P. Gravity evidence for the depth and regionality of isostatic compensation of topography. CUMSEA Symposium.

WELLMAN, P., & DOOLEY, J.C. Australian geodesy - BMR's role. Forum on The Future of Geodesy in Australia, University of NSW, 29 June.

WILKES, P.G. The characteristics and interpretation of geophysical anomalies in the Cobar area, New South Wales. Eighth BMR Symposium, Canberra, May 1979.

WILLCOX, J.B. Continental margin survey - overview. AMSTAC workshop on marine geosciences, Canberra, 22-23 February 1979.

WILLCOX, J.B. Petroleum prospectivity of the Australian marginal plateaus. BMR Symposium, Canberra, May, 1979.

WILLCOX, J.B. Structure and Petroleum potential of Lord Howe Rise, offshore Australia. European Association of Petroleum Geophysicists meeting, Hamburg, May, 1979.

WILLCOX, J.B. Marine geophysics in BMR, and structure of the Australian margin. Bedford Inst. of Oceanography, Halifax, Nova Scotia, Oct., 1979.

WYATT, B. The Georgina Basin: sixites-data; seventies-interpretation; eighties-discoveries? ASEG Biennial Conference, Adelaide, August 1979.

OVERSEAS VISITS AND CONFERENCES

DENHAM, D. Sixth Annual European Geophysical Society Meeting, Vienna, 11-14 Sept, 1979.

DENHAM, D. Governing Council of the International Seismological Centre, Vienna, 17-18 Sept (as representative of Australian Academy of Science).

DOOLEY, J.C. ANZAAS Congress, Auckland, NZ, 22-26 January.

DOOLEY, J.C. United Kingdom Geophysical Assembly, Southampton University, 2-5 April (private visit).

GIDLEY, P.G. USA. SEG 29th Annual Meeting, New Orleans, November, 1979 (private visit).

GREGSON, P.J. ANZAAS Congress, Auckland NZ (Jan, 1979).

JOHNSTON, C.R.	Bandung, Indonesia: Invited speaker at SEATAR working group meeting on the geology and tectonics of eastern Indonesia, 9-14 July, 1979.
McGREGOR, P.M.	UN Ad Hoc Group of Scientific Experts, Geneva: 7th and 8th Sessions (February, July 1979).
MUTTER, J.C.	New York: 2 year Commonwealth Scholarship for post-graduate study at Lamont-Doherty Geological Observatory of Columbia University from August, 1978.
SPIES, B.R.	SEG 29th Annual Meeting, New Orleans, USA, November, 1979. (Return to duty during private overseas visit.).
SPIES, B.R.	USSR. Study trip under Australian/USSR Science Agreement, September-October, 1979.
TUCKER, D.H.	Fiji. SOPAC/CCOP symposium on petroleum potential in island arcs, small ocean basins, submerged margins and related areas. Sept. 1979.
WHITWORTH, R.	Boulder, Colorado. NOAA Data Studies Division. Private visit to study methods and results on nuclear variation in the Earth's magnetic field. Oct. 1978 - March 1979.
WILLCOX, J.B.	Hamburg, W. Germany: 41st meeting of European Association of Exploration Geophysicists, 29 May - 1 June 1979.
WILLCOX, J.B., & CAMERON, P.J.	Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR), Hanover, F.R.G. Under FRG/Australia Science Agreement to co-operate in processing and interpretation of geophysical data from 1978 Australian cruises of R.V. SONNE.

LOCAL CONFERENCES

CAMERON, P.J.	AMSTAC workshop on marine geosciences, Canberra, 22-23 February 1979.
DOOLEY, J.C.	CUMSEA Symposium, Canberra, February.
DOOLEY, J.C.	National Committee of Geodesy and Geophysics, Canberra, 11 September. do., Sub-Committee for Geodesy, Sydney, 28 June.
DOOLEY, J.C.	Australian National Committee for Antarctic Research (ANCAR), Melbourne, 15 October.
DOOLEY, J.C., & WELLMAN, P.	The Future of Geodesy in Australia. University of New South Wales, 29 June.
HONE, I.G.	AMP/Victorian Department of Minerals and Energy seminar: Victoria - exploration potential. Melbourne, June, 1979.
JOHNSTON, C.R.	AMSTAC workshop on marine geosciences, Canberra, 22-23 February, 1979.
KARNER, G.D.	AMSTAC workshop on marine geosciences, Canberra, 22-23 February, 1979.
MATHUR, S.P.	Crust and upper mantle of SE Australia Symposium, Canberra, 12-14 February, 1979.
MOSS, F.J.	Exploration in the Eighties. First biennial Conference, Australian Society of Exploration Geophysicists, Adelaide, 6-10 August 1979.

SMITH, R.S. DOMSAT '79 'A communications satellite for Australia - who will benefit?' Canberra, Feb 79.

SMITH, R.S. Communications Satellite Workshop, Canberra, August 79.

SPIES, B.R. ASEG First Biennial Conference, Adealide, August 1979.

STAGG, H.M.J. AMSTAC workshop of marine geosciences, Canberra, 22-23 February, 1979.

STUART, D.C. IUS, Sydney, June, 1979.

SYMONDS, P.A. AMSTAC workshop on marine geosciences, Canberra, 22-23 February, 1979.

TILBURY, L.A. AMSTAC workshop on Marine Geosciences, Canberra 22-23 February, 1979.

TUCKER, D.H. CUMSEA symposium, ANU, Canberra, February, 1979.

TUCKER, D.H. IUS, Sydney, June, 1979.

TURPIE, A. AMSTAC workshop on Marine Geosciences, Canberra, 22-23 February, 1979.

WELLS, R. AIMM Annual Conference, Perth, August, 1979.

WHITWORTH, R. ANCAR workshop on Antarctic geoscience, Melbourne, 18 May 1979.

WILLCOX, J.B. AMSTAC Workshop on Marine Geosciences, Canberra, 22-23 February, 1979.

WYATT, B. CUMSEA symposium, ANU, Canberra, February, 1979.

WYATT, B. ASEG First Biennial Conference, Adelaide, August, 1979.

YOUNG, G.A. ASEG First Biennial Conference, Adelaide, August, 1979.

Official Geophysical Branch Delegates attending IUGG General assembly 2-15 Dec 1979

J. Branson
F. Brown
C. Collins
J. Connelly
J.P. Cull
D. Denham
J. Dooley
B. Drummond
I. Everingham
D. Finlayson
M. Idnurm
G. Jacobson
C. Johnston
G. Karner
S. Mathur
A. McEwin
P. McGregor
M. Muir
E. Paull
G. Small
R. Smith
P. Symonds
L. Tilbury
A. Turpie
P. Wellman
R. Whitworth

TRAINING COURSES

Internal

BAUER, J.A.,	Basic management. Departmental course.
BAUER, J.A., & HARRISON, P.L.,	Photo-interpretation, by J. Perry and C. Simpson, BMR, Canberra, Mar. 8-9, 1979.
BROWN, F.W.	Career counselling
DULSKI, R.A.	Basic Fortran
GRACE, J.K.	Interviewing techniques
JENNINGS, G.S.,	Fortran programming. Departmental course. Sept-October 1979.
MULDER, J.	Introduction to computer programming. Dept. Nat. Dev. March, 1979.
SALIB, J.F.S.	Introduction to FORTRAN programming H.P. 2100 Computing System, Oct. 1978.
SAMPATH, N.	Fortran programming. Dept. Nat. Dev.
THOMAS, G.H.Y.	Introduction to ADP May 1979 " " FORTRAN programming, May/June 1979

External

BAUER, J.A. BRANSON, J.C. BRASSIL, F.M. BROWN, F.W. CAMERON, P.J. FRASER, A.R. HARRISON, P.L. HOGAN, A.P. JOHNSTON, C.R. KARNER, G.D. SYMONDS, P.A. TILBURY, L.A.	Marine seismology, 1979, - R. Gregory and D. Maughan, Earth Resources Foundation, Canberra, 27 February - 2 March
ANFILOFF, W.	Gravity over Australia's Sedimentary Basins, by C. Dampney and B.D. Johnson, Macquarie University Workshop, Sydney.
GIDLEY, P.G.	AMF Workshop Course on modern EM and IP exploration techniques, Adelaide, October 1979.
HONE, I.G.	Schlumberger logging course, Brisbane, March 1979.
JENNINGS, G.S.	Seminar on log interpretation by Schlumberger. November 1978.
LUYENDYK, A.	A.D.P. Project Management Seminar, April 1979.
MATHUR, SP.P (lecturer)	Seismic reflection data processing and interpretation. West Australian Institute of Technology, Perth, 20-24 August 1979.

MOSS, F.J. — Depositional system and seismic stratigraphy. F. Brown, AMF, Adelaide, 22-28 July 1979.

MURRAY, A.S. — Gravity exploration over Australia's sedimentary basins. Macquarie University 21-25 May.

RICKARDSSON, L.A., & CHERRY, R.D.E. — Shotfirer's refresher course, Telecom, Sydney.