DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/195

GEOPHYSICAL BRANCH
SUMMARY OF ACTIVITIES
1973

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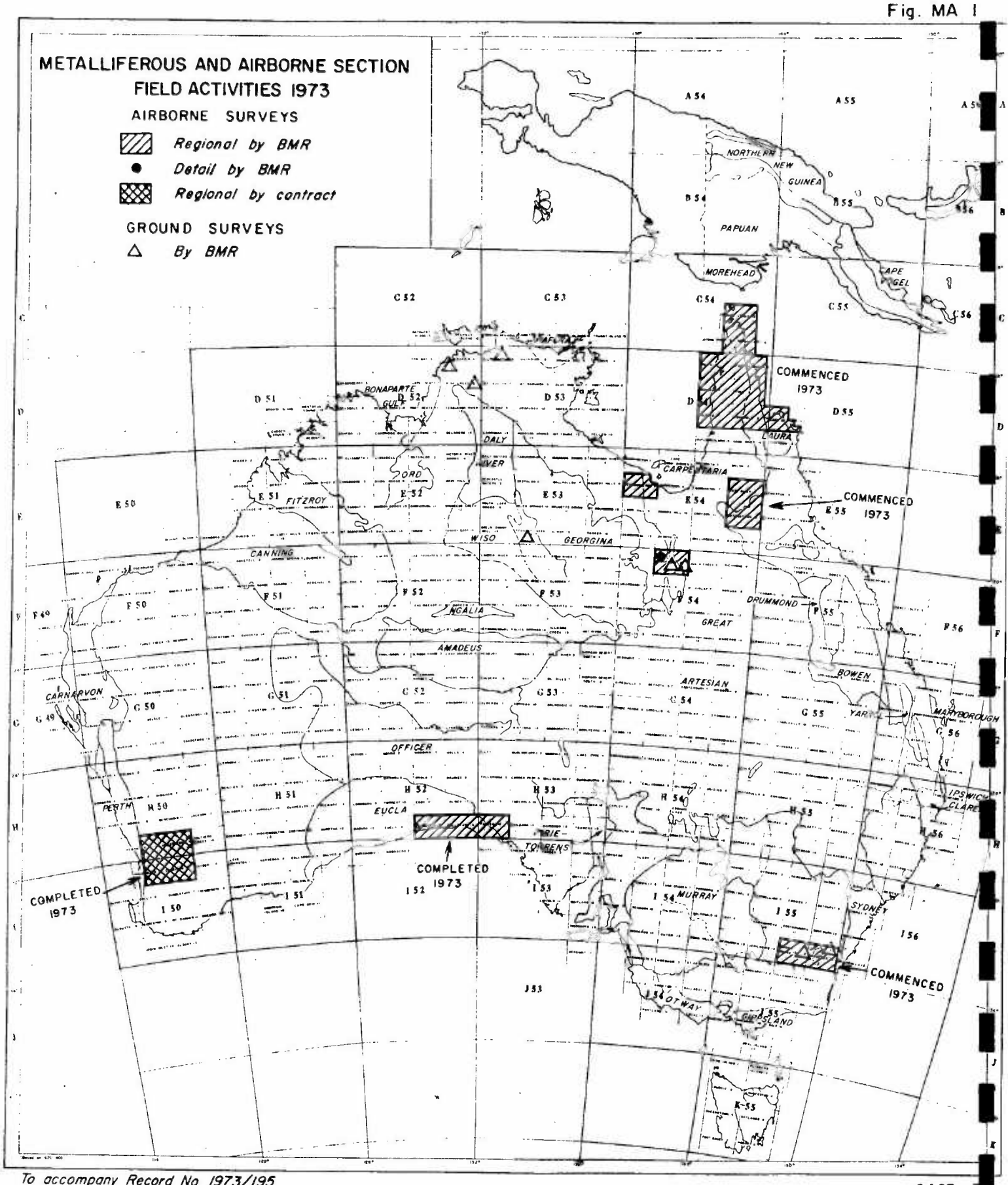
CONTENTS

Fig. MA 1



To accompany Record No. 1973/195

SUMMARY

1. Metalliferous and Airborne Section

The locations of the activities of the Section during 1973 are shown in Figure MA 1.

The Metalliferous Subsection commenced a program of investigation of down-hole geophysical techniques. Holes were made available by companies at Woodlawn and near Tumut, NSW, and radiometric and various electric methods were used, including applied potential and frequency domain IP. The applied potential results from Tumut were particularly interesting and showed the continuity or discontinuity of mineralization between drill-holes. The program will be continued in 1974 with tests of down-hole EM equipment, development of time-domain down-hole IP equipment, and further applications of the applied potential system.

A limited amount of transient EM model studies was undertaken to gain an understanding of the transient EM response of various typical bodies. Further model studies are planned for late 1973 and 1974.

Further transient EM field tests were made at Mary River and Rum Jungle, NT, and in the Mount Isa/Cloncurry area, Qld. At Mary River the method was used as the main electromagnetic exploration method, and several conductors were outlined and drilling targets selected. At the other areas the work was aimed at complementing the laboratory model tests and assisting the metalliferous surveys in the areas.

Surveys at Tennant Creek and Mary River, NT, were undertaken in co-operation with the NT Mines Branch. A gravity survey was made in the Tennant Creek area to obtain detail on a gravity high which may be due to uplifted Archaean basement. The Mary River area is in the magnetically disturbed metamorphic zone of the Lower Proterozoic Masson Formation around the Cullen Granite; an exploration survey using a variety of geophysical methods was made, and drilling targets were selected.

In the Mount Isa/Cloncurry area exploration surveys were made in four areas selected on the basis of BMR's detailed geological mapping. No significant anomalies were found. In addition work was done to evaluate techniques of mapping variations in resistivity of Precambrian rocks buried under Mesozoic sedimentary rocks.

The Darwin Uranium Group geophysical staff provided radiometric assaying and logging services as required, operated the Manton Seismic Station and made preliminary analyses of the results, made a geophysical survey in the Mary River area, and made a brief gravity survey in the Alligator River area.

In the early part of the year, the Twin Otter aircraft completed the major part of the coverage of the FOWLER, NULLARBOR and COOMPANA and part of the NUYTS 1:250 000 Sheet areas. Together with the survey of the BARTON, COOK and OOLDEA 1:250 000 Sheet areas in 1970, this work completed the commitment to South Australian Department of Mines for airborne survey coverage in the South Eucla Basin.

The next survey scheduled for the Twin Otter was in the WAGGA WAGGA and CANBERRA 1:250 000 Sheet areas. The coverage of the western portion was carried out in combination with test flying of a production-model fluxgate magnetometer. The eastern portion is expected to be covered by early 1974.

The Carpentaria Basin survey was commenced in October, the 1:250 000 Sheets of HOLROYD, EBAGOOLA and CAPE MELVILLE being selected for survey coverage in the remaining limited period of the field season.

The Aero Commander aircraft was flown to Mount Isa in May. The regional airborne survey of the CLONCURRY 1:250 000 Sheet and the detailed survey of the PROSPECTOR 1:100 000 Sheet were followed by regional survey coverage of the WESTMORELAND 1:250 000 Sheet. The survey of the GEORGETOWN and RED RIVER 1:250 000 Sheets was commenced from Cairns base in early October.

Several airborne geophysical survey contracts were handled during 1973. The contract for aeromagnetic survey of PERENJORI, NINGHAN, MOORA, BENCUBBIN, GLENBURGH, ROBINSON RANGE, PEAK HILL, NABBERU, and STANLEY 1:250 000 Sheets, WA, was completed and the data processed and released. A contract for aeromagnetic survey of KELLERBERRIN, CORRIGIN, PERTH, and PINJARRA Sheets, WA, was awarded to Geosearch Ltd, and the contract was completed in October. Tenders were called for aeromagnetic survey of the West Australian portion of the Officer Basin, covering sixteen 1:250 000 Sheets. Tenders were also called for compilation of an aeromagnetic map of Australia and for control flying (aeromagnetic traverses) for this project.

Throughout 1973, the resources of the Airborne Reductions and Contracts Group have been directed towards processing airborne geophysical data from BMR and contract surveys, specification and negotiation for aeromagnetic data acquisition and processing contracts, and preparation for the change from processing on the CDC 3600 to the CYBER 76 system. Data from 229 578 km of surveying were processed and 20 aeromagnetic maps in the 1:250 000 series from New South Wales, Victoria, South Australia, and Western Australia were produced. Substantial increase in the data input volume, staff deficiencies, and the tight CYBER 76 conversion schedule have created significant problems and caused a reduction in the feedback services provided to field personnel.

VH-BMG's new digital system has increased the primary data acquisition rate from 1 word per second on punched paper tape to 10 words per second on magnetic tape. Based on this system, the required processing through-put in words per generation per copy per 1:250 000 map sheet for 11 000 km coverage is:

magnetic	147 000 words
spectrometer	785 000 "
navigation	31 400 "

The total final storage and maintenance required, assuming minimum generations and copies, amounts to 6 million words per sheet, thus reflecting a 663% increase over the 942 000 words per sheet required under the old acquisition system.

Survey data processed during the year included:

229 578 km magnetic (68 643 km from BMR; 160 935 km from contracts and data purchase)
49 033 km spectrometer data
68 643 km Doppler navigation data.

The total envisaged archival storage requirement will be approximately 35 million words of digital information.

A total of 15 magnetic data maps scribed at 1:250 000 and 48 preliminary sheets at 1:100 000 have been completed.

The increase in data input volume from multi-channel systems has over-extended the processing capabilities under the CDC 3600 system, and as a consequence the group has had to neglect the presentation requirements of spectrometer data and has deferred the introduction of any systematic interpretative procedures. Staff movements have created labor shortages within the group during the year.

To overcome the problems and permit easier extension to processing and presentation services while taking advantage of the CYBER 76 facilities and incorporating in-house plotting and digitizing facilities, the requirements of a more flexible data management system have been reappraised. Recommended changes in design will be implemented with the change to CYBER 76 in November.

2. Seismic, Gravity and Marine Section

The main activity of the Section was again the Continental Margin Survey that started in December 1970 and finished in January 1973. In fact the survey started as a survey of New Guinea waters in September 1970 and continued through without pause into the Continental Margin Survey around Australia. Bathymetric, seismic, gravity, and magnetic data were recorded over a total of 100 575 nautical miles of traverse. Traverses were mainly at right angles to the coast and 20 to 30 miles apart. The data processing started concurrently with the field work, but in January 1973 the contractor (Compagnie Generale de Geophysique) and BMR staff still faced a mammoth task of data processing and presentation. This task occupied a large proportion of the manpower of the Section for the rest of the year, and is still far from finished. The other major activity in the Marine Group comprised reporting assignments to interpret and present the preliminary results of the survey. As noted last year, the continuous nature and magnitude of the survey was demanding of both professional and technical staff.

A circular letter giving the tentative schedule for release of data and preliminary reports from the Continental Margin Survey was issued to companies and institutes in July. Copies can be obtained on request from BMR.

Staffing for the high level of marine activity was again maintained at the expense of other seismic and gravity activities. Little field work was done by these groups and it was very much a reporting year for the depleted staff.

The geophysical surveys of the Carpentaria Basin and adjacent areas were reviewed. This was a joint project with the Geological Branch which has been mapping the geology of the area in recent years. An objective of the study was to recommend what further geophysical surveys should be done.

The results of the combined seismic and gravity survey in the Officer Basin, WA, in 1972 were interpreted and a report was written. This also was a joint study with the Geological Branch which has been mapping the area recently.

Structural models were drawn from regional gravity and geological data along a proposed seismic survey line across the margins of the Amadeus and Ngalia Basins with the Arunta Block through the Ormiston Nappe structure. These studies were made to forecast what information might be obtained from the proposed survey and to plan the best survey procedure.

Deep reflection soundings have now been made by BMR in 45 areas throughout Australia. F.J. Moss made a broad analysis of the whole of these soundings and presented his results to a special symposium on the subject at the S.E.G. Meeting in Mexico City in October.

A final report was written on the results from the three seismic surveys made by BMR in the Ngalia Basin between 1967 and 1969.

A strong effort was put into completing the interpretation and reporting of the results of the reconnaissance gravity surveys made in Western Australia between 1969 and 1972.

Drafting of the preliminary gravity map of Australia at a scale of 1:5 000 000 was completed. The map is a scaled-down version of the 1:2 534 400 map but on the same projection as the 1:5 000 000 geological maps. It includes all helicopter gravity data to date and marine gravity data to 1968, together with some data from earlier BMR surveys and some from external surveys. The map will be updated as further data becomes available. This map as dyeline prints or transparent overlays has been available for purchase through the Government Printing Service since July.

3. Observatories and Regional Section

A minor reorganization of the Observatories Subsection was approved early in the year. It involved the Toolangi, Headquarters, and Regional Magnetic Groups. As a result there are now two Groups at Headquarters, one of which is responsible for geomagnetic charting, and the Toolangi Group has been diminished by one position.

The main programs of the Subsection were related to geomagnetism and seismology, and were carried out by means of five geophysical observatories, 14 seismograph stations, and 20 accelerographs. An ionospheric program was continued at Mundaring Observatory in co-operation with the Ionospheric Prediction Service Division (IPSD); that at Port Moresby was terminated.

A highlight of the year was the installation of a digital-recording, 3-component magnetic observatory system at Kowen Forest (near Canberra). Although problems were encountered in the absolute control of the results, the system hardware worked faultlessly and variation data were satisfactory.

The regional magnetic program was exceptionally heavy: four surveys were made occupying 12 man-months in the field, and staff from other Sections had to be used.

The most important activity for the Regional Gravity Group was the joint BMR-Soviet gravity survey along the Australian Calibration Line in May and June and the subsequent adoption of a new datum and scale for Australian gravity data. Other field activities included Isogal follow-up surveys in Western Australia and South Australia, operation and maintenance of the horizontal pendulums (tilt-meters) at Cooney Observatory near Armidale, NSW, and a gravity survey in conjunction with the East Papua Crustal Survey.

Recomputation of the BMR gravity survey data in central Australia was completed and the results were added to the tape files. The contract for recomputation of gravity data was awarded to Layton Geophysical Consultants, and work commenced in August.

No new computer programs were written and only a few small modifications were made to existing programs on the CDC 3600 computer. A draft record on the gravity data computer system was completed. All programs in the system were rewritten for the Cyber 76 computer and thorough testing was done.

Construction of the unattended tape-recording seismographs for the Regional Structural Survey Group was completed. Nine of these were used for a deep crustal refraction survey in the Bowen Basin in Queensland, in which the energy sources were explosions in open-cut coal mines.

Preparations for the East Papua Crustal Survey continued, and this survey started in October. The objectives are to study the structure of the crust under the Papuan peninsula, in particular in relation to the ultramafic belt and the boundary between the Australian and Solomon Sea plates.

Analysis, interpretation, and reporting continued on surveys previously completed, and computer programs were developed to assist interpretation.

4. Geophysical Services Section

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

No major new projects were undertaken in the Electronic Subsection, mainly owing to a large carry-over of work on deep crustal seismic equipment and airborne survey magnetometers. The use of digital techniques continued to expand and a Hewlett-Packard 2100 computer intended primarily for data conversion was installed.

A magneto-telluric system, using three magnetic and two electric channels and a computer-based data acquisition system, was checked-out in a short reconnaissance survey in the Murray Basin. Data processing programs were written, and the quality of the data was proved.

Major tasks in the Mechanical Subsection were rebuilding of BMR's 3000 m well logger and a feasibility study and market survey for a marine coring drill for offshore sampling.

In the Services Subsection the Engineering Geophysical Group carried out many small surveys in support of engineering geology in the ACT, and conducted hydrological surveys near Yaraka (SW Queensland), in Papua New Guinea, and on Christmas Island. Other activities involved high-resolution seismic profiling over water, blast and vibration measurements, and well logging.

The Geophysical Drafting Office produced approximately 1090 plates or illustrations in support of geophysical survey records or reports, and 310 drawings for slides. Twelve aeromagnetic maps were printed and released, and nine await release. 47 Bouguer anomaly maps were printed and released. Approximately 84 800 dyelines were printed for use in BMR or in production of Records. The newly installed digital flat-bed plotter produced 304 maps, 276 being contour maps of aeromagnetic or marine data.

Measurements were made of the physical properties of 320 rock specimens in the Rock Measurements Group.

1. METALLIFEROUS AND AIRBORNE SECTION

METALLIFEROUS SUBSECTION

Woodlawn, NSW (J.A. Major, I.G. Hone, R.D. Ogilvy)

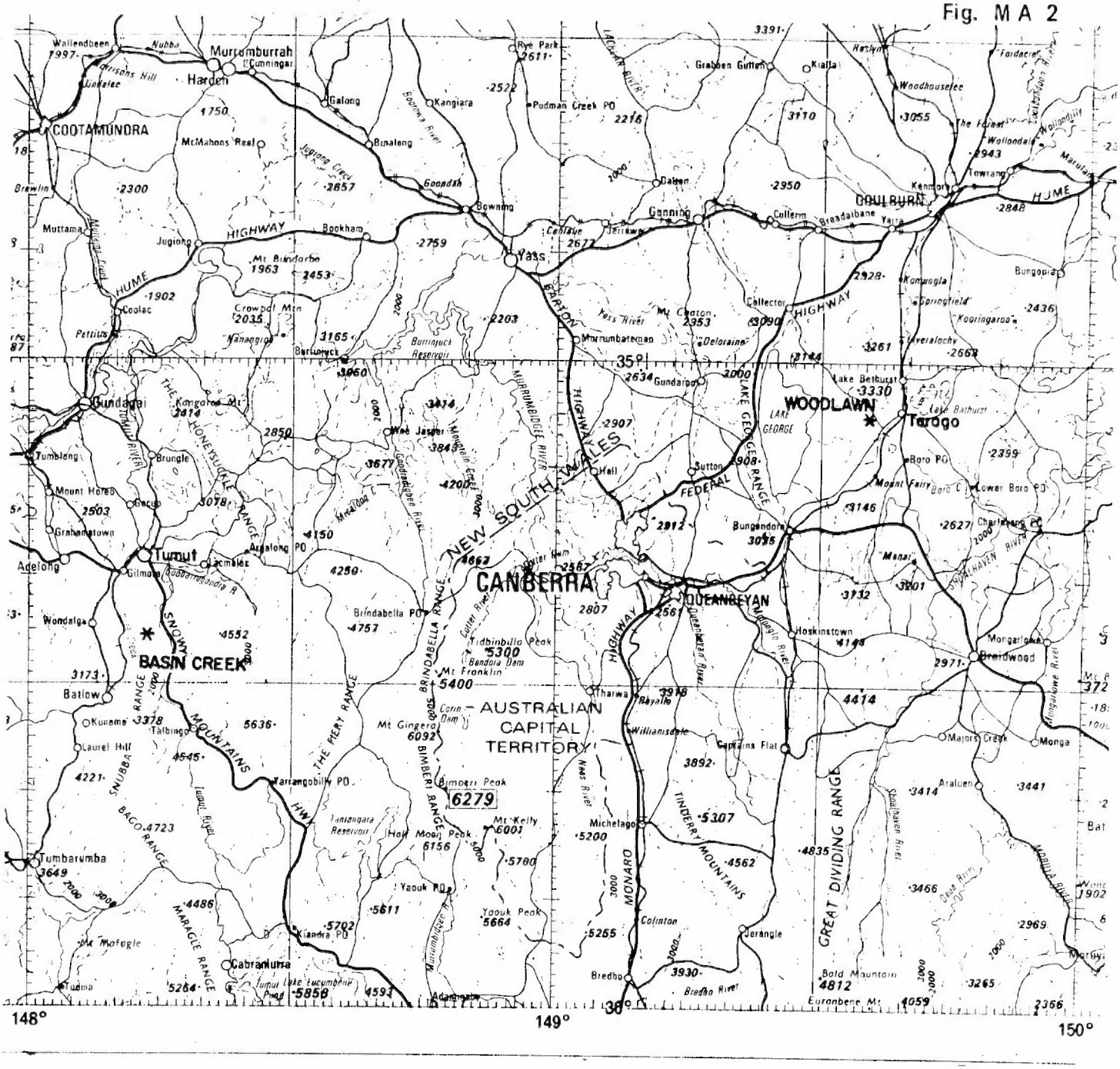
Between February and April geophysical test surveys were carried out over the Woodlawn copper-lead-zinc deposit near Tarago (Fig. MA 2) in co-operation with Jododex Australia Pty Ltd. Induced polarization, electrical, and gamma radiation measurements were made in four drill holes which either intersected or approached the deposit, in order to obtain in-situ physical property measurements of the mineralization and its host rocks. A transient EM survey was carried out over the orebody and the region to the west and south where resistivity data were available. The work was primarily of an experimental nature aimed at testing equipment and yielding data to complement other geophysical information.

The drill hole measurements had limited success. The data acquired with conventional electrical and gamma radiation tools yielded good correlation with known geology. In-hole induced polarization measurements involving frequency-domain equipment with dipole-dipole electrode configurations were generally unsuccessful owing to the low resistivities associated with the massive sulphide mineralization. In-hole self-potential data revealed a strong negative gradient towards massive sulphide mineralization, a phenomenon which might assist the design of drilling programs for similar targets in this area. A distinctive anomaly was recorded over the orebody by the transient EM survey. The westerly dip of this orebody is reflected by the transient EM data, and laboratory studies are in progress to model responses recorded with different equipment parameters. No additional anomalies indicative of mineralization were recorded in the area surveyed, but man-made electrical noise severely restricted the application of BMR's equipment. Further work is warranted using more advanced equipment with improved signal-to-noise enhancement properties, particularly in an abnormally noisy place west of the orebody.

Tumut, NSW (R.D. Ogilvy)

A geophysical test survey was carried out at Basin Creek near Tumut (Fig. MA 2) between November 1972 and March 1973 in co-operation with A.O.G. Minerals Pty Ltd. Down-hole induced polarization, electrical, and gamma radiation logging techniques were first employed to establish in-situ physical properties of rock units and mineralization intersected by selected drill holes. It was also hoped that these measurements might indicate mineralization narrowly missed by such drill holes. Subsequently a three-dimensional

Fig. MA 2



TUMUT AND WOODLAWN GEOPHYSICAL SURVEY AREAS

NSW, 1973

LOCALITY MAP

KILOMETRES

20 10 0 20 40 60

To accompany Record No. 1973/195

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applied potential survey was carried out by obtaining surface and down-hole measurements. The purpose of this work was to outline possible extensions to known mineralization and thereby assist further exploratory drilling.

Only limited success was obtained with the drill hole logging operations, IP measurements in particular failing to yield reliable results. Resistivity measurements were successful in indicating conductive mineralized zones. The applied potential measurements were found to be effective in establishing the continuity or discontinuity of mineralization between drill holes. Extensions to such known mineralization were interpreted, and drill hole tests were recommended to check these findings.

Transient EM model studies (B.R. Spies)

This project commenced with the construction of simple modelling facilities. The objective of the studies was to gain an understanding of transient EM response produced by bodies of different shape, size, and conductivity, thereby assisting the interpretation of field data. In early work, models were studied which simulated geological conditions encountered by metalliferous survey parties at Rum Jungle, Mary River, and Woodlawn in 1972 and early 1973. Results from this assisted the interpretation of survey data and contributed towards the design of further field trials at Rum Jungle and Mary River in 1973. Improved transmitter loop geometries also resulted from these studies.

Transient EM tests, NT and Qld (I.G. Hone, B.R. Spies, J.W. Williams)

Further field tests of the MPPO-1 transient EM equipment were carried out in the Northern Territory and Queensland from June to October. Work was designed to assist the current metalliferous surveys and complement laboratory model studies.

Rum Jungle area, NT. Work was carried out in the Mount Minza, Woodcutters L5, Gould and Crater Lake areas.

At Mount Minza a more detailed survey was made over the anomaly recorded in 1972 from conducting shale. Various loop sizes were used to obtain depth control on the anomaly source.

At Woodcutters L5, coverage was extended south of the area covered in 1972. Continuity of the main anomaly recorded in 1972 was established.

Data were acquired at the Gould and Crater Lake areas to enable comparative studies to be made with 1973 drilling information and earlier Slingram results. Initial inspection of the data obtained confirms the Slingram results.

Mary River area, NT. Work was done in the Minglo 2, Gubberah and Mary River West areas.

At Minglo 2, detailed work was done over an intense anomaly recorded in 1972 and a drill hole site was selected to test the anomaly; drilling commenced in October.

Further detailed work was done at the Gubberah Gossan using 50-m loops. A resistive zone associated with quartz-sphalerite mineralization in conductive shale was clearly delineated and established an anomaly pattern to be sought in neighbouring localities. Survey coverage was extended to the north and south with 60-m loops, and an anomalous feature similar to that at the Gubberah Gossan was found at Gubberah South.

At Mary River West an area of 7½ km^2 was covered by reconnaissance and semi-detailed surveys. The results show a number of anomalies indicative of conductive rock. Distinctive anomalies were defined for follow-up work.

Cloncurry/Mount Isa area, Qld. Work was done at Mount Frosty, BMR No. 5, BMR No. 5 Extended, Dobbyn, Pymurra, and Arrolla (Fig. MA 3).

In the Mount Frosty and BMR No. 5 Extended areas signal levels were small and interference from power lines was a problem. Noise level was reduced by using dual loops. Small anomalies were obtained which correlated with known IP and EM anomalies. In the BMR No. 5 area, negative transient EM readings were obtained south of the drill hole, and positive readings with fast decays to the north. The area is underlain by graphitic shale, and IP effects are considered to be the cause of the negative readings and the anomalously fast decays. An IP survey was made on a north-south line near the drill hole; the results show the presence of IP anomalies.

Several traverses were surveyed in the Dobbyn area over holes drilled in 1966. Different loop sizes and single and dual loops were used. The results conform with model test results over steeply dipping conductors.

In the Pymurra and Arrolla areas, east of Cloncurry, transient EM profiling using 50-m loops and depth sounding tests using varying loop sizes were carried out in October.

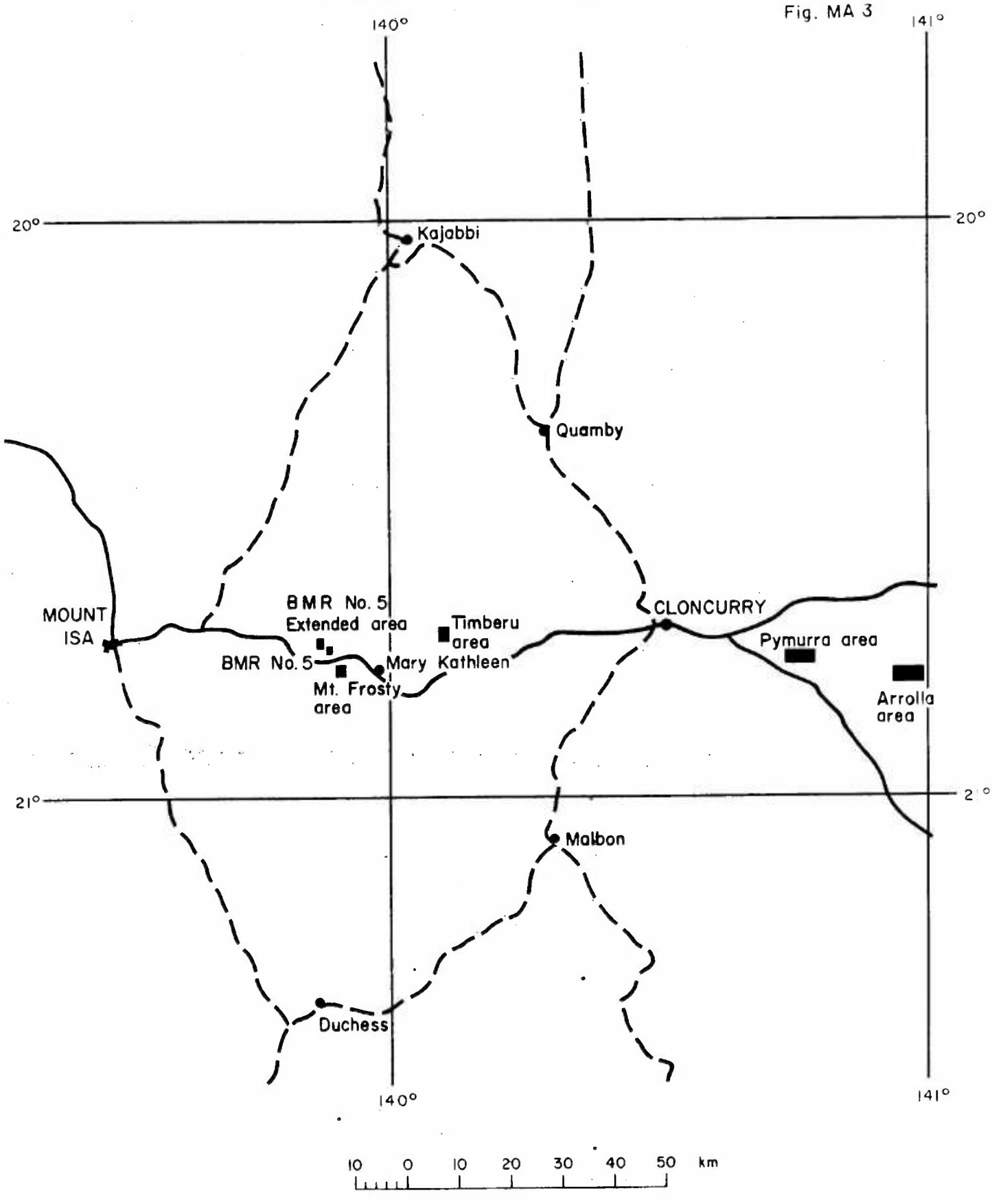
Mary River, NT (J.A. Major, E.B. Wronski)

Geophysical surveys were made in Government Mining Reserve No. 275 in the Mary River area, NT (Fig. MA 4), to locate drilling targets and for stratigraphic and structural information.

Detailed work was done in areas of interest found during the 1972 survey. A transient EM survey at Mingle 2 defined accurately a drilling target located in 1972. As a gravity traverse over the anomaly did not reveal a positive mass distribution, the drilling target is not massive sulphides but either carbonaceous shale or disseminated sulphides. Transient EM and potential-drop ratio surveys at and north of the Gubberah Gossan showed that the gossan is a resistive feature cutting across a conductive sequence of probable carbonaceous shale and siltstone. A gravity survey was made on several traverses at the Gubberah Gossan, but the results were inconclusive because it was not possible to make accurate terrain corrections in such a rugged area. Transient EM, potential-drop ratio, gravity, and magnetic readings were made at a gossanous outcrop on the 1970 geochemical grid south of the Gubberah Gossan. Results indicate that this outcrop may be part of a fissure filling between two different rock types: a conductive zone northeast of the outcrop and a resistive zone southwest.

Reconnaissance magnetic and transient EM surveys were made in the Mary River West area. The results showed four zones: a zone of low magnetic relief and low conductivity, identified as the Cullen Granite; a zone of high magnetic relief and low conductivity, identified as the metamorphic

Fig. MA 3



GEOPHYSICAL SURVEYS MOUNT ISA— CLONCURRY AREA 1973 LOCALITY MAP

To accompany Record No. 1973/195

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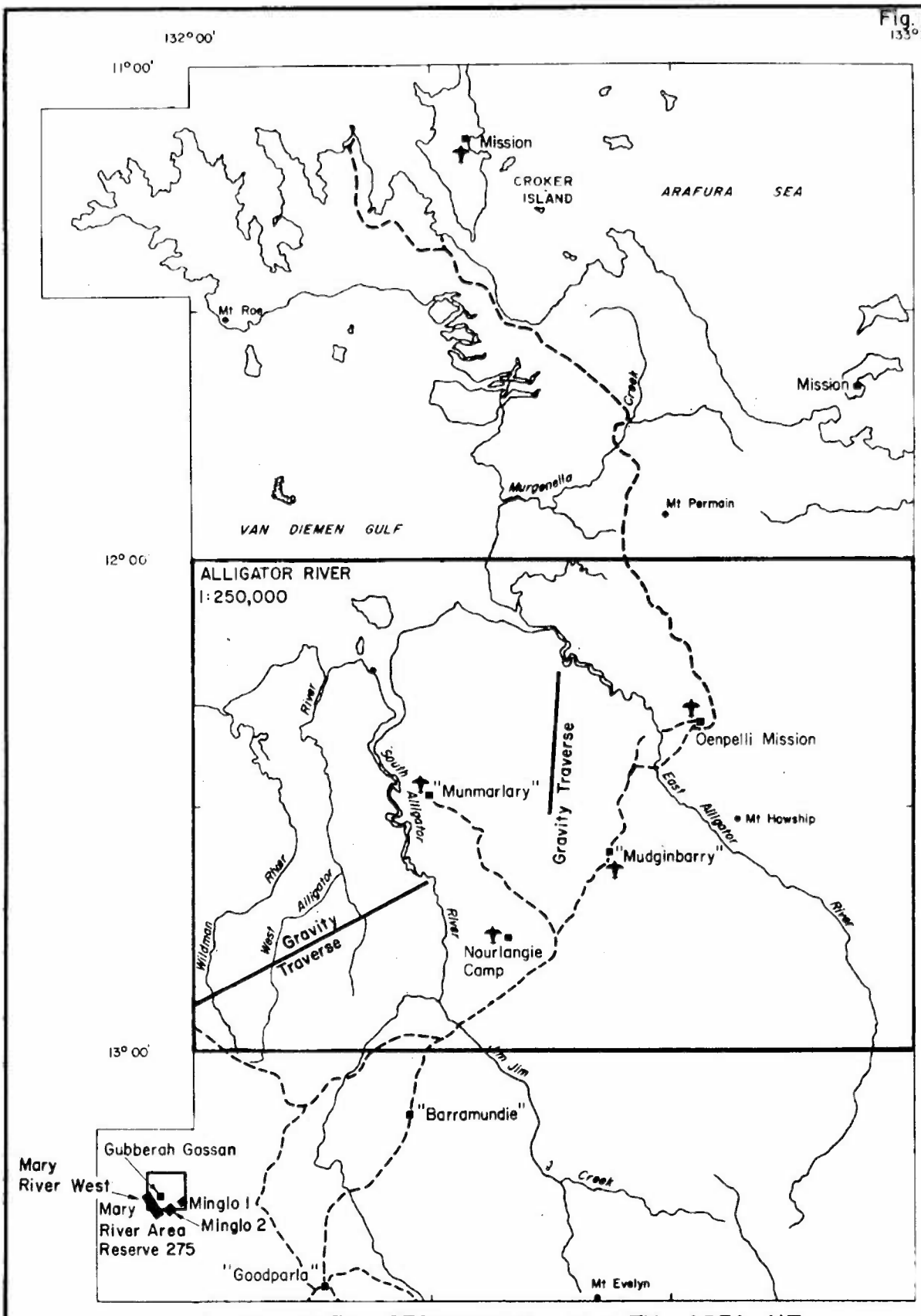
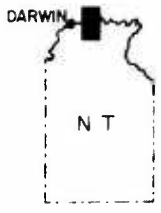
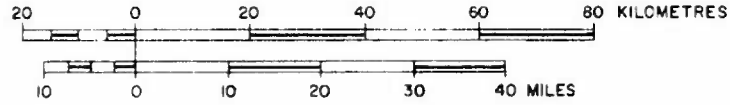
Fig. MA 4



MARY RIVER GEOPHYSICAL SURVEY AREA NT AND ALLIGATOR RIVER GRAVITY SURVEY AREA NT 1973

LOCALITY MAP





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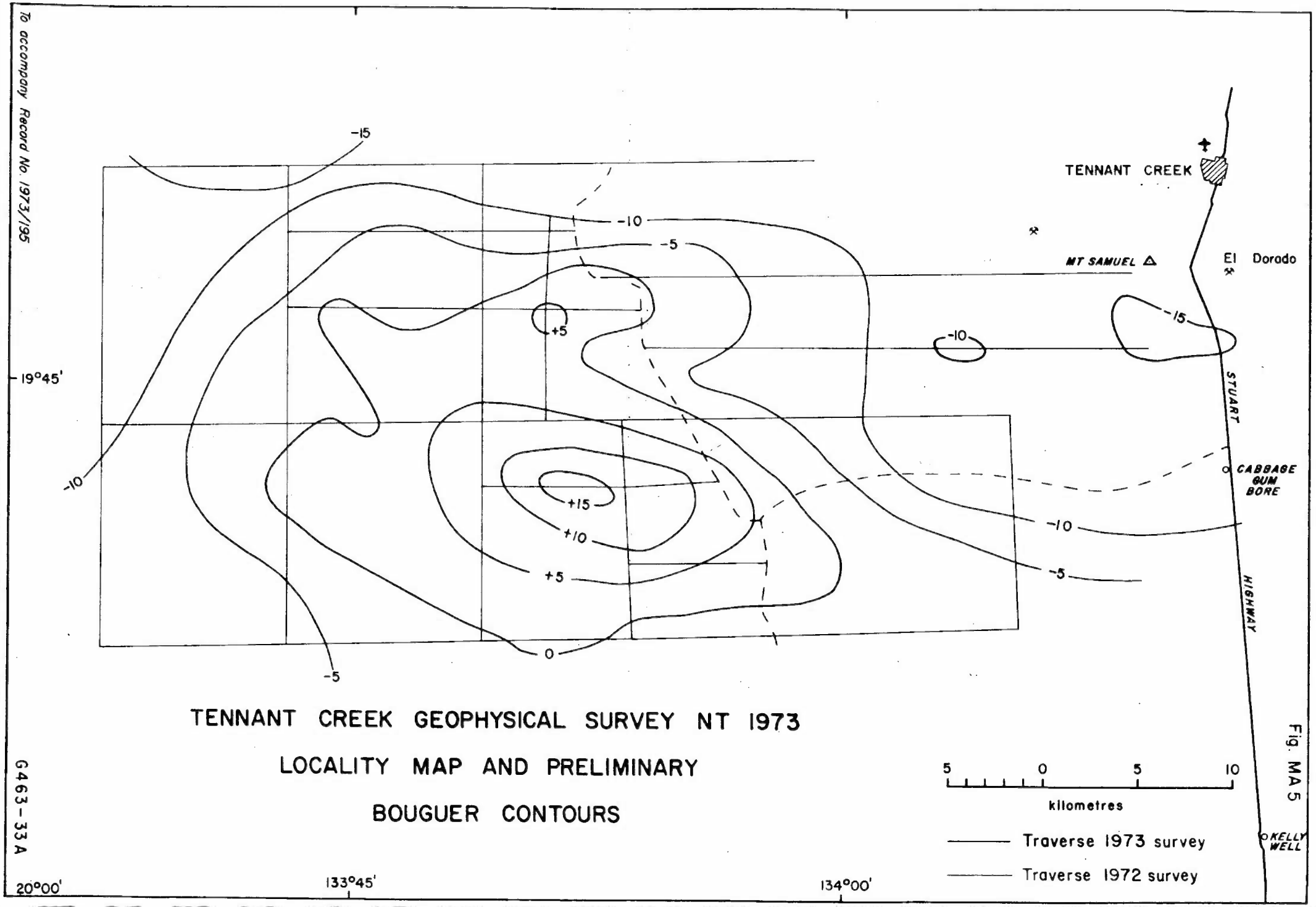
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-15
-10
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-15
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+5
-5
0
-5
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-5
TENNANT CREEK
MT SAMUEL
El Dorado
STUART
HIGHWAY
CABBAGE GUM BORE
KELLY WELL
19°45'
20°00'
133°45'
134°00'
5 0 5 10
kilometres
Traverse 1973 survey
Traverse 1972 survey
TENNANT CREEK GEOPHYSICAL SURVEY NT 1973
LOCALITY MAP AND PRELIMINARY
BOUGUER CONTOURS
Fig. MA 5
G463-33A

aureole adjacent to the granite; a zone of moderate magnetic relief and high conductivity, possibly carbonaceous shale in a moderately metamorphosed zone; and a zone of moderate magnetic relief but not as conductive as the previous zone, possibly a unit containing less carbon than the previous zone. Gravity was read along two traverses to obtain information on the granite boundary.

Slingram and Turam electromagnetic methods also were used at Mary River West. The results showed many conductors, some of which have a correlation with transient EM anomalies, but many appear superficial and may be due to variations in conductivity in the Quaternary cover. In the northeast corner of the grid the electromagnetic results show evidence of a cross-cutting resistive feature within the sedimentary rocks. Preliminary potential-drop ratio results confirm this.

Self-potential results from Mary River West show four areas of interest associated with conductive zones. A radiometric survey revealed one anomaly that requires further investigation.

Follow-up work, mainly gravity, is being done to analyse anomalies. Drilling by NT Mines Branch commenced in October with one hole at the Gubberah Gossan and one at Minglo 2.

Tennant Creek, NT (P.W.B. Bullock, F.N. Michail)

From July to September a geophysical survey was made in the Tennant Creek area with the objectives of following-up in detail a gravity high which may be due to uplifted Archaean basement, and of studying the relation of Archaean rocks to the Lower Proterozoic sediments of the Warramunga Group.

The area surveyed and preliminary results are shown in Figure MA 5. The main grid was pegged and levelled by a survey party from the Department of Services and Property, and intermediate traverses were pegged and levelled by the geophysical party using compass, vehicle speedometer, and micro-barometers. Station spacing was 1 km.

In general the gravity results follow the pattern of the results from earlier reconnaissance surveys and show a broad high of about 20 milligals with smaller highs on and around it. The interpretation has not yet been completed.

A magnetic survey was made concurrently with the gravity survey; the results conform with previous aeromagnetic results.

Cloncurry/Mount Isa, Qld (N. Sampath, R.D. Ogilvy, B.R. Spies)

From June to August geophysical surveys were made in four areas (Timberu, Mount Frosty, BMR No. 5 and BMR No. 5 Extended) shown in Figure MA 3. These areas were selected from mapping results by the Geological Branch, and the objective was to search for sulphide mineralization. From August to October surveys were made in two areas east of Cloncurry (Pymurra and Arrolla) with the aim of evaluating techniques of mapping variations in resistivity in Precambrian rocks buried under Mesozoic sedimentary rocks.

Timbery, Mount Frosty, BMR No. 5, and BMR No. 5 Extended areas are in the Corella Formation. At Timbery the geophysical results indicate minor near-surface sulphide mineralization. At Mount Frosty, electromagnetic results show the presence of shear zones and induced polarization results show minor mineralization associated with these shear zones.

At BMR No. 5 carbonaceous shale gave rise to pronounced induced polarization, resistivity, and self-potential anomalies. At BMR No. 5 Extended lines of gossans occur in calcareous shale and limestone. Electromagnetic and induced polarization results show weak anomalies due to near-surface sources associated with the gossans.

The results from the Pymurra and Arrolla areas indicate that in these areas the equatorial dipole array is an effective method for routine vertical electrical soundings and the Schlumberger array for routine profiling. Tests were made using various arrays for various depths to Precambrian rocks.

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

Routine maintenance and testing of field and laboratory equipment were carried out. Investigations were made of quantitative gamma-ray spectral analysis methods for uranium and thorium. Samples from water bores at Tennant Creek and Alice Springs were analysed with the gamma-ray spectrometer for the Water Resources Branch. A ground follow-up using a portable gamma-ray spectrometer was made of airborne spectrometer anomalies in the Rum Jungle area. Density determinations were made on rock samples from the Alligator River area and the Gubberah Gossan in the Mary River area to assist in gravity interpretation.

Radiometric and electric logs were made of drill holes in the Alligator River area, and assistance was given in logging holes in the Rum Jungle and Cobourg Peninsula areas.

Personnel from the Darwin Uranium Group participated in the Mary River area metalliferous survey from June to October. Two gravity traverses were read in the ALLIGATOR RIVER 1:250 000 Sheet area in October to determine if rock units could be recognized from gravity results. The position of these two traverses is shown in Figure MA 4.

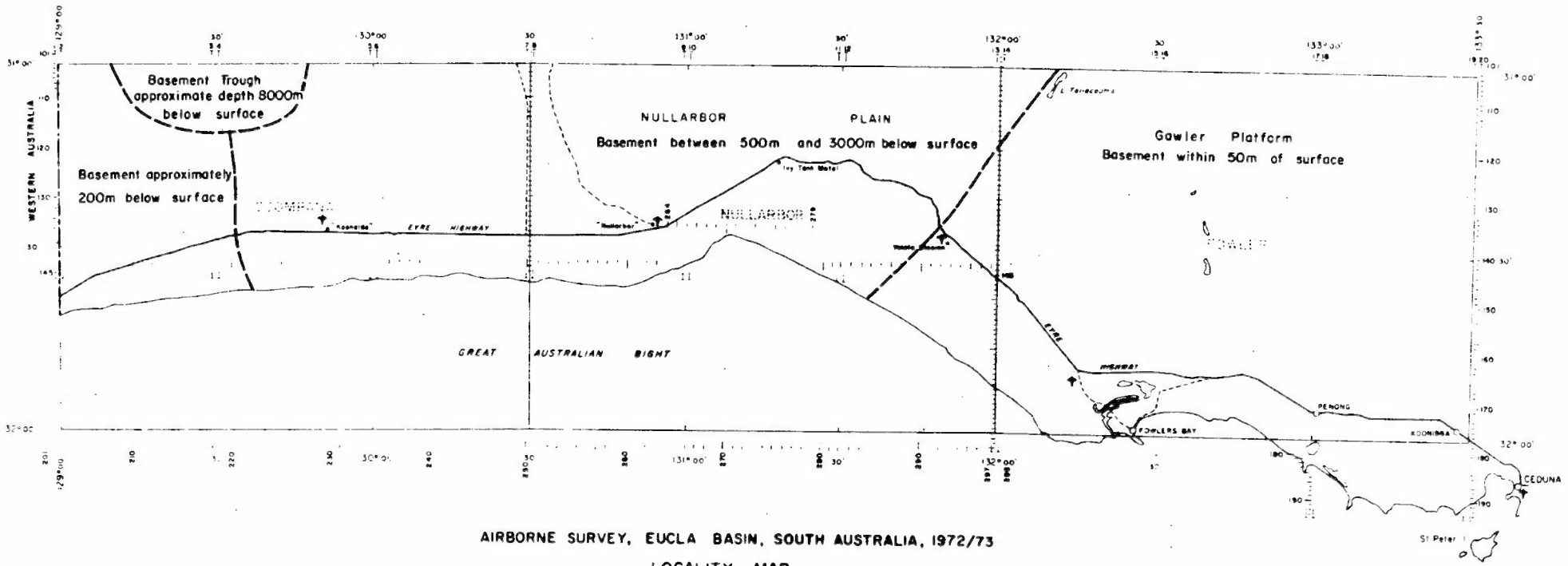
The Manton Seismic Station was kept in operation. Some time was spent in repairing the Helicorders and tracing sources of interference. Analyses of seismograms were sent to Canberra and first arrivals were telegraphed to HOA.

In May, P. Bullock was transferred to Head Office and J. Major appointed to Darwin.

AIRBORNE SUBSECTION

South Eucla Basin airborne magnetic and radiometric survey, 1972/73, SA (VH-EMG) (S.S. Lambourn)

The second part of the survey, covering the FOWLER, NULLARBOR, COOMPANA, and part of the NUYTS 1:250 000 Sheet areas, was flown between February and March 1973. During early March the magnetometer failed and the field party returned to Canberra. The survey was completed during August 1973. The survey was flown in two sections: the land section was covered by east-west flight-lines spaced 1.5 km apart at a height of 150 m above ground level, and the offshore section by north-south lines spaced 3.0 km apart at a height of 150 m above sea level (Fig. MA 6).

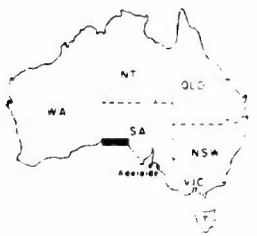


AIRBORNE SURVEY, EUCLA BASIN, SOUTH AUSTRALIA, 1972/73

LOCALITY MAP

FLIGHT-LINE AND TIE-LINE SYSTEM

LOCATION DIAGRAM



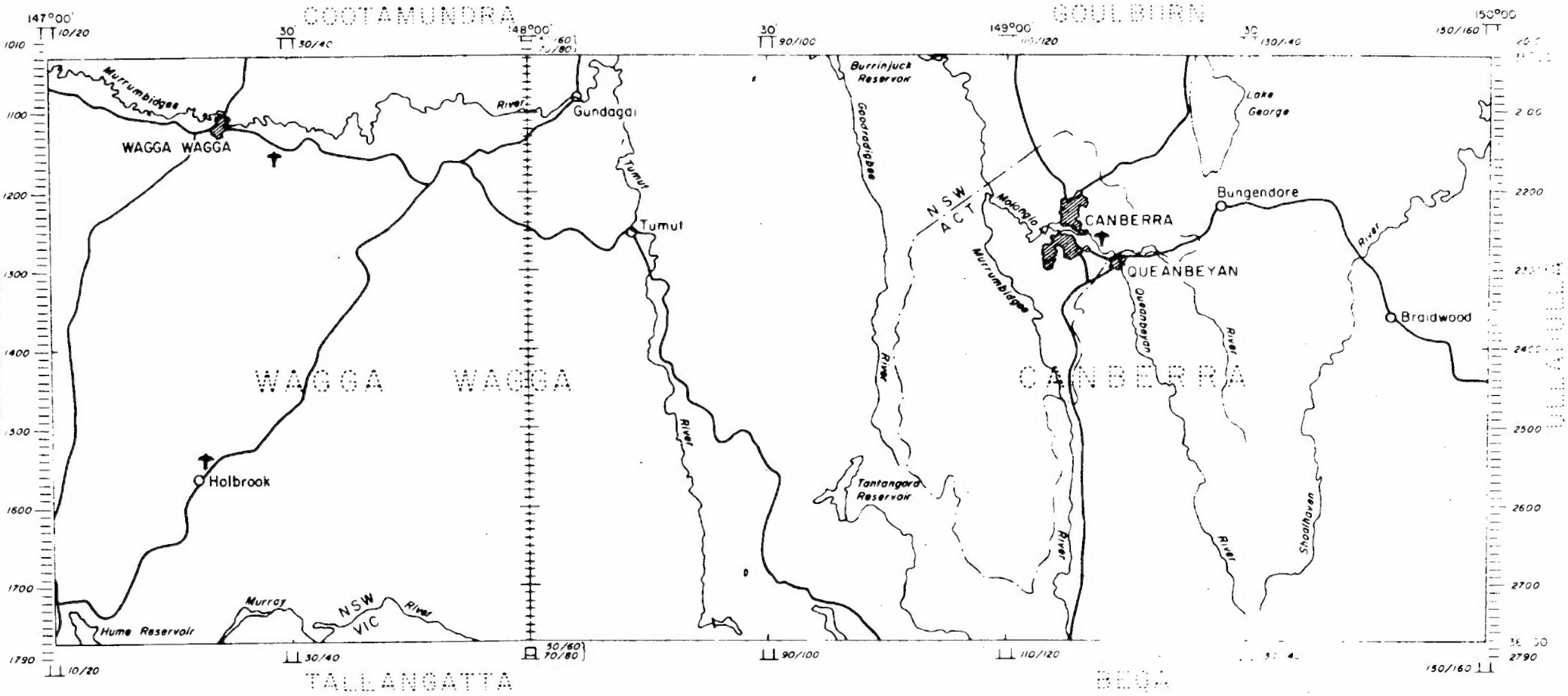
REFERERENCE TO 1:250,000 MAP SERIES

FORREST	COOK	GOLDEA	BARTON	TARCOOLA
EUCLA	COOMPANA	NULLARBOR	FOWLER	CHILDARA
KOONIBBA			NUYTS	STREAKY BAY

(Based on H52/BI-2) To accompany Record No 1973/195

G463-35A

FIGURE MA6



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

FLIGHT-LINE AND TIE-LINE SYSTEM

KILOMETRES 20 0 20 40 60 KILOMETRES

MILES 10 0 10 20 30 MILES

Highway

State boundary

To accompany Record No 1973/95

I55/BI-90AR

FIGURE MA 7

The data were collected in digital form on magnetic tape and sent to Canberra for processing. The magnetic data have been produced in stacked profile form at a scale of 1:250 000 and ultimately will be contoured at this scale. The radiometric data have been produced in stacked profile form for each channel, at a scale of 1:250 000.

A map of depth to magnetic basement is being prepared for the area, using estimates derived from the raw data by several interpretative computer programs recently developed. The magnetic data clearly show the edge of the Gawler Platform, where short-wavelength intense anomalies of amplitude about 2000 gammas give way to long-wavelength anomalies of amplitude about 300 gammas. Depth estimates show the basement to be within 50 m of the surface in the FOWLER area, where it forms the Gawler Platform, whereas in most of the NULLARBOR and COOMPANA areas depth estimates indicate a basement between 500 and 3000 m below ground level. A large negative anomaly recorded in the north of the COOMPANA area indicates a remanently magnetized 'dyke-like' source, striking north, at a depth of 8000 m. The data show a second magnetic basement horizon in this area, at an estimated depth of 3000 m, and also several intense negative anomalies delineating remanently magnetized sources at or near the surface. Data recorded in the south and west of the COOMPANA area indicate a shallower basement depth of about 200 m.

The radiometric data, recorded at 1-second intervals, were of uniformly low count rate in all channels. To amplify the more regional trends, and smooth the data, a 20-second time constant has been applied, and the data have been normalized to a height of 150 m above ground. The data show the eastern boundary of the Nullarbor Plain by a rise in count rate in all channels (a 100% increase in the geological background count rate recorded over the Gawler Platform for the Total and Potassium Channels, and a simultaneous increase but of only 50% for the Uranium and Thorium Channels), but this delineation becomes more obscure in the north of the NULLARBOR and FOWLER areas. A uranium anomaly, of amplitude 3 times geological background count rate, was recorded over Lake Tallacootra in the north of the FOWLER area, although no anomalies were recorded over the salt lakes in the centre of the area.

A reconnaissance flight to investigate further some of the more significant radiometric anomalies recorded during the 1970 Eucla Basin Survey was made in August 1973. Uranium anomalies, with count rates of between 10 and 20 times the geological background count rate, were recorded over several of the salt lakes in the BARTON Sheet area. These data are currently being processed.

Wagga Wagga-Canberra Airborne magnetic and radiometric survey, NSW (P. Wilkes)

This survey over the WAGGA WAGGA and CANBERRA 1:250 000 Sheet areas was planned to assist geological mapping and the search for minerals. The survey area, which is shown in Figure MA 7, was divided into two blocks along longitude 148°E. The western block was to be flown at 150 m above ground level with magnetometer and gamma-ray spectrometer. The eastern block was to be flown at 600 m above sea level with magnetometer only.

The survey was flown in conjunction with the flight testing of the MFS-7 magnetometer. Consequently progress was slow, and the survey was interrupted in October so that the Carpentaria Basin survey could commence. At this stage the western block had been completed and portion of the eastern block had been flown. It is expected that the flying of the eastern block will be completed early in 1974.

Carpentaria Basin airborne magnetic and radiometric survey, Qld (D. Dowmie, K. Mornfall, B. Wyatt)

The airborne survey of Cape York Peninsula and adjacent areas was planned to commence in May and continue for the rest of the year, using Twin Otter aircraft VH-BMG. The survey area shown in Figure MA 8 extends over part of the Carpentaria, Laura, and Hodgkinson Basins and basement rocks of the Peninsula ridge.

Difficulties were experienced with the production-model fluxgate magnetometer, and it was not until early October that this equipment was considered ready for operations remote from Canberra. With the prospect of a short period of weather suitable for airborne operations in Cape York, surveying of the HOLROYD, EBAGOOLA, and CAPE MELVILLE 1:250 000 Sheet areas was commenced. The survey will be continued through 1974.

Cloncurry airborne magnetic and radiometric survey Qld (VH-BMR) (D. Tucker, B. Wyatt, R. Taylor)

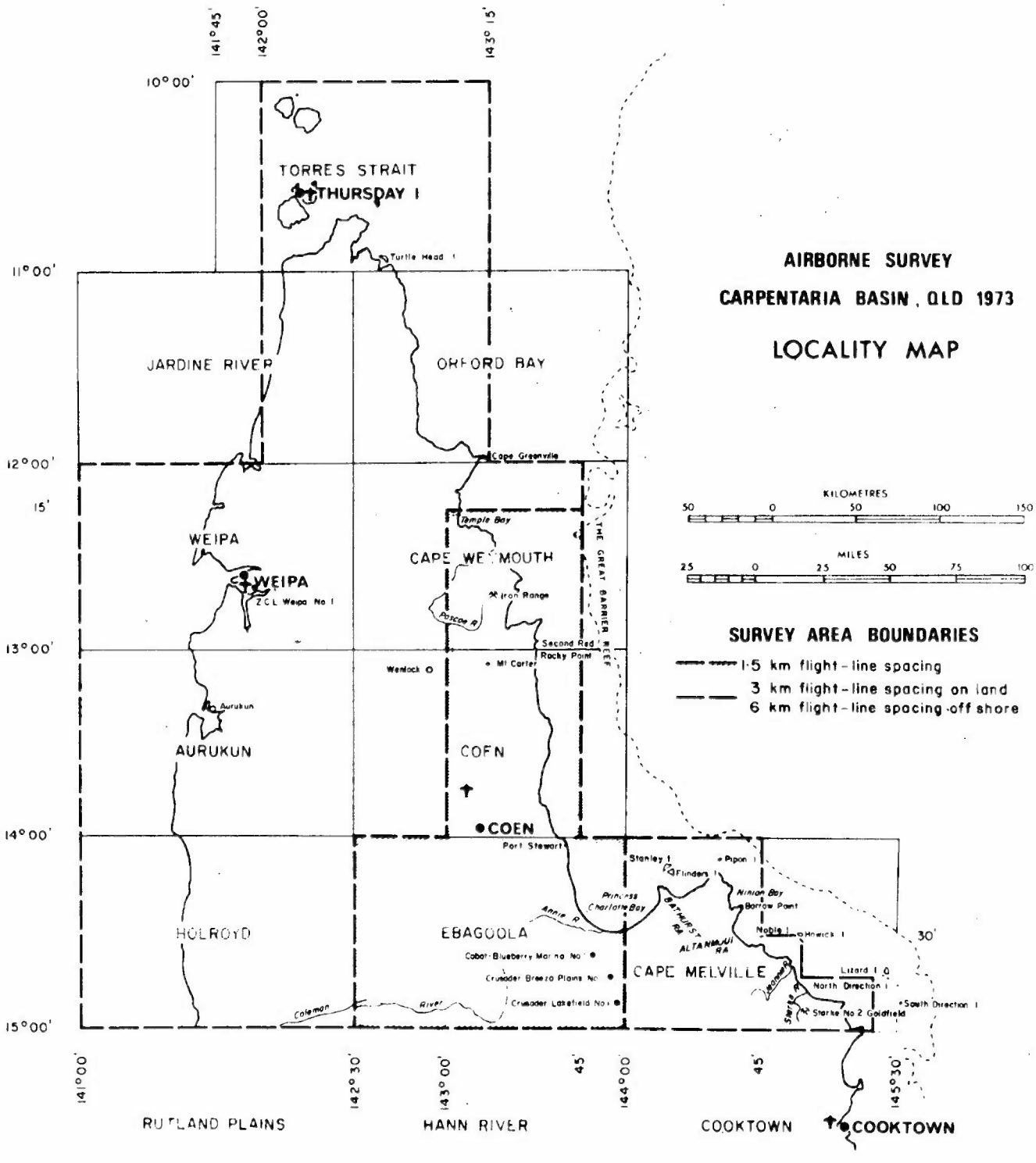
This survey covering the CLONCURRY 1:250 000 Sheet area was made in May and June 1973 (Fig. MA 9). The survey was flown on east-west lines 1500 m apart at a nominal ground clearance of 150 m. Analogue magnetic data were recorded by a 1000 gamma f.s.d. pen and a 10 000 gamma f.s.d. pen. Four channels of radiometric data were recorded (Total, Potassium, Uranium, Thorium).

In most of Cloncurry, over both Precambrian outcrop and the areas of Cainozoic cover in the east, the magnetic profiles show a pattern of essentially north-trending anomalies of amplitude 1000 to 5000 gammas due to exposed or nearly exposed sources. Trends of anomalies over the Precambrian generally correspond to the geological boundaries or mapped faults. The anomalies of highest amplitude appear to lie over the Corella Formation, either close to contacts with granites or over faults. Though the identity of the magnetic basement is not known in the area of Cainozoic in the northeast one-third of CLONCURRY, the magnetic pattern is similar to that over the exposed Corella Formation. Granites are mainly magnetically quiet, but linear anomalies cut across some of them.

In the far east of the sheet, the magnetic profiles are essentially flat. This may indicate the presence of a basement of non-magnetic rocks, for example granite, or a great thickness of non-magnetic sediments. There is a correspondence between Bouguer gravity anomaly lows and areas of flat magnetic response. Similarly there is a correspondence between Bouguer anomaly highs and areas of extremely high magnetic response.

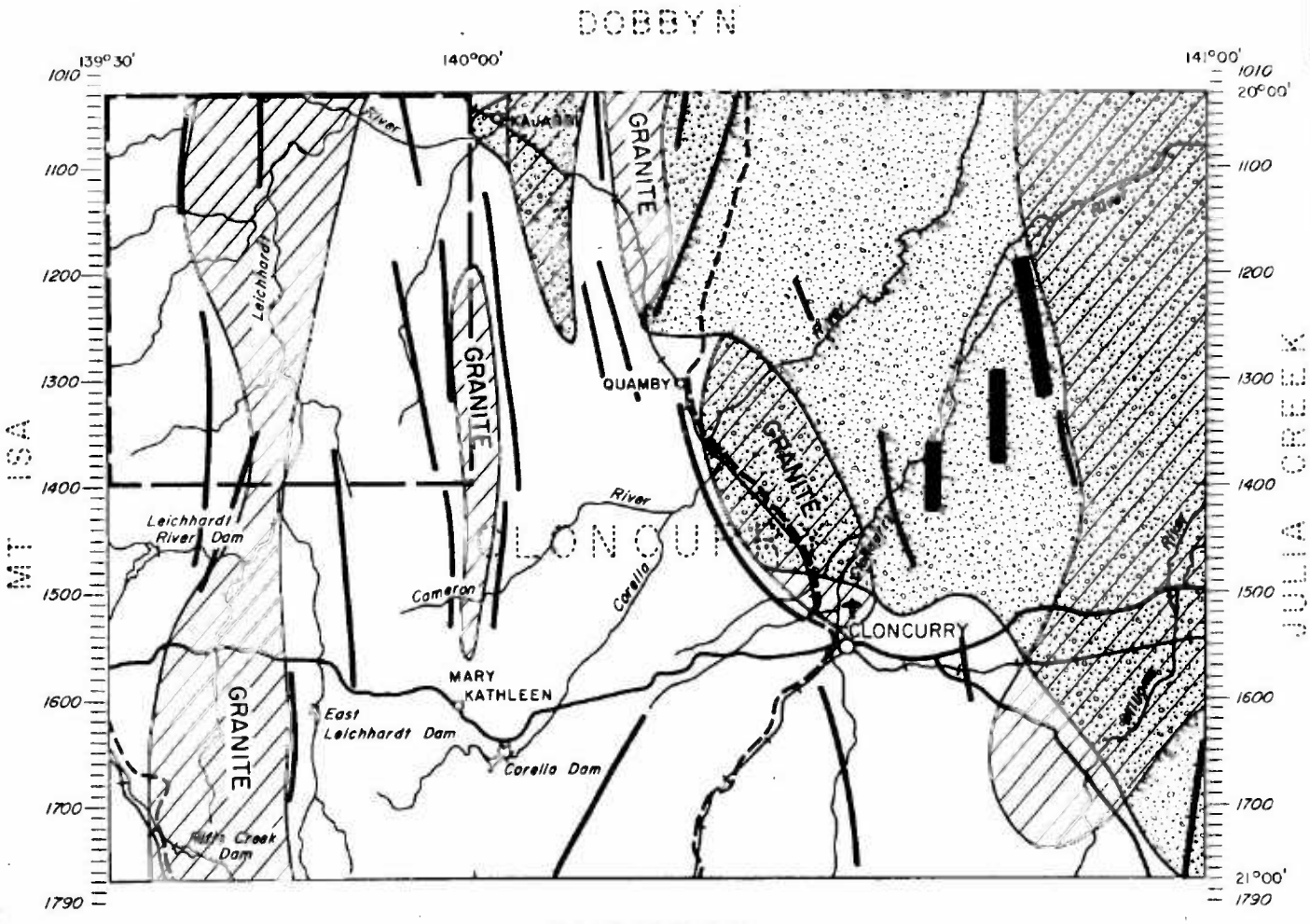
The lack of a functional radio altimeter on the survey has presented problems in the interpretation of the radiometric data. On the whole there is a close correlation of radiometric highs with topography. Ground traverse were run at five places of interest to help establish suitable interpretation criteria.

In general, the depth to the shallowest magnetic bodies increases towards the east of the Sheet area from near surface in the west to 1000-2000 m in the east. However, near the southeast corner, broad anomalies are attributed to an unknown body at a depth of about 6000 m. A zone of linear anomalies attributed to dolerite dykes at depths of 1000-2000 m runs close to this body and may provide a better estimate of depth to basement.



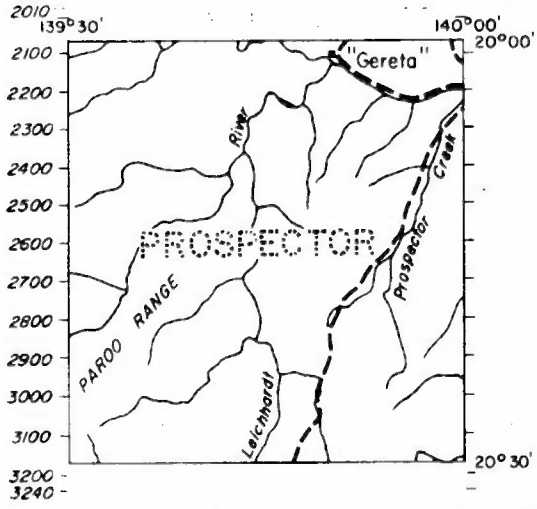
To accompany Record No 1973/195

D54/B1-2AR



DUCHESS

REGIONAL SURVEY AREA



DETAILED SURVEY AREA

GEOLOGICAL LEGEND

- Cainozoic Cover
- Proterozoic and Precambrian rocks

MAGNETIC INTERPRETATION

- Prominent Magnetic Trends – Anomalies of Amplitude 1000–5000 gammas
- Prominent Magnetic Trends – Anomalies of Amplitude up to 8000 gammas
- Magnetically Quiet Zone – Anomalies of Amplitude up to 200 gammas

TOPOGRAPHIC LEGEND

- *Highway*
- *Road*
- *Railway*
- *Detailed survey boundary*

AIRBORNE SURVEY, CLONCURRY, QLD 1973

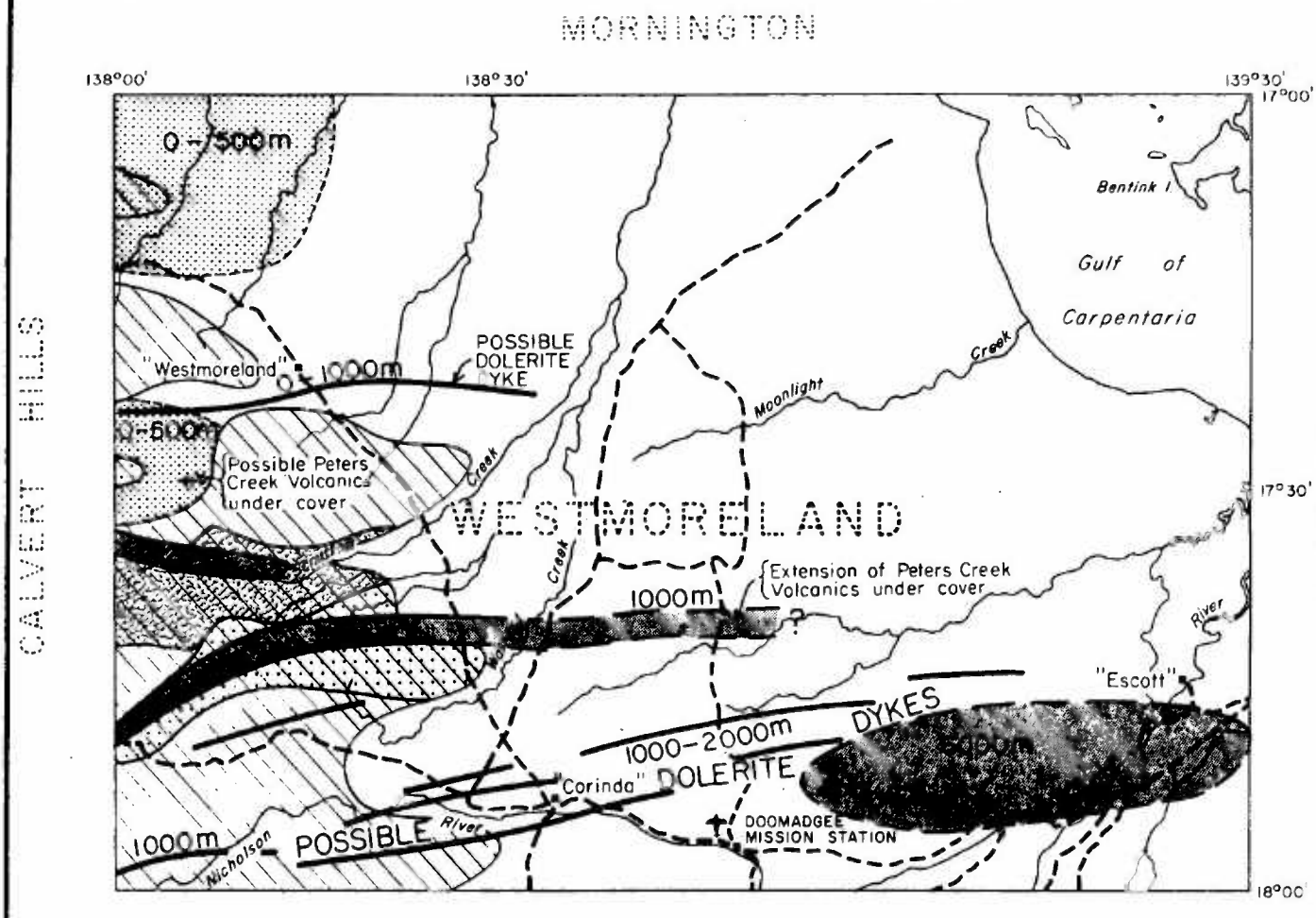
FLIGHT – LINE SYSTEM

KILOMETRES 20 0 20 40 60 KILOMETRES

MILES 10 0 10 20 30 MILES

To accompany Record No 1973/195

G463-38A



REGIONAL SURVEY AREA

MAGNETIC LEGEND

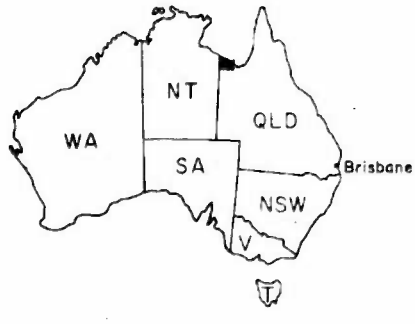
Trend Line. Anomalies of Amplitude 100-500 γ
Depth as shown.

Zone of Anomalies of Amplitude up to 200 γ
Trend directions uncertain. Depth as shown.

Linear zone of Anomalies of Amplitude up to 500 γ
Depth as shown.

Deep Magnetic Body – Amplitude 200 γ
Depth as shown.

n.b Depth estimates very approximate



GEOLOGY LEGEND

Precambrian Rocks

Cliffdale Volcanics

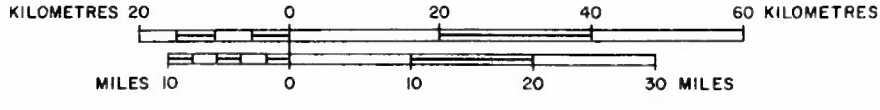
Peters Creek Volcanics

Road

Detailed survey boundary

AIRBORNE SURVEY, WESTMORELAND, QLD 1973

INTERPRETATION MAP



To accompany Record No 1973/195

G463-37A

There is a correlation between magnetic trend directions and Bouguer anomaly trends.

Radiometric anomalies (not shown on map) were recorded over the Westmoreland Conglomerate, Peters Creek Volcanics, and small outlines of Mesozoic sediments in the Precambrian outcrop area. The most prominent anomalies lie over known uranium prospects.

Prospector airborne magnetic and radiometric survey, Qld (VH-BMR) (D. Tucker, R. Taylor)

This detailed survey covering the PROSPECTOR 1:100 000 Sheet area was flown in July and August 1973 (Fig. MA 9). The survey was flown on east-west lines 500 m apart at a nominal ground clearance of 80 m. Magnetic and four channels of radiometric data were recorded in analogue form.

The magnetic anomalies in this area are up to 3000 gammas in amplitude, and are attributed to near-surface sources. The anomalies of highest amplitude were recorded over the Corella and Argylla Formations. Most trend directions of both the magnetic and radiometric anomalies closely parallel the mapped geological trends, for example, formation boundaries and faults. The most prominent radiometric anomalies were recorded over the Corella and Argylla Formations and also over the Myally Creek Beds.

Westmoreland airborne and radiometric survey, Qld (VH-BMR) (D. Tucker, R. Taylor)

This survey covering the WESTMORELAND 1:250 000 Sheet area was flown in August and September 1973. The survey was flown on north-south lines 1500 m apart in the western one-third of the Sheet and 3000 m apart in the eastern two-thirds. The nominal ground clearance was 150 m. Magnetic and four channels of radiometric data were recorded in analogue form.

About one-quarter of the area consists of Precambrian outcrop and the rest Cainozoic cover (Fig. MA 10). It appears that magnetic anomalies arise from sources at two levels at least, the geologically mapped Precambrian sedimentary formations, and possible dolerite dykes beneath them.

Over areas of outcrop the amplitude of magnetic anomalies arising from sources near the surface is usually less than 500 gammas. Formations with associated anomalies of about this amplitude are the Peters Creek Volcanics and the Cliffdale Volcanics. The Peters Creek Volcanics south of Scrutton Creek can be separated into a strongly magnetic northern component and a weakly magnetic southern component. It appears that a linear zone of the strongly magnetic component extends eastwards towards Escott, at a depth of up to 1000 m, for at least 30 km from recognized outcrop.

Northern Eromanga Basin project (H.D. Hsu)

This project involves a detailed study of the aeromagnetic data in the northern Eromanga Basin and Galilee Basin in Central Queensland.

In the quantitative interpretation of the aeromagnetic data, depths to magnetic basement units were determined at a number of places, and subsequently divided into two groups - upper magnetic basement depths and the lower magnetic basement depths - with the use of exploration well and borehole information. Contours of the upper magnetic basement were then constructed, and they broadly represent the variations in depth of the crystalline basement.

The magnetic basement has been divided into magnetic provinces of five basic types according to their magnetic expression and intensity. This may prove useful in understanding the nature of the concealed basement.

There appears to be a broad correlation between one particular type of magnetic province and the Galilee Basin. This probably implies that the magnetic basement underneath the Galilee Basin lithologically and structurally differs from that around it.

Cobourg Peninsula, Alligator River, and Mount Evelyn (northern half) airborne magnetic and radiometric survey 1971-72

Interpretation and data presentation (K. Horsfall, P. Wilkes)

Work on data presentation and interpretation has continued during 1973. Early in 1973, preliminary magnetic contour maps and total-count radiometric profiles were released. They are at a scale of 1:100 000 and are accompanied by flight path maps at a scale of 1:250 000. Production of fair-drawn magnetic contour maps at a scale of 1:250 000 is in progress.

The main part of the magnetic interpretation has concentrated on dividing the area into zones of different magnetic character and interpreting these in terms of the extent of different rock types.

The magnetic results show that the areas of Nanambu Complex are magnetically 'flat' (or weakly disturbed). It is thus difficult to map their extent directly from the magnetic data. But Koolpin Formation rocks in the transition zone of the Complex contain magnetite and produce a magnetic response over sections of the outer part of the Complex. The definition of the limits of the Nanambu Complex is important because of the occurrence of major uranium deposits (e.g. Jabiluka and Ranger) and prospects close to the margin of the Complex. It seems impossible to define the margins of the Nimbuwah Complex from the magnetic data.

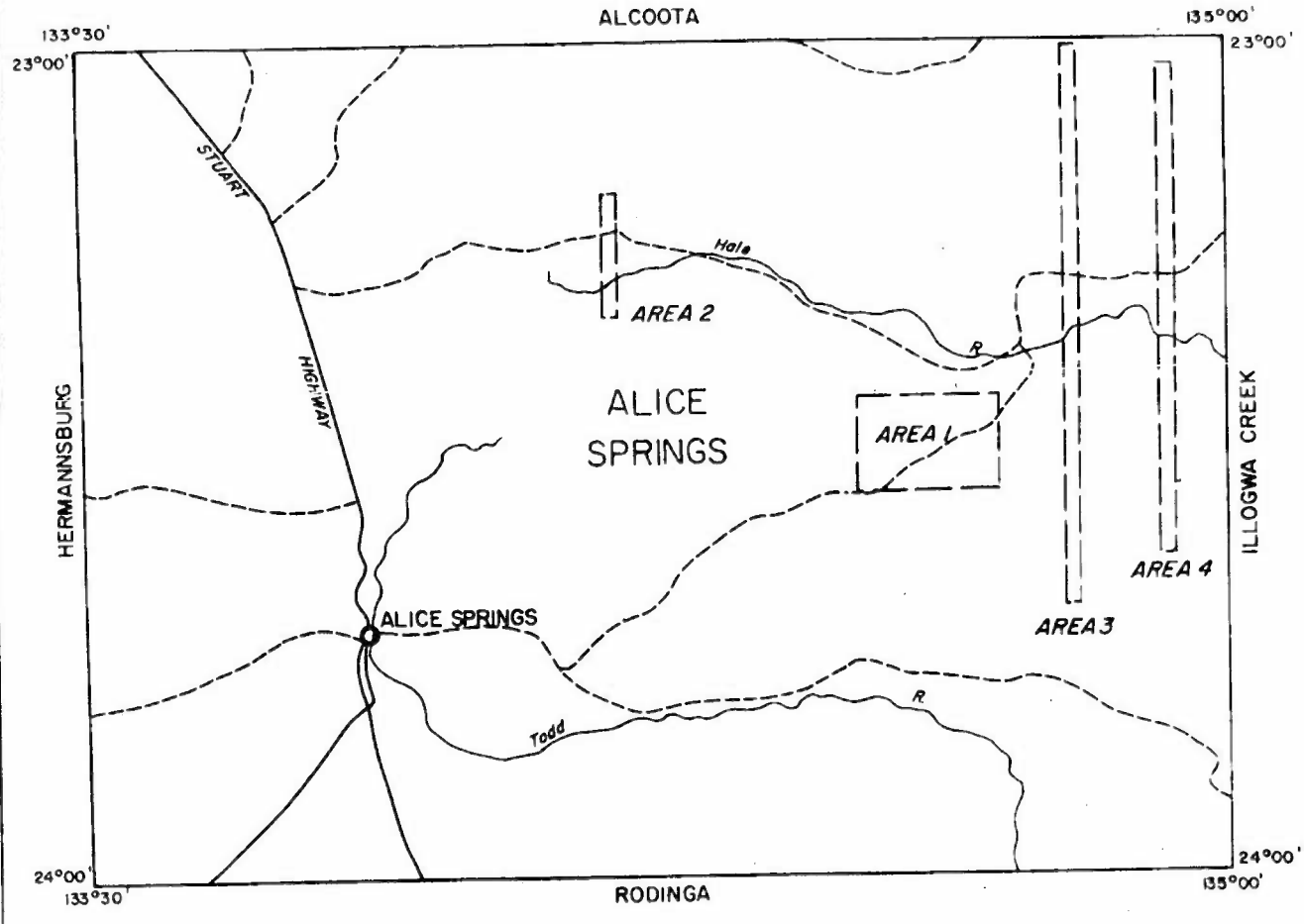
Dolerites appear to be very much more widespread than suggested by original mapping. Magnetic anomalies occur over both the Zamu dolerite and the Oenpelli dolerite. The linear magnetic features, which mainly tend SW-NE and W-E, in the south-eastern part of the survey area are attributed to magnetic infilling material along major fractures within the Kombolgie Formation. These may be near-vertical dykes of dolerite. Depth calculations indicate that they should extend close to the surface or possibly be exposed. Brief reconnaissance work (by helicopter) has not found any indication that these features come to the surface.

The magnetic data and their interpretation have aided considerably the current geological mapping and have helped to define suitable sites for drilling done during 1973.

From a study of the total-count profiles, original records, and the most recent maps produced by the BMR geological party, radiometric interpretation maps have been produced at a scale of 1:250 000. The interpretation has divided the radiometric anomalies into four groups defined by their predominant source component i.e. potassium, uranium, thorium, or mixed source.

About 40 anomalies are included in the uranium group. These include all the major uranium deposits except Jabiluka (not detected in the BMR survey), a number of adjacent prospects, and a number of other areas with anomalously high uranium-to-thorium ratio.

FIGURE MA II



LOCATION DIAGRAM

Detailed survey boundary

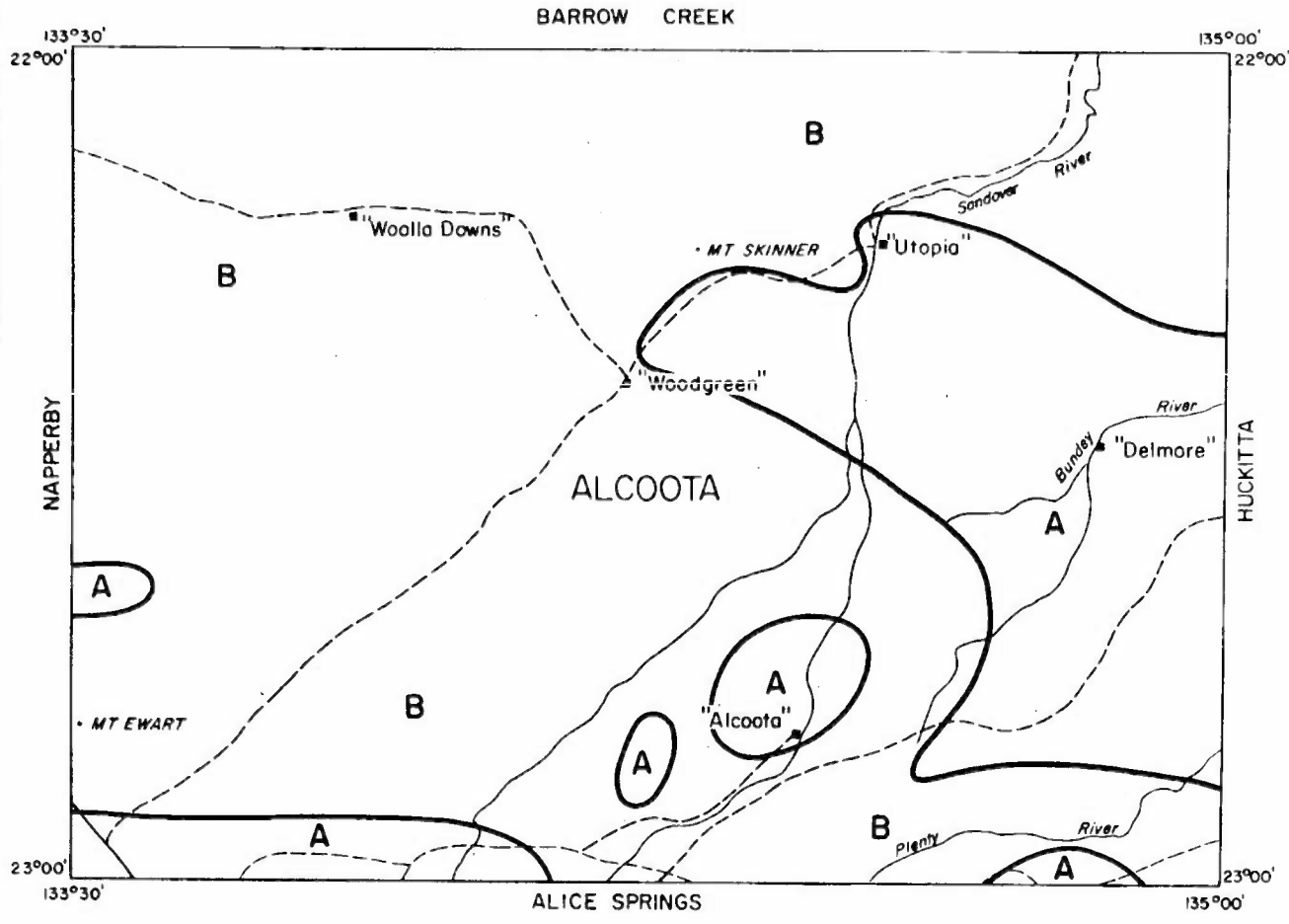
AIBORNE SURVEY, ARLTUNGA NAPPE COMPLEX, NT 1972

LOCALITY MAP

F53/BI-120A

To accompany Record No. 1973/195

FIGURE MA12

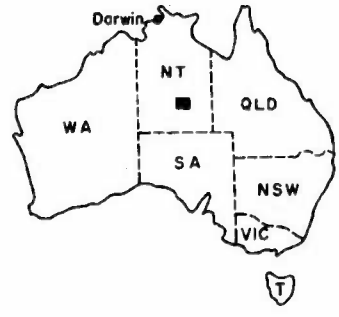


GENERALIZED INTERPRETATION

A Strong magnetic anomalies correlated with granulites, amphibolites, schist, basic rocks, high grade metamorphic rocks and granites

B Low to weak magnetic anomalies correlated with sedimentary rocks, gneisses and some granites

LOCATION DIAGRAM



AIRBORNE SURVEY, ALCOOTA, N.T. 1972

LOCALITY MAP

20 0 20 40 60 KILOMETRES

10 0 10 20 30 MILES

To accompany Record No 1973/195

G463-32A

During part of August some follow-up work was done with the geologists to examine some of the high uranium-to-thorium ratio anomalies on top of the Arnhem Land Plateau, found by the airborne survey in 1972. All but one of these anomalies were traced to radioactive laterites either at the base of Nungbalgarri Volcanics or at the base of the newly discovered Gilruth Volcanic Member, which occurs about half-way up the top section of the Kombolgie Formation.

Measurements were made with a ground-spectrometer on these anomalous areas and also on various other sites including the Jim Jim Granite.

In the COBOURG PENINSULA Sheet area a striking correspondence was found between areas of bauxitic laterite and thorium anomalies. These occur on Croker Island and on the northern part of the mainland.

Arltunga Nappe Complex detailed airborne geophysical survey, NT 1972 (R.J. Taylor)

The areas flown are shown in Figure MA 11.

Processing and interpretation of the geophysical data were continued up to May and a draft Record was produced.

Various features delineated from the magnetic contour maps could be correlated with known geological structures, and a boundary between granulite and greenschist facies rocks was interpreted.

However, resolution of some smaller units was not possible because of the high magnetic disturbance in the area.

ALCOOTA 1:250 000 Sheet magnetic and radiometric survey, NT 1972 (B.W. Wyatt)

Processing and interpretation of the data from this survey continued into 1973 and a preliminary report on the results was completed by April.

Magnetically disturbed areas (Fig. MA 12) correlate with rocks of high metamorphic grade, and many of the magnetic lineaments are due to WNW-trending faults. Depth estimates indicate a maximum sedimentary thickness of about 2700 m in the Dulcie Syncline and up to 300 m of Tertiary sediments in the remainder of the Sheet area. Basement relief is fairly high in the northern part. Thorium anomalies generally correlate with outcrops of laterite, granite, and orthogneiss. Potassium anomalies correlate with some granite and orthogneiss.

RED RIVER and GEORGETOWN 1:250 000 Sheets airborne magnetic and radiometric survey, Qld 1973 (R.J. Taylor, E. Olsen)

The survey party assembled in Cairns on 8 October and routine survey flying commenced on 15 October.

The survey is being flown in support of current mapping in these areas by the Geological Branch.

Airborne remote sensing project, WA (E.P. Shelley)

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

The Record on the results of the 1970 survey was completed and issued early in the year. From 26 September to 10 October a visit was made to the test areas (Fig. MA 13) in company with a geologist from the WA Geological Survey. The major rock types in each area were inspected and sampled and some ground magnetic and radiometric traverses were made.

Tennant Creek airborne surveys review (E.P. Shelley)

Interpretations were commenced on the results of the 1971 airborne surveys in TENNANT CREEK (detailed radiometric) and BONNEY WELL (regional magnetic and radiometric). The recontoured magnetic data from the 1960 regional survey were prepared for preliminary release. This project will be continued in 1974.

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

95 hours were flown in the Canberra region during the year to test geophysical equipment and train personnel in equipment operation and photo-navigation.

An investigation of the sources of magnetometer 'noise' showed the signal cable, which also supports the drag load of the towed 'bird', to be a major weakness in the system. Discussions have been held with TAA and Executive Air Services on various alternative systems including a nylon strainer on the cable and a tail boom installation. A new toroidal detector has been constructed for both 'bird' and boom installation.

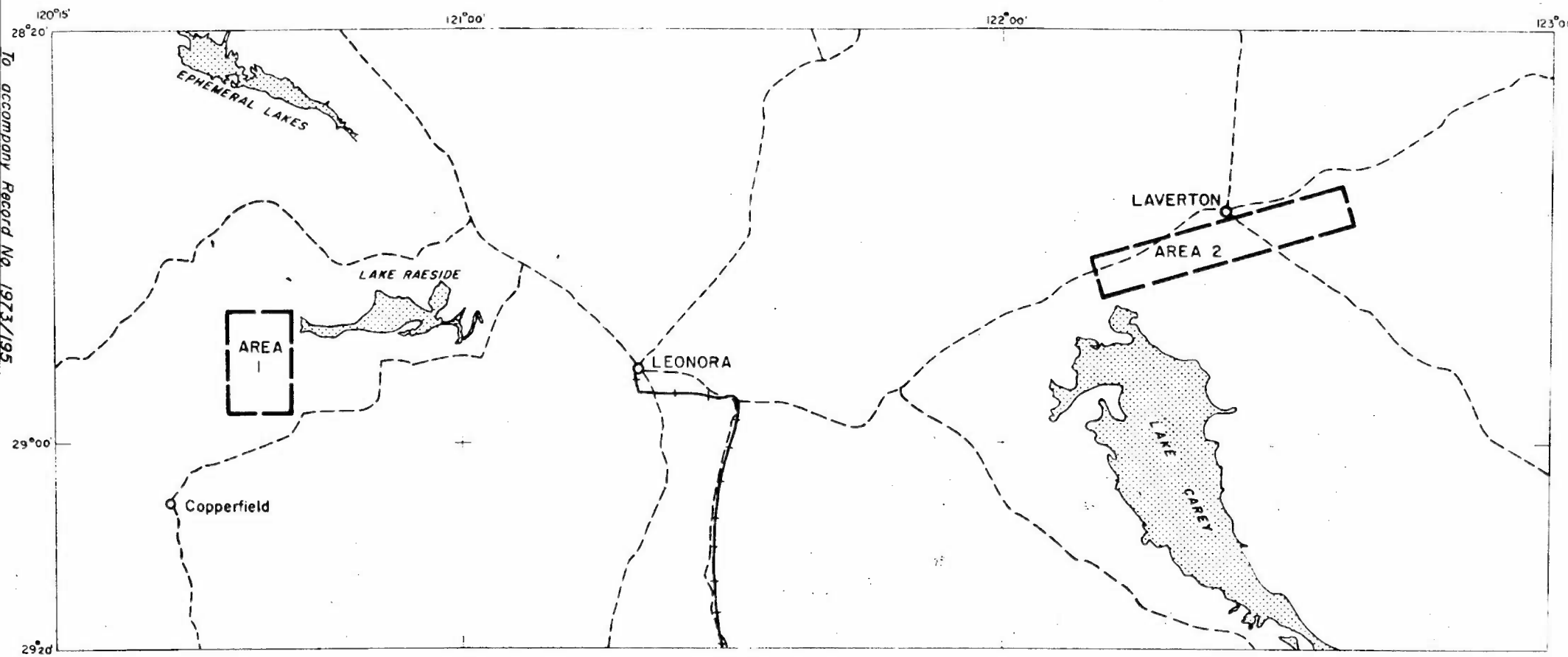
Contracts have been let for a digital acquisition system and new radio altimeters. It is hoped to have these installed and tested during the 1973 Christmas lay-up.

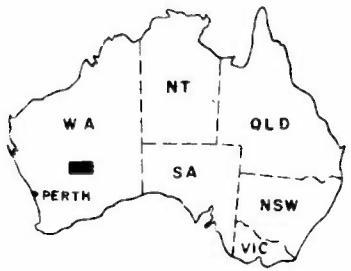
During the 1972 lay-up, autopilot, DME, and glide-slope receiver systems were installed in the aircraft. The aircraft is now fully instrumented and can be operated in most types of weather.

VH-BMG (Twin Otter) test flying (R. Wells, P. Wilkes, S. Lambourn, D. Downie)

Because of a failure of the prototype MFS-7 magnetometer, the aircraft returned from Coduna in March with the South Eucla Basin survey not quite completed. The Laboratory Group decided to replace the prototype with a production model which was currently awaiting flight testing. Early flight tests revealed the need for design changes in this model which caused a delay of some weeks before an acceptable modified design was achieved. A resumption of flight testing revealed some unsatisfactory features in the method of circuit board construction adopted for the production model. These resulted in a disappointingly low service reliability.

In August the remaining coverage of the South Eucla Basin was successfully completed and the way was clear to consider commencing the Carpentaria Basin survey which had been programmed to start some months earlier. It was not until October that two production-model magnetometers were available and considered sufficiently reliable to attempt a survey remote from laboratory support. Data were successfully collected in the Carpentaria Basin, but the incidence of magnetometer failures on that survey indicates the need for a review of the construction methods used.





AIRBORNE REMOTE SENSING SURVEY, WESTERN AUSTRALIA, 1970

LOCALITY MAP

Survey boundary

10 0 10 20 30 40 50 60 70 80 KILOMETRES

5 0 10 20 30 40 MILES

To accompany Record No. 1973/195

H51/BI-96 A

FIGURE MA13

All other equipment systems in VH-BMG performed satisfactorily. During flight testing in Canberra some data were recorded for the Canberra-Wagga survey, but on the whole the results for the year were disappointing and it was regrettable that the high survey potential of the Twin Otter was not realized.

Data acquisition system in Aircraft VH-BMG (D. Downie)

The digital data acquisition system installed in VH-BMG continued to perform with high reliability throughout the year. This system, which records eight channels of geophysical and navigational information on magnetic tape at a variety of time intervals, is based on a Hewlett-Packard 2114B digital computer. The data are coded on the magnetic tape in a form suitable for processing by the Airborne Reductions and Contracts Group.

Some software changes were made during the year to enable the system to bypass intermittent hardware failures, and a new version of the program was developed in anticipation of the change to the CYBER 76 computer for basic data processing.

A Record describing the system was prepared.

Review of Doppler navigation system in Aircraft VH-BMG (D.N. Downie)

Owing to the labour involvement in testing the production model MFS-8 magnetometer this review was postponed until 1974. Experience in operating the system during the year indicates that while the system performs well as a survey navigational aid there are minor errors in the recorded Doppler co-ordinates which will need further investigation to achieve optimum accuracy of flight path recovery. The errors appear to be associated with the behaviour of the gyrosyn compass system after the heading change at the start of a flight-line.

Contract aeromagnetic survey, WA 1972; Data processing (B. Wyatt)

The contract survey by Aero Service Ltd covered the GLENBURGH (part), ROBINSON RANGE, PEAK HILL, NABBERU, STANLEY, PERENJORI, MOORA (part) and BENCUBBIN 1:250 000 Sheet areas. During 1973 the data were processed and magnetic contour maps at a scale of 1:100 000 were released. An interpretation of the results in the GLENBURGH, ROBINSON RANGE, PEAK HILL, NABBERU, and STANLEY areas is in progress.

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

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

Tenders for the compilation were called in July, and a recommendation for the award of the contract was made in October. Some fill-in survey flying will be undertaken by aircraft VH-BMR in 1974 to improve the presentation. A contract for control flying to enable the integration of data in various regions was also awarded.

The project is due for completion by mid-1976.

Gamma-ray spectrometry project (P. Wilkes)

The objective of this project is to study and improve existing methods of collecting, processing, and interpreting airborne gamma-ray data.

Preparatory work commenced using the data recorded in the Alligator River region. Stabilization of the spectrometer by means of Cobalt 57 and increase of crystal volume in the scintillation detector will be examined. Computer programs for correcting the recorded data are to be prepared. The project will continue until mid-1974.

AIRBORNE REDUCTIONS AND CONTRACTS GROUP

Survey data processing

Northeast Victoria, 1972

(a) Northeast block: TALLANGATTA, WANGARATTA ($\frac{1}{3}$)
Magnetic data for the 14 220 line km coverage in the block were positioned using full control point photographic recovery and levelled to remove systematic drift patterns using film-matched crossovers on double tie pairs at 0°30' longitude intervals. Data quality had been degraded by cumulative trace shifts in the acquisition system. The regionally estimated International Geomagnetic Reference Field (IGRF) was removed, and satisfactory contour maps were scribed at 1:250 000.

(b) Northwest block: BENDIGO, WANGARATTA ($\frac{2}{3}$)
Magnetometer, four-channel spectrometer, altimeter, and Doppler data were processed for the 17 775 line km in the block. Both full photographic and Doppler flight-path recoveries were used to verify the Doppler navigation system. Magnetic data were levelled using double tie pairs at 0°30' longitude separation using crossovers derived from film matching and transformed Doppler data, the latter producing a more consistent solution. The estimated IGRF was removed from the magnetic data prior to containing at 1:250 000.

Eucla Basin, SA 1972-73

(a) Onshore block: COOMPANA ($\frac{1}{2}$), NULLARBOR ($\frac{1}{2}$), FOWLER, NUYTS (part)
A total of 24 148 line km of magnetic, spectrometer, altimeter, and Doppler data were processed with flight-path recovery via Doppler navigation using 10 fixes per line. Levelling of the magnetic data will employ 10 double tie pairs at 0°30' longitude intervals and crossovers recovered from Doppler navigation data. Scribed 1:250 000 maps of magnetic data with IGRF removed will be produced.

(b) Offshore block: COOMPANA ($\frac{1}{2}$), NULLARBOR ($\frac{1}{2}$)
The magnetic data for 5390 line km at 3-km spacing will be positioned using Doppler navigation with 4-6 onshore fixes to control the initial recovery; this will yield estimates of the surface drift components to be incorporated in the final navigation recovery. The offshore block will be levelled to the onshore block using common onshore lines in the north and east as ties.

FIGURE MA 14

INDEX TO ADJOINING 1:250000 SERIES MAPS

121°30'

130°30'

24°

TRAINOR	MADLEY	WARRI	COBB	RAWLINSON	BLOODS RANGE
STANLEY	HERBERT	BROWNE	BENTLEY	SCOTT	PETERMANN RANGES
KINGSTON	ROBERT A	YOWALGA C	TALBOT D	COOPER	MANN
DUKETON	THROSSELL B	WESTWOOD	LENNIS C	WAIGEN	BIRKSGATE
LAVERTON	RASON	NEALE	VERNON E	WANNA	NOORINA
EDJUDINA	MINIGWAL	PLUMRIDGE	JUBILEE	MASON	WYOLA
KURNALPI	CUNDEELEE	SEEMORE	LOONGANA	FORREST	COOK

AUSTRALIA NORTHERN TERRITORY

AUSTRALIA WESTERN SOUTH

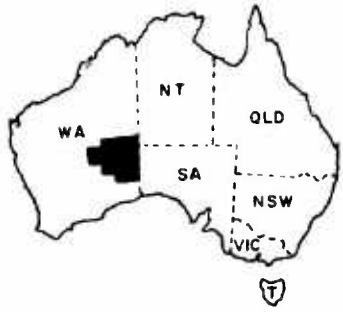
31°

130°30'

OFFICER BASIN CONTRACT AEROMAGNETIC SURVEY

KILOMETRES 50 0 100 200 300 400 500 KILOMETRES

MILES 50 0 50 100 150 200 250 MILES



To accompany Record No. 1973/45

GA67-36

Wagga Wagga-Canberra, 1973

(a) Wagga Wagga block: WAGGA WAGGA (⅔)
A total of 7110 km of magnetic, spectrometer, altimeter, and Doppler data has been processed for the block. Doppler-derived crossovers along 3 double tie pairs will be used to level the magnetic data. Levelling will be performed using both raw data and data diurnally corrected by means of records from Kowen Forest Observatory. Contouring will be at 1:250 000.

(b) Canberra block: WAGGA WAGGA (⅓) CANBERRA
Only a small percentage of data from the total block coverage of 14 220 km has been received.

Contracts

Western Australia, 1972 (Aeroservice Contract)

(a) Southern block: PERENJORI, NINGHAN, MOORA (⅔), BENCUBBIN
Magnetic data for 41 659 km with IGRF removed and levelled to BMR 1969 survey results were contoured as 22 preliminary 1:100 000 maps and scribed at 1:250 000.

(b) Northern block: GLENBURGH (⅓), ROBINSON RANGE, PEAK HILL, NABBERU, STANLEY
Magnetic data for 40 186 km with IGRF removed and levelled to BMR 1969 survey results were contoured as 26 preliminary 1:100 000 maps and scribed at 1:250 000.

Western Australia, 1972-73 (Geosearch Contract)

PERTH, KELLERBERRIN, PINJARRA, CORRIGIN
37 070 km of magnetic data were received and accepted from the contractor. The IGRF has been removed and the data levelled to the WA 1972 (Aeroservice Contract) Southern Block for contouring at 1:100 000 for preliminary release and at 1:250 000 for final publication.

Ausminex data purchase

RASON, MINIGWAL, CUNDEELEE, PLUMRIDGE
A total of 42 020 km of magnetic data have been purchased. The data required considerable adjustment and correction to achieve an acceptable quality. Flight-path recovery has been completed for RASON, and levelling runs are in progress prior to contouring at 1:100 000 and 1:250 000.

Officer Basin, Western Australia

Tenders have been received for the acquisition of 132 436 km of aeromagnetic data as detailed in Figure MA 14. The contract will be awarded in the near future, and flying operations will commence early in 1974 for completion by the end of 1974. It is hoped to incorporate the data in the Aeromagnetic Map of Australia.
A study of the geology and previous geophysics of the area and the surrounding region has been made and a draft Record has been prepared by D. Tucker.

Aeromagnetic Map of Australia

Tenders were called and contracts awarded for two parts of this project, viz. digitization and compilation of aeromagnetic data and control flying.

System development

The large increase in volume and types of data input, the proposed introduction of a digital acquisition system on VH-BMR, and conversion to the CYBER 76 computer have fully extended the capabilities of the present data processing system in the group.

Specifications for a more flexible and more efficient data management system have been compiled with the aim of increasing the rate of data processing by exploiting the advantages of the CYBER 76, thus reducing labour requirements and costs while increasing the reliability and quality of data storage and allowing greater access to information within the data base.

Basic to the system has been the development of an upgraded multi-channel data storage format for use on sequential and/or random access files.

Routine survey data processing using the new system will be phased-in with conversion to operation on the CYBER 76 which commenced in November. The new processing system has been designed to permit easier incorporation of interpretative, analytical, and presentation processes.

Software production

Most programming in the Airborne Reductions Group was associated with maintenance and updating of CDC 3600 software to cope with the volume of data being processed and with conversion and redesign for CYBER 76 operation.

Programs and supporting routines were developed to perform the following tasks:

(a) Doppler navigation recovery: to transform raw Doppler data to geographical co-ordinates using fixes. Two versions have been established: (i) general least-squares co-ordinate transformation (3600), and (ii) incremental recovery and least-squares adjustment on the spheroid (3600, 76).

(b) Thorough checking and reporting of statistics for data tapes prior to contouring.

(c) Crossover extraction from navigation data documents.

(d) Plotting of navigation data (3600 only).

(e) Control point editing with optimized correction functions.

(f) Basic input, output, and editing routines for CYBER 76 system.

(g) Data manipulation and general-purpose editing programs (76).

(h) General multi-level data reporting programs for line printer listing reports and for multi-channel, multi-plot line printer plotting.

To accompany Record No. 1973/195

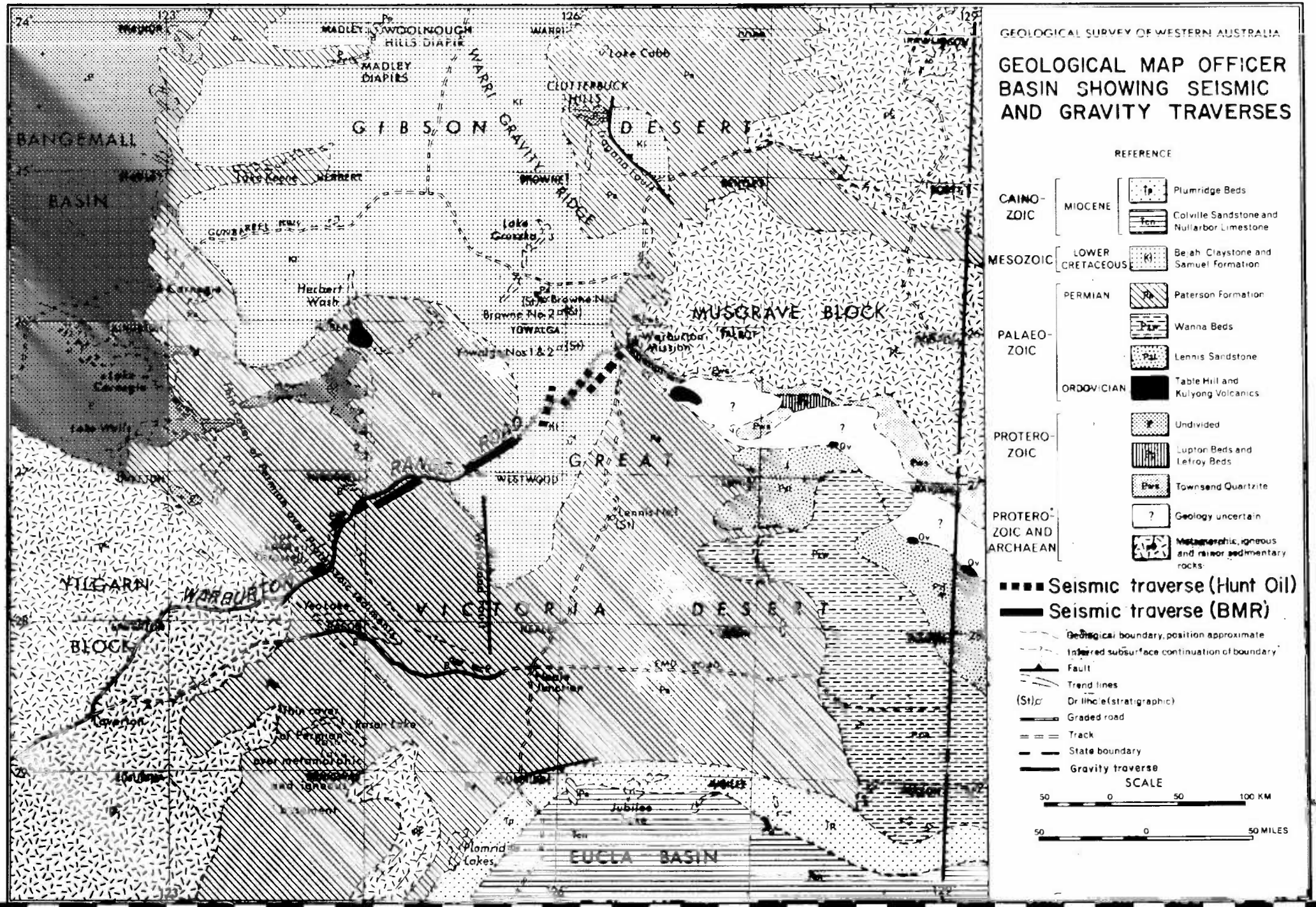
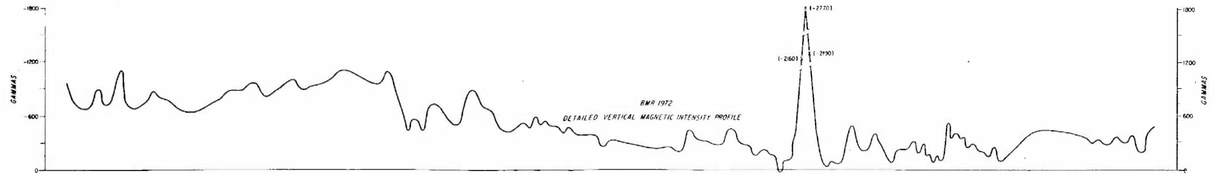


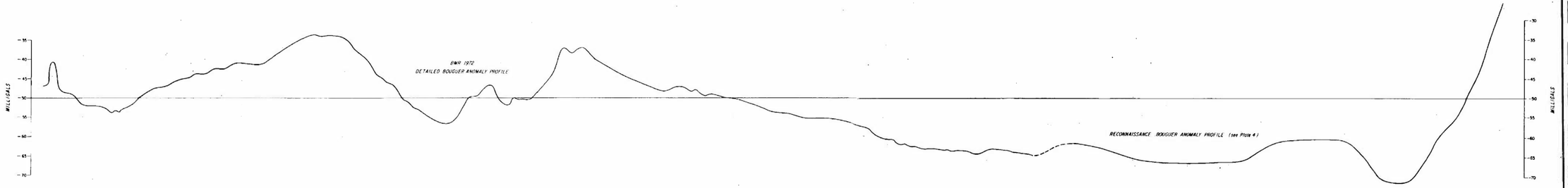
Fig. SGM 1

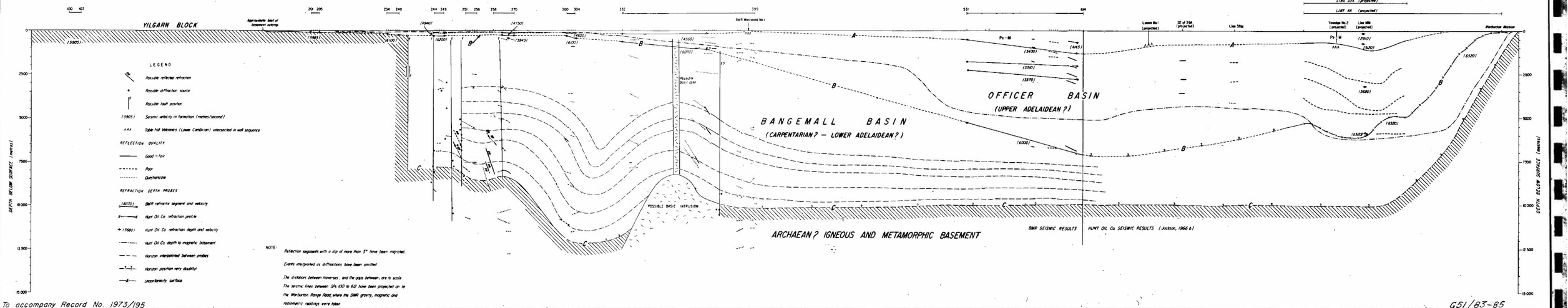
G463-19A

Fig SGM 2

INTERPRETED SECTION ACROSS OFFICER BASIN W.A.







To accompany Record No. 1973/195

G51/83-85

(i) Conversion of magnetic, spectrometer, and navigation tapes from CDC 3600 to CYBER 76 format.

(j) VH-BMG field tape conversion to CYBER 76.

(k) Contour program - the airborne version of the BMR package is continually being modified and adjusted to improve data sampling and contour presentation.

(l) Stacked profiles - the change to Doppler navigation has required redesign for conversion to the CYBER 76/BMR flatbed plotter configuration, and full specifications are being carefully compiled prior to conversion.

(m) Map data digitizing conversion will incorporate additional features to permit more rapid recovery of fixes for Doppler navigation recovery.

The program for systematic software documentation commenced in 1972 has been suspended because of staff shortages and projects of higher priority. However, basic description and instruction for use of all CYBER 76 software is being compiled at the time of development.

2. SEISMIC, GRAVITY AND MARINE SECTION

SEISMIC SURVEYS

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

The data collected during the survey in 1972 have been processed and interpreted. An interpretative model of the sediments in the Basin in the form of a cross-section along the seismic traverses (Fig. SGM 1) between the Yilgarn and Musgrave Blocks is shown in Figure SGM 2. It is based on BMR seismic, gravity, magnetic, and radiometric surveys in the centre and southwest, Hunt Oil seismic surveys in the northeast, and the geological and drilling data.

Three major groups of sediments separated by surfaces of unconformity have been identified on the basis of velocities and depths obtained from the seismic data.

The surface A corresponds to a basalt layer, the Lower Cambrian Table Hill Volcanics, at the base of the Phanerozoic sediments. This layer has been correlated with a good reflector, Horizon A, and a refractor of velocity 5100-5430 m/s. The overlying sediments, which are flat-lying, are thickest (about 1300 m) in the centre of the basin and thin out gradually towards the margins.

The surface B lies between two distinct sedimentary sequences, the upper one with velocities of 5100-5700 m/s and the lower one with velocities of 6000-6500 m/s. The upper layer correlates with the sequence 5000 m thick of Upper Adelaidean sediments exposed on the southern flank of the Musgrave Block. This sequence is estimated to be about 7500 m thick in the centre of the basin and thins out rapidly to the southwest. In the area of SP303 its basal unit, the Townsend Quartzite, is exposed north of the seismic traverse.

The surface C is postulated as the interface between the basin sediments and the igneous and metamorphic basement. No reflections or refractions have been recorded from this boundary, and its position has been estimated as the downward limit of possible reflections on the seismic sections. The sediments between the surfaces B and C are estimated to be about 10 000 m thick in the southwest. They are believed to correspond to a sequence 9000 m thick of slightly folded Carpentarian-Lower Adelaidean? sediments in the Bangemall Basin to the northwest. The folding and faulting near the southwest margin of the Officer Basin are suggested by the presence of numerous diffraction and reflected-refraction events on the seismic records and by the gravity anomalies in the area. The details of the gravity interpretation are discussed under Gravity Surveys.

Geophysical review of Carpentaria, Olive River, and Laura Basins (Qld) (J. Pinchin)

A review of the past geophysical and geological surveys in the area has been made to assess the current knowledge of the Basins and to determine the need for further seismic surveys. The locations of the Basins are shown in Figure SGM 3 and the interpretations of the data are shown as cross-sections in Figures SGM 4 and 5.

The major gravity anomaly features in the area seem to reflect density variations in the crystalline basement and deeper in the crust rather than the thickness of the sediments in the basins. However, the basement depths obtained from magnetic, seismic, and drilling data are in general agreement.

The Carpentaria Basin contains Mesozoic and Tertiary sediments which attain a maximum thickness of 1200 m in the centre of the Gulf of Carpentaria (Fig. SGM 4) and thin gradually towards the west, south, and east. The velocities of the sediments are 1590-1820 m/s for the Tertiary and 2000-2330 m/s for the Mesozoic sections. The basement has a velocity of 5370-5940 m/s and shows several minor faults in the seismic sections.

The Olive River Basin has no surface expression. The sediments are indicated by the seismic and magnetic results to be about 900 m thick, overlying a metamorphic basement. The stratigraphy of these sediments is unknown but is possibly similar to that of the Carpentaria Basin sediments.

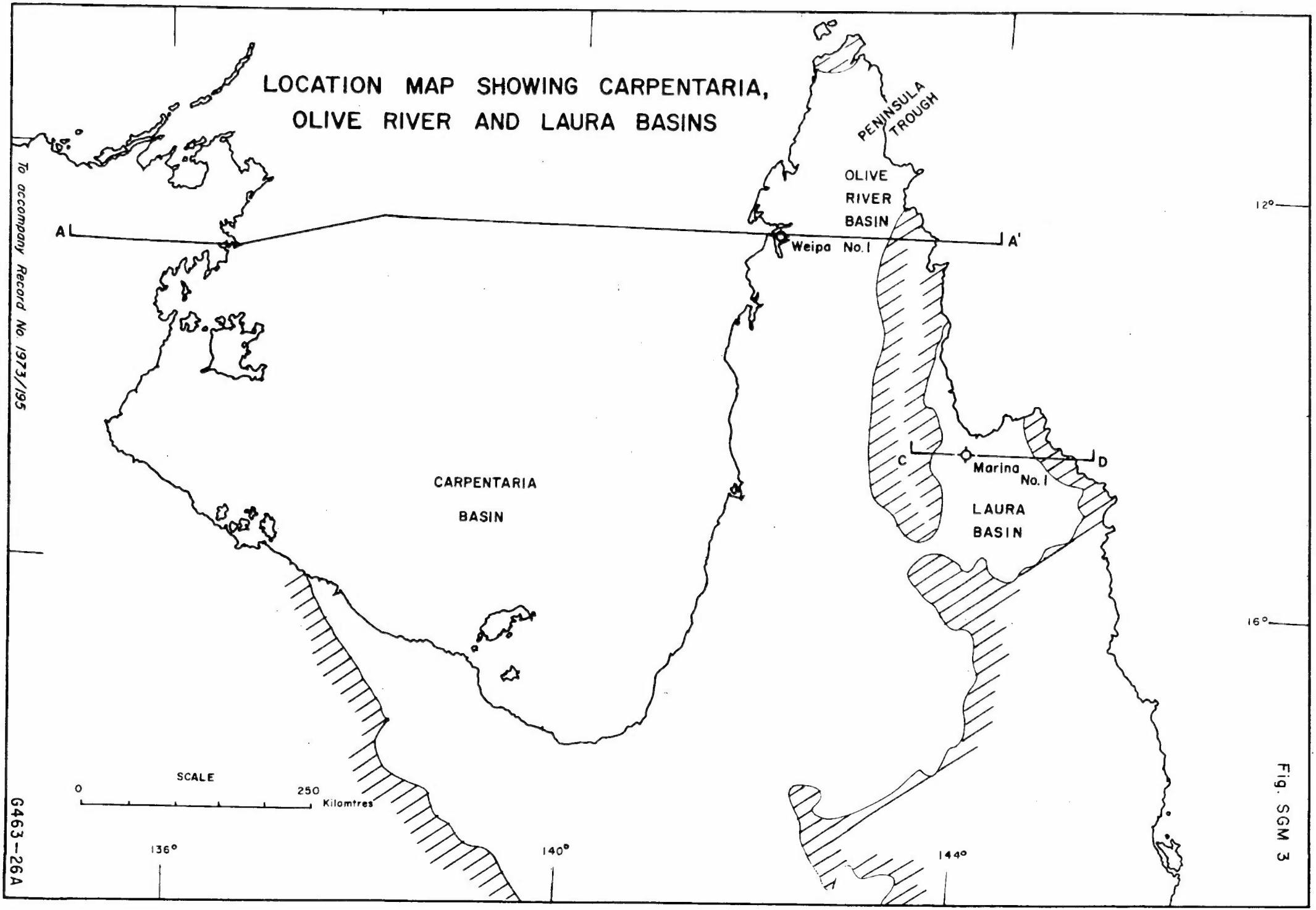
The Laura Basin (Fig. SGM 5) contains Mesozoic and Cainozoic sediments to a maximum thickness of 900 m, and has been considered to overlie the Devonian-Carboniferous Hodgkinson Formation. However, the presence of dipping seismic reflections between 0.6 and 4.0 seconds on both sides of the Palmerville Fault in the northern part of the basin indicates that about 8000 m of sediments may lie between the Mesozoic sediments of the Laura Basin and the Hodgkinson Formation.

To assist in assessing petroleum prospects of the area, it is recommended that further seismic surveys be made to:

a. Define the north and northwest boundary of the Carpentaria basin

b. Outline the nature and thickness of the sediments in the Peninsula Trough, a possible northward extension of the Olive River Basin.

c. Investigate the geologic section below the Mesozoic sediments in the Laura Basin.

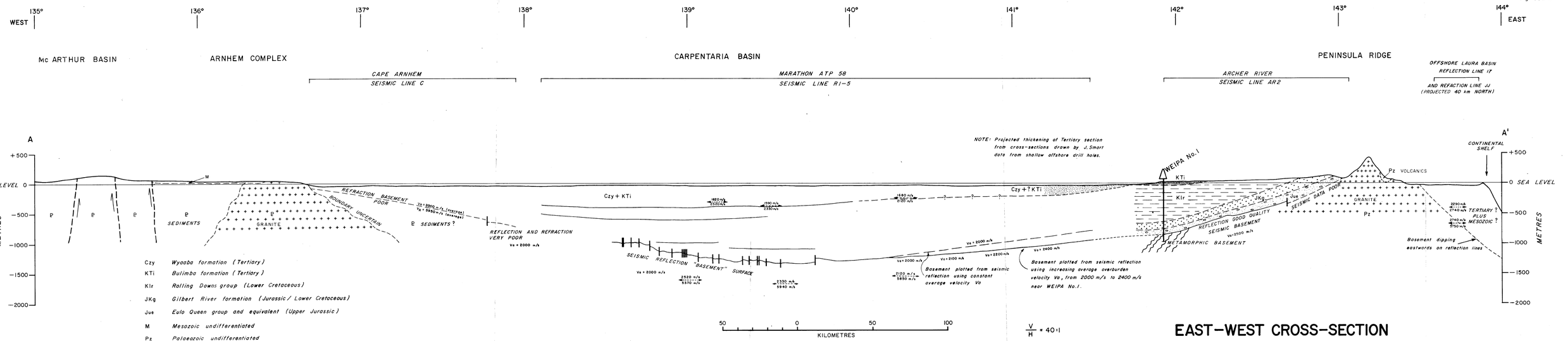


To accompany Record No. 1973/195

Fig. SGM 3

G463-26A

Fig. SGM 4

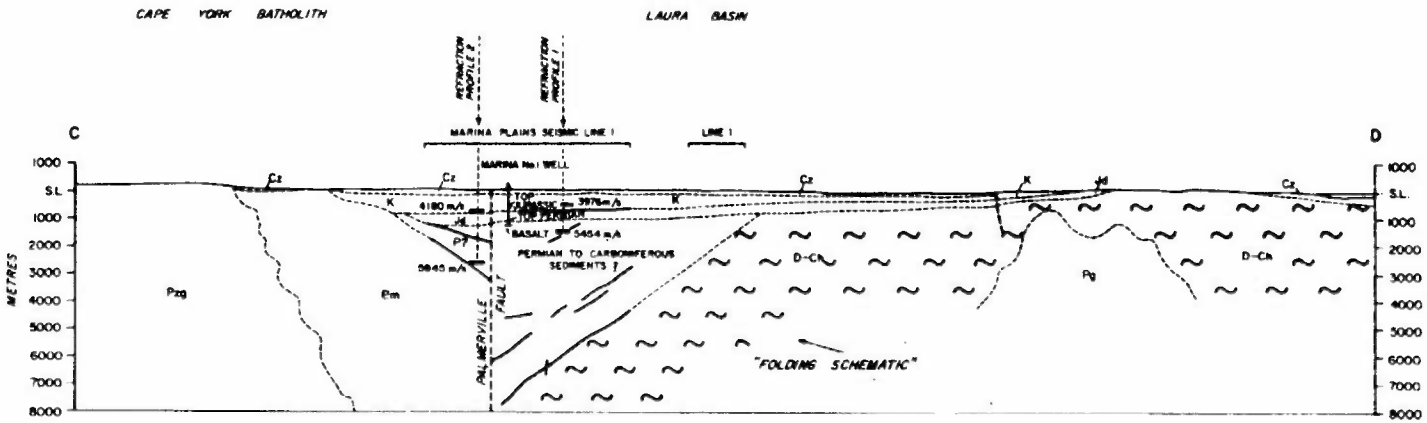


EAST–WEST CROSS-SECTION ACROSS THE CARPENTARIA BASIN

To accompany Record Nr. 1973/132 and 1973/195

Q/83–7

To accompany Record No. 1973/195



Cz		CAINOZOIC SEDIMENTS
K		CRETACEOUS SEDIMENTS
Jd		JURASSIC DALRYMPLE SANDSTONE
P		PERMIAN SEDIMENTS
Pg		PERMIAN GRANITES
D-Ch		MIDDLE DEVONIAN - LOWER CARBONIFEROUS ? HODGKINSON FORMATION
S-Dh		UPPER SILURIAN - LOWER DEVONIAN CHILLAGOE FORMATION
Pzg		LOWER PALAEOZOIC ADAMELLITES OF CAPE YORK BATHOLITH
Pm		PROTEROZOIC METAMORPHICS

FAULT

SEISMIC REFRACTING HORIZON

SEISMIC REFLECTING HORIZON

INFERRED BOUNDARY

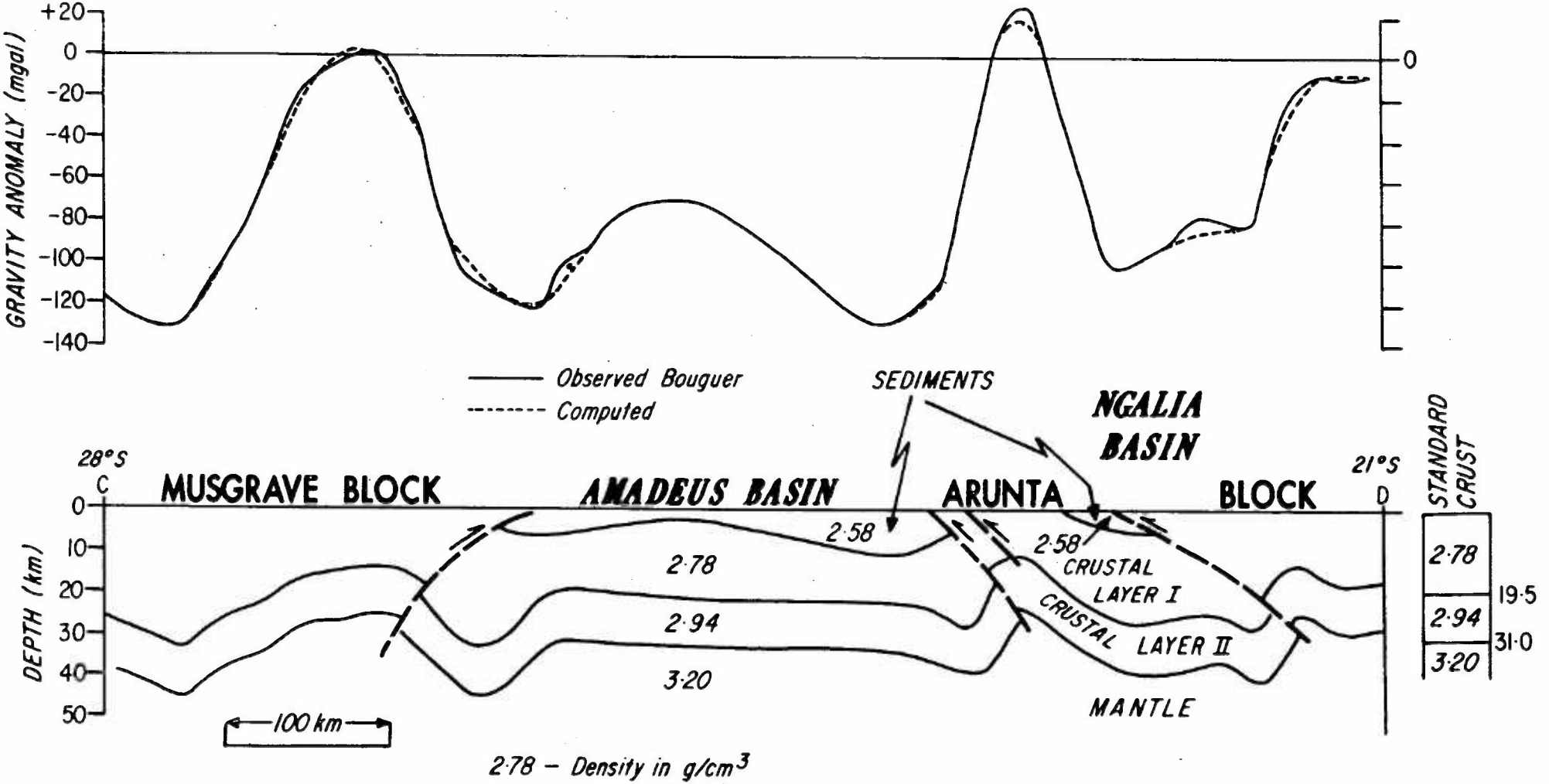
10 5 0 10 20km $\frac{V}{H} = 4$

INTERPRETED CROSS-SECTION ACROSS THE LAURA BASIN

Fig. SGM 5

G463-28A

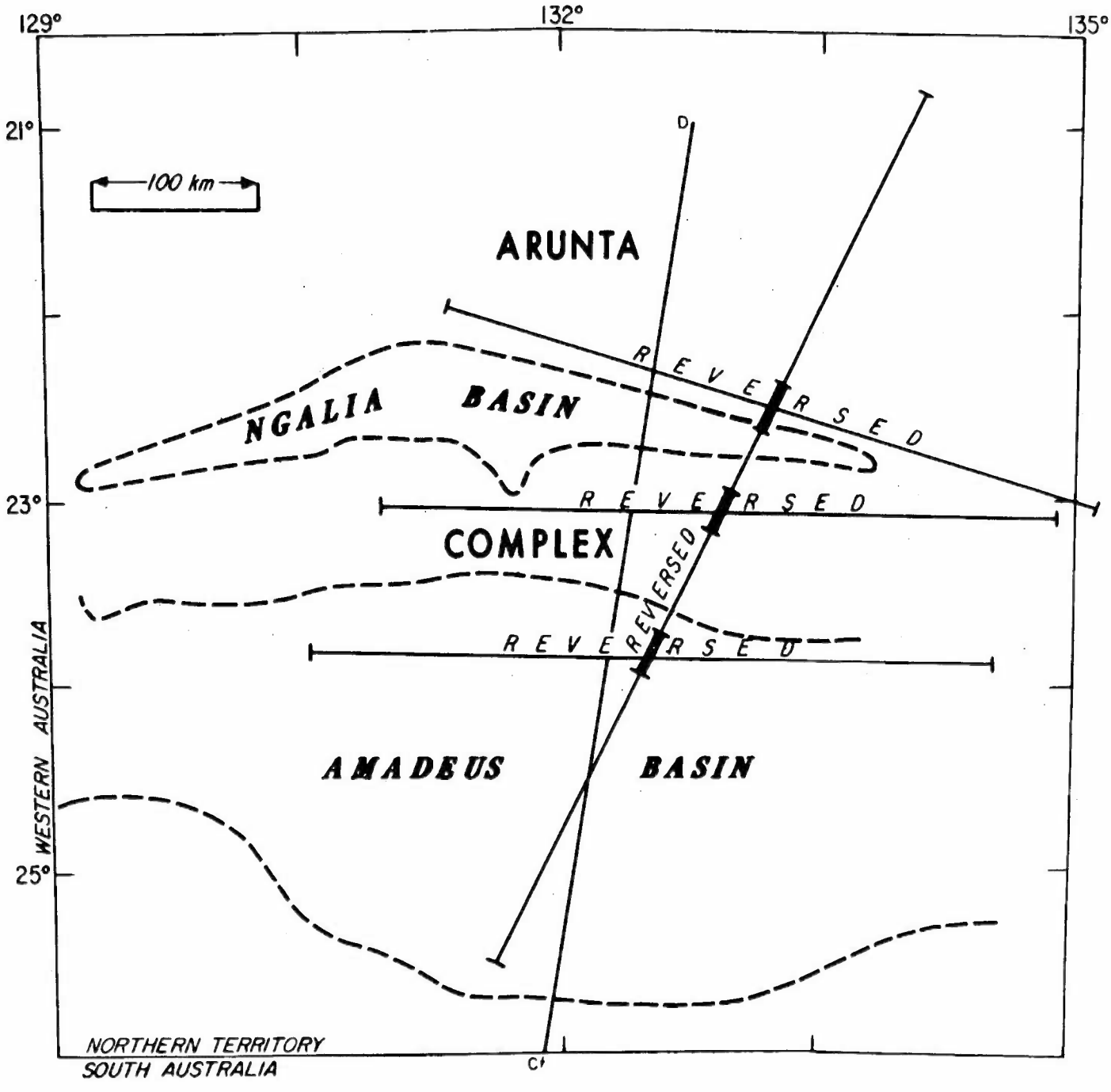
To accompany Record No. 1973/195



GRAVITY INTERPRETATION CENTRAL AUSTRALIA

G 463–43

Fig. SGM 6



PLAN FOR DEEP SEISMIC SURVEY CENTRAL AUSTRALIA

Preview of deep seismic sounding in central Australia (S.P. Mathur)

A review has been made of the existing geological and geophysical data in the region of the Amadeus and Ngalia Basins and the surrounding metamorphic areas to consolidate the present knowledge about the structure of the crust and upper mantle in central Australia. A simplified model of the possible structure (Fig. SGM 6) has been derived from the study of the surface geology and gravity anomalies in the area, assuming the crustal densities and standard crustal parameters that were found suitable for similar studies in the shield area of southwestern Australia.

The region has been deformed along three major overthrust fault zones, at the northern margin of the Ngalia Basin and at the northern and southern margins of the Amadeus Basin. The shape and size of the gravity anomalies indicate that the whole of the crust and parts of the upper mantle are involved in the deformation. The depths shown in the model for the intermediate and Mohorovicic discontinuities in the northern part of the Amadeus Basin and in the Ngalia Basin agree with those obtained from isolated deep reflection recordings.

In order to obtain more precise information on depths and velocities of deep layers, investigate the structure across the deformed zones, and thereby test the validity of this and other models, a seismic survey consisting of simultaneous refraction and reflection recording is proposed in the northern part of the Amadeus Basin and in the metamorphic areas and the Ngalia Basin to the north (Fig. SGM 7).

Deep crustal and upper mantle reflection studies in Australia (F.J. Moss)

Deep seismic reflection records obtained by the Seismic Section in 45 areas over the whole of Australia during normal sedimentary surveys since 1957 and during deep seismic surveys in 1968 and 1969 were studied for events between the times of 8 and 15 seconds. The study indicated that the deep reflections of best quality were recorded in sedimentary areas where shallow reflections of good quality had also been recorded. Single-shot results from early surveys were inconclusive, but results from spreads shot perpendicular to each other indicated that the reflections were of near-vertical incidence, supporting the theory that they were from deep within the crust and upper mantle. In some cases, the expanded spreads provided realistic vertical velocity information in the deep crust. Recent efforts using a higher multiplicity of geophones and shot-holes, longer spreads, cross-spreads, common-depth-point recording, expanded spreads, magnetic recording, and digital processing have yielded more reliable reflection information.

Ngalia Basin seismic surveys, NT 1967-1969 (F.J. Moss)

A final report on the results from three seismic surveys made during 1967 to 1969 was completed. Good to poor quality seismic reflections were obtained using single-coverage continuous profiling techniques. Generally the reflection quality was best in the deeper parts of the Basin with Quaternary cover, and deteriorated in most traverses near the margin of the Basin and in areas of outcropping Palaeozoic and Proterozoic rocks. Refraction profiling was attempted in some areas to define marker horizons. It was successful in finding high-velocity refractors, up to 6030 m/s, but the interpretation of refraction results was inconclusive.

Summaries of the results in the Bismarck Sea and Gulf of Papua were given in 1971 and in the Coral Sea, Tasman Sea, and offshore Tasmanian area in 1972.

Figure SGM 14 shows minimum sediment thickness on the continental margin around Australia. It is based on the interpretation of BMR seismic results, and no distinction has been made between deep-sea sediments and shallow-water shelf-type sediments. In many places the sediments may be much thicker than is indicated since the basement reflection is often not reached on the seismic records.

Off the continental shelf the thickest sediments appear to lie in the Great Australian Bight. However some areas shown as having between 1.5 and 2.0 km thickness of sediments may have over 2 km. The Timor Trough, parts of the northwest margin including the Exmouth Plateau, parts of the Naturaliste Plateau, and large areas of the Tasman Sea are off-shelf areas which may contain deep sedimentary basins.

The Coral Sea Plateau (Fig. SGM 16) has a crustal thickness of 25-35 km, and is covered by 1 to 1.5 km of sediments. It is separated from the mainland by the Queensland Trough which contains a large wedge of probably continent-derived sediments.

The Lord Howe Rise (Fig. SGM 17) covers an area of probably continental type crust 25 to 30 km thick, overlain with thick sediments. In the north it is separated from the Australian continent by the Cato Trough, Kenn Plateau, and Nova-Argo Basin which form a zone underlain by a crust of intermediate thickness. Farther south the Rise and its flanking ridges are separated from the mainland by the Tasman Basin (Fig. SGM 18) which is then underlain by crust of oceanic thickness.

The Tasmania Ridge (Fig. SGM 19) culminates in a central feature named the South Tasman Rise where the highest point lies at a depth of 1000 m. The ridge is connected to Tasmania by a topographic saddle. Most sediments occur only in scattered pockets, and the underlying crust is of intermediate thickness.

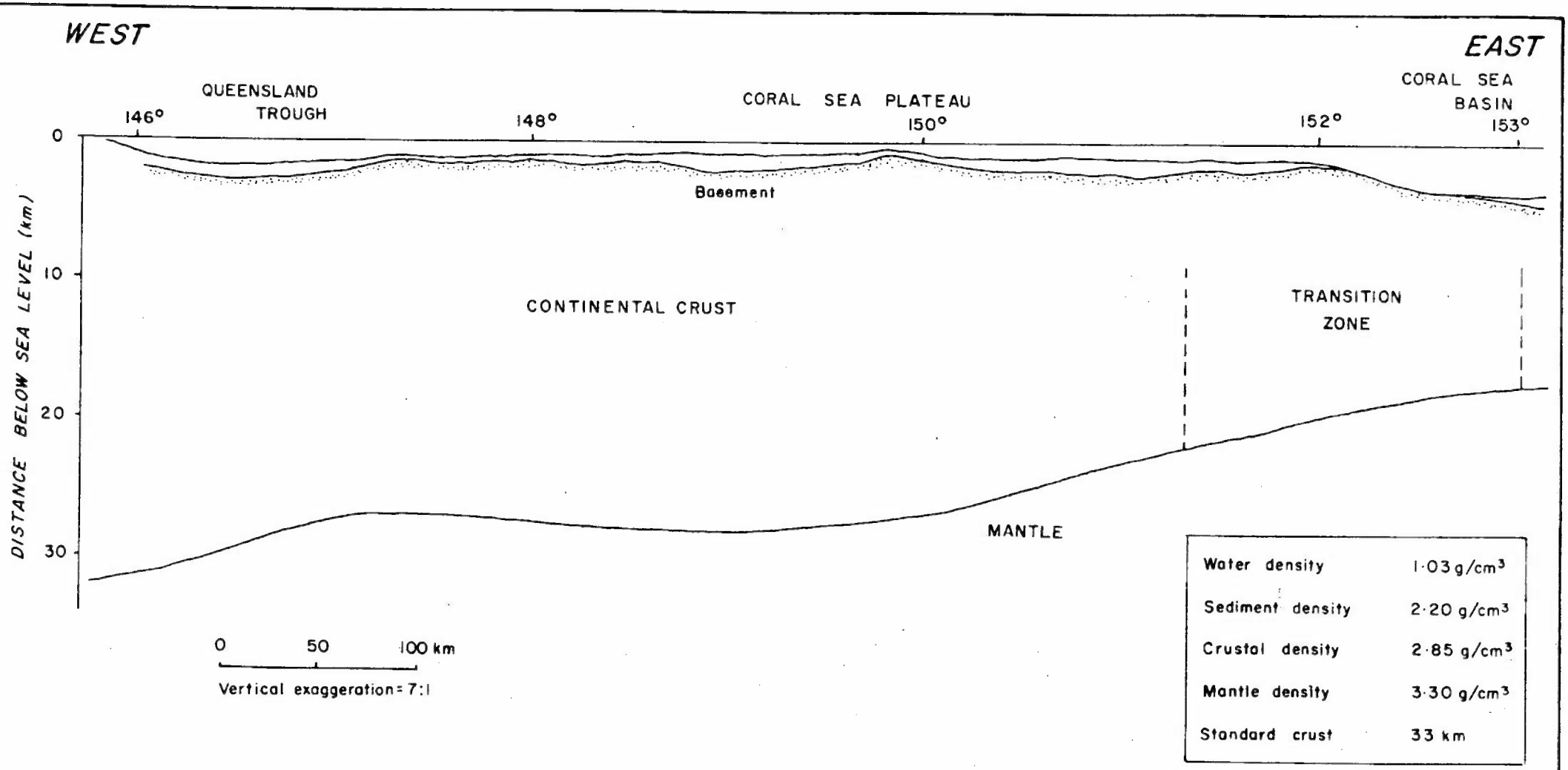
Gravity modelling suggests that the crust may thicken appreciably to over 40 km north of the Timor Trough (Fig. SGM 20). There is at least 2 km of sediments on the southern margins of the Trough. The sedimentary reflections dip towards the Trough and disappear abruptly at the faulted northern margin. The northern slopes of the Trough are rugged and appear to consist of highly folded and faulted sediments.

The Great Australian Bight (J.B. Willcox). Gravity, magnetic, and seismic reflection records were obtained in the Great Australian Bight (between 124° and 141°E) as part of the Continental Margin Survey. Lines were oriented north-south and separated by 20-25 nautical miles.

High noise levels and interference from multiples resulted in poor seismic records over the continental shelf, but elsewhere the quality is fair. Gravity and magnetic data are good throughout.

Bathymetric measurements outlined the continental shelf, continental slope, continental rise, Eyre Plateau, Ceduna Plateau, and small areas of abyssal plain.

To accompany Record No. 1973/195

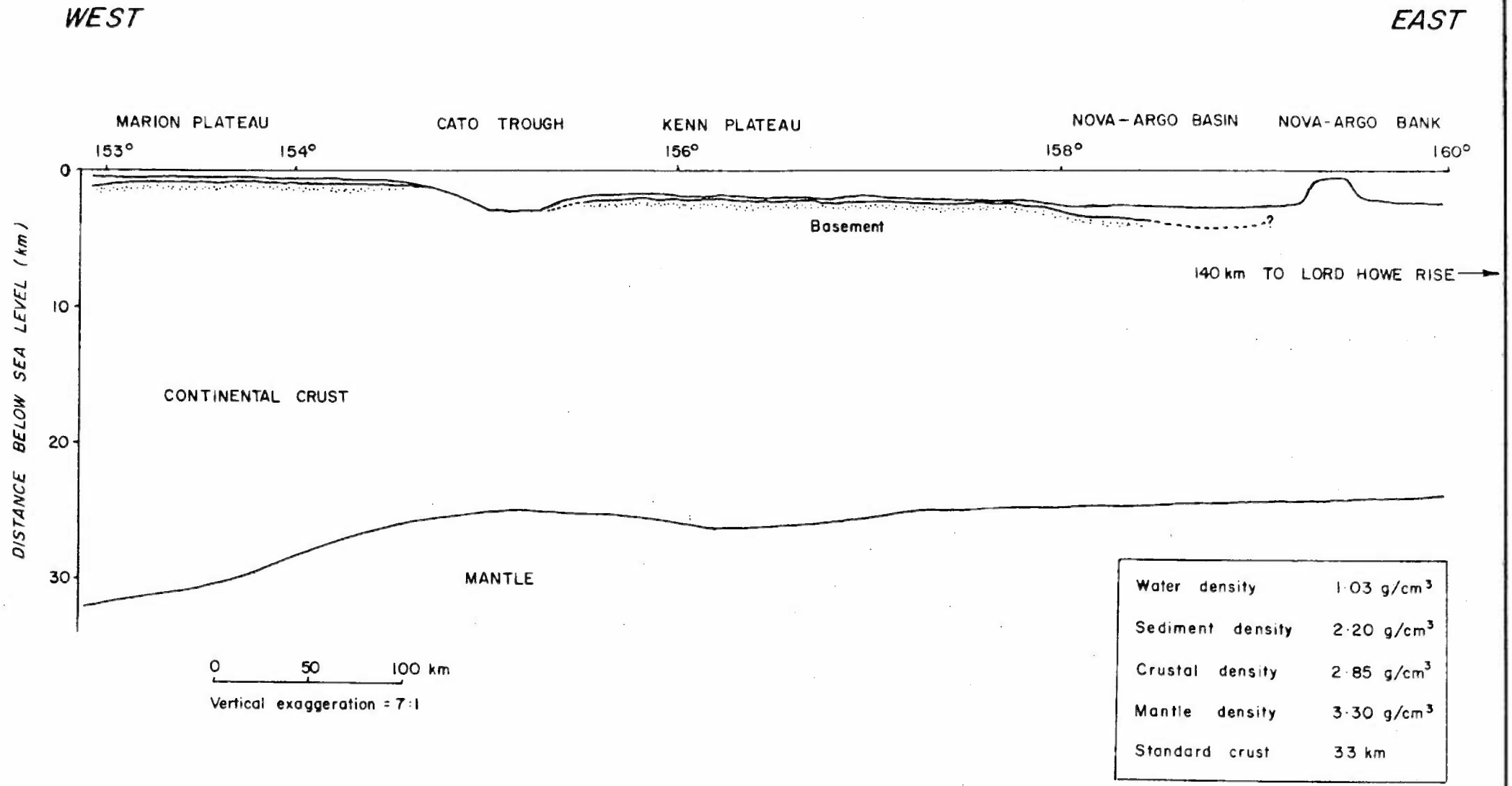


SECTION THROUGH THE CORAL SEA PLATEAU (15°40'S)

Fig. SGM 16

G463-23A

To accompany Record No. 1973/195

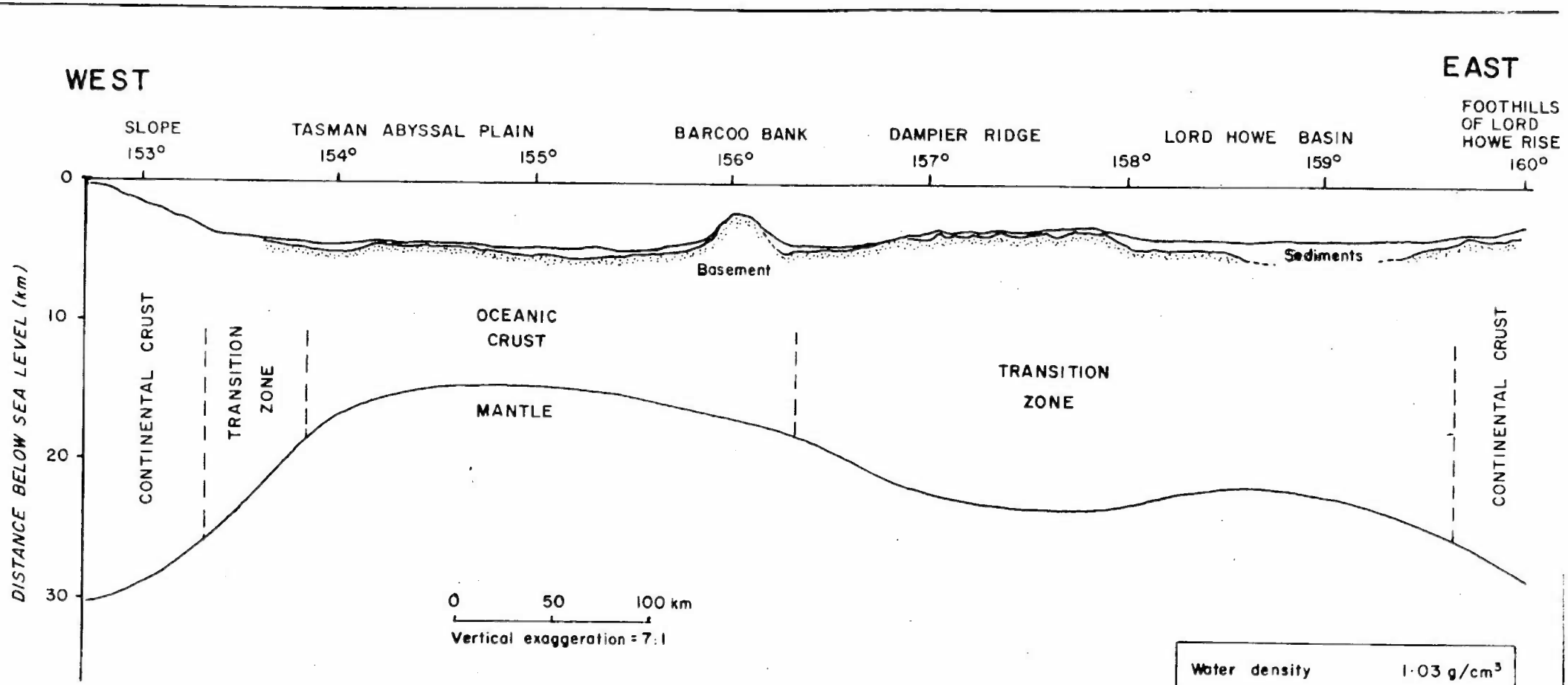


SECTION ACROSS THE SOUTH CORAL SEA (23°S)

Fig. SGM 17

G463-14A

To accompany Record No. 1973/195



Water density	1·03 g/cm³
Sediment density	2·20 g/cm³
Crustal density	2·85 g/cm³
Mantle density	3·30 g/cm³
Standard crust	33 km

TASMAN SEA LINE 15/56

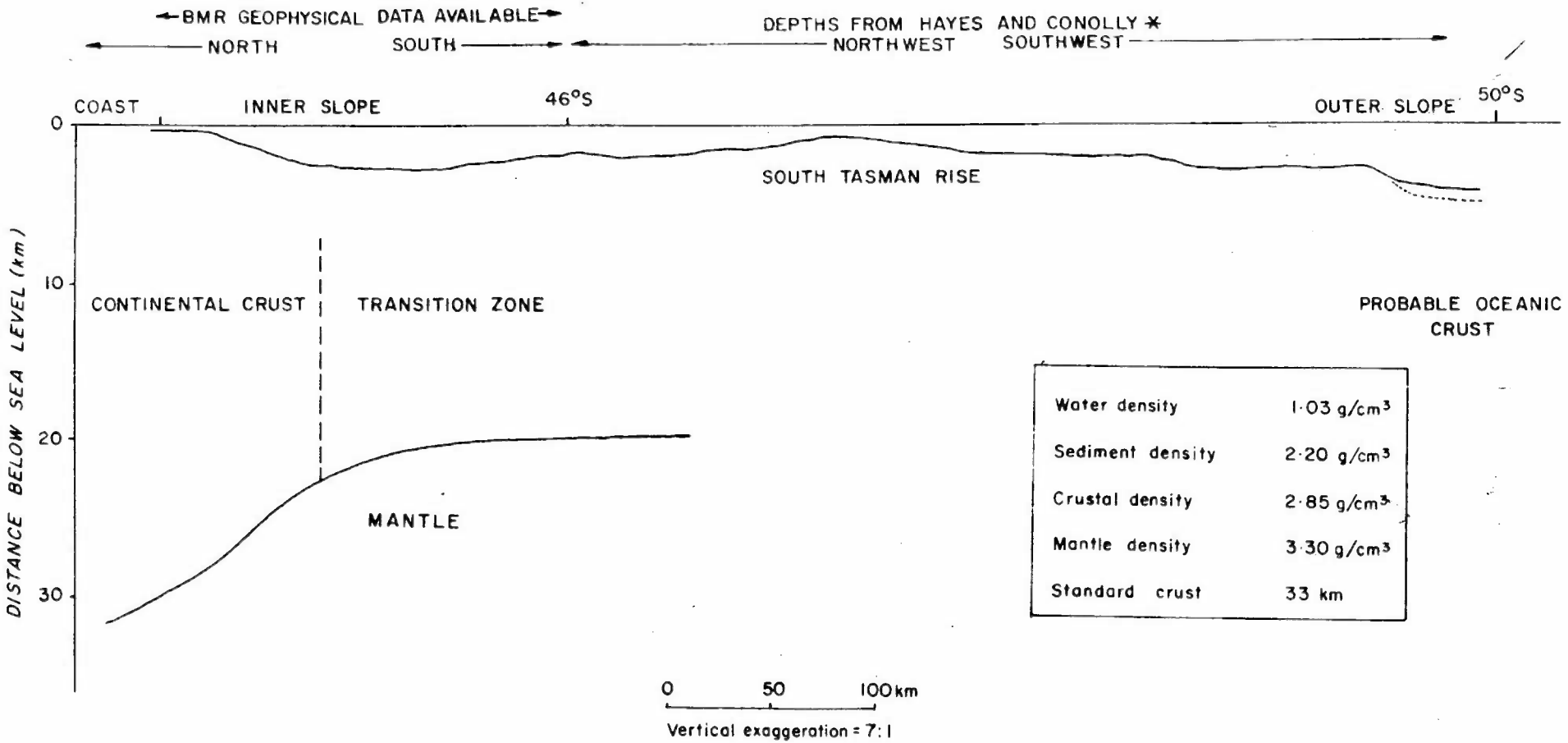
32° 30'S

SECTION ACROSS THE TASMAN BASIN

Fig. SGM 18

G463-20A

Accompany Record No. 1973/195



Water density	1·03 g/cm³
Sediment density	2·20 g/cm³
Crustal density	2·85 g/cm³
Mantle density	3·30 g/cm³
Standard crust	33 km

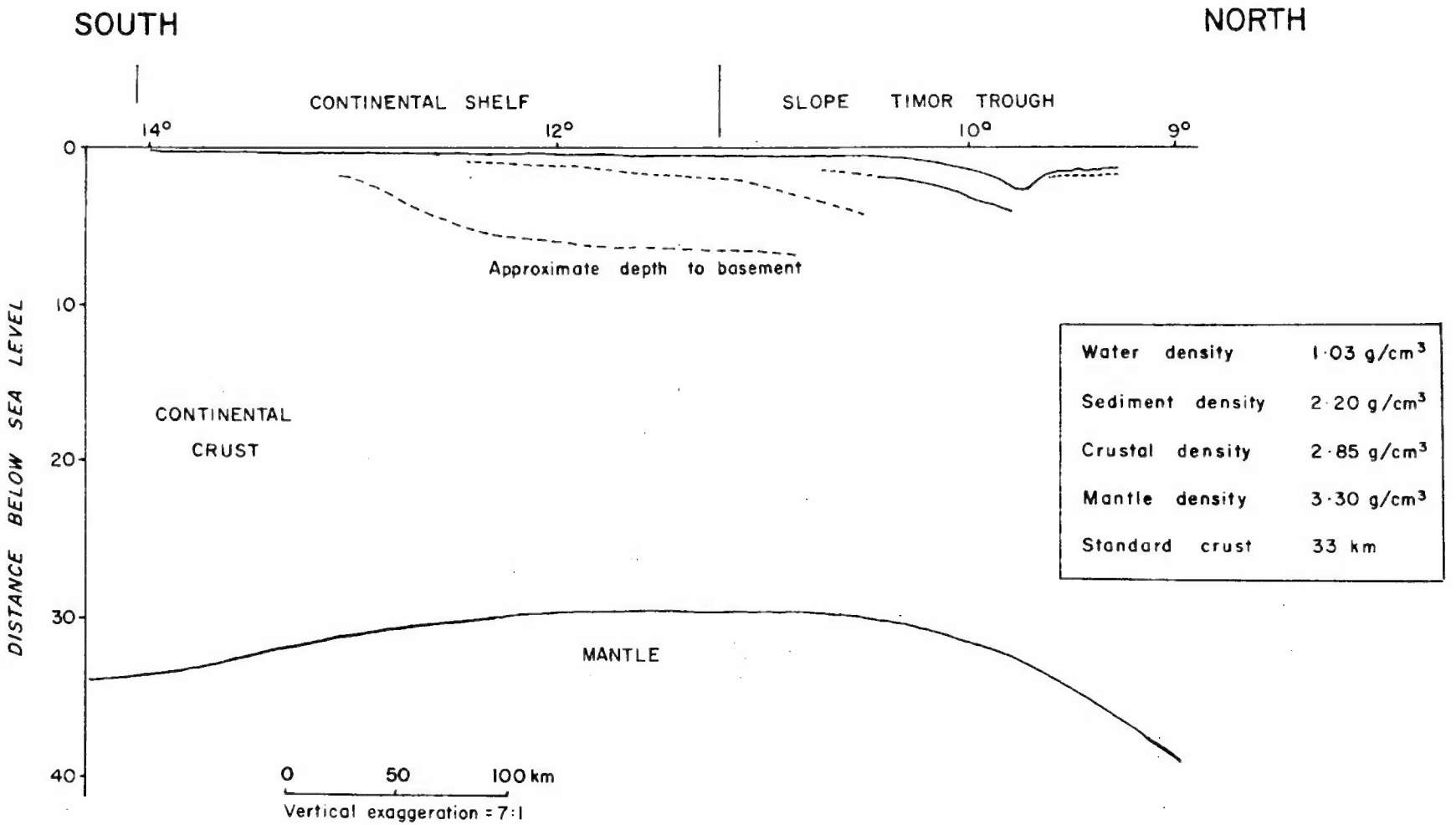
* HAYES AND CONOLLY (1972)
AMERICAN GEOPHYSICAL UNION, ANTARCTIC RESEARCH SERIES, VOL 19

SECTION THROUGH THE TASMANIA RIDGE

Fig. SGM 19

G463 - 21A

To accompany Record No. 1973/195

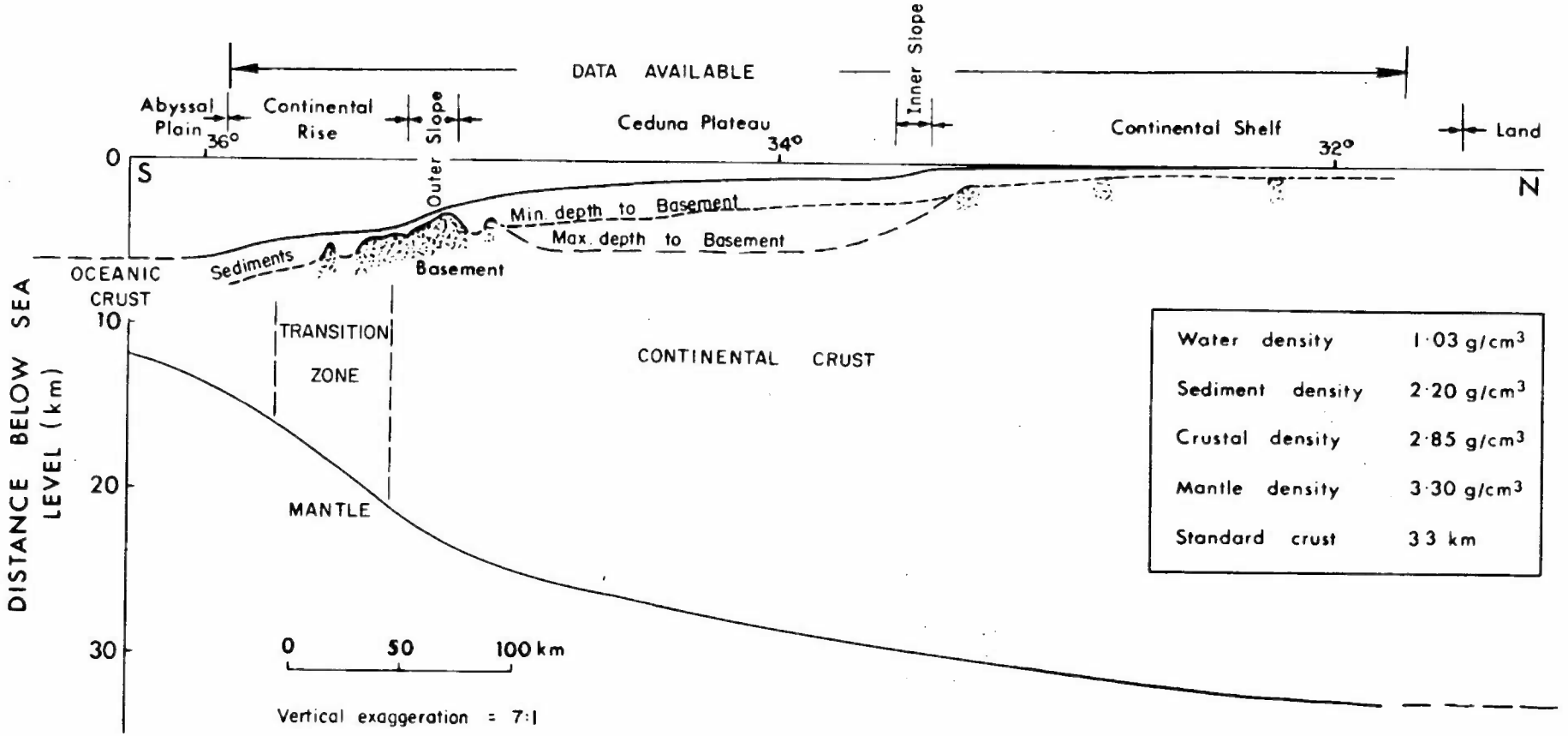


SECTION THROUGH THE TIMOR TROUGH (126° E)

Fig. SGM 20

G463–15A

To accompany Record No. 1973/195



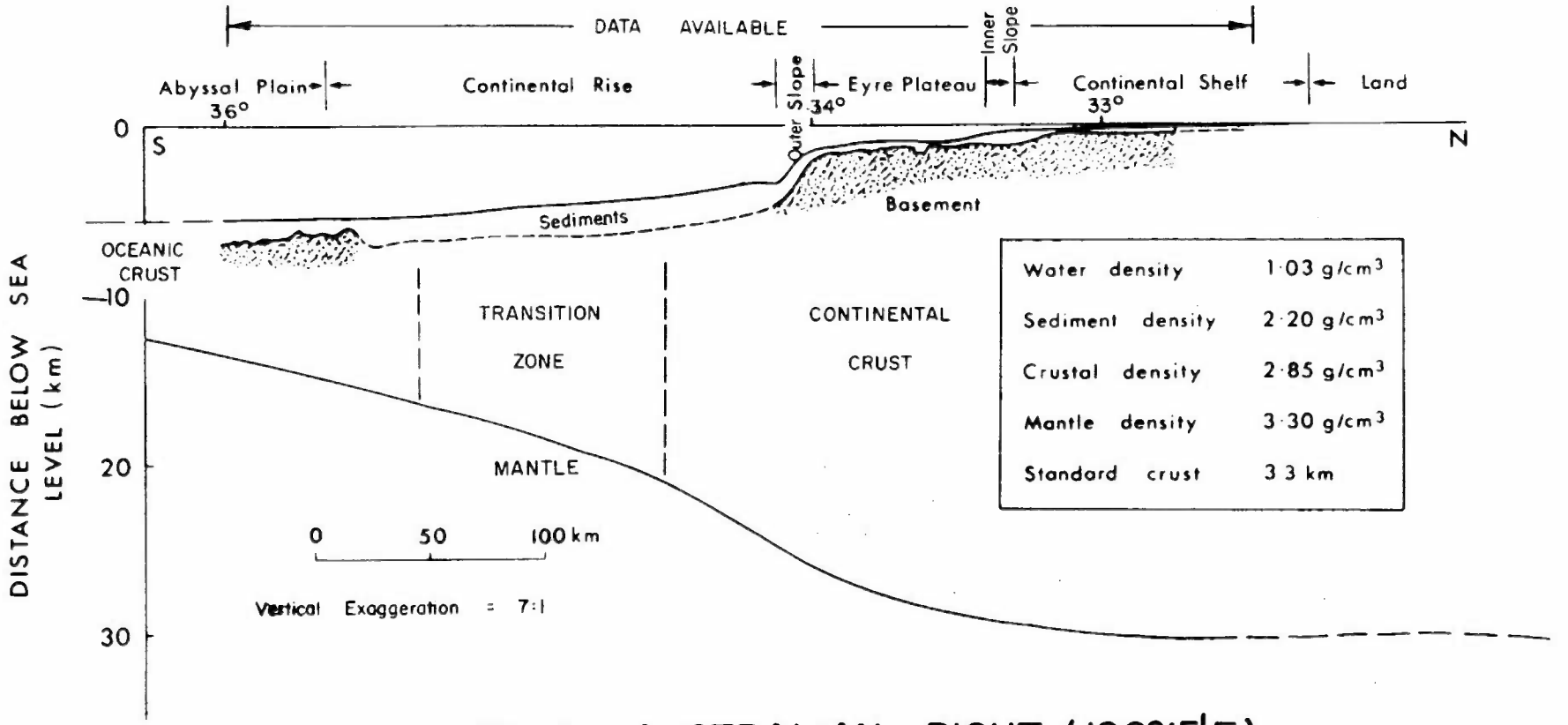
GREAT AUSTRALIAN BIGHT (130°35'E)

SECTION THROUGH THE CEDUNA PLATEAU

G463—13A

Fig. SGM 21

To accompany Record No. 1973/195



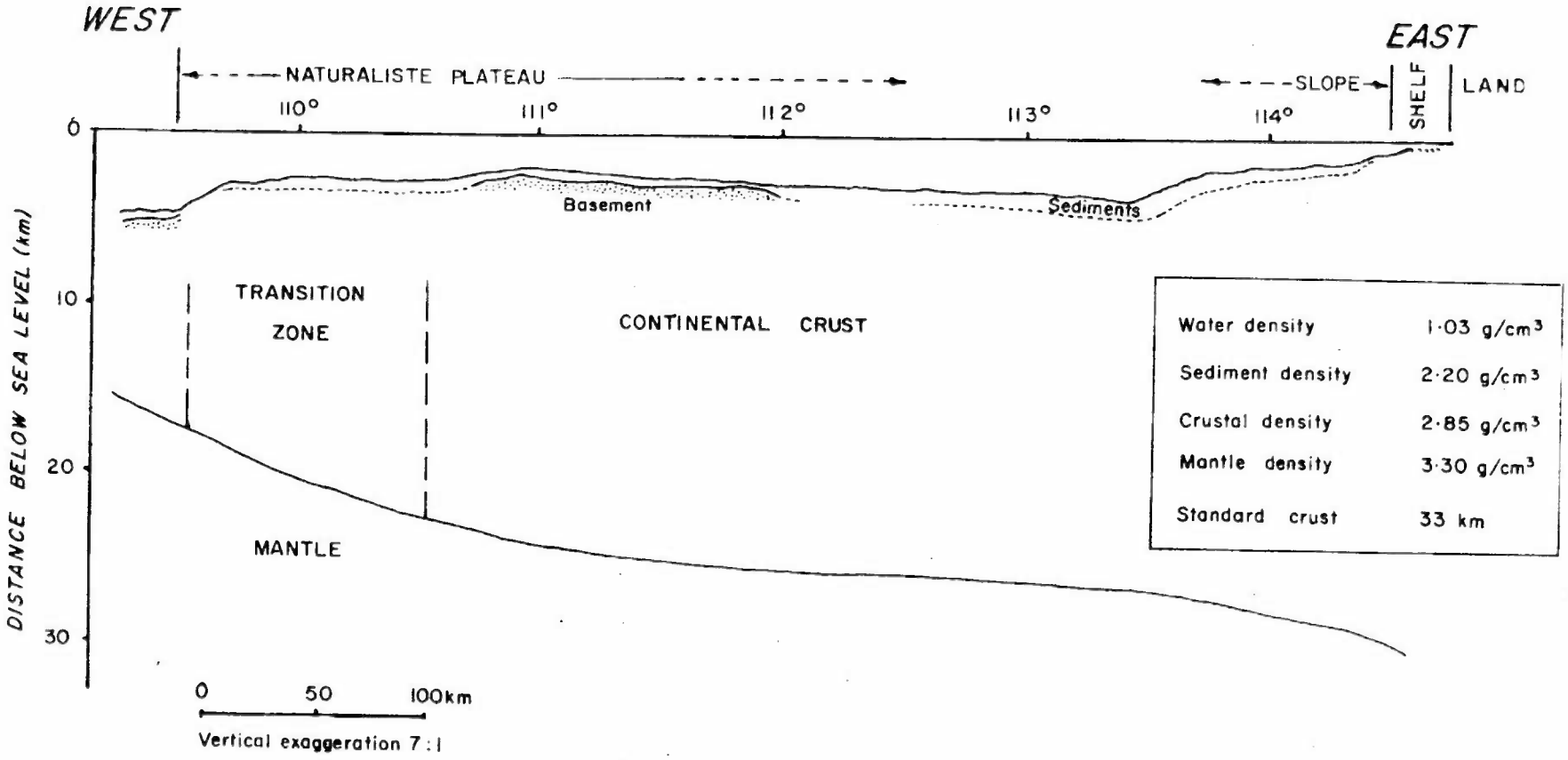
GREAT AUSTRALIAN BIGHT (126°15'E)

SECTION THROUGH THE EYRE PLATEAU

Fig. SGM 22

G463-12A

To accompany Record No. 1973/195



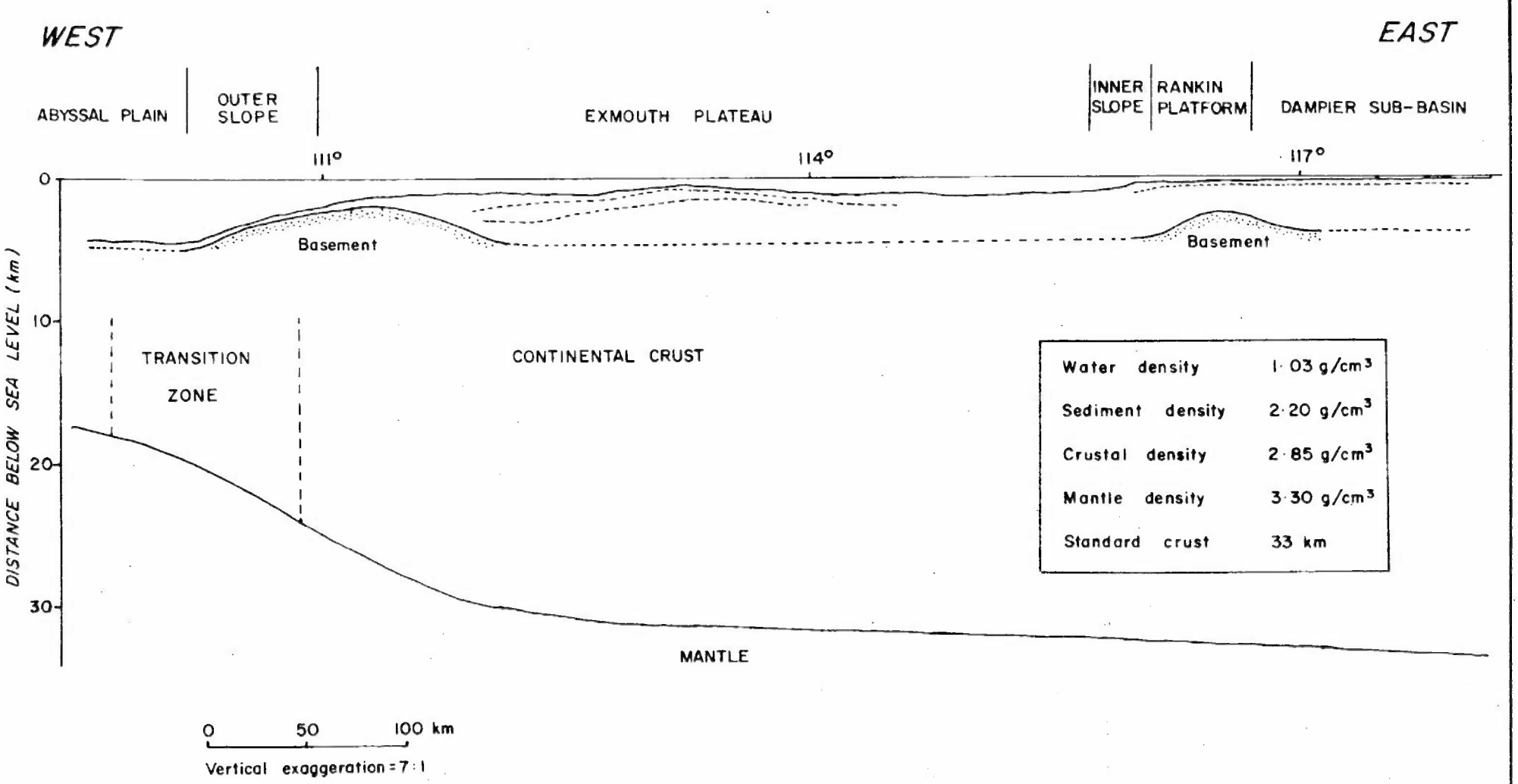
NATURALISTE PLATEAU LINE 19/02 (WEST-EAST
33° 50' S

SECTION THROUGH THE NATURALISTE PLATEAU

Fig. SGM 23

G463-18A

To accompany Record No. 1973/195



SECTION THROUGH THE EXMOUTH PLATEAU (20° S)

LINE 68 (WEST–EAST)

G463–22A

Fig. SGM 24

Sediment thicknesses of 0.5-1 km are confirmed in the offshore Eucla Basin and also on the Eyre Plateau. The Denman Basin probably extends onto the continental shelf for 50 km and occupies a total area of 10 000 km^2. The Polda Trough is a true graben containing at least 2 km of sediments and with boundary faults extending westwards across the northern edge of the Ceduna Plateau and southern edge of the Eyre Plateau. The gravity anomalies indicate 3 or 4 km of sediments under the Ceduna Plateau. The Duntroon Basin and Ceduna Plateau are sediment piles overlying a downfaulted block of the Gawler Craton. Both are bounded by a basement rise or band of intrusions along their southern edges (Fig. SGM 21 and 22).

The outcropping Gawler Block is encircled by a Bouguer anomaly ridge which may originate from an ancient mobile belt.

Faults along the margins of the Eyre Plateau, Ceduna Plateau, and Duntroon Basin, together with the Polda Trough graben, and graben development during the early stages of formation of the Otway Basin, support the notion that the present continental margin developed as a rift during the Jurassic period. The fault pattern is consistent with that predicted by the seafloor spreading hypothesis.

Naturaliste Plateau (P. Petkovic, P.J. Cameron). A total of 4500 nautical miles was surveyed over the Naturaliste Plateau during December 1972. The plateau extends 500 km west from southwest Australia between 32°S and 36°S latitude. Figure SGM 23 shows an east-west section through it. Gravity values indicate a crustal thickness of 20 to 25 km, i.e. intermediate between continental and oceanic thicknesses. The average sedimentary cover is less than 1 km thick but increases to over 2 km on the eastern part of the Plateau close to the mainland. The magnetic anomaly pattern is similar to that recorded over onshore areas of metamorphic basement, and the character and the seismic basement reflection suggests continental as opposed to oceanic crust for the Plateau.

The western part of the Plateau is topographically higher than the eastern part. The basement is shallower, and sedimentary cover less. Two unconformities within the sediments can be traced regionally. Results from the JOIDES drill-hole No. 258 dates the sediments as Cretaceous and earlier.

The sediments appear to have been largely undisturbed by tectonism. Within the basement there appears to be a northwest structural trend striking diagonally across the Plateau, and a north-trending fracture zone to the east.

Northwest Margin (E. Jacobson, A.P. Hogan). During the latter part of 1972 about 13 000 nautical miles were surveyed over the Australian northwest continental margin. The area covered extends from 12°S to 26°S latitude and includes the Exmouth Plateau, Wallaby Plateau, and Offshore Carnarvon Basin.

The Exmouth Plateau appears from the seismic records to have considerable thickness of sediments (Fig. SGM 24). Normal faulting and folding in the sediments are evident. A basement ridge along the northwestern margin of the Plateau appears to have formed a dam against sediment transport. The sediment source was probably the Australian mainland to the southeast. The crustal thickness of the Plateau is estimated from gravity results to be about 30 km. The Plateau appears to have formed as a sunken block of continental material during the opening of the Indian Ocean.

The Wallaby Plateau is separated from the continental shelf by a trough 4000 m deep. Structurally it is a series of north-trending basement ridges with about 0.5 km of sediments filling the troughs between. It appears to have an intermediate crustal thickness (Fig. SGH 25).

The seismic sections over the inner continental slope to the northeast of the Exmouth Plateau show considerable thickness of sediments, but structure and basement reflections are obscured by multiples. On the continental slope south of the Exmouth Plateau, the sedimentary section thickens towards the west. Normal faulting can be seen on many sections, but the rugged topography here degrades the seismic record quality.

Continental Margin survey, data processing

The navigation, gravity, and magnetic data from the Continental Margin Survey were acquired on board ship in the form of both analogue paper charts and 10-second samples on digital magnetic tapes in 2.5-minute buffered blocks.

The data processing system consists of four phases with the following broad functions:

Phase 1 - Removal of errors and interference from the field tapes. Replacement where necessary by hand digitization from the analogue charts. Production of clean 10-second tapes.

Phase 2 - Conversion to 1-minute data. Selection and processing of best navigational data from satellite data and alternative ship speed data. Application of Eotvos correction to gravity data. Application of magnetic diurnal corrections.

Phase 3 - Assessment of misties in gravity and magnetic data networks. Adjustment of misclosures by the method of least-squares.

Phase 4A- Production of edit maps. Final editing.

Phase 4 - Production of final maps.

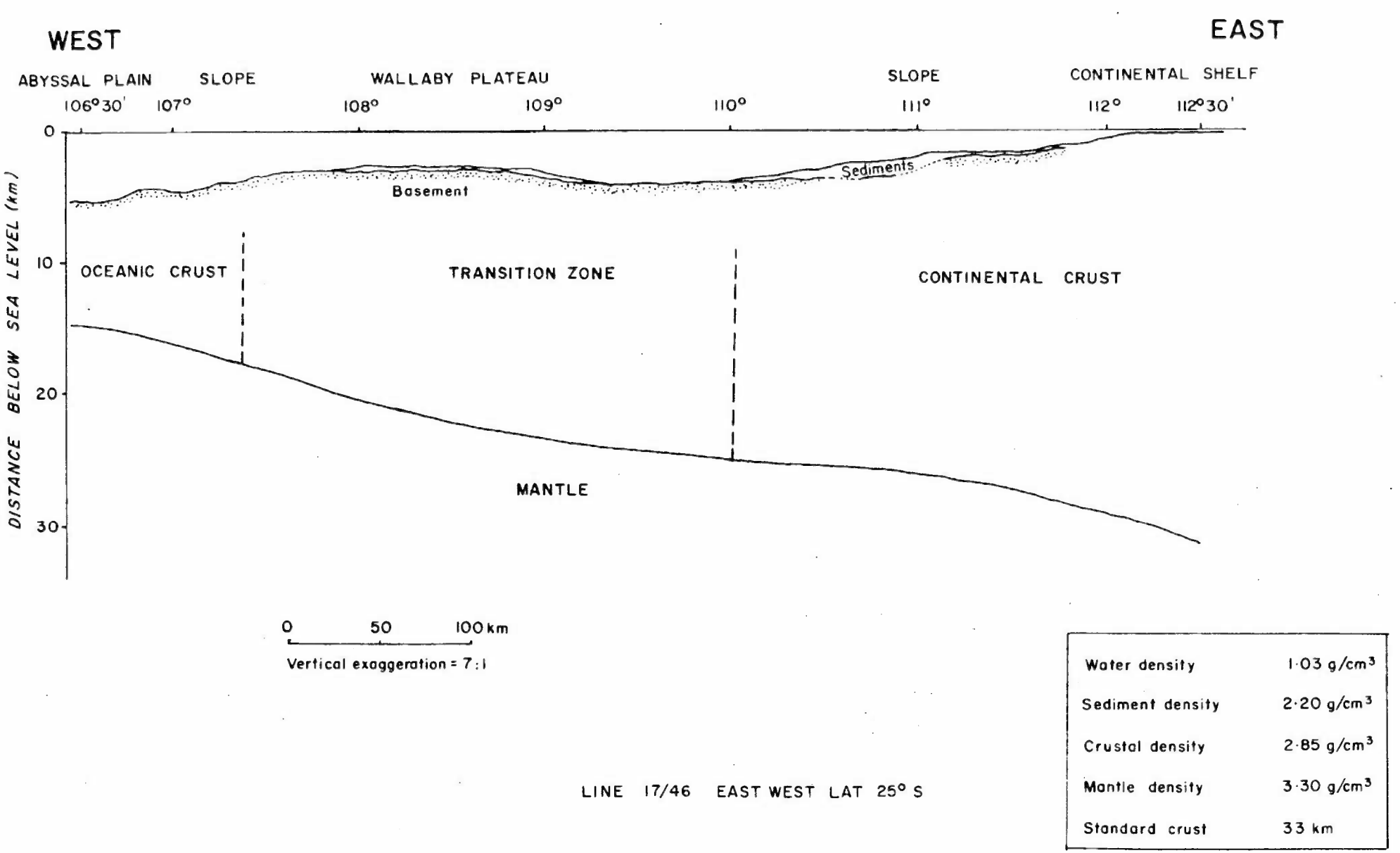
The responsibility for the processing of the data rests with the contractor, but BMR undertook to carry out visual checks of data and data plots to ensure that the data quality was satisfactory. Also BMR undertook to develop the complete suites of programs for phases 3 and 4. These programs are built around pre-existing BMR programs.

The contractor (CGG) set up an office in Canberra and uses BMR's computing facilities, mostly the CDC 6600 in Sydney via the terminal in the BMR building in Canberra.

The plotting of the final maps will be done by BMR on its flat-bed plotter over a period of about a year.

During phases 1 and 2 various problems arose in relation to data quality and several researches had to be done by BMR personnel to arrive at a best solution to each problem. Programs to implement the solutions were written by BMR personnel. Notes on various major examples of these activities are given below.

To accompany Record No. 1973/195



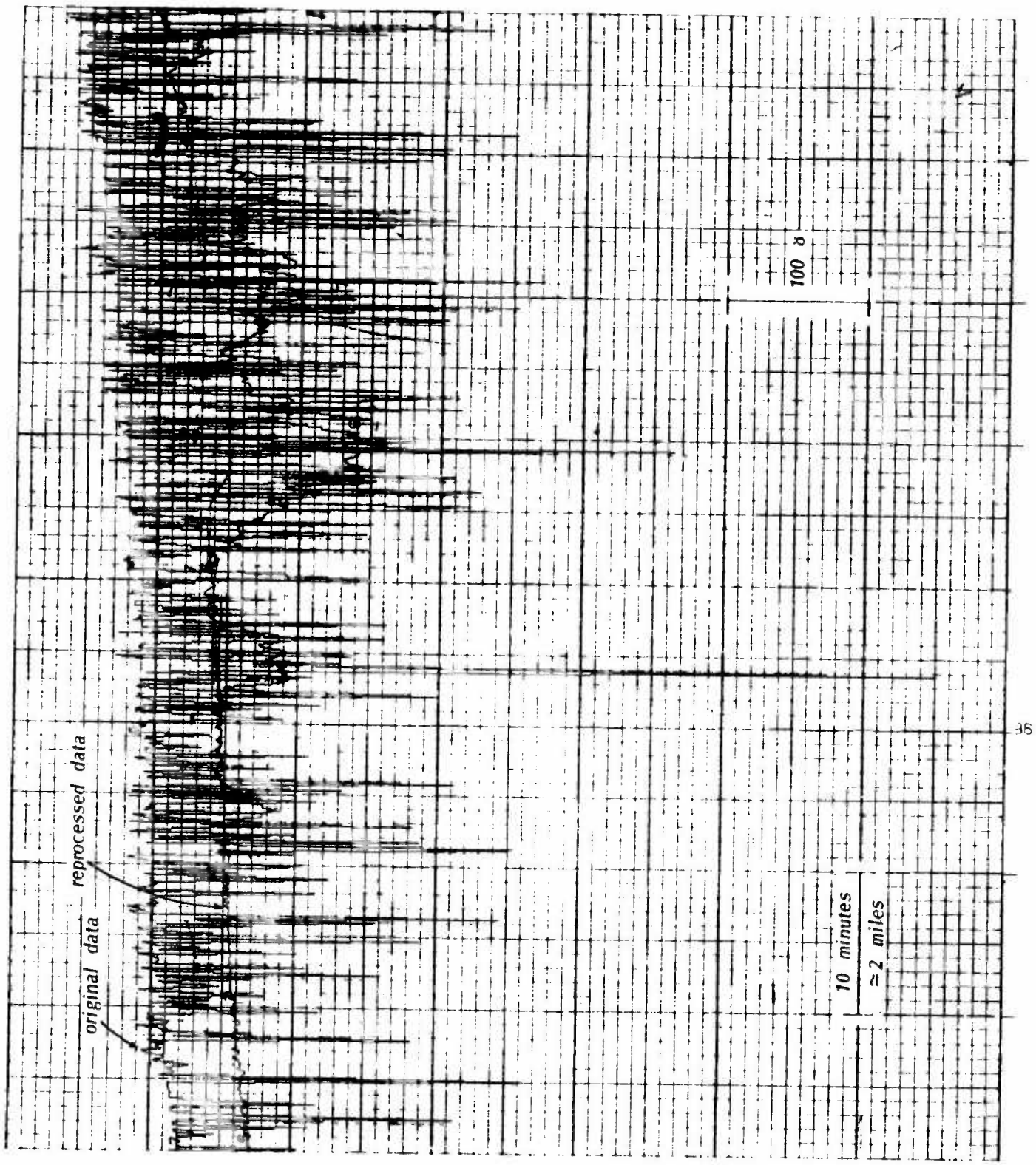
Water density	1·03 g/cm³
Sediment density	2·20 g/cm³
Crustal density	2·85 g/cm³
Mantle density	3·30 g/cm³
Standard crust	33 km

LINE 17/46 EAST WEST LAT 25° S

SECTION THROUGH THE WALLABY PLATEAU

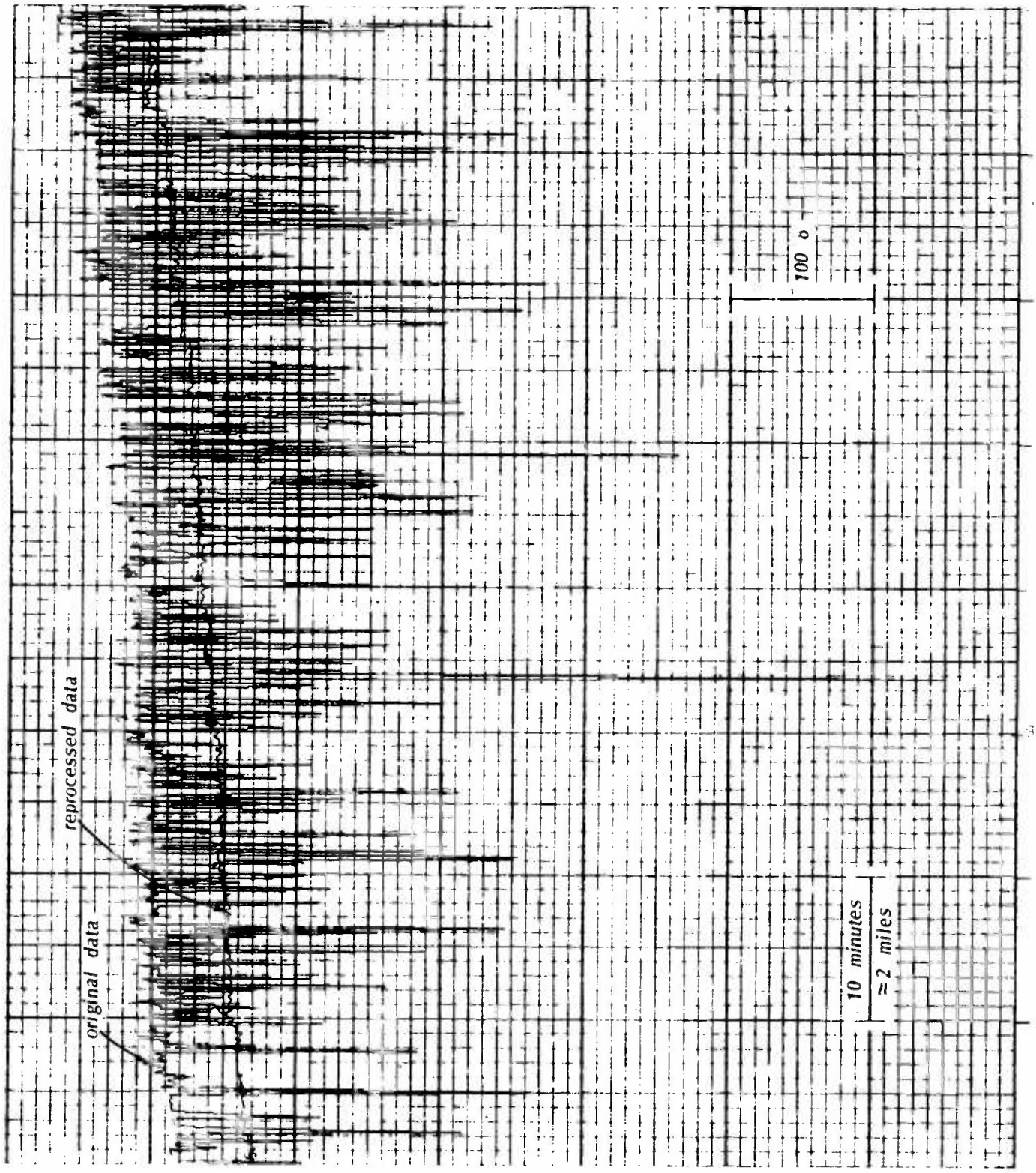
463-17A

Fig. SGM 25



REPROCESSED MAGNETIC DATA

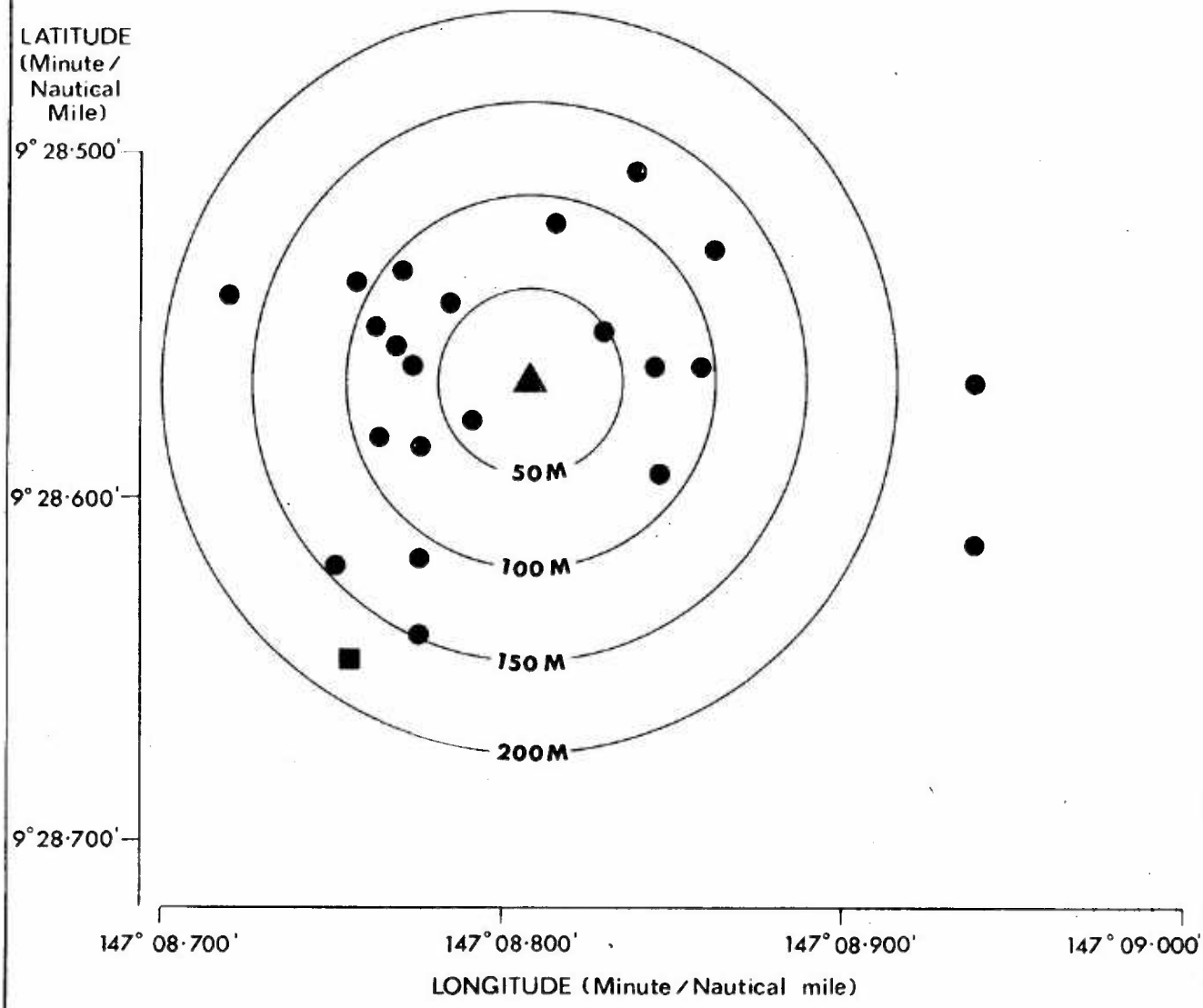
using MEDIAN ANALYSIS and 6–minute window



REPROCESSED MAGNETIC DATA

using MODE ANALYSIS and 6–minute window

Fig. S G M 28



● Satellite fix

▲ Mean position (9° 28·566', 147° 08·807')

■ Geodetic position (9° 28·647', 147° 08·755')

Number of positions = 22

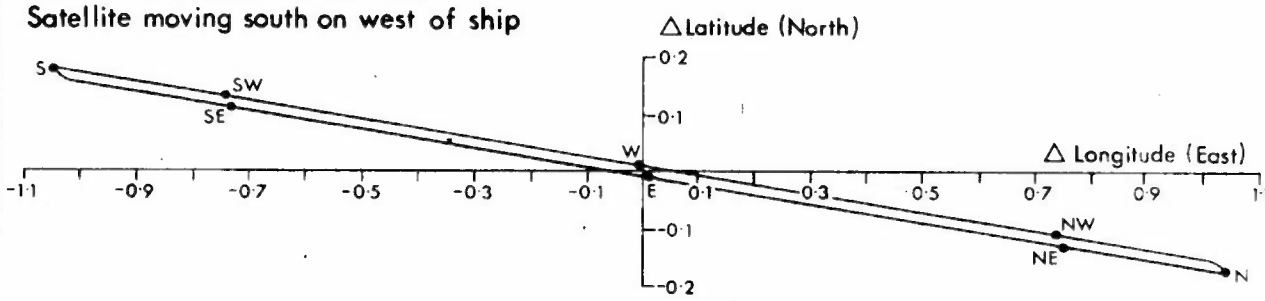
Standard deviation – 0·035' (Lat.)
0·058' (Long.)

DISPERSION OF ACCEPTABLE SATELLITE FIXES AT PORT MORESBY

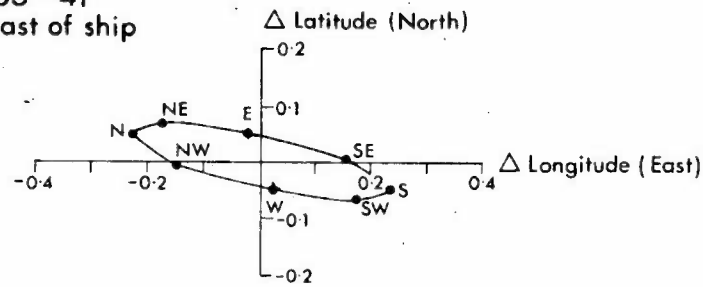
To accompany Record No. 1973/195

C55/B8–35A

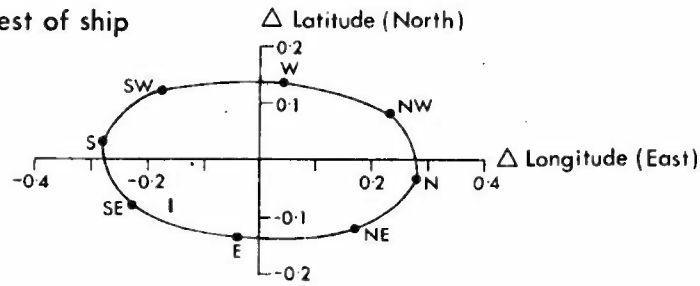
HIGH ALTITUDE PASS – 82°
Satellite moving south on west of ship



MEDIUM ALTITUDE PASS – 41°
Satellite moving south on east of ship

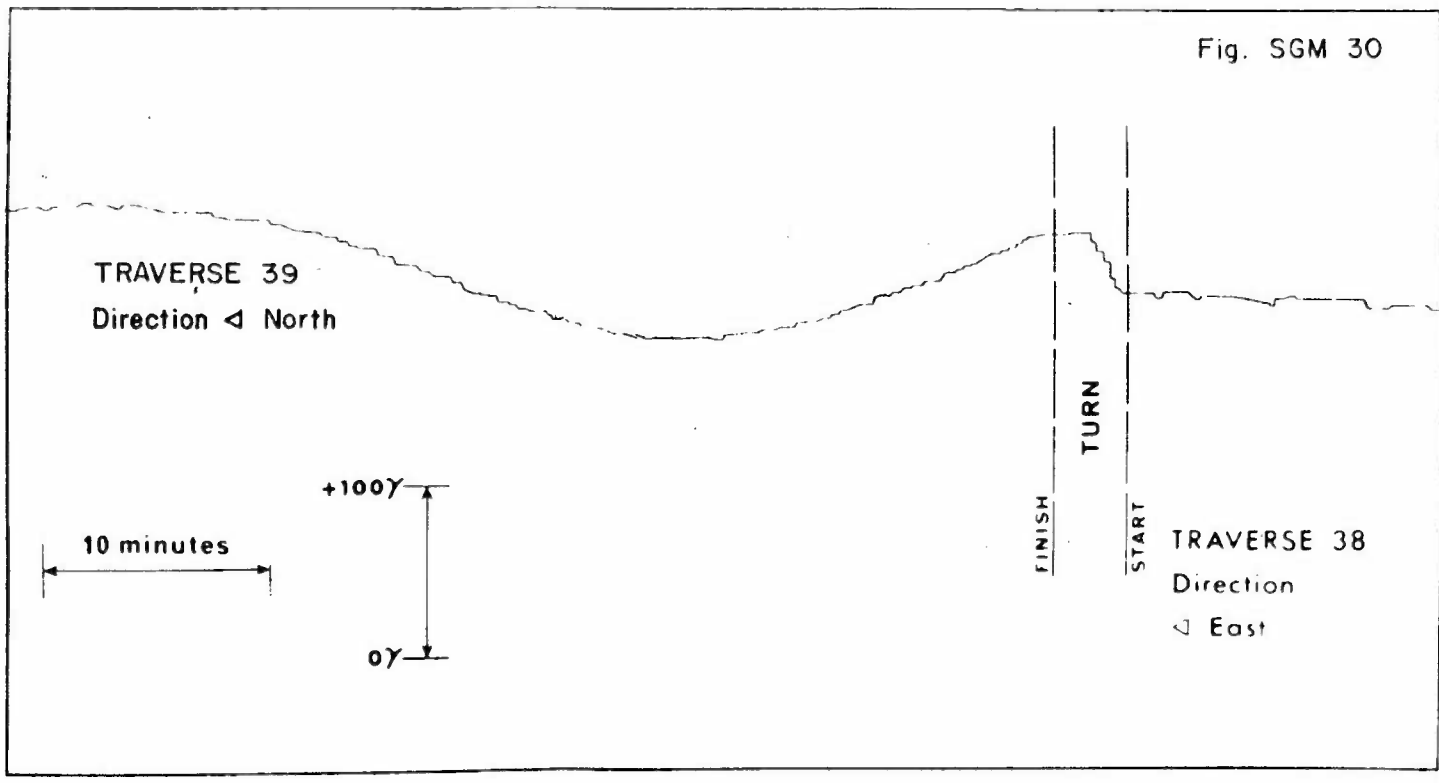


LOW ALTITUDE PASS – 8°
Satellite moving south on west of ship

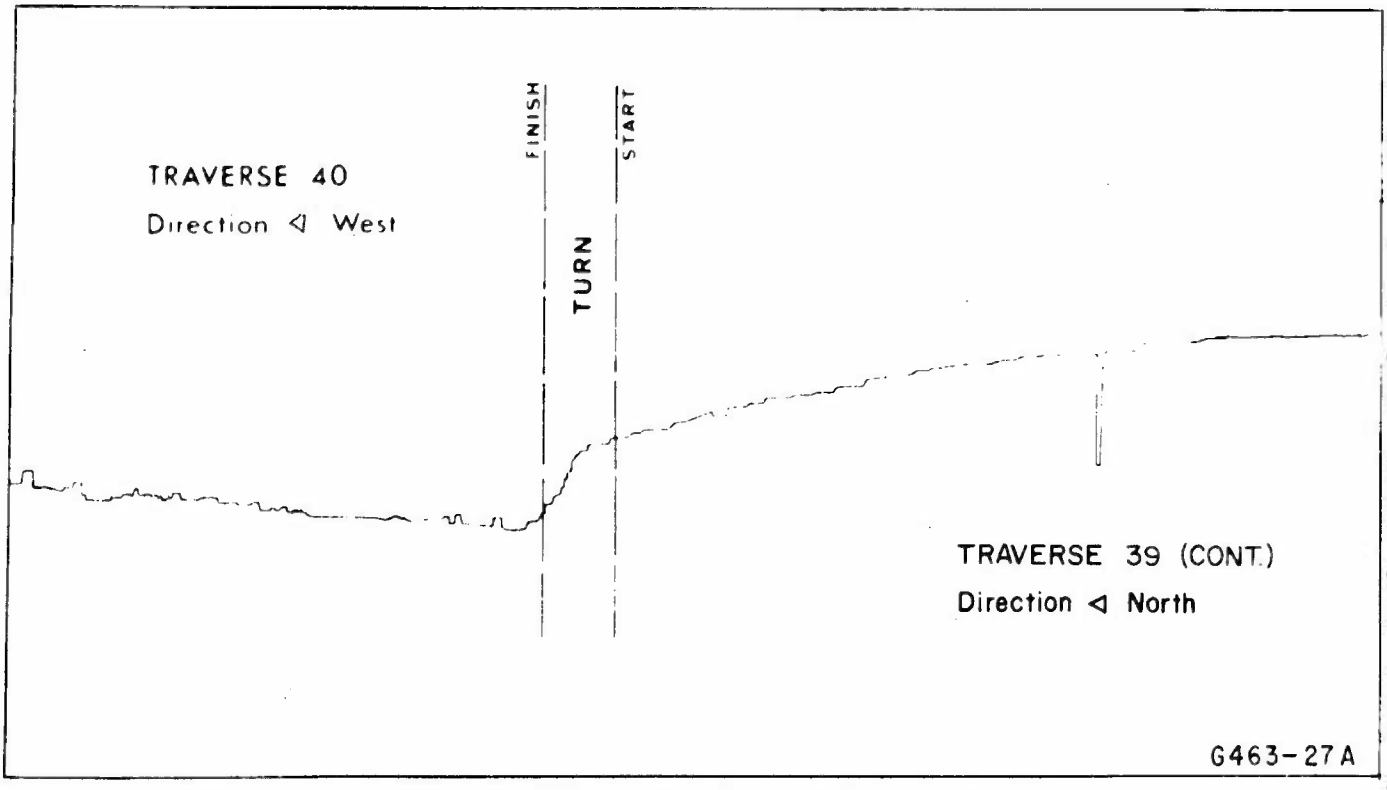


Directions indicated on elipses correspond to a velocity error of one knot in that direction.

CONFIDENCE LIMITS OF SATELLITE FIXES AT SEA



SURVEY 14 - Lines 38, 39 and 40



EXAMPLES OF MAGNETIC JUMPS ON TURNS.

Programming support (R. Whitworth, L.A. Tilbury, C.J. Watt, P. Petkovic). Computer programs have been developed to speed assessment and correction of errors. Programs VARPLOT and TWOPLOT have been used extensively to plot raw data, and raw and corrected data respectively in a form suitable for editing. Final editing has been done using EDITAPE, which allows data correction over irregular time intervals with minimal effect on valid observations.

The complexity of the correction procedures has required a versatile program that can apply the most appropriate technique to a particular channel over a limited time interval. Program FIXMAG provides five different techniques, each of which has an advantage with certain types of noise. To allow selective filtering and merging of any channel over any interval following automated correction, programs ANALYSE and MGDATA were developed.

Magnetic data corrections (P.A. Symonds). Noise introduced into the magnetic data by cable leakage and phase-lock amplifier problems has caused difficulties in processing. The standard processing system was found unsuitable, in some cases aliasing the noise into the period range accepted by later programs. Remarkable success has been achieved using program FIXMAG even on data of poor quality.

Figures SGM 26 and 27 show the recovery obtained using median and mode analysis respectively. In the first technique, the median value found in a window centred upon a particular time is compared with the observed value at that time. Moderate gradients do not significantly affect the technique, but when the spurious values reach 50% of the number of values in the window, the result becomes erratic. On the other hand the mode technique can work satisfactorily when spurious values exceed 80%, but a slope across the window can create difficulties.

Navigation data reduction (J.C. Mutter, L.A. Tilbury). Processing of the navigation data is continuing. The final position data will be an integration of satellite Doppler fixes and sonar Doppler and Chernikeeff log distance measurements. While the accuracy of a satellite fix is good when the observation point is fixed (Fig. SGM 28), uncertainty in the velocity of a moving ship can be an order of magnitude greater. The degree of reliability is a complex function of the geometry of the satellite pass, the Doppler counts obtained, and errors in the ship's velocity (Fig. SGM 29).

Inaccuracies in position of the satellite fixes cause spurious changes in the Eotvos correction to the gravity data. This is further complicated by erratic currents in deep water where the sonar Doppler system operates off back-scatter within the water layer. Further analysis of the satellite fix data is being done in an attempt to resolve this problem.

Anomalous magnetic results caused by course changes (C.J. Watt). The magnetic field measurements were often found to jump when there was a heading change. These jumps varied from a few gammas up to an extreme of around 50 gammas, averaging about five gammas for a 90-degree turn. Many turns did not show obvious jumps and it was difficult to tell if they occurred at all; they may have been too small to detect considering the average noise level, gradients, and change in gradient during the turn. Figure SGM 30 illustrates two examples of the phenomenon at the beginning and end of line 14/039.

A harmonic analysis of the jumps and associated heading changes showed they could be satisfactorily explained by a secondary field generated by the permanent and induced magnetism of the ship. This field is complex and varies with latitude and heading, but may be closely approximated by a major term involving the cosine of the heading (caused by the permanent field of the ship), and a minor term of twice the heading caused by the ship's induced field (Fig. SGM 31).

Although information on variations of the sensor position was poor, the higher-amplitude jumps were found to correspond to periods when the sensor was trailing closer to the ship.

Magnetic diurnal study (J.C. Mutter). Magnetic diurnals were monitored during the survey successively at eleven shore stations around the coast of Australia. The recorded diurnal is used in the final reduction of magnetic data for profiles and anomaly maps. On many occasions the ship traversed several hundred kilometres from its controlling shore station, and a study was undertaken to establish the applicability of shore station diurnals to the recorded marine data.

The survey was divided into sixteen areas of approximately equal extent and an averaged marine magnetic diurnal was produced for each area by analysing the misties in the recorded magnetic field at traverse intersections. The analysis consisted of a study of the diurnal harmonics by fitting weighted sums of cosine curves up to the sixth harmonic to the observed mistie values using a least-squares technique. In general, going beyond the third harmonic to get a best fit was not warranted. The best-fitting curve computed from the mistie values on the southwest coast is shown in Figure SGM 32. An identical analysis was made on the shore station data and the ship and shore data were then compared.

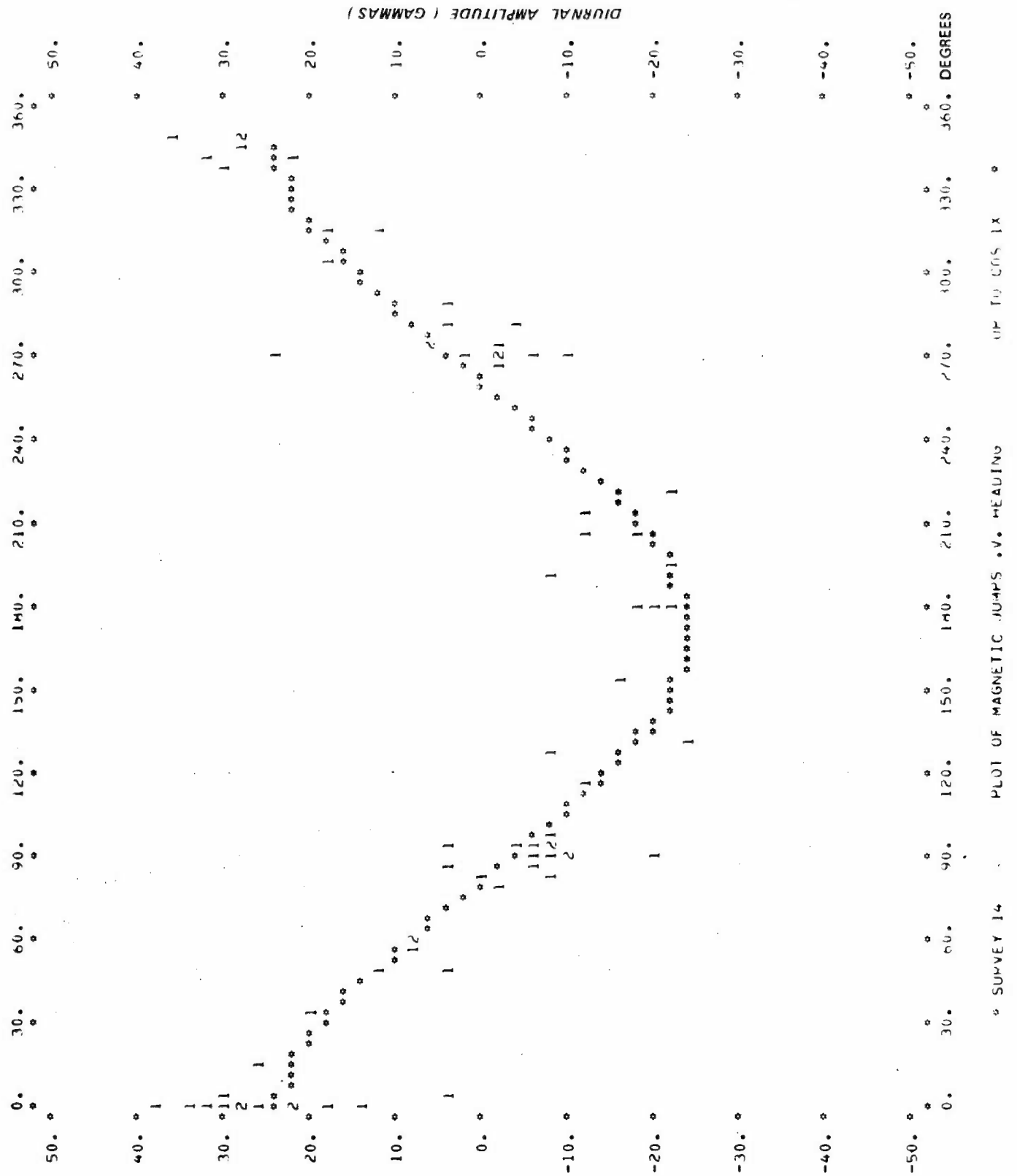
In general the diurnal and semidiurnal harmonic amplitudes were greater at sea than on shore. No consistent amplitude difference was observed for harmonics greater than the third order, and no consistent phase shifts are present. The marine data are noisier than the shore station data; this may account for the increase in harmonic amplitudes although the effect of conductivity in the ocean should also contribute. Further study is being undertaken to better understand the observed results.

Drift in LaCoste & Romberg gravity meter S24 (R.A.P. Garnett). LaCoste & Romberg marine gravity meter S24 was used for continuous measurement of gravity during the Continental Margin survey, a period of almost 30 months' operation.

The meter measures relative differences in gravity but an actual value of gravity may be obtained by adding the meter reading value to the meter zero value (the absolute value of gravity which would cause the meter to read zero). This type of meter normally exhibits a very stable, negative, meter-zero drift rate of less than 0.5 mGal/month. Mechanical adjustments or changes in its internal pressure may also alter the meter zero.

At each port call during the survey the marine meter value was tied to a BMR Isogal station in order to calculate this meter zero. Although these ties were not carried out as vigourously as they could have been the meter zero value may be as accurate as $\pm$ 1.0 mGal.

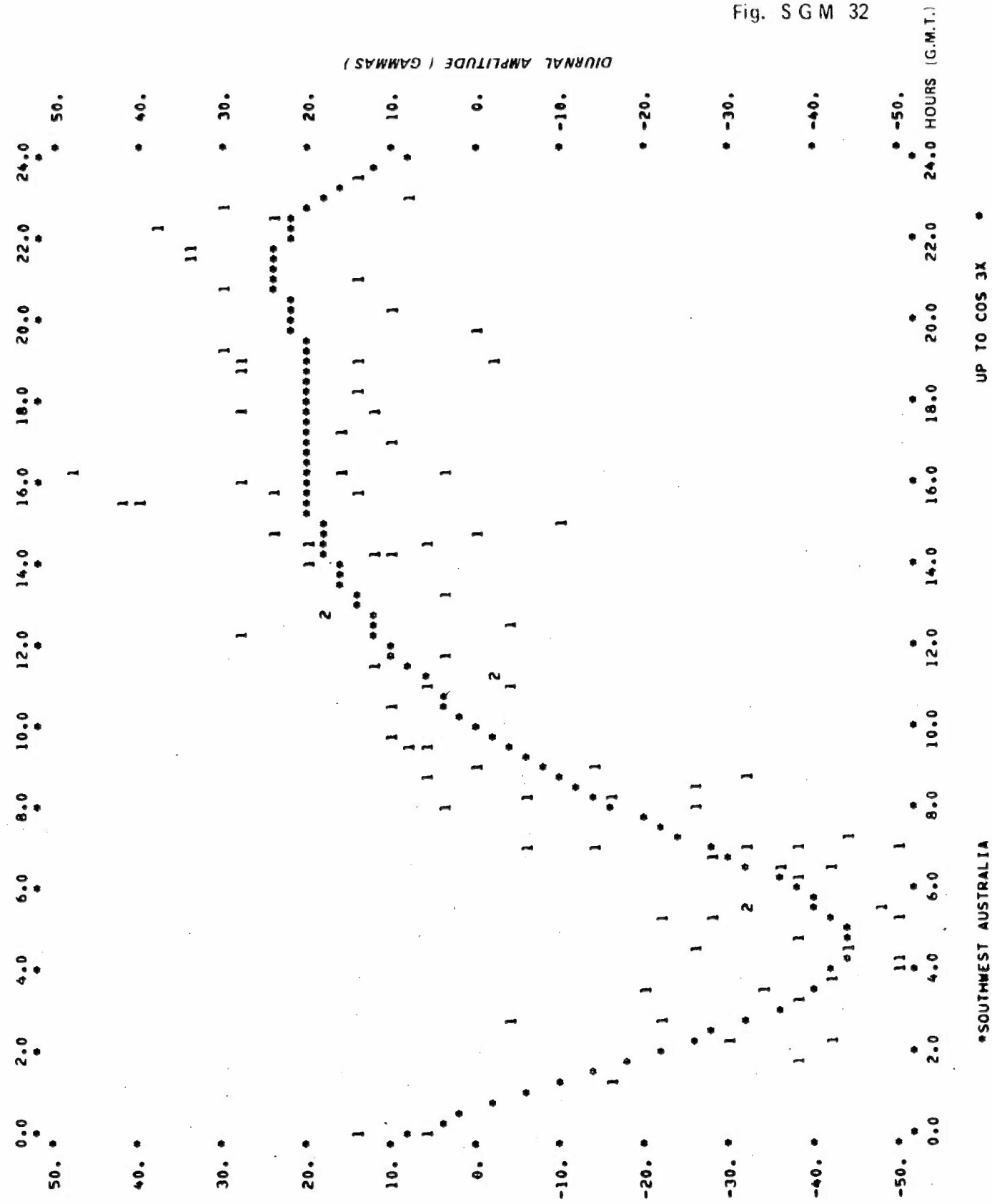
Fig. S G M 31



MAGNETIC JUMPS vs HEADING

Showing first harmonic curve fitted by least–squares to differences in observed magnetic field values before and after turns.

Fig. S G M 32



COMPUTED DIURNAL FOR S.W.AUSTRALIA

Showing combined first/second/third harmonic curve fitted by least–squares to observed mistie differences at traverse intersections.

To accompany Record No. 1973/195

DRIFT OF LACOSTE AND ROMBERG GRAVITY METER ZERO

GRAVITY METER ZERO (MILLIGALS)

971156 160 164 168 172 176 180 184 188 971192

1970 AUG
- SYDNEY
- CAIRNS
- MACKAY
- PORT MORESBY

SEP
- LAE
- MADANG

OCT
- RABAUL

NOV
- PORT MORESBY

DEC

1971 JAN
- HOBART
- HOBART

FEB

MAR

APR
- EDEN

MAY
- NEWCASTLE
- NEWCASTLE

JUN
- BRISBANE

JUL
- GLADSTONE
- BRISBANE

AUG
- GLADSTONE

SEP
- TOWNSVILLE

OCT
- CAIRNS

NOV
- BRISBANE

DEC
- CAIRNS

1972 JAN
- CAIRNS
- HOBART

FEB
- LAUNCESTON

MAR
- NEWCASTLE

APR
- LAUNCESTON

MAY
- PORTLAND
- PORT ADELAIDE

JUN
- PORT ADELAIDE

JUL
- PORT LINCOLN

AUG
- ESPERANCE

SEP
- FREMANTLE

OCT
- PORT HEDLAND

NOV
- BROOME
- BROOME

DEC
- CARNARVON

1973 JAN
- DARWIN

- PORT HEDLAND

- FREMANTLE
- ALBANY
- FREMANTLE

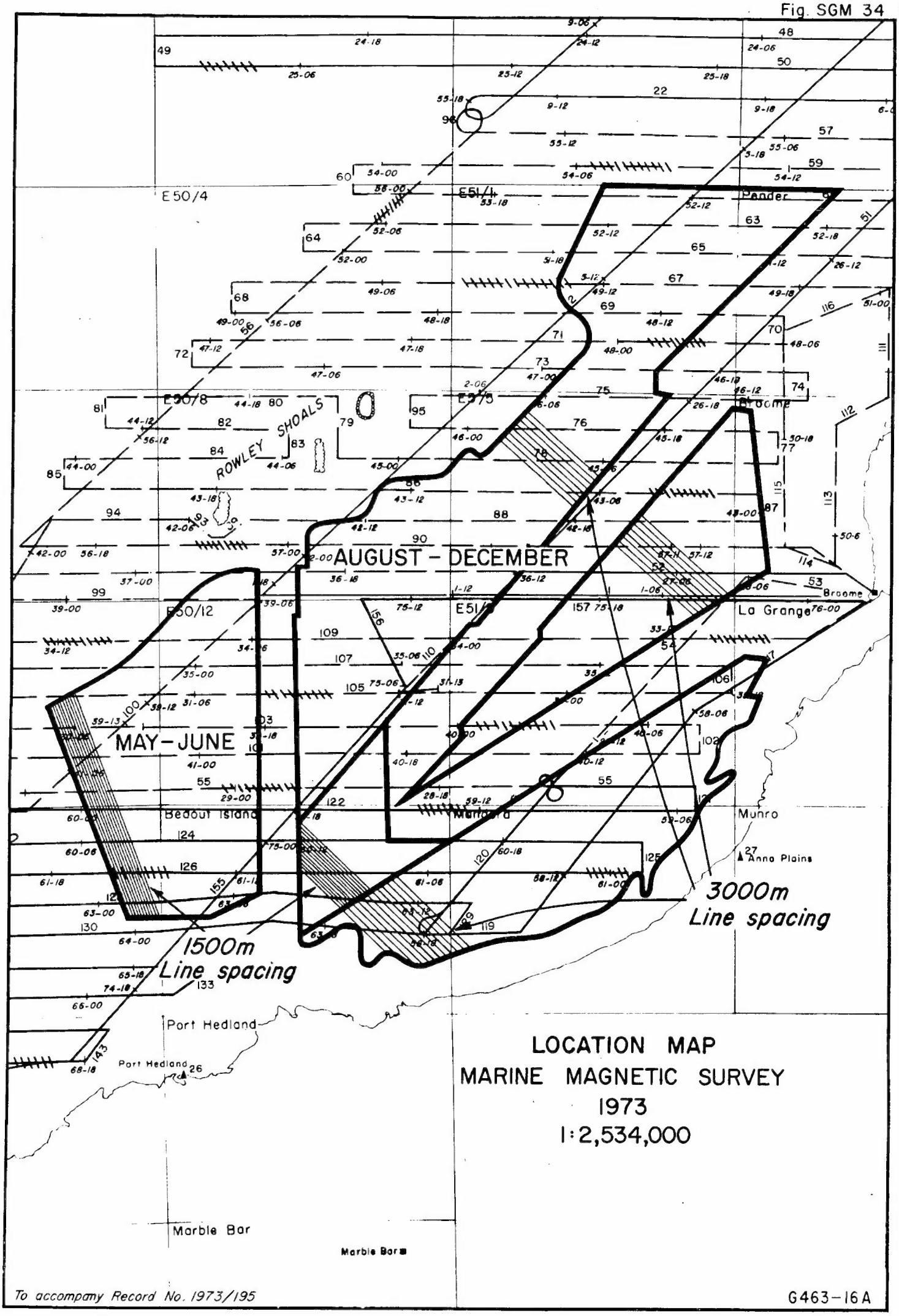
971156 160 164 168 172 176 180 184 188 971192

MILLIGALS

Fig S G M 33

A/B2-84

Fig. SGM 34



LOCATION MAP
MARINE MAGNETIC SURVEY
1973
1:2,534,000

To accompany Record No. 1973/195

G463-16A

Long periods of linear drift of the meter zero seem to have occurred. The drift was always negative and ranged from zero to 1.6 mGal/month, though the most reliable average is about 0.6 mGal/month. Individual values may depart from this line by up to 1.0 mGal (Fig. SGM 33). Between these periods of regular drift there were sharp positive changes, or tares, in the meter zero; the largest of these was about 10 mGal. It is not always clear whether they happened at sea or in port. An analysis of gravity misties may help establish the times of the tares and so simplify reduction of the gravity data.

Magnetic disturbance field study (J. Petkovic). The magnetic field measured at the shore monitor can be separated into two major components: the diurnal, with periods of the order of a day, and the disturbance with periods generally less than one hour. Uncertainty exists as to whether the monitor field applies at the ship's position, which can be several hundred kilometres away. The result of an analysis of the short-period component is given here.

Shore data corresponding to three magnetic storms were digitized and converted into values at one-minute intervals. The ship and shore data for each interval were then filtered and the residuals with periods less than 30 minutes were cross-correlated. Two of the storms occurred when the ship was surveying in geologically disturbed areas, and no sensible correlation was observed. But the third storm occurred when the ship was working in deep water in a magnetically quiet area; here the correlation between the residuals was significant and a ratio of 0.98 was determined for ship/shore values. One may reasonably conclude that the amplitude of the short-period events at the ship's position is identical with that observed at the shore position. It does not appear feasible to remove the disturbance field by cross-correlation on a systematic basis because of the large variations in the observed field in many areas. However this result shows that removal of the disturbance field by simple subtraction should be adequate.

Marine magnetic surveys

A twelve-year program of bathymetric soundings over the Australian continental shelf at 1.5 and 3-km spacing is being done by the Division of National Mapping. Navigation is by shore-based radio-positioning aids such as SHORAN, supported by satellite navigation and sonar Doppler. BMR is taking the opportunity to record the magnetic field, using BMR equipment installed on the National Mapping vessel.

The first magnetic survey of this series was carried out during 1972 off the east coast but was soon curtailed when the magnetometer sensor, towed behind the ship, snagged on fishing traps and was lost. A new sensor was obtained in time for the first contract bathymetric operation over the northwest shelf. Nearly 8000 km of magnetic data were recorded at a line spacing of 1.5 km between Port Hedland and Rowley Shoals during May and June 1973. SHORAN was used for position fixing, and a satellite Doppler navigation system was operated on board. A magnetic shore monitor station was operated continuously at Port Hedland airport. Figure SGM 34 shows the boundary of the survey area and indicates the line spacing and orientation. This is superimposed on the traverses of the 1968 marine geophysical survey.

A larger operation started in August and continued to the end of the year. Substantially the same equipment was installed on the contract vessel in Broome. The main radio positioning system was Decca HI-FIX with SHORAN backup and National Mapping's satellite Doppler navigation system.

Line spacing was mostly 3 km except close to Port Hedland, where it was reduced to 1.5 km. The magnetic shore monitor was operated continuously at the meteorological station close to Broome airport. It is expected that about 18000 km of magnetic traverse will be completed. Figure SGM 34 shows also the boundary of the survey area and indicates the line spacings and orientation.

The magnetic data from these surveys are in the form of continuous traces on paper charts, and the positioning data are tabulated as 5-minute values of radio-net co-ordinates. These require preparation in digital form, along with the bathymetry, and collation on digital magnetic tape. The digitizing is in progress and preliminary results should be published in 1974 or 1975.

Inspection of the analogue magnetic charts shows that many anomalous magnetic features have been recorded. The closeness of the traverses in this work should ensure that reliable magnetic basement depths may be estimated. Other valuable interpretation seems possible.

Marine Group subroutine library

Computer subroutine requirements increased as processing of the continental margins data accelerated. An efficient subroutine library system was needed to provide for additions, modifications and access. The concept adopted was to collect all Marine Group subroutines in standardized format on one magnetic tape. The initial system consisted of a serial listing in card image format. Additions and changes were made using an edit program, NEWFILE, which made the necessary changes and produced as output a new library tape to replace the previous one. To assemble a program for a particular job, CREATOR was used to pick the required subroutines from the library tape and store them together until the completion of the job.

By the middle of the year nearly 100 subroutines had been assembled in this way, and it appeared that the size of the library made the card image format inefficient. A CDC editing program, UPDATE, was adopted which accepts card image input but creates and operates on a magnetic tape in binary format, using an index system to increase efficiency. Edit jobs using UPDATE require about one-third the time of NEWFILE. An additional advantage is that UPDATE is compatible with the CYBER 76 computer.

At the end of the year the Marine Group subroutine library was in active use with about 200 subroutines.

Machine-contouring system revisions (I.C. Briggs)

The BMR machine-contouring system was designed around a basic algorithm using the principle of minimum curvature to contour geophysical data. Important considerations in the system design were:

- high-quality output suitable for a flat-bed plotting machine,
- versatility in accepting data formats,
- capacity to handle large amounts of data,
- operational simplicity and economy, and
- adaptation to specific plotting machines and computers.

Priority tended to be in this order, and considerable effort during 1973 was aimed at simplifying the operational procedures with particular emphasis on:

- simpler control-card format,
- simpler control-card compilation,
- reduction in the need for high-level understanding of the system, and
- greater restart facilities, both automatic and operator-initiated.

Other work concerned adaptation to the CDC 6600 computer in Sydney, much of which should benefit the current conversion to the CYBER 76 computer installed recently by CSIRO in Canberra, and adaptation to the CALCOMP flat-bed plotter system installed this year in BMR.

In a system of this size and complexity there is a normal, continuing need for revision and updating to meet changing circumstances. The operating system is usually retained in active use until the changes have been completed to a satisfactory operational stage, tested, and debugged. This procedure was followed to the extent possible during 1973 in updating the contouring system.

A paper describing the contouring system is being published in 'Geophysics', the journal of the Society of Exploration Geophysicists.

NEWDAS - Marine data acquisition program (I.C. Briggs)

This program was written in 1971 and set up, tested, and debugged in 1972. It was fully operational and performed satisfactorily for the final six months of the continental margin survey, which terminated early in January 1973.

Mr Briggs completed documentation of the program during 1973, including a brief history of its development.

Map production (J.K. Grace, F. George)

Hourly data values were extracted on board the ship and used for preliminary reduction. These data have been placed on computer-based files and form input to a fast contouring program to produce preliminary maps at 1:2 500 000 showing water depth, Bouguer anomaly, free-air anomaly, and magnetic anomaly values. Plots of ship's track have also been produced.

The survey including New Guinea waters has been broken into eight areas. A total of 40 maps were drawn using the CALCOMP 745 flat-bed plotter. Manual annotation of contour levels has been necessary as there is still not a satisfactory automatic annotation system. Some editing of the water depth contours was done around reef areas as such information was not included in the data files.

It will be necessary to integrate coastline data (i.e. the zero depth contour) into the data files if sensible contouring is to be obtained directly on the flat-bed plotter.

3. OBSERVATORIES AND REGIONAL SECTION

OBSERVATORIES SUBSECTION

Headquarters Observatory Group

Geomagnetism. 58 observatory-months of magnetograms were scaled and 33 observatory-months were reduced. Many problems were experienced with breakdowns of the Typetronics paper tape equipment and with the reduction programs on the CDC 3600 computer. As a result a backlog of about 20 observatory-years remains to be reduced.

Volume 21 of the Geophysical Observatory Report was prepared and distributed.

A two-component (X and Y) fluxgate variograph was run at Kowen Forest, ACT, as a contribution to the Australian-USSR conjugate point project, until April, when the equipment was required for the first-order regional magnetic survey.

In April an Elsec automatic magnetic observatory (AMO) was installed at Kowen Forest (Fig. OR 1). This produces digital and analogue recordings, at one-minute intervals, of total intensity and variations of declination and inclination. The acquisition of the AMO is the first major step in a long-term plan to improve the efficiency of magnetic observatory operation. By the end of October some of the computer programs to convert the reduced data into digital records of the main magnetic elements (D, H, Z, and F) had been written. Work is still being done on the calibration of the AMO.

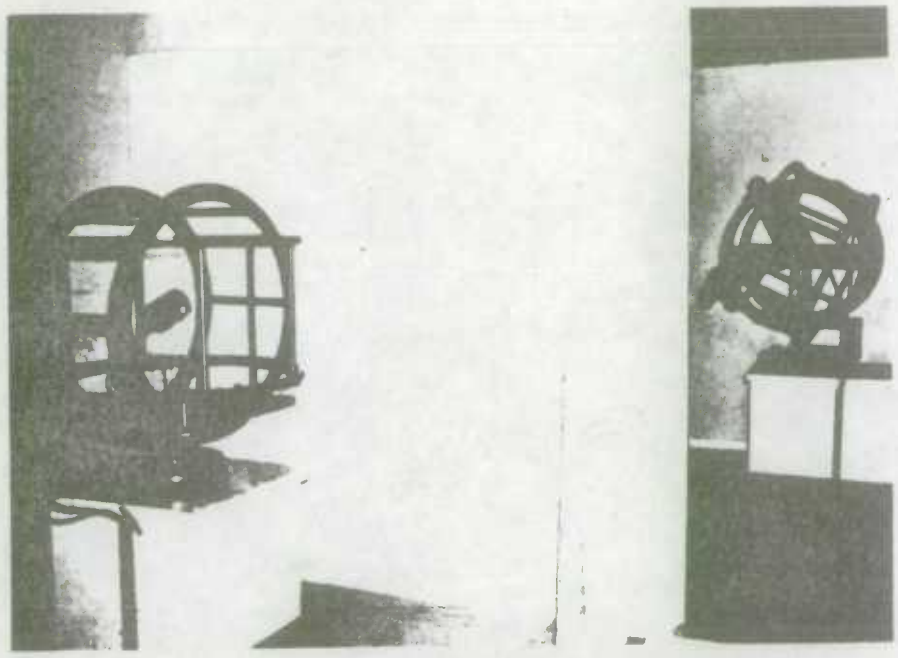
Investigations were continued to find a suitable site for a permanent observatory in the Canberra area. The Forests Branch of the Department of the Capital Territory is opposed to the development of the Kowen Forest site; a magnetic survey of the Mount Stromlo area has shown this to be unsuitable, so plans are being made to develop a site east of Kowen Forest. This site is also controlled by the Forests Branch, who have to date raised no objections for its use as an area for observatory work.

Seismology. The locations of seismograph stations and accelerographs operated by BMR are shown in Figure OR 2. Analysis of the Alice Springs seismographs continued throughout the year and preliminary bulletins were prepared and distributed for this station. Preliminary monthly bulletins were also issued for the stations at Manton (Darwin), Toolangi, Norfolk Island, Ballfield, Macquarie Island, and Mawson. Final data for the International Seismological Centre from all institutions within Australia, Papua New Guinea, and the British Solomon Islands were processed for the period February-December 1971 and sent to Edinburgh on magnetic tape. Time-sorted bulletins for the same period were also prepared and distributed. Delays were experienced in obtaining data from some of the universities and this slowed down the production of bulletins. Figure OR 3 indicates the amount of data produced by the BMR stations, excluding those in Antarctica.

Work continued throughout the year on the Earthquake Data File and all recorded earthquakes in the region 0-90°S, 75-165°E, for the period 1900-1972 are now assembled in the file. Extensive use of the system has been made and many requests have been processed from both within and outside BMR. Editing the file involved relocating early Australian earthquakes from 1918-1954, locating some Western Australian earthquakes from 1968-1971, and adding magnitude and intensity data where possible for all New Guinea earthquakes.

AUTOMATIC MAGNETIC OBSERVATORY (AMO)
AND PROTON VECTOR MAGNETOMETER (PVM)

PVM FOR F,H AND Z



AMO FOR ΔD, F AND ΔI

COILS AND SENSORS

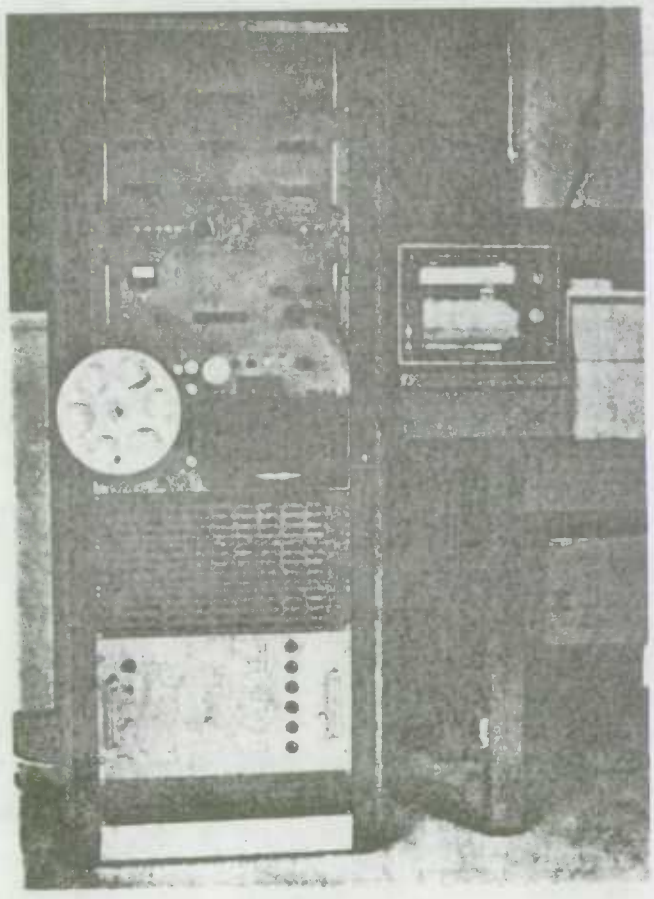
CRYSTAL CLOCK

CONTROL UNIT

MAGNETOMETER

PAPER TAPE PUNCH

POWER SUPPLIES



ANALOGUE RECORDERS

AMO CONSOLE

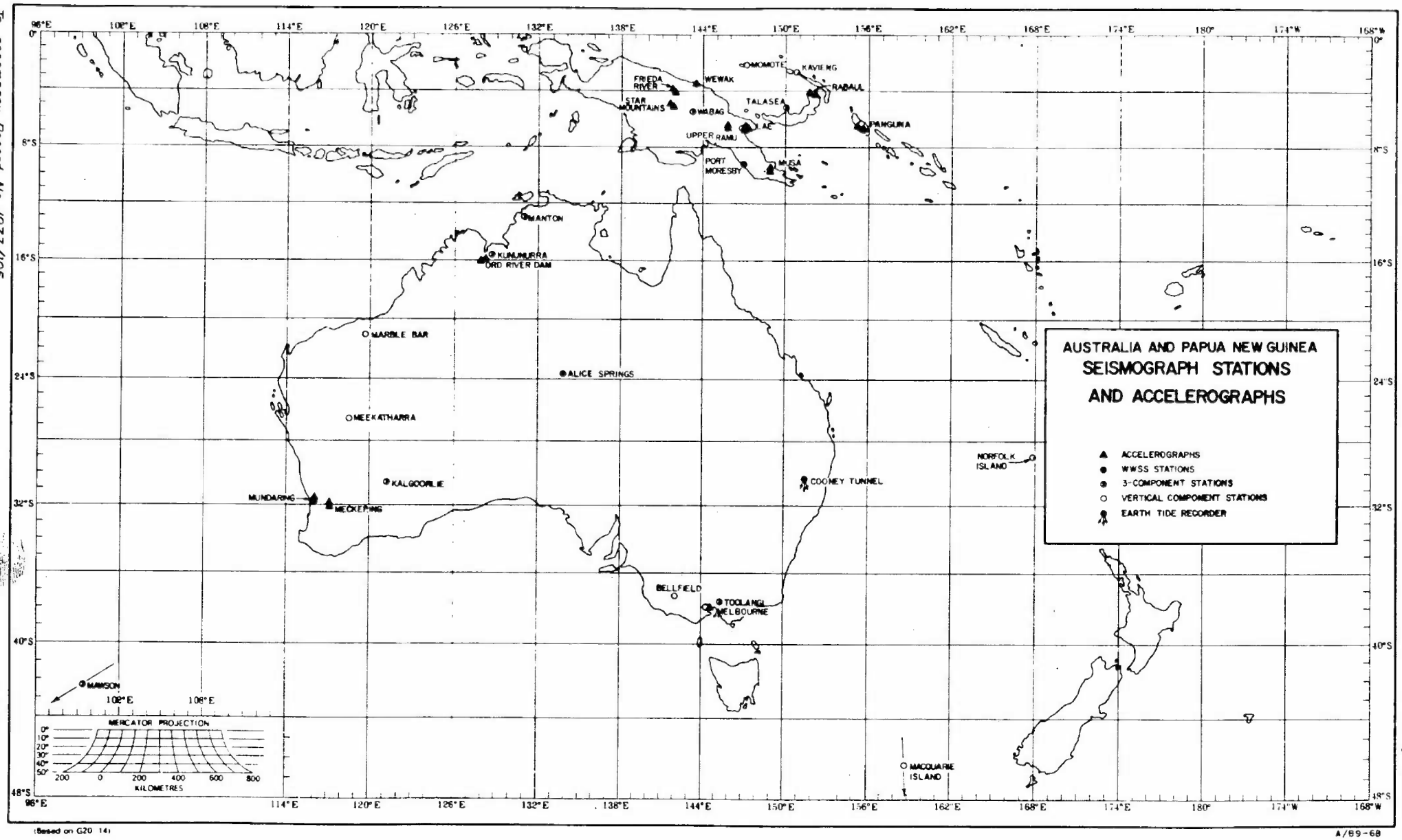
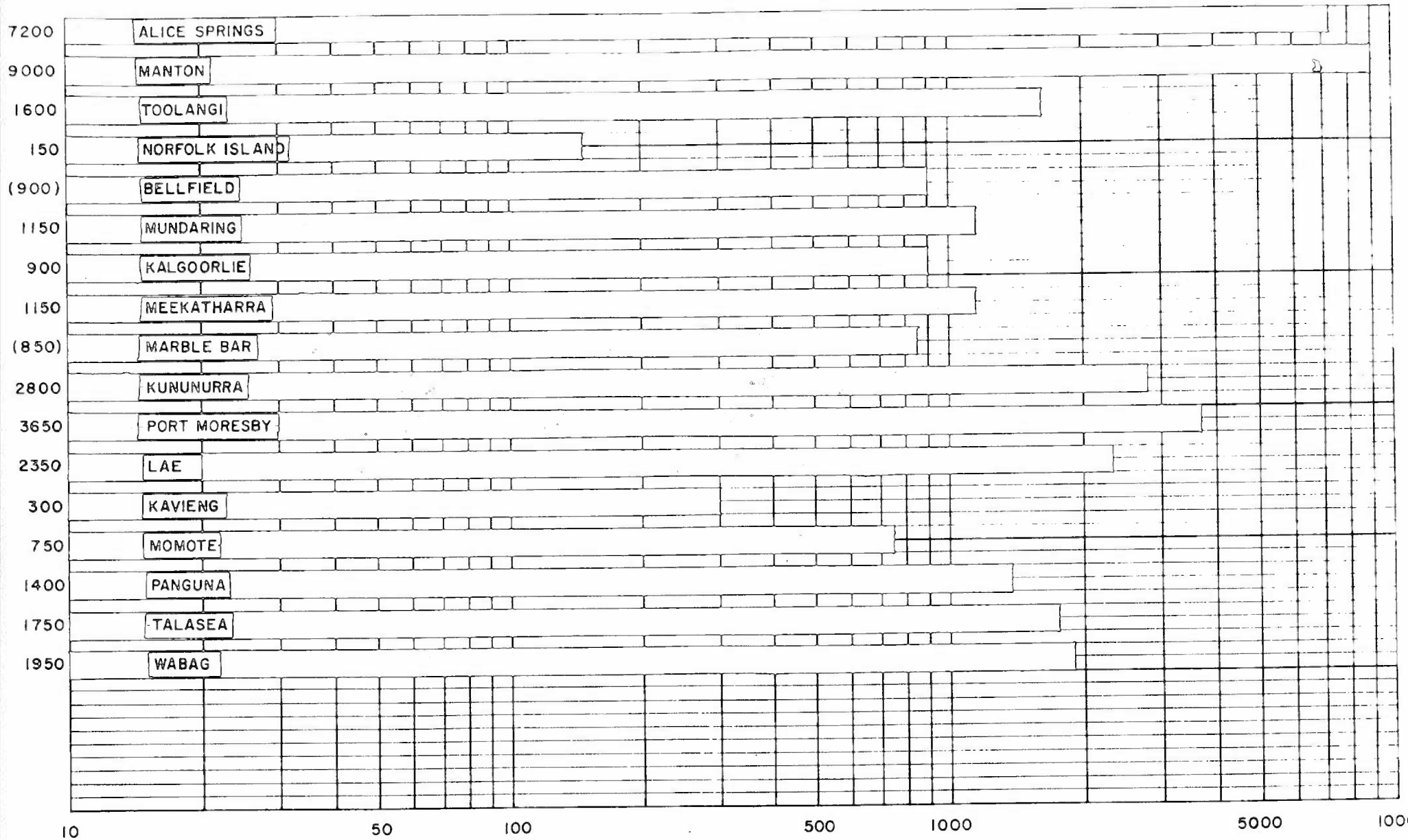

AUSTRALIA AND PAPUA NEW GUINEA
SEISMOGRAPH STATIONS
AND ACCELEROGRAPHS
ACCELEROGRAPHS
WWSS STATIONS
3-COMPONENT STATIONS
VERTICAL COMPONENT STATIONS
EARTH TIDE RECORDER
FRIEDA RIVER
WEWAK
OMOMOTE
KAVIENG
RABAUL
STAR MOUNTAINS
WISBAG
TALASEA
LAE
PANGUNA
UPPER RAMU
PORT MORESBY
MUSA
MANTON
KUNUNURRA
ORD RIVER DAM
MARBLE BAR
ALICE SPRINGS
MEEKATHARRA
KALGOORLIE
MUNDARING
MECKERING
COOMEY TUNNEL
NORFOLK ISLAND
BELLFIELD
TOOLANGI
MELBOURNE
MAWSON
MACQUARIE ISLAND
MERCATOR PROJECTION
KILOMETRES
(Based on G20 14)
A/69-68

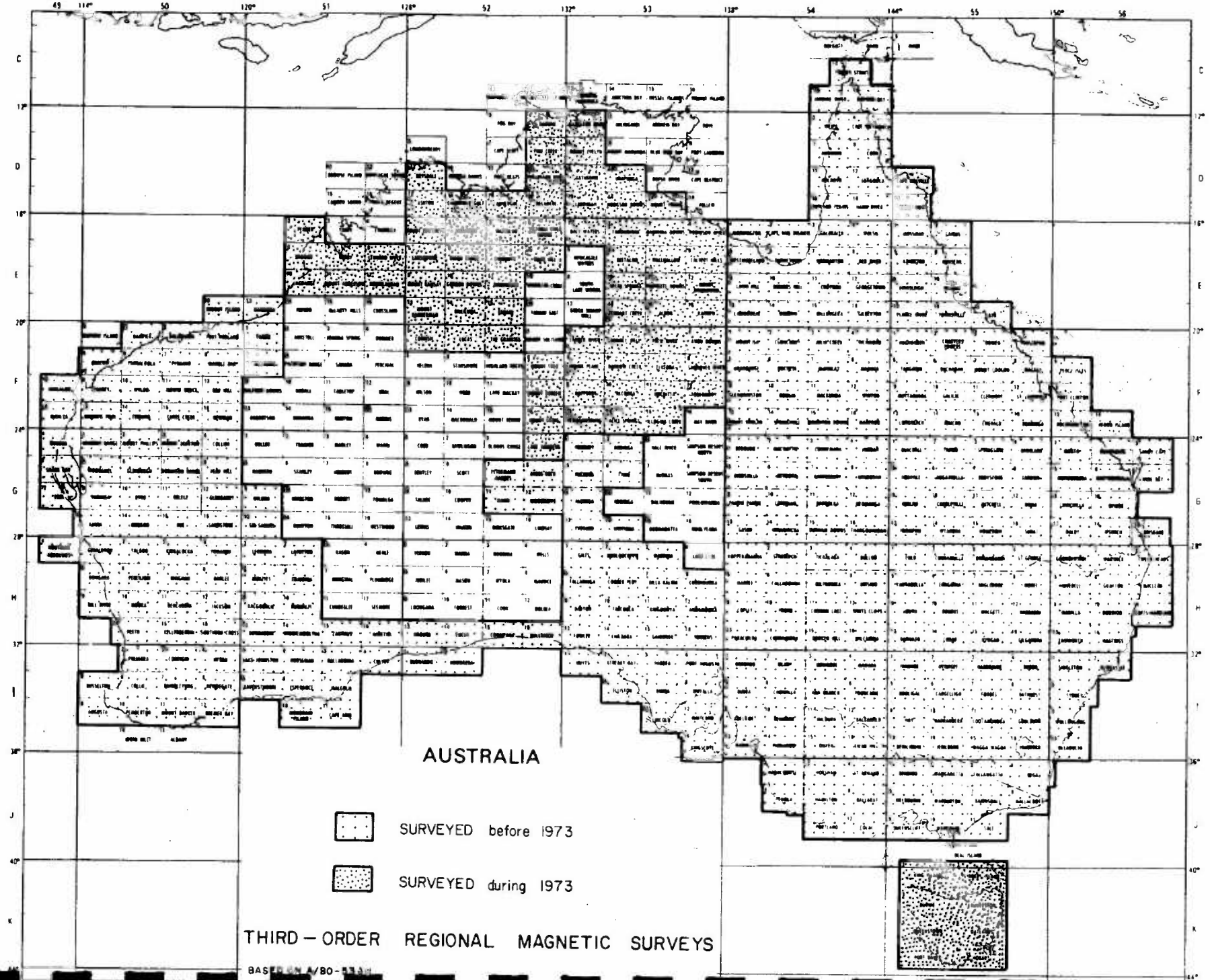
Fig. OR 2

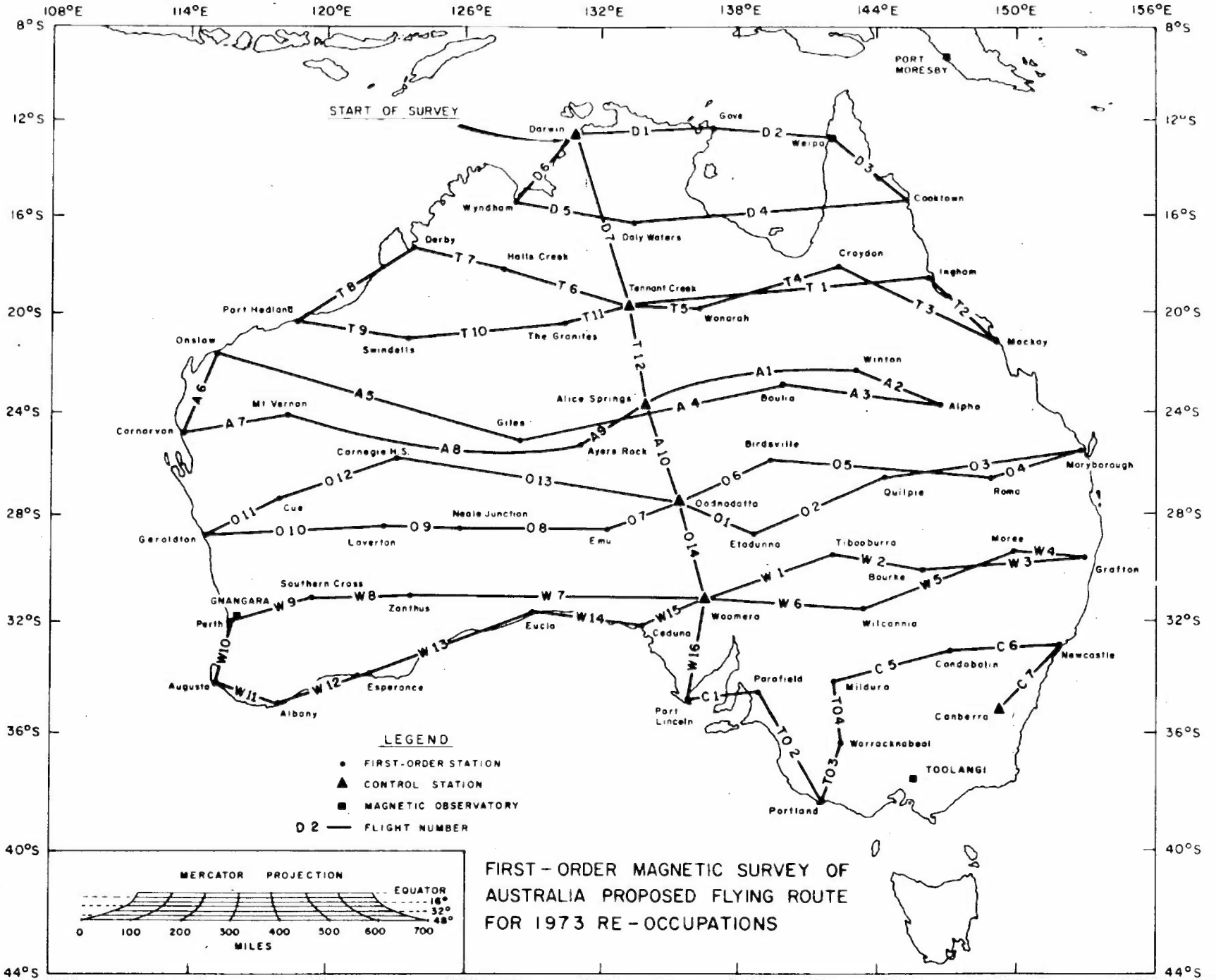
P-WAVE ARRIVALS, BMR STATIONS
(SEPT 1972-AUG 1973)



(Numbers are rounded to nearest 50)

Fig. OR 3


AUSTRALIA
SURVEYED before 1973
SURVEYED during 1973
THIRD – ORDER REGIONAL MAGNETIC SURVEYS



(BASED ON A/BG-59A) To accompany Record No. 1973/195

A/BG-88A

Fig. OR-

Work continued on assembling the equipment for the new seismic stations at Broken Hill and Giles. Delays were caused by a shortage of some electronic components, but the station is expected to be installed by December.

Strong ground motion. Seven accelerograms from Yonki and Lae were analysed during the year, and a paper describing the results at the Yonki and Panguna sites was presented at the 5th World Conference on Earthquake Engineering.

On 10 March 1973 an earthquake took place near Picton in New South Wales. It was located at 34.14°S, 150.29°E, at a depth of about 20 km. Its magnitude was about 5.5 on the Richter scale and it caused minor damage to buildings over a wide area (4000 km^2). Most of the structures affected were very old (some over 100 years) and damage was generally confined to plaster work, tops of chimneys, and brick or stone walls. Some of the areas most affected were investigated. No reports were received of complete chimneys breaking at roof level and only one instance of significant damage to stock inside buildings (Wollongong Glass Works) was discovered.

Regional magnetic surveys. Third-order surveys were completed in Tasmania and northern Australia as shown in Figure OR 4. Over the areas accessible by road, observations of D, H, and F were made at nominal 15-km intervals. Altogether 79 1:250 000 Sheet areas were completed at an average station density of about 14 stations per Sheet area (i.e. at 1 station per 1300 km^2). Two 1:250 000 Sheet areas (MOUNT BANNERMAN and CORNISH) were surveyed by helicopter (utilizing the same aircraft as used by the Canning Basin Geological party) to test the feasibility of using helicopters to cover the Sheet areas that are inaccessible by road. It was found that, provided fuel dumps could be sited at suitable places, it would be possible to complete three Sheet areas per week, observing at 24 stations per Sheet area.

In August a first-order magnetic survey was started using a fixed-wing aircraft to provide transport between the 62 stations (Fig. OR 5). H, D, and F measurements were made at each station, and a fluxgate variograph was installed in turn at the control stations to provide a record of the transient variations. Figure OR 5 shows the route and station positions. The data will be used to compile maps of the magnetic field over the Australian continent for epoch 1975.0.

Crustal movements project, Papua New Guinea. Meetings of an intradepartmental committee of Messrs Aronson, Denham, and Dow (BMR), Cook and Murphy (National Mapping), and Williams (Head Office, Minerals & Energy) were held during the year to manage the crustal movements project in Papua New Guinea. The first set of measurements in the Markham Valley was made by National Mapping in August and a preliminary survey of the St George's Channel sites was made in September.

Mundaring Observatory Group

Standard programs. A normal-run magnetograph, World Standard and supplementary seismographs, and an IPSD ionosonde were operated all the year, and preliminary results were distributed.

A 2-component Wood-Anderson seismograph was installed at Mundaring and the peak magnification of the supplementary (short-period vertical) seismograph was increased to 300 000.

Regional seismology. Seismographs were operated at Kalgoorlie, Marble Bar, Meekatharra, and Kununurra (co-operatively with the WA Public Works Department). Resiting of the Kalgoorlie seismometer and installation of a telemetered seismograph at Swan View/Mundaring were deferred because of delays in equipment delivery and site construction respectively. Short-term recordings to study microtremors were made at Wongan Hills and Wagin.

Nearly 4000 microtremors which occurred in the southwest seismic zone between 1966 and 1973 were analysed, and a paper on them was presented at the ANZAAS Conference in August.

One of the two accelerographs at Meckering was just triggered by a minor earthquake (ML = 3.8) on 19 August (UT), but the recording was too weak to be analysed; i.e. the maximum acceleration was about 0.01 g.

Port Moresby Observatory Group

Standard programs. A La Cour normal-run magnetograph and a World Standard and a supplementary seismograph were operated throughout the year, and the results were distributed regularly. The IPSD ionosonde was closed down in May after many failures in the previous six months.

The reporting service for felt earthquakes, previously operated by the Rabaul Volcanological Observatory, was transferred to the Port Moresby Observatory in June. The PNG Seismicity File was maintained throughout the year and earthquake hypocentres and intensity data from the area 0–12°S, 130–165°E were added to the file.

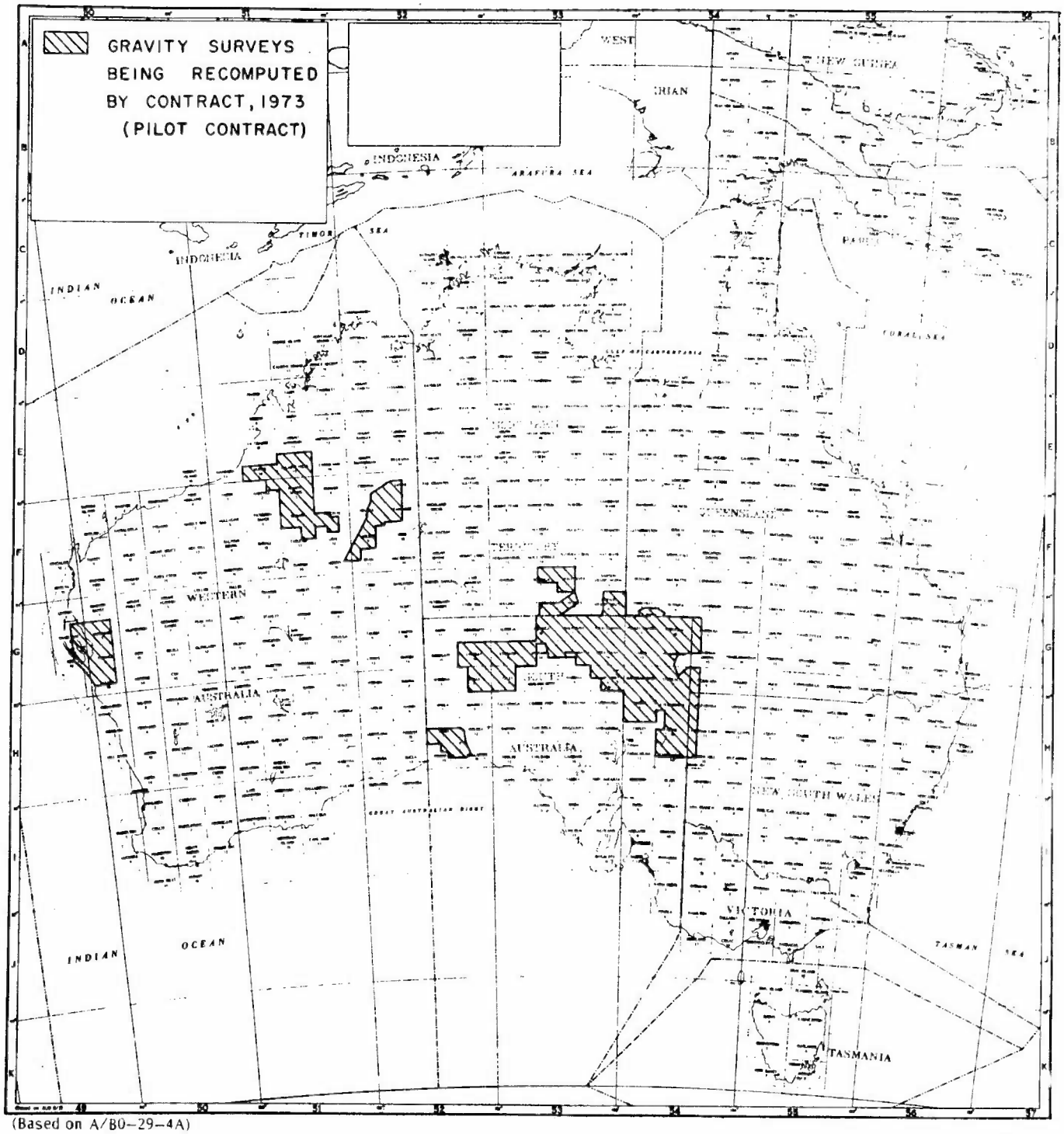
Regional seismology. Seismograph stations were operated at Kavieng, Lae, Momote, Panguna (previously Kobuan), Talasea, and Wabag; the station at Goroka was closed in November 1972. No progress was made on the establishment of a station at Vanimo because of lack of equipment, and the proposed site at Star Mountains was not tested because the future development of the area is uncertain. Frequent record losses occurred at all outstations; most losses were due to the use of photographic recorders, obsolete electronic systems, and high failure rates of the EMI crystal clocks. A re-equipment program is needed to reduce the number of maintenance and repair visits.

There were 18 accelerographs in PNG, two operated by a mining company, and 14 accelerograms were obtained. At Lae, acceleration amplitudes in a thick gravel subsoil are about three times as great as those on a solid basement rock. At the Musa damsite, accelerograms from a basement rock site are significantly different from those on a hilltip; higher intensities are likely to be felt at the latter. The accelerograph network needed maintenance visits every four months.

Studies and reports were made or continued on regional focal mechanisms, strong-motion results, seismicity, and the Alotau earthquakes of May 1973.

East Papua crustal survey. Assistance was given to the survey in the preparatory stages early in the year, and one observer was provided during the Survey (October, November).

Fig. OR-



(Based on A/80-29-4A)

To accompany Record No. 1973/195

G463-23A

Toolangi Observatory Group

A La Cour normal-run magnetograph and 3-component short-period and long-period seismographs were operated continuously at Toolangi; short-period vertical seismographs were operated at Ballfield and Norfolk Island. A visual seismograph was reinstalled in Melbourne (January) for public information purposes. The magnetic instrumentation was improved by the addition of a single-component micropulsation recorder (dX/dt).

Three local earthquakes (ML less than 4) were reported as felt, and intensity questionnaires were distributed for one of them, but the replies were conflicting and no useful isoseismal data were obtained. A study of a possible effect from the filling of Lake Eildon in 1958 was begun, and the assessment of the value of the Norfolk Island seismograph was continued.

Antarctic program

Continuous recordings were made at Macquarie Island (La Cour normal-run and rapid-run magnetographs and short-period vertical seismograph) and Mawson (normal-run and sensitive magnetographs and 3-component short-period seismograph). Preliminary data were distributed via the Toolangi Group. At Macquarie Island a tide gauge and a micropulsations recorder were operated for Flinders University and the University of Alaska respectively.

No magnetic measurements were obtained in the field owing to a change in annual relief procedures, but arrangements were made to ensure that a geophysicist accompanies future field expeditions.

REGIONAL SURVEYS SUBSECTION

Regional Gravity Group

Gravity Map of Australia. Very little progress has been made in producing 1:250 000 computer-contoured Bouguer anomaly maps owing to the data on the tape files not being in final form and to hardware problems on the CSIRO computer. Before final contoured maps can be produced, all station positions must be checked, heights must be converted to Australian Height Datum (AHD) and ties between surveys must be checked. Mechanical failure in the 30-inch drum plotter at CSIRO prevented any plotting during September. The slow turnaround on the CDC 3600 computer after the CYBER 76 was installed hampered the production of maps for checking.

Recomputation of gravity surveys. The pilot contract for recomputation of data was awarded to Layton Geophysical Consultants and work started in August. The surveys chosen for recomputation during the trial contract are shown in Figure OR 6. Each survey is assessed by the contractor and an assessment report is submitted to the contract supervisor. If the survey is suitable for recomputation the principal facts or field data are obtained and punched on cards for processing into final principal facts on the tape files. On completion of the recomputation a final report is submitted to the supervisor. The data processing has been held up by the changeover from CDC 3600 to CYBER 76 computer, a reduction in shifts on the CDC 3600, and parity errors on reading and writing magnetic tapes.

Recomputation of the BMR surveys in central Australia was completed. All surveys were adjusted at common tie stations with the road survey results controlling the helicopter work. The results have been added to or updated on

the tape files, and map production has started. Work commenced on the 1960 helicopter survey of the Canning Basin. The 1969 contract helicopter survey was recomputed for AHD heights and maps were produced for data checking.

Computing and calculating. No major changes were made to the suite of programs for computing gravity data during the year, but several errors were corrected and some small modifications were made. A new gravity datum was derived from the scale determined on the BMR-Soviet survey, and a conversion formula between this datum (Provisional 1973) and the Potsdam datum currently being used was incorporated in the programs. The contouring programs were modified to enable maps to be plotted on conic and rectangular projections as well as Transverse Mercator. CSIRO's CYBER 76 computer commenced operation in July and conversion of programs from the CDC 3600 computer commenced in September. The CYBER editions of the programs were thoroughly tested before the data files could be transferred to the new computer format. A draft Record entitled 'The Australian National Gravity Repository Computer System' was completed; this Record describes the suite of programs and the tape file system and includes user instructions.

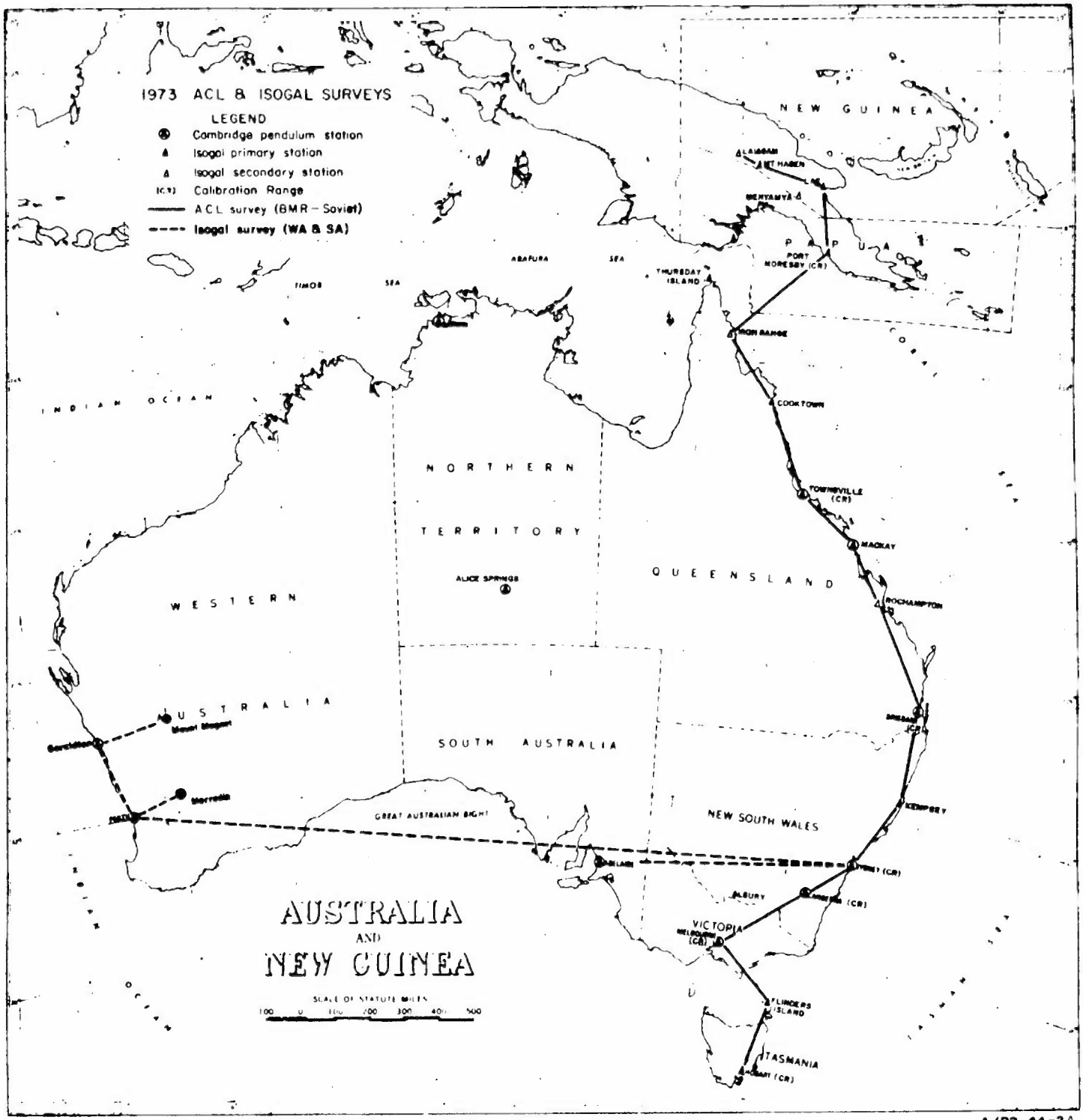
BMR-Soviet gravity survey. A gravity survey along the Australian Calibration Line (ACL) between Hobart and Laiagam, PNG, during May and June was a co-operative project between BMR and the Soviet Academy of Sciences. The survey involved five BMR officers with four LaCoste & Romberg meters and five Worden meters and six Russians with nine GAG-2 meters. A chartered DC.3 aircraft (VH-MIN) was used for transport. The results of the survey were written up in a joint paper entitled 'Soviet Australian Gravity Survey Along the Australian Calibration Line' submitted for publication in Bulletin Geodesique. The stations read on the BMR-Soviet survey on the ACL are shown in Figure OR 7.

A new milligal scale based on measurements with the Soviet GAG-2 gravity meters has been adopted. This scale agrees substantially with U.S. Air Force results from 1965, but changes the previously adopted Australian milligal by about 1:2000. These scales and other pertinent measurements are compared in Figure OR 8.

Isogal network. A suspected error in the Isogal network between Perth and Geraldton was confirmed by measurements using two LaCoste and Romberg and one Worden meter. The value listed for Geraldton in the BMR Isogal list is 0.26 mGal too high. During the survey ties were made between Canberra, Sydney, Perth, Geraldton, Mount Magnet and Merredin, all with two LaCoste and Romberg meters. Seven new Isogal stations were established, one each in Sydney and Geraldton and five in Perth. A new calibration range was established in Perth, near Mundaring Observatory, using two LaCoste and Romberg, two Wordens and one Sharpe meter. All meters gave consistent results but the Wordens had apparently changed in calibration factor since their last calibration on the Canberra Calibration Range. A Beechcraft Baron aircraft was chartered for the ties between Perth, Geraldton, Mount Magnet, and Merredin. A tie between Perth and Christmas Island was made with the co-operation of the Engineering Geophysics Christmas Island Groundwater survey party and a geophysicist from Mundaring Observatory. The Isogal work is shown in Figure OR 7.

During the ACL survey several new Isogal stations were established at airports along the east coast. New Isogal stations were set up at Adelaide Airport to replace stations destroyed by redevelopment of the terminal buildings.

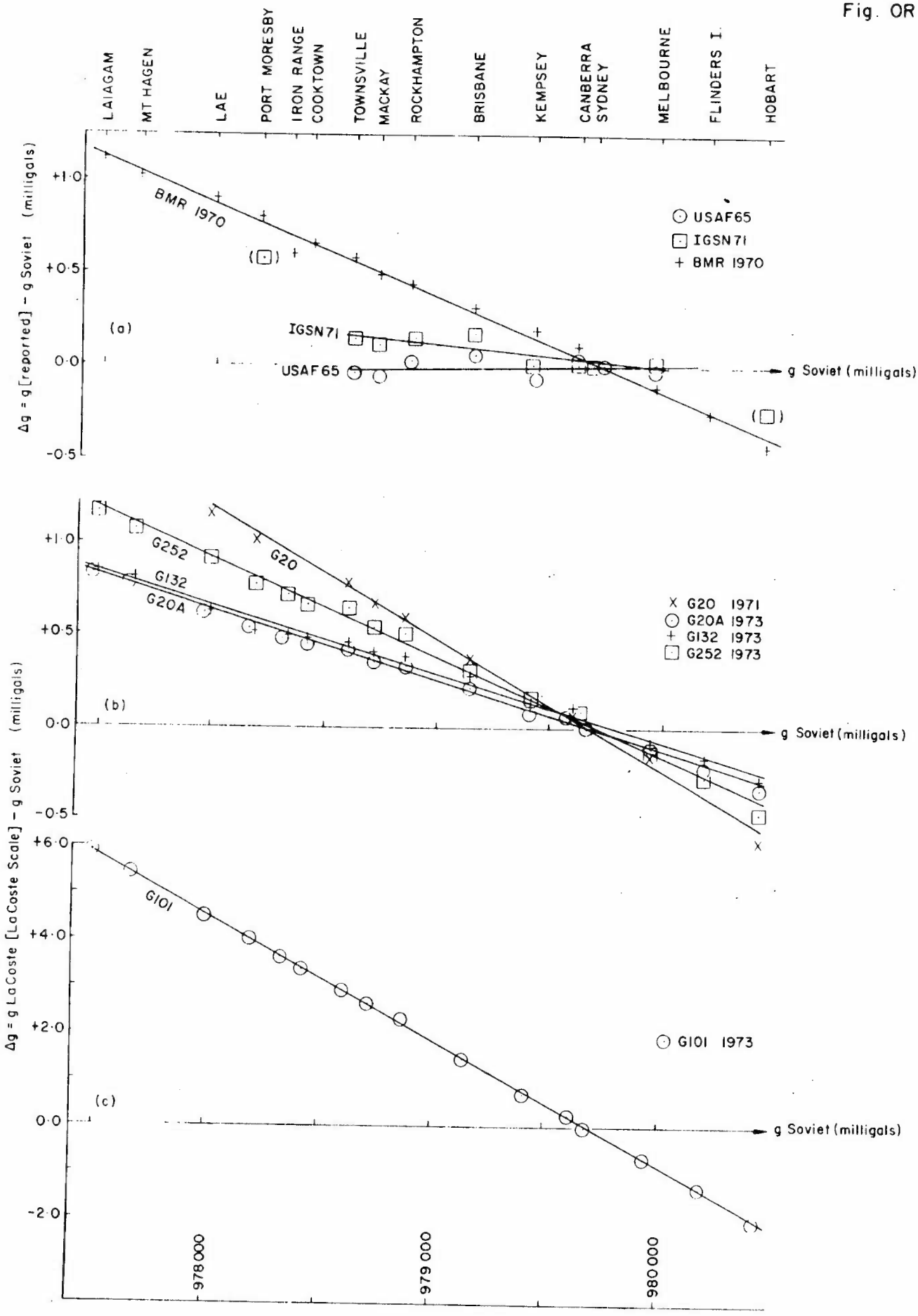
FIG. OR-7



A/B2-44-2A

To accompany Record No. 1973/195

Fig. OR 8



COMPARISON OF GRAVITY METER RESULTS BY REGRESSION

To accompany Record No 1973/195

G65-354-1A

All results from LaCoste and Romberg measurements on the ACL have been recomputed using new calibration factors determined by the BMR-Soviet survey results. New values have been adopted for calibration ranges as a result of this recomputation.

Descriptions of new Isogal stations at important sites were sent to the International Gravimetric Commission for inclusion in the IGC lists of stations.

Horizontal pendulums and earth tides. Continuous records for most of the year were obtained from both horizontal pendulums installed at the Cooney Observatory near Amidale. An attempt was made to improve the quality of the traces by replacement of the mirrors. New mirrors which were bought as optically flat were found to be inferior to the original mirrors, so the original mirrors were resilvered and replaced in the pendulums, and the quality of the traces was much better. There are still some unexplained jumps in the traces which occur independently on both pendulum records. The ambient temperature and pressure in the niche are now being recorded.

The records are scaled on a magnetogram scaler, and the digitized values are processed and analysed into Earth tide components. The processing of the records has proceeded slowly owing to lack of staff.

East Papua gravity survey. A gravity survey is being carried out in conjunction with the East Papua crustal survey. The helicopter chartered for the crustal survey is used for transport on gravity work whenever available.

Lake George gravity survey. Gravity measurements were made on and around Lake George, taking advantage of the unusually low level of the Lake. The Department of Services and Property levelled some traverses on and around the Lake at the request of BMR. The Lake George area is of interest because of a high gravity anomaly feature. More work will be done if the Lake dries up further.

Antarctic gravity surveys. Eighty new stations were established in the Prince Charles Mountains and Mawson areas of Antarctica. The results of all BMR surveys in Antarctica have been computed on the LaCoste meter scale.

A tie between Sydney, Christchurch, and McMurdo is planned for December. This tie would make use of a United States Air Force aircraft for transport between Christchurch and McMurdo. It is proposed to make measurements in New Zealand during the survey.

Equipment. All gravity meters to be used on the BMR-Soviet survey were thoroughly checked and adjusted, and the five Worden meters were evacuated; the battery packs were overhauled and 60 new Ni-Cd batteries were bought. After the survey the meters were checked and freed for use by other groups. Worden meter 169 and LaCoste and Romberg G132 were sent to their respective manufacturers in the United States for maintenance and repair. Master Worden 548 was converted to constant-temperature operation after the ACL survey and it showed better drift characteristics, but there is some uncertainty in its calibration factor.

General. Gravity data for road surveys in New South Wales were received from the NSW Geological Survey. All the data held by WA Petroleum were made available to BMR for recomputation and incorporation in the BMR tape files. Copies of the BMR gravity computer programs were given to WAPET and the South Australian Mines Department. The SA Mines Department is converting the programs to run on a CDC 6600 computer in Adelaide and will be able to exchange data with BMR in the standard BMR format.

REGIONAL STRUCTURAL SURVEYS GROUP

Bowen Basin survey

A seismic refraction survey was conducted in the Bowen Basin, Central Queensland, during May-June 1973 by BMR and the University of Queensland, using the routine blasting in the open-cut coal mines in the Basin as energy sources. The locations of shots and recording stations are shown in Figure OR 9.

The survey provided a field test of BMR recording equipment prior to the East Papua crustal survey. The data obtained are to be used in an M.Sc. thesis by C.D.N. Collins, a cadet with BMR at the time of the survey. A Record describing the background and operations of the survey was prepared.

All recording was done on magnetic tape and played back later in Canberra. The development of play-back equipment currently in progress will enable the quality of many of the records to be improved, by reduction of play-back noise.

Both first and later arrivals were picked from the records, a preliminary time-distance curve was plotted, and seismic velocities were derived from it. It is hoped to be able to add considerably to these arrivals by re-reading records and correlating events between records.

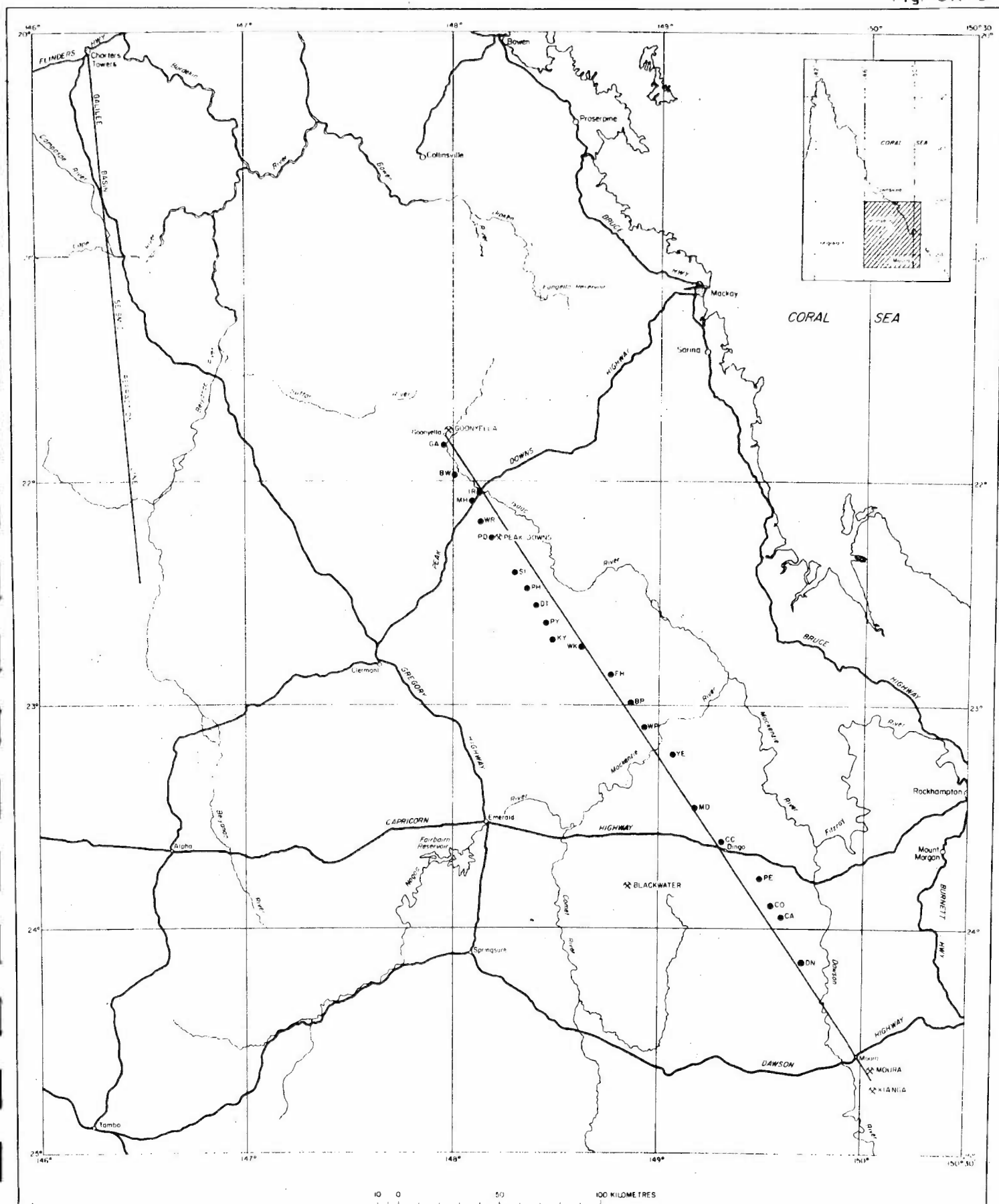
There is evidence of four distinct crustal layers overlying the mantle. Their velocities are, in order of increasing depth, 4.0, 5.5, 6.4, and 6.9 km/s respectively. The uppermost layer velocity (4 km/s) was found by laying a spread cable adjacent to one of the blasts. There are no first arrivals from the lowest crustal layer (velocity 6.9 km/s) and its existence is inferred from later arrivals.

The Upper Mantle velocity is found to be about 8.2 km/s with an intercept time of 7.3 s.

All arrivals, irrespective of shot-to-recorder azimuth, have been plotted together. Evidently there is little or no dependence of velocity on direction of travel of the seismic waves and hence the layering is substantially horizontal along the axis of the Basin.

Strong S-wave arrivals with a velocity of 4.7 km/s are present on all records, as well as surface-wave arrivals.

Recordings made at the Charters Towers Seismic Observatory will also be included in the interpretation, giving distances up to 650 km between shot and recorder. Regional gravity will be taken into account in interpreting the data and it is planned to use a ray-tracing program to test the crustal models derived.



BOWEN BASIN : LOCATION OF SHOTS AND RECORDING STATIONS

To accompany Record No. 1973/195

F55/83-103

This survey should give detailed and well established velocity information along the axis of the Bowen Basin from which the structure of the whole Basin can be obtained by the placing of recording stations at appropriate distances on either side of this main traverse.

East Papua crustal survey

This survey was planned as a joint project with Australian National University, Melbourne University, Queensland University, and Hawaiian Institute of Geophysics. BMR organized and co-ordinated the project and has provided the bulk of manpower, equipment, and finance.

The objectives of the survey are to investigate the gross tectonic features in the Papuan peninsula, in particular the supposed boundary between the Solomon Sea and Australian plates along the Owen Stanley fault system, possible differences of crustal structure on either side of the boundary, the nature and configuration of the Papuan Ultramafic Belt, and subsurface structure relating to the volcanic and seismic activity in the area.

The survey comprises two traverses across the peninsula with shots at sea north and south of the peninsula, and further shots in two lines along the NE and SW coasts. Distribution of stations in the peninsula is necessarily somewhat irregular because of difficult access. There will be about 60 shots of 1 tonne each, intended to be recorded at distances up to 400 km; about 50 additional small shots (180 kg) will be located close to the coast to provide detail of the shallower formations.

The coastal barge Sir Alan has been chartered for the shooting vessel. Four cabins and caravans have been installed on the deck for accommodation, offices, and toilet facilities.

The recording sites were surveyed by Amalgamated Decca Surveys under contract, and the position of the boat at shooting times is being determined using SHORAN equipment by Navigation Australia Pty Ltd under contract. These two contracts were supervised by the Department of Services and Property. A helicopter and light aircraft have been chartered for moving equipment and personnel in setting-up recording stations.

The recording equipment for BMR stations, designed and assembled in the BMR Geophysical Laboratories, consists of 21 sets of analogue tape recording equipment capable of running unattended for about two weeks. The marine explosives used in the survey are part of a batch donated by WAPET to BMR for use in scientific research.

Messrs Finlayson and Coutts visited Papua in February to make preliminary arrangements and inspect recording sites. Messrs Dooley and Everingham inspected Sir Alan in May and discussed with the owners and shipping authorities in Port Moresby problems of fitting-out the vessel to BMR requirements. The equipment left Canberra on 29 August for shipment at Sydney but owing to various strikes did not arrive in Port Moresby until 9 October. The vessel was eventually fitted out, recording stations were installed, and shooting started on 25 October.

Head Office activities

Some preliminary work was done on the results of the Trans-Australia seismic survey carried out late in 1972, but the analysis was not completed because of faults in the playback equipment, the preoccupation of the group with organizing the East Papua survey, and delays in obtaining records from other participants.

The main analysis of the 1967-69 New Britain crustal surveys was completed and several papers have been published, but analysis of special aspects of the data continued intermittently.

Computer programs were developed for tracing seismic rays through a layered spherical Earth, and interpretation of magnetic anomalies, and work was started on digitizing records from the tape-recording seismographs. Conversion of previously written programs to the CYBER 76 computer was begun.

4. GEOPHYSICAL SERVICES SECTION

ELECTRONICS SUBSECTION

The Subsection is divided into three groups: Instrument Development, Systems Development, and Electronic Maintenance and Testing. No new major projects were undertaken in Instrument and Systems Development Groups in 1973, and considerable assistance was given to Procurement Group in their plant buying program.

Instrument Development Group

No new major projects were undertaken this year because of unforeseen development and production problems with the MFS airborne fluxgate magnetometer and the recording seismograph stations. Capacity was still limited by the number of staff, and a worldwide scarcity of quality electronic components resulted in many delays.

MFS7 Fluxgate Magnetometer. The prototype continued to function in aircraft VH-EMG until March, when the pre-production model was installed. The original intention was to proceed directly from the prototype to the final production version, but because of extensive wiring and mechanical differences a pre-production model was necessary to resolve problems caused by layout changes. Debugging this model and its installation continued until July, when production model S/N 1 was completed and installed. A further month was necessary to obtain satisfactory performance, i.e. noise below one nanotesla, repeatability to one nanotesla, thermal drift less than one nanotesla per degree, and freedom from baseline shifts produced either by the unit itself or other aircraft equipment. An identical unit, S/N 2, was completed in September and is to be a back-up. Both units were tested operationally before the aircraft departed for Cooktown at the end of September.

Both ASQ-10 detector heads used with the MFS7 were overhauled mechanically during the year, but a fault in the S/N 2 head was not isolated in time for survey use.

Work commenced on the construction of a third electronic unit which will incorporate improved construction methods for higher reliability.

MNS2 Proton Magnetometer. Construction of serial numbers 4 to 6 proceeded until completion in July. This project, in particular, suffered from delays in component delivery. Field tests revealed two problems not encountered in the first three production models. One, a design error in the depolarizing circuit, was easily remedied; the other, marginal instability in the preamplifier, is under review at the time of writing (September).

Noise levels higher than normal from most operational units were found to be caused by insufficient fluid in the detectors as a result of dimensional changes in the production of rubber fluid bottles. Tests with an experimental toroidal detector showed considerable signal improvement, and a second toroid of optimized dimensions was designed to fit the Aero Commander towed bird. Because of increased weight this cannot be flown until a strainer cable is fitted.

MNS3 Proton Magnetometer. No significant progress was made with the design of this low-power magnetometer because of concentration of effort on projects of higher priority.

Regional Structural Group recording and playback systems. Because of deficiencies found in prototype units, work continued on the recording systems until August. This work included the design of an improved dual FM modulator TMF 2 which was more immune to interference from associated modules and facilitated setting up of the TAM 5 seismic amplifier, construction of calibrator modules TSC 1, temperature tests on TAM 5 amplifiers, and the redesign of power supplies to reduce power consumption.

A total of 21 recording systems were produced for the East Papua Crustal Survey in October.

Initially, the Thermionics system was adapted to play back records produced on the modified Akai recorders. Because of low signal-to-noise ratio obtained from the Thermionics amplifiers, results were unsatisfactory and did not permit proper evaluation of the recording systems. A prototype system, suitable for field playback and using an Akai tape deck fitted with a servo-controlled motor, was designed together with low-noise amplifiers and phase-locked loop demodulators. A dynamic range of 40 dB is obtainable at speeds varying from 15/256 in/s to 7½ in/s. This system has completely validated the recording systems. Some remaining design problems concerned with low-speed operation will be investigated on completion of the survey.

BH-BMR digital acquisition system. Construction of a hard-wired acquisition system for the Aero Commander aircraft was let to contract, and delivery is expected in November. Construction of a digital scaler for the gamma-ray spectrometer and modification to an MNS2 magnetometer were commenced to permit interfacing with this system.

Magneto-telluric system. In co-operation with the Electronic Maintenance Group the Geotronics magneto-telluric system and Hewlett-Packard 2116 digital acquisition system were checked out and the data acquisition software written and documented. D. Kerr participated in the combined survey with Macquarie University during June and July in the Mildura area.

Observatory magnetogram digitizers. The project was deferred until 1974.

Ad hoc jobs. These jobs included: design and construction of two 5-W temperature control units, PZC1, to maintain a constant temperature of 0°C in an instrument hut at Mawson; rebuilding of the prototype MNS1 ground station magnetometer and construction of a second production model; design of thermometer temperature probes for the Airborne Subsection; elimination of temperature effects in a film processor transport, for the Airborne Subsection; elimination of interference between the camera motor and gamma-ray spectrometer in aircraft VH-BMR; and design of a timing circuit for various observatory applications.

K. Seers was a delegate to the IREE Convention in Melbourne during August.

Systems Development Group

D. Ramsay was employed full-time on the G.S.I. Pendulum project until the beginning of March when he was seconded to the Geophysical Engineering Group. The sub-professional staff were fully employed on Instrument Development. P. Hillman was the only other member of the group, and from April onward some of his time was allocated to plant purchasing with the Procurement Group.

Tidal gravity. The work on this project was reviewed with the Crustal Studies Group in February and it was concluded that neither the North American nor Heiland gravity meter is suitable for modification to a tidal gravity meter. The main problem is their large temperature coefficient which necessitates very accurate temperature control and measurement before dependable tidal gravity records could be obtained.

G.S.I. pendulums. Most of the time spent on this project was devoted to reducing the noise on the pulse from the photo-FET detector used to detect the laser light beam from the swinging pendulums. The noise was reduced from 50 mV to 5 mV by rebuilding the associated electronics using CMOS integrated circuits instead of T.T.L. integrated circuits. The remainder of the time was spent testing the National Standards Laboratory pendulums, which have 178° knife edges. The first set of tests produced anomalous results because the period of the pendulums increased non-linearly as the amplitude of swing decreases (equivalent to 1500 mGal change for half amplitude and probably due to movement of the pendulums on their agate planes). The original G.S.I. pendulums' period decreases as the amplitude decreases in an almost linear manner and at much smaller rate (equivalent to 7 mGal for half amplitude). The knife edges from the N.S.L. pendulums were returned to Sydney, where the angle was changed to 173°. After this modification the results obtained were closer to the results with the original G.S.I. pendulums, but indicated that the N.S.L. pendulums were still moving slightly on the agate plane during a series of swings and that more work on the knife edges was needed. The results will be reviewed in the near future to decide whether additional work is justified.

Remote sensing. P. Hillman attended meetings of the A.C.E.R.T.S. Committee and continued reading relevant literature. Assistance was given to the Geological Branch from time to time when requested.

Long-period seismometer. A handbook is being produced.

Electronic Maintenance and Testing Group

This group provides the following services: maintenance and testing of electronic equipment used by the Geophysical Branch in field surveys and observatories; acceptance testing of new electronic equipment; assembly of new equipment and systems designed in the EMR laboratories, and the installation of equipment in road vehicles, aircraft, and ships. An increasing amount of similar work is also being done for other EMR branches.

Services were supplied in 1973 to the following groups:

Observatory. Two seismograph stations were assembled. One is to be installed at Giles, WA; the other at Broken Hill. Modifications were made to the seismograph installation at Manton Dam, NT. Assistance was given with setting up the Elsec digital magnetic observatory at Kowen Forest, ACT.

The program of modifying EMI digital clocks continued, and a new time-pip generator was designed and built. This will be used to provide ABC radio at Port Moresby with hourly time signals.

Maintenance was performed as necessary on various magnetometers, digital clocks, and time-signal receivers.

Engineering Geophysics. The new Geotronics high-current IP transmitter was checked out operationally. Assistance was given in assembling and testing resistivity and magnetic equipment for both the Canaway Ridge and Christmas Island surveys, and seismic equipment for the former survey.

Shallow marine seismic equipment was set up for the Westernport Bay, survey in Victoria, where both reflection and refraction techniques were used very successfully. Technical manpower was provided to help start the survey.

Minor repairs were done on equipment ranging from seismic cables to marine recorders.

Marine Seismic. A marine proton magnetometer was installed on the M.V. Manly Cove, the vessel engaged on National Mapping's bathymetric survey, and the accompanying shore magnetic monitor station was set up.

Crustal Studies. For the 1973 East Papua survey 21 automatic remote seismograph stations, designed in the BMR Laboratories, were assembled and tested; eight hand portable transceivers were modified for shot-instant transmission and the marine seismic sparker equipment was checked and housed in a container for installation in the shooting ship. Assistance was given with setting up the equipment on the ship.

Metalliferous. Repairs were done on logging and Turam equipment.

Marine Geology. A marine proton magnetometer was installed and urgent technical assistance provided on two occasions.

Bathymetry Section, National Mapping Division. EDO sonar Doppler equipment and a Raytheon bathymetry system were tested and installed on the M.V. Cape Pillar. Assistance was also given in the magnetometer installation and servicing.

Geological Branch. Various radio transceivers and portable loggers were serviced.

General acceptance testing was carried out as various items of new equipment were received. In particular, considerable work was done on the Geotronics magneto-telluric equipment.

Magneto-telluric survey. In the first half of 1973, the commercial Geotronics magneto-telluric equipment bought by BMR was interfaced to a Hewlett-Packard 2116B computer and peripherals and, with BMR-written software, these provided a complete magneto-telluric data acquisition system.

The equipment was installed in a standard shipping container mounted on a 3-ton truck. In June-July 1973, a joint team of eight people from BMR and Macquarie University took the MT acquisition system on a trial survey in the Murray Basin area. Six sites between Mildura and Broken Hill were covered. No major problems were encountered during the survey and considerable experience was gained by the BMR party by working with Professor Vozoff of Macquarie University. The data from the survey have been processed on the same minicomputer as was used for the field recording. Results so far agree well with the known geological features of the Basin and confirm DC deep resistivity measurements carried out near one of the six sites. This is the first use known to BMR of 3-dimensional magnetic and 2-dimensional electric magneto-telluric equipment in Australia. Further field work with Macquarie University is planned for 1974.

Trainee Technical Officers. Of the seven trainees who commenced at the beginning of the year, three have left and those remaining are employed throughout the Electronics Subsection. The Electronic Maintenance and Testing Group is responsible for their general supervision.

MECHANICAL SUBSECTION

The subsection comprises three groups: Mechanical Design, Mechanical Instrument Construction, and Mechanical Maintenance and Testing. Loss of trade staff and the need to let many machining jobs to contract seriously affected progress in 1973.

Mechanical Design Group

The group comprises an engineer with subprofessional support staff. Several major projects and many minor design projects occupied the group throughout the year.

Rebuilding of 3000-m well logger. This project involved extensive redesign of major systems and components and rebuilding of the old cab. The hydraulic winch drive and control system was redesigned using a high-torque slow-speed motor to provide safer and more flexible speed control. Emergency braking was also provided. The cable layering device was rebuilt and new logging speed, cable strain, and depth monitoring facilities were provided. A new hydraulic and electric power plant was specified and bought. The truck winch and fuel tanks were relocated on the new Dodge 784T chassis, and other lesser modifications were necessary because the vehicle had not been supplied to BMR specifications. Cab air conditioning was provided and appropriate protective and safety enclosures, where necessary. Extensive modifications were made to down-hole flowmeter and caliper tools to enable them to be used simultaneously.

Ground power-unit for survey aircraft. A compact ground power-unit suitable for transport by air was designed for airborne surveys. It incorporates a Wankel rotary motor and aircraft generator built on to a light manoeuvrable trolley. The unit received a Department of Civil Aviation certificate approval for operation within 50 feet of an aircraft during refuelling operations.

Minor design projects. Design projects of a smaller nature or in support of projects outside the section included: a fibreglass-enclosed liquid-filled toroidal coil for the towed bird associated with the MNS-1 proton magnetometer; modifications to a sampling tube plunger and its support, for the Baas Becking Laboratory sediment sampler; a tilting frame for dispensing of liquid nitrogen in the Baas Becking Laboratory; a motorized drive for a 2000-ft portable well logger; a drying cabinet for crushed core samples stored in the Core and Cuttings Laboratory; a tape slack eliminating device for Akai tape recorders used with the crustal survey equipment; modifications to a towing shank of trailer ZTB-847; a support structure for roller tables used for ejecting explosive charges on crustal surveys.

Drafting services. Services mostly in support of Electronics Subsection projects included: chassis and panels for the MFS-7 magnetometer and power supply; panels to suit Isep chassis for the Broken Hill and Giles seismic stations; a thermistor enclosure for the temperature controller at the Mawson Antarctic station; mounting of a magnetometer coil on a water ski for the Westernport Bay survey.

Consulting services. Consulting services were provided throughout the year and included the two major projects listed below.

Marine coring drill for offshore sampling. Work for the Geological Branch on the feasibility of ocean bottom drilling for mineral sand samples progressed during the year to the stage where two definite proposals were received for the purchase of equipment from overseas suppliers. Two definite proposals for the hire of equipment and personnel for mineral exploration were also received. Further inquiries from one Australian company are continuing on the basis of their supplying equipment and services with a view to future BMR purchase, or continuing future contracts.

Camera for reduction of continuous seismic sections. This investigation was requested by the Sedimentary Basins Study Group to meet a need for reduction of x and y axes of long records to different scales. The investigation has advanced to the stage where a Sydney company has a practical proposal for the development of one of their existing machines for continuous operation instead of a frame-by-frame operation. The development of the machine to such a stage could involve a cost of up to $20 000.

Mechanical Instrument Construction Group

The group, which comprises the machine shop, the heavy workshop, and the model maker's shop, was mainly concerned with the construction of new equipment and instruments and modifications of existing equipment. The shops contributed substantially to the following projects:

PNG Crustal Study Project. (1) construction of a large number of electronic chassis components for the recording seismographs; (2) extensive modifications and refitting of two ship's containers to serve as mobile workshop, office, and living quarters for the geophysical crew on board the survey vessel; (3) a boom to support a sparker array from a survey vessel; (4) a steel roller support for sliding canisters with explosive charges overboard.

Rebuilding of 3000-m well logger. (1) relocating an under-chassis winch on the new logging vehicle to avoid interference from the cab when that is placed on its chassis; (2) relocating the fuel tanks to allow more ground clearance on cross-country journeys; (3) rewiring the cabin, relining its walls, fitting new flooring, construction and fitting of work bench, and inside and outside painting.

The group constructed such instruments and equipment as a drying cabinet for the Earth tide recording equipment at Armidale; a support and cover-cum-transit case for a magnetic storm warning detector; slide adapters for fitting 35-mm transparancies in a 2½ inch square slide holder; a crankwheel for a constant-temperature stirring bath; a mould for a fibreglass enclosure to fit a fluxgate magnetometer head in the Twin Otter aircraft; six decomposition vessels for the Baas Becking Laboratory; a rain sensor and housing for the Division of National Mapping; two trailer-mounted cable reels for the Engineering Geophysical group; developing tanks and plate holders for the Geochemical group. The towing shank and trailer of the 20 kVA motor alternator were modified and strengthened; a stainless steel transducer mounting shaft for a shipborne Doppler navigation system was repaired and a marine cable winch was repaired, derusted and repainted.

Mechanical Maintenance and Testing Group

The group overhauled, repaired, and tested field instruments such as an OCE 16 copying machine; Porta-loggers; Polaroid cameras; PRO-11-6 seismic cameras; the escape mechanism of two Patek-Phillippe clocks; a TRO-6 paper magazine; gearboxes and chart-drive mechanisms of Esterline Angus, Hewlett Packard, Rustrak, Widco, and Speedomax recorders; the gearbox of a fish-eye survey camera; stereoscopes; portable cable reels, and a Statfile camera. The group serviced and calibrated such equipment and instruments as Esterline-Angus, Moseley, EPC, and Rikadenki recorders; Philips multimeters; psychrometers; Mechanism and Askania microbarometers; a 35-mm strip camera, and a Vinten instrumentation camera; Worden and LaCoste & Romberg gravity meters; and a tachometer for the well logging equipment to monitor the depth of the logging tool in a borehole. The group modified the brake system on a Porta-logger reel to allow for a controlled descent of the logging tool; designed and made an antiwrapping device to avoid jamming of film in a 35-mm survey camera; and rebuilt an ASQ-10 detector head for an airborne fluxgate magnetometer from new parts supplied from overseas. The group also constructed a number of cylindrical detectors for an MNS-2 proton magnetometer and fitted one of these in a newly made towed bird. Work continued on the upgrading of a spare airborne strip camera.

SERVICES SUBSECTION

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

Procurement Group

The group carried out technical investigations for a wide range of geophysical equipment, including writing of tender specifications and recommendations for acceptance of tenders. Technical enquiries for components for plant construction in the Geophysical Services Section continued to occupy most of the time of one member of the group.

Rock Measurements Group

300 rock samples and 20 other assorted samples were measured during the year. The measurements were principally on palaeomagnetic parameters, electrical properties, magnetic susceptibilities, and ultrasonic velocities. Most of this work originated from within BMR, but several requests were received also from external organizations (Burmah Oil, CCAE, RAAF).

A program of rock sampling in connexion with engineering geophysics and palaeomagnetism was undertaken during the excavation of the Tuggeranong sewer tunnel. The palaeomagnetic work was carried out in conjunction with the Research School of Earth Sciences, ANU. About 100 oriented rock samples were collected and measured along the tunnel. For each sample one pilot specimen was demagnetized in stages in an alternating field and at least two other specimens were measured for initial stable remanence. The results give a new palaeomagnetic pole for the Late Silurian-Early Devonian period which supplements other pole positions obtained from Southeast Australia. The palaeomagnetic data have also indicated some folding in the rock which has proved difficult to determine by other means. This work will continue into 1974 when the tunnel will be completed.

Design and preliminary work was done on the manufacture of a heat conductivity apparatus and on an alternating field demagnetizer for palaeomagnetic investigations. Specifications were worked out for a rock mechanics press, and after extensive negotiations with the manufacturers a particular press was recommended for purchase. It is expected that this press will be installed early next year. A Shore hardness test instrument was adapted for automatic recording of readings. The existing laboratory equipment for the measurement of electrical conductivity and IP parameters of rock samples was redesigned to eliminate several sources of error. A 12-inch diamond saw machine and an 8-inch diamond lap were installed.

Engineering Geophysical Group

The Engineering Group was at full strength during the whole of the year. F.J. Taylor attended the International Conference on Geophysics of the Earth and Ocean at Sydney; G.R. Pettifer attended an AMF course on Engineering Site Investigations in Adelaide. B. Dolan attended the 4th Groundwater Conference and also an AMF course on Formation Evaluation and Log Interpretation in Adelaide. F.J. Taylor and G.R. Pettifer attended a course on magneto-tellurics given by Professor Vozoff at BMR.

Field surveys during the year were conducted in Papua New Guinea, Queensland, NSW, ACT, Victoria, Tasmania, and Christmas Island.

Black Mountain engineering survey. Seismic refraction work was done at the proposed site of the Black Mountain Communications Tower. A complete investigation was not possible because of restrictions in the use of explosives in the vicinity of the existing television transmitters. A hammer was used as an energy source and the results indicate that slightly weathered rock exists within a few metres of the surface.

Tuggeranong Tunnel engineering survey. Additional seismic refraction work was done along the tunnel line ahead of underground workings. Nineteen seismic spreads were completed and the results indicated that the tunnel would be in fresh bedrock over the area investigated. Good correlation exists between structural features indicated in the seismic sections and the geology along the tunnel line. Faults subsequently encountered in the tunnel correlate with anomalies in the seismic sections.

Weetangerra Reservoir engineering survey. Seismic refraction work was carried out over the proposed sites of the Weetangerra Reservoir No. 2. The aim of the survey was to determine conditions of excavations for a large rectangular reservoir. The results indicated that heavy blasting would be required for most of the excavation; consequently an alternative scheme of circular tanks sited on the surface was adopted.

Vanniassa and South Torrens Reservoir Sites engineering survey. Seismic refraction work was done at five reservoir sites in the Tuggeranong Valley. The results indicate high bedrock velocities close to the surface on most of the sites and that heavy blasting will be required for excavation.

Mount Stromlo engineering survey. Seismic work was done on a proposed site for a settlement lagoon on Mount Stromlo. The aim was to determine rippability of the material to be excavated. Results indicate that blasting will be required over about two-thirds of the site. It was recommended that the site be moved a short distance in order to reduce the amount of blasting.

Googong Damsite engineering survey. Seismic work was done at selected sites along the path of the proposed pipeline from the damsite, to determine seismic velocities in areas of deep cuts. Six spreads were completed and the results were supplied to the Engineering Geology Group.

Tuggeranong Town Centre engineering survey. A seismic survey, consisting of five isolated spreads, was made to assist with a study of the town centre. At the time of writing the results had not been analysed.

A magnetic survey was also made along five traverse lines to locate faults which might allow seepage from a proposed lake in the vicinity. The coverage was not sufficient to make a thorough appraisal, but there were no obvious indications of faulting over the areas covered.

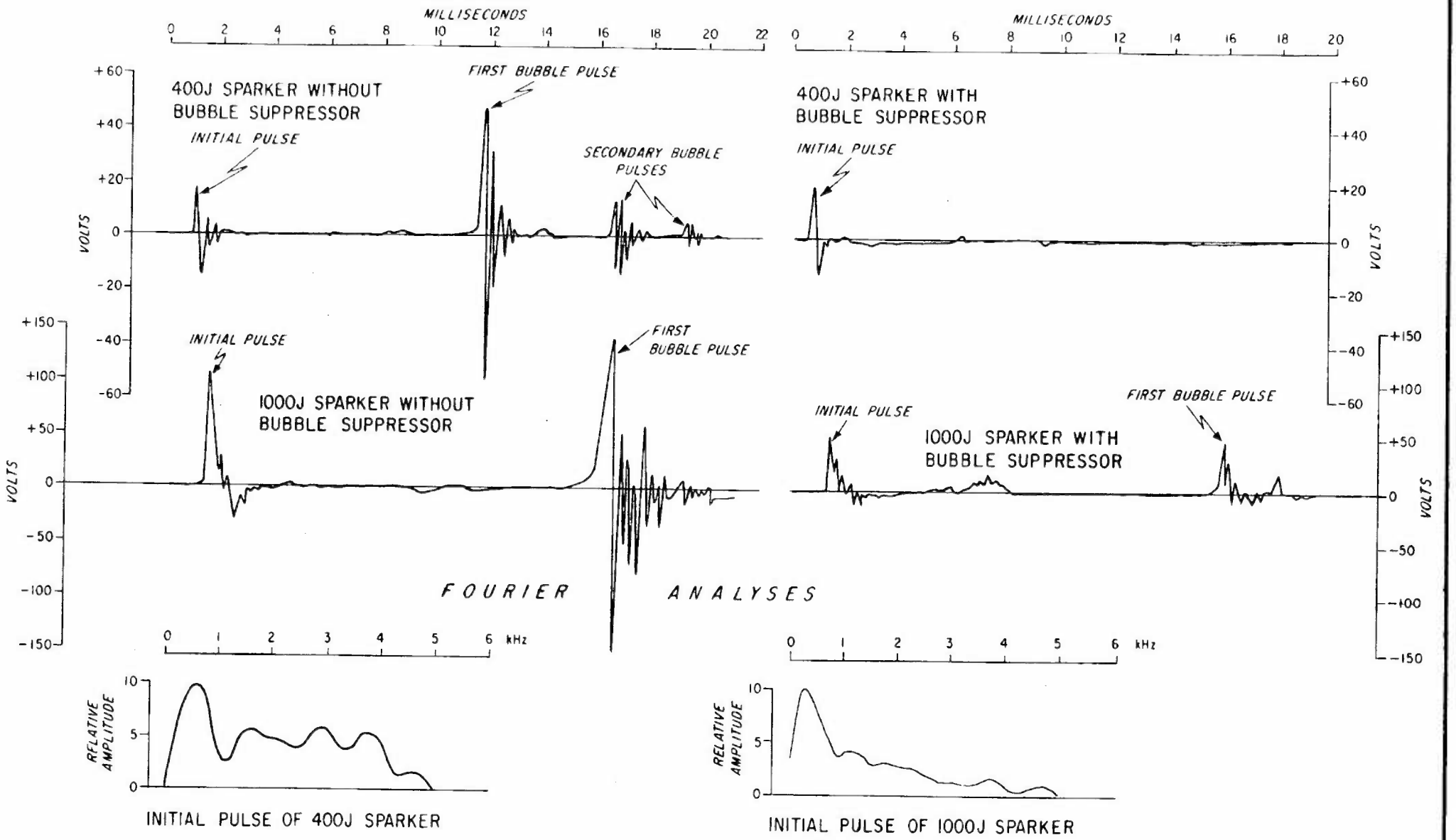
Orroral Valley Laser Lunar Ranger Site engineering survey. The Division of National Mapping proposed to install a Laser Lunar Ranger station in the ACT as part of a worldwide study of geodesy using a number of such stations. An important requirement for the installation is that it be founded on bedrock. The Engineering Geophysics group made a seismic refraction and resistivity survey of three sites to determine the best foundation conditions.

Two of these sites had over 10 metres of highly weathered material overlying bedrock. The third site had bedrock outcropping at the edge of a steep slope and beside another area of very deep weathering; this site was the best of the three but is not considered ideal.

ACT vibration measurements. The Engineering Geophysics group conducted a number of vibration investigations in the ACT during 1973. Most of these investigations were to ensure that ground vibrations from blasting did not threaten nearby structures.

Measurements were made at the Mount Stromlo water treatment works, the Tuggeranong Sewer Tunnel site, and at Weston near the Tuggeranong Freeway construction site. For residences a limit of 0.75 in/s particle velocity was set and for other structures 1.5 in/s. The maximum peak particle velocity recorded near a residence was 0.44 in/s and next to a water main was 1.50 in/s.

To accompany Record No. 1973/195



PULSE CHARACTERISTICS OF SPARKERS

G16-113A

Fig. GS 1

To accompany Record No. 1973/195

SAMPLE HIGH RESOLUTION RECORD FROM WESTERN PORT SURVEY

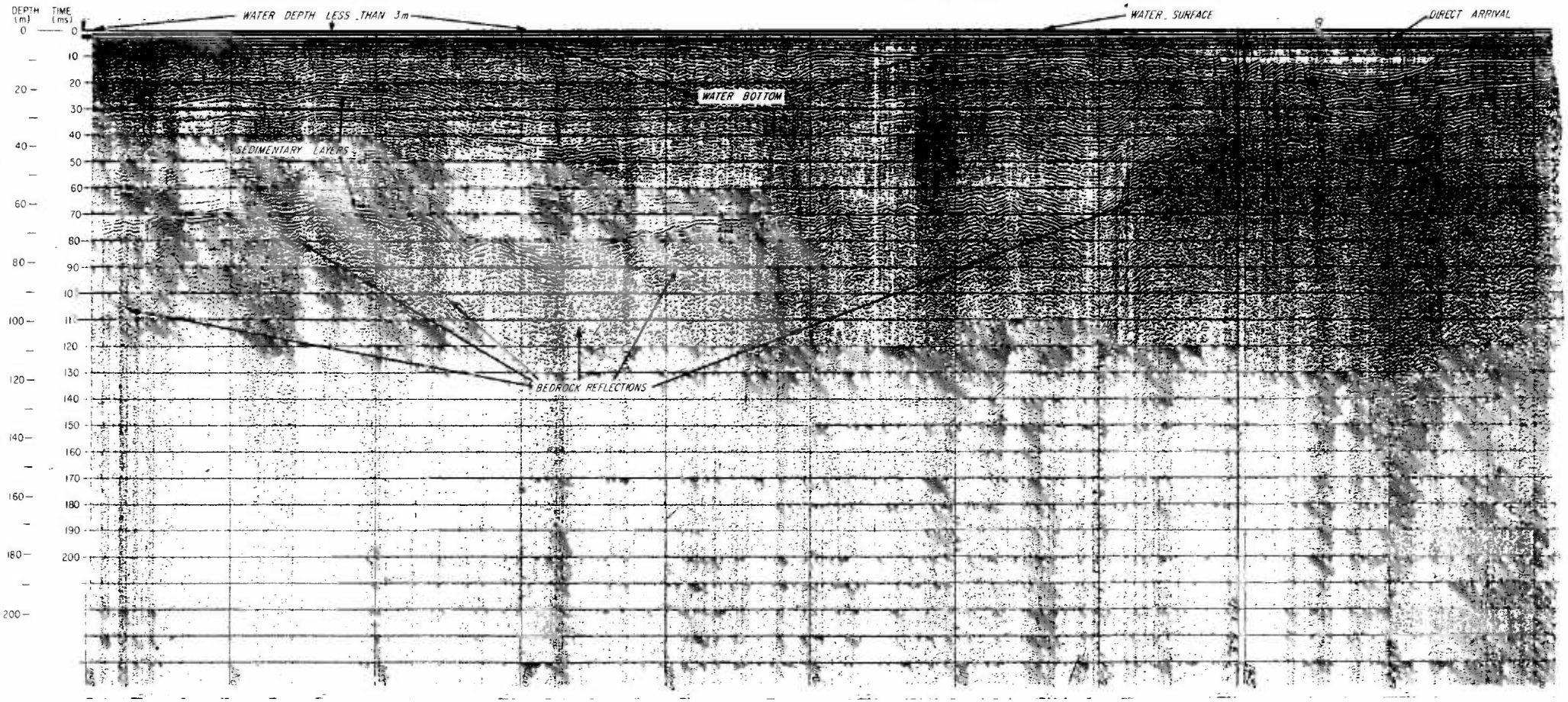
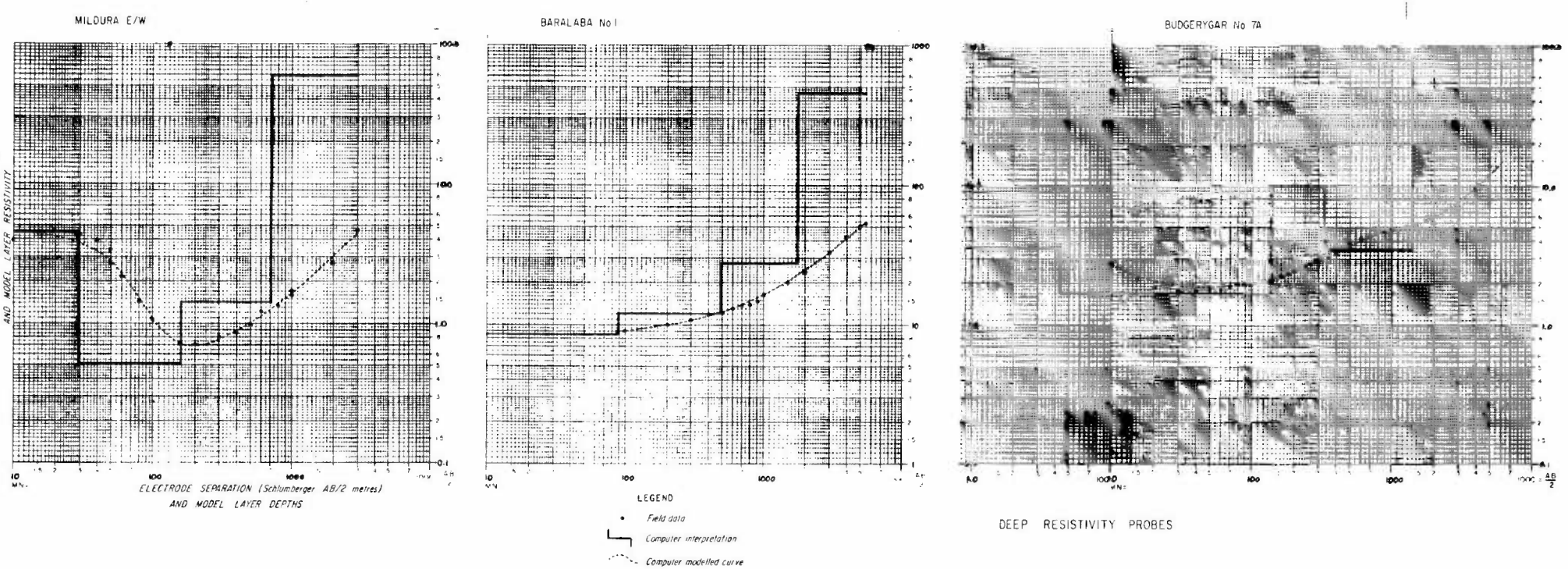


Fig. GS 2

G463-29A

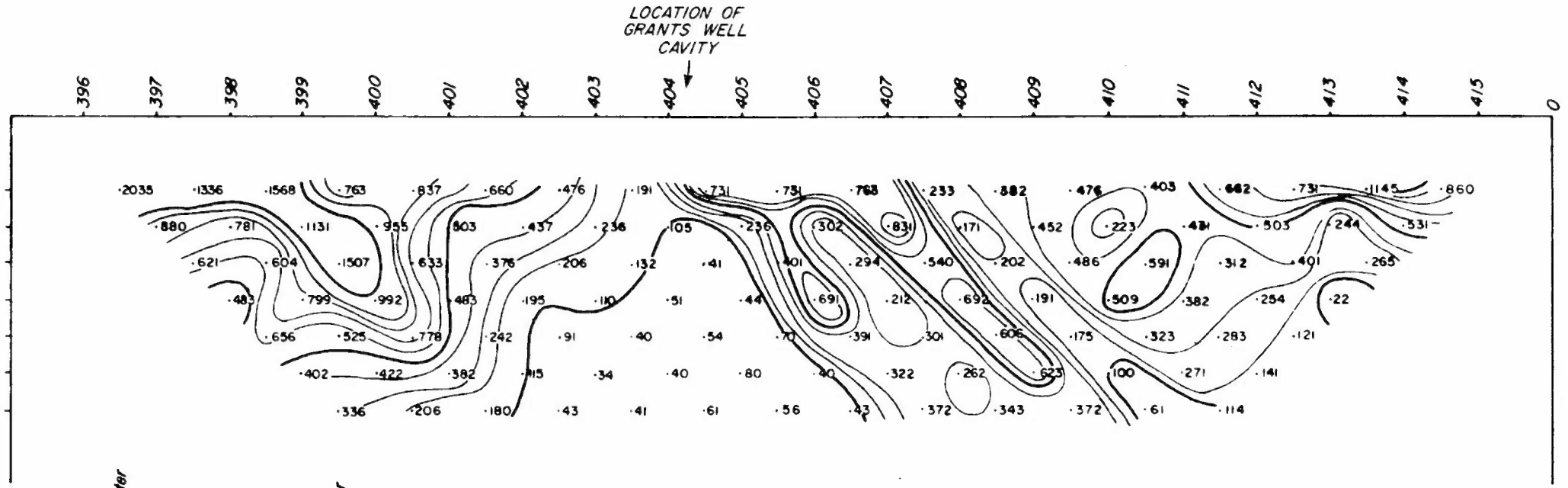
To accompany Record No. 1973/95

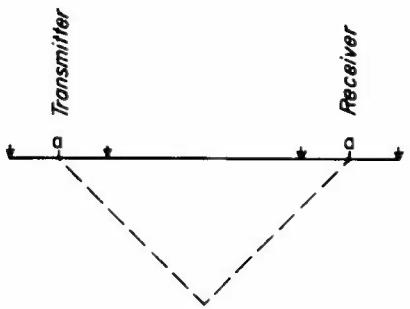


DEEP RESISTIVITY PROBES

Fig. GS 3

G463-30A





Arrangement of electrodes
for n = 3
a = 10 m

CHRISTMAS ISLAND GROUND WATER SURVEY.
DIPOLE — DIPOLE TRAVERSE
ACROSS A KNOWN STRUCTURE

Lae geophysical survey (hydrology, PNG). A geophysical survey was conducted around the town of Lae and its environs to assist with groundwater studies of the area and to assist with town planning in regard to earthquake risk.

The area consists of unconsolidated sand, silt, clay, gravel, and boulder gravel which, according to drill-hole data, extend to depths beyond 100 m. The seismic data indicate that the boulder gravel may extend to depths of 715 m in one place.

The results of the survey indicate that water bores can be extended to much greater depths than the existing bores. Seismic data from the area of proposed industrial development west of the Lae township show a large thickness of floodplain alluvium, probably water-saturated mud and clay, which can extend to a depth of 250 m. This area is likely to be more susceptible to earthquake damage than those regions of boulder gravel north of the Lae township.

Markham Valley seismic survey (hydrology, PNG). Seismic refraction work was done at three places in the Markham Valley in order to determine the thickness of unconsolidated sediments. This project was of particular interest since no seismic work or deep drilling had been undertaken in the valley previously. The results of work on the Leron Plains, which are typical of the Markham Valley, show that unconsolidated sediments (sand, clay, gravel, and boulder gravel) extend to a depth of 600 m. This is underlain by consolidated sedimentary rock (velocity 3500 m/s) which is probably intruded by metamorphics. Similar results were obtained at another place near the Rumu River. The conclusion drawn from these results is that there is a good possibility of finding deep aquifers which could provide adequate supplies of water for stock and irrigation.

Christmas Island groundwater survey (hydrology). Additional water supplies are required to work the inferior grades of phosphate on Christmas Island. An experimental survey was made to assess the value of geophysical methods in locating groundwater in cavities in the limestone which covers the island.

Dipole-dipole and Schlumberger electrode arrangements were used in resistivity traversing. The resistivity of water-filled cavities was found to be much lower than that of limestone, but dry cavities were characterized by very high resistivities. Figure GS 4 shows the results of a dipole-dipole traverse across a known water-producing cavity.

The seismic refraction method was used to determine the thickness of the limestone but did not prove directly useful in locating cavernous areas. Gravity anomalies were obtained over the cavities, and magnetic survey results gave some indication of the thickness of limestone over basalt.

Moura Coal Field investigations, Qld. Magnetic and resistivity work was done in the vicinity of Moura as part of a continuing study of the use of geophysics in mapping structures in the coal fields.

Twelve depth probes were completed using the Schlumberger electrode configuration with current electrode spacing varying from 10 m to 1 km. These probes were located in the vicinity of the open-cut coal mines. In addition one deep resistivity probe, involving a total current electrode

spacing of 11 km, was located on the Baralaba road in the vicinity of the Moura No. 1 oil well. A 4-layer computer interpretation of one probe is shown in Figure GS 3. The boundary shown at 480 m corresponds with the top of the Baralaba coal measures.

Fifteen kilometres of continuous magnetic traverse was completed in the vicinity of the open-cut coal mines. The recording technique allowed readings to be taken at approximately 1-m spacing along the entire traverse.

Computation of magnetic and resistivity results has not been completed as yet but preliminary analysis of the resistivity results indicates good correlation with borehole data.

A request was made by the Queensland Mines Department and the mining operator of the Moura coal mine to measure the level of vibration from the heavy blasting used to remove overburden in the open-cut coal mine. The request followed complaints made by a resident living about 3 km from the workings.

BMR officers recorded the level of ground vibration from an explosion of 100 tons of ammonium nitrate at a distance of 335 m from the explosion. This measurement indicated that there is little possibility of such explosions causing damage at distances greater than 300 m from the explosion.

Deep resistivity probes, Mildura. Two deep resistivity probes were carried out 30 miles southwest of Mildura, Vic. The Schlumberger electrode configuration was used with current electrode separation up to 6 km. An interpretation of the east-west line is shown in Figure GS 3. The boundary shown at 710 m corresponds with the top of the granite basement given by seismic results. These depth probes were made in preparation for magneto-telluric experiments in the area.

Well Logging. Supervision of contract well logging. The group was responsible for technical supervision of two contract logging surveys, the first of which commenced in 1972 and the second in October 1973. Both surveys were in the Surat Basin in the southeast of the Great Artesian Basin. Gamma, neutron, temperature, differential temperature, flow-meter, and caliper logs were obtained.

BMR's deep logging equipment was transferred to a new truck chassis and rebuilt, with considerable improvements in layout and design. The work could not be completed in time for field work in 1973 because of tendering delays for the supply of new motor-generator and compressor power unit.

Considerable assistance was given to geologists in the use of small portable loggers, including a number of visits to field parties to repair faulty equipment.

Geophysical Drafting Office

The flat-bed digital plotter became operational in 1973 and greatly increased rate of production of maps. Two additional drafting staff positions were created to look after this specialized activity. At the end of 1972 the Drafting Office had filled almost all positions but at time of writing this report there were eight vacancies and little prospect of these being filled. A submission for additional staff for marine survey drafting has been prepared.

Ground Surveys Drafting Group. This group is responsible for the drafting requirements of seven geophysical groups. Work completed during the year comprised:

(a) Seismic surveys. Officer Basin Survey - 20 plates; Carpentaria Basin - 1 plate; Bowen Basin refraction - 2 plates; Trans Australia survey - 5 plates.

(b) Crustal studies. Rabaul Caldera - 5 plates; New Britain and stations - 113 plates; magnetic and gravity curves - 60 plates; New Britain/ New Ireland - 9 plates; Trans Australia - 7 plates; Australian regional magnetic - 3 plates.

(c) Observatories. Strong-motion results - 8 plates; Lae area PNG - 4 plates; Australian earthquake data - 5 plates; Trans Australia - 11 plates; Mawson annual report - 4 plates; USSR pendulum equipment - 6 plates; Tsunami catalogue - 3 plates; East Canning Basin earthquake - 3 plates; distance from Alice Springs in degrees - 1 plate; working report of geodynamics project - 7 plates.

(d) Metalliferous surveys. Captains Flat 1972 - 20 plates; Tennant Creek 1971 - 21 plates; Downhole IP tests - 6 plates.

(e) Engineering surveys. Tharwa-Williamsdale - 5 plates; Naas-Tharwa - 5 plates; Molonglo freeway - 4 plates; Tuggeranong urban - 6 plates; Tuggeranong freeway - 2 plates; Currarong vibrations - 2 plates; Musa damsite 1972 - 54 plates; Mordialloc Beach - 2 plates; Mildura deep resistivity - 2 plates; Googong damsite - 1 plate; Tuggeranong tunnel - 3 plates; Orroral Valley ACT - 5 plates; Lunar Laser Ranger site - 2 plates; Isaacs suburb - 5 plates; shallow profiling - 6 plates; computer forms - 3 plates; Graph particle v. distance - 1 plate; Googong damsite pipeline - 1 plate.

(f) Gravity surveys. National Gravity Computer System - 11 plates.

(g) Marine surveys. Gravity tie data, structural trends and bathymetric features - 2 plates; wharf Isogal stations - 43 plates.

(h) Miscellaneous

137 miscellaneous drawings were made for various groups, and final additions and amendments were made to 362 plates for inclusion in the Record series.

198 drawings for slides were produced for symposiums, lectures, and journal papers.

The Petroleum Titles Map for December 1972 was produced for 3-colour printing for the Petroleum Technology Section.

The following plates were drawn for Operations Branch: BMR Program 1973 - 9 plates; organization charts - 4 plates; computer costing forms - 2 plates.

During the year, 84 830 prints were made in the plan printing group for the whole of BMR.

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

(a) Regional surveys. BENDIGO-WANGARATTA, TALLANGATTA Vic 1972 (completed); Eucla Basin SA 1972-73 (completed); ALLIGATOR RIVER, MOUNT EVELYN and COBOURG PENINSULA NT 1971-72 (completed); Western Australia purchase survey: RASON, MINIGWAL, PLUMRIDGE, and CUNDEELEE 1:250 000 Sheets (checking completed, compilation for automatic processing commenced); ALCOOTA NT 1972 (compilation completed and Record plates commenced); Officer Basin (presurvey compilation completed); CLONCURRY Qld 1973 (compilation completed); WESTMORELAND Queensland 1973 (compilation completed); WAGGA WAGGA-CANBERRA NSW/ACT 1973 (compilation of survey data continued); GEORGETOWN-RED RIVER Qld 1973 (presurvey compilation completed); Carpentaria Basin Qld 1973 (presurvey compilation completed); Western Australia 1972 Contract computer generated contours (finalization of total magnetic intensity contours completed); Northern Eromanga Basin Queensland (nearly completed); control traverses 1973 for Aeromagnetic Map of Australia (presurvey compilation completed); Northern Eucla Basin radiometric follow-up traverses (compilation of survey data completed); PERTH, PINJARRA, CORRIGIN, and KELLERBERRIN, WA 1972 (compilation completed ready for machine contouring); Victoria River Basin NT (plates for Record commenced); Magnetic Map of Australia 1:2 500 000 (compilation continued).

(b) Detailed surveys. Arltunga Nappe Complex (compilation completed); PROSPECTOR, Queensland 1973 (compilation completed); HEDLEYS CREEK, Queensland 1973 (presurvey compilation completed).

214 plates were drawn for presurvey reports and Records. Final amendments of 98 plates were made. 51 drawings for slides were produced for lectures, etc.

Gravity Drafting Group. This group is trying to handle the more urgent marine work coming off the flat-bed plotter.

(a) Gravity surveys. 1970 helicopter gravity survey, SA (completed); 1973-74 helicopter survey NSW/Vic/Tas (plotting of elevation control traverses 80% completed); 1971-72 helicopter survey, WA (57 Bouguer anomaly maps completed); 1:2 534 400 map of Australia, updated WA 1972 material added (completed); 1:5 000 000 Gravity Map of Australia (black and white edition completed, hand coloured version prepared for photography); 1972 helicopter survey contract drafting WA (56 x 1:250 000 Sheets, 20 sheets completed to Stage I); Gravity Map of Australia 1:2 500 000 (no progress since end of February 1973).

(b) Marine surveys. Continental Margin marine survey preparatory work (completed); Continental Margin preliminary flat-bed plotted contours (49 maps at 1:2 500 000; preparation for reproduction 80% complete).

There were 235 miscellaneous plates drawn for Records, and additions and amendments to 186 plates. 61 drawings for slides were produced for symposiums or lectures. 47 Bouguer anomaly maps at 1:500 000 scale were printed.

Cartographic Group. This section fair draws for photo-litho reproduction. The following were completed:

Western Australian 1969 aeromagnetic and radiometric survey (contour sheets completed); 19 geophysical base maps 1:250 000 (completed); Central Great Artesian Basin 1968 aeromagnetic (printed and delivered); SANDSTONE and YOUANMI aeromagnetic and radiometric (printed and delivered); Papua New Guinea 1969-71 aeromagnetic (9 maps, at the printers since August 1973); Western Australia 1972 aeromagnetic contract surveys (4 sheets, continued); GOULBURN 1965 aeromagnetic and radiometric (completed); Southern Cape York Peninsula - WALSH, MOSSMAN, CAIRNS 1:250 000 sheets (bases being redrawn); Gravity Map of Australia 1:250 000 (S.E. quadrant sheet scribed); Petroleum Titles map to June 1973 (commenced).

Plates for BMR magnetic, gravity, and radiometric pamphlets were redrawn. 12 Aeromagnetic and 10 mini-max 1:250 000 'flat-bed' scribed sheets awaiting processing.

Flat-bed plotter. Early in the year the flat-bed digital plotter installation was completed, and after trial runs began to produce aeromagnetic and marine maps according to program. The following maps were produced: Continental Margin preliminary contours - (187 maps); preliminary T.M.I. contours, airborne, 1:100 000 (70 maps); final T.M.I. contours airborne, 1:250 000 (19 maps); Continental Margin current vector maps (12); 1:100 000 map graticules (9); 1:50 000 map graticules (7).

Miscellaneous program tests and grids at various scales and spacings were also produced.

5. REPORTS, MAPS, LECTURES

Listed in the following pages are reports and maps issued during 1973, reports in preparation, papers published in outside journals, and addresses delivered at meetings and conferences.

BMR PUBLICATIONS

Bulletin 105	FOWLER, K.F.	Ice thickness measurements in MacRobertson Land, 1957-59.
In Bulletin 125 (Geological Papers, 1969)	WATTS, M.D.	Geological interpretation of a gravity survey over basement inliers near Millungera, north Queensland.
	MANWARING, E.A.	Palaeomagnetism of some Recent basalts from New Guinea.
Bulletin 152	HAIGH, J.E. & SMITH, M.J.	Standard curves for interpretation of magnetic anomalies due to thin finite dykes.
Report 159	FINLAYSON, D.M.	Isomagnetic map of the Australian region for epoch 1970.0.

Report 163	BROWN, A.R.	A detailed seismic study of Gosses Bluff, NT.
Report 168	ALMOND, R.A.	AFMAG field recordings, 1968-1971.

EXTERNAL PUBLICATIONS

BOULANGER, Yu.D. SHCHEGLOV, S.N. (USSR Acad. of Sciences) WELLMAN, P., COUTTS, D.A., BARLOW, B.C.	Soviet-Australian gravity survey along the Australian Calibration Line.	Bull. Geodesique (in press)
BRIGGS, I.C.	Machine contouring using minimum curvature	Geophysics Feb 1974
DENHAM, D.	Seismicity, focal mechanisms and the boundaries of the Indian-Australian plate, in The Western Pacific Island areas, Marginal seas, Geochemistry.	Univ. West. Aust. Press, 1973
DOOLEY, J.C.	Is the Earth expanding?	Search, 4, 1973, p. 9
FINLAYSON, D.M., CULL, J.P.	Structural profiles in the New Britain/New Ireland region.	J. Geol. Soc. Aust., 20, 1973, p. 37
FITCH, T.J., WORTHINGTON M.H.(A.N.U.), & EVERINGHAM, I.B.	Mechanisms of Australian earthquakes and contemporary stress in the Indian Ocean plate.	Earth and Plan. Sci. Letters, 18, 1973, p. 345
MILSOM, J.S. (formerly BMR, now Imperial College, London)	The gravity field of the Papuan Peninsula	Geologie en Mijnbouw, 52, 1973, p. 13
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1969/154	WILLCOX, J.B.	Presurvey report on 1970 geophysical survey of the Law Ice Dome, Wilkes Land, Antarctica.
1972/81	DOW, D.B., TAYLOR, G.A.M., DENHAM, D.	Geology, volcanoes and earthquakes of Papua New Guinea.
1972/90	RIPPER, I.D. SMITH, R.S.	Port Moresby Geophysical Observatory annual report, 1970.
1972/120	LAMBOURN, S.S.	Aeromagnetic survey of the Glengarry, Wiluna and Kingston 1:250 000 Sheet areas, WA 1970.
1972/122	MUTTER, J.C.	A recent geophysical reconnaissance of the Gulf of Papua and northwest Coral Sea.
1972/131	SHELLEY, E.P., SIMPSON, C.J.	Airborne remote sensing project Western Australia 1970.
1972/134	MUTTER, J.C.	Marine geophysical survey of the Bismarck Sea and Gulf of Papua 1970 - A structural analysis of the Gulf of Papua and northwest Coral Sea region.
1973/4	RIPPER, I.D. GAULL, B.	Port Moresby Geophysical Observatory annual report, 1971.
1973/8	TAYLOR, F.J.	Currarong vibration measurements, NSW 1972.
1973/9	BISHOP, I.D. DOLAN, B.H.	Molonglo Freeway, Black Mountain,ACT seismic survey, 1972.
1973/12	TUCKER, D.H. BROWN, F.W.	Reconnaissance helicopter gravity survey in the Flinders Ranges, SA 1970.
1973/13	DENHAM, D., SMALL, G.R. EVERINGHAM, I.B.	Some strong-motion results from Papua New Guinea,1967-1972.
1973/14	ZADOROZNYJ, I. COUTTS, D.A.	Central Highlands helicopter gravity survey, PNG, 1970.
1973/16	BRIGGS, I.C.	Machine contouring using minimum curvature (Restricted).
1973/18	EVERINGHAM, I.B.	The major Papua New Guinea earthquakes near Madang (1970) and beneath the north Solomon Sea (1971).
1973/20	EVERINGHAM, I.B.	A submarine slump and tsunami in the Lae area, 26 August 1972.
1973/21	FINLAYSON, D.M. CULL, J.P.	Time term analysis of New Britain-New Ireland arc structures.
1973/28	BULLOCK, P.W.B.	Interpretation of gamma ray spectra of uranium and thorium.

1973/31	KERR, D.W.	Program MANYPLOT - Computer calculated inverse Laplace transforms for prediction of circuit behaviour.
1973/33	HARRISON, P.L. ANFILOFF, W. MOSS, F.J.	Galilee Basin seismic and gravity survey, Qld 1971.
1973/34	CONNELLY, J.B.	Magnetic and seismic profiler records in the Bismarck Sea and Melanesian Archipelago.
1973/38	WILLCOX, J.B.	Preview report for the marine geophysical survey of the Gulf of Papua and the Bismarck Sea, 1970.
1973/40	BISHOP, I.D.	Gravel for rural roads seismic surveys, Tharwa, Williamsdale, ACT, 1972.
1973/41	PETTIFER, G.R.	Gravity survey Goulburn and Ovens River Valleys, Victoria 1972.
1973/42	TAYLOR, F.J.	Broken Hill Power Station vibration measurements, Nov. 1972.
1973/60	C.G.G.	Eastern Papua aeromagnetic survey, Part 2. Southwestern panel (onshore) flown in 1970-71.
1973/62	HARRISON, P.L.	Officer Basin seismic survey, WA 1972. Operational Report.
1973/63	MATHUR, S.P.	Crustal structure in southwestern Australia from seismic and gravity data.
1973/65	DOLAN, B.H.	High-resolution seismic profiling survey of Port Phillip Bay near Mordialloc, Victoria 1972.
1973/66	EVERINGHAM, I.B.	Seismological report on the Madang earthquake (31 October 1970) and aftershocks.
1973/71	ZADOROZNYJ, I.	Officer Basin detailed gravity survey, WA 1972. Operational Report.
1973/72	WELLMAN, P., DOOLEY, J.C. BARLOW, B.C.	Soviet gravity tie from Moscow to Sydney, 1972.
1973/76	WHITWORTH, R., BROWN, F.W., GRACE, J.K.	Presurvey report on marine geophysical survey No. 21 (magnetic) northwest continental shelf (Division of National Mapping Contract No. 3).
1973/81	REES, J.E. TAYLOR, R.J.	Tottenham detailed aeromagnetic survey, NSW, 1971.
1973/96	BOULANGER, Yu.D. SHCHEGLOV, S.N. (USSR Acad. of Sciences) WELLMAN, P., COUTTS, D.A. BARLOW, B.C.	Soviet-Australian gravity survey along the Australian Calibration Line

1973/105	FRASER, A.R.	A discussion of the gravity anomalies of the Precambrian shield of Western Australia.
1973/106	THYER, R.F. BARLOW, B.C.	Recent advances in gravimetry for physical geodesy in Australia.
1973/107	MUTTER, J.C.	Aspects of the structure and tectonic history of the continental margin of northern Queensland.
1973/108	WILLCOX, J.B.	Visit to geophysical survey vessel, M.V. Petrel, March 1973.
1973/109	STEWART, I.C.F. (Univ. of Adelaide) DENHAM, D.	Simpson Desert earthquake, central Australia, August 1972.
1973/111	DOWNIE, D.N.	Digital data acquisition system for Twin Otter aircraft.
1973/112	MATHUR, S.P.	Crustal structure in southwestern Australia.
1973/114	TAYLOR, F.J. McDOWELL, M.I.	Lake Windermere seismic refraction survey, ACT 1969.
1973/115	GUSEV, N.A. (USSR Acad. of Sciences)	Determination of gravity acceleration at Sydney with Pendulum apparatus.
1973/116	FINLAYSON, D.M.	Program for East Papua crustal survey, Oct-Nov 1973.
1973/118	POLAK, E.J. RAMSAY, D.C.	Moura coal mine blasting vibration measurements, Moura, Queensland, 1973.
1973/119	SLIVIN Yu.A. (USSR Acad. of Sciences)	Papers on the measurement of gravity with USSR pendulum equipment (transl. by J.C. Dooley).
1973/121	CULL, J.P.	Computer processing of seismic data.
1973/122	CULL, J.P.	Seismic ray tracing in a spherical earth using computer models.
1973/124	WYATT, B.W.	Presurvey report for the airborne magnetic and radiometric surveys of the Cloncurry 1:250 000 and Prospector 1:100 000 Sheet areas, Qld 1973 (Restricted).
1973/125	SAMPATH, N. OGILVY, R.D. SPIES, B.R.	Captains Flat metalliferous survey, NSW 1972.
1973/128	PINCHIN, J.	A reinterpretation of seismic results in the Laura Basin, Queensland.
1973/130	FRASER, A.R.	Reconnaissance helicopter gravity survey, WA 1971-72.

1973/132	PINCHIN, J.	A geophysical review of the Carpentaria, Laura, and Olive River Basins.
1973/137	WYATT, B.W.	Presurvey report for the airborne magnetic and radiometric surveys of the Westmoreland 1:250 000 and Hedleys Creek 1:100 000 Sheet areas, Qld 1973 (Restricted).
1973/149	PETKOVIC, J.	Mawson Geophysical Observatory annual report 1971.
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1973/159	HORSFALL, K.R.	Presurvey report, Cape York Peninsula airborne magnetic and radiometric survey, 1973 (Restricted).
1973/167	SYMONDS, P.A.	The structure of the north Tasman Sea.
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BULLOCK, P.W.B.	The follow-up of an airborne gamma-ray spectrometer survey in the Rum Jungle area, NT.
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DOLAN, B.H.	The development of a high-resolution seismic profiling system for shallow water, 1971-72.
POLAK, E.J.	Visit to Hong Kong, Japan, USA, Canada, England, and Poland, 1972-73.
POLAK, E.J.	Christmas Island groundwater survey, 1973.
POLAK, E.J., & RAMSAY, D.	Canaway Ridge, Queensland, groundwater survey, 1973.
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SEERS, K.J.	Notes on the fabrication of printed circuit boards
MULDER, J.M.	A discussion on the design, manufacture and tests of radar intersection buoys.
KERR, D.W.	The effects of finite magnetometer bandwidth on a point-source aeromagnetic anomaly.
RAMSAY, D. & HILLMAN, P.J.	Development of a digital counter for GSI and NSL quartz pendulums.
HILLMAN, P.J.	Modification of Press-Ewing long-period seismometer to compensate for effects of temperature changes.
KERR, D.W. & SEERS, K.J.	High-performance airborne fluxgate magnetometer MFS7.
SEERS, K.J.	General-purpose proton magnetometer MNS2.
SEERS, K.J.	General-purpose seismic amplifier TAM5.
DEVENISH, B.A.	A time-varied gain amplifier for shallow seismic profiling.
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ALLEN, M.G. - Highlights of BMR's geophysical programme in 1972 and in the programme for 1973. ASEG meeting, Sydney, 10 April 1973.

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BARLOW, B.C., COUTTS, D.A., SYDENHAM, P., - Tidal deviations of the vertical at Armidale, Australia. Symposium on Earth's Gravitational Field and Secular variations in Position. Sydney, 29 November.

BARLOW, B.C. - Possible correlations between the Gravity Map of Australia and mineral provinces - BMR Symposium Canberra, 22 May 1973.

BARLOW, B.C. - Gravity surveying in Australia - Department of Foreign Affairs International Training Course in Mineral Exploration Administration - Canberra 25 May.

BROWN, F.W. - Applications of geophysics in exploration of the continental margins. Department of Foreign Affairs, International Training Course in Mineral Exploration Administration, Canberra, May 1973.

BRANSON, J.C. - Operation of the marine geophysical continental margin survey. Australian Institute of Mining and Metallurgy, Cooma Branch, May 1973.

COUTTS, D.A. - Use of a remote-reading airborne gravity meter to obtain readings over difficult terrain in Papua New Guinea. First Conference on Science Technology, ANZAAS SA Inc./Aust. Inst. of Science Technology, Adelaide, November.

DENHAM, D. - Continental drift. Haas Recking Symposium, BMR, Canberra, 17 April 1973.

DENHAM, D. - Major Papua New Guinea earthquakes near Madang (1970) and beneath the north Solomon Sea (1970) by I.B. Everingham. 5th World Conference on Earthquake Engineering, Rome, 25 June 1973.

DENHAM, D. - Some strong-motion results from Papua New Guinea 1967-1972, by D. Denham, G.R. Small and I.B. Everingham. 5th World Conference on Earthquake Engineering, Rome, 28 June 1973.

DENHAM, D. - A new look at Australian earthquakes, by D. Denham and G.R. Small. 45th ANZAAS Congress, Perth, 17 August 1973.

DENHAM, D. - Earthquake risk. Canberra College of Advanced Education, 21 and 23 August 1973.

DENHAM, D. - Dynamics of the northern margin of the Australian plate near New Guinea and the stress regime within the Australian continent. Symposium on Recent Crustal Movements, Bandung, 10-18 November 1973.

DOOLEY, J.C. - The gravity anomalies of Central Australia and their significance for long term tectonic movements. Symposium on Earth's gravitational field and secular variations in position. Sydney, 27 November.

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FRASER, A.R. - A discussion on the gravity anomalies of the Precambrian Shield of Western Australia. Second International Conference on Geophysics of the Earth and the Oceans, Sydney, January 1973.

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GREGSON, P.J. - Australian seismicity. University of Brasilia, September 1973.

GREGSON, P.J. & SMITH, R.S. - Micro-earthquakes in the southwest of Western Australia. 45th ANZAAS Congress, Perth, August 1973.

HARRISON, P.L. - Officer Basin geophysical surveys. BMR Symposium, Canberra, May 1972.

HEMPHILL, L.E. - Instrumentation for seismic prospecting. ANZAAS Conference in conjunction with SA Institute of Technology, Adelaide, November 1973.

MATHUR, S.P. - Crustal structure in southwestern Australia. Second International Conference on Geophysics of the Earth and the Oceans, Sydney, January 1973.

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MOSS, F.J. & DOOLEY, J.C. - Deep crustal and upper mantle reflection studies in Australia. Society of Exploration Geophysicists, 43rd Annual Meeting, Mexico, October 1973.

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MUTTER, J.C. - Aspects of the structure and tectonic history of the continental margin of northern Queensland. Second International Conference on Geophysics of the Earth and the Oceans, Sydney, January 1973.

RIPPER, I.D. - Some anomalous aspects of New Guinean seismicity. 45th ANZAAS Congress, Perth, August 1973.

RIPPER, I.D. - Some anomalous aspects of New Guinean seismicity. PNG Geological Survey, September 1973.

SEDMIK, E.C.E. & DAVIES L. (E.Z.) - Review of geophysical exploration at Captains Flat, NSW. Second International Conference on Geophysics of the Earth and Oceans, Sydney, January 1973.

SYMONDS, P.A. - The structure of the north Tasman Sea. Second International Conference on Geophysics of the Earth and the Oceans, Sydney, January 1973.

WELLMAN, P. - Gravity fields associated with Cainozoic volcanic rocks. Symposium on Tertiary and Quaternary volcanism in eastern Australia. Melbourne, February 1973.

WELLMAN, P. - Regional variations of the Australian crust inferred from the gravity field. 45th ANZAAS Congress, Perth, August 1973.

WILLCOX, J.B. - Preliminary results from a marine geophysical survey of the Great Australian Bight. BMR Symposium, Canberra, May 1973.

WILLCOX, J.B. - Operations and results of the marine geophysical survey of the Great Australian Bight. University of Melbourne, September 1973.

WILKES, P.G. - Uses of gamma-ray spectrometry with examples from Alligator River, NT. BMR Symposium, Canberra, May 1973.

YOUNG, G.A. - Airborne and ground geophysical methods used by BMR to assist metalliferous mineral exploration. Department of Foreign Affairs, International Training Course in Mineral Exploration Administration, May 1973.

1:250 000 AEROMAGNETIC AND RADIOMETRIC MAPS PRINTED

Survey	Year	Type	Map Name	Remarks
Sandstone	1968	M/R	Sandstone	Printed and released 1973
Youanmi WA		M/R	Youanmi	"
Central Great Artesian Basin Qld	1968	M	Adavale	"
		M	Blackall	"
		M	Brighton Downs	"
		M	Eromanga	"
		M	Jundah	"
		M	Longreach	"
		M	Maneroo	"
		M	Quilpie	"
		M	Thargomindah	"
		M	Windorah	"
Eastern Papau PNG	1969&71	M	Abau	Printed 1973
		M	Buna	"
		M	Cape Nelson	"
		M	Fergusson I	"
		M	Kalo	"
		M	Port Moresby	"
		M	Samarai	"
		M	Trobriand I	"
		M	Tufi	"

M = Aeromagnetic Results only

M/R = Aeromagnetic and radiometric results

PRELIMINARY GEOPHYSICAL MAPS RELEASED

The following preliminary maps were released and became available from the Commonwealth Government Printer and the relevant State mines departments.

Aeromagnetic contour maps 1:250 000

Bendigo, Wangaratta, and Tallangatta Sheet areas.

Aeromagnetic contour maps 1:100 000

These are listed in alphabetic order under the 1:250 000 Sheet names.

1:250 000 Sheet area	1:100 000 Sheets released
Alligator River	Field Island, East Alligator, Oenpelli, Kapulga, Cahill, Howship
Bencubbin	Kalannie, Beacon, Wialki, Koorda, Bencubbin, Barbalin
Cobourg Peninsula	Wellington Range, Cobourg, Croker, Murgenella,
Glenburgh	Landor, Erong
Melville Island	Cape Don
Moora	Watheroo, Dalwallinu, Moora, Wongan
Mount Evelyn	Mundogie, Jim Jim, Gilruth
Nabberu	Fairbairn, Methwin, Rhodes, Merrie, Nabberu, Granite Peak
Ninghan	Ninghan, Marangalgo, Bungar, Mount Gibson, Jeallan, Earoo
Peak Hill	Jamindie, Three Rivers, Marymia, Bryah, Doolgunna, Thaduna
Perenjori	Yandanooka, Perenjori, Rothsay, Carnamah, Caron, Monger
Robinson Range	Errabiddy, Marquis, Milgun, Gould, Moorarrie, Padbury
Stanley	Earaheedy, Lee Steere, Coonabildie, Mudan, Glenayle, Kahrban

Bouguer Anomaly maps

Bouguer anomaly map of Australia 1:5 000 000.

Bouguer anomaly maps of the following 1:250 000 Sheet areas.

Ajana
Barlee
Belele
Burnabbie
Byro
Cooper
Cue
Culver
Dongara
Duketon
Edjudina
Eucla/Noonaera
Forrest
Geraldton
Glenburgh
Glengarry
Jubilee
Kennedy Range
Kingston
Kirkalocka
Laverton
Lennis
Leonora
Loongana
Madura
Mason
Menzies
Minigwal
Mount Phillips
Murgoo
Nabberu
Naretha
Neale
Ninghan
Peak Hill
Perenjori
Plumridge
Quobba
Rason
Robert
Robinson Range
Sandstone
Seemore
Sir Samuel
Stanley
Talbot
Throssell
Vernon
Waigen
Wanna
Westwood
Wiluna
Wooramel
Yalgoo
Yaringa
Youanmi
Yowalga

GRAVITY MAPS PRINTED

1:500 000 scale Bouguer anomaly maps of the following 1:250 000 Sheet areas in 1973:

Abminga
Alberga
Barton
Birksgate
Callabonna
Childara
Chowilla
Cook
Coompana
Copley
Curnamona
Everard
Fowler
Frome
Lindsay
Mann
Maurice
Noorina
Nullarbor
Nuyts
Olary
Ooldea
Orroroo
Parachilna
Port Augusta
Streaky Bay
Tarcoola
Wells
Woodroffe
Wyola

1:500 000 scale Bouguer anomaly maps reprinted in 1973:

Balladonia
Baralaba
Corrigin
Cundeelee
Dampier
Jackson
Minilya/Winning Pool
Mondrain Island
Moora
Mount Barker
Mount Isa
Newdegate
Robertson
Runton
Winning Pool
Zanthus