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Geophysical Branch

Summary of Activities 1971

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PART I - METALLIFEROUS AND AIRBORNE SECTION

1. GROUND SURVEYS

Captains Flat, NSW (R.A. Almond, I.G. Hone, P.J. Gillespie)

A metalliferous geophysical survey was conducted by the Bureau in co-operation with Electrolytic Zinc Co. of Australia Ltd in the Captains Flat area from 18 January to 10 March 1971.

The main objective of this survey was to study the Molonglo Fault which has terminated the main orebody of the, now closed, Lake George Mine. Only gravity work could be employed in this area because of the promimity of buildings, telephones, and power lines. In addition, various tests were conducted in the Copper Dam, Baldwins, and Gourlay Hickey areas to familiarize new staff with the handling of geophysical instruments (Plate 1).

Gravity results across the Molonglo Fault showed no features which could be related to a fault structure, and no positive conclusion could be made about the throw of the fault.

Turam, VLF, I.P., magnetic, and S-P methods were used in the Copper Dam area. The Turam and VLF results showed the existence of strong electromagnetic anomalies, the VLF results correlating very closely with the Turam. These anomalies consisted of a series of conductors arranged en echelon, having a meridional strike, and decreasing intensity towards the southern end of the prospect. I.P. apparent resistivity and metal factor anomalies were found to be associated with the electromagnetic anomalies, and on the basis of this correspondence two shallow drill holes were recommended. Magnetic anomalies were also detected but appeared to be unrelated to the E.M. and I.P. anomalies. No S-P anomalies were found.

VLF readings were taken using transmitting stations at N.W. Cape and Japan in order to obtain a comparison of the usefulness of the two stations. On the basis of the VLF work done in the Copper Dam area, and on two VLF traverses in the Baldwin area, it was concluded that although the signal from Japan is generally much weaker than that from N.W.C., it is usually readable and can be used to advantage in areas where the strike of the conductors is unfavourably situated for energisation from N.W.C.

A traverse in the Gourlay Hickey area was a repeat of the VLF work done in 1968 with the same instrument. The results agreed well demonstrating the repeatability of the method over a period of several years.

Investigation of I.P. logging methods (P.J. Gillespie)

Induced polarization logging methods have been studied by BMR since 1969 when the first design of a logger was conceived. However, construction of a prototype had to be deferred during 1970 because of shortage of staff caused by resignations.

During 1971 construction of a logging unit was resumed in a modified form as a down-hole I.P. probe to operate in conjuction with BMR's McPhar field equipment. Several prototypes were constructed and tested at Fyshwick and Kowen Forest before the unit was ready for routine field surveying.

During the period 26-30 July 1971, an I.P. logging test survey was carried out at Currawang, near Collector in NSW, where holes DDH-C_6 and DDH-C_7 were logged on a mining lease held by Hasting Exploration N.L. Logging revealed strong frequency effect anomalies which correlated well with zones of mineralisation previously detected by drilling.

Between 31 August and 20 October extensive evaluation tests of the down-hole technique were carried out at Tennant Creek N.T. jointly with N.T. Regional Geologist, Geopeko and Australian Development N.L. (Plate 2). Actual logging commenced on 2 September when Australian Development's H 373 drill hole was logged to a depth of approx. 260 m before losing the probe when endeavouring to retrieve it from the hole on the following day. This necessitated revision of probe design and construction of a new probe.

The new probe had the dipole-dipole electrode array incorporated in the cable making it flexible and of an external diameter only slightly greater than that of the cable. This probe was run in drill hole H 373 for comparison purposes and the results were found to correspond exactly with those obtained with the rigid probe. The new probe has the added advantage of being easily stowed and transported.

In all, thirteen drill holes were logged once using 3 metre dipole spacing and again using 9-metre dipole spacing. All I.P. logs showed good correlation with the geological logs, with magnetite and/or pyrite-chalcopyrite zones being reproduced as frequency effect anomalies. This was demonstrated very well by the I.P. logs of the East Peko 14 and 16 holes where the core trays were laid out and the core was examined using the I.P. log as a guide.

An electric "mise a la masse" test was carried out at Nob West where a well defined conducting zone in DDH 384 was energized and the resulting distribution of electric potential was measured on the surface. Tests for maximum current revealed that the optimum position for the in hole electrode was at the resistivity low defined in the down-hole I.P. logging of H 384. Even in this position a current of only 1 amp could be transmitted. Voltages measured were extremely low and this meant that a considerable time was required at each station to buck out S-P effects and to compensate for the noise. The extremely low resistivities made the environment of Nob West unsuitable for tests with the low-powered transmitter which was available. Nevertheless equipotential lines could be traced which delineated the shear zone in which mineralization was found in H 384.

Test area

The aim of this project is to find an area in or close to the A.C.T. suitable for testing geophysical equipment used in metalliferous prospecting. Several possible sites in the A.C.T. were visited but were rejected for various reasons. Two sites in the extreme north of the A.C.T. may be suitable, and geophysical tests will be made in them towards the end of 1971.

Mount Isa-Cloncurry area (J.E.F. Gardener)

A preliminary report was written on the assessment of geophysical data in the Mount Isa-Cloncurry area as part of a study of the mineralization.

The area has been covered by regional gravity surveys; the results give broad information on structure and also outline the Precambrian buried under younger sediments. Detailed gravity surveys made in selected areas have outlined structures associated with mineralization. Aeromagnetic and airborne electromagnetic methods have been largely ineffective in direct exploration for orebodies mainly because of the very large numbers of anomalies obtained. However, aeromagnetic results have been used successfully to give depths to and map the structure of the magnetic basement. Airborne electromagnetic data could possibly be used for regional resistivity mapping to study variations in electrical properties or rocks, as a aid to exploration; this is being done overseas. Detailed metalliferous geophysical surveys in the area have in many cases successfully detected mineralization and geological features associated with mineralization.

Suggestions made as a result of the preliminary assessment of geophysical data were to study problems related to the detection of non-outcropping orebodies such as those in areas of deep weathering or in areas of Precambrian buried under younger sediments; to consider making detailed surveys to study subsurface distribution of intrusive rocks as a possible aid to the study of oregenesis; to ask exploration companies if they are willing to make airborne electromagnetic results in the area available to BMR for possible reinterpretation for resistivity mapping purposes; and to consider completion of the regional aeromagnetic coverage of the area.

Tennant Creek ground magnetic survey (E.C.E. Sedmik, I.G. Hone, P. Bullock)

During the period 2 August-15 October geophysical surveys employing magnetic and gravity methods were carried out in four areas at Tennant Creek N.T. (Plate 2). The N.T. Mines and Water Resources Branch has been drilling geophysical targets in three of the four areas based on recommendations made following previous magnetic surveys carried out by BMR in 1967 and 1969.

The purpose of the 1971 survey was partly to investigate the Mary Ann area, to assist in interpreation of the Aeromagnetic Ridge structure and to experiment with additional geophysical techniques in areas in which targets were already drilled.

The Mary Ann area and the magnetic anomaly situated immediately east of the Stuart Highway and southwest of Mary Ann have been located and investigated. A well defined gravity anomaly was found over the Mary Ann workings.

Traverse 96E in the Aeromagnetic Ridge area has been selected for regional study of the "ridge structure". This traverse has been extended to a total length of approx. 25 km and has been surveyed with the Sander magnetometer and with a Worden gravity meter. Preliminary interpretation suggest that the "ridge" is a horst like structure. The "ridge" does not have a gravity expression but the outcropping ironstone formations east of the Juno mine appear associated with a gravity high.

Total field measurements were made over several traverses in areas C_6, C_8 and C_{11} using a proton precession magnetometer. Magnetic gradients were measured by readings with the sensing head of the magnetometer located 6 feet and 14 feet above the ground. High magnetic gradients were observed near and above shallow ironstone bodies. Quantitative interpretation of magnetic gradient measurements could be carried out on

Traverse 3600 E in area C_{11} and on Traverse 70 W in area AR_2.

Investigation of electromagnetic methods (E.C.E. Sedmik)

Background reading of literature on new developments in E.M. techniques used in metalliferous exploration was done during the year following an overseas study trip during the latter part of 1970.

Arrangements were made for the purchase of a one looptime domain E.M. equipment manufactured in the USSR under the name of MPPO-1 and enquiries were made for the acquisition of a wave impedance E.M. equipment MELOS manufactured by the BRGM in France.

No field tests could be conducted because no equipment was delivered during 1971.

AFMAG field recording (R.A. Almond)

Field strength recorders near Darwin and at Mundaring Geophysical Observatory near Perth operated continuously during the year except for periods when the recorders were under repair. These recorders have been operating since the summer of 1968-69.

A report on the study of the AFMAG fields has been commenced, the principal object of the study being to establish the season and part of the day which is most suitable for the operation of the AFMAG method in Australia.

The analysis of the records started with finding the average field strength for each hour over each month, and so constructing an average "AFMAG day field strength" for each month. The average "AFMAG days field strength" have been used as the basis of studying diurnal and seasonal variations in the field, and for attempting correlation of average monthly AFMAG field strengths with the number of thunderdays per month near the recording stations. Also, an attempt has been made to study the secular variation of the field; i.e. the variation of field strength at a particular time of day over the year. As well as much study based on averages of the records, individual records have been used to try to isolate effects due to local thunderstorms and solar flares. A draft report should be completed by the end of the year.

Darwin Uranium Group (P. Bullock)

Areas in which geophysical surveys were made in 1971 by the Darwin Uranium Group are shown in Plate 3.

Mary River area

A self-potential survey was made in Government Mining Reserve No. 275 in the Mary River area over the geophysical grid pegged in 1970 to determine whether self-potential anomalies are associated with gossan in the area. The results show that no significant anomalies coincide with gossanous outcrop; however, the results are probably related to structure and carbonaceous shale.

Heatleys and Jar Prospects

Tests of geophysical methods were made at the request of Central Pacific Minerals N.L. at two prospects near Hayes Creek; electromagnetic and self-potential methods were used.

Slingram and self-potential methods showed no anomalies at the Jar prospect.

At Heatleys prospect, the Slingram results were disturbed due to the rugged terrain. Four self-potential traverses indicated an anomaly extending over a strike length of more than 1200 metres in a shale horizon in the Golden Dyke Formations. A Turam survey was made over part of the self-potential anomaly and large ratio anomalies were found.

Radiometric Laboratory

The gamma-ray spectrometer was reinstalled in January after being serviced at Head Office. Eighty samples were assayed, eleven for exploration companies and the remainder for BMR projects. Other samples, mainly from Union Carbide's prospects in the Alligator River area, were tested to distinguish between radioactivity due to the uranium and thorium series, but were not assayed.

Routine maintenance and calibration of field and laboratory equipment were carried out. Radiometric equipment was repaired for the local Civil Defence.

The AFMAG station near Batchelor was kept in operation. Equipment troubles caused frequent loss of records.

Darwin Seismic Station

The East Point station was kept in continuous operation and provisional and supplementary data were issued. The galvanometer and crystal clock were replaced during the year. A calibration unit was installed in September. Construction of the new station site near Manton Dam was commenced in April and is near completion. A room at the Darwin Office was prepared to house the recording units.

2. AIRBORNE SURVEYS

Ngalia Basin project (E.P. Shelley)

An interpretation of the 1958 Mount Hardy airborne survey was made and tied in with the Ngalia Basin subsidized aeromagnetic survey flown in 1963 for Pacific American Oil Co. Pty Ltd. A start was made in writing a report on these surveys for inclusion in a Bulletin which is a joint project with the Geological Branch.

Central Eromanga Basin project Qld. (M. Mancini)

Total magnetic intensity and magnetic basement contour maps were assmebled for publication as part of this project. The area is situated in the southwest

corner of Queensland and comprises twenty 1:250,000 map areas. Data are being compiled from BMR and subsidized aeromagnetic surveys, and areas of disagreement are being investigated.

Twin Otter VH-BMG aeromagnetic and radiometric survey of Wagga and Cootamundra 1:250,000 Areas, N.S.W. (D. Downie)

Owing to the delay in completing the equipping of the Twin Otter for geophysical surveying, this survey was not commenced.

M. Mancini completed a presurvey report of the geology of the area.

Twin Otter VH-BMG aeromagnetic and radiometric survey of Wangaratta, Tallangatta and Bendigo 1:250,000 Areas, Victoria and NSW (D. Downie)

Owing to the delay in completing the equipping of the Twin Otter for geophysical surveying, this survey was not commenced.

M. Mancini completed a presurvey report of the geology of the area.

Tottenham NSW detailed aeromagnetic survey (J. Rees, K. Horsfall, R. Taylor)

At the request of the Department of Mines, NSW, an area of 2900 sq. km centred on Tottenham (Plate 4) bounded by latitudes 32°02'S and 32°28'S and by longitudes 147°43'E (approx. 58 km by 50 km) was subject to an aeromagnetic survey at an altitude of 300 m a.s.l. (approx. 80 m a.g.l.) along east-west lines spaced 250 m apart.

The surface geology of the survey area is predominantly Quaternary soil cover with limited outcrops of phyllite, schist (quartz, albite, muscovite) and low grade quartz-rich metasandstone of the Girilambone Group of Ordovician age. Diorite and possibly altered gabbro constitute at least part of the Tiger Camp Creek intrusive complex 21 km southwest of Tottenham.

Rationalization of preliminary interpretation is shown in Plate 1. Faulting and/or intrusives have been interpreted as delineating the western edge of the Tullamore syncline. A magnetic basement depth of roughly 1.6 km to the north and northwest of Tottenham and the dominant NW-NNW magnetic lineations reflect the regional tectonic basement influence over the survey area. An anomalous zone (or series of zones) extends in an arc from the Tiger Camp Creek intrusive complex south of Tottenham and intersects another structural zone along which most mines are located, striking northwest through Tottenham. All these zones are considered to be basement controlled features possibly involving major transcurrent and/or normal basement faulting and must relate to the source and localization of the copper lodes in the Tottenham district.

As well as basement lineaments there are several areas where delineation of basalt remnants and/or basic intrusives within the Girilambone Group will be possible.

Aero Commander VH-BMR Alligator River region aeromagnetic and radiometric survey N.T. (K. Horsfall, B. Wyatt, R. Taylor)

The survey operations commenced in September in the northern half of the Mount Evelyn 1:250,000 sheet area. Difficulties with the gamma-ray spectrometer equipment slowed the progress of the survey. The coverage to the end of October is shown in Plate 5. Due to cloud cover associated with the onset of the wet season, the survey was terminated in mid-November, to be recommenced April 1972.

The magnetic data in the Mount Evelyn sheet area show strong linear anomalies corresponding with major joints in the Kombolgie sandstone, and reflect underlying structures. Low-amplitude anomalies are recorded over granite outcrops in the central and western parts of the area, and the extension of the granite under the surface is indicated.

North and northwest striking magnetic lineations in the western part of the sheet are correlated with dolerites and fissures such as the South Alligator River fault zone.

Some gamma-ray response (probably thorium type) was recorded over granites and part of the Mundogie sandstone. An aerial reconnaissance of Deaf Adder Creek produced no significant gamma-ray anomalies. In Jim Jim Creek gorge, higher thorium-type response was correlated with the granite floor of the gorge. No significant gamma-ray response was recorded in the gorge.

Detailed magnetic and radiometric survey, Cloncurry, Qld. 1970 (S. Lambourn)

This survey was carried out in the Cloncurry region between April and July 1970. The area covered consisted of two east-west strips approximately 110 x 6 km (Plate 6) crossing the Mary Kathleen, Marraba, and Cloncurry 1:100,000 sheets. The survey was flown at an altitude of 80 m a.g.l. with east-west flight-lines spaced at 300 m.

The revised detailed geology of the Mary Kathleen and Marraba sheets (G.M. Derrick et al), was produced at a scale of 1:50,000 while that of the Cloncurry sheet was increased to a similar scale to facilitate overlaying the magnetics.

Interpretation of the geophysical data was continued in 1971. Magnetic interpretation consisted of the delineation of trends and the subdivision of the seven sub-areas into zones of high and low activity. The correlation between magnetic anomalies and geology is very varied. The relatively strongly magnetic Magna Lyne Basalt, Chumvale Breccia and the associated Overhang Jaspillite correlate well, as do the relatively weakly magnetic Leichhardt Metamorphics, Ballara Quartzite, and Kalkadoon Granite. However, the correlation with the gabbros and dolerites, which would be expected to be good, is quite variable and in some places is non-existent, although the rock units involved in each case are apparently identical.

Most of the geology strikes NNE and NNW. In Area 2, however, the geological strike is east-west, and, not suprisingly, the correlation in this area is very poor.

In general, faults do not show up well, but some geological boundaries are well delineated, such as the Kalkadoon Granite unit in Area 1. There are several inexplicable large-amplitude anomalies that warrant further investigation.

The differing magnetic response of the gabbros and dolerites indicates some variation in geochemical composition within these units. Some sampling of these rock types would be worthwhile for analysis.

The conclusion reached by the study of the magnetics was that they were of limited use as an aid to detailed mapping in areas of such complex geology.

The radiometric data have been presented in unstripped 3-channel stacked-profile form at a scale of 1:100,000 together with a flight-line plan for each area. Radiometrically active areas were zoned by selecting anomalous sections in all three channels for Areas 5, 6, and 7 using uncorrected data, and "Uranium" contours were plotted for Area 2 by manual reduction of the data. However, both these approaches are highly subjective and of doubtful value.

A purely qualitative approach of zoning only those area that were clearly caused by uranium anomalies did produce some correlation with areas of known activity on the ground. Several magnetic anomaly drilling targets were also prepared for this party, and although only one anomaly was partly drilled, it did prove of value in delineating a shear zone.

Further comprehensive follow-up work investigating both magnetic and radiometric anomalies would be of interest both geologically and geophysically.

Digital acquisition is essential in order to analyse radiometric data further, and for the purpose of detailed mapping, a much higher count rate must be achieved to be statistically meaningful.

VH-BMR remote sensing survey, W.A. 1970 (E.P. Shelley)

Interpretation of the geophysical data from this survey was resumed in July. Magnetic trends and fold axes were delineated to resolve the detailed geological structure of the two areas. A detailed zoning of the areas is currently being done to enable a comparison with the photo-interpretation to be made early in 1972.

Open Day and King's Hall displays

All officers in the section helped prepare and man exhibits of airborne survey activities during the BMR Open Days in May and the display in King's Hall in August.

Tasman Geosyncline project (M. Mancini)

The aim of this project is the regional interpretation of all airborne magnetic surveys flown by BMR over the western branch of the Tasman Geosyncline in New South Wales.

This region is covered by the BOURKE, COBAR, NYMAGEE, CARGELLIGO, NARROMINE, FORBES, BATHURST, and GOULBOURN 1:250,000 map areas and small parts of DUBBO, NARRANDERA, COOTAMUNDRA, and CANBERRA.

Regional magnetic trends have been accentuated by the graphical removal of the regional magnetic gradient. Depths to magnetic basement are being systematically determined and contoured starting from the northernmost areas.

VH-BMG (Twin Otter) modification and testing (R. Wells, D. Downie)

The design of a geophysical equipment system for VH-BMG was well advanced by early 1971 and it was intended that two regional surveys, one in northeastern Victoria and one in southern New South Wales, would be completed by the aircraft during the year. This design provides for the digital recording in flight of data from a fluxgate magnetometer, a 4-channel gamma-ray spectrometer, a radioaltimeter, and a doppler navigator to aid in flight path recovery. The central unit in the system is a Hewlett Packard 2114B digital computer with an 8000-word memory to which the various data channels are interfaced through digital converters and a multiplexer. Data assembled in the computer are recorded in 10-second blocks on a Kennedy incremental magnetic tape recorder equipped with a flux check facility to check the recorded data. The computer simultaneously outputs the data to a digital-to-analogue converter so that they can be displayed in flight on a bank of moving paper chart recorders.

The project started to get into difficulties early in the year because of the late delivery of some of the electronic equipment on order. This led to delays in the commencement of the construction of equipment in the BMR laboratory. It also became apparent, as the year progressed, that the labour requirement for this work had been underestimated. The labour problem was further aggravated by the resignation of the two officers responsible for the development of the magnetometer. The failure to develop a magnetometer with adequate temperature stability finally led to the deferment of the 1971 survey program for the Twin Otter. By November 1971 an improved design for the magnetometer was well advanced, and it is scheduled for bench testing during December 1971.

The writing of a data acquisition program for the airborne computer was to be done by outside contract early in the year. When delays were encountered in the calling of tenders D. Downie commenced the writing of what was at first intended to be a makeshift program for this purpose so that digital hardware could be test flown. As time became available later in the year he completed this program, together with ten others necessary to edit and store the magnetic tape field data on the CSIRO 3600 computer, to the full specification of the original tender.

In October the construction of digital scalers for the gamma-ray spectrometer and the timer unit were completed by the laboratory, and D. Downie undertook the bench testing and flight testing of the digital acquisition system. Over several flights a total of 3000 digital records (a record being 10 seconds of flight time) were acquired and checked by the 3600 computer. Total recovery of all the data was achieved, only one record requiring minor editing.

In November the project was awaiting the completion of the magnetometer and the radioaltimeter digital scaler to make the Twin Otter operational as a survey aircraft.

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

Approximately 45 hours have been flown in the Canberra area this year for the purposes of testing geophysical equipment and training new personnel in equipment operation and photo-navigation.

3. AIRBORNE REDUCTIONS AND CONTRACTS GROUP (C. Leary, J. Rees, B. Wyatt, J. Gordon, R. Wang, P. Elliott)

Data Processing

Western Australia 1968. SANDSTONE and YOUANMI have been machine contoured with a contour interval of 50 gammas in 12 sheets at 1:100,000 scale.

Central Great Artesian Basin 1968. Five sheets at 1:250,000 comprising BRIGHTON DOWNS, MANEROO, JUNDHA, LONGREACH, and BLACKALL have been machine contoured at 10-gamma interval. One map at 1:250,000 including parts of WINDORAH, ADAVALE, EROMANGA, QUILPIE, and THARGOMINDAH has been completed with a contour interval of 10 gammas.

Western Australia 1969. Eight maps from BYRO and BELELE have been contoured at 1:100,000 scale with 50-gamma interval and a further 16 maps from MURGOO, CUE, YALGOO, and KIRKALOCKA are near completion.

Southern Cape York Peninsula 1969. WALSH, MOSSMAN, and CAIRNS have been machine contoured in four parts at 1:250,000 with a contour interval of 10 gammas.

Eucla Basin 1970. No processing is required.

Tottenham 1971. Four maps at 1:31,680 forming part of the NARROMINE sheet are near completion.

It is expected that machine contouring of the magnetic data for all the incomplete surveys above will be available before the end of the year.

Program Development

Software documentation. (J. Rees, P. Elliott). A proposal to introduce a systematic user-oriented software documentation system is being evaluated prior to introduction.

Contouring. (C. Leary, I. Briggs). The program for machine contouring is now operating on the CDC 6600 machine in Sydney.

Analog digitizing (J. Rees). A program for the digitizing of any form of continuous chart or map using the D-Mac Digitizer at CSIRO is now complete.

Flight path recovery (J. Rees). For digitizing control point fiducials for flight path recovery using D-Mac Digitizer at CSIRO.

Control point editing (J. Gordon). To check control point data for errors in plotting, transferring and/or digitizing utilises least-squares analysis of control point data for each flight line.

"Stage 2" re-evaluation (J. Rees, B. Wyatt). Two particular methods for datum adjustment of aeromagnetic data are being investigated, one employing successive least-squares adjustment of flight drift patterns and the other using simultaneous adjustment of crossover grid pattern under controlled variation conditions.

Regional and diurnal corrections (B. Wyatt). Automatic computation of diurnal and/or regional corrections to magnetic data using International Geomagnetic Reference Field for regional corrections.

Filter design (B. Wyatt, J. Rees). Design and presentation of one-dimensional filters specified in the frequency domain.

Filtering (J. Rees, B. Wyatt). Filtering of profile data with specification in the frequency domain. Calculations of coefficients are intervally optimized to account for variations in data spacing and to minimize loss of data at the ends of the profiles.

Interpretation (J. Rees, P. Elliott). Program development is continuing on the automatic interpretation of aeromagnetic data. A program for interpretation of dyke-like magnetic anomalies using either a separation method or a best fit approximation (least-square or linear condition) is near completion.

Numerous programs and alterations to existing programs have been written for routine handling and processing of magnetic data.

Contracts

Western Australia 1971. The contract for an aeromagnetic survey of the areas, NABBERU, PEAK HILL, ROBINSON RANGE, GLENBURGH (part), BENCUBBIN, PERENJORI (part), NINGHAN AND MOORA (part) has been awarded to Aeroservice Australia Pty Ltd. The dates for commencement and completion of the survey are subject to negotiation with the contractor. Western Australia 1970. Preliminary contours of the aeromagnetic survey of GLENGARRY, WILUNA, and KINGSTON were received from G.R.D. Pty Ltd and copies were made available for release.

East Papua contract aeromagnetic survey onshore part (1969-71) (J.H. Quilty, C. Leary)

The completion of aeromagnetic coverage of the onshore part of East Papua had been delayed by unsuitable weather conditions since the previous year. The panel to be flown consisted of a grid of E-W and N-S flight-lines at an altitude of 15,000 feet above sea level.

Compagnie Générale de Géophysique succeeded in completing the coverage in May. The geophysical and navigational data were taken to Paris for processing and the flight-line plot was submitted to BMR for inspection in October. The contractor is proceeding with the compilation and presentation of the data.

4. PUBLICATIONS

Bulletin 118, D.B. Tipper, Laverton-Edjudina airborne magnetic and radiometric survey W.A. (in press)

Bulletin 119, J.E. Haigh, Standard curves for magnetic anomalies due to spheres (in press)

Bulletin , J.E. Haigh and N. Smith, Standard curves for magnetic anomalies due to finite dykes (with Editor)

Report 139, G. Young and P. Shelley, Amadeus Basin airborne magnetic and radiometric survey (with Editor)

Maps

Maps were prepared to printing stage or printed for the following areas during 1971.

Astrolable aeromagnetic survey, PNG, 1966. Port Moresby 1:250,000 map area; 1:50,000 scale maps Goldie River, Laloki River, Sogeri, Tupuseleia, Port Moresby, Gaile, Gea, Kemp Welch River, Round Point.

Sir Samuel/Duketon aeromagnetic radiometric survey, W.A. 1967. Sir Samuel and Duketon 1:250,000 map areas; 1:126,720 scale maps Sir Samuel - NE, -SE, -SW, -NW, and Duketon -NE, -SE, -SW, -NW.

Sydney Basin aeromagnetic survey, NSW, 1966. Sydney 1:250,000

Amadeus Basin aeromagnetic radiometric survey, N.T., 1965. Petermann Ranges and Mount Rennie 1:250,000 maps (awaiting contract for printing).

Victoria River aeromagnetic survey, N.T., 1966-67. Waterloo 1:250,000 map area; 1:126,720 scale maps Waterloo -NE, -SE, -SW, -NW. (awaiting contract for printing).

The following maps are proposed for printing or to be up to the printing stage by 31 December 1971.

Victoria River aeromagnetic survey, N.T., 1966-67. Limbunya and Birrindudu 1:250,000 map areas 1:126,720 scale maps, Limbunya -NE, -SW, -NW, Birrindudu -NE, -SE, -SW, -NW.

Herberton aeromagnetic survey, Qld. 1967. Atherton 1:250,000 map area; 1:63,360 scale map Herberton.

PART II - SEISMIC AND MARINE SECTION

5. SEISMIC SURVEYS

Gosses Bluff seismic survey, N.T., 1969

Work on this project was completed in May 1971. The final report has been approved for production as a BMR Report.

The shape of the zone of disruption associated with Gosses Bluff has been deduced from the seismic and gravity results to be a shallow saucer of diameter 23 kilometres and maximum depth 800 metres superimposed on a roughly hemispherical part of diameter 8.6 kilometres and depth 4300 metres.

The results are entirely consistent with Gosses Bluff being an impact feature, and the structure deduced is shown schematically in Plate 7. The major disruption within the hemispherical zone is assumed to have been produced in immediate response to the impact. Below this, however, a salt pillow has been shown to exist which developed initially as part of the Gardiner-Tyler Anticline and later renewed the upward movement initiated by the impact.

Geotraverse project, W.A., 1969

Seismic refraction and reflection and gravity data have been analysed and a possible model postulated from these results is shown in Plate 8. The results of refraction analyses along two profiles, Offshore-Perth to Jubilee Mine (Kalgoorlie) and Offshore-Perth to Offshore-Albany, indicate that the crust under the southwest Australian shield undergoes a transition from a normal continental type to an abnormal composition towards the Perth Basin. The crust is 34 km thick and consists of two layers of P-velocities 6.12 and 6.66 km/s near Jubilee Mine and it is abnormally thick (44 km) near the western margin of the shield owing to the presence of an extra basal layer of velocity 7.41 km/s. The P-velocity of the mantle under the abnormal crust is 8.39 km/s in E-W direction and 8.11 km/s in NW-SE direction. The upper two crustal layers show thickening towards the east and southeast while the basal layer shows thinning. The Perth Basin is composed of two eastward-dipping sedimentary layers of P-velocities 2.51 and 4.60 km/s overlying a block of the shield crust which has been thrown down by about 7.5 km to the west.

The reflection data, which have been digitally processed including deconvolution, and frequency and velocity filtering by Western Geophysical Company under contract, show considerable enhancement of signal compared to the original records. A number of reflections of varying quality can now be picked on the processed sections. Several of the reflecting horizons are found to correspond in depth to refracting boundaries in the areas Wundowie, Doodlakine, and Boorabbin.

Gravity anomalies computed for the seismically determined model of the crust show good agreement with the gross features of the observed Bouguer gravity field in southwest Australia. Crustal root calculations at several places along the profiles indicate that the crust in the shield area is in isostatic equilibrium. The high free-air and Bouguer anomalies in the southwest part of the shield, therefore, reflect only the excess mass of the basal layer in the crust.

Galilee Basin seismic survey, Qld, 1971

The field work took place between August and November inclusive. The objective of the survey is to define the nature of the eastern margin of the Galilee Basin where it connects with the Drummond Basin.

Seismic reflection quality ranges from poor to fair. The problems of recording good seismic data are due to poor energy penetration of the "P" horizon, Permian Coal Measures, multiple reflections mainly of the "P" horizon, random noise, and ghosting.

The survey commenced in the vicinity of Exoil's Lake Galilee No. 1 Well, and traversing has been carried out eastwards towards the Drummond Basin outcrops. The "P" horizon is becoming shallower to the east while two as yet unidentified deeper horizons at about 1.5 and 2.0 seconds reflection time have remained essentially horizontal.

Traversing has reached the Belyando River (Plate 9) near the eastern limit of the Basin, and the deeper horizons are still horizontal suggesting that a major fault may be present at the margin.

Seismic data processing

Work during the year has involved the use of BMR's analogue playback equipment, the LaserScan optical data processing equipment, the CSIRO CDC-3600 computer, and contract digital processing.

108 seismic record cross-sections have been produced mainly for inclusion in reports on the following projects: Galilee Basin, 1971; Ngalia Basin, 1967-69; and Gosses Bluff, 1969. A number of cross-sections were produced to assist the Basin Studies Group display and apply common filters, A.G.C., etc. to company seismic data.

Data from Ngalia Basin Traverse K were digitally processed by Geophysical Service International in Sydney in an attempt to resolve some questions relating to the interpretation of high-angle overthrust faulting at the northern margin of the Ngalia Basin. A contract was let for digital processing of reflection seismic data from the Geo Traverse, 1969. This project is now complete.

6. GRAVITY SURVEYS

Field work during 1971 by the Gravity Group of the Section was limited to a month and a half of contract reconnaissance helicopter gravity work in Western Australia representing the early stage of a lengthy operation to complete the reconnaissance gravity survey of the State. The main effort in the Canberra office lay in recomputation of old surveys and in computation of the Kalgoorlie detail data. Automatic techniques were developed further, notably the digitizing of point locations and automatic computation of geophysical co-ordinates. Preparation of several records advanced.

Contract helicopter gravity survey, W.A.

A contract was let in September for a survey conforming in most respects to that of 1969. The area to be covered is shown on Plate 10. Most of the boundaries are common to previous BMR reconnaissance gravity surveys to which ties should be readily effected. The area to be covered falls over the Yilgarn Block of the Western Australian Shield, over the western half of the Officer Basin, thought to be largely a late Proterozoic feature covered thinly by Palaeozoic and later sediments, and over the western half of the Eucla Basin, which is believed to be mainly a Tertiary basin although localized troughs with Palaeozoic deposition may occur.

Field work commenced on 12 October and progress was fair until the end of November. The total number of 1:250,000 scale map sheets involved is about 60, and allowance has been made to continue until October 1972.

Gravity Map of Australia

This map is currently produced as a preliminary Bouguer anomaly contour map at a scale of 40 miles to one inch conforming to the current tectonic map of Australia. It is made, therefore, in four basic sheets which now include all data collected to the end of 1969. During the year a similar preliminary Bouguer anomaly map was made available for the land area of New Guinea, New Britain, and New Ireland.

It is now intended to reduce these maps to a scale of 1:5,000,000 so that all of this area, plus substantially all of the marine data being collected, can be incorporated on four sheets conforming to the new tectonic map soon to appear.

The main contribution to the Gravity map of Australia comes from the reconnaissance helicopter gravity surveys carried out by the section. The final contours of the work completed in South Australia in 1970 are now in preparation and the survey to complete the reconnaissance of Western Australia is currently in progress. There will then remain only parts of New South Wales, Victoria, and Tasmania to complete the coverage of Australia. A large part of New Guinea is still inadequately covered by reconnaissance gravity surveying.

Collation of density data

This is intended to become a continuing project concerned with the determination and systematic filing of rock density data from rock specimens collected primarily by Geological Branch field parties. During the year computer programs were developed to create a master file and to sort it into suitable groups according to such parameters as map sheet name and rock type. To make the project more general, a new sample submission form was designed in close collaboration with Geological Branch. It is proposed that this form should be the source for punched card geological data to be used as the input for the filing and sorting programs. Provision is made for updating magnetic tape files with new laboratory data on existing specimens or for altogether new data.

This is in the nature of an experimental project which will, nevertheless, provide a means of storing current data in magnetic tape form. No doubt system changes will be required in time but it should then be a simple matter to reconstitute the data in a new or modified format with little additional clerical effort.

Galilee seismic survey, gravity project, 1971

A party of two attached to the seismic party established several hundred gravity stations along and across the seismic profile at about 1 km intervals during October and November. It is hoped that the closer, more accurate gravity data, compared with the reconnaissance helicopter gravity network of data, will permit quantitative gravity interpretation in support of the seismic investigation.

7. MARINE SURVEYS

Introduction

A contract survey for a bathymetric, gravity, seismic, and magnetic survey around the Australian coast between the shore and the 4000-metre isobath commenced in December 1970 and continued throughout 1971. A total of 28,000 nautical miles had been surveyed in 142 operational days up to 6 October (Plate 11). The activities of the marine group during 1971 were largely devoted to planning, supervision, reporting, and interpretation of this survey.

Interpretation of the 1970 Gulf of Papua and Bismarck Sea surveys continued as operational requirements from the current survey allowed. Final gravity maps of data acquired during the 1968 marine survey of the northwest continental shelf were completed.

Continental margins survey operations

The survey commenced in December 1970 with about 2,000 nautical miles of traverse in the Coral Sea. At the end of December the survey vessel 'Hamme' sailed to Hobart. Following delays in January and early February occasioned by instrumental performance problems, work commenced south of Tasmania. The survey was again delayed by bad weather during March, and traverses between Hobart and Wilsons Promontory were left until the 1971-72 summer.

The narrow coastal shelf region between Wilsons Promentory and Sydney was completed during early April. The survey continued north of 32°S with long east-west traverse lines extending across the Tasman Sea to the Lord Howe Rise at 160°E. In late June the vessel entered Queensland waters. No survey work was undertaken west of the outer margin of the Great Barrier Reef. North of Mackay the long east-west traverse lines were terminated at 156°30'. The area north of Cooktown and out to the edge of the Coral Sea Basin was surveyed by November, completing planned coverage at 20-mile traverse spacing of the eastern Australian continental margin.

The shore monitor station was set up in January at Hobart to record the daily variation in the magnetic field and the V.L.F. transmission path characteristics. As the survey moved northward the station was progressively moved to Eden, Coffs Harbour, Mackay, and Cairns. (see Plate 11).

The instrumentation and techniques were the same as those used for the 1970 survey. The data acquisition system continued to record samples of data from bathymetry, gravity, magnetic and several navigation aids at 10-second intervals, using a Hewlett Packard 2116B computer. This system was critically reviewed and a new computer program written and partly tested during the last four months of 1971.

The main bathymetric recording devices were not consistently recorded in digital form on the data acquisition computer and most of the water depths were hand digitized from the seismic and bathymetric charts. In October a new digital fathometer and shallow sub-bottom profiler was installed to upgrade the bathymetry system.

A number of visits were made to the 'Hamme' by LaCoste & Romberg and CGG specialists, and the contractor's boat geophysicist also visited the LaCoste & Romberg office in Austin in an attempt to improve the performance of the gravity meter in rough seas. About 5,000 nautical miles of the survey contains seriously degraded gravity data; of this lost mileage, approximately half occurs south of 28°S.

The seismic amplifier system was replaced by a transistorized series of amplifiers at the beginning of the year, and new marine recorders were installed progressively from April onwards. The second 2116B computer used to sample and process the seismic data on line was removed from the ship late in the year for further laboratory tests necessary before resumption of on-line processing.

Refraction profiles were recorded from the 120-kilojoule sparker source using sonobuoy receivers.

The contract vessel M.V. 'Hamme' changed owners and name to the M.V. 'Lady Christine' during early August.

Bismarck Sea 1970 (J.B. Willcox)

An interpretation of preliminary data from the 9,000 nautical miles (14,500 km) of gravity, magnetic, and seismic reflection traversing in the Bismarck Sea was carried out. Plate 12 shows some of the major features disclosed.

The bathymetric data detailed the main features on existing maps, namely: an overall platform of less than 2,000 metres depth, an eastern deep of about 2,500 metres, and a western incursion of the Pacific Ocean of between 2,000 and 4,000 metres. The Melanesian Trench and the extremities of the Planet Deep were also evident. Several ranges of seamounts with a roughly east-west trend were defined.

Bouguer anomalies show a characteristic correlation with depth, and reach +200 milligals in the deeper water. A gradient of 3 milligals/km along the New Guinea coast tends to obscure superficial geological effects. Free-air anomalies are predominantly positive and about 50 milligals. Highs of 70-100 milligals occur over the Witu Islands, Schouten Islands and other volcanic groups. A pronounced negative of -190 milligals lies between Astrolabe Bay and Vitiaz Strait. This is probably due to thick uncompensated sediments and a 'root effect' from the ranges on Huon Peninsula. The Bougainville trend extends northwest as a high of about 140 milligals superimposed on a broad regional low of -200 milligals. This could result from the combined effects of a downwarped plate and local ultramafic intrusions.

Magnetic anomalies show east, WNW, and northeast trends. Two pronounced east-west trending magnetic ridges of about 2,000 gammas amplitude correlate closely with the epicentres of the Bismarck Sea shallow earthquake lineament (Denham, 1969 J. geophys. Res. 74(17). Focal mechanism solutions

have shown that this probably represents a major left-lateral shear zone. Extending eastwards from Wewak, the lineament is also in proximity to a seamount chain of about 2,000 metres elevation.

Sonobuoy refraction records were very poor and yielded little information. Seismic reflection records were fair although penetration was variable. The Bismarck Sea is seen to have an overall east-west grain. Thin sediments (about 100 m) occur along a central band and thicken to 2,000 metres or more in Kimbe Bay, north of the Huon Peninsula, offshore Sepik, and on a ridge stretching between New Ireland and Manus Island. On the ridge the sediments are moderately folded. In the Sepik and Huon areas the basement was not defined. Numerous graben-like features are found between New Britain and New Ireland but are largely absent in the west. The Weitin fault of southern New Ireland extends parallel to the coast and then probably swings WNW. The Wide Bay-Open Bay graben on the southwest Gazelle Peninsula and the New Guinea coast are probably controlled by major faulting. A large trough is found at the foot of the slope, about 25 kilometres off Wewak. Krause (1965, Geol. Soc. Amer. Bull. 76(1), 27-41) has suggested that this marks a continuation of the Ramu-Markham lineament. Sediments in the Northern New Guinea Basin do not extend beyond the top of the slope, about 20 kilometres offshore.

The use of a simple crustal model and filtered free-air anomalies, with densities and depths from the Rabaul Crustal Survey (Cull & Weibenga, BMR, pers. comm.) has indicated that the depth to Mohorovicic Discontinuity in the Bismarck Sea is about 20 kilometres, deepening rapidly at the coasts.

Gulf of Papua and northwest Coral Sea (J.C. Mutter)

In November and December 1970, 5300 miles of multisensor data were acquired between latitudes 8° and 13°30'S, the interpretation of which has answered some old questions and pointed to some interesting possibilities regarding the origin of the region. Bathymetric contours and main features are shown in Plate 13.

The Aure Trough/Papuan Basin has been found to extend southeast down the Moresby Trough to 10°S, its southwest margin being defined by structural rises on which the modern platform reefs (Portlock, Boot, and Eastern Fields) are located. This extension is marked by a deep free-air anomaly low (-100 mgal), interpreted as arising from a basinal thickness of sediment in the Moresby Trough which has a crustal section thinned by about 7 kilometres.

South of the Papuan Basin is a larger fan-shaped plateau (Eastern Plateau) bounded in the west by a tension-faulted graben (Portlock Trough) and underlain by crust of thickness less than 25 kilometres. A further change in crustal thickness occurs when an embayment feature south of 12°S is reached. Thicknesses here are generally less than 20 km, according to gravity evidence.

An oceanic section is not found until the Coral Sea abyssal plain is reached, the northwestern extent of which is limited by a steep scarp which has a strong positive magnetic anomaly and associated intrusions.

All major features of the region appear to have arisen from tensional tectonics. It is contended that this supports current theories which suggest that the Coral Sea opened by rifting in the Upper Oligocene. A reconstruction of the pre-Oligocene situation would require clockwise rotation of the Papuan peninsula to contact the scarp feature and the consequent closing of the Aure/Moresby Trough, without disturbance to any continental features.

Southern Tasmania (P.J. Cameron)

Plate 11¢ shows the main features revealed by the survey. A shelf some 20 miles wide parallels the coast around southern Tasmania and is bordered by a fairly uniform slope from 200 to 2500 metres. Two broad plateaux between depths of 2500 and 3500 metres are present; one extends directly south of Tasmania and one to the southeast. They are bounded on the east and west by a sharp increase in depth to approximately 4,500 metres and are separated by a broad channel beginning on the northeastern margin of the shelf and extending in a southerly direction. The Southern Plateau extends southward out of the area surveyed. The topography on the southern plateau is quite rugged compared with the Eastern Plateau, which has considerable sedimentary cover.

One distinctive feature is a topographic high in the eastern end of the Eastern Plateau rising some 1500 metres above the surrounding area over a distance of about 20 miles. This may be an intrusion. There are also several highs on the Southern Plateau of about 600 metres, some of which extend as ridges in a north-south direction.

Both the shelf and the rugged Southern Plateau are overlain by only a very thin sedimentary cover apart from isolated pockets of sediments containing up to 1500 metres of section in some cases. Some of these pockets may be fault controlled.

On the flatter Eastern Plateau, sedimentation appears to be more continuous and average cover varies from about 500 to 1000 metres, again with some deeper pockets. There are several basement highs in this plateau, associated with low-amplitude magnetic anomalies. An apparent intrusive mass appears as a basement feature on the central eastern portion of the plateau together with a second basement high. The intrusion is associated with low Bouguer anomaly values. This anomaly has a gradient of about 6 mgal/mile over a feature of 20 miles wide.

The most consistently thick sediments occur in the broad channel between the two plateaux. Here horizontally bedded sediments, with an average thickness of 1200 metres, extend across the channel. Southwards, the channel veers to the east and its northern flank shows an increase in sedimentation against the Eastern Plateau.

Generally the magnetic values in the area are some 100-400 gammas above the regional field. Some vague north-south trends exist. The only negative anomalies occur on the southwest of the Southern Plateau and are associated with the increase in slope to deep water.

Regionally the Bouguer contours reflect the bathymetry. The shelf and slope region is marked by a gradient of about 40 mgal/mile.

The broad plateau areas show low gradients with a regional Bouguer value of about 130 mgal; the value increases sharply at a rate of 8 mgals/mile to reach a general Bouguer value of about +200 mgal as the depth increases on the eastern and western limits of the area.

Central-eastern Australia (P.A. Symonds)

The area extends from the coast to longitude 160°E and lies between latitudes 34°S and 24°S. Surveying was conducted on a 20-nautical mile line spacing using marine seismic (reflection and refraction), gravity, and magnetic techniques. In all, about 16,800 nautical miles of traverse was surveyed along 29 east-west lines, and 1700 nautical miles along north-south tie lines.

The area can be divided into the following physiographic provinces as shown in Plate 15:

Australian continental margin - consists of a narrow shelf averaging about 40-50 km in width south of the Stradbroke Islands and increases in width northward to about 100 km at Gladstone. The continental slope, which flattens out at 4500 metres depth, is quite steep, having an average slope of 4 to 8°.

The residual magnetic field is marked by positive, small-wavelength anomalies south of 33° and north of 28°. Those south of 33° occur over the offshore Sydney Basin and may be related to outcrops of Lower Permian volcanics on the slope and near-shore shelf. Anomalies east of the Stradbroke Islands may be related to Tertiary volcanics which crop out on the coast north of Brisbane and elsewhere in the central-eastern part of the Ipswich-Clarence Basin. An anomaly northeast of Fraser Island may be the magnetic expression of the basement ridge that is considered to mark the northeastern margin of the Maryborough Basin.

In the southern part of the area the shelf and slope are characterized by a prograded wedge of up to 500 metres of sediment, overlying what appears to be a palaeo-slope cut into basement. Basement crops out on the slope at less than about 1500 metres, and pockets in the basement are filled with slumped and contorted sediments.

Tasman Basin - an abyssal plain area which ranges in depth from 4500 to 4800 metres and extends from the slope to longitude 157°.

The residual magnetic field throughout much of the survey area is characterized by small, irregular closures which tend to show a general NNE trend in the Tasman Basin, but this becomes more nebulous to the east.

In the southern portion of the Tasman Basin, sediments are thickest (greater than about 1.5 km) just east of the base of the slope and generally thin eastwards (0.5 - 1.0 km) towards the Tasmantid seamount chain. The basement surface is very irregular but tends to smooth to the east.

Dampier Ridge - a north-south trending ridge about 100 km wide and 1800 metres below sea level at its highest point.

It is associated with a broad, positive, NNE-trending magnetic anomaly on which are superimposed shorter-wavelength anomalies associated with shallow or exposed basement.

The Dampier Ridge is marked by rugged and occasionally exposed basement. Basement highs or intrusions protrude from the sea floor and are usually separated by narrow (less than 5 nautical miles) sediment filled depressions.

Lord Howe Rise - the survey area reaches only the foothills of the rise, at a depth of 1500 metres. They are covered with about 500-800 metres of sediment which appears to have slumped somewhat, towards the west.

Tasmantid seamount chain - a roughly north-south trending chain of guyots, which stand 1400 to 4400 metres above the Tasman Basin.

Lord Howe Island seamount chain - a roughly north-south chain of guyots and seamounts, lying between the Dampier Ridge and Lord Howe Rise. Some of these occur at sea level as reefs and islands and others are up to 1500 metres below sea level.

Short-wavelength, relatively high-amplitude positive and negative magnetic anomalies are associated with many of the guyots and seamounts of the Tasmantid and Lord Howe chains. However, some, such as the Stradbroke, Brittania, Brisbane, and Gifford guyots appear to have little or no magnetic expression. This is probably a function of their depth below sea level.

The guyots in the Tasman Basin are normally very flat topped and appear to have little or no sediment on their tops and flanks.

Middleton and Lord Howe Basins - these basins, which lie between the Dampier Ridge and Lord Howe Rise, are at depths of 3400 metres and 3900 metres respectively. Their average widths are 130 and 80 km respectively.

The thickness of sediment in the basins is hard to determine, as basement is never reached. However, it is probably greater than 1 km in many areas.

The Bouguer anomaly contours generally bear a very close resemblance to the bathymetry. The guyot chains, although gravitationally positive with respect to their surroundings, tend to exhibit less gravity effect than that calculated theoretically. This may be due to a terrain effect.

Marine data processing (R. Whitworth, I.G. Briggs)

The main effort in the data processing carried out by the marine group has concerned the assessment, error removal and reduction of the field data on the current survey by the contractor. The principal steps in this process are shown in Plate 16 leading from the raw field tapes to the production of final contoured maps and anomaly profiles.

Extensive consultation, design, and programming assistance were provided to enable development by CGG of this system for the CDC 6600 computer.

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The digital data acquisition software package on board the survey vessel was redesigned to enlarge its function and improve its performance and versatility following installation of additional core memory.

70 sub-programs were written to enable data to be read, checked, reduced, listed on magnetic tape, and regularly monitored by teletype. Several operator-controlled sub-programs perform specific calculations to allow investigation of data quality. A simplified diagrammatic illustration of these functions is shown in Plate 17.

A number of investigations were made into the performance and operation of the gravity meter and seismic systems.

Some crustal modelling has been undertaken during the interpretation of the free-air and Bouguer anomalies in the Gulf of Papua and Bismarck Sea. Contour maps were prepared of finally reduced gravity data acquired in the 1968 marine survey of the northwest Continental Shelf.

Data collected by BMR's marine surveys and by oceanographic institutions were indexed in a computer compatible form.

8. PUBLICATIONS ETC.

Records, issued during 1971

1971/4 Gosses Bluff seismic survey, N.T. 1969 (preliminary report); by A.R. Brown.

1971/32 Oceanographic investigations in Melanesia by Hawaii Institute of Geophysics, 1970 - Equipment and operations; by A.R. Brown & J.P. Webb (University of Queensland).

1971/58 Russian Oceanographic Vessel 'VITIAZ' - Techniques and equipment; by K.R. Vale, A.R. Brown & A. Turpie.

In preparation

A detailed seismic study of Gosses Bluff; by A.R. Brown

A partial compilation of regional geophysical work in the Australian area; by E.J. Riesz & F.J. Moss.

Overhaul of PT-700/PMR-20 seismic recording equipment June-July 1971; by L.E. Hemphill & A.R. Brown.

Experiments in controlled directional reception and digital processing, 1969-70; by A.R. Brown.

Ngalia Basin seismic surveys, N.T., 1967-69; by P. Jones, D.G. Townsend & F.J. Moss.

New Guinea airborne seismic survey 1970; by P. Harrison & F.J. Moss.

Deep crustal investigation along the GeoTraverse, W.A. 1969; by S.P. Mathur, J.C. Branson & F.J. Moss.

Deep crustal reflection seismic surveys in eastern Australia, 1968-69; by J.C. Branson, F.J. Taylor & F.J. Moss.

Galilee Basin seismic survey, Qld 1971 (preliminary report); by P.L. Harrison.

Preliminary report on a reconnaissance helicopter gravity survey in W.A., 1969; by A.R. Fraser & F.W. Brown.

Preliminary report on a detailed gravity survey in W.A., 1970; by A.R. Fraser & F.W. Brown.

Report on a reconnaissance helicopter gravity survey in the New Guinea Highlands, 1970; by I. Zadoroznyj & D.A. Coutts.

Interpretation of detailed gravity traverses in southwestern Australia; by W. Anfiloff.

Preliminary report on a reconnaissance helicopter gravity survey in S.A., 1970 - Area A; by G.R. Pettifer.

Report and interpretation of a reconnaissance helicopter gravity survey in S.A., 1970 - Area B; by D.H. Tucker & F.W. Brown.

Report on a computer-oriented system for storage and retrieval of rock density data; by W. Anfiloff.

Pre-survey report on a reconnaissance helicopter gravity survey in W.A., 1971-72; by I. Zadoroznyj.

Lectures delivered outside BMR

J.B. Willcox: Preliminary results of a marine geophysical survey in the Bismarck Sea (ANZAAS, Brisbane).

J.C. Mutter: A recent geophysical reconnaissance of the Gulf of Papua and NW Coral Sea (International Marine Science Symposium, Sydney).

A.R. Brown: Gosses Bluff astrobleme (ANZAAS, Sydney).

" " Geophysical investigations on Moura Coalfield (ANZAAS, Sydney, on behalf of F.J. Taylor).

J.C. Branson: Combined geophysical investigations along the Geo Traverse (University of Sydney).

PART III - OBSERVATORIES AND REGIONAL SECTION

9. OBSERVATORIES

The Observatories sub-section was seriously affected by staff shortages during the twelve-months to November 1971, and this enforced the deferment of some projects and a rearrangement of workload between some groups. Areas mostly affected were the Headquarters and Toolangi Groups.

Geomagnetism

Standard programs were maintained at Gnangara (WA), Port Moresby (PNG), Toolangi (Vic), Macquarie Island, and Mawson (Antarctica). At Canberra Headquarters, the monthly Geophysical Observatory Report was prepared and issued, magnetograms were digitized (53 observatory-months), and mean hourly values were derived (51 observatory-months). Non-standard data and magnetogram copies were supplied to several prospecting companies and other organizations.

Little progress was made on the joint project, with the Systems Development Group, to develop an automatic digital variograph; the purchase of a commercial automatic digital observatory and components for digital recording of total intensity at Antarctic stations was deferred to late 1972 through cut backs in funds.

A commercial (Elsec) vector coil system for the absolute determination of H and Z was received and tested. To measure H an Elsec proton precession magnetometer was modified to extend its lower limit from 25,000 nT to 22,000 nT. Thus BMR now has for the first time a workable geomagnetic standard which can be used at all main observatories, and which is almost independent of overseas instruments.

Following a decision made late in 1970 to eventually transfer the Toolangi Group to Canberra, and the consequent need to transfer the magnetic observatory, a master plan for this move was prepared. Little progress was made with its implementation. Some aeromagnetic traverses were made by the Airborne Group as a first step in selecting suitable sites in A.C.T. but further tests await advice from responsible authorities on future development of the Territory.

Seismology

Station seismology. Stations were operated in Western Australia at: Mundaring, Kalgoorlie, Meekatharra, Kununurra (with WA Public Works Dept), Karratha (from February); in PNG at: Port Moresby, Lae, Goroka, Wabag, Kavieng (from July), Pomio (from August); and at Toolangi (Vic), Darwin (NT), Norfolk Island (with IPSD), Macquarie Island and Mawson (Antarctica), Alice Springs (NT, from mid-December 1970).

The station at Pomio was set up to record aftershocks of two large earthquakes (magnitude 8) which occurred in the north Solomon Sea in July. The equipment will be transferred to the new regional station at Talasea about the beginning of 1972.

At Alice Springs the short-period vertical helicorder system (installed Dec. 1970) was supplemented by two SP horizontal recorders in August. Because of the low staff numbers at Toolangi, the analysis of Alice Springs seismograms had to be made at Headquarters throughout the year. Seismograms from here and Darwin were included, at the request of the United States NAS/NRC, in the microfilming program at the international Seismic Data Centre (North Carolina); only a few other non-WWSSN stations have been selected for this program.

The station at Karratha was installed temporarily pending the selection and development of a permanent high-gain site in the northwest of Western Australia, for the investigation of the relatively high seismicity of the region. A suitable site was located near Marble Bar.

Construction of the new regional station at Manton Dam (to replace Darwin) proceeded. The buildings and access road were completed, and the power line was almost completely erected. The telemetry equipment was tested in Canberra and the design of accessory panels and devices completed.

Telemetry equipment for the Macquarie Island plateau seismograph was tested before shipment in November.

In co-operation with the Maintenance and Testing and the Workshops Groups general accessory equipment was constructed or modified as follows:

EMI digital clocks. The internal 24-volt supply system was stabilized to prevent breakdowns when the clock is operated under no-load conditions. A 6-hour program circuit was designed, and fitted to some clocks.

STA-3 time pulse amplifiers. A design modification allowing mains as well as battery operation was completed and four units were converted.

Calibrators. A design was submitted for a more robust electromagnetic calibrator for Willmore seismometers; a stabilized precision current supply for E-M calibrators was requested and four were constructed; 8 jigs for performing weight-lift tests on Benioff horizontal seismometers were made.

Preliminary data from the stations were distributed from Mundaring, Port Moresby, and Headquarters. Data from the NT, Antarctica, Norfolk Island, and Toolangi were put into bulletin form by the CDC 3600 computer, using the punched cards prepared for International Seismological Centre (ISC) purposes, thus eliminating two steps in the preparation of bulletins. Final ISC data from all stations were processed at Headquarters. This involved the preparation of about 34,000 punched cards, and associated magnetic tapes.

Strong-motion data centre. The centre operated successfully throughout the year and about 25 accelerograms from New Guinea have now been analysed. The maximum acceleration so far recorded was at Yonki, near the Upper Ramu damsite, in February 1971, when a value of 180 cm/sec^2 was obtained. Sixteen accelerographs are now in operation in Papua New

Guinea. These are located at Panguna (4), Rabaul (2), Wewak (1), Upper Ramu (2), Lae (3), Frieda River (2), and the Star Mountains (2). In Australia, seven accelerographs are expected to be in operation by the end of 1971. These will be located at the Ord River damsite (2), Meckering region (3), and Adelaide (2). These accelerographs are not all owned or operated by BMR but access to all the records has been obtained.

Travel-time project. On 2 May 1971 a 524 Mg explosion was detonated at the Ord River damsite in Western Australia. The blast was equivalent to a magnitude $4\frac{1}{2}$ earthquake and it enabled recordings to be made of P and S wave velocities in the crust and upper mantle down to depths of about 160 km. It was recorded by most permanent observatories to distances of 20 degrees from the explosion, and in addition 19 temporary stations were installed. These were manned by personnel from BMR, the Australian National University, the University of Adelaide, and the University of Queensland. Members of the observatory group manned seven field stations as well as setting up instruments close to the shot-point to record strong ground motion and the origin time of the blast. The main analysis of the results will be completed in 1971.

Ionospheric recording

Standard programs were maintained at Mundaring and Port Moresby; the data were published by IPSD.

10. REGIONAL MAGNETIC SURVEYS AND TESTS

At the request of the Department of Civil Aviation two series of tests were made at the new Melbourne Airport (Tullamarine), the first late in 1970 and the second in August 1971. These were to locate a suitably uniform site for an aircraft compass-swinging base. No site meeting the various requirements was found, but correction data were obtained for the chosen site.

A third-order survey of southwest Western Australia was commenced in September. It will cover the area bounded by the coast and lines from Shark Bay through Leonora and Balladonia.

Compilation of third-order charts for eastern Australia (surveyed between 1967 and 1970) was well in hand at the end of the year.

Observations in Antarctica were confined to the Prince Charles Mountains region and, jointly with the Antarctic Division, along traverses inland from Casey.

11. REGIONAL GRAVITY GROUP

Gravity surveys and calibrations

The 1970/71 Canberra gravity survey completed detailed gravity coverage in the Belconnen and Weston Creek/Mount Stromlo areas. The coverage of the Canberra suburban and near-future suburban areas is now substantially complete. The data were computed and contoured, and errors detected by the computer contouring were corrected.

In conjunction with BMR's Open Days in May a helicopter gravity survey provided a semi-detailed coverage with station spacing of 2 km and extending 15 km beyond the edge of the detailed Canberra suburban coverage. Over 100 stations were read and added to the magnetic tape files after computation and correction.

The Australian Calibration line established in 1970 was strengthened and used to calibrate a new La Coste & Romberg gravity meter. Three other La Coste meters were used as reference meters. The calibration run was flown in two legs. The northern section from Canberra to Mount Hagen in PNG and return included readings at Sydney, Brisbane, Mackay, Townsville, Cairns, Port Moresby, and Lae. The southern section from Canberra to Hobart and return included readings at Melbourne and Launceston; the latter was included only on the return trip owing to limitations of airline schedules.

A technical officer from the Group conducted a gravity survey in the Western Highlands of New Guinea near Telefomin in cc operation with a BMR geological party. A helicopter was used for gravity work during the time it was not required by the geologists.

Tidal gravity

In co-operation with the University of New England, a project was started to record earth movements due to tidal forces. The equipment used is a pair of Verbaandert-Melchior horizontal pendulums, which are installed so as to record ground tilts in two orthogonal directions. The pendulums should be installed one or two hundred metres underground in order to reduce environmental effects.

Before installation, one of the pendulums was set up for test recording in a thermostatically controlled room at Kowen Forest. An automatic calibration device was received from Belgium during the year and was also thoroughly tested.

In August-September, the equipment was transported to the Hillgrove site for installation in the Cooney Observatory. This has been developed by U.N.E. in an old mine tunnel about half-way down a gorge at Hillgrove, about 30 km southeast of Armidale. The pendulums were set in a niche which had been cut in the end wall of one arm of the tunnel, and are being operated under the supervision of Dr P. Sydenham of U.N.E. Recording at present is at low sensitivity pending settlement of the rock after the disturbances during preparation for installation.

Open Days

Static displays and a synchronized slide show with taped commentary were prepared for the BMR Open Days, and a helicopter gravity survey was organized. The displays included: a coloured Bouguer anomaly map of Australia; gravity work in New Guinea, Antarctica, Gosses Bluff, and Canberra; and computer applications and equipment. The slide show has been retained for possible future use. The helicopter survey introduced about 20 staff members involved in gravity work to the planning and execution of helicopter surveys.

Equipment

The G.S.I. pendulum apparatus was returned from the National Standards Laboratory in Sydney to BMR, and test runs were started using the new timing and recording equipment constructed in BMR laboratories. One new La Coste & Romberg gravity meter was received and a World-Wide meter was declared irreparable during the year. A new battery charging system for Ni-Cd batteries used in La Coste & Romberg meters was developed and tested.

Hewlett-Packard 9100B

A Hewlett-Packard 9100B calculator and printer was purchased. Hewlett-Packard also provided use of one of their plotters without charge intermittently during the first half of the year. The calculator has been in constant heavy use since its arrival, with many other Sections taking advantage of its programming facility. Programs of about 300 steps can be entered and recorded on magnetic cards for future use. A number of programs have been written and documented and are available to any interested Sections. The main programs written for gravity work are Bouguer anomaly calculation, gravity loop reductions, and the gravity effect of two dimensional quadrilateral bodies calculated as a profile along a line traverse over the body. Versions for use with the plotter have also been written.

Computing and magnetic tape files

The conversion of data magnetic tapes from old Monash format to buffered block form was completed. An additional 30,000 stations were added to the tape files, bringing the number on tape to about 87,500. Referencing of the data held on tape files was commenced to indicate what data are available on tape, and their reliability and accuracy.

Most programs were improved in flexibility of card input, options, and data format. The most notable improvement was to the locating program which can now output data in flexible BCD format or binary on to tapes, disc file, or cards. The facility for location by station number as well as by latitude and longitude limits or by area name was also added. New area names were introduced to indicate which survey each area contains and the location of the area to provide easier reference and automatic location.

To prevent documents being flushed from the disc owing to lack of use, a program was developed to transfer all documents of a particular charge code from the disc to the drum. For jobs submitted to the computer by teletype a program was written to transmit job-cards to the line printer at CSIRO for retention by the operators.

A machine language translating routine was written which provides an equally general translater as the one available at CSIRO. As this requires only half the core storage, it enables Fortran programs to be used in the console system.

General

The 1:250,000 map sheet key map indexing system was progressively redrawn during the year, and a substantial amount was completed. These key maps show at a glance what gravity work has been done on each map sheet, and the relevant survey numbers.

12. REGIONAL STRUCTURAL GROUP

Interpretation of 1967-69 New Britain/New Ireland survey data

Interpretation of the seismic refraction data obtained from the 1967 and 1969 crustal surveys in the New Britain/New Ireland region continued throughout the year. The 1967 records were all re-examined to bring the data to approximately the same standard as the 1969 data so that the two surveys could be interpreted concurrently. Associated with these surveys is the gravity information obtained from regional helicopter gravity coverage on the islands and marine sparker and magnetic profiles obtained from the shooting ship.

The interpretation has taken longer than expected mainly because of the complexity of the crust and the crust/mantle interface. Various interpretation methods have been tried, and each shows serious limitations. Time-term techniques give a broad structure quite different from detailed but time-consuming tailor-made techniques. A technique was developed for the construction of crustal cross-sections which satisfies both seismic refraction and gravity data, neither of which give a unique solution when used on their own.

An operational report was completed on the 1969 results, and interpretational reports and papers are being prepared with the co-operation of Dr J. Webb of the University of Queensland and Dr A.S. Furumoto of the Hawaii Institute of Geophysics. Dr Webb, who has been associated with all aspects of this work, spent four weeks in BMR working on the data.

Bismarck Sea magnetic interpretation

As mentioned above, a number of magnetic profiles were surveyed in the waters surrounding New Britain/New Ireland during the 1967 and 1969 seismic surveys. These were supplemented considerably during 1970 by the magnetic traverses of the BMR marine geophysical survey of the Bismarck Sea.

During 1971, a number of computer programs were developed to a stage whereby modelling of profiles could be achieved using the CSIRO Vista display system on the CDC 3600 computer. The method has been applied to a number of marine traverses in the Bismarck Sea/St Georges Channel region to complement work being done by the BMR Seismic, Gravity and Marine Section and the seismic interpretations being carried out as mentioned above.

Ord River blast refraction survey

During April-May a survey was carried out, in association with BMR Observatories Sub-Section and various university groups, to record a 500 ton explosion, detonated at the Ord River damsite in Western Australia, along three lines traversing the Australian mainland. These lines were directed from the damsite towards (a) Adelaide, (b) Perth, and (c) Brisbane. Very good results were achieved by the various parties, and are being analysed in BMR and the Australian National University.

Googong Damsite seismicity survey

Acting on a request from the BMR Engineering Geology Group, the Observatories and Regional Section undertook a study of seismicity in the region of the proposed Googong Dam, which is being investigated as a future water storage for Canberra. The Queanbeyan Fault runs along one edge of the water storage area, and the study was undertaken so that seismicity could be considered in design specifications for the dam wall.

Recordings at the site were made through a network of five seismometer stations from September until December, the bulk of the work being done by the Regional Structural Surveys Group.

1972 East Papua crustal survey planning

Throughout the year planning proceeded for a crustal survey in the Port Moresby-Popondetta-Lae region of PNG during October-November 1972. A pre-survey report was written, and the budgeting and programming for equipment and survey operations were arranged.

Open Days

The Group put on a display of seismic recording equipment and other survey material for the Open Days in May to celebrate the 25th anniversary of BMR.

Galilee Basin co-operation

During November, a geophysicist was attached to the Galilee Basin seismic party for the purpose of recording large shots for deep refraction interpretation, and training.

Equipment

Through the year the Group has been developing portable automatic tape recording systems for use in large-scale seismic refraction surveys. The BMR Design and Development Section have carried out design studies on various systems, and some of these were field tested on the Ord River blast survey. The Group took delivery of six slow-speed tape recorders and some associated equipment during the year, and development work is almost completed on prototype clocks, amplifiers, and cheaper tape recorders. Production of eighteen complete systems was instigated near the end of the year.

The development of tape recording equipment for crustal survey work is a new departure for BMR, and it is hoped that it will increase the efficiency of manpower on field surveys as well as providing an opportunity for record analysis which was not possible with photographic and ink recording systems.

Computing

The CSIRO CDC 3600 computer is an essential tool for the Group's activities. Production of travel-time plots for refraction interpretation survey is geared to the CSIRO plotters and it is hoped that in future, seismic ray tracing programs will be developed.

Two-dimensional gravity modelling has been developed as an interpretation tool, and magnetic modelling has been developed for use with the Vista display peripheral on the CDC 3600.

Documentation procedures for programs are being thought out in BMR and will be adopted once the guide-lines have been set.

13. PALAEOMAGNETIC GROUP

No palaeomagnetic survey work or analysis was conducted during the year, following the decision to review the program in the light of BMR functions. Suggestions for palaeomagnetic survey work are being studied and it is hoped to instigate pilot field surveys in 1972 if the necessary staff is recruited.

14. PUBLICATIONS AND LECTURES

Journals and external publications

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Ripper, I.D. - Earthquake focal mechanism in the east New Guinea region. (1971/27).

Smith, R.S. - Mawson geophysical observatory annual report 1968. (1971/10).

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Townsend, D.G. - Improvements to BMR's gravity retrieval system, June 1969. (1971/8).

van der Waal, C.A. - Toolangi geophysical observatory annual report 1968. (1970/92).

Wilkie, J.R. - The south Gippsland earthquake of 20 June 1969. (1970/91).

Wilkie, J.R. & van Erkelens, C.H. - Magnetic test, Moorabbin airport compass swinging site. (1970/103).

Addresses to scientific bodies etc.

NZ National earthquake engineering conference, Wellington, May 1971

"Strong motion data centre: BMR Canberra" - D. Denham

Twelfth Pacific Science Congress, Canberra, August 1971

"The seismicity of the southwest Pacific and the new global tectonics" - D. Denham

"The Bismarck Archipelago, a structure formed by tensional stresses" - W.A. Wiebenga, D.M. Finlayson, J.P. Cull, J.P. Webb (Univ. Queensland), and A.S. Furumoto (Hawaiian Geophysical Institute) (presented by W.A. Wiebenga).

Australian Geological Society, Canberra, 1971

"Earthquakes" - D. Denham

Second Indian Symposium on the Upper Mantle Project, Hyderabad, Dec. 1970

"Seismological studies of the Upper Mantle in the Australian region" - J.C. Dooley

XV General Assembly, International Union of Geodesy and Geophysics Moscow, Aug. 1971

"A study of the Earth's gravitational field in the Australian region" - R.S. Mather (Univ. N.S.W.), B.C. Barlow, and J.G. Fryer (National Mapping Division). (Presented by R.S. Mather)

Lectures to Universities of Melbourne, Monash, New England, Newcastle, Macquarie, Sydney, N.S.W.

"Gosses Bluff" - B.C. Barlow

PART IV - GEOPHYSICAL SERVICES SECTION

The Section comprises three Sub-sections: Electronics, Mechanical, and Services. The Electronics and Mechanical Sub-sections are concerned primarily with equipment development, construction, and maintenance, and the Services Sub-section covers equipment procurement and utilization, rock property measurements, engineering geophysics, and geophysical drafting. The activities of the sub-sections and groups are reported under these headings.

15. ELECTRONICS SUB-SECTION

The sub-section is divided into three groups: Instrument Development, Systems Development, and Electronic Maintenance. The sub-section was under strength in electronic design because of staff shortage. Instrument Development projects were given priority at the expense of progress in some Systems Development projects. However, Electronic Maintenance was at almost full strength for most of the year.

Instrument Development Group

MFS-7 airborne fluxgate magnetometer. The conversion of the AN/ASQ-10 magnetic airborne submarine detector for use as a survey magnetometer in the Twin Otter aircraft played the major role in the group's activities for 1971. Many difficulties were encountered with the initial prototype equipment which had to be redesigned almost completely. The original ASQ-10 drive system was also found to cause trouble and this required extensive testing and redesign. By December 1971 all known problems should be overcome except for temperature compensation of the detector. An electronic circuit to achieve this has been designed and should be tested by the end of the year. After the prototype magnetometer has proved successful two production models will be constructed in 1972.

Twin Otter installations. Other projects concerned with this airborne installation in the Twin Otter included: design and construction of a timing unit to interface instrument operation with the data acquisition computer; stepping motor controls to allow recorder charts to be driven from navigation information; a numerical read-out for the gamma-ray spectrometer and a temporary magnetic compensator. Various power supplies and filters were also built. A digitizer and display unit for the doppler navigation system is being constructed.

MNS-2 proton magnetometer. A number of problems were met in the construction of production model proton magnetometers. Mechanical and electronic modifications proved necessary. This work could not be completed because of the over-riding priority of the airborne fluxgate magnetometer for the Twin Otter aircraft. However, the unit in its present form has operated satisfactorily in the Aero Commander aircraft since May. Work done on this aircraft early in the year showed that the basic magnetometer noise is masked by noise from the aircraft installation. A toroidal detector is to be wound and may reject some of this noise. Construction of production models 2 and 3 is proceeding as time permits and preliminary work has started on models 4 to 6 which are to have a different type of read-out. These will not be completed until late 1972. A signal simulator unit was designed to facilitate laboratory testing of proton magnetometers.

General purpose seismic amplifiers and unattended seismograph stations. Twenty seismic amplifiers were constructed after modifying the design used for airborne seismic experiments. These found application in observatories, the Ord River crustal project, and the Googong Dam project. An accompanying booster amplifier was also designed.

Minor projects included: evaluation of low-power crystal oscillators for crystal clocks; a C.R.O. trace stepper; preamplifiers for airborne recorders; and various power supplies.

Frequent use was made of the CDC 3600 computer terminal for developing programs associated with frequency and transient response and noise performance of various systems, including the airborne fluxgate magnetometer, seismic amplifiers, and tracking filters.

In the final two months of the year emphasis is on the design and construction of prototype unattended seismographs for the 1972 regional crustal survey. This equipment includes: a new general-purpose seismic amplifier; a four-track recorder modified for low-speed recording with a stepper motor drive; modulators to provide an f.m. seismic signal; a low-power crystal clock and programming unit; and various power supplies and calibrating units. About fifteen complete stations are to be ready for field testing in June 1972. Preliminary work has started on a playback system for this project.

Instrument laboratory and electronic drafting. Throughout the year all test instruments were kept calibrated and maintained by the instrument laboratory attached to this group. Similarly, the electronic drafting section were kept occupied with the preparation of equipment drawings, artwork for circuit boards, equipment handbooks, and the indexing of component literature.

Systems Development Group

Tidal Gravity. Measurements of meter drift in the tidal gravity equipment were continued and the drift rate was computed. The rate was found to be variable in the first year but stabilized to about three microgals per day during 1971. Solid-state electronics is to be installed and tidal recordings will be obtained early in 1972.

Pendulum gravity apparatus. Work has continued on electronics for the G.S.I. pendulum system. Several modifications to the original circuits were necessary. The main remaining problem is associated with timing accuracy from the light pulse received from the pendulums.

Automatic digital magnetic observatory. After modifying the power supplies, the servo system for the automatic digital observatories was tested at Kowen Forest. Servo instability and zero drift were eliminated by appropriate redesign. Further work was postponed because of the diversion of labour to other projects in the Instrument Development Group.

Long-period seismometers. Electronic servo systems were built for temperature stabilization of the Press-Ewing long-period seismometers. Modifications to three seismometers were completed and tested in the laboratory. Field tests are scheduled for early 1972.

Remote sensing. Investigations into the literature on remote sensing techniques continued and assistance was given with interpretation of the infrared line scan imagery of Talasea. Similar assistance was given with imagery of the Captains Flat area.

Electronic Maintenance Group

General maintenance and acceptance testing continued throughout the year. Preparation of field equipment and prototype design work were also carried out. Considerable maintenance effort was necessary on Traegar transceivers, EMI clocks, and Elsec magnetometers.

The large number of new items received during the year also required considerable time for acceptance testing. These items included bathymetry equipment, E.P.C. seismic profiler recorders, SSB transceivers, seismometers, and recorders.

The main field parties assisted were Marine Seismic, Regional Crustal (Ord River blast), and Mallacoota shallow seismic profiling. For the last mentioned much time was spent in preparing different hydrophone arrays, source transducers, and amplifiers.

Design effort included seismometer calibrators, power supplies, linear and digital programmed gain amplifiers and an observatory timing unit.

Telemetry equipment was prepared for installations at Darwin, Alice Springs, and Macquarie Island.

Assistance was given with the setting up and lighting of many of the Open Day displays.

16. MECHANICAL SERVICES SUB-SECTION

The sub-section comprises three groups: Mechanical Design, Mechanical Instrument Construction, and Mechanical Maintenance and Testing. The position of Mechanical Design Engineer again remained unfilled in 1971.

Mechanical Design Group

The Mechanical Design Group was mainly occupied with the design of electronic chasses and modules and the layouts of the various front panels for a number of instrument systems. Many pieces of mechanical equipment were designed and their prototypes tested, and existing instruments were modified. Work done during the year by the Group included jobs for the following BMR groups:

Airborne Section. (1) Modification of a 35-mm strip film camera, which involved the fitting of a more efficient drive motor, with matching sets of worms and worm wheels; replacement of all parts which showed signs of wear. (a) Design of a rack for mounting of equipment in the Twin Otter aircraft.

Seismic Section. (1) A chart winder for winding and rewinding paper charts of various widths without the usual damage to the edge of the paper. (2) A push rod arrangement to bury geophones in solid soil under swampland in New Guinea. (3) Design of an annex tent for a seismic caravan together with modifications to the caravan's interior.

Marine Group. (1) Modifications to a 5000-ft streamer cable winch to withstand greater side thrust. (2) Modifications to an anemometer. (3) Design of racks to hold shipborne equipment.

Observatory Section. (1) Modifications to a Wild T.O. compass theodolite to facilitate attachment of a pentagonic prism in a true vertical position. (2) Modification of a Roelofs sun prism to fit a pentagonic prism. (3) Design of a chassis to fit a low-powered digital clock. (4) A calibrator for Willmore seismometers.

Rock Testing Group. (1) Design of a tilt table for a spinner magnetometer. (2) Various holders for pressure transducers for ultrasonic tests. (3) Modifications to an old milling machine for rock coring and cutting. (4) Design of a rock core facing jig. (5) Adapter plate and steel collars for drillability button tests on rock specimens.

Engineering Group. (1) Well logging requests included modifications to power takeoff in 10,000-ft logging truck, modifications to 2000-ft logger to limit cable speed to 35 ft/min, design of adapters to mate Gearhart Owen head with Widco tools and vice versa. (2) Shallow water seismic profiling equipment included the design of 'tow fish' to carry sonic transducers at controlled depth, and construction of a fresh water sparker transducer.

Geophysical Drafting Office. Design of a support frame for an OCE-7 flat bed printer.

Geological Branch. (1) Design of a constant-temperature bath with stirrers. (2) A similar bath with flow guides, rocking platform, and stirrers. (3) Special tongs to lift dishes out of a brine bath. (4) Modifications of a Toko Stereoscope. (5) Modification to an Eastern 70-mm film winder.

Mechanical Instrument Construction Group

The Mechanical Instrument Construction Group, comprising the machine shop, heavy workshop, and modelmaker's shop, had as its main function the construction of new equipment or components for new equipment. The group played a significant role in the manufacture and setting up of display material for EMR's 25th Anniversary.

During the year the group manufactured four double Helmholtz coils of 224-mm diameter, a coupling to fit a Selsyn motor to a Hewlett Packard recorder, a map layout bench, a frame to hold a water tank, an instrument platform for use in shallow lakes, a EMZ magnetometer tripod, a number of prototype radar intersection buoys, various component parts for well logging tools (Widco and Gearhart Owen), transducer holders to fit a hydraulic press when testing rock specimens, a constant-temperature bath to study the thermodynamics of brines, an experimental toroidal coil for a proton magnetometer, several steel benches, a storage rack for geophones, a drill jig for the location of electronic components on printed circuit boards, a drill core facing jig for dressing rock specimens, a probe for measuring the height to watertable in boreholes, a cable reel with brake for a well logging party, various components for hydrophone streamer cables, and a great number of electronic chassis components such as cross bars, modules, side plates and front panels complete with engraving.

Mechanical Maintenance and Testing Group

The Mechanical Maintenance and Testing Group was concerned with the repair, servicing, and calibration of the mechanical instruments in use by the Geophysical Branch and other Branches in BMR.

During the past year the group serviced such instruments as thermographs, Askania circles, a 35-mm strip film camera, various meters, microbarographs, a La Cour vertical variometer, a Sharpe ES-180 magnetometer, various pen-writing moving-coil and potentiometric recorders including conversion from pen-writing to electro-writing. The shop modified F24 camera mounts in BMR aircraft, repaired small gearboxes, adjusted 'Precision Instrument' tape recorders for remote seismographs, overhauled seismic SIE oscillographs Type PR011-6, and manufactured gears for a 2000-ft logger to limit the tool descent speeds to 35 ft/min. The shop also repaired electrostatic voltmeters and various accelerographs, an Elsec magnetometer, and an RV 301 Helicorder. The shop carried out modifications to a Wild compass theodolite, serviced a Dynavac high-vacuum pump, restored an E. G.& G. seismic profiler recorder for shallow profiling work, corrected a fault in the Compur shutter in the Laser-Scan lens system and manufactured calibration jigs for Benioff seismometers.

The group modified a 70-mm Eaton film winder, a meteorological box, an ASQ-10 airborne magnetometer chassis, and F24 camera mounts. Several pieces of equipment were overhauled, serviced, and repaired among which were Honda and other motor generators of various capacities, seismic geophone cable reels, a JLO engine for the Turam 2S equipment, an I.P. generator, and a 3-element sparker array. A Proline auger drill was completely rebuilt and fitted on a short wheelbase Land Rover.

17. SERVICES SUB-SECTION

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

Procurement Group

This year much of the group's effort was devoted to equipment for the marine contract survey, precision bathymetry and sub-bottom equipment, seismic profiling recorders, on-line correlator for seismic profiling, seismic amplifiers, magnetometer, digital tape recorder etc. Another major item involving a lot of work was a computer-controlled digital flat-bed plotter for automatic production of contour maps etc., and an associated digital-to-analogue and analogue-to-digital data conversion system.

Rock Measurements Group

Some 300 rock samples were examined in the course of the year. The majority of the tests were for the mechanical properties of drill cores (elastic modulus, ultrasonic velocity, hardness, and compressive strength) for various civil engineering projects. These included the Wilhelmina and Ada-LaTrobe dams in Victoria and Googong damsite near Canberra, and the Tuggeranong, Ryan, and Pine Ridge sewer tunnels in the A.C.T. A separate record was submitted on the Tuggeranong tunnel rock measurements which included drillability tests to determine whether the tunnel could be excavated by mechanical drilling rather than by blasting methods. The other measurements included magnetic susceptibility determinations of Tennant Creek district drill cores for the Metalliferous Section, ultrasonic velocity and density determinations of PNG rock samples for the Crustal Studies Group,

and various smaller routine measurements. Although most of the work was carried out for BMR, some requests were also received from external organizations such as Kennecott Exploration and the Geological Survey of New South Wales.

Several modifications were made to the laboratory techniques to eliminate sources of experimental error. In particular the magnetic susceptibility measurement procedures were altered to reduce errors due to sample contamination. BMR's 5-Hertz spinner magnetometer purchased in 1970 was given a complete check-out, and modifications were made to improve its noise level. Morris drillability equipment was set up and tested. A second-hand milling machine was converted for coring of palaeomagnetic speciments and for precise surface grinding of compressive strength test specimens. Several outside laboratories, including some in U.K., were visited to learn about recent advances in rock measurements.

Engineering Geophysics Group

General. Throughout the year the group was at full strength. E.J. Polak attended the First Australia-New Zealand Conference on Geomechanics in Melbourne and read a paper "Seismic Attenuation in Engineering Site Investigation". The paper was published in Proceedings of the Conference pages 430 to 434. F.J. Taylor prepared a paper on Moura Coalfield survey for the Mining Symposium in Brisbane. The paper was delivered by Mr A.R. Brown. R. Whiteley published a paper "A combined deep resistivity and magnetotelluric sounding in the Eromanga Basin, Queensland. (Search, 2(3), 103-105).

During the year several geophysical surveys were done for Federal and State Authorities.

Pumped Storage Hydro-electric Scheme, Victoria. The State Electricity Commission of Victoria, in an attempt to overcome the shortage of electric power during the peak consumption time in Melbourne, proposes to construct several pumped storage hydro-electric schemes. Each of the schemes will consist of an upper storage and a lower storage. The water storages would be connected through a power station by a tunnel 2-3 km long, the head available for power generating being in order of 300m. During the low power demand in Melbourne the turbines will be reversed and the water pumped up from the lower storage area into the upper reservoir. Two alternative sites for the schemes were investigated:

The Ada-La Trobe scheme - the proposed scheme is located in the Warburton area, 70 miles east of Melbourne. The seismic refraction method was used and 64000 ft of traverses were shot. The results indicate very deep weathering in granite with some slumping of weathered material on steep slopes. Several possibilities of faulting were also indicated.

The Wilhelmina Falls scheme - the proposed scheme is located in the Yea area 60 miles north of Melbourne. The seismic refraction method was used and 20,000 ft of seismic traverse were surveyed.

The results indicate very deep weathering exceeding 150 ft on some locations. The deeper bedrock is of good quality, high-velocity rock; decrease in velocity close to a steep slope may be an expression of more open jointing.

Goulburn Valley survey. A geophysical survey involving seismic, gravity, and electrical techniques was carried out near Numurkah in northern Victoria with the co-operation of the Victoria Mines Department and the

Victorian State Rivers & Water Supply Commission. The aim of the survey was to provide information on the depth to bedrock and to locate shallow and deep fluvial gravel deposits along two traverse lines north of Numurkah and Nathalia.

The results of the seismic work show bedrock velocities varying widely in different areas and the depth to bedrock ranges between 200 metres and 500 metres. The regional gravity map compiled shows that the gravity values are affected more by deep seated causes (changes in bedrock densities?) than by changes in the thickness of Cainozoic sediments.

Shallow resistivity profiling appears to have outlined a reliable method of locating prior river streams near the surface. Deep resistivity probing on one traverse indicated a high resistivity laterally confined zone above the bedrock. Drilling which is proposed may indicate whether this type of zone is a deep fluvial gravel containing fresh water, or older 'bedrock' of relatively low seismic velocity.

There is need for further work in 1972 to resolve some of the problems raised by the geophysical results.

Shallow-water seismic profiling, 1971. In March of this year a meeting was held in co-operation with Geological Branch Phosphate Group and the Electronic Maintenance Group to prepare a plan for carrying out the shallow-water, high-resolution experiments programmed for 1971. The experimental aims were to devise systems of techniques in seismic profiling to obtain:

(a) Penetration of 70-100 feet;
(b) Resolution of 1 millisecond or better;
(c) Operational depths of from 6' of water to 100'.

A literature search was undertaken in preparation for the experimental work. This involved a review of the physics of shallow profiling systems, case histories and equipment available. Following this the 'Sparker', 'Boomer', and 'Pinger' were examined to determine their transmission characteristics controlling various parameters and their suitability for our work.

Modifications were made to the conventional E.G.& G. Sparker system and boomer. The parameters of these modified systems were compared with the unmodified systems. Tests were carried out on Lake Burley Griffin and the Molonglo River as well as laboratory tests.

The recording side of shallow profiling was also investigated. As a result a time-variable gain amplifier was constructed and a second more flexible digital type is under construction. A two-dimensional hydrophone array designed for vertical directivity and to peak at about 1,000 Hz was also constructed.

The first field evaluation of the new systems is being undertaken in Mallacoota Inlet at time of writing this report (November 1971). In spite of some equipment failures results to date are encouraging.

Belconnen No. 5 Reservoir A.C.T. Seismic refraction work was carried out at the site to determine rock conditions likely to be encountered in the planned excavation for the reservoir. The seismic velocities recorded indicate that excavation could be achieved by ripping and some light blasting.

Gravel in Hall area, A.C.T. Using the seismic refraction method a number of localities in the Hall area were investigated as to their suitability for the establishment of a road-gravel quarry. Three possible sites were located.

Tuggeranong sewer tunnel, A.C.T. Drilling and seismic work along the Weston Creek section of the tunnel line indicated unsuitable rock for tunnelling. To locate an alternate route of more competent rock for the tunnel in this area, two traverses normal to the tunnel line were investigated using seismic refraction and magnetic methods. No appreciable improvement in rock conditions at tunnel level was found.

Belconnen No. 6A and 6B Reservoirs, A.C.T. The sites of four proposed reservoirs were investigated using the seismic refraction technique to assess ease of excavation. A maximum seismic velocity of 600ft/s was recorded for material to be excavated at the Reservoirs 6A (stage 1) and 6B sites, indicating that excavation should be accomplished by a combination of ripping and light blasting; at the Reservoir 6A (stage 2) site the maximum velocity was 9300 ft/s, and here heavy blasting will be required.

Belconnen refuse disposal area, A.C.T. The suitability of the proposed site to be worked by the landfill method was dependent primarily on there being an adequate depth of rippable overburden. Using seismic refraction it was found that the average depth of rippable material was about 30 feet, thus establishing that the site chosen was suitable.

Tuggeranong freeway, A.C.T. A section of the proposed route for the freeway was investigated using seismic refraction to determine to what degree the material in the cuttings required could be ripped and how much of it would need to be blasted.

Googong damsite, A.C.T. At Googong damsite, 4000 feet of close-spacing seismic work was completed on the proposed spillway area. The object of the survey was to investigate the possibility of deep zones of weathering. No such areas were found.

Tennent damsite, A.C.T. Some additional seismic refraction traverses were shot at the Tennent damsite, south of Tharwa. Interpretation of the results from 1970 and 1971 was completed. This showed that much of the bedrock on the east abutments and diversion tunnel is deeply weathered.

Village Creek arterial road, A.C.T. Seismic work was carried out along a section of the proposed road to investigate subsurface conditions for the road excavations. In addition possible drainage channel areas adjacent to the road were investigated.

Woden trunk sewer, A.C.T. Seismic refraction was used to investigate the tunnelling and excavation conditions likely to be encountered along the Woden trunk sewer pipeline.

Molonglo sewer outfall, A.C.T. A proposed pipe construction site for the Molonglo sewer outfall pipeline was investigated. The proposed site requires levelling and possibly terracing depending on the rock conditions. Seismic refraction investigations were undertaken to determine the rippability of the material on the site.

Belconnen sewer relocation, A.C.T. Seismic refraction work was carried out at selected positions along the proposed relocation of the Belconnen trunk sewer line. The sewer line is being relocated around the site of the proposed lake scheme in Belconnen. Results indicated that

some blasting will be required at some places in order to excavate the trench for the sewer pipeline.

Vibration tests, Civic Offices, A.C.T. At the request of the Department of the Interior, floor vibrations in the vertical and horizontal directions were recorded with Willmore seismometers. These measurements were carried out in several locations to assess site suitability prior to installation of sensitive photogrammetric equipment and an electronic computer.

Vibration tests, Tuggeranong tunnel line, A.C.T. Tests were fired in drill holes and the resulting ground vibrations measured, in order to establish maximum charges that could be used during excavation of the proposed tunnel so as to remain within safe limits as regards structural damage and nuisance.

Christmas Island groundwater survey. Engineering Geophysics Group was involved in the interpretation of magnetic and resistivity data obtained by the British Phosphate Commission staff. The interpretation was partly successful: one borehole drilled on indicated locations produced large quantities of water. A survey was proposed to refine the methods of interpretation and to reduce field work, especially as similar but more difficult conditions exist in the Northern Territory. The survey was cancelled.

Surveys on program but cancelled. The proposed surveys at Canaway Ridge and Musa Gorge were postponed until 1972. The Markham Valley survey was postponed until 1973.

Geophysical Drafting Group

The activities of the group are summarized under its four major sub-groups: ground, airborne, gravity, and cartography.

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

71 plates for seismic surveys
105 plates for engineering surveys
105 plates for observatory and regional magnetic surveys
70 plates for crustal studies
52 plates for metalliferous surveys
15 Sparkarray sections and
17 lecture transparencies for the Marine Sub-section
12 colour slides for the Asst Director (Operations)
2 Petroleum Titles maps for 3-colour lithography
53 maps and illustrations and numerous labels, captions etc. for the BMR Open Days.
180 miscellaneous drawings and
56 lecture slides.

The plan-printing service controlled by the group had an output of 114, 192 prints for the year.

The Ground Surveys group is responsible for training all staff appointed to the Geophysical drawing office and of Trainee Draftsmen passing through the group on rotation. A contour training programme was initiated in September, to be supervised by the Senior Draftsman of the group. This involves selected personnel from each of the groups within the Geophysical drawing office.

In-house training for Trainee Draftsmen recommenced on 3 August and continued at weekly intervals until 28 October. The Supervising Draftsman was responsible for the preparation and delivery of the lectures on map reproduction to the trainees, and to a second group comprising draftsmen from Geophysical and Geological Branches.

Airborne Surveys Group. Work consists of pre-survey compilation of programmed areas, plotting, digitizing of flight-line plots, compiling and drawing plates for Records, and quality control of contract surveys.

The following regional survey areas were covered during the year. Asterisked areas are those completed in 1971. Work on other areas will continue into 1972:

Canberra, A.C.T./N.S.W.	1967-69	
*Sandstone-Youanmi, W.A.	1968	
*Eucla Basin, S.A.	1970	
*Shoalhaven River, N.S.W.	1970	
*Bonney Well, N.T.	1970	
N - E Victoria	1971	
Cootamundra-Wagga, N.S.W.	1971	
Alligator River, N.T.	1971	
Eastern Papua	1969	(Contract)
*Western Australia	1970	"
Western Australia	1971	"

Work on the following detailed survey areas was done during the year:

*Rum Jungle, N.T.	1969
Cloncurry, Qld	1970
*Tennant Creek, N.T.	1970
Western Australia	1970
Tottenham, N.S.W.	1971

Work on the Tasman Geosyncline, a miscellaneous survey, was also done during the year.

Gravity Survey Drafting Group. Preparatory work for 1971/72 helicopter gravity survey, Western Australia, was completed. This survey will cover fifty 1:250,000 sheet areas or 780,000 km^2.

Fair drawing of 41 Gravity Station Description Studies of the Western Pacific Calibration Line Survey was finalized.

Sheets completed in the 1:250,000 sheet Bouguer anomaly series were:

1969 Helicopter Gravity Survey WA - 51 map sheets.
1962 Southwest Queensland survey - data recomputed for 5 sheets.
1968 Marine Survey NW Continental shelf - 36 map sheets (by contract).

About 200 illustrations were drawn for BMR Records. Illustrations for two displays (Kings Hall and Open Days) were produced.

Cartographic Drafting. Maps were prepared to printing stage or printed for the following areas during 1971.

Astrolabe aeromagnetic survey, PNG, 1966: 1 map at 1:250,000 and 10 maps at 1:50,000

Sir Samuel-Duketon Aeromagnetic/Radiometric Survey, W.A. 1967: 8 maps at 1:126,720

Sydney Basin aeromagnetic survey, N.S.W. 1966: Sydney 1:250,000 map

Amadeus Basin aeromagnetic/radiometric survey, N.T., 1965: Peterman Ranges and Mount Rennie 1:250,000 maps

Victoria River aeromagnetic survey, N.T., 1966/67, Waterloo 1:250,000 map area (4 maps at 1:126,720)

The following maps are proposed for printing or to be up to the printing stage by the end of 1971:

Victoria River aeromagnetic survey, N.T., 1966/67: Limbunya and Birrindudu 1:250,000 map areas (8 maps at 1:126,720)

Herberton aeromagnetic survey, Qld, 1967: Herberton 1:63,360 map.

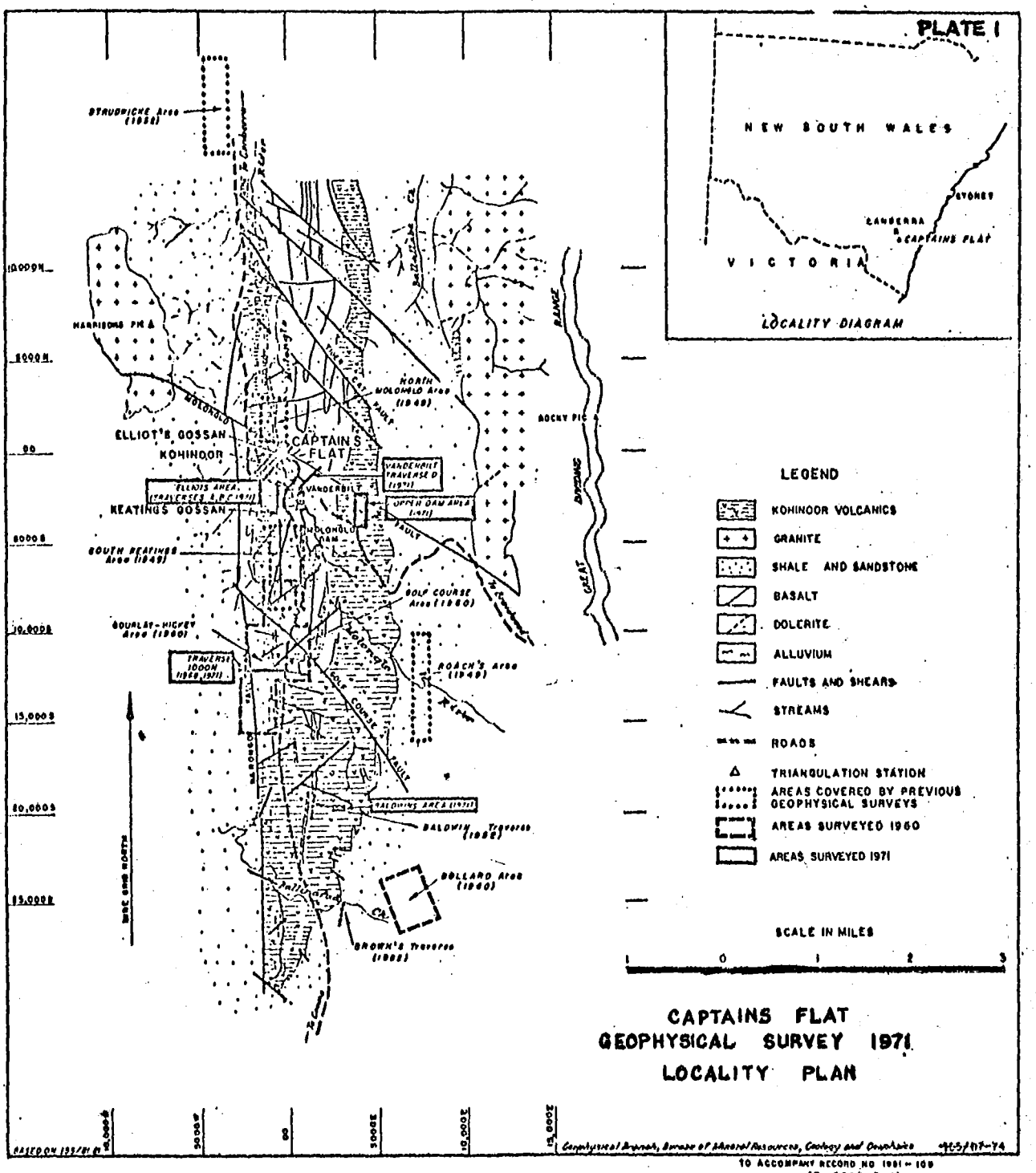


PLATE I
NEW SOUTH WALES
SYDNEY
CANBERRA & CAPTAINS FLAT
VICTORIA
LOCALITY DIAGRAM
STRUDWICKE Area (1958)
HARRISONS PM &
COLORADO
ELLIOT'S GOSSAN
KOHINOOR
CAPTAINS FLAT
KEATINGS GOSSAN
ELLIOTS AREA (TRAVERSES A,B,C 1971)
VANDERHILT TRAVERSE D (1971)
VANDERHILT
UPPER DAM AREA (1971)
SOUTH KEATINGS Area (1949)
GOURLAY-HIGNEY Area (1960)
TRAVERSE 10000N (1969, 1971)
NORTH WOLOMBI Area (1948)
WOLOMBI DAM
GOLF COURSE Area (1960)
ROACH'S Area (1948)
BALOWIN Traverse (1962)
BOLLARD Area (1960)
BROWN'S Traverse (1962)
ROCKY PIC
RANGE
GREAT
DIVIDING
LEGEND
KOHINOOR VOLCANICS
GRANITE
SHALE AND SANDSTONE
BASALT
DOLERITE
ALLUVIUM
FAULTS AND SHEARS
STREAMS
ROADS
TRIANGULATION STATION
AREAS COVERED BY PREVIOUS GEOPHYSICAL SURVEYS
AREAS SURVEYED 1960
AREAS SURVEYED 1971
SCALE IN MILES
0
1
2
3
CAPTAINS FLAT
GEOPHYSICAL SURVEY 1971
LOCALITY PLAN
Geophysical Branch, Bureau of Mineral Resources, Geology and Canberra
TO ACCOMPANY RECORD NO 1971 - 109
(Ex 0365-3-1)

PLATE 2

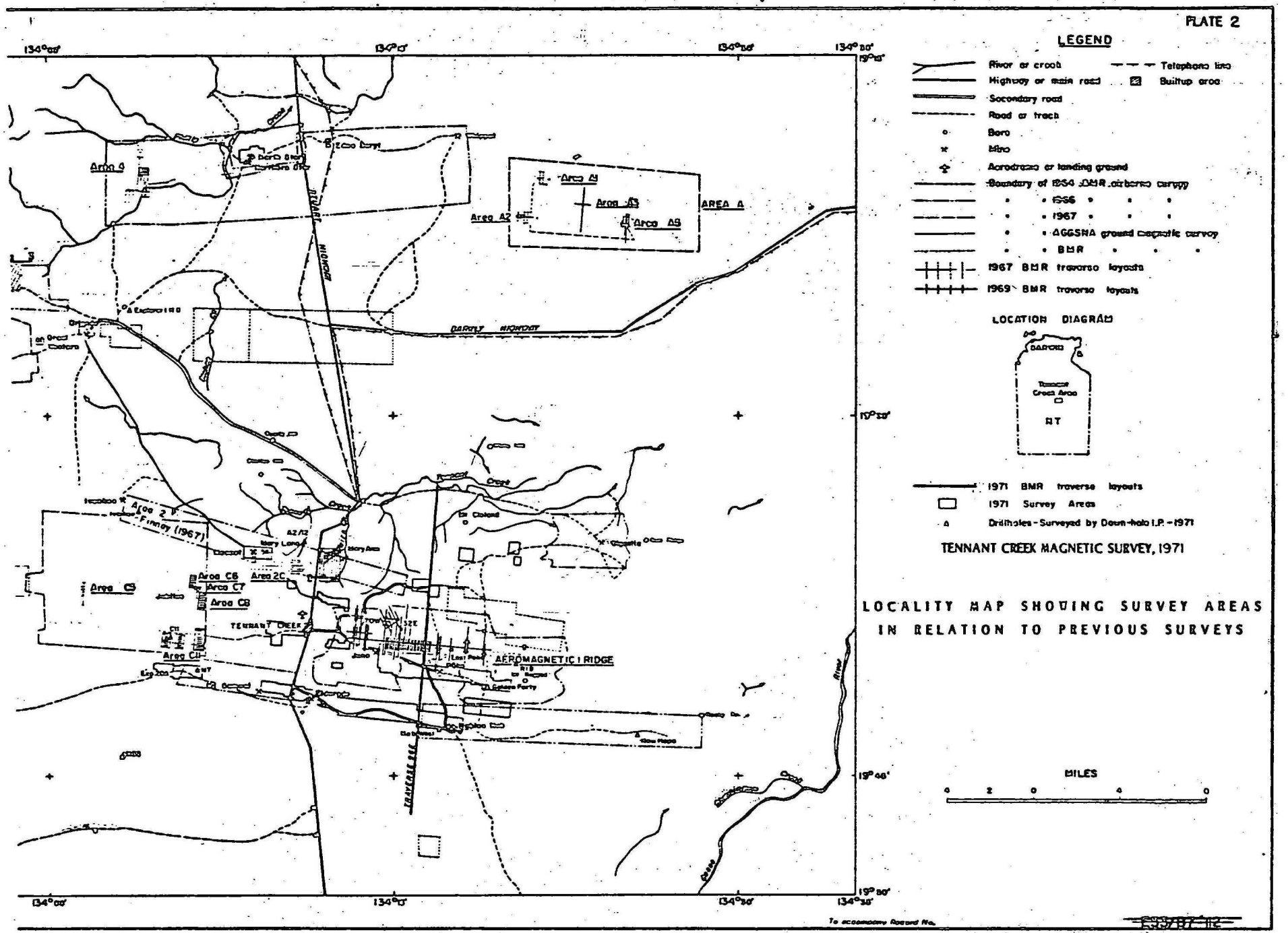
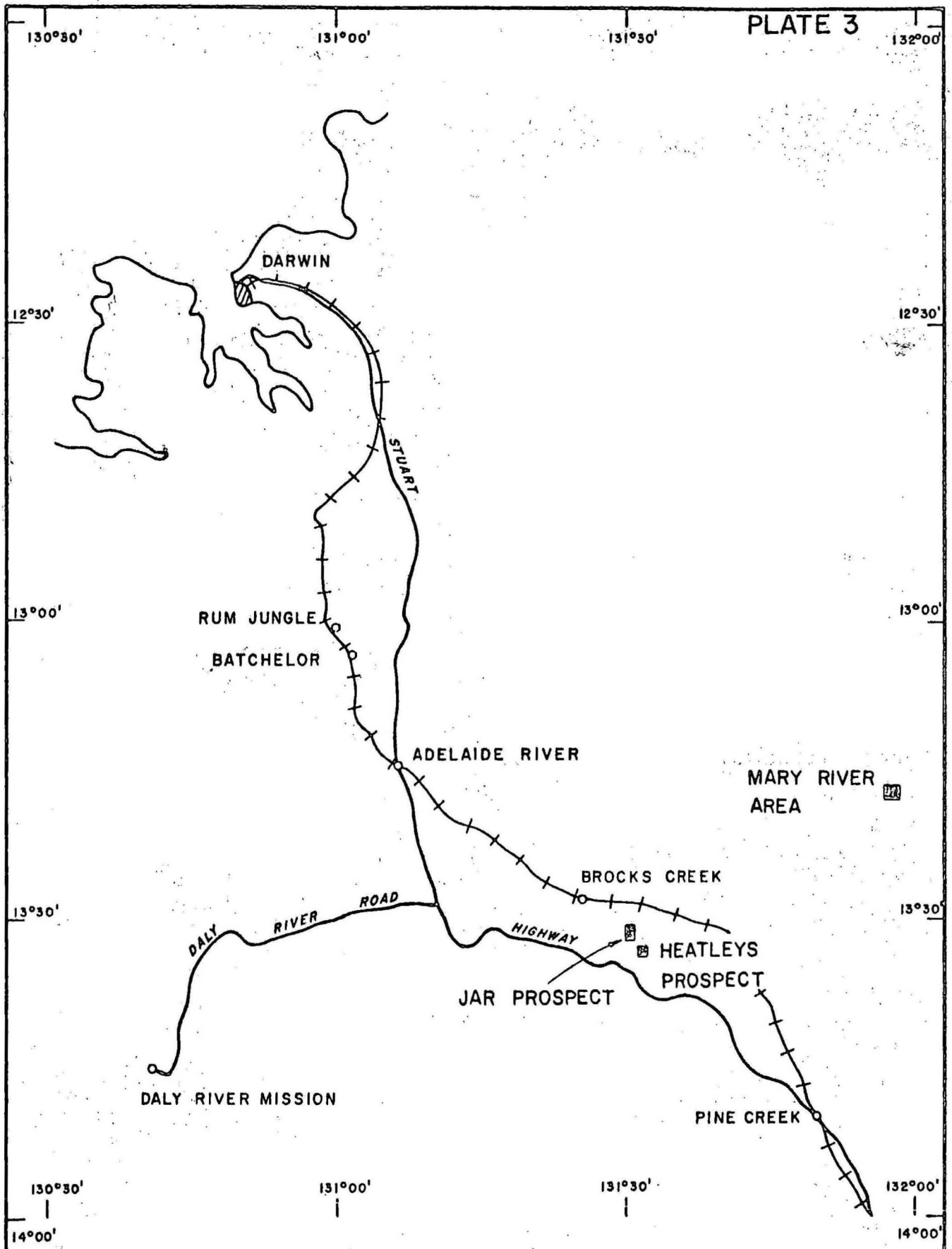

LEGEND
River or creek
Telephone line
Highway or main road
Built-up area
Secondary road
Road or track
Bore
Mine
Aerodrome or landing ground
Boundary of 1954 BMR airborne survey
1966
1967
AGGSHA ground magnetic survey
BMR
1967 BMR traverse layouts
1969 BMR traverse layouts
LOCATION DIAGRAM
DARWIN
Tennant Creek Area
NT
1971 BMR traverse layouts
1971 Survey Areas
Drillholes - Surveyed by Down-hole I.P. - 1971
TENNANT CREEK MAGNETIC SURVEY, 1971
LOCALITY MAP SHOWING SURVEY AREAS IN RELATION TO PREVIOUS SURVEYS
MILES
0 2 0 4 0
Area A
Area A1
Area A2
Area A3
Area A5
Area 4
Area 2
Area 2C
Area C5
Area C6
Area C7
Area C8
Area C1
Firmey (1967)
TENNANT CREEK
AEROMAGNETIC RIDGE
DARWIN HIGHWAY
STUART HIGHWAY
TRANSCONTINENTAL RAILWAY
134°00'
134°30'
19°00'
19°30'

PLATE 3



GEOPHYSICAL SURVEYS BY DARWIN URANIUM GROUP, 1971

LOCALITY MAP

20 0 20 40 60 KILOMETRES

10 0 10 20 30 MILES

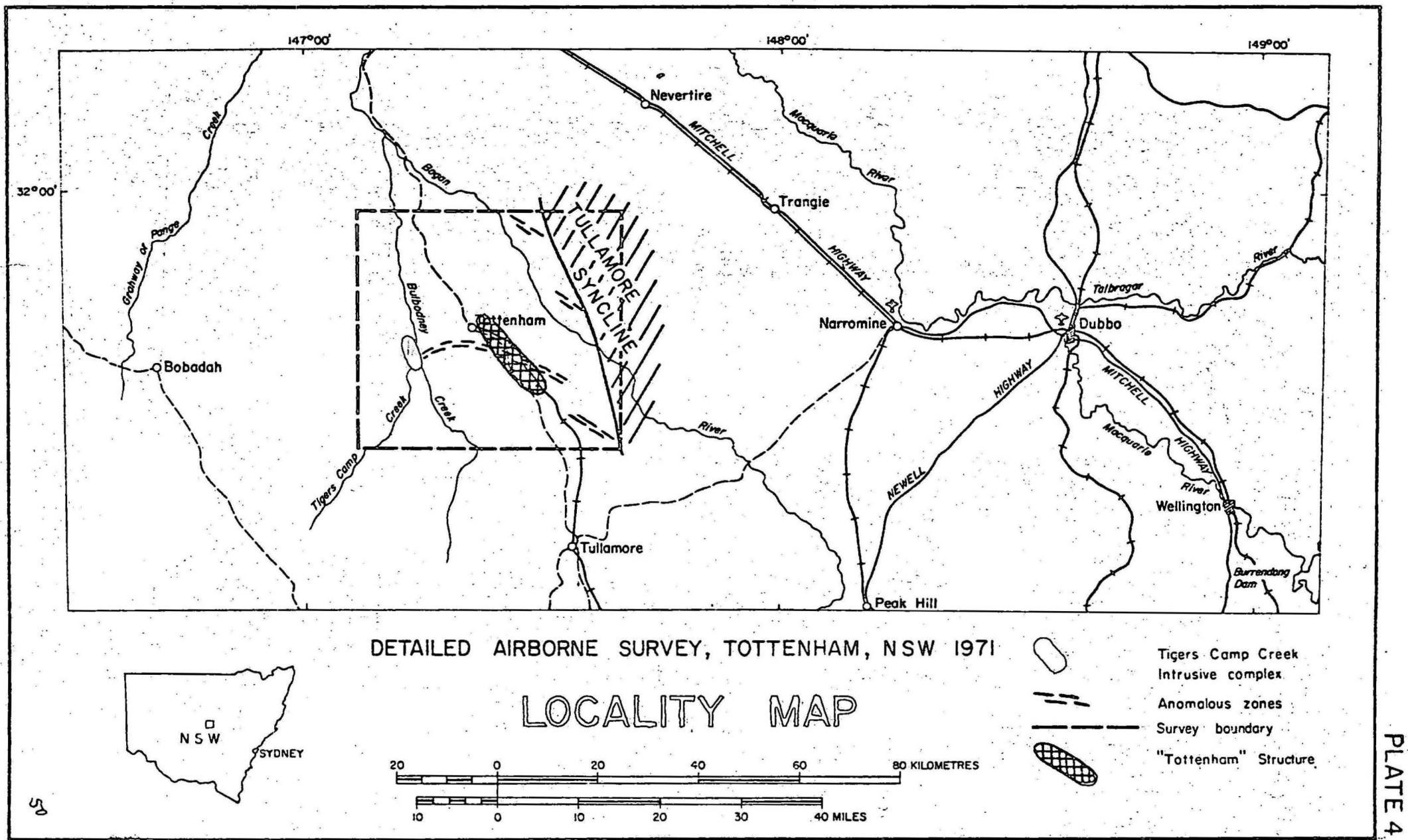
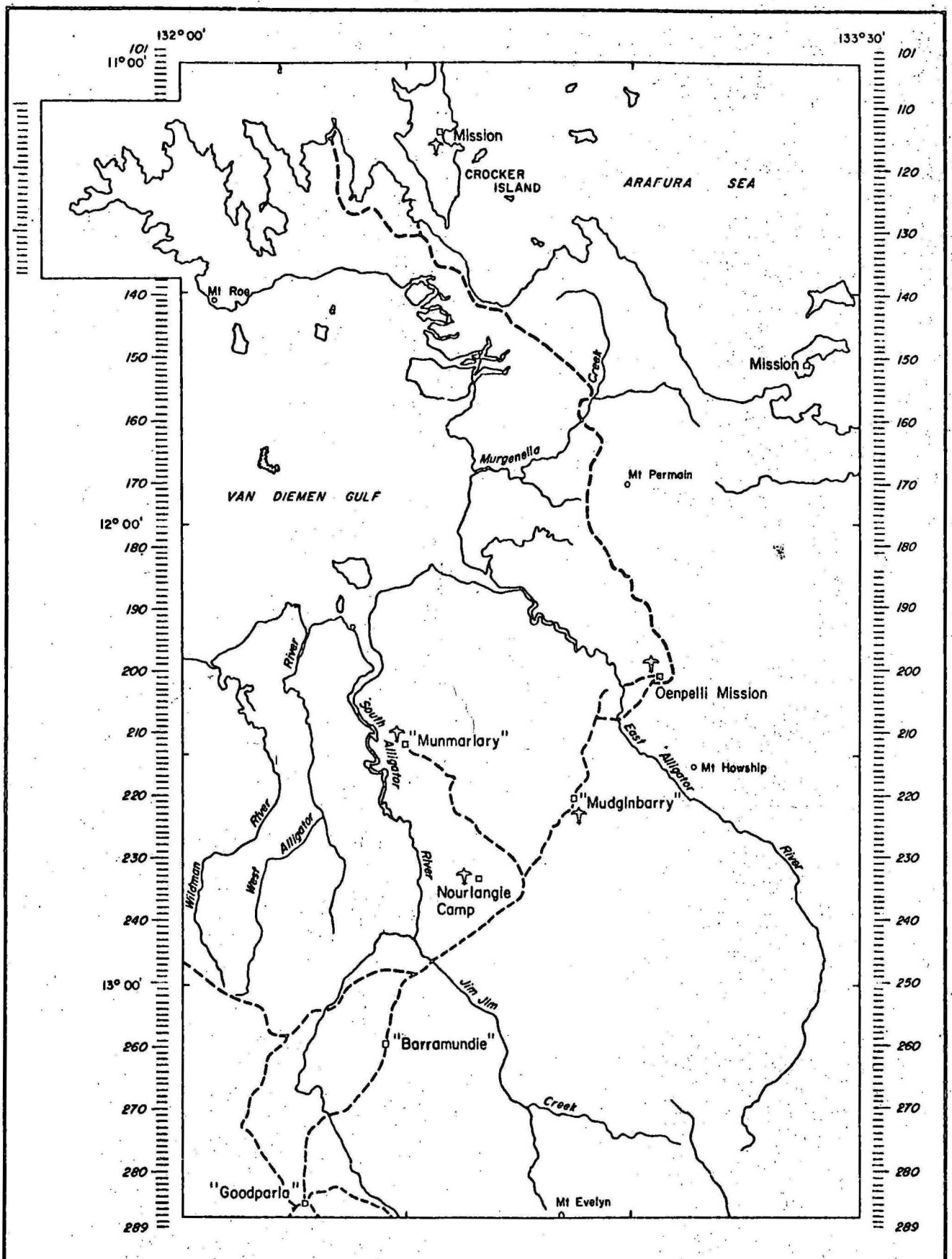

147°00'
148°00'
149°00'
32°00'
Nevertire
MITCHELL
HIGHWAY
Trangie
Macquarie
River
Bogan
Creek
Gradway or Pangee
Bobadah
Bulbodney
Creek
Tottenham
TULLAMORE
SYNCLINE
Tigers Camp
Creek
Creek
River
Tullamore
Narromine
Dubbo
Talbragar
River
HIGHWAY
MITCHELL
Macquarie
HIGHWAY
River
NEWELL
Wellington
Burrendong
Dam
Peak Hill
DETAILED AIRBORNE SURVEY, TOTTENHAM, NSW 1971
LOCALITY MAP
N S W
SYDNEY
20 0 20 40 60 80 KILOMETRES
10 0 10 20 30 40 MILES
Tigers Camp Creek
Intrusive complex
Anomalous zones
Survey boundary
"Tottenham" Structure

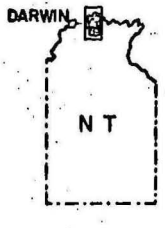
PLATE 4

PLATE 5



AIRBORNE SURVEY, ALLIGATOR RIVER, NT 1971

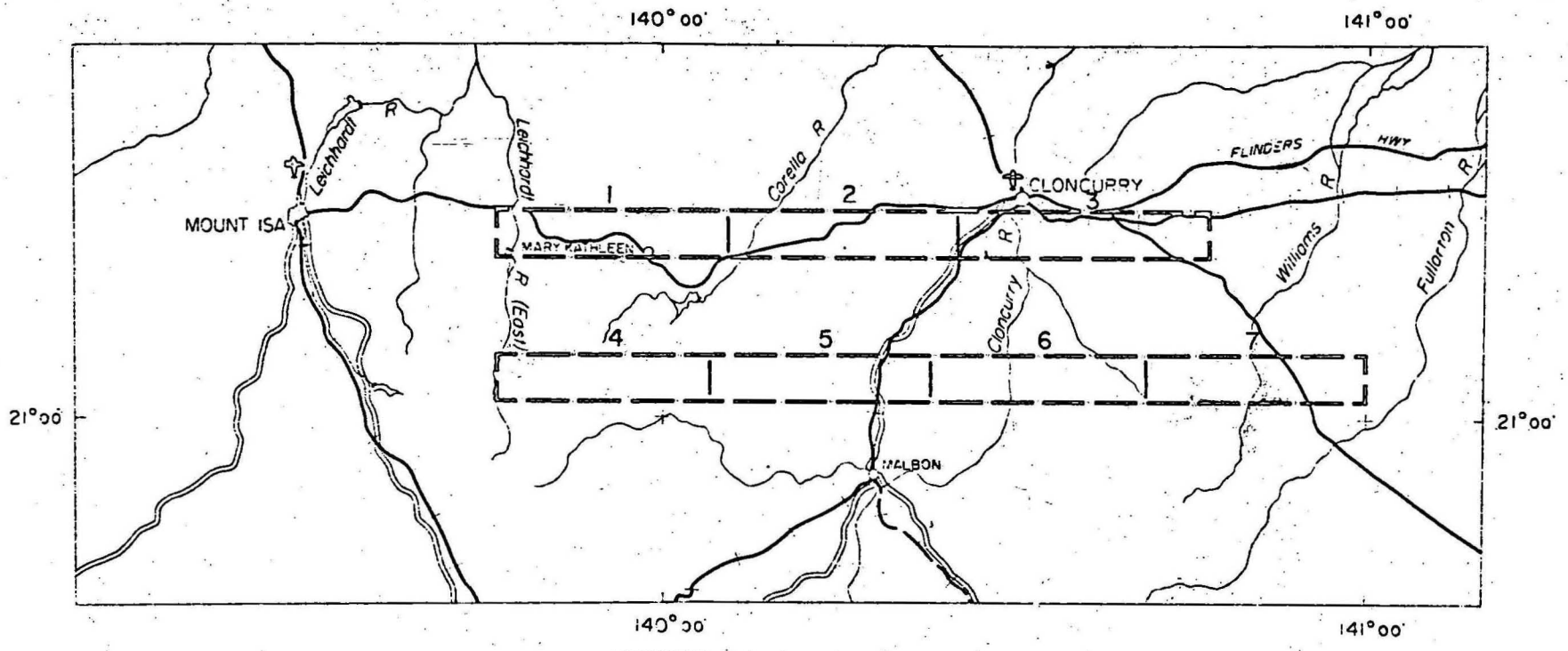
FLIGHT - LINE SYSTEM

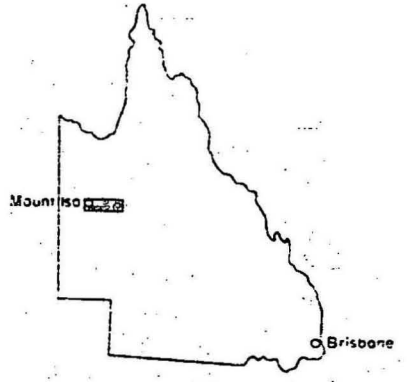


20 0 20 40 60 80 KILOMETRES

10 0 10 20 30 40 MILES

D53/BI-4





DETAILED AIRBORNE SURVEY, CLONCURRY, QLD 1970

LOCALITY MAP

MILES 10 0 10 20 30 40 50 MILES

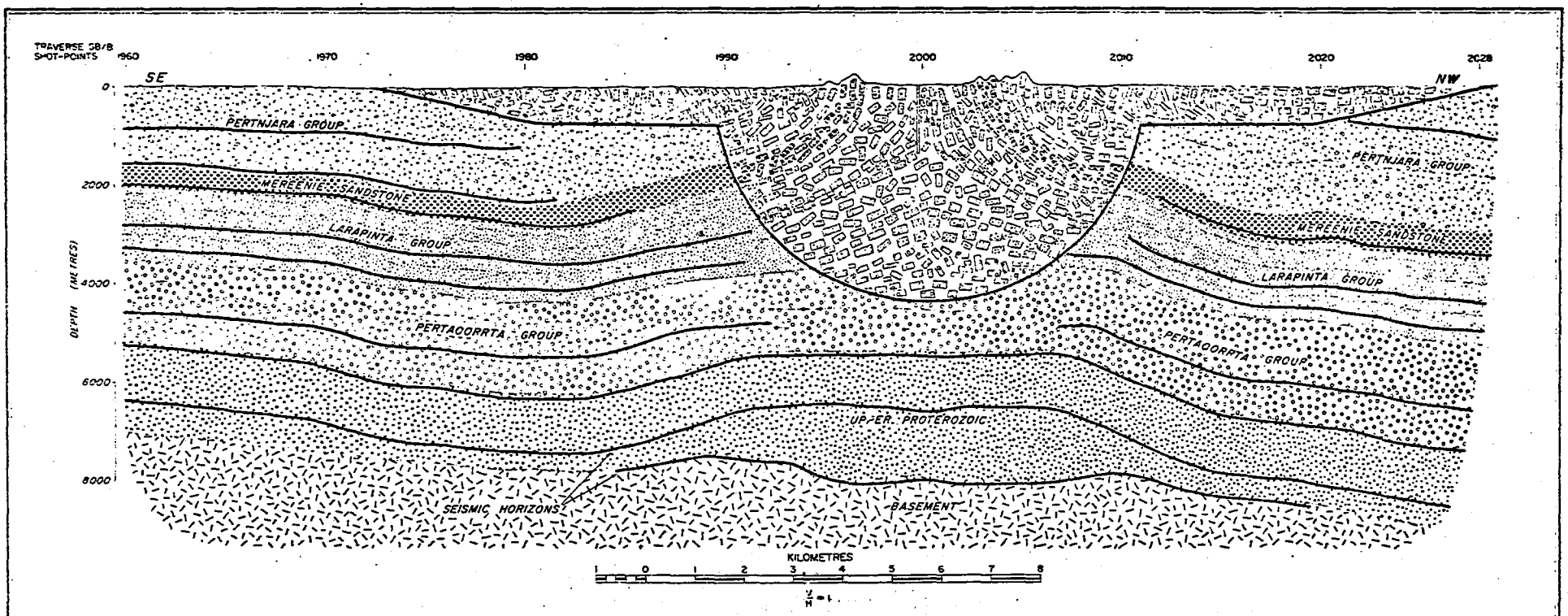
KILOMETRES 10 0 10 20 30 40 50 60 70 KILOMETRES

Boundary of survey area

F54/B1-49 A

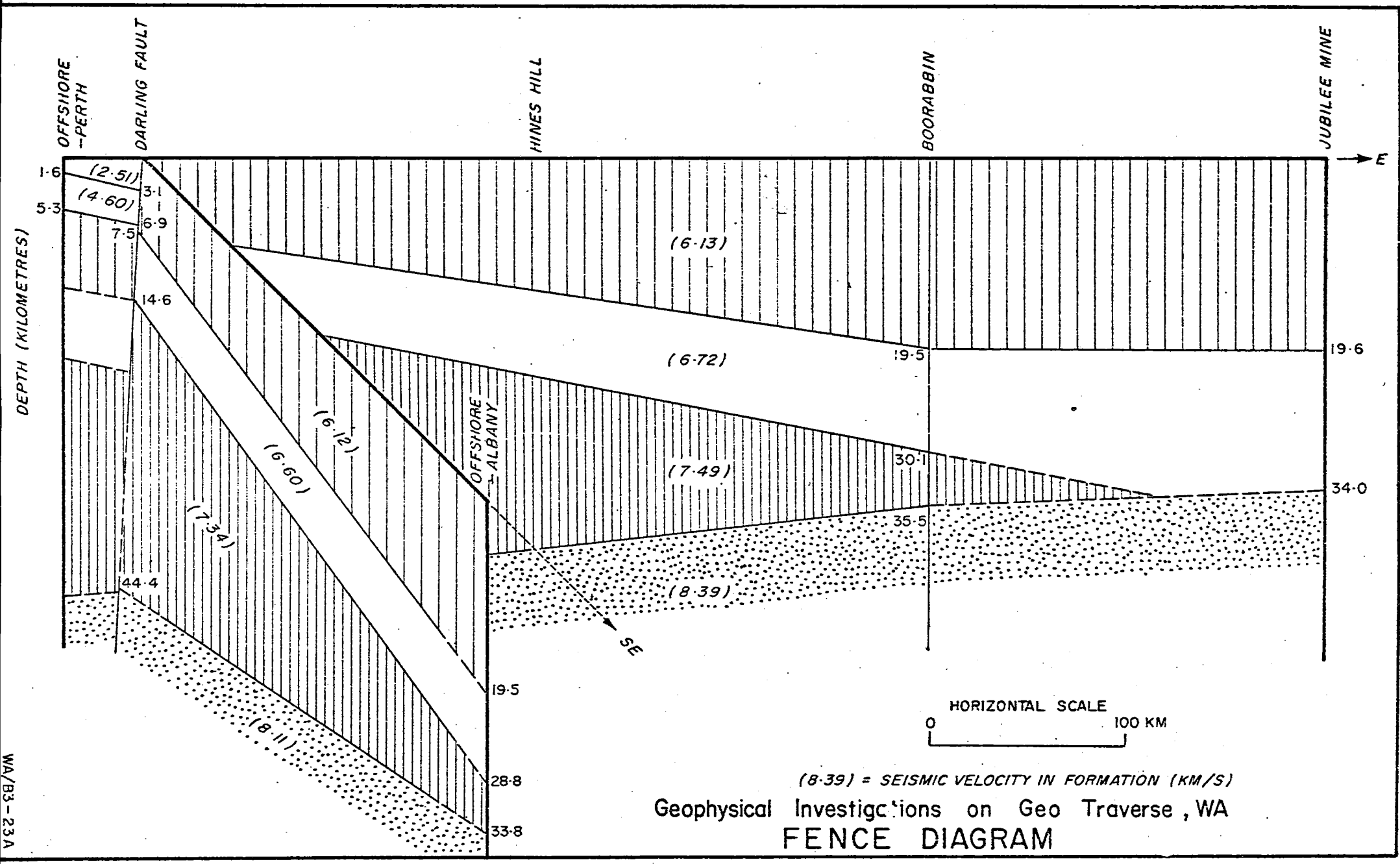
PLATE 6

52



POSSIBLE CROSS-SECTION THROUGH GOSSES BLUFF

PLATE 7



(8·39) = SEISMIC VELOCITY IN FORMATION (KM/S)

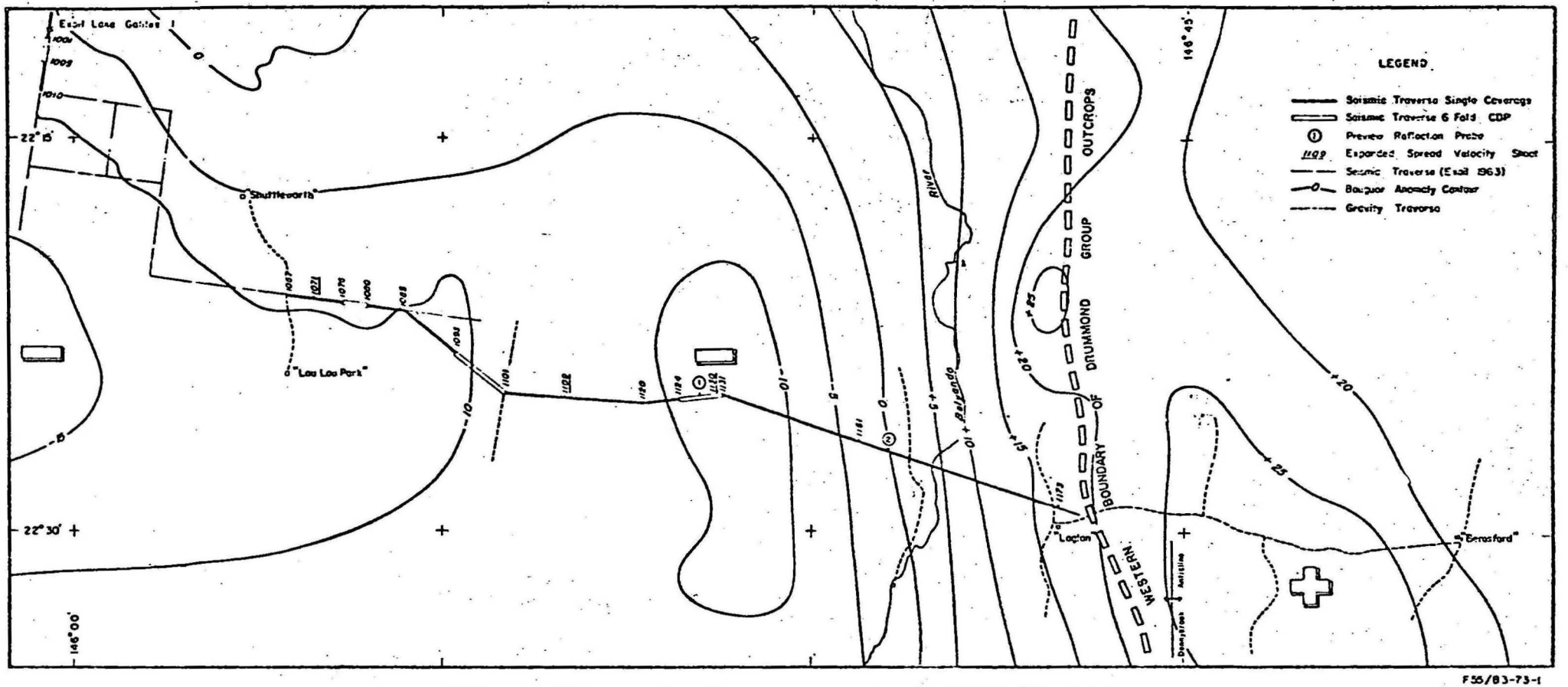
Geophysical Investigations on Geo Traverse, WA

FENCE DIAGRAM

PLATE 8

WA/B3-23A

PLATE 9



GALILEE BASIN SEISMIC SURVEY 1971 LOCATION MAP

5 0 5 10 15 20 25 30 KILOMETRES

5 0 5 10 15 MILES

F55/83-73-1

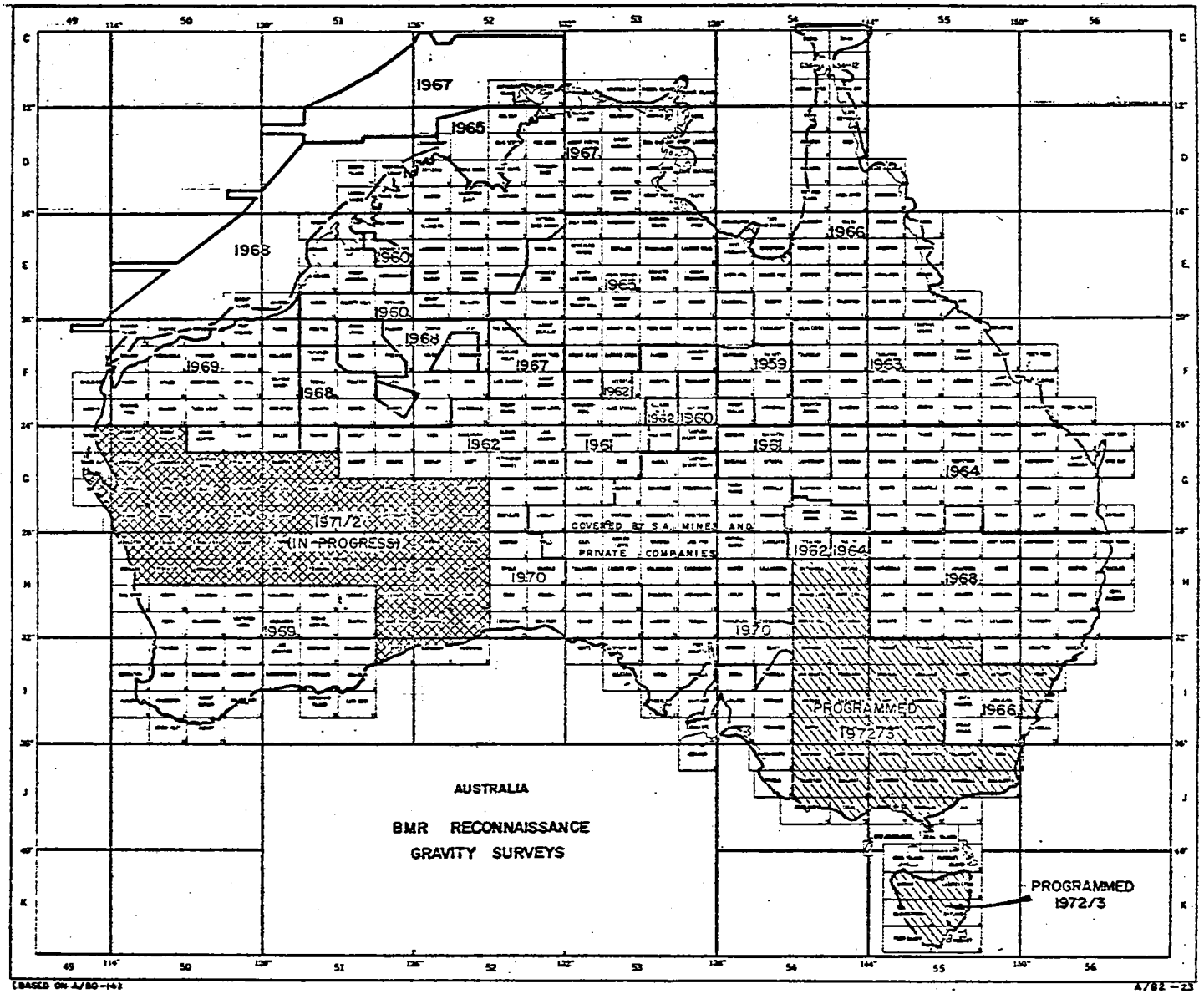
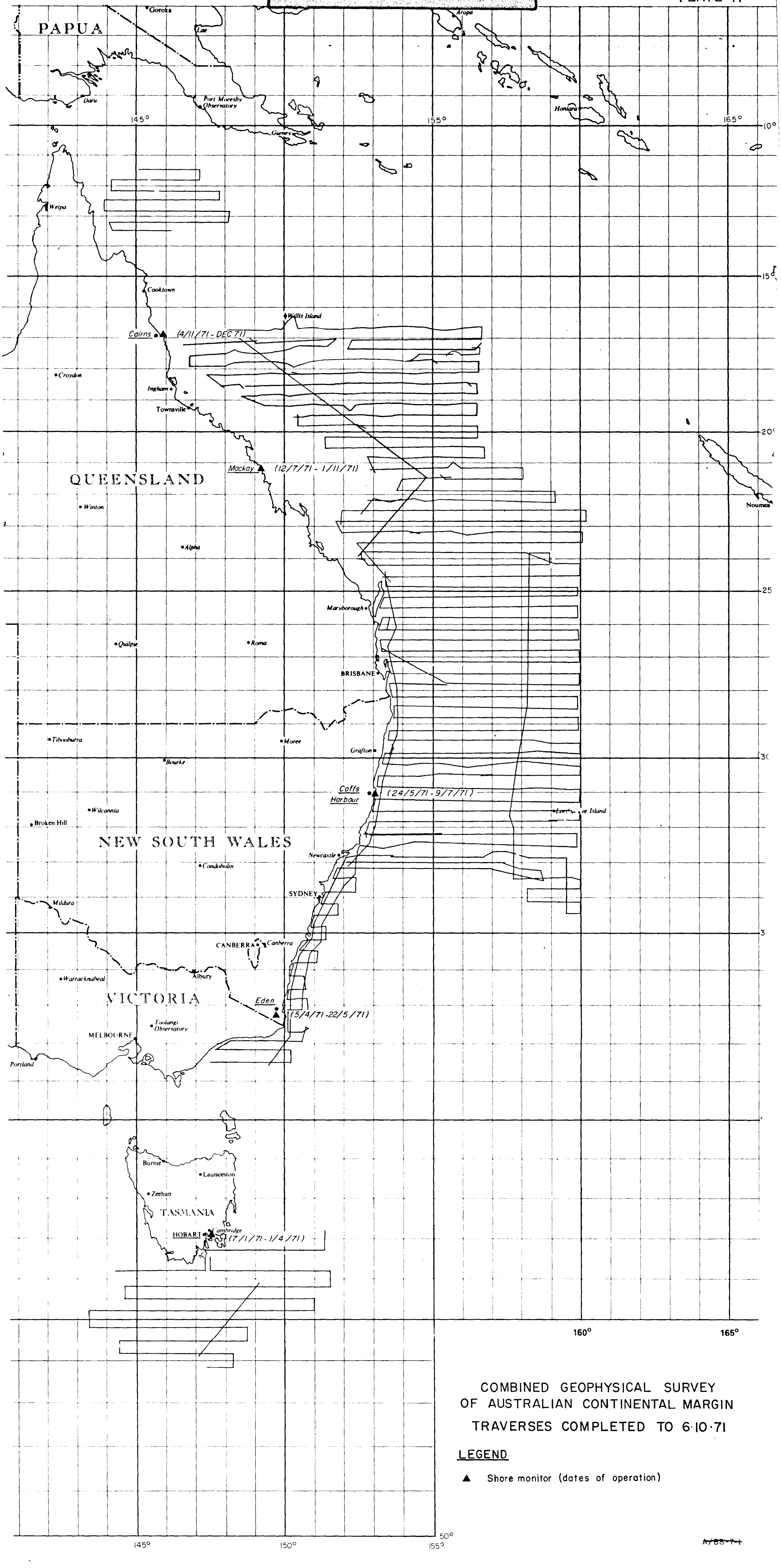

1967
1965
1967
1966
1968
1960
1965
1960
1968
1969
1967
1959
1963
1968
1962
1962
1960
1962
1961
1951
1964
1971/2
(IN PROGRESS)
COVERED BY S.A. MINES AND
PRIVATE COMPANIES
1962 1964
1970
1968
1959
1970
PROGRAMMED
1972/3
1966
AUSTRALIA
BMR RECONNAISSANCE
GRAVITY SURVEYS
PROGRAMMED
1972/3
(BASED ON A/80-142)
A/82-23

PLATE 10

PLATE 11



COMBINED GEOPHYSICAL SURVEY OF AUSTRALIAN CONTINENTAL MARGIN

TRAVERSES COMPLETED TO 6·10·71

LEGEND

▲ Shore monitor (dates of operation)

A/88-7-1

PLATE 12

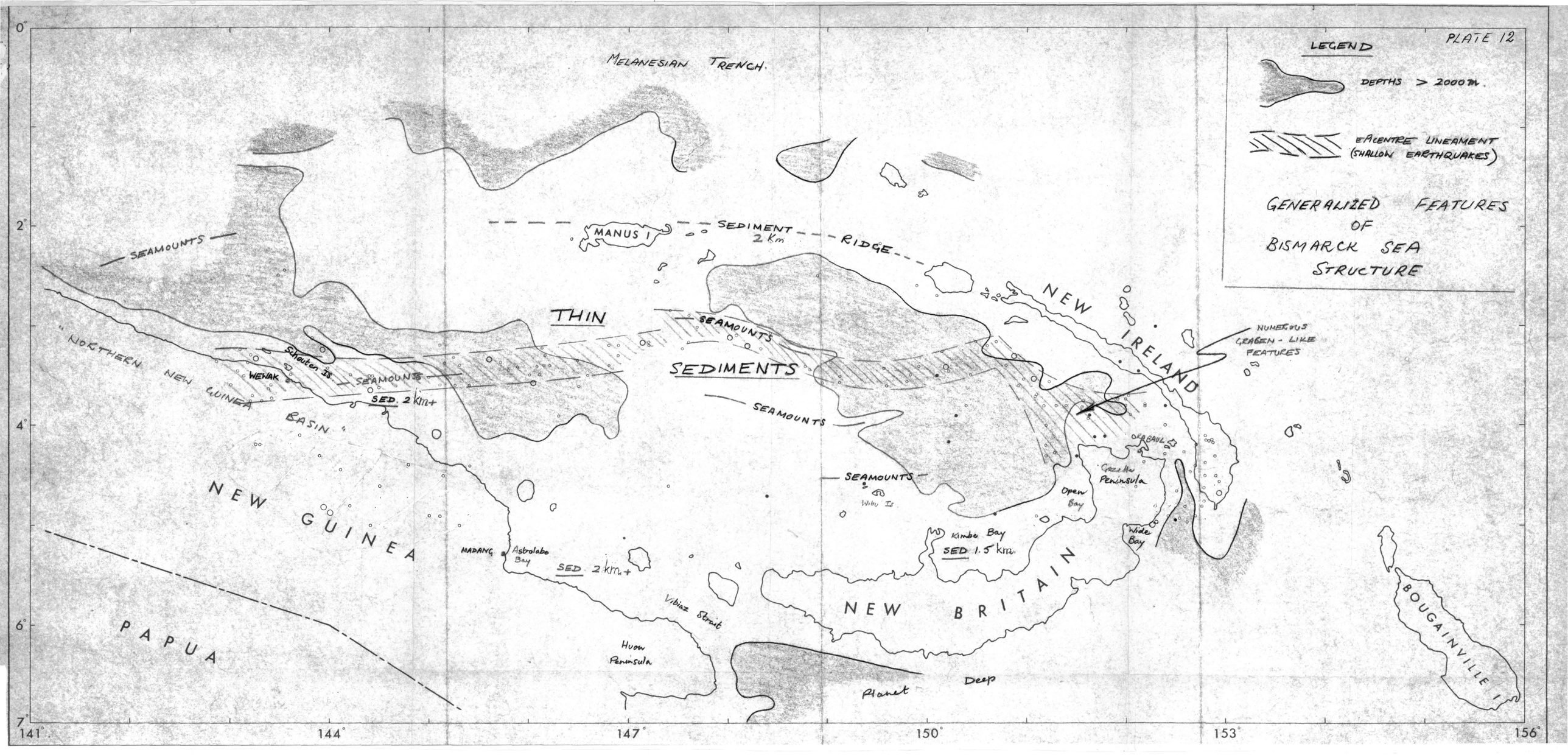

LEGEND
DEPTHS > 2000 m.
EPICENTRE LINEAMENT (SHALLOW EARTHQUAKES)
GENERALIZED FEATURES OF BISMARCK SEA STRUCTURE
MELANESIAN TRENCH
MANUS I
SEDIMENT 2 Km
RIDGE
SEAMOUNTS
THIN SEDIMENTS
NEW IRELAND
NUMEROUS GRABEN-LIKE FEATURES
"NORTHERN NEW GUINEA BASIN"
Schouten Is
WEWAK
SED. 2 km+
NEW GUINEA
PAPUA
KAVIENG
Gazelle Peninsula
Open Bay
Wide Bay
Kimbe Bay
SED 1.5 km
Wibu Is
MADANG
Astrolabe Bay
SED 2 km+
Vitiaz Strait
Huon Peninsula
NEW BRITAIN
Planet Deep
BOUGAINVILLE I
0°
2°
4°
6°
7°
141°
144°
147°
150°
153°
156°

PLATE 13

BATHYMETRY WITH APPROXIMATE S.E. EXTENSION OF PAPUAN BASIN AND MAJOR PHYSIOGRAPHIC PROVINCES

AURE TROUGH

MIOCENE BASINAL LIMESTONE PAPUAN BASIN

PORTLOCK REEF

BOOT REEF

MORESBY TROUGH

EASTERN FIELDS

EASTERN PLATEAU

PORTLOCK TROUGH

PAPUAN PLATEAU

OSPREY EMBAYMENT

CORAL SEA ABYSSAL PLAIN

Miocene basinal limestone (Papuan basin)

Fault

BASED ON PNG 88-29

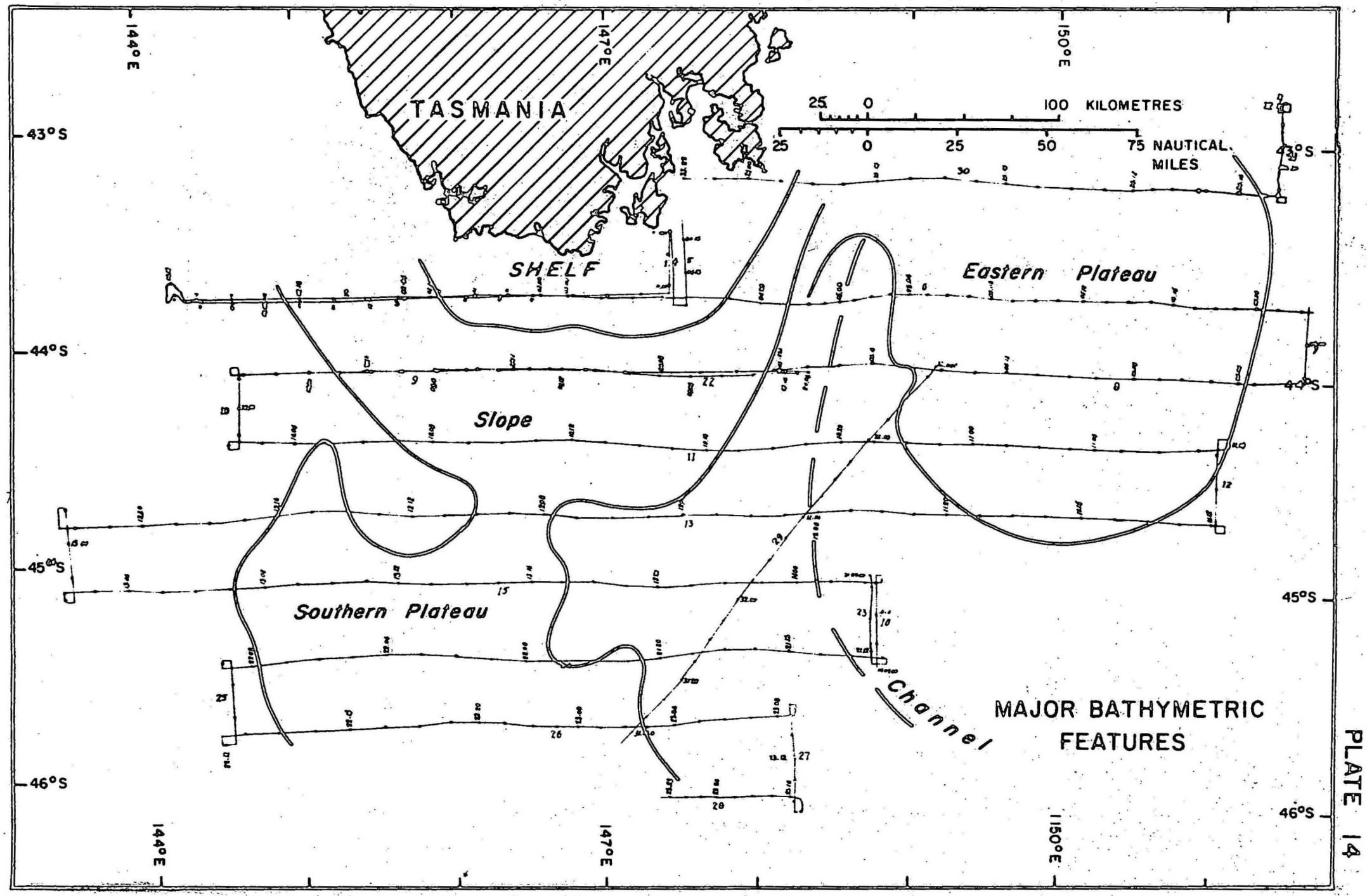
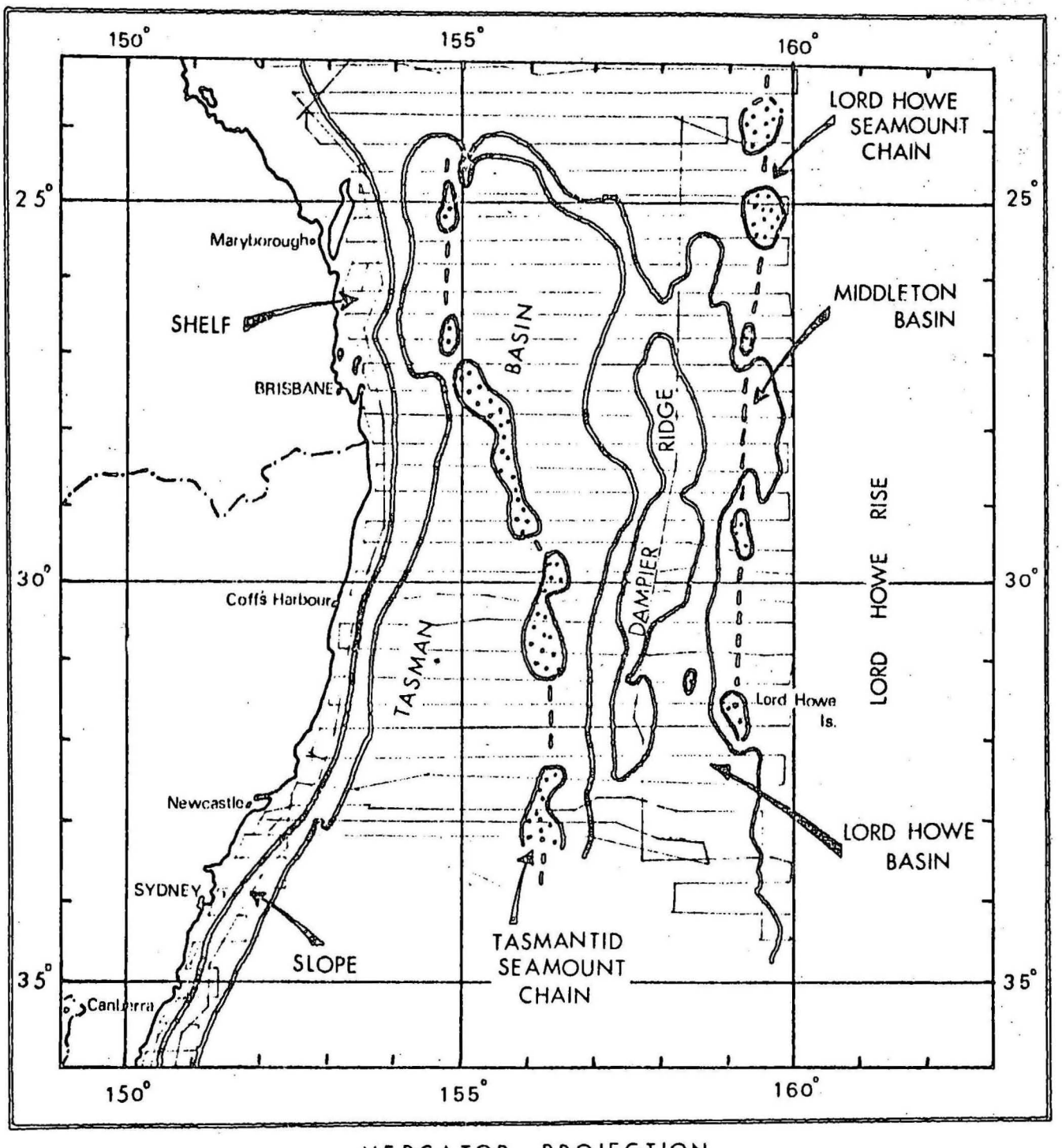
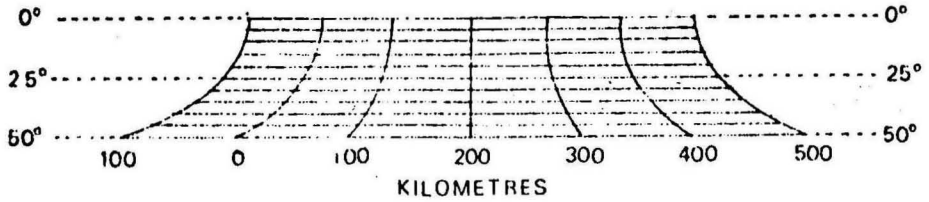

TASMANIA
SHELF
Eastern Plateau
Slope
Southern Plateau
Channel
MAJOR BATHYMETRIC FEATURES
25 0 100 KILOMETRES
25 0 25 50 75 NAUTICAL MILES
144°E
147°E
150°E
43°S
44°S
45°S
46°S

PLATE 14

MAJOR PHYSIOGRAPHIC PROVINCES IN THE TASMAN SEA

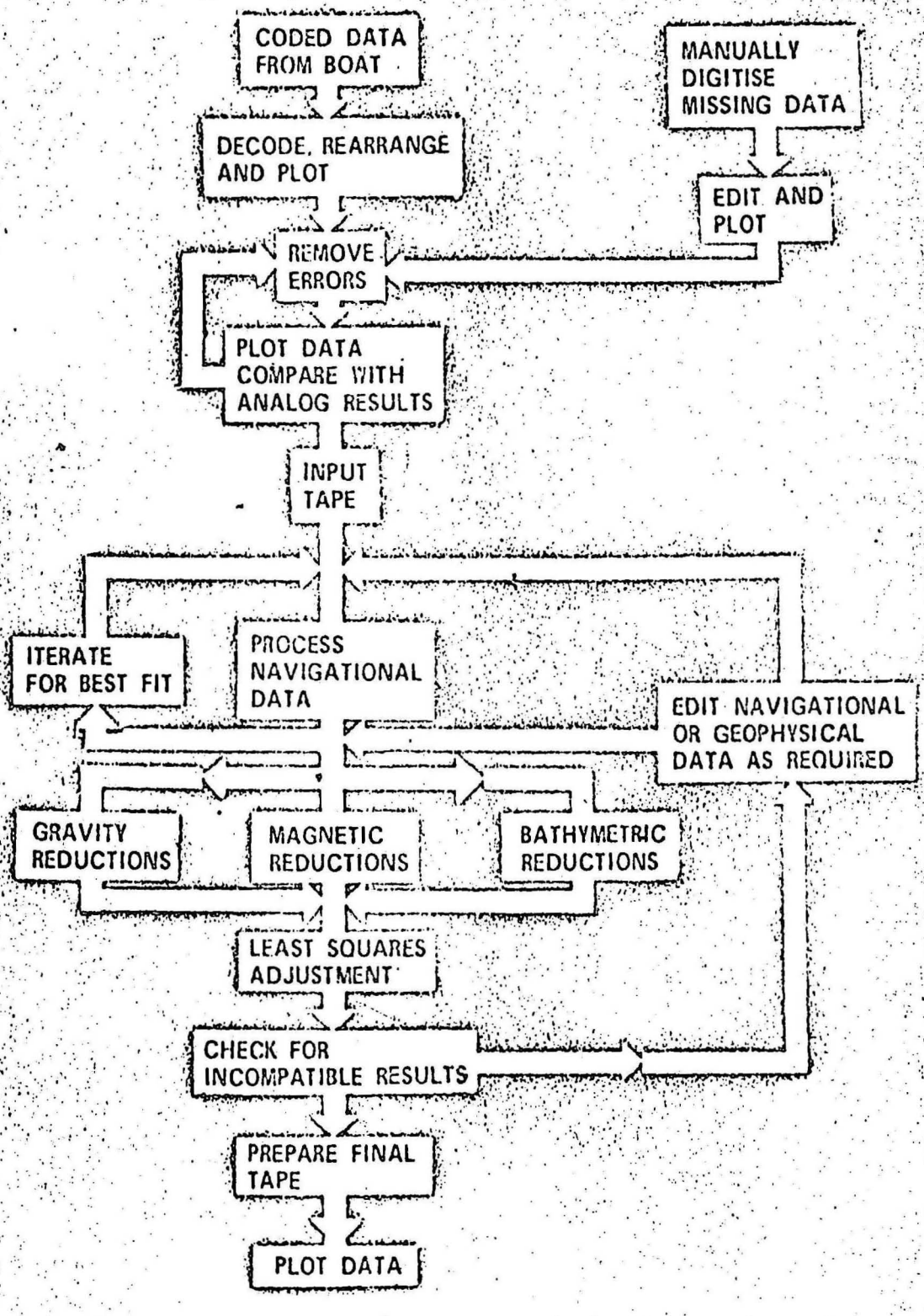


MERCATOR PROJECTION



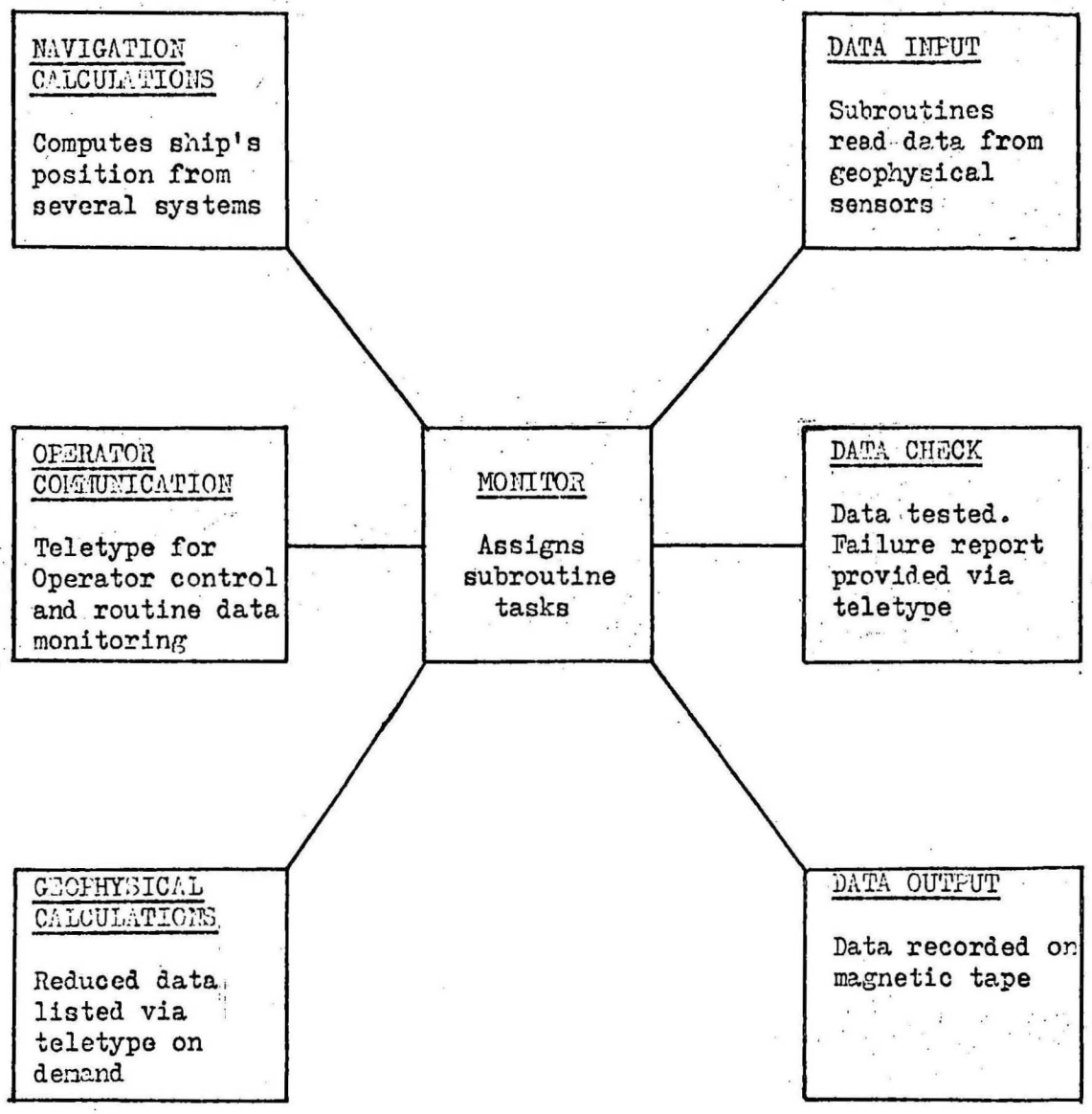
SCALE 1 : 10,000,000 AT EQUATOR

PLATE 16



DATA PROCESSING FLOW CHART

6449 .05A



GENERALISED FUNCTIONS

OF

DIGITAL DATA ACQUISITION SYSTEM