BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

Record 1981/15

INTERNAL USE ONLY

REVIEW OF BMR ACTIVITIES IN THE FIELDS OF EARTHQUAKE SEISMOLOGY AND GEOMAGNETISM

by

D. Denham, K.M. Kennedy, and R.W. Johnson

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CONTENTS

RECOMMENDATIONS

1. BMR is the appropriate government organisation in Australia to undertake activities in the fields of earthquake seismology and geomagnetism, particularly where these activities meet national and international needs.
2. The objectives of the Geomagnetism and Seismology Sub-Section should be as follows: (i) Seismology - to provide and publish information on seismic waves from near and distant earthquakes and explosions as a contribution to global seismology, to study the tectonic implications of earthquakes, particularly those in the Australian region, and to assess earthquake risk throughout the Australian continent.
   (ii) Geomagnetism - to provide and publish information on the Earth's magnetic field throughout the Australian region, including its territories and offshore, to provide geomagnetic reference standards at international level, and to study regional and local features of the Earth's internal field, particularly with relation to the overall structure of the continent.
3. The Sub-Section should be adequately staffed so that it can be organised on disciplinary lines and so that more emphasis can be given to research and publication.
4. A national seismograph network should be developed to provide the capability for (1) locating continent-wide all Australian earthquakes with magnitudes greater than 4.0 on the Richter Scale; (2) locating all earthquakes with magnitude greater than 3.0 on the Richter Scale in the continent's most seismically active and populous areas; and (3) detecting continent-wide all earthquakes with magnitudes greater than 3.0 on the Richter Scale.
5. The operation of the seismograph stations, Brisbane (BRS) and Charters Towers (CTA) in Queensland; Savage River (SVR), Savannah (SAV) and Tasmanian University (TAU) in Tasmania; Canberra (CAN), Dartmouth (DRT), Riverview (RIV) and Young (YOU) in the ACT, Victoria and New South Wales, and Adelaide (ADE), Cleve (CLV), Hawksnest (HKN), Partacoona (PNA) and Willolooka (WKA) in South Australia should be supported financially by BMR. The level of support should be restricted to the costs of operating these stations. BMR should be provided with the basic data recorded at the stations it supports. These stations are all currently operating.

6. Within the next five years new seismograph stations should be installed near Mount Morgan, Roma, Aramac, Quilpie, and Coen in Queensland; Nyngan in New South Wales and; Halls Creek, Northampton, Albany, Kellerberrin, Forrest, and Wongan Hills in Western Australia. These stations should be operated either by BMR or, in the case of the Queensland stations, under a co-operative arrangement with the University of Queensland.
7. BMR should aim to operate five more permanent magnetic observatories, near Darwin, Alice Springs, Charters Towers, Marble Bar, and Woomera. The first-order regional magnetic surveys should be continued, to determine secular change in the Earth's magnetic field for the production of magnetic charts.
8. BMR should continue to record the Earth's magnetic field at Mawson and Macquarie Island; the stations at Davis and Casey should be upgraded to provide a continuous record of the magnetic field at each station; the seismographs at Mawson and Macquarie Island should continue to be operated; and that eventually a seismograph should be installed at Casey. High priority should be given to the proposals to install automatic recording stations in the Antarctic to reduce the manpower requirements.
9. The funding and manpower requirements The Sub-Section should be divided into two parts for the purpose of funding and manpower requirements one should provide the basic geophysical data and should have secure funding and staffing during a rolling three-year period; the second should compete annually with other research projects for both staff and funds available within the BMR budget and staff ceiling.

BACKGROUND

Membership of committee

A committee made up of Dr D. Denham, Dr R.W. Johnson, and Mr K.M. Kennedy was formed in August 1980 to review BMR activities in the fields of earthquake seismology and geomagnetism and to report its recommendations to the Director.

Terms of reference

"The Committee is asked to review BMR activities in the fields of earthquake and geomagnetism and report to the Director by mid-November 1980. As a first step the Committee should report on:

1.1 Current objectives of earthquake seismology and geomagnetism projects/ programs in BMR;

1.2 The nature, location, manpower requirements and approximate costs to BMR of existing stations/observatories

- belonging to BMR
- attached to other institutions but partly or wholly funded by BMR
- attached to other institutions, not funded by BMR but providing it with information
- attached to other Australian institutions, not funded by BMR and not providing it with any information;

1.3 The use BMR makes of seismological and geomagnetic data it collects and receives including the amount of interpretative work and a history of ensuing publications;

1.4 The dissemination of data gathered by BMR observatories and BMR-sponsored observatories, and the use made of these data by the recipients;

1.5 The activities undertaken by staff of the Observatory Sub-section not associated with the seismological and geomagnetism programs.

Secondly, the Committee is asked to provide the Director with its assessment of:

2.1 The appropriate role and objectives of earthquake seismology and geomagnetism programs in BMR, taking into account the role of BMR defined in the Minister's statement of 25 October 1979, and as described in the ASTEC Review of BMR; and taking into account the possible role in monitoring nuclear explosions;

2.2 The value of the earthquake seismology program and staff expertise as an adjunct to possible short-term projects of study of crustal structure ('COCORP'-type studies);

2.3 The nature, cost to BMR (1980 cost basis), and manpower requirements of program, including a network of stations/observatories designed to achieve these objectives over the next five years."

Input to committee

In August 1980 the Committee called for written submissions from all staff members then employed in the Geomagnetism and Seismology Sub-Section. An invitation was also given to Dr W.D. Parkinson, Reader in Geophysics with the University of Tasmania and a former supervisor of the Sub-section, for his comments.

The replies received are contained on file (80/959) and these, together with BMR's draft reply to a request from the Vice Chancellors of the Universities of Queensland and Adelaide for funds to support the operation of seismograph stations in Queensland and South Australia, formed the basis for the report presented here. Two of us (KMK and RWJ) spent a half-day familiarisation visit to the Canberra Observatory at Kowen Forest.

We wish to thank all those who gave of their time to provide input to this investigation.

A glossary is provided at the end of the report which explains some of the technical terms referred to in the text.

INTRODUCTION

BMR was created in 1946, primarily as a geological and geophysical survey for the Federal Government. However, it soon became involved in observatory programs when the Toolangi (Vic.) and Watheroo (WA) magnetic observatories were transferred to it in 1946 and 1947 respectively. Subsequently further magnetic observatories were opened in Antarctica and the Australian mainland as indicated in Table 1.

TABLE 1: Australian magnetic observatories

Name	Locality	Duration of operation
Canberra	ACT	1978-
Casey	Antarctica	a
Darwin	NT	1957-1959
Davis	Antarctica	b
Gnangara	WA	1957-
Heard Island	Indian Ocean	1952-1954
Macquarie Island	Southern Ocean	1952-
Mawson	Antarctica	1955-
Toolangi	Victoria	1919-
Watheroo	WA	1919-1958
Wilkes	Antarctica	1957-1967

a regular absolute observations only, since 1974
b regular absolute observations only, since 1972

At present no other authority operates permanent magnetic observatories on the Australian mainland, but several countries operate stations in the Antarctic.

BMR's first seismograph was acquired in 1950 from Melbourne University and subsequently several stations have been installed both in the Antarctic and on the Australian continent. Table 2 shows the main BMR-operated stations which have been installed since 1950 and Figure 1 shows the locations of those currently operated by BMR and other agencies on the Australian continent.

AUSTRALIA

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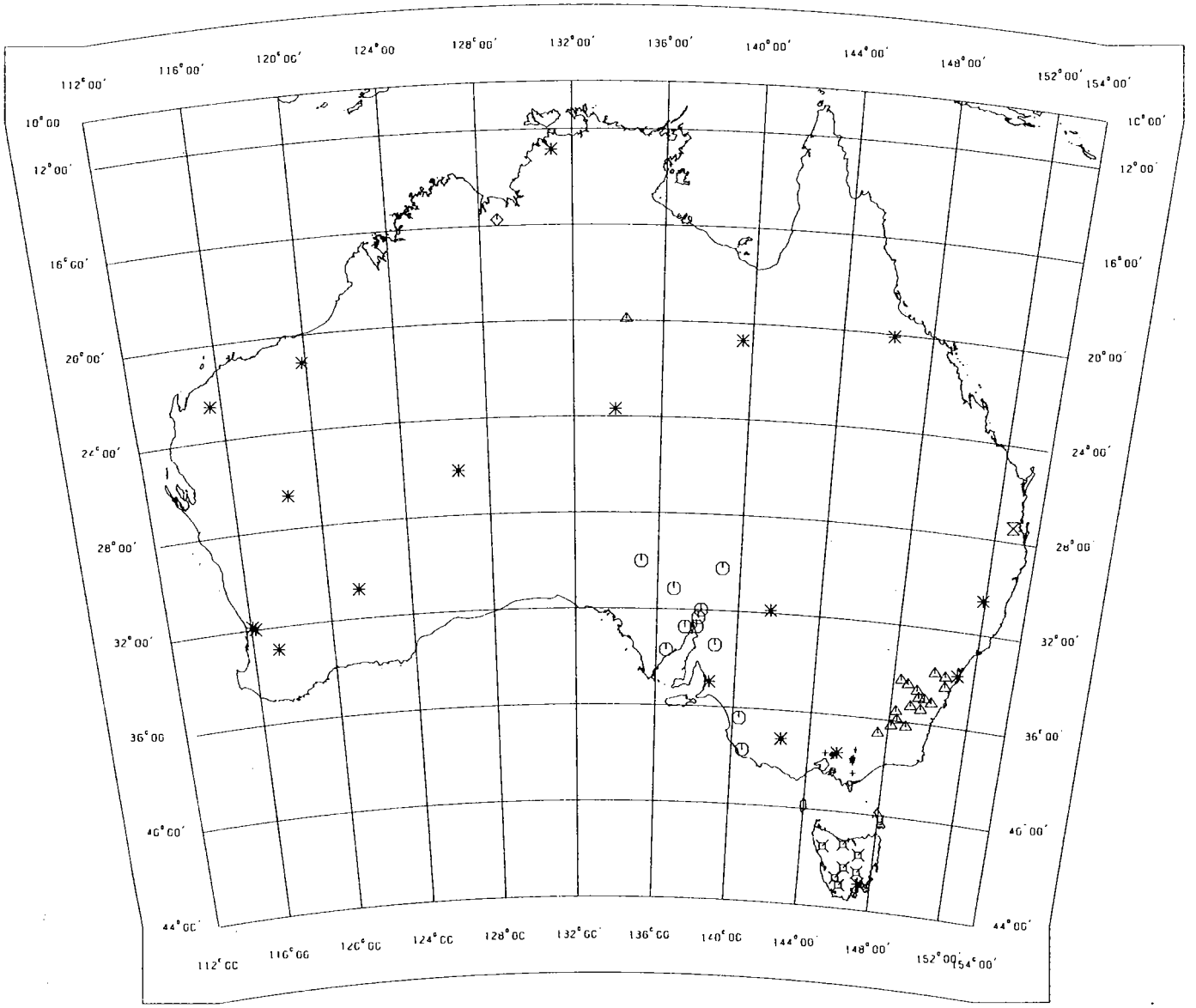

AUSTRALIAN NATIONAL SPHEROID
SIMPLE CONICAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 18°00' AND 36°00' SOUTH

AUSTRALIA

Fig. 1 SEISMOGRAPH STATIONS 1980

✳ Stations operated by BMR or jointly with another organization.

⏀ △ ✕ + ⧖ ◈ Stations operated by Adelaide University, Australian National University, University of Tasmania, Preston Institute of Technology, University of Queensland and W.A. Public Works Dept.

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TABLE 2: BMR seismograph stations

Code	Name	Locality	Station type	Duration of operation
ASP	Alice Springs	NT	3D + array	1970-
BFD	Bellfield	Vic.	short-period Z	1972-
CNB	Canberra Observatory	ACT	short-period Z	1975-
COO	Cooney	NSW	short-period Z	1974-
DAR	Darwin	NT	3D components	1961-1972
GLS	Giles	WA	short-period Z	1974-1978
HII	Heard Island	Ind. Ocean	2-component h	1951-1954
ISQ	Mount Isa	Qld.	short-period Z	1979-
KLG	Kalgoorlie	WA	short-period Z	1964-
MAW	Mawson	Antarctica	3-component	1956-
MBL	Marble Bar	WA	short-period Z	1972-
MCQ	Macquarie Island	S. Ocean	short-period Z	1951-
MEK	Meekatharra	WA	short-period Z	1967-
MTN	Manton (replaced DAR)	NT	3-component	1972
MUN	Mundaring	WA	3-component	1959-
NAU	Nanutarra	WA	short-period Z	1980-
NWAO	Narrogin	WA	6-component	1975-
STK	Stephens Creek	NSW	short-period Z	1974-
SWV	Swan View	WA	short-period Z	1976-
TOO	Toolangi	Vic.	3-component	1962-
WBN	Warburton (replaces GLS)	WA	short-period Z	1978-
WIL	Wilkes	Antarctica	3-component	1957-1966

Financial assistance by the Commonwealth to operate seismograph stations dates back to 1934 when a sum of £300 per annum was contributed towards the upkeep of the *Riverview Observatory (RIV) and support for this station now runs at $6000 per year from BMR's contract vote. Since then financial assistance has been given to the State universities of Queensland (from 1974), Tasmania

*Throughout this report seismograph stations are usually referred to by their appropriate three-letter code. Table 3 lists the stations mentioned in the report, and their current and proposed level of BMR support.

(from 1974) and South Australia (1976). Currently these three universities receive $17 800, $6300 and $20 050 per annum. The terms of the current agreements are that BMR now owns the World Standard Seismographs at the stations ADE, RIV, CTA and TAU and in return each authority (except RIV) provides BMR with phase data and regional earthquake hypocentres.

TABLE 3: Non-BMR seismograph stations

Code	Location	Type of station	Is station supported now by BMR	Recommended for BMR support
ADE	Adelaide, SA	6-component WWSSS*	Yes	Yes
BRS	Brisbane, Qld	3-component	No	Yes
CAN	Canberra, ACT	3-component	No	Yes
CLV	Cleve, SA	1-component SPZ	No	Yes
CTA	Charters Towers, Qld	6-component WWSSS plus SRO°.	Yes	Yes
DRT	Dartmouth, Vic.	1-component SPZ	No	Yes
HKN	Hawksnest, SA	1-component SPZ	No	Yes
KNA	Kunnunurra, WA	3-component	No	No
PNA	Partacoona, SA	1-component SPZ	No	Yes
RIV	Riverview, NSW	6-component WWSSS	Yes	Yes
SAV	Savannah, Tas.	1-component SPZ	No	Yes
SVR	Savage River, Tas.	1-component SPZ	No	Yes
TAU	Hobart, Tas.	6-component WWSSS	Yes	Yes
WKA	Willalooka, SA	1-component SPZ	No	Yes
WAA	Warramunga, NT	Multi-component array	No	No
YOU	Young, NSW	1-component SPZ	No	Yes

* World Wide Standard Seismograph System

\+ Short-period vertical (Z≡ vertical component)

o Seismological Research Observatory

A three-component station records ground motion in the vertical, north-south and east-west directions. A six-component system has both long- and short-period three-component recorders.

In 1979 and 1980 the Preston Institute of Technology applied for a grant on a similar basis but was advised that because of the local nature of its network, which is not required for the national network, it would not be appropriate for BMR to assist this operation. ANU applied for assistance in 1980 and was told that its request would depend on a review of our operations (File 80/561). However, it should be pointed out that both PIT and ANU provide BMR with earthquake hypocentres for the national earthquake data file.

There are no such financial commitments for assistance of non-BMR geomagnetic observatories.

SCIENTIFIC OBJECTIVES AND COSTS OF CURRENT PROGRAMS

1.1 Current objectives of earthquake seismology and geomagnetism projects/programs in BMR

(i) Seismology. One objective is to provide information on seismic waves from near and distant earthquakes and explosions as a contribution to global seismology. This contributes to the understanding of the structure of the Earth's interior and the dynamic processes taking part within the Earth.

The other objective is to carry out research on earthquake distribution, wave attentuation, foreshocks, aftershocks, magnitudes, mechanisms, prediction and other features, in order to determine the tectonic implications of seismicity and earthquake risk. This is carried out with particular emphasis on the Australian region.

The work program involves operating a network of seismographs in Australia and Antarctica, some of which are operated jointly with universities and overseas organisations. The long-term aim is to detect all earthquakes in Australia of magnitude 3 or greater, and to locate such earthquakes in critical areas of high polulation density and a high level of seismic activity.

BMR acts as the Australian seismological data centre; it maintains an Australian regional earthquake data file, collates and transmits data to the International Seismological Centre, Newbury, U.K. and acts as seismological consultant to the Australian Government and public. It operates accelerographs in crucial areas of comparatively high earthquake risk and studies the main effects of earthquakes to estimate seismic risk.

From time to time, temporary networks are set up to monitor aftershocks of major earthquakes.

Seismology provides the main method of detecting underground nuclear explosions. BMR is represented on the Committee of Disarmament's Group of Seismic Experts, which is preparing recommendations for an international network for monitoring explosions; it is expected that BMR will be responsible for the Australian contribution to this network when established.

(ii) Geomagnetism. A primary objective is to provide and publish information on the Earth's magnetic field throughout the Australian region, including its territories and offshore. Other objectives are to provide geomagnetic reference standards at international level, and to investigate regional and local features of the internal field, in particular with relation to the overall structure of the continent.

The work program consists of operating geomagnetic observatories in Australia and Antarctica, and developing of efficient instrumental and data-acquisition and distribution systems.

BMR operates the National Geomagnetic Data Service and provides data, information, and advice to international agencies, government and commercial bodies and the public. The data from the geomagnetic observatories are used for global studies of geomagnetism and are published monthly in BMR's Observatory Report.

The recordings at the permanent observations are supplemented by about 60 first-order regional magnetic stations (see Fig. 2). These are observed at regular intervals to provide a record of the secular variation of the magnetic field, and isomagnetic charts are published at regular intervals.

The long-wavelength geomagnetic anomalies are used to study regional crustal variations and mineralisation of the crust.

1.2 The nature, location, manpower requirements and approximate costs to BMR of existing stations/observatories

The location of the seismic stations owned and operated by BMR are shown in Figure 1. Figure 2 shows the locations of the permanent magnetic observatories and the first-order regional magnetic stations.

Current manpower deployment (as of January 1981) is as follows:

Mundaring Geophysical Observatory: Science 3, Science 2, T02 and T01 (Engineering) and a Typist. This staff is responsible for all the seismographs in WA and the Gnangara geomagnetic observatory.

(Based on A/BO-59-1A) Record No 1981/15

Fig. 2

FIRST-ORDER MAGNETIC STATIONS

A/BO-59-1A

Canberra HQ: one Science 4, three Science 3, two Science 2, one TO1 (Science), two TA2 and one STO1 (Engineering) (from ES Branch).
Mawson: one Science 1.
Macquarie Island: one Science 1.

The following establishment positions are currently vacant: one Science 2, one STO1 (Science), four Science 1 (these include 3 Antarctic and 1 Mundaring positions). One CA3 and one Gardener or Caretaker at Mundaring have been put in the pool.

During the 79/80 financial year the following costs were incurred:

Vote		Canberra	Mundaring	Total
432-2-01	Travel	6 646	3 402	10 048
-02	Office requisites	*	1 305	1 305
-03	Postage	*	14 783	14 783
-04	Office services	*	7 979	7 979
-05	Printing & Publications	5 880	nil	5 880
-06	Motor Vehicles	100	4 462	4 562
-08	General stores	2 382	7 276	9 658
-09	Contract services	58 818	7 059	65 877
-10	Freight & cartage	*	1 144	1 144
-11	R & M to plant & equipment	42	299	341
-12	Computer services	18 088	nil	18 088
891-1-01	Plant and equipment	20 479	nil	20 479
432-1-01	Salaries	210 510	113 520	324 030
-02	Overtime	5 003	139	5 142
				$489 316

* These items could not be extracted from BMR's accounting system.

This amounts to about 4% of BMR's total expenditure of $13.3 million.

Of this total of about $500 000 the costs to BMR of the stations funded partly by BMR during 1979/80 were as follows:

Riverview Observatory	$ 5 000
University of Queensland	$ 9 605
University of Adelaide	$18 450
University of Tasmania	$ 3 150

These monies were used to operate the following stations and provide phase, amplitude, and hypocentral data as follows:

Riverview Observatory - phase data only.

Queensland University - phase data from CTA & BRS

Adelaide University - phase data from ADE on regular basis. Hypocentral data from the SA network on a regular basis and phase data on request.

Tasmania University - phase data from TAU
- hypocentral data for Tasmania earthquakes using Tasmanian stations on a regular basis and phase data on request.

There are two main institutions which provide BMR with data but are not being funded by BMR; these are the ANU and the PIT. The annual operating costs of the ANU network of stations is about $40 000. BMR receives hypocentres from ANU for earthquakes in NSW and phase data on request. The same holds for PIT; the costs of operating their network are not known.

All the stations in Australia being funded by BMR provide BMR with data.

1.3 The use BMR makes of seismological and geomagnetic data it collects and receives including the amount of interpretative work and a listing of ensuing publications

BMR uses the seismological observatory data to locate earthquakes that have occurred in the Australian region and to assess earthquake risk on a continent-wide basis. The national earthquake data centre operated by BMR contains records of all earthquakes known to have taken place in the Australian regions; about 2000 earthquakes per year are added to the data file. This data file is the basis for the many requests generated both within and outside BMR.

The main research activities carried out within BMR on the data gathered by the observatories include: the study of strong ground motion which has been recorded by the accelerographs; studies of assessing earthquake risk; studies of seismicity patterns and the radiation patterns from earthquakes to infer the continental stress field, the relationship of the stress field to plate tectonic forces, and the intra-plate tectonics of the Australian Plate; and studies of travel-time residuals carried out to relate the residuals to the tectonic provinces.

Geomagnetic data are mainly used in BMR to prepare magnetic maps of the Australian region. Because the Earth's magnetic field is continually changing a full set of magnetic maps is produced every ten years. These are used primary for navigation and exploration purposes.

As part of its study of the Earth's magnetic field BMR is partaking in the MAGSAT project in which satellite data will be integrated with surface and airborne observations to study broad variations in crustal magnetisation.

A list of the main publications (not including Records) produced within BMR, using observatory data, during the last five years is given in Appendix 1.

1.4 The dissemination of data gathered by BMR observatories and BMR-sponsored observatories, and the use made of these data by the recipients

Teleseismic data are telexed to the United States Geological Survey twice weekly for the preliminary determination of hypocentres which are distributed world-wide.

Complete phase data and regional hypocentres are sent to the International Seismological Centre in UK on magnetic tape for Australia, Papua New Guinea, and the Solomon Islands.

Copies of seismograms from key stations are sent to the World Data Centre A in USA. There are hundreds of examples of the use of these data in international publications such as Tectonophysics, Geophysical Journal, Journal of Geophysical Research, Bulletin of Seismological Society of America, etc. The data are used mainly in studies of the structure of the Earth, earthquake risk assessments, and geodynamical processes. The geomagnetic data are also widely used in studies of the Earth's magnetic field and in studies of the ionosphere and solar studies. As both the seismic and magnetic data are sent to World Data Centres we do not have a full picture of the use to which our data are put (BMR also obtains data from the World Data Centres). However, Australia is in a key position in all global studies of seismology and geomagnetism and the data obtained in our region are invaluable for this reason.

Appendix 2 gives an indication of some of the requests for data dealt with during 1979 and the first half of 1980.

1.5 The activities undertaken by staff of the Observatory Sub-section not associated with the seismological and geomagnetic programs

Very little is done outside the seismological and geomagnetic programs. Some work is done at Mundaring to record reflections from the ionosphere for the Ionospheric Prediction Service, and magnetic pulsations are also recorded there for the University of Newcastle. However, little analysis is carried out on the data recorded.

From Canberra some surveys of aircraft compass-swinging sites and calibrations of magnetometers and compasses are undertaken but these tasks constitute only a minor effort.

FUTURE ROLE, OBJECTIVES, AND LEVELS OF ACTIVITY

2.1 The appropriate role and objectives of earthquake seismology and geomagnetism programs in BMR, taking into account the role of BMR defined in the Minister's statement of 25 October 1979, and as described in the ASTEC Review of BMR; and taking into account the possible role in monitoring nuclear explosions.

The ASTEC report unfortunately did not contain a discussion on BMR's activities in the fields of earthquake seismology and geomagnetism. However, as the report did not contain specific recommendations to change the status quo in this area we infer that the Council must have been satisfied with the continuation of these activities within BMR.

There is a clear need for observatory-type operations in Australia. On the international scale Australia occupies, and therefore is responsibile for, the geophysics of, a large area of the globe. If a country is not to have a poor reputation in the scientific community someone must undertake the responsibilities of recording and reporting good quality data for international requirements.

Within Australia there is a need for seismological and geomagnetic facilities and expertise for national, regional, and local requirements. Because earthquakes and geomagnetic fields know no political boundaries it makes sense for one national organisation within the Federal Government to assume overall responsibility for this work.

We do not believe it is appropriate for a university to carry out this work because of the ongoing nature of the regular recording and data processing; furthermore it would seem to contradict their primary roles of teaching, producing post-graduate theses, and carrying out research in short and medium-term projects. State Governments have restricted areas of responsibility, and private companies would find difficulties in producing something saleable and would be unlikely to have back-up resources or accept an indefinite future commitment.

The question, therefore, is which Federal organisation should carry out this work. We examined four possible options - CSIRO, Department of Science and Technology, BMR, or a new organisation.

CSIRO is mainly concerned with short to medium term research projects, usually initiated by or having strong connections with industry. The long-term operation of geophysical observatories does not fit into this role.

The Antarctic Division, the Bureau of Meteorology, and the Ionospheric Prediction Service operate within the Department of Science and Technology (DOST). But none of these organisations have strong links with the earth sciences and we cannot find any advantage in a transfer of observatory operations to DOST.

BMR is designated as 'a geoscientific research organisation' and although its main efforts are towards the development of our mineral and energy resources, its role is to develop an integrated, comprehensive, scientific understanding of the geology of the Australian continent, the Australian offshore area and the Australian Antarctic Territory ...' and 'to be the primary national source of geoscience data and to publish and provide information'.

BMR has developed the expertise and facilities for geomagnetic and seismological operations and though these operations contribute little to mineral search, 'the primary national source of geoscience data' clearly includes the geomagnetic and seismology operations. The Federal Government also recognises BMR's role in these fields, and matters relating to the detection of underground nuclear explosions and earthquake risk are always referred to BMR. Clearly, the nuclear explosion monitoring role, which is closely linked to global seismology, should rest in the Federal sphere.

We therefore conclude that: BMR is the appropriate government organisation in Australia to undertake activities in the fields of earthquake seismology and geomagnetism, particularly where these activities meet national and international needs. There is no need to establish another organisation.

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In reviewing the objectives of BMR's program in these fields we recommend that the objectives of the Geomagnetism and Seismology Sub-Section should be as follows:

(i) Seismology - to provide and publish information on seismic waves from near and distant earthquakes and explosions, as a contribution to global seismology, to study the tectonic implications of earthquakes, particularly those in the Australian region, and to assess earthquake risk throughout the Australian continent.

R2

(ii) Geomagnetism - to provide and publish information on the Earth's magnetic field throughout the Australian region, including its territories and offshore, to provide geomagnetic reference standards at international level, and to study regional and local features of the Earth's internal field, particularly with relation to the overall structure of the continent.

These objectives are similar to the present objectives outlined earlier and which we believe to be satisfactory. However, we feel that the objectives have not been fully realised because primarily of three factors.

1. Understaffing

The work program has been severely overloaded in recent years because of falling staff ceilings and the consequent inability of the Sub-Section to recruit into vacant positions. At the same time the work load has grown as a result of BMR's involvement in the monitoring of nuclear explosions for the Department of Foreign Affairs and the increase in requests for data and information (see Appendix 2). As a result the technical support has not been adequately provided, so professional officers have not been able to escape the routine data processing and frequent deadlines for data. Thus, short term requests and data processing have been undertaken at the expense of worthwhile medium and long-term research programs. One result of this policy has been the abandonment of the strong-ground-motion analysis program.

2. Emphasis on data

The dominance of data processing has pervaded the whole Sub-Section to the extent that the main structural units in the Geomagnetism and Seismology Sub-section come under such titles as: Reductions and Data Group, Canberra Observatory Operations Group, Technical Support Group, Mundaring Observatory Operations Group, and Special Projects Group (which consists of one person plus the Antarctic Program). We believe that to strengthen the effectiveness of the group it should be organised along disciplinary lines so that expertise in the disciplines of geomagnetism and seismology can be properly fostered and researchers can interact closely with the data collection processes.

We believe that the two groups would be large enough to be self-sustaining.

Although it may be necessary at some levels for officers to be familiar with and able to perform each other's basic tasks, we feel that specialisation in geomagnetism and seismology is necessary if the studies are to advance; if everybody can do everything at all levels there is a danger of mediocrity. We believe that specialist expertise is almost essential and hence recommend a disciplinary organisation.

3. Scientific leadership

While there has been a worthwhile publication record in recent years (see Appendix 1) we feel that much more should and could be achieved. There is enormous scope in both geomagnetism and seismology for exciting and important research, but without top quality leadership and proper encouragement the data being recorded will not be put to the best use and the important problems in these disciplines will not be tackled.

We believe there should be a two-fold approach, (1) to encourage programs of research for present staff and (2) to recruit highly qualified staff from outside BMR, so that the scientific capability of the group can be significantly enhanced.

R3 We therefore recommend that the Sub-section should be adequately staffed so that it can be organised on disciplinary lines and so that more emphasis can be given to research and publication.

2.2 The value of the earthquake seismology program and staff expertise as an adjunct to possible short-term projects of study of crustal structure ('COCORP' type studies)

The earthquake seismology program can contribute to crustal structure studies in a broad way through analysis of travel-time residuals at various stations and by studying aftershock sequences to identify active faults.

However, we see these programs as of secondary importance to the main COCORP type studies which are undertaken using mobile field recorders and digital exploration-type reflection seismic equipment in conjunction with controlled sources of seismic waves.

2.3 The nature, cost to BMR (1980 cost basis), and manpower requirements of program, including a network of stations/observatories designed to achieve these objectives over the next five years

(i) Seismology. We assume that BMR has two major roles to play in earthquake seismology. The first is to co-ordinate Australia's commitment to global seismology. Australia occupies a unique position in the southern hemisphere and the data recorded by several of the Australian seismographs are vital to international studies of earthquakes and large explosions. The Australian responsibility in this field is largely borne by BMR.

The second and perhaps more important role is to carry out research on the earthquakes that occur in the Australian region. This work is important in studies to develop an integrated, comprehensive scientific understanding of the geology of the Australian continent. It is also required for accurate estimation of earthquake risk throughout the continent and for studies of the possibility of forecasting earthquakes in regions of comparatively high risk.

In order to achieve these aims we recommend that a national seismograph network should be developed to provide the capability for:

(1) locating continent-wide all Australian earthquakes with magnitudes greater than 4.0 on the Richter Scale (to locate an earthquake reliably, it must have been recorded at three stations);

(2) locating all earthquakes with magnitudes greater than 3.0 on the Richter Scale in the continent's most seismically active and populous areas, viz.: eastern Australia including Melbourne, Canberra, Sydney, and the region north of Brisbane; southeastern Australia (including Adelaide) and southwestern Australia (including Perth), and

R4

(3) detecting continent-wide, all earthquakes with magnitudes greater than 3.0 on the Richter Scale.

Figure (3) shows the present distribution of seismograph stations and the capability for locating earthquakes of magnitude ML greater than 4.0 if all stations are operating. These stations are made up of the following permanent stations not presently funded by BMR: BRS, CAN, KNA and the South Australian network station HKN. To complete the coverage, stations are required near Mount Morgan and Coen in Queensland.

To locate earthquakes of magnitude ML > 3.0 in the seismically active and populous areas of the continent it is not necessary for all the South Australian, Tasmanian and ANU network stations to remain operational (see Fig. 4). These networks were set up to study local features in greater detail than BMR would require for the national objective of locating all earthquakes with magnitudes ML > 3.0 in the seismically active populous areas. In order to achieve this objective, only the following stations would be required in addition to the major permanent stations at BRS, CTA, ADE, TAU, WRA and KNA:

HKN, PNA, CLV and WKA (Adelaide University)

SVR and SAV (University of Tasmania)

YOU, DRT and CAN (ANU)

We do not regard any of the Preston Institute of Technology stations as necessary for this purpose.

To complete the coverage of the ML > 3.0 earthquakes in the seismically active populous areas additional stations will be required as follows:

Queensland	Mount Morgan, Roma, Aramac
NSW	Nyngan
WA	Kellerberrin, Wongan Hills, Northampton and Albany.

In order to complete the coverage of the continent so that all earthquakes with ML > 3.0 are detected, new stations are needed near Halls Creek and Forrest in Western Australia and Quilpie in Queensland.

Figures 3 and 4 show the current location and detection capabilities and the proposed capabilities if the new stations mentioned above are installed.

We therefore recommend that: the operation of the seismograph stations at Brisbane (BRS) and Charters Towers (CTA) in Queensland; Savage River (SVR), Savannah (SAV) and Tasmania University (TAU) in Tasmania; Dartmouth (DRT), Canberra (CAN), Young (YOU) and Riverview (RIV) in the ACT, Victoria and New South Wales and; Adelaide (ADE), Cleve (CLV), Hawksnest (HKN), Partacoona (PNA) and Willalooka (WKA) in South Australia be supported financially by BMR. The level of support should be restricted to the operation of these stations. BMR should be provided with the basic data recorded at the stations it supports.

R5

Furthermore we recommend that within the next five years new stations should be installed near Mount Morgan, Roma, Aramac, Quilpie and Coen in Queensland; Nyngan in New South Wales and; Halls Creek, Northampton, Albany, Kellerberrin, Forrest and Wongan Hills in Western Australia. These stations should be operated either by BMR or in the case of the Queensland stations under a co-operative arrangement with the University of Queensland.

R6

We have not ranked these new stations in an order of priority but Mount Morgan, Roma, Kellerberrin, Wongan Hills and Nyngan would appear to have higher priority than the others.

Costs. The cost of operating seismograph stations varies from station to station. Charters Towers for example has a very high operating cost. It is a sophisticated nine-component station which uses photographic recording and necessitates the employment of a full-time technical officer to maintain the station. Thus the total operating cost is probably at least $15 000 per year. In contrast the operating cost of each of the ANU stations is only about $4000 per year.

On a State by State basis we estimate that the costs to BMR of operating the existing non-BMR stations for which we recommend BMR support, are as follows:

Tasmania:	SVR, SAV, TAU ($4k, $4k, $11k) $19 000
Queensland:	CTA ($15k), BRS ($5k) $20 000
New South Wales:	DRT, CAN & YOU ($4k each) RIV ($6k) $18 000
South Australia:	HKN, PNA, WKA, CLV, ($4k each), ADE ($11k) $27 000

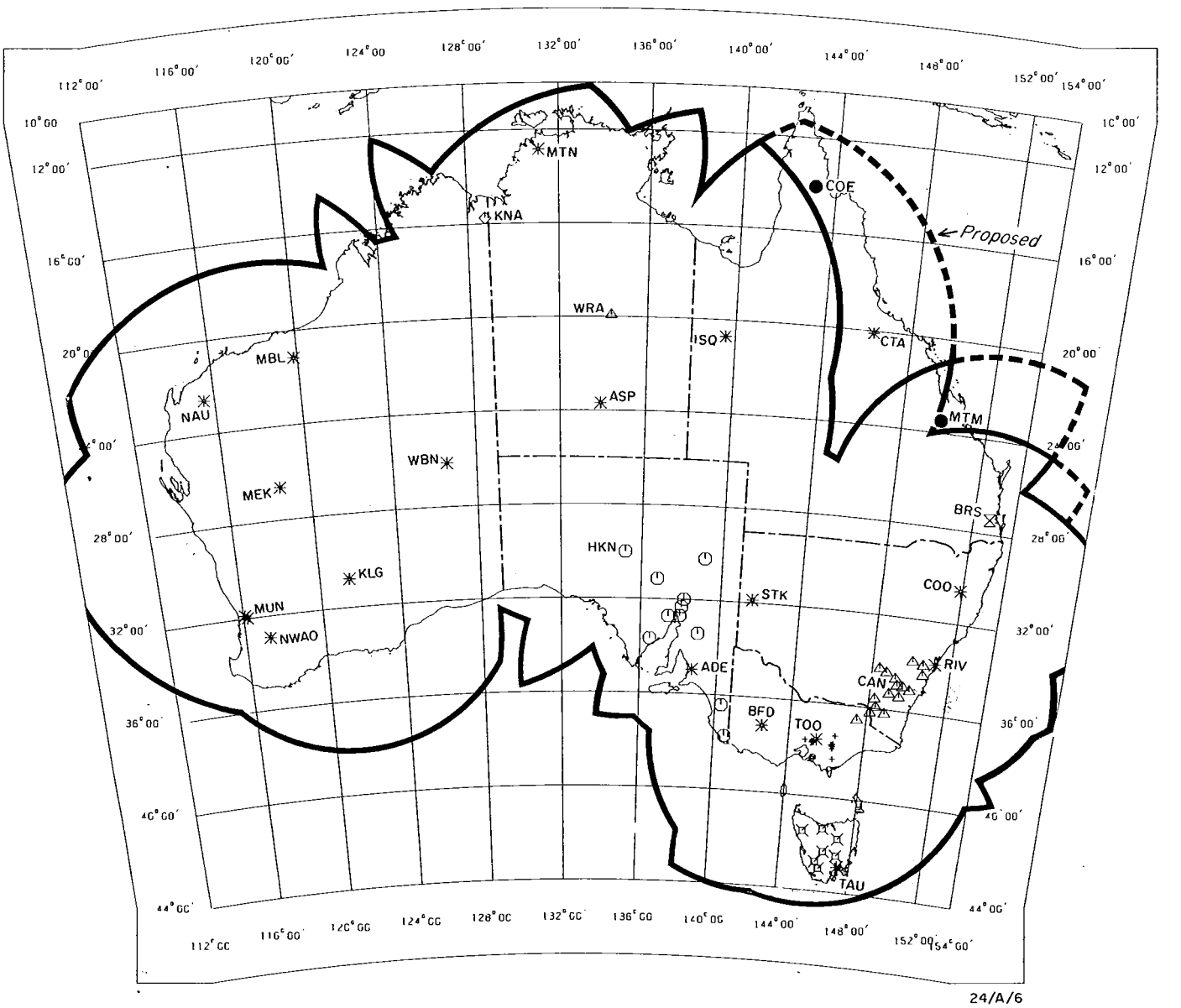
These costs, based on current methods of recording seismograms, would amount to an increase of about $36 000 above the current level per year of expenditure in the contract vote(see page 11), and would not involve any additional BMR staff.

The cost of installing and operating the proposed new stations is difficult to estimate but if Queensland University pays for the equipment at Mount Morgan and Aramac the cost to BMR in terms of plant and equipment would be about 8 x $15 000 (assuming that the equipment for Kellerberrin and Wongan Hills is already available, and that Queensland University do not contribute for the other Queensland stations) i.e. $120 000 and the operational costs, at about $5000 per station could be $60 000 per year. We believe that BMR should pay for the capital cost of new stations that are part of the national network.

We have not been able to make a thorough evaluation of the extra staff positions required to meet the extra work load to cope with the 12 new stations but we believe that an extra TA2 at Mundaring and another in Canberra would easily be able to handle the extra analysis and an additional extra TO (Engineering) in Canberra to operate proposed new stations.*

AUSTRALIA

SCALE 1:30000000 EDITION OF 1980/12/04



AUSTRALIAN NATIONAL SPHEROID
SIMPLE CONICAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 18°00′ AND 36°00′ SOUTH

AUSTRALIA

Fig. 3 EARTHQUAKE LOCATION CAPABILITY, ML≥4, 1980 NETWORK

● Stations proposed to complete coverage

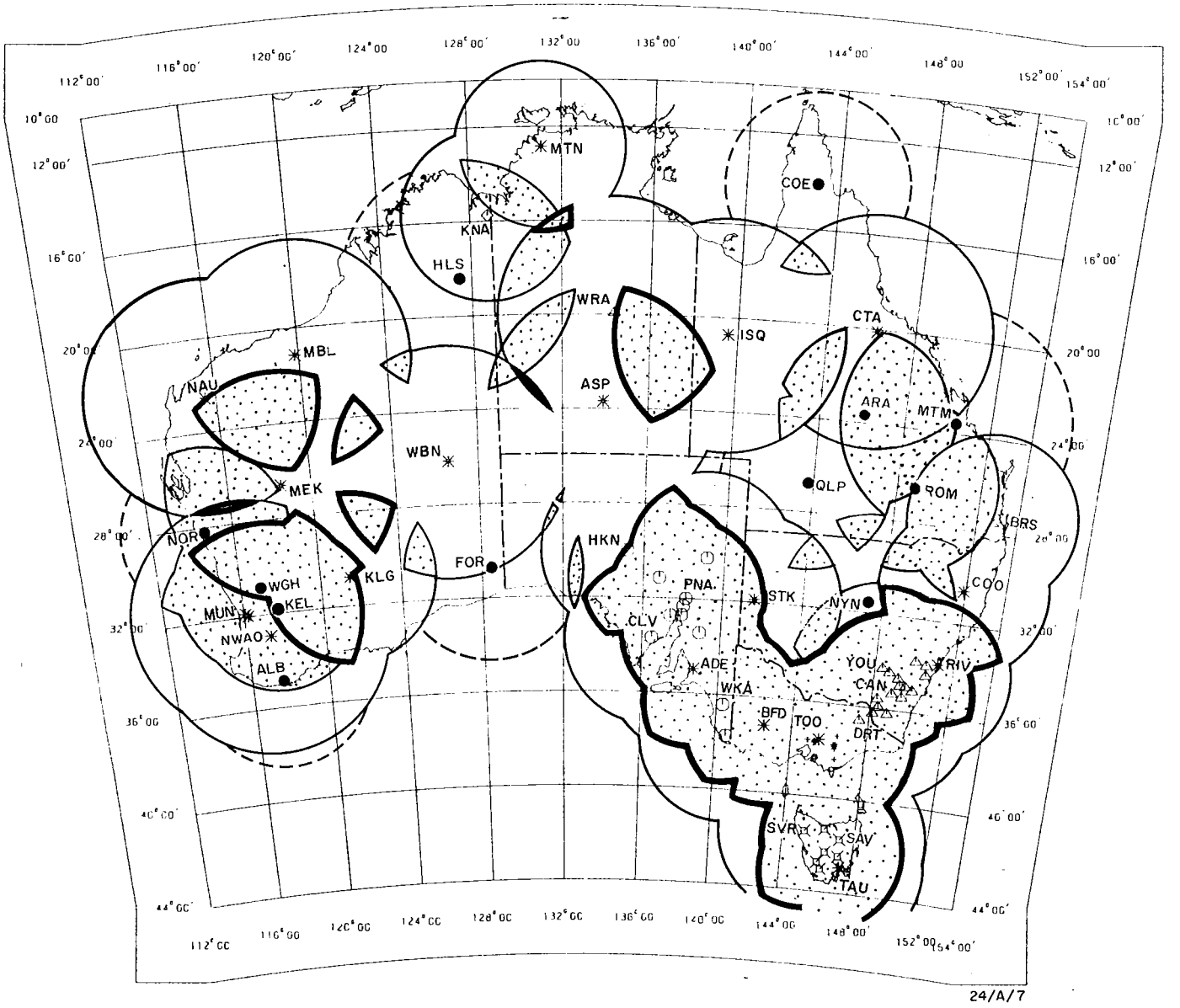
✳ Stations operated by BMR or jointly with another organization.

Stations operated by Adelaide University, Australian National University, University of Tasmania, Preston Institute of Technology, University of Queensland and W.A. Public Works Dept.

AUSTRALIA

SCALE 1:30000000

EDITION OF 1980/12/04



AUSTRALIAN NATIONAL SPHEROID
SIMPLE CONICAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 18°00′ AND 36°00′ SOUTH

AUSTRALIA

Fig. 4 EARTHQUAKE LOCATION CAPABILITY, ML ≥3, 1980 NETWORK

● Stations proposed to improve coverage Coverage Proposed coverage

✳ Stations operated by BMR or jointly with another organization.

Stations operated by Adelaide University, Australian National University, University of Tasmania, Preston Institute of Technology, University of Queensland and W.A. Public Works Dept.

Record No 1981/15

* This analysis is based on expanding the current network using technology already in operation. Using recently available digital technology with Australia-wide digital data links the total additional costs would be roughly the same.

(ii) Geomagnetism. As BMR is the only institution in Australia monitoring the Earth's magnetic field there is no problem in interacting with other institutions. The problem is rather one of setting an appropriate level of input by BMR to meet our national requirements and to fulfil our current objectives.

By overseas standards the Australian region is poorly equipped with magnetic observatories, e.g. in North America there is one observatory for every one million sq. km whereas in Australia there is only one every six million sq. km. However, Australia's small and generally sparse population, and large distances between centres, limit the number of sites where observatories can conveniently be operated. Furthermore the local needs for magnetic information are similarly smaller because of the smaller client market.

We would therefore follow the arguments of P. McGregor (BMR Journal of Australian Geology & Geophysics, 4, 1979, 361-371) in his paper on Australian magnetic observatories:

> "Overseas densities will be unachievable until there are dramatic advances in the development of highly stable, low-powered automatic observatories which will utilise satellite data transmissions and allow quasi-unmanned operation.
>
> In these circumstances the design of the network should take into account:
>
> . The scale of the features to be described. Isoporic cells may have dimensions of only one or two thousand kilometres, so this suggests that measurements are needed farther apart than about 500 km. The BMR first-order stations have this average spacing.
>
> . The area over which a station's recordings are representative. This depends mainly on the nature of the external (ionospheric and magnetospheric), and the internal (induction) components of the more rapid transient variations. In the Australian region, the focus of the solar quiet day (Sq) ionospheric current system crosses about the middle of the continent (dip latitude is a controlling factor in the Sq system, at least in middle latitudes, and the average focal path appears to follow dip latitude 40°S (Matsushita, 1967, fig. 7a): this runs from Grafton to Carnarvon). Hence variations in F and H are reversed in northern and southern Australia, and the present (southern) observator-

ies cannot provide information for northern Australia. Moreover the path of the focus is highly variable from day to day, e.g. McGregor (1966b) showed that Watheroo lies to the north of the focus about 30 percent of the time. The internal induced component of external fields gives significant effects near the coasts (Parkinson, 1961). Experience gained by BMR during a first-order regional survey in 1973 underlined the futility of attempting to apply measurements made near the cost to data recorded inland.

. The time-scale of secular changes. Observatory data clearly show that rates can alter quite sharply over a short time-interval, and ideally data should be produced continuously. It is equally clear that it is impracticable to operate 40 or more present-day observatories; but the re-occupation of 60 first-order stations more frequently than every five years is a costly venture in terms of money and manpower.

Taking these factors into account, most of the immediate deficiencies in the existing network could be overcome by establishing observatories, in order of priority, at or near Alice Springs, Mackay, Onslow, Woomera, and Darwin: they could reduce the number of first-order stations by 30-40 percent"

and we recommend that BMR should aim to operate five more permanent magnetic observatories, near Darwin, Alice Springs, Charters Towers, Marble Bar, and Woomera. The recent advent of compact, digital, stable magnetographs makes it feasible to operate these stations as quasi-unmanned observatories requiring calibration only once every three months.

R7 (a)

At Darwin the magnetic detectors could be housed at the seismographic site, at Charters Towers the present seismic vault site could be used, at Alice Springs the Joint Geological and Geophysical Station could be used and at Marble Bar the same site as is used for the seismic station could be utilised. The Woomera site would have to be investigated.

The installation costs at each station would involve approximately $10 000 for the construction work to house the detector, and about $50 000 for the equipment. Operating costs at each station would arise from a calibration visit every three months and some simple checks by the seismic attendant; overall these would amount to about $5000 per year.

To carry out this additional work load BMR would require an additional ST01 or Science 1.

R7 (b)

The first-order regional magnetic surveys should be continued to determine secular change for the production of magnetic charts.

(iii) Antarctic operations: BMR has a long history of monitoring seismographs and magnetographs in Antarctica (see Introduction). Currently it operates permanent seismographs and magnetographs at Macquarie Island and Mawson and quasi-permanent magnetic observatories at Casey and Davis. In view of BMR's responsibility in the geosciences in the Antarctic we believe that it should continue to operate observatories to record earthquakes and the geomagnetic field, at Mawson and Macquarie Island.

These stations are all important in studies of the secular variation of the Earth's magnetic field and also in observing high latitude magnetic phenonema. We agree with ARPAC that these stations should be upgraded so that the monitoring of geomagnetic phenonema should be properly carried out, and that automatic stations be introduced to reduce the manpower requirements.

This will cost about $50 000 at each of the four bases, with the running costs the same as they are now.

We do not allot a high priority to installation of a seismic station at Davis but there is a strong argument for re-opening a station at Casey (the old Wilkes station had both magnetic and seismic recorders) because of the lack of seismic stations in that region and because it would be a valuable station to provide southern control for large Australian earthquakes and also for those associated with the mid-ocean ridge between Australia and Antarctica. The capital cost could be about $15 000 and the extra running costs would be about $1000 per annum if a scientist already wintering at the base is responsible for the operation of the station.

However, we believe that the installation of this station should be delayed until all the mainland Australian stations have been commissioned.

We therefore recommend that BMR continue to record the Earth's magnetic field at Mawson and Macquarie Island; the stations at Davis and Casey should be upgraded to provide a continuous record of the magnetic field at each station; the seismographs at Mawson and Macquarie Island should continue to be operated; and that eventually a seismograph should be installed at Casey. High priority should be given to the proposals to install automatic recording stations in the Antarctic to reduce the manpower requirements.

R8

(iv) Staffing and funding

From the evidence presented to this inquiry and from our observations of other similar facilities around the world it seems to us clear that the Geomagnetism and Seismology Sub-Section has been understaffed for many years. When one considers that the Americans have budgeted $2.8 million just to

improve their one station at Alice Springs it makes BMR's total budget of about $0.5 million per year, for the whole of the geomagnetic and earthquake seismology program, a very small effort.

We see the need for research scientists to concentrate on research and hence for an increase in the technical support staff to enable the collection, analysis and distribution of data to proceed. Because a continuous data set loses its value when it is interrupted, the Sub-Section has in the past tended to try and ensure the continuation of basic recording and processing at the expense of analysis and research.

For example the strong-ground-motion program has been temporarily abandoned because of staff shortages even though this work has a large component of research and its results are much in demand by the Australian community. We therefore recommend that The Sub-Section be divided into two parts for the purpose of funding and manpower requirements. One part should provide the basic geophysical data and should have secure funding and staffing during a rolling three-year period; the second should compete annually with all other research projects for both staff and funds available within the BMR budget and staff ceiling.

R9

Cost and manpower summary

To fully implement these recommendations the following costs, additional to the $500 000 currently spent per annum by BMR on the Geomagnetism and Seismology Sub-Section, would be incurred over a five-year period.

Seismology	Capital Costs	Operating Costs per year	Additional Staff
Support for existing stations		36 000	nil
Purchase of 8 seismographs at $15 000 each	120 000		1 T02 (E)
Operation of 12 new seismograph stations at $5000 per year		60 000	2 TA2's
	120 000	96 000	
Geomagnetism			
Installation of 5 new geomagnetic observatories (Æ $60 000 each)	300 000		1 Science 1 or ST01 plus 1 T02 (Science)
Operating costs at $5000 per year		25 000	
	300 000	25 000	
Antarctica			
Replacement equipment at Mawson and Macquarie Island	80 000		
New Magnetic recorders at Davis and Casey	100 000	1 000	probabily nil
New seismic station Casey	15 000	1 000	
	295 000	2 000	
Total	$715 000	$123 000	

This table provides the basic requirements to operate the national networks. In addition there should be a research scientist appointed to each discipline plus a research assistant or technical officer (per discipline). We have not costed the salary components for the additional research staff. As an order of magnitude estimate we are probably looking at another $85 000 to the salary vote for the positions in the above table and another $80 000 for the research scientists and their assistants (see page 11 for current costs).

Appendix 1

Publications emanating from BMR using BMR data

1975 - Distribution of underthrust lithospheric slabs and focal mechanisms - Papua New Guinea and Solomon Islands Region, Bull. Aust. Soc. Explor. Geophys., v. 6, no. 2/3, 78-79, Denham, D.

1975 - Australian earthquakes (1897-1972), Search v. 6, no. 1/2, 34-37, Denham, D., Small, G.R., Cleary, J.R., Gregson, P.J., Sutton, D.J., and Underwood, R.

1975 - Large earthquakes in the New Guinea/Solomon Islands area 1873-1972, Tectonophysics, v. 23, 323-338, Everingham, I.B.

1975 - Faulting associated with the major Solomon Sea earthquakes of 14 and 16 July, 1971, J. geol. Soc. Aust., 22, 61-69, Everingham, I.B.

1975 - Papua New Guinea earthquake strong motion recordings, Science in New Guinea, v. 2, 187-9, Gaull, B.A.

1975 - Accelerograph recordings of the Musa River earthquake, 16 September 1971. Bulletin N.Z. Nat. Soc. Earthq. Eng., Gaull, B.A.

1975 - Seismicity and earthquake focal mechanisms in the New Guinea Solomon Islands region. Aust. Soc. Exp. Geophys. Bull., v. 6, 80-1, Ripper, I.D.

1976 - Seismicity and Earthquake Risk in Eastern Australia, BMR-Bulletin, 164, Denham, D.

1976 - The state of stress in the upper part of the Earth's crust in Australia, according to measurements in mines and tunnels from seismic observations. Proc. of ISRM Symposium, Investigations of stress in rock, advances in stress measurement, Sydney. G. Worotnicki (CSIRO) and Denham, D.

1976 - Earthquake Risk in Australia, BMR Journal 1976, vol. 1, 15-21. McEwin, A.J., Underwood, R. and Denham, D.

1976 - Tsunamis in Papua New Guinea, Science in New Guinea, 4(1), 10-20, Everingham, I.B.

1976 - An explanation of water level changes preceding the Meckering earthquake, 14 October 1968. Bull. Seism. Soc. America v. 66, 631-632. Gregson, P.J., Smith, R.S. & McCue, K.R.

1977 - Analysis of the geomagnetic diurnal variation during the International Geophysical Year, BMR Bulletin 173, W.D. Parkinson.

1977 - A catalogue of earthquake focal mechanisms for the Western Pacific and Indonesian regions 1929-1973. Geodynamics International-10, World Data Center A for Solid Earth Geophysics, Denham, D.

1977 - Preliminary catalogue of tsunamis for the New Guinea/Solomon Islands region, 1868-1972 - BMR Report 180, Everingham, I.B.

1977 - Effects of a major earthquake near Bougainville, 20 July 1975, BMR J. of Aust. Geol. & Geophys. 2, 305-10. Everingham, I.B., Gaull, B.A. & Dent, V.

1978 - An analysis of strong motion accelerograms from Yonki, Papua New Guinea, 1967-1972, BMR Report 184, Denham, D.

1978 - Earthquake hazard in Australia, pp. 94-118 in Natural Hazards in Australia, edited by R.C. Heathcote & B.C. Thom, Australian Academy of Science, Denham, D.

1979 - Stresses in the Australian crust - evidence from earthquakes and in-situ stress measurements, BMR J. of Aust. Geol. & Geophys., 4, 289-295, Denham, D., Alexander, L.G. and Worotnicki, G.

1979 - Seismological services of the Australian Bureau of Mineral Resources, Geology and Geophysics. Phys. of the Earth and Planetary Interior, 18, 105-113, McGregor, P.M.

1979 - Implications of fault plane solutions for Australian earthquakes on 4 July 1977, 6 May 1978 and 25 November 1978. BMR J. Aust. Geol. & Geophys, 4, 297-301, Everingham, I.B. & Smith, R.S.

1979 - The effects in Western Australia of a major earthquake in Indonesia on 19 August 1977, BMR J. of Aust. Geol. & Geophys. 4, 135-40, Gregson, P.J., Paull, E.P. & Gaull, B.A.

1979 - Preliminary report on the Cadoux earthquake, Western Australia, 2 June 1979, BMR Report, 215. Gregson, P.J. & Paull, E.P.

1979 - Australian magnetic observatories, BMR J. of Aust. Geol. & Geophys. 4, 361-371. McGregor, P.M.

1980 - The stress field near the sites of the Meckering (1968) and Calingiri (1970) earthquakes, Western Australia, Tectonophysics, 67, 283-317. Denham, D., Alexander, L.G. & Worotnicki, G.

1980 - Earthquakes - BMR Earth Science Atlas of Australia, Denham, D.

1980 - Earthquake accelerograms and attenuation of seismic waves at Oolong, N.S.W., BMR J. of Aust. Geol. & Geophys., 5, 63-67, Smith, R.S. & McEwin, A.J.

Appendix 2

OBSERVATORY DATA REQUESTS - GEOMAGNETISM 1979 - August 1980

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
L. Ingall Wongela	Representative values F & I + susceptibility values (Ph.req).	Jan.	78/1273, 5.
F/O Mayger RAAF Laverton Vic.	Value of D at RAAF Base Laverton 0-1° accuracy (Ph.req)	Feb.	77/659, 60.
Inst. of Earth Physics, Moscow	Preliminary annual mean values of all stations 1978, 14 Magnetograms.	Feb.	77/1422, MR
Paddy Pallin, Sydney	Mag. declinations for capital cities	Feb.	78/1273, 7,8
Mr Fulrio	Kp indices, 9 days, 9 Dec. 77, Jan. 78	March	Corresp.
Inst. of Earth Physics Moscow	Magnetogram copies (26)	March	78/1273
Headquarters	Magnetograms, all 1978	March	78/1273
Prof. K.D. Cole, La Trobe Univ., Bundoora, Vic.	Toolangi Magnetograms Sept & Oct 1978	March	78/1273, 12,14, 10,9
Aust. Survey of Melb. Vic.	Magnetic Variation Chart Epoch '80	March	77/659, 63,62
Dr Polatayko, Flinders Univ. S.A.	Magnetogram copies - Toolangi 24-29/7, 30/11-4/12 1975	April	78/1273, 18,17
Mrs Marion Sloane ANU	Magnetogram microfilms - Dec 1978 and all 1979	April	78/1273, 23.
Dr Briggs Univ. of Adelaide, S.A.	Mag. tape Toolangi + P+ 8 years Moresby - mean hourly values		78/1273, 22,16, 15,11
Mr Jacob - Lamont Doherty Obs. N.Y.	Seismogram copies BFD, STK, Alaskan earthquake 28/2/29	April	80/375, 143,141
Ron Furnass, Naval Hydrographer Office NSW	Details of when 1980 maps avail. (Ph. request)	May	77/659, 61,64
World Data Centre A	Check magnetic storm data, 1979	June	77/659
Mapping & Surveying Qld	Mag. declination Epoch 1980 for Aust.	June	77/659, 65
Prof. R. Green, Univ. New England.	Info. on Herberton observatory and establishing magnetic station at UNE	May	78/381
K. Poynter, Fawkner Vic.	Mag. data and references List of monthly K indices	May	78/1273, 25,20.

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
NSW Univ., Broken Hill Division	Toolangi magnetogram and reduction data - 6-16 March 1979	May	Corresp. 78/1273, 24,21
Mr Cawthorne, Wild Pty Ltd	Calibration of compass theodolite Ph. request	June	R101
Ron Wink Pipeline Authority Young	Magnetograms 6-8 June inc. (Ph. request) & 29-31 May	June	78/1273, 29,28
Miss Finlayson, Swan Hill Vic.	K Indices, May + solar data	June	78/1273, 33,31
Gas & Fuel Co. Melbourne	Copies of Magnetograms 28-29 May 1 June	June	78/1273, 26.
Schlumberger Sasco	Declination Map	July	78/1273
Mr K. Lindworth, Ringwood, Vic.	Data on Toolangi Observatory	August	77/549
Telecom Aust.	Magnetic declination map (Ph. request)	August	77/659, 69,68,67
A. Romana, Observat del Ehro, Spain	Checking lists, Rapid Variations 1978 - Toolangi, Macq. Isle. Mawson	July	77/1422
Univ. of Ad. SA (Dept Physics)	Toolangi secular variation data 1925-78. (Ph. request)	July	78/1273, 34,32
Flinders Univ. SA	Magnetograms Toolangi Vic. 1-15/6/77 - 5-15/7/77	July	78/1273, 35
EDS Boulder Col.	Lists of principal mag. storms Mawson, Mac Isle & Toolangi	July	77/1021.
Dept Mapping & Surveying Qld	Magnetic charts 1980 epoch	August	77/659, 75-70
Wild Leitz (Aust P/L) North Ryde NSW	Tests on compass theodilite index corrections	August	76/921
Dept Science & Environment, Antarctic Div Melbourne	Antarctic isogonic charts 1978 (7 copies)	Sept	77/569, 94,93.
P. Gregson, Mundaring Obs.	13 Aug '79 Magnetogram (Ph. request)	Sept	
Dept Mineral Resources NSW	Magnetic Declination Sydney	Sept	77/569, 96,89,88, 95,90. Also 78/1273 & 77/659 82,76,77
A.J. Wilhelm, Morwell Vic.	Magnetic declination, Morwell area 1879-79	Sept	77/569, 87,91,86, 83,80,79,78

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Mr Downe, Royal Exchange, NSW	Declination chart Aust. region at epoch 1970	August	78/1273, 85,84
L. Gheller, Rockbank, Vic.	Declination changes, long. & lat. re: Explorer Charles Sturt	Oct.	77/659, 103,104, 97-100.
Prof. Cole, LaTrobe Univ.	Functioning of Observatory ADO mag. data - Casey, Wilkes	Oct.	78/1273, 68,66, 64, 62-59.
Univ. Sth Pacific Fiji	Magnetic/Geophysical Equipment	Oct.	78/1018
Antonio Romana Pt Moresby Geoph. Obs.	Magnetograms, April June	Oct.	78/1273, 71,70, 69.
McCarthy, Air Force	Magnetic dip - Darwin, Townsville Perth Sydney (Ph. request) 6 seismograms	Oct.	77/659, 102
Univ. College of Wales, Aberystwyth	Data (magnetograms) Toolangi/Pt Moresby 1970-76	Oct	78/1273, 67,65
EDS, Boulder Col.	MAGSAT: Observatory data - hourly values	Sept	79/762
B. Fitzgerald, Aust. Survey Dept Melb.	Magnetogram 14-16 Nov. & monthly means Aug/ Sept/Oct. (Ph. request)	Nov.	78/1273, 73.
Brian Fraser, Univ. Newcastle	Values D I & F - fireball (Ph. request)	Nov.	78/1273, 72.
Research Inst. for Basin Sciences, S. Korea	Geophysical Observatory Reports	Dec.	74/381
M. Imigneri, BHP Melbourne	Magnetogram Toolangi 13-15/8/79	Dec.	80/376, 53
Director, Div. National Mapping	Magnetic Observations at Heard Isle	Dec.	78/641

1980 OBSERVATORY GEOMAGNETIC DATA REQUESTS

INQUIRY FROM	DATA REQUESTED	MONTH	FILE, FOLIO, # OR OTHER
Surveyor General Brisbane	Magnetic stations/ Epoch charts (1980) BMR Rept 159	January	77/659 105-6
Environmental Data Service (EDS) Boulder Col. U.S.A.	Magnetic tape hourly values Gnangara Sept/Oct/Nov. 1979		79/762
" "	Magnetic tape hourly values Gnangara Dec. '79		79/762
Geophysical Observatory Christchurch NZ	Macquarie Island. Magnetograms & reduction data. All '78; Jan/Mar 79 - monthly means		78/1273 80, 81, 77-78
Univ. Otago, NZ	Magnetograms, Macq. Isle, Sept 73	February	78/1273 # 82
Prof. Cole, La Trobe Univ. Vic	Magnetograms (microfilms) (3) Mawson, Macq. Isle Toolangi		78/1273 83, 79
Hydrographer, R.A.N. Sydney	Magnetic Declination Chart 1980		77/659, 112, 109
Central Mapping Authority BATHURST NSW	Isogenic Chart		77/659, 111, 110
Aerodata Services	Magnetogram copies (6)		80/1190, 140
J. Silke, Goodwood S.A.	Magnetogram Toolangi 5/6 Feb. Mod. Mag. Storm.	March	78/1273
Envtl Data Service Boulder Col. USA	Magnetograms Mawson Sept. 21-22 '79		77/1071
" "	Pt Moresby Sept, Dec '79 Gnangara Jan 80 - May tapes		79/762
Defence Sci & Tech. Org'n	Offshore mag. values - Jervis Bay 1980		80/659, 116, 114 113, 107
Telecom. Brisbane	Mag. charts (phone request)		80/659, 117
RAAF Base, Laverton	Value of D. at Laverton (phone)	March	80/659, 118
La Trobe Uni	2 microfilms - monthly magnetrons		1978/1273, 89,88
Aberfoyle, Expln Co.	Copy Toolangi magnetron 5/6 Feb '80 maps, declination, inclination total field in Aust. for mag. storms		1978/1273, 89,88

INQUIRY FROM	DATA REQUESTED	MONTH	FILE, FOLIO, # OR OTHER
Envtl., Data Services Boulder Col.	Magsat Observatory Data Pt Moresby Jan '80 Gnangara Feb '80.	April	79/762
" "	Mag tape, monthly tabs. Pt Moresby '78		77/1071
Qld Uni	Station Data Atherton tableland 28/4/63		79/376, 1
Director, Kakioka Magnetic Observatory Japan	Magnetic data Mac Isle	May	1978/1273 # 97
E.D.S. Boulder Col.	Mag Tape Gnangara Mar 80 Pt Moresby Feb 80, Canberra Sept/Oct 79.		79/762
Dr F. Chamalaun Flinders Uni	Values for magnetic station Parafield		77/659, 119 Also 78/1273
Lands & Surveys (Perth)	Declination map		80/1190, 153
E.D.S. Col.	Data on stations Davis & Casey - regular absolute values for secular change Modellers		78/1273 93, 92
" "	Mcq. Isl. magnetogram, Mar 10/79	June	78/1273
" "	Hourly values Gnangara, April/March, Canberra, Nov-Feb - Mag tape		79/762
Ionosphenic Prediction Monthly Service DARLINGHURST	K-indices Mawson		78/1273
Watil Broadcasting Commission of PNG	Magnetic inclination/ declination S.W. Pacific	June	77/659 # 122,121,120
Pipeline Authority	Toolangi Magnetograms 6-10/6/80		79/1273
Dept. Forestry Brisbane	Magnetic declination Chart '80.		77/659
Geosearch Pty./Ltd.	Magnetogram copies (8)		80/1190, 157
Govt Observatory Sydney	Magnetic Data, Syd. region 1980	July	77/659 128, 123
E.D.S. Boulder Col.	Mean hourly values, Gnangara May '80, Pt Moresby April '80 Canberra Mar/Ap. 80		79/762
Flinders Uni	Mean hourly values - Jan-April 1980 - Magnetograms		78/1273
E.D.S. Boulder Col.	List Principle magnetic storms Toolangi, Gnangara, Pt Moresby, Mcq. Isle, Mawson 1979		77/1071

INQUIRY FROM	DATA REQUESTED	MONTH	FILE, FOLIO, # OR OTHER
K. Venkatowaman INDIA	K Indices - limits - Toolangi		80/944
E.D.S. Boulder Col.	Mawson Magnetogram 9/2 & 8-9/10/79 and reduction data.		78/1273
W.A. Public Works Dept.	Copy of Magnetic Declination Chart 1980		78/1273, 111 Also 77/659
D of Transport, Canberra	1980 Charts (phone request)		77/659, 126
CRA Adelaide	Declination Charts, north of Cedura (phone request)		77/659, 127
Surveyor General's Office, Adelaide	Isomagnet charts epoch 80		77/659, 130, 129
Central Mapping Authority, NSW Govt	" " " "		" 131, 139
B.P.	D & I charts for Aust/ PNG area	July	77/659, 141, 138
Dept Forestry Qld	Magnetic declination charts 1980		" 142
E.D.S. Boulder Col.	1 tafe hourly values, Gnangara June 80, Pt Moresby May 80, Canberra May & June 80, Macq. Isle magnetograms 29/8/77	August	79/762
Czechoslovak Academy of Science	Daily means of magnetic elements		78/1273

OBSERVATORY DATA REQUESTS - SEISMOLOGY 1979 - August 1980

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Mrs P. Cooper, Hawaii Institute of Geophysics	Mac-Isle Seismogram - short period, 29/11/75	Jan.	80/375, 99.
OIC PMG Obs. Papua New Guinea	ASP & MTN stations - 4 dates Seismogram copies	Jan.	80/375, 97.
Director of Services NSW Ed. Dept, Nrth SYDNEY	Request on Meckering earthquake Prelim. Report etc.	Jan.	77/1740
Daryl Fernance	Earthquake, Goulburn 16 Dec. '78 (Ph. request)	Jan.	Correspondence
EDS Colorado USA	ASP, Toolangi & Man. stations 4,5, 29 Nov. 78	Jan.	80/375, 96 (79/1273, 3)
Mr Doyle, Dept Geol. Univ. WA, Nedlands	5 Seismicity plots. various areas 1:1 million scale	Jan.	80/375, 86-89
Dr Pascal, Univ. Scientific, France	Copy of documents from 1970 'Madang Earthquake Report'	Jan.	74/254
Alan Cristie, Dept Construction	Occurrence Earthuakes - damage CCAE boiler (Ph. request)	Jan.	Correspondence
C. McMahon, Energy, Mines & Resources, Canada	Seismic records (SPZ) Aust-Maw station, several listings	Jan.	80/375, 100,101
Earthquake Inst. Uni. Tokyo	Seismogram copies	Jan.	80/375
Geology Res. Division Uni. Calif.	Seismogram copies	Jan.	80/375
Prof. Adams, Hawaii Inst of Physics, Hawaii	Tsunami along Aust.	Feb.	76/997
Manilla Observatory Philippines	Bagino - result of study 1968	Feb.	74/88
OIC PMG Observatory Papua New Guinea	Rabaul reports Dec. 1953-59	Feb.	77/957
Lamont Doherty Geol. Obs., NY	Seismogram copies (6)	Feb.	80/375
Institute of Physics of the Earth, Strasburg	44 Seismogram copies	Feb.	80/375
J.B. Berrill, Christchurch NZ	Accelerograph results PNG	Jan.	80/375
R. Abell	Plot and list 1900 + All Mag. 35-36°S, 149-150°E	Jan.	80/375

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Mr L. Hicks, Croydon Vic.	Earthquake data Croydon, Sept 1978	March	80/375, 123,124
Pacific Geoscience Centre, Sidney, B.C. Canada	Seismogram copies 1977 (3 days)	March	80/375, 135,118
Seismic Institute Caracas, Venezuela	Caracas earthquake 1900	March	80/375, 117,116
Pt Moresby Obs.	Seismogram copies (7)	March	80/375, 137
EDS Boulder Col.	Seismograms (12)	March	80/375, 139
Californian Inst. of Tech.	Seismogram copies (6)	March	80/375
Aust. Atomic Energy Comm., Sutherland, NSW	Warragamba Tiltmeter - Earthquake records	March	80/375, 140 78/1273, 102
Univ. of Adelaide	Copy of event - station STK 19/12/78	March	80/375, 119.
Mt Lee, Hawthorn, Vic.	Melbourne seismicity - 1 July 31 Dec 1977 (Ph. req)	Feb.	80/375, 114, 113
Mrs Jones, Springvale, Vic.	List of earthquakes, Aust. 75 mag. 0-90°S to 550165°E.	Feb.	80/375, 112-110.
J. Branson	Seismological data	April	80/375
Institute of Physics of the Earth	12 seismogram copies	April	80/375
Insurance companies (various) eg Q.B.E. Sydney	Seismic data	April	80/375, 157
Univ. of Technology, PNG	Earthquake data request 1900-1977	April	80/375, 170,169, 168.
R.S. Merrillees	Bowning Earthquake	March	80/375, 138
Mr L. House Lamont-Doherty Geol. Obs., N.Y.	Copies of seismograms from TOO, BFD & STK for 13 Feb. 1979	March	80/375, 136,134, 133
Sedgwick Forbes Leslie P/L Brisbane	Earthquake risk map etc.		80/375, 132,131
Dr Rynn Univ. Qld	EBF listing 0-10°S, 148-150°E (Ph. request)	March	80/375, 115
Mr Rixon, Leongatha, Vic.	List largest earthquakes 1/12/75-31/1/77 (monthly listings)	March	80/375, 130,129, 123-128
Craig & Whitmore, Mawson, ACT	Earthquake query - Goulburn 16/12/78	March	80/375, 120-122

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
E.D.S. Boulder, Col.	Copies of records - ASP, TOO & MTN. 14 Mar 79, 16/1 & 28/2/1979 + Tsunami data. (6)	April	80/375, 181,180, 144 76/997
Met. Bureau, Melb.	Existence of earth tremor - eastern suburbs 17/4/79 (Ph. request)	April	80/375
Mr Adam, Braidwood, NSW	Earthquake info on Braidwood area	April	80/375, 153,152
Univ. Qld	Copies (100) of blasts 4/4/78 and 10/8/77	April	80/375, 149.
Port Moresby Geoph. Obs, PNG	Can and other seismological data re: Gazelle Peninsula	April	80/375, 155,156, 148,147,146,145
Dept Min. Res. & Dev't Sydney, NSW - Mr Markham	Listing of earthquakes	April	80/375, 142,160
I.B. Everingham	Several plots	April	80/375
OIC Mundaring Obs	Seismogram copies all BMR stations - major earthquake 250 k NW Broome, 23 April	May	80/375
Western Mining Co.	Earthquake risk map	May	80/375
Geological Survey WA	Earthquake risk map	May	80/375
Insurance Co.	MM intensity data	May	80/375
I. Everingham	Seismogram copies for Rowley Shoals earthquake	May	80/375
Lamont Doherty Geolog. survey	Seismogram copies (3)	May	80/375
OIC-PMG Obs	Seismogram copies TOO, CPZ and CAN records	May	80/375, 171
J.O. Zelnder, Santos Ltd	E.Q. risk map for Cooper Basin (Ph. request)	April	80/375, 158
Gary Crowley ANU	gen'l info and references re: seismicity, volcanology (Ph. req)	April	80/375 107
Graham Robilliard Dimet, Melb.	Toolangi seismograms - 29, 30 Mar '79	April	78/1273, 19
Clark & Chapman, Insurance Melbourne	Shock waves 3/12/77	June	80/375 193-195
Pt Moresby Geoph. Observatory Papua New Guinea	plots and lists all earthquakes 1900. All NG 1977.	June	80/375

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
World Data Centre A	Seismogram copies	June	80/375
K. Sundonalingam, PNG	Listing 1900-1977	May	(Corresp) 80/375, 170,169
Dept Min. Resources & Devt, NSW	Earthquake data request 26-31°S & 151-156°E	May	80/375, 179,178.
I.B. Everingham	several plots and lists	May	80/375
E.D.A. Boulder Col.	New Guinea, Solomon Island - tsunamis	May	76/997
David Denham	Lambert Conformal - 30-36°S, 148-152°E.	June	80/375
Mr Withers, Woodward-Clyde Consultant San. Fran. US	Magnetic tape Aust. earthquake data	June	80/375, 189,188
Belcot-Walmsley, Melb.	Earthquake risk map	June	80/375, 186.
Ms Poloski, Parliamentary Library	NW Shelf seismicity Listing 1975-78	June	80/375, 184
Univ. Qld	P & S times loca earth-quakes May 14 STK	June	80/375
I.D. Ripper, Pt Moresby Geoph. Obs	Seismogram copies SPZ & LPZ June 25/'79	July	80/375, 232
Wainwright, Science	Anything on seismograms day Skylab fell ? (Ph. request)	July	80/375, 225
Mr Hansen, Higgins ACT	Earthquake 4 July 1977 epicentre near Bowning/ Boorowa	July	80/375, 216, 197-8, 201
Public Works Dept Perth WA	Earthquake data lists	July	80/375
Pt Moresby Obs	6 seismograms	July	80/375
I.B. Everingham	18 seismograms	July	80/375
Inst. of Physics of the Globe	35 seismograms	July	80/375, 183, 173-175
Dept Lands & Survey Geological Survey	Risk maps	July	80/375
Kim Bell, Kemper Ins. Co.	Details Cadeoux earth-quake (Ph. request)	June	80/375, 206
Mr Colinarv, Higgins ACT	Strathfield seismicity, Sydney Canberra seismo-grams Jan-May '79	June	90/375, 202
Ms Pam Scott, Wilton NSW	Recent seismicity in Picton area	June	80/375, 207, 190

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Shane McGuire, Sydney Daily Mirror	Lane Cove area earth tremors 2/8/79 (Ph. request)	August	80/375, 233
Penhalluriack & Sons Melb, Vic.	Dandenong Earthquake, April 1979	July	80/375, 230,229, 226,222,221,220
J. Ansell, Victoria Univ. of Wellington NZ	Seismogram copies 31/5, 1/6/77 (7 stations)	July	80/375, 223,191
Chris Hudson & Co. ACT	Binalong earth tremor 5/3/79	July	80/375, 215,224
Westwood, Garton & Assoc. Insurance N.T.	Earth tremors Darwin 27/28 May '79 (Ph. request)	July	80/375, 213,187
George Daniels I.P.S.	Earthquakes Aust. region since 31 Dec. 1969. Mag. 77 (Ph. req.)	August	80/375
Mt Withers, Woodward-Clyde Consultant San. Fran., US	Earthquake data Aust- 10-45°S 110-158°E	August	80/375, 245
Dept Nat Dev. Natural Disasters Mitigation Committee	Examine draft - Mitigation of earthquakes, enclose maps, papers, seismicity/seismograph network	August	77/107
Dept Geology Univ. Tas.	Interpret seismograms for TAU station	August	79/502
Industrial Risk Insurers USA	Papers seismicity & explanation of seismic zones	August	80/375, 243
Qld Water Resources Commission	Earthquake data Boondooma Dam area 24-28°S, 149-153°E	August	80/375, 240
CSIRO	All earthquakes 31-33°S, 116-119°E. Scale 1:1 000 000	August	80/375
E.D.F. request	Plot 10-30°S, 137-156°E	August	Corres. 80/375, 235.
Mr Ripper, Pt Moresby Geoph. Observatory	Strong motion analysis - program for reduction of strong motion accelerogram data	Sept	78/1029
Dr Parkinson, Geol. Dept Uni. of Tas, Hobart	TASF results, data and two plots. Isoseismal data	Sept	78/1172 78/1273, 37,37a & MR
Mundaring Obs.	KNA times - Cadeux aftershock 7/6/79 & networks record of event	Sept	79/502

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Calif. Inst of Technology	Seismogram copies (6)	Sept	M.R.
I.D. Ripper, Pt Moresby Geoph. Observatory PNG	Seismograms - copies & originals (9 areas) 107 Seismograms. Original request 17 August	Oct	80/376, 15,14,13, 10. Also monthly reports
Jeff Newell, Bondi	Earthquakes - damage in Sydney (Ph. request)	Oct	" " "
Universite Louis Pasteur, France	Seismogram copies - Darwin, Toolangi, Manton	Oct	" " 20,19, 18,17
R. Goldsmith, Dept Minerals & Energy PNG	Earthquake data PNG	Oct	80/376, 123
Mr Ripper, Pt Moresby Geoph Obs.	Relocations of earthquakes	Sept	80/376, 1-2, 25,24,22
W. Barbour, Utah	Details any potentially damaging earthquakes Ainslie (Ph. request)	Dec.	80/376, 44
B. Fitzgerald, Aust. Survey, Dept Admin.	Copies TOO & Canberra magnetic data 14-16 Oct & Canberra 1979 (Ph. request)	Dec.	78/1273, 74
Snowy Mounts Engineering Corp. Cooma	Earthquake List Sumatra	Nov.	80/376, 32,29,26.
Wellman	4 plots	Nov.	80/376
Everingham	3 listings 3 plots	Nov.	80/376
Austrian Embassy ACT	Advice re: tectonic forces Canberra-past 50 yrs	Nov.	80/376, 40
Des Norris, ANU	Earthquakes plot 3.0- 40S 143.5-145.5° E. 1965-present	Nov.	80/376, 39
Inst. Geolog. Sciences Edinburgh UK	Austrn earthquake risks	Nov.	80/376, 28,27
Alan Maher, U of Qld	1979 COO records, records. (Conversation)	Oct	80/376
Westwood, Garton & Assoc. P/L Darwin	Earth tremors - Darwin 10/10/79-20/11/79	Dec.	80/376, 67,65
E.D.S. Boulder Col.	Seismograms, stations ASP MTN & COO, Earthquake 12/9/79 - West Irian region	Dec.	80/376, 45,34

SEISMOLOGY

INQUIRY BY:	NATURE OF REQUEST	MONTH	FILE, FOLIO, OTHER
Golder & Assoc. W. Perth	W.A. Seismicity plot 20-36°S, 108-118° Mag. 3, 1900-Feb '78	Dec.	80/376, 50,49
R. Obent, C. Deucher & Associates P/L, Melb.	Seismicity list Dec 1977, 34-40S 141-150°E	Dec.	80/376, 48,47
Gammage, Canberra	Details of any damaging quake in area (Ph. request)	Dec.	80/376, 53
Lindner, Sth'n Pacific Petroleum	Earthquakes 150 km inland Qld - Time, intensity, location of Epicentre	Dec.	80/376, 52,51
Geol. Survey of Qld	Copies of COO bulletin 1978/79 (Ph. request)	Dec.	80/376, 46,42

1980 OBSERVATORY SEISMIC DATA REQUESTS

INQUIRY FROM	DATA REQUESTED	MONTH	FILE/FOLIO, # OR OTHER
International Tsunami Centre	1964 Tsunami Sea level fluctuations	January	76/997 also 80/1190 # 140
Observer-in-Charge Geophysical Observatory P.N.G.	Woodlark Basin earthquake epicentres. List Events '59-0-12°S, 130-163°E		79/376 # 56 # 59
Mr Newall North Bondi	Earthquake info-Wiesmans Ferry & Sydney area (phone request)		79/376 # 57
Dr G. Purcaru Frankfurt W.G.	Request for info-earthquakes Indonesia/Aust area		79/376
Univ. West Indies Jamaica	Jamaica Earthquake-seismograms Feb. 26/79		79/376 # 58-60
E. Smilek	All earthquakes 1976-79 around world (Phone request)		79/376 # 55
A. McGinnis Switzerland Gen. Ins. Co.	Any earthquakes Melbourne May '79 (Phone request)		79/376 #62
G. Small	Seismicity printout 28-32°S, 150-154°E (Phone request)		79/376 # 62
R. Hanley	C/- Dept. Def. Russell Any events in Melbourne (Phone request)		79/376 # 64
Dawes & Moore	Listing for M 4.0 for NSW Plot simple conic M 3.00 NSW (Phone request)		79/376 # 70
I.B. Everingham	9 copies of Aust. seismic station listings (Phone request)		79/376 #75 Also M.S.A.
Mal Robinson CSIRO	Info large China earthquake 1976		79/376 # 6
Everingham	4 plots + a listing		80/376
D. King	Original risk data used in zoning maps for Aust.		
Institute of Geological Sciences Edinburgh, UK	Seismology re: British earthquake 26/12/79	February	80/376 # 81,82
State Emergency Service W.A.	List of Australian earthquakes in each State with mag. 4		80/376 80,79,78
Mr Egan	Earthquakes in area, April 1979		80/376, 84,83
Alexander Gibb & Partners Dulwich S.A.	Seismological info "Earthquake risk map of Aust."		80/376, 91,87

INQUIRY FROM	DATA REQUESTED	MONTH	FILE/FOLIO, # OR OTHER
ANARE	Details quake McQ Isle. MM6 7/2/80 (Phone request)		80/376, 93
Insuran e Sydney	Earthquake damage Sydney August 2, '79 (Phone request)		79/367, 97
Kevin McCue Port Moresby	Accelerograph constants - Oolong for 4/7/79 (phone)		79/367, 98
French National Centre for expl'n oceans	Seismogram copies (5)		80/1190, 140
D.S.I.R., NZ	" " (1)		" "
Stanfor Uni	" " (2)		" "
D. Denham	1:100 000 plot Dalton/ Gunning area		80/376
Everingham	Ref. seismicity map of Aust. 1 x 10^7.		80/376
(E.D.S. Nat'l Geophysical & Solar-Terrestrial Data Centre (TGSTDC) Boulder Col.	Seismograms, 15 Oct-12 Dec.'79 ASP, COO & MTN Stations	March	80/316
Dept H & C, Mr Edwards	List Events Macq Isle		80/376, 96,95
B.H.P.	Plot of earthquakes, 21-23°S, 125-128°E 1:250 000 (Canning Basin)		80/376, 100, 103
Gregson, BUMIN	Earthquake listings for 7 areas (W.A.)		80/376, 101,102
McDougal) Univad Sutton)	Seismogram (2) A.S.P. 9/2/80 S.T.K. 3/3/80		80/376, 107,108
I. Mumme AAEC, PMB Sutherland NSW	Magnitude scales		80/376, 121-115
Finlayson	Plots of NSW earthquakes	April	80/376
Beca, Carter, Hollings & Ferner	Magnetic tape of PNG		80/376, 134, 129
Everingham	Earthquake map of Aust. 1:10 000 000		M.S.A.
McCue	P.N.G. 1960-63 list of earthquakes		(April-May) 80/376, 134
Swan Resources Ltd	Plot of earthquakes of Aust. at 1:2 500 000 scale at different projections, depth, magnitudes		80/376, 132, 123

INQUIRY FROM	DATA REQUESTED	MONTH	FILE/FOLIO, # OR OTHER
University, Adelaide	Seismograms Eyre Peninsula 15/4/80		1978/378, 141
Dept H & C	Co-ordinate earthquakes at Macq Isle - couple months before	May	correspondence
Mrs Luke	Existence of earthquakes at Rooky Hill 12-13/4/80.		78/376, 138,137
Irian Jaya Mapping Project	Earthquake data	May	78/376
University, Adelaide	Seismogram - Simpson Desert event 1/4/80 ASP station		80/376, 142
Mr Mason, West Perth	3 Seismicity plots		80/376
Bec Carter, Hollings & Femer Ltd NZ.	PNG earthquake study M in lat 0-12°S, 138-163°E		80/376
RSES ANU (Prof. K. Lambeck)	Earthquake listing 39-42°S-142-160°E		80/376, 135
Dept. Communications Jakarta	P-arrival-time-readings for earthquake 16/4/80 8 Stations		80/376, 143
Insurance Co	Earthquake listings 1978-79		80/1190, 153
BHABHA Atomic Research Centre	Seismogram copies (4)		" "
Lamont Observatory	" " (3)		" "
Finlayson	North Lachlan fold belt, seismicity plots		" "
Dept. Min. Res. Sydney	Earthquake listings 35-37°S 149-151°E, 1900-1978 - Deep Ck, Sth Batemans Bay	June	80/376, 147
McDougall, University of Adelaide	Seismogram 1/5/80 STK event. Seismogram WA event 3/6 ASP		80/367 153,152
Ken Muirhead	Earthquake list Kimberley WA 76-79		80/376, 140
Everingham	Simple conic plot to eliminate explosions from affecting plots	June	80/376
D. Denham	List of earthquakes, Mag. 3.5-8-44°S; 108-107°E		80/376
Dept H & C	Negative of '78 Earthquake risk map Aust.		80/376, 146
C. Allen Mt Stromlo	Assistance with updating article		80/376, 145,144

INQUIRY FROM	DATA REQUESTED	MONTH	FILE/FOLIO, # OR OTHER
Lumney & Co	List of Publications on W.A. seismicity		80/1190, 157
Californian Institute of Technology	Seismogram copies (6)		" "
McDonald Insurance Co.	Earthquake lists 1979		" "
Kunming Seismological Brigate	Seismogram copies (20)		" "
Miss Robe, Potts Pub. NSW	Likelihood Tsunamis/ earthquake Aust.	July	76/997
Dept. Scientific & Industrial Research NZ	Seismogram, Melbourne Bay (Hawke) 2/2/31, prelim. analysis		80/376 # 150, 149
Geophysics Observatory Pt Moresby	Copies N.G./Solomon Islands seismicity rept.		" "
Messrs Treloun & Simpson	Earth tremours - Benalla 17/3/79 & 20/5/79		80/376
AAEC Research Establishment Sutherland NSW	Earthquake risk Darwin, data on 'quake 29/10/74, Tennant Ck., Alice Springs		80/376
Gibb & Partners	Earthquake risk Aust. - printout expected 50 yrs acceleration, velocity & intensity.		80/376
USA Embassy	Details Eyre Peninsular 15/4/80	July	80/376
Dept H & C	Earthquakes magnitude w/i 300 k of 2 sites - Canberra & Sydney		80/376 # 154
Geological Survey of Qld	Earthquake data - list & plot Qld		80/376, 155 Also M.S.A. Aug
Earthquake Research Inst. Japan	Seismogram copies (12)		80/1190, 161
Mr Allen, Dept Mines, Brisbane	Seismograms 6/4/80 & bulletins of readings Jan/Feb 1980	August	80/376
Preston Inst. of Technology	Listing of all events (12-44°S - 108-156°E) mag.		80/376 Also Aug M.S.A.
Hanards Assoc. of Aust. Sydney	Newspaper & BMR photos & postcards - Cadoux damage		80/376
L. Alexander CSIRO, Applied Geomechanics	Cadoux after shocks - radius 100 Km 13/6/79-4/8/		80/376, 167

INQUIRY FROM	DATA REQUESTED	MONTH	FILE/FOLIO, # OR OTHER
Everingham	Aust'n seismicity plots		80/376
Denham	S.E. Aust'n seismicity plot		80/376
Dept H & C	Addition to previous request for mag. 2.1-4		80/376

GLOSSARY

hypocentre : the place within the Earth where the earthquake originates.

magnitude : the magnitude of an earthquake relates to the energy released, and is determined from the amplitude and period of the seismic waves recorded at seismograph stations at different points of the Earth's surface. The magnitude varies logarithmically with the amplitude of the earthquake recorded by the seismograph. This means that every time the magnitude goes up by one unit the amplitude of the ground motion increases 10 times.

The best known scale for measuring magnitudes is the Richter Scale which was devised by Charles Richter for Californian earthquakes. A shock of magnitude 2 is the smallest normally felt by human beings, and earthquakes of magnitude 5 and above can cause serious damage if they are shallow and close to habitation.

phase data : the arrival times and amplitude of earthquake phases, such as the P-waves or S-waves, as recorded at a seismograph station.