

1988/40-2
c.3



BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

No 88/40



BMR SUBMISSION TO

1988 REVIEW OF BMR

PART II

RESTRICTED DISTRIBUTION

BMR COMP
1988/40-2
c.3

The information contained in this report has been obtained by the Bureau of Mineral Resources, Geology and Geophysics as part of the policy of the Australian Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director.

BMR SUBMISSION TO 1988 REVIEW OF BMR

	<u>PAGE</u>
PART I CORPORATE SUBMISSION	
1. Summary	1
2. General statement on role	
(a) Overview of BMR role, program and costs	8
(b) Importance of the role	17
(c) Relations with other organisations	31
(d) Appropriate level of activity	35
3. Program formulation	45
4. Organisational Structure and Staffing	52
5. Operating and management procedures	64
6. Overseas programs	69
7. Cost Recovery	72
PART II BMR PROGRAM: CURRENT AND FUTURE	
1. The research function	
A. Division of Continental Geology	3
B. Division of Marine Geosciences and Petroleum Geology	34
C. Division of Petrology and Geochemistry	53
D. Division of Geophysics	79
E. Engineering Support	122
2. The resource assessment function	123
3. The database function	148



BMR SUBMISSION TO 1988 REVIEW OF BMR

PART II: BMR PROGRAM - CURRENT AND FUTURE

In this section of the submission BMR's program is reviewed in terms of its main elements, the Components. For each component current objectives, products, quality and relevance, and strategic plans are discussed. Detailed comments are also provided on opportunities for cost recovery.

This is done in the context of the divisional structure of BMR. Comments are also made on possible improvements in the carriage of the program by the Divisions.

Table 1 provides a list of Components with Divisional responsibilities.

The most significant conclusions and recommendations have been incorporated in Part I of this Submission.

DPIE SUBPROGRAM 3.1 NATIONAL GEOSCIENCE RESEARCH AND RESOURCE ASSESSMENT

FOSSIL FUELS AND MINERALS RESEARCH

Component	110 Controls on Fossil Fuels Occurrence	Cont
Component	120 Onshore Sedimentary Basins	Cont
Component	130 Offshore Sedimentary Basins	Marine
Component	140 Overseas Basins	Marine
Component	150 Mineral Province Studies	P&G
Component	160 Regolith, Related Resources and Remote Sensing	P&G
Component	170 Regional Structure and Tectonics	P&G
Component	180 Geophysical Mapping - Continental and Offshore	Geoph

GROUNDWATER RESEARCH AND ASSESSMENT

Component	210 Basin Hydrogeology	Cont
-----------	------------------------	------

NATIONAL GEOPHYSICAL OBSERVATORIES AND ANTARCTIC SURVEYS

Component	310 Earthquake and Volcanic Hazards	Geoph
Component	320 Monitoring of Nuclear Explosions	Geoph
Component	330 Geomagnetism	Geoph
Component	340 Antarctic Onshore Surveys	Geoph
Component	350 Antarctic Offshore Basins	Marine

PETROLEUM AND MINERALS RESOURCE ASSESSMENT

Component	410 Petroleum Resource Assessment and Availability	RAD
Component	420 Mineral Resource Assessment and Availability	RAD

NATIONAL GEOSCIENCE DATABASES

Component	510 Databases Coordination, Research & Operations	RAD
Component	520 Geoscience Maps, Cartography and Image Processing	GPIB

BMR MANAGEMENT AND INFORMATION

Component	610 Geoscience Management & Coordination	GPIB
Component	620 Publications	GPIB
Component	630 Library	GPIB
Component	640 Resources Management and Services	RMB
Component	650 International Agreements and Project Coordination	GPIB
Component	660 Information and Museum	GPIB

Divisions and Branches

Resource Assessment Division (RAD)
 Division of Continental Geology (Cont)
 Division of Marine Geosciences and Petroleum Geology (Marine)
 Division of Petrology and Geochemistry (P&G)
 Division of Geophysics (Geoph)
 Geoscience Planning and Information Branch (GPIB)
 Resource Management Branch (RMB)

1A DIVISION OF CONTINENTAL GEOLOGY

CURRENT FUNCTIONS

The Division of Continental Geology has as its function, to-

"Study sedimentary basins and systems which may host fossil fuels and groundwater; study the characteristics and origin of fossil fuels; study low-temperature (including geobiological) processes associated with hydrocarbons in sedimentary basins through the study of the modern and ancient depositional systems; undertake palaeontological studies as an aid to dating and correlating sedimentary sequences; and carry out hydrogeological studies of basins as an aid to groundwater assessment and the mitigation of groundwater-related salinisation problems."

(Functions of the Division of Continental Geology, BMR Yearbook, 1987).

These functions require the Division to -

Investigate onshore sedimentary basins and sedimentary sequences; carry out Australia-wide investigations of those sequences and of their economically significant resources (fossil fuels and related sedimentary minerals and groundwater) in order to

- establish the optimum environment for resource exploration in Australia's onshore sedimentary basins.
- provide the best possible basis for the assessment of onshore sedimentary resources.
- provide technical advice on environmental matters in sedimentary basins particularly those related to groundwater.
- assess the extent of the nation's groundwater resources.

ORGANISATIONAL ARRANGEMENTS

The Division pursues its existing program through two closely co-ordinated components concerned primarily with investigations directly relevant to fossil fuels (and related sedimentary minerals) and one concerned with groundwater. The rationale for the linking of fossil fuels and groundwater in the one Division is that both programs are underpinned by basin analysis and use many of the same skills and techniques such as sedimentology, palaeontology and geochemistry. In addition, an understanding of reservoir rocks, caprocks etc, and their geometry, is essential to an understanding of fluids in basins, whether those fluids are oil or water.

In all Components, the Division, of necessity carries out its investigations in a multi-disciplinary mode. In addition seismic input is provided through the Division of Petrology and Geochemistry. There is some interaction with RAD in the area of assessment of undiscovered resources.

FOSSIL FUELS (AND RELATED SEDIMENTARY MINERALS)**Current Program**

Component 9110 : Controls on fossil fuels occurrence incorporates a variety of integrated palaeogeographic, sedimentological, biochronological and geochemical studies aimed at understanding the occurrence, distribution and nature of petroleum source rocks and reservoirs and sedimentary mineral resources on an Australia-wide basis. For example 160 draft maps for 70 Phanerozoic biostratigraphic intervals depicting the Australia-wide distribution of sedimentary environments, sedimentary thickness, tectonic frameworks etc, have been compiled (9111.01). These enable the relationships of palaeoenvironment to petroleum occurrences to be demonstrated, and predicted. Chronological support is being provided in the form of annotated biochronological charts (9111.03). These charts summarise the status of current Australian biostratigraphical schemes from all available fossil groups, and relate them to other aspects of dating in stratigraphy, for example geochronology and magnetic polarity dating. They are a valuable tool for BMR and industry projects in sedimentary basins.

Studies of Cambrian sedimentary phosphate deposits (phosphorites) and associated hydrocarbon source rocks in the Georgina Basin (9111.04) aim to produce a regional synthesis of phosphogenic events occurring in successive intervals of Middle Cambrian time using recently - obtained geochemical, sedimentological and palaeontological information. Resultant maps plotted chronologically and palaeogeographically (9111.02) will have considerable relevance for exploration in the Georgina Basin and elsewhere.

A study of non-marine source rocks and oils (9112.01) has provided new insights into assessment procedures for non-marine source rocks, controls on source rock occurrence in non-marine sequences, and maturity level for generation of non-marine oils. Petroleum geochemical research (9112.04) is now shifting to systematic studies of the character and biomarker composition of source rocks as a function of age and depositional environment in both marine and non-marine sequences. This will aid exploration and assessment of undiscovered resources in such sequences.

Reconnaissance studies of modern analogues of ancient petroleum systems (9112.03) including modern fluvial and lacustrine environments, have been commenced in the Margaret River (Western Australia) and Barmah Forest-Cumbang Swamp (Murray Basin) areas to assess their suitability to provide modern analogues for non-marine facies in the Eastern Australian Basins.

Component 9120 (Onshore sedimentary basins) covers a major part of the work of the Division of Continental Geology. As it is a staff-intensive exercise, it is only possible to undertake a limited number of basin projects at any one time. At the present time one project is at the writing-up stage, two are in the final stages of field activity and two are being planned and preliminary work underway.

Basin analysis is pursued as a multidisciplinary activity requiring the combined input of sedimentologists, palaeontologists, structural geologists and organic geochemists from within the Division. These activities are coordinated with the geophysical activities of other Divisions.

The present basin analysis projects were initiated in 1983 following discussions with BMR and with industry. They represent a mix of frontier areas (McArthur Basin) and areas where there has been a significant level of activity but where there is believed to be scope for a new look in order to encourage further exploration (Amadeus and Clarence-Moreton Basin)

The McArthur Basin project (9120.01) has been highly successful both scientifically and in encouraging new exploration interest. Most effort is now devoted to writing up results.

The Amadeus Project (9120.02) is now in its final stages and is showing the results of detailed sedimentological and biochronological studies that complement the studies of the history of extensional and compressional events already established in the basin. Detailed sedimentological studies have resulted in a much better understanding of the main petroleum source rock units in the basin. Together these studies have led to an increase of interest in the Basin by exploration companies.

The Clarence-Moreton Basin project (9120.03) is also moving to completion. Significant progress has been made in rationalising stratigraphic nomenclature problems and sedimentological studies have contributed to a better understanding of the basin. Results of source rock and maturation studies have significantly upgraded its petroleum potential, and made it into a more attractive petroleum exploration target.

As these projects move to completion, two new projects are being initiated. Planning has commenced for an investigation of the stratigraphic and sedimentological evolution of the Canning Basin (9120.04) as a companion project to studies of structure and Mississippi Valley Type lead-zinc deposits in the basin being undertaken by other Divisions. A proposed Eastern Australian Basins project (9120.05) will build on the knowledge obtained from the Clarence-Moreton project to better understand the evolution of the basins in the surrounding area namely the Gunnedah, southern Bowen and eastern Surat Basins.

Products from the Current Fossil Fuels Program

The results of studies carried out within the Division are made available through a wide variety of products including traditional BMR outlets (Records, maps, Bulletins, BMR Journal), in outside journals, by means of papers at conferences, symposia/workshops, and by means of 'new' products (eg special map folios). From time to time articles have been published in the popular press. Digital data sets will shortly be available.

Early release of information is normally achieved through presentation of results at scientific meetings. The BMR Symposium is a particularly valuable form for the early release of information to industry. In the case of conferences convened by particular disciplines, or by special interest groups, information can be conveyed to a target audience in a highly effective way. A good example is MURRAY BASIN 88, held in May 1988, in which scientists, policy makers, and members of the rural industry and general public came together to discuss the problems of Murray Basin salinity and groundwater, and possible solutions.

The palaeogeographic map series, of which the first maps have just been published, is another way in which very large sets of data have been integrated and synthesised, and presented in a form which will be of great value to many petroleum and mineral exploration companies. A steady flow of such maps is expected over the next few years.

The output of the main components/subcomponents in which the Division is active, is given below and covers the years 1983-88. In summary the output of the Division over that 5 year period is:

Maps 1:10 million (published)	13
(in press)	140
Maps 1:5 million	1
Maps 1:1 million	3
Charts (mainly stratigraphic) (published)	20 (est)
(in press/in prep)	50 (est)
Publications in scientific journals	180
Publications in advanced stage of prep	30 (est)
Articles in newspapers, newsletters etc.	20-30 (est)

Products from Subcomponent 9111

The concept for the Palaeogeographic map project was developed during 1983. The project was viewed as a high priority project but given the level of resources available at that time, it was concluded that it would take at least 6 years to complete. It was therefore decided to seek support from industry to speed up the project. Funding from sponsoring companies began in 1984. The first stage of the project was largely completed by 1987, and a steady flow of maps and charts has flowed to sponsors from as early as 1984. In all a total of 160 maps have now been made available to sponsors in draft form. In addition, a series of geochemical data bases have also been provided to sponsors. Material is now becoming available to the public including several papers (APEA, PESA, Conference proceedings, IGCP) and most recently an atlas of Cambrian maps, the precursor to nine other folio's of this type. Digital data sets derived from this project will also be released to companies over the next 1-2 years.

Project 9111.03 (Chronology of sedimentary sequences) has since 1986 had as its focus the production of a set of chronological charts for the Phanerozoic: preliminary versions of these were produced in 1985-1987: final products, are anticipated in 1989. A review of progress was presented at the 9th AGC in 1988. These charts have been made available to APIRA sponsoring companies in draft form since 1986. The production of a chronological scheme for Australia has been supported by many scientific papers - an average of some fifteen published papers per year.

Project 9111.04 - (PHOSREP), an international research effort into Australia's phosphate deposits, coordinated by BMR, was inaugurated in 1986, and during that year a major symposium in Canberra, and a field excursion to the Georgina Basin Phosphate deposits, were convened. A major book and many research papers have been published since 1986, and a final synthesis of achievements of the project is to be presented in September 1988 at the final meeting of IGCP Project 156.

Products from Subcomponent 9120 - Basin Analysis

The Roper Project (9120.01) results were first made available in 1984, and again in 1985 after field work and drilling. In 1986 much industry interest was generated by conference presentations to APEA and AAPG. The release of the NERDDC report in 1987, within a year of completion of field studies, saw the bulk of new data and interpretations made available to industry and the public. A series of papers, based on the material in the report to NERDDC, has been or will be published, and will form the main scientific syntheses of results from the project.

The Amadeus Basin Project (9120.02) products have included many conference presentations and papers in scientific journals, and at present a BMR bulletin is in preparation. This will bring together summary papers on virtually all aspects of the basin, and will provide an invaluable handbook for all future exploration or studies. A folio of maps at 1:1,000,000 scale is also being prepared. This will incorporate much material interpreted from company seismic surveys, and will be highly relevant to companies involved in exploration. Both a bulletin and map folio are planned to be produced during 1989. Digital data sets will also become progressively available.

The first results of the Clarence-Moreton Basin Project (1920.03) were available publicly in the year the project commenced (1984).

Dissemination of the results has continued and results made available to company personnel. Large parts of the basin are held under petroleum exploration licence and whilst not all the results of the basin synthesis are available to the companies, some of the more important conclusions such as the encouraging petroleum source rock studies have been conveyed to them. A 1:1 million folio will be published on the project, and digital data sets will be made available.

PRODUCTS FROM THE DIVISION OF CONTINENTAL GEOLOGY1983-1988

COMPONENT	1983	1984	1985	1986	1987
9111	2 papers at A.G.C. 14 published papers	21 papers 2 BMR records Reports to sponsors (9111.01)	12 papers Cambrian and Cainozoic time charts	Papers at 2 major conferences. 20 papers and 1 book Triassic, Cainozoic, and part of Jurassic to sponsors	15 papers 3 BMR records
9112		5 conference papers 1 published paper	1 conference paper 1 paper 1 report to company	2 conferences 2 papers 1 report to company	3 conferences 3 papers
9120	projects initiated mid-year	3 conference papers 1 drilling Record BMR Research Newsletter	3 papers 2 BMR Records BMR Newsletter Articles & numerous press reports on 'world's oldest oil'	5 conference papers 2 BMR Records 7 papers in journals 2 excursion guides (12th IAS Conference)	3 conference papers 1 Record 1 special report (NERDDC) 4 papers in journals
9210	2 progress reports to Coordinating Committee 1 BMR Report 7 Conference papers 3 journal papers	2 progress reports 2 conference papers 1 journal paper	1 progress report 1:1,000,000 map - Murray Basin Geology (prelim.) 1 BMR Record 2 conference papers 1 BMR report	6 conference papers 2 conference excursions 5 journal papers	6 records 9 conference papers 2 journal papers 1 map (Hydrogeology, Ayers Rock sheet)

Cost Recovery from the Current Onshore Fossil Fuels Program

At the present time a level of cost recovery in the fossil fuels areas is achieved by sale of products such as map folios and BMR bulletins. However in addition, and perhaps more importantly, a significant level of financial assistance is provided by industry through the Australian Petroleum Industry Research Association (APIRA). Through this arrangement 10-15 exploration companies each contribute approximately \$15,000 a year to enhance BMR's core program in palaeogeography. A total of approximately \$750,000 will be provided over the six years 1984-1987 and 1988-1991. Under this arrangement the sponsoring companies have early access to data but the net result is that the entire community gains because the data becomes available to them too, earlier than would have otherwise have been possible from BMR resources alone. The published products from this arrangement are sold at normal cost (ie. using the AGPS formula), however it is planned in the future to make digital data tapes available to non-sponsoring companies at relatively high cost. Additionally it is proposed to release basin folio's. The first of these, for the Amadeus Basin is currently in preparation. Again, whilst the cost of the published version will be kept at a level to encourage exploration, digital data tapes will also be made available but at a relatively high cost that will give a measure of cost recovery.

Relevance and Quality of the Current Onshore Fossil Fuels Program

There is strong evidence of "relevance" of the "products" of the Division of Continental Geology as far as the petroleum exploration industry is concerned, as indicated by

- . The number of papers accepted by prestigious journals and at major meetings that are specifically for the exploration industry including AAPG, PESA, APEA and the World Petroleum Congress.

- . The extent to which the advice of officers is sought by the exploration industry in basin studies, palaeogeography, biostratigraphy, and geochemistry.

The extent to which the exploration industry is prepared to support (through funding and other forms of assistance) the efforts of the Division, notably APIRA funding for palaeogeography, provision of seismic data etc. (at no cost) to onshore basin analysis projects, provision of unique samples for organic geochemistry.

The extent to which increased exploration and company activity can be related to BMR projects, or extensive use of BMR data used in those activities in the McArthur Basin (new explorations leases taken out following BMR's work), in the Clarence-Moreton and Eromanga Basins (application of geochemical results obtained by BMR), and in the Murray Basin (in the search for mineral sands).

The quality of the science undertaken by the members of the Division is evident from the recognition accorded to their work by their scientific peers within Australia and overseas. Tangible indications of this include

Recent invitations to give lectures, such as the PESA Distinguished Lecture tour, the World Petroleum Congress, Houston, the Anton Bruun Memorial Lecture, Paris and many other national and international conferences.

Requests to referee proposals for funding agencies such as the ARC, NSF (USA), NERC (UK), and Fulbright Awards.

Appointments to prominent roles in national and international scientific bodies such as IUGS, UNESCO, IGCP, stratigraphic sub-commissions, international research groups (such as PPRG) and the Academy of Sciences.

Requests to edit books, prepare papers.

The large number of Australian and overseas geoscientists wishing to spend sabbaticals etc. participating in BMR onshore basin analysis projects

The large number of papers accepted by prestigious international journals and national and international conferences including a "Best Paper Award" by the Geochemical Society.

Future Onshore Fossil Fuels Program

The objectives of a future strategic onshore fossil fuels program by BMR must be to:

- . Provide the optimum environment for resource exploration (particularly for fossil fuels) in Australia's onshore sedimentary basins through the provision of geoscientific data, play concepts and exploration models.
- . Provide the basis for a reliable assessment of the nation's undiscovered fossil fuel (and related sedimentary mineral) resources.
- . Whilst pursuing a long term strategic program, retain the flexibility and expertise to react to short term needs to assess the sedimentary resources of areas where public land use issues arise.
- . Contribute to the development of a comprehensive database of the nation's mineral and energy resources, in sedimentary basins.

For the most part, these aims are and will continue to be met through broadscale basin analysis accompanied by both detailed and Australia-wide studies. BMR must retain this ability to carry out investigations at all scales and collect and disseminate data, keeping in mind relevance and quality.

Future Organisational Arrangements

At the present time onshore sedimentary basin studies concerned with fossil fuels are undertaken primarily by the Division of Continental Geology, with seismic and geochronology studies by the Division of Petrology and Geochemistry, palaeomagnetic and aeromagnetic studies by the Division of Geophysics and assessment of undiscovered fossil fuel resources by the Resource Assessment Division. Whilst all of these current activities are coordinated it is recognised that there is a need to bring these activities even more closely together. It is proposed to do this by focussing onshore sedimentary basin activities primarily within one Division and strengthening the links with the Resource

Assessment Division. This will require that resource assessment staff are directly involved in onshore basin studies and conversely research staff in undiscovered resource assessment activities in those same basins. This will be achieved through closer integration of the activities of the two Divisions.

It is also proposed to relocate part of the seismic group within the Division of Continental Geology in order to achieve the maximum level of co-ordination between the sedimentologists etc and the seismologists. Similarly, some members of the aeromagnetic (after completion of the current program) and palaeomagnetic groups would be relocated within the Division.

At this stage it is proposed to retain 3 components within the Division, however it is considered desirable to modify the responsibilities of the components somewhat in order to place petroleum and source rock studies, together with modern sediment studies, within the basin analysis component to ensure the optimum level of integration between basin studies and related studies (Fig. 1). Where possible, basin analysis would be pursued in cooperation with the States in order to ensure there is no duplication of effort, and that uniform data bases for sedimentary basin are developed cooperatively by the States and the Commonwealth (this is already being done for the Murray-Darling Basin, for example as part of the groundwater program).

Future Program

At the present time 2 to 3 fossil fuel-related basin analysis projects are underway at any one time and complete analysis of a large sedimentary basin using current financial and staffing resources can take from 3 to 5 years. Given that there are approximately 40 onshore sedimentary basins (Fig 2), the complete analysis of all of Australia's onshore sedimentary basins by BMR is not practicable with current resources, within a reasonable period of time (say, by the year 2000). Nevertheless a long term strategic program that will ultimately lead to a better understanding of all of Australia's onshore sedimentary basins is necessary within a reasonable time frame. At the same time it must be recognised that assessment of undiscovered resources is ongoing as our knowledge increases, and techniques improve. Also if basin studies are

ADMINISTRATIVE ARRANGEMENTS
DIVISION OF CONTINENTAL GEOLOGY

Fig 1

DIRECTOR
RWR RUTLAND

CHIEF
PJ COOK

9111
JH SHERGOLD

9112
9120
TG POWELL

9210
MR WALTER

- 01 PJ COOK
- 02 EM TRUSWELL
- 03 EM TRUSWELL
- 04 JH SHERGOLD
- 05 JH SHERGOLD

- 03 RV BURNE
- 04 RE SUMMONS
- 02 RJ KORSCH
- 03 AT WELLS
- 04 MJ JACKSON
- 05 RJ KORSCH
- 06 MR WALTER

- 01 WR EVANS
- 02 MA HABERMEHL
- 03 G JACOBSON
- 04 G JACOBSON
- 05 RS ABELL

ADMINISTRATIVE UNIT

16.

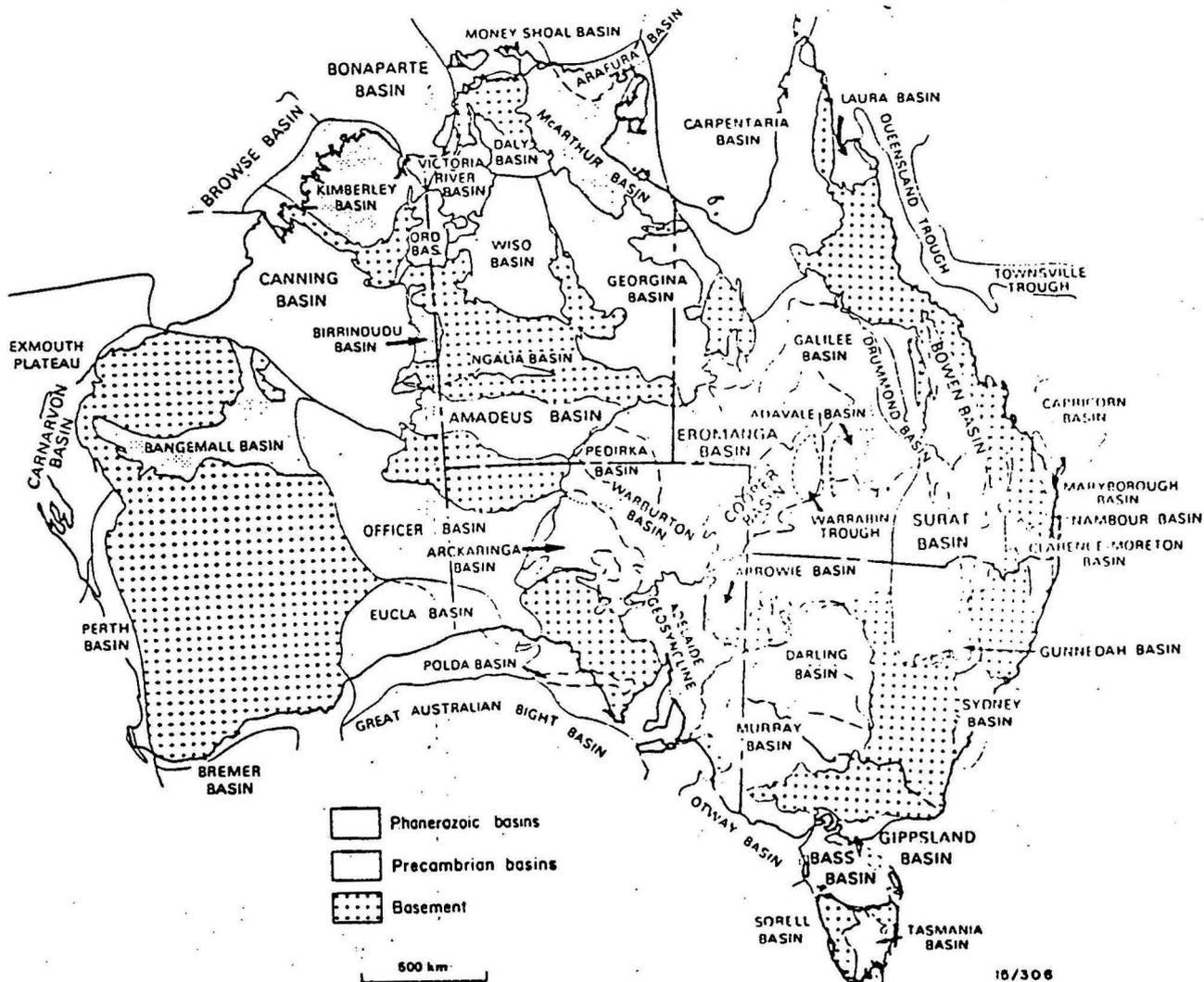


Fig. 2. Australia's sedimentary basins. 'Basement' denotes regions generally unprospective for petroleum - mainly areas underlain by crystalline rocks or by tightly folded or metamorphosed strata. The dashed lines are boundaries of concealed basins; locally relationships are complex, e.g. the Galilee Basin overlies the Adavale Basin and underlies the Eromanga Basin.

to be prioritised then there is a need for a national organisation such as BMR to be concerned not only with highly prospective basins but also with basins that may appear to have a low prospectivity. There is also a need to guard against establishing a program that could result in very detailed knowledge in one small area and little or no information in adjacent areas. A "patchwork" of knowledge of uneven geographic spread might provide only a limited improvement in our total knowledge of Australia's onshore sedimentary basins and their undiscovered resources.

Bearing all these constraints in mind, the proposed strategy is to undertake a program that will incorporate the solution of specific problems and detailed basin studies with continent-wide and regional studies, with a view to developing an improved understanding of all of Australia's onshore sedimentary basins and their resources by the year 2000. Whilst it is not possible to study all of the onshore basins in great detail, it is possible to group basins on the basis of their age, geography etc. Thus a group of basins could be considered as a unit. The regional geological events that occur throughout the unit can be considered as a whole, but need to be supplemented by detailed studies of particular basins in order to resolve problems of prospectivity. However, it would not be necessary to complete an in-depth and time consuming investigation of every basin in turn (Fig.3).

The major basin types could, for example, be grouped as

Cratonic Basins

eg. Canning, Amadeus, Officer, Ngalia, Georgina, Daly, Arrowie, McArthur (these are mainly of Proterozoic-early Palaeozoic age and are characterised by extensive shallow marine sedimentation)

Eastern Australian Basins

eg. Surat, Bowen, Eromanga, Clarence-Moreton, Sydney, Gunnedah (these are mainly of Late Palaeozoic-Mesozoic age and are characterised by extensive non-marine sedimentation).

Marginal Basins

eg. Carnarvon(?), Perth, Eucla, Otway, Gippsland (these are mainly of late Mesozoic-Tertiary age and are characterised by mixed marine-marginal marine-continental sequences).

NATIONAL PRIORITIES

- ENCOURAGE RESOURCE EXPLORATION
- ASSESSMENT OF UNDISCOVERED RESOURCES
- CONTRIBUTE TO PUBLIC LAND ACCESS ISSUES

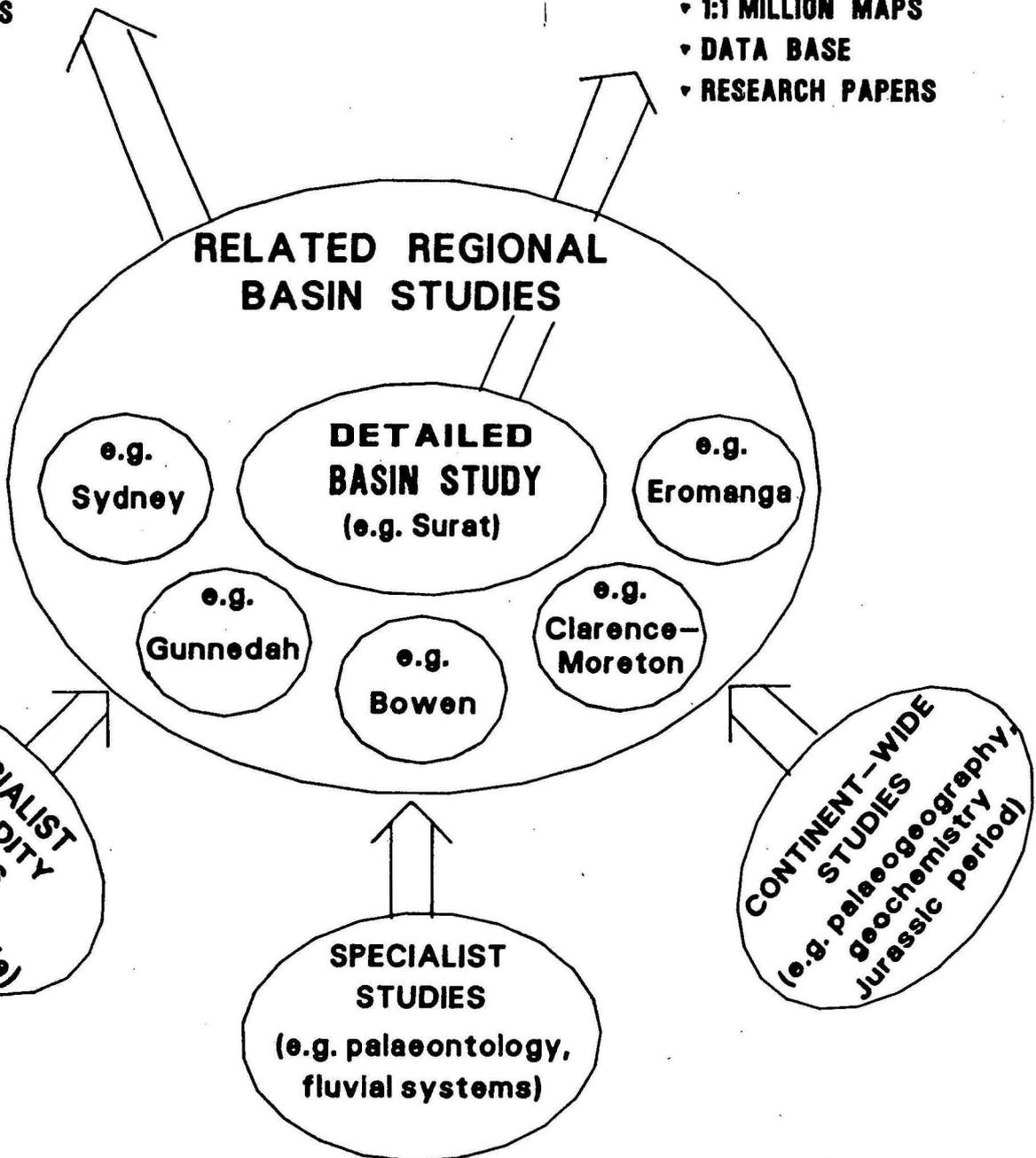


REGIONAL

- APPLICATION OF "TYPE" BASIN MODELS
- REGIONAL ASSESSMENT OF UNDISCOVERED RESOURCES
- 1:1 MILLION MAPS (?)
- DATA BASES

DETAILED

- BASIN FOLIO
- BASIN MODELS
- EXPLORATION MODELS
- BASIN ASSESSMENT OF UNDISCOVERED RESOURCES
- 1:1 MILLION MAPS
- DATA BASE
- RESEARCH PAPERS



There have been widespread geological events of great resource significance which affected many contemporaneous sedimentary basins. Consequently it is necessary to undertake Australia-wide studies of these particular periods in order to more effectively extrapolate models, play concepts and resource assessment from relatively well-known basins to poorly known basins. Further, there are common patterns in the mode of occurrence of particular commodities. Therefore there is also a need to undertake studies of particular resources, (such as potash or coal), or of particular sediment types that may host oil or gas (such as fluvial sands) and a consequent need to maintain in-house expertise on those topics.

Therefore, the objectives of fostering exploration in Australia's onshore sedimentary basins and comprehensively assessing undiscovered resources may be most effectively pursued through

- . Detailed basin analysis of specific examples of sedimentary basins for use as a yardstick
 - less detailed investigations of other similar basins utilising models obtained from detailed basin studies
- . This would be accompanied by Australia-wide studies of
 - particular geological periods of resource significance.
 - palaeogeography
- . Specialist investigations based on
 - commodity (hydrocarbons, coal, oil shales, potash, etc.)
 - geological features of particular significance to oil generation, migration or entrapment (eg. fluvial sands, reefal carbonates)
 - palaeontological or geochemical studies.

However it is stressed that these various types of investigations are necessarily pursued in a coordinated manner, and that commonly the same people would be involved with all three facets. For instance, detailed basin studies and Australia-wide palaeogeographic studies are dependent on time controls which is provided largely through palaeontology. Because of the knowledge and expertise likely to be built up through such a scheme it should be possible for BMR to respond promptly and authoritatively to land use issues as and when they arise in any onshore sedimentary basins.

Future Program: Current Level of Resources

A potential scheme for onshore sedimentary basin investigations, the products resulting from those investigations and the relation of investigation and products to national priorities is shown in figure 3. Assuming

- . the cooperation of State Geological Surveys
- . coordination with State geological programs
- . the current level of resources continues to be available to BMR

then the following forward program is proposed:

1989-1994**Cratonic Basins**

- . Canning Basin analysis (detailed)
 - related regional studies (Bonaparte, Carnarvon(?), Officer, Amadeus, Ngalia, Arrowie, Adelaide (?)).

East Australian Basins

- . Surat Basin analysis (detailed)
 - related regional studies (Gunnedah, Sydney, Clarence-Moreton, Bowen).

1994-2000**Cratonic Basin**

- . Georgina Basin analysis (detailed: much research already done)
 - related regional studies (Wiso, Daly, Lander, Ord, sub-Georgina)
- . McArthur Basin analysis (already completed detailed study)
 - related regional studies (Victoria River, Birrindudu, Bangemall; and sub-Georgina).

East Australian Basins

- . Central Eromanga basin analysis (detailed)
 - related regional studies (Cooper, Pedirka, Galilee, Drummond, Adavale, Darling(?)).

Future Program: Additional Resources

The current level of onshore activity related to fossil fuels (and sedimentary minerals) is not at an optimum level given the rate at which identified petroleum resources are being depleted. Whilst the conventional wisdom is that future onshore discoveries are unlikely to have a major impact on total oil production, this cannot be allowed to dominate exploration strategy and thus become a self-fulfilling prophesy. Additionally the economic impact of a major find of potash for example in one of the onshore sedimentary basins must not be underestimated (the potash industry in Canada generates income worth hundreds of millions of dollars each year). The provision of additional resources would make it possible to not only undertake the previously outlined forward program, but also further studies directly relevant to resource exploration.

It is considered that in order to attain the optimum level of activity there is a need for a 30% increase in resources available for studies of onshore sedimentary basins. This would allow activity not only in the basins outlined above but also in other basins such as -

Cratonic (?) Basin

Warburton Basin analysis (detailed)

- related regional studies (Arckaringa, Pedirka, Adavale).

Detailed studies in the Bonaparte and Wiso Basins

Marginal Basins

Perth Basin (detailed)

- related regional studies (Carnarvon)

Otway Basin (detailed)

- related regional studies (Eucla, Poldia, Gippsland)

Laura Basin analysis (detailed)

- related regional studies (Maryborough, Nambour, Carpentaria?)

GROUNDWATER

Current Program

Component 9210 : Basin hydrogeology covers all of BMR's current groundwater activities. Since BMR's inception it has had a small groundwater program. However in recent years the level of BMR's groundwater activity has been increased both by the internal re-allocation of Bureau resources and the provision of FWRAP funds. Most recently, as part of the May Statement, and the Industry Development Review, there was a further modest increase in resource allocation to BMR's groundwater program. Most of Australia's major groundwater resources and most of the environmental problems related to groundwater occur within sedimentary basins. In addition as oil and gas and water follow the same rules of fluid flow and because many of the same basin analysis skills are required for both fossil fuels or groundwater investigations, the groundwater program is pursued by a multi-disciplinary team within the Division of Continental Geology.

The current groundwater program is based on long term strategic investigations but with short to medium term studies as required. Projects currently underway include.

Murray Basin hydrogeology (9210.01)

- this is the major groundwater project at the present time; approximately 90% of the groundwater budget is devoted to this project.
- the aim of this work is to contribute to the development of salinity management strategies for the Basin.

Great Artesian Basin hydrogeology (9210.02)

- this is an important long term project (the GAB covers almost one-third of the continent) but only limited effort is currently devoted to it
- the GAB contains the nation's largest groundwater resources.

. Amadeus Basin hydrogeology (9210.03)

- this project will be completed within the next few months
- it has provided important insights into arid-zone hydrogeology.

. Australia-wide studies

- continental-wide groundwater compilations
- such as the national assessment of the extent of pollution incidents affecting groundwater (required by AWRC)
 - .. production of an Australia-wide (1:5 million) hydrogeological map (required by AWRC).

Relevance and Quality of the Current Groundwater Program

Evidence of relevance to the groundwater program to national priorities is indicated by

- . The extent to which the advice of BMR is sought by State Water Authorities, the Murray-Darling Basin Commission, the Interstate Committee for the Great Artesian Basin, AWRC, AWRAC, AIDAB, International Bodies (such as UNESCO, IAH and sub committees of the MDB Ministerial Council.
- . The provision of funds by FWRAP, through the May Statement/Industry Development Reviews by industry, and by AIDAB.
- . The general community interest in BMR's work, particularly in the Murray Darling and Great Artesian Basins in media interviews and articles, through the number of people (170) from the water industry community groups and state authorities attending the Murray Basin 88 Conference in Canberra earlier this year, and in the many requests to present lectures on groundwater and salinity to user and community groups in the Murray Basin.

The degree to which hydrogeological work by BMR assists with practical problems such as the extent to which the Roxby Downs developments will affect the groundwater resources of the GAB and their impact on the environmentally sensitive mound springs.

The extent to which salinisation can be related to groundwater in the Murray Basin including the likely rate of salinisation in the future, the recognition of areas under threat from future salinisation if water tables continue to rise at their present rate; the extent to which there can be conjunctive use of groundwater and surface water to overcome some of the Basin's problems; the identification of previously-unknown resources of fresh groundwater; and the likely impact of broad scale vegetation changes (eg. clearing of the Mallee in western NSW) on groundwater and salinisation in the basin.

Evidence of the quality of BMR's groundwater program is indicated by, for example,

The extent which members of the BMR hydrogeology group are asked to referee research proposals to AWRAC and similar bodies

Appointments to national and international groundwater bodies (eg. International Association of Hydrogeologists)

The number of requests to give lectures or write papers

The readiness with which outstanding international scientists spend extended periods with BMR to participate in hydrogeological studies

Products from Component 9210

A special series of Groundwater Records, within the BMR Record series, was initiated in 1986 in order to disseminate results as quickly as possible. These are particularly directed to field practitioners in groundwater. 14 Groundwater Records have been published in the past 18 months.

A 1:1,000,000 scale map showing shallow groundwater salinity of the Murray Basin was published during 1988, within one year of its initiation and a major effort has just started in order to produce 28 groundwater maps covering the Murray Basin at 1:250,000 scale. In addition, 6 maps covering the Darling Basin will be produced within 6 years.

A large number of studies have been reported in both published and unpublished papers, and communicated at Australian and overseas conferences. Many articles have appeared in newspapers and magazines, based on press releases, interviews and scientific papers on the basin. Specific mention of such papers has also been made in the Commonwealth of Australia Hansard (House of Representatives).

Cost Recovery

It would be totally inappropriate to seek a high level of cost recovery from the current groundwater program. A primary objective of the program is to contribute to the development of salinity management options for the Murray Basin. Salinity is currently costing communities within or adjacent to the Basin in excess of \$100 million per annum. It would be impractical to cost BMR's groundwater program to these communities or the individual user. Cost recovery comes from the net savings to the nation not from charging Murray Basin users who are already severely disadvantaged by the problems of the Basin.

Even in the sale of products, BMR must balance the need to set the price of the products such as a map or a report against the far greater economical advantage accruing to the country as a whole if the individual users can be persuaded to change his use of surface or groundwater through developing an appreciation of the problems affecting the basin as a whole.

Future Groundwater Program

More than 70% of the Australian continent together with much of inland agriculture and most inland industry (particularly mining) is wholly dependent on groundwater. Groundwater provides the underpinning of much of Australia's primary industry and therefore much of the nation's export income. Conversely groundwater-related salinisation is costing the

nation tens of millions of dollars in lost income. Given this situation it is essential that the Commonwealth maintain and strengthen its groundwater program.

Future Organisational Arrangements

The current BMR arrangements linking onshore fossil fuels and groundwater are seen as scientifically appropriate, economically and organisationally practical. As pointed out earlier, fossil fuel and groundwater investigations are underpinned by basin analysis and use essentially the same geoscientific skills. There is seen to be merit in the future in linking the drilling section with the groundwater group in order to most effectively use drilling skills in hydrogeological studies when they are not being used for the seismic program. The links with State water authorities and geological surveys and with bodies such as the MDB Commission are seen as essential to the success of the groundwater program. BMR will seek to strengthen those links, both formally and informally.

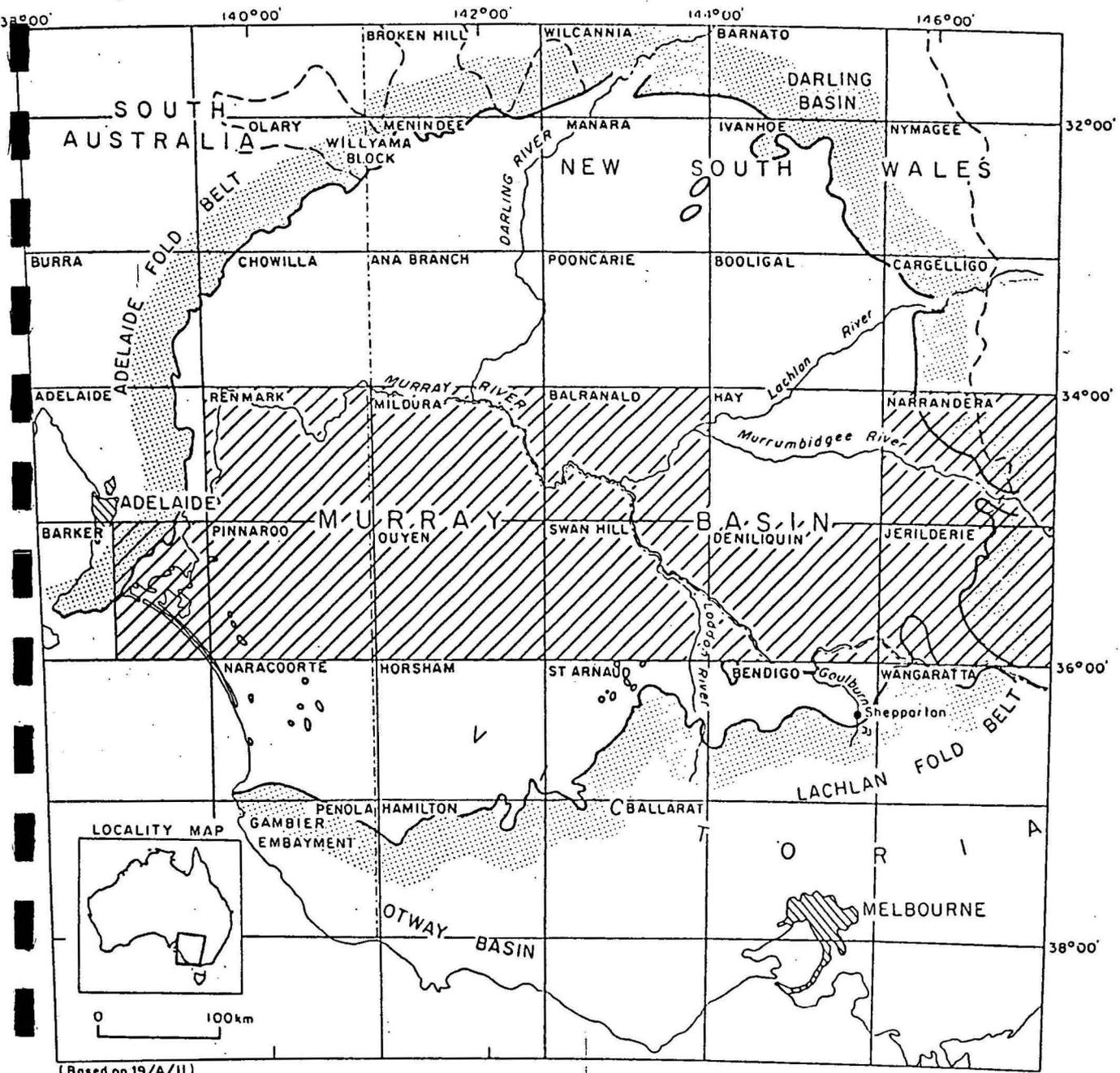
BMR recognises that there is a need to further strengthen the area of groundwater studies and will continue to seek to do this through further re-allocation of resources (though it believes that little additional scope remains for doing this) and by endeavouring to obtain extra resources.

Future Program : Current Level of Resources

As a result of recent directives from the Murray-Darling Basin Ministerial Council, BMR together with the relevant State water authorities and geological surveys is to undertake a six year program (1989-1995) in the Murray Darling Basin. Objectives of this program are:

- . Develop a comprehensive groundwater data base for the Murray Basin.
- . Compile 28 x 1:250,000 hydrogeological maps for Murray Basin (Fig.4).
- . Compile 6 x 1:1 million hydrogeological maps for the Darling Basin. (Fig.5).

FIG.4

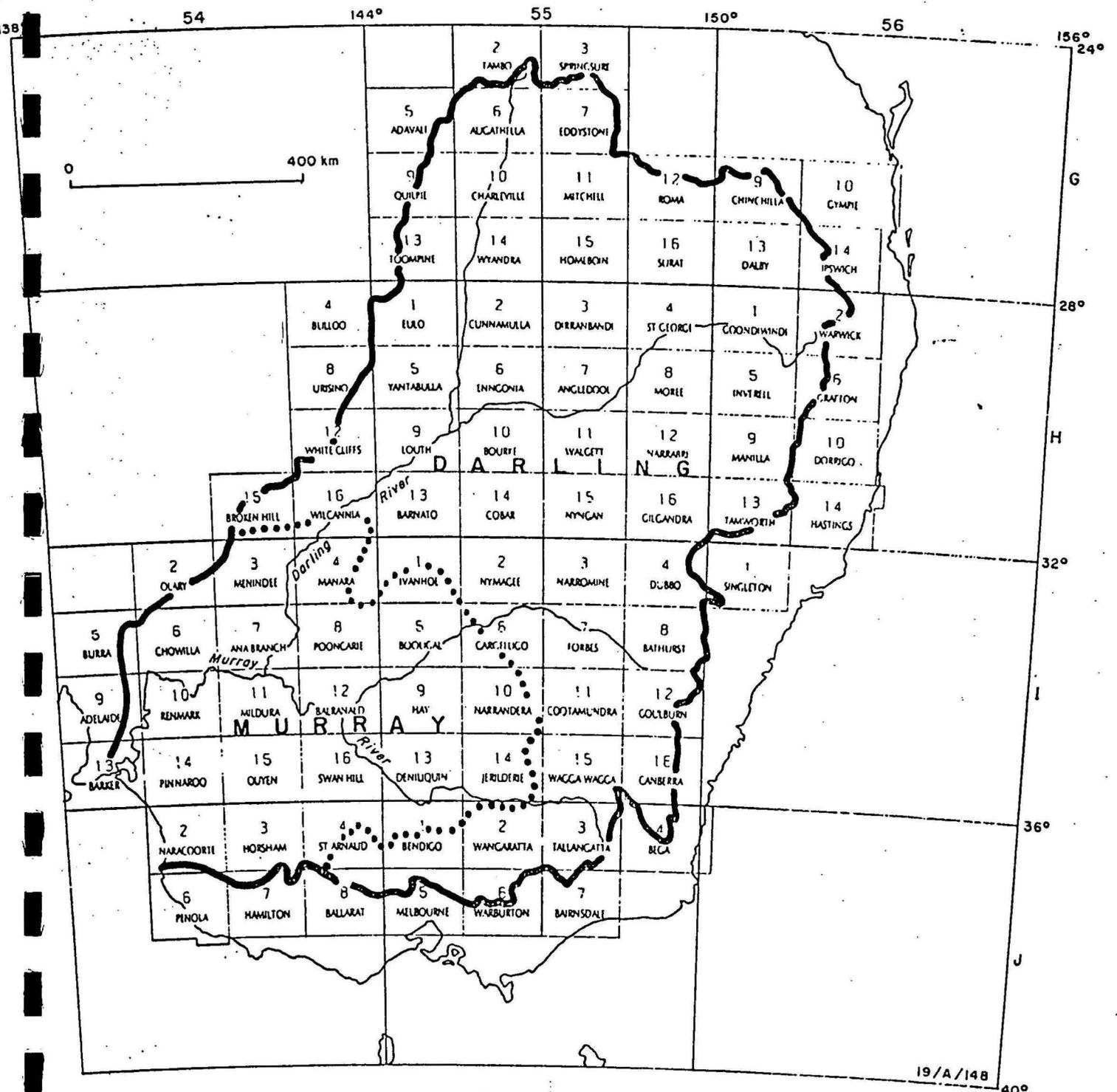


(Based on 19/A/11)

19/A/150

 High priority areas

FIG.5



19/A/148

Murray-Darling Basin, 1:250 000 sheet areas.

. Publish maps for the MDB.

. In addition develop a basin-wide groundwater model for the GAB.

At the end of the six year period (1995-2000) BMR proposes to undertake the following tasks.

. Publication of all remaining MDB maps and accompanying texts.

. Develop a basin-wide groundwater model for the Murray Basin (however the MDB Commission has recently asked BMR to examine the feasibility of accelerating the development of the model).

. Develop a basin-wide groundwater model for the Darling Basin.

. Implement a program of 1:1 million hydrogeological mapping in the Great Artesian Basin (the GAB is likely to be an area of major community concern in the future).

. Undertake tasks as required by the Ministerial Council.

In addition, based on experience in recent years it is likely that BMR will be asked to carry out hydrogeological investigations overseas for AIDAB (on a cost recovery basis).

It must also be recognised that BMR has wide national responsibilities in groundwater which cannot be discharged by any other body. The completion of national maps such as the 1:5 million hydrogeological map, the Water 2000 report on groundwater and the recently completed national pollution inventory are examples of this. BMR must continue to have the capacity not only to respond to requests (by for example AWRC) for such studies, but must also be ready to recognise the need in the first instance. An example of this may be the need to determine the groundwater resources of the coastal zone and assess the likely future impact of global sea level rise on those coastal aquifers, given that any major deterioration of water quality or yield could have important implications for many parts of the country. It is also important to note that the long-term groundwater record in basins such as the Great Artesian Basin may provide us with insights into the past effects of global climate changes and by implication of the "greenhouse effect" on the Australian hydrological cycle.

Future Program: Additional Resources

BMR does not regard the current level of staffing for the groundwater program as optimum to undertake all the tasks outlined above in a timely manner. Given the aridity of Australia and our increasing dependence on groundwater to support inland portions of the country in particular, and the increasing concerns regarding salinity and land degradation, it is self evident that Australia as a nation is not putting sufficient effort into identifying its groundwater resources, conserving those resources, or solving groundwater related environmental problems.

The provision of additional resources in this area would be utilised to accelerate the existing groundwater programs. For example the early provision of a basin-wide groundwater model for the Murray Basin could be of considerable value for broadscale planning purposes and is required in the next 3-4 years rather than in the 7-8 years that it will take to produce the model using existing resources. Given that salinity in the Murray Basin alone is costing the community in excess of \$100 million a year there is obviously a need to tackle salinity problems as speedily as possible not only in the Murray Basin but in many other parts of the country. Some of these problems can and should be tackled by state water authorities and geological surveys. Some cross state boundaries or are of such a magnitude that it is appropriate, even essential, that BMR is involved in cooperation with the States.

Similarly an enhanced rate of activity is desirable in the Great Artesian Basin where environmental concerns are becoming increasingly evident, largely due to the vast amount of groundwater currently being wasted from uncontrolled bores, and the long term effects of "mining" groundwater.

BMR also considers that it is important to undertake future long term strategic research into topics such as:

- . The role of groundwater in the formation of oil and mineral deposits
- . The economic potential of Australia's vast saline groundwater resources.
- . The potential long-term impact of the "greenhouse effect" on the nation's groundwater resources.

A total of six additional staff and an extra \$500,000 per annum would accelerate the program and enable BMR to tackle other high priority groundwater projects.

RECOMMENDATIONS

General

1. The Division of Continental Geology focus on strategic studies related to onshore fossil fuels (including sedimentary minerals) and groundwater. Consideration be given to changing the name to the Division of Onshore Fossil Fuels and Groundwater to reflect this commodity emphasis.
2. In line with Recommendation 1, those parts of the geophysical program concerned with onshore sedimentary basins, to be placed within this Division - including relevant parts of the onshore seismic group and palaeomagnetism. The placement of parts of the aeromagnetic group to be re-examined on completion of the current aeromagnetic program.
3. Cost recovery in the onshore fossil fuels program to be achieved primarily through the sale of products, but seek to maximise returns through the sale of digital data sets. The provision of financial assistance from industry to accelerate "core program" (eg. through APIRA) is seen as appropriate, provided it does not deflect the program from its overall strategic thrust.
4. Cost recovery is not appropriate for the groundwater program other than through the sale of products and even here costs should be kept to a minimum to ensure that the general community has the widest possible access to results arising from BMR's groundwater program:

Future Program

5. The Division to undertake comprehensive strategic investigations of Australia's sedimentary basins ranging from detailed to continent-wide in scale in order to improve the climate for exploration and provide a firmer basis for resource assessment.

6. The groundwater program must focus on the Murray-Darling Basin for the immediate future, but BMR must continue to have an Australia-wide perspective and must have a capacity to continue to study the Great Artesian Basin in particular which is seen as a future area for community concern. The future impact of the "greenhouse effect" on the nation's groundwater resources must be evaluated.

7. Both the onshore fossil fuels and groundwater areas are presently under-resourced. This is limiting the capacity of the Division to tackle all identified high priority projects and is slowing down the rate at which current projects can be successfully completed.

1B DIVISION OF MARINE GEOSCIENCES AND PETROLEUM GEOLOGY

CONTINENTAL MARGINS PROGRAM - COMPONENT 130

Objectives

- . To develop a knowledge and understanding of the geological framework of the continental margins around Australia and its territories, in order to more effectively promote exploration for petroleum by industry.
- . To identify the petroleum and mineral resource exploration potential of the offshore area under Australian jurisdiction and to provide the basic information necessary for the formulation of independent advice to Government on offshore resource development.
- . To develop models of the geological processes which have formed the continental margin and led to economic accumulations of petroleum and minerals.

Rationale

- . Demand for petroleum in Australia is forecast to increase by 25% by the year 2000. In the same period, Australia's current mean self sufficiency is projected to fall from 90% to 30-60% with an expected cost to the nation (on the current low oil price) of \$2-4 billion per year in necessary oil imports. Finding new petroleum is a problem of national priority. Over 90% of Australia's undiscovered petroleum is projected to lie offshore.
- . The United Nations Convention of the Law of the Sea is likely to come into operation in the next few years. The Convention will affect sovereignty over areas of possible petroleum and mineral resources offshore of Australia's margins and territories, and Australia will have eleven years to finalise a jurisdictional claim based partly upon a geological knowledge of areas beyond the 200 nm EEZ.

The objectives are achieved, and the rationale effected, through the Continental Margins Program (CMP).

Commitment

The Continental Margins Program began in 1985 and is an important element in the Federal Government's strategy to encourage the exploration for and development of Australia's offshore petroleum resources. A March 1988 Cabinet decision agreed that:

- . The Continental Margins Program would continue for a further 10 years subject to triennial review, and
- . The charter on the seismic/research vessel, Rig Seismic, the basic tool of the CMP, would be extended for a further 10 years, with an escape clause after 5 years.

THE CONTINENTAL MARGINS PROGRAM

The CMP strategic plan emphasises the development of innovative geoscientific research programs which enhance the prospects of finding new petroleum. Projects are encouraged in three areas:

- . In sedimentary basins currently considered to have moderate to good prospectivity, and which are consequently being actively explored (eg. Gippsland Basin) the CMP aims at specific problem solving, through the acquisition of the kind of geological and geophysical data that is not routinely collected by industry: deep crustal seismic, shallow high resolution seismic and seabed geology and geochemistry. This provides for a more flexible examination of new geological models and petroleum play concepts, and so acts to enhance conventional exploration strategies, and contribute to increased petroleum exploration efficiency.
- . In sedimentary basins previously explored, but with no active exploration (eg. Perth Basin) the CMP aims to reassess regional resource potential, redefine conventional exploration strategies, reassess and, where possible, reduce prospectivity risk assessments and promote renewed exploration. This is achieved principally through regional seismic and geological framework studies.
- . In frontier areas, not so far explored by industry (eg. Kerguelen Plateau) the CMP aims, through reconnaissance studies, to assess long term resource potential and formulate the technical basis of Australia's Law of the Sea claim.

Program Formulation and Consultation

The program is implemented through a series of strategic projects defined around one or two successive cruises. These projects are conducted in a specified area of the continental margin and are designed to carry out specified, problem-oriented, data collection. Projects, addressing the objectives and strategy, are formulated up to 2 or 3 years ahead of cruise start. Exploration problems, issues and priorities emerge from industry through conference presentations, industry forums and individual discussions.

Project options and outlines are drawn up within the Marine Division as a basis for further discussion.

The Division Chief and senior scientific staff attempt to consult each major domestic explorer annually, either in their offices, or at APEA and PESA national conferences

- individual discussions have proved much more effective than open forum discussions.

As far as practical forward program in currently and previously explored areas is linked to anticipated acreage releases

- this requires consultation with DPIE Petroleum Division and State Mines Departments.

Program in frontier areas is deliberately diverse and aimed at the progressive acquisition of data required to maximise our offshore jurisdiction.

Projects last an average of 2 years after cruise completion. As far as practical, an appropriate and designated product range defines the conduct of each cruise/project, subsequent data processing, analysis and interpretation. Projects are not open-ended.

Current Program Activity

For 1988/89 the CMP consists of the following projects:

		Scheduled Completion
Project 131.03	Carbon cycling in east Australian continental margin sediments and its control on the formation and distribution of Quaternary phosphorite	Dec. 88
131.06	Exmouth Plateau Project	Dec. 88

131.07	Basin framework and resource potential of the North Perth Basin	Dec. 88
131.08	Structural evolution of the southern Australian continental margin	June 89
131.10	Structure, stratigraphy and kinematic development of the northeast Gippsland Basin, the southern NSW Continental Margin and the conjugate margin on the Lord Howe Rise	Dec. 89
131.11	Structure, stratigraphy, evolution and regional framework of the Marion Plateau, Townsville Trough and Queensland Plateau	1990
131.12	Deep basin and crustal structure of the Gippsland and Bass Basins	1990
131.13	Geological framework and hydrocarbon resource reassessment of the West Tasmanian Margin plus preliminary investigations in the Tasmania Basin	1990
131.14	Geological framework and hydrocarbon resource reassessment of the South Perth Basin	1990
131.16	Deep crustal structure and stratigraphy of the Kerguelen Plateau incorporating results from ODP	1991
131.20	Hydrocarbon gas geochemistry of the Otway and Gippsland Basins	1990

Data and interpretations obtained from some of these projects are expected to be substantially augmented by drillhole data obtained through the Ocean Drilling Program in relevant areas.

In addition to the above, Marine Division has primary responsibility for the Tripartite Geoscience Project of BMR Component 140 (Overseas Basins), and the offshore East Antarctica Project of Component 350 (Antarctic Offshore Basins). Both of these projects are dependent on external funding and involve only minor effort in 1988/89. Principal objectives of the two projects are:

1. 140.01: under programs of foreign aid, to assist developing nations in the Asian/Pacific area to understand the geological framework and resource potential of their offshore areas with a view to promoting resource exploration, and
2. 350.01: to develop an understanding of the general geological and environmental framework and petroleum resource potential of the continental margin of the Australian Antarctic Territory.

Products and Reporting

The principal program products valued most highly by the petroleum exploration industry are basic data, which can be reinterpreted "in house" in terms of individual corporate strategies.

- . Multichannel seismic reflection digital data and processed record sections.
- . Geological, geochemical and geothermal data.
- . Gravity, magnetic, bathymetric and sidescan sonar data.

Interpretative data are also utilised by industry both as a new venture review and as a check evaluation of prospectivity. These include:

- . Basin folios, reports and records.
- . Written papers in exploration industry journals and technical volumes.
- . Presentations at industry conferences and symposia.

A further important mechanism for reporting projects, whose results are relevant to new acreage releases, is the Basin Workshop. These are usually in the form of one day presentations on the reassessed prospectivity of defined areas. So far, successful workshops have been held covering the Bass, Otway and North Perth Basins. A Great Australian Bight Basin workshop will be held early in 1989.

Ship operations covering 16 projects have been completed to August 1988, and processing of data for eight of the sixteen has already been completed and data released to industry. This has included almost 10 000 digital magnetic tapes and 25 000 kilometres of seismic data displayed on approximately 200 individual record sections. A breakdown of seismic data released for each project is given below:

<u>Projects</u>	<u>Seismic Data (km)</u>	<u>No. of Lines</u>	<u>Approx. No. of Tapes</u>
Bass Basin	2216	10	2200
Lord Howe Rise	940	5	279
Heard-Kerguelen	5600	20	1301
Otway Basin	3304	46	948
Northeast Aust 1&2	4134	49	990
Exmouth Plateau	2720	23	1303
Nth Perth Basin	2445	18	608
Southern Margin	3574	23	833

Product Sales Policy

Data from areas adjacent to States and Territories are supplied to Designated Authorities at copying cost. These are not for recopying, resale or trade. Data from cooperative programs are supplied free to the cooperating institution under strict written agreement. These are only for internal use. All other data are sold at the list price and under the conditions set out on product advertising brochures.

. Seismic record sections on film, ranging from \$5 to \$20 per km.

. Seismic digital field tapes, from \$5 to \$10 per km, plus

- . Digital non-seismic data, from \$300 to \$500 per cruise.
- . Maps, at \$25 each on paper and \$75 each on film.
- . Folios vary according to content, with numbers 1 and 2 priced at \$950 per copy.
- . Records and reports at list price.

Discounts are offered on whole survey and multiple copy purchases. Data over existing permits are supplied to operators upon request at copying cost, covering the limits of the permit only.

Promotion and Marketing Strategy

The principal mechanism for advising industry of the availability of products from the Continental Margins Program is the project brochure, or "flier". This contains a description of the project objectives and outcome; a track map of available data; references and publications; digital, analogue, map and section data and reports available for purchase. It is made available to industry through the DPIE Petroleum Division world-wide mailing list of exploration companies.

- . 11 fliers, covering completed, or partially completed projects from 1985 to 1988 are currently available.
- . Advertising in overseas industry magazines will begin soon.

Marine Division now regularly mounts program and product display booths at relevant industry conferences such as APEA and PESA.

- . It is proposed to mount a similar promotional display at future overseas conferences, such as the American Association of Petroleum Geologists and the European Association of Exploration Geophysicists
 - this mechanism is intended to promote Australia to the large number of foreign companies not represented domestically.
- . The Basin Workshop, tied to an impending acreage release is also an important promotional tool.

Preparation and presentation of scientific papers reporting the interpretative products of projects is also an important aspect of promotion and product marketing. Such papers are directed towards journals such as APEA, PESA, AAPG, Geophysics, Oil and Gas Journal and the Journal of Marine and Petroleum Geology, to reach the industry audience.

Port calls by Rig Seismic are also used to promote the program, its capabilities and products.

- . Media releases are used to announce results or impending program.
- . Visits to, and inspections of, the ship by industry representatives.

Projected Continental Margins Program

Assuming no significant change in Marine Division's role and in the operating strategy of the Rig Seismic (ie. 180 ship operational days per year), the following CMP projects form the draft, or indicative program from mid 1989 through early 1991:

- . SE Queensland - Regional (seismic and geology)
- . Sydney Basin - Regional (seismic)
- . Vulcan Graben/Browse Basin - Detailed (geochemistry)
- . Vulcan Graben/Browse Basin - Deep Structure (seismic)
- . NW Shelf - Deep Structure (seismic)
- . NW Shelf - Detailed (geochemistry)
- . Torres Shelf - Detailed (seismic and geology)
- . South Carnarvon Basin - Regional (seismic)
- . Bonaparte Gulf/Timor Sea - Regional/Deep Structure (seismic)
- . Southern Margin - Regional (geology)

These projects will follow on those already in the 1988/89 forward program. However, they will be scheduled to maintain the present mix of 3 or 4 seismic cruises, 1 or 2 geological cruises, and 1 geochemistry/ geological cruise per year, as well as to take account of the timing of new acreage releases and changes in areas and emphasis of exploration interest and activity.

Over the last year the Division has taken on an increasing level of product generation and marketing, aimed at increasing the level of cost recovery. This has been at the cost of some data processing and project work. Both the basic and interpretative data generated by the CMP are cost recoverable to some extent. The indicative level of product sales this financial year, based on the value of orders received in July and August, is around \$300 000. This should increase further in 1989/90 towards the 5% level. However, the level of future product sales will depend to a large degree upon Marine Division's ability to:

- (i) invest in new technology to keep up with increasing company expectations of data quality; and
- (ii) produce and market products in a timely fashion.

A method of providing the extra funds required to better sustain the "core" CMP and make provision for updating technology would be to allow the program to retain real cost-recovery monies over the target figure of 5%. It is understood that this strategy now applies in CSIRO.

At present, shortages of staff within the Marine drafting group and the data release/marketing area of the Division are causing major delays in the release and promotion of the full range of program products (particularly interpretative products) and hence, are limiting potential cost recovery. To overcome these difficulties, an estimated 7 extra staff are needed: 3 for the Marine drafting group, and 4 within the Division to relieve processing and project staff currently involved with the preparation, marketing and promotion of saleable products.

In addition, a significant and expanding workload, which has the potential to impact on future program, is developing in areas such as increasing accountability in program management and budgeting, Law of the Sea documentation and advice, and technical advice and provision of special data packages related to the release of new areas for petroleum exploration. To overcome this problem, an extra 3 staff are needed in the project and science management area.

Program Achievements

In 1982 the pilot study for the Continental Margins Program was carried out in the Bass Basin, between Victoria and Tasmania.

- it was a contract seismic survey costing approximately \$4 m and since BMR data release, over \$100 m has been invested in exploration in the Basin.
- BMR identified a number of new petroleum plays in 1984, including the Yolla structure, which was drilled by AMOCO in 1985. This was an oil discovery, as yet non-commercial.

In 1985 and 1987 Rig Seismic operations in the Otway Basin (offshore South Australia, Victoria and Western Tasmania) identified new potential petroleum plays.

- hydrocarbon seeps were detected in seafloor sediments.
- new exploration permits in the Basin were recently granted to companies, and new exploration is underway.
- there has been continued interest in this area, previously considered unprospective, and recent applicants for acreage have quoted BMR data in submissions and presentations. Most of the offshore basin is expected to be under exploration permit by the end of this year.

In 1985 a large new structural trend was discovered extending into Australian waters east of Torres Strait. New petroleum accumulation models have been developed and presented to industry.

- this new exploration lead has now been drilled in PNG waters as Pandora-1 and is a major gas discovery.

The 1985 and 1987 surveys in the Townsville Trough and Marion Plateau discovered a new sedimentary basin to the east of the Great Barrier Reef Marine Park off Townsville and containing up to 6 km of sediments.

- seismic indicators of possible hydrocarbons have been discovered in the eastern part of the basin.
- there has been strong interest from both overseas and local companies in potential release of permits in this area.

The 1986 Exmouth Plateau project (NW Shelf) ascertained a total thickness of about 10 km of sediment and discovered previously unknown deep petroleum source rocks.

- taken together with recent ODP drilling results, a new Triassic reefal play and a new Barrow delta play have been identified.

The 1986 North Perth Basin project has identified three sub-basins and a new range of hydrocarbon plays. As well, the 1986 Great Australian Bight project identified a new group of structures with possible hydrocarbon potential in a previously undrilled area beyond the shelf.

- both areas will be offered for exploration permit in 1989.

A considerable amount of new deepwater sediment thickness data has been collected which is applicable to Australia's Law of the Sea claim beyond 200 nautical miles.

- Exmouth Plateau, off northwest Australia.
- Great Australian Bight.
- Deepwater Gippsland Basin.
- Lord Howe Rise.
- Australian sector of the Kerguelen Plateau (Heard Island area).

A forthcoming deep seismic program in the Gippsland Basin is expected to outline new petroleum plays beneath those currently being developed in the area. It has strong support from industry.

THE OCEAN DRILLING PROGRAM

The Ocean Drilling Program (ODP) is the largest and most important international geoscience and marine engineering technology research program of this decade and the next. Results of the program are having a major impact throughout the earth sciences and specifically upon petroleum exploration concepts and methods, oceanography and climatology. The program is global in concept, participation and significance.

It is expected that 20-30 drillholes (costing a minimum \$100 m, if drilled commercially) will have been drilled in areas of direct interest to the Continental Margins Program between 1988 and 1991, on the Kerguelen Plateau, Exmouth Plateau and north east Australia. Data from ODP cores will be applied directly to seismic interpretation, and source and reservoir rock characterisation, and hence to petroleum exploration and the development of new ideas of petroleum generation. In addition, the cores will provide information on past climates. Early results from the Kerguelen Plateau have revealed previously unknown potential petroleum source rocks beneath the Raggatt Basin.

During 1988, five BMR scientists are involved in the cruises of the Ocean Drilling Program in Australian waters. Australian membership of ODP (in consortium with Canada) will ensure continued scientific involvement, access to data and technology, and provide for enhanced graduate and staff training. BMR's staff and funding contribution will be found from across lower priority elements of BMR's program.

POTENTIAL NEW INITIATIVES

The Marine Division is technically equipped to expand its operation into new research and survey activities which would enhance and strengthen the CMP. Program expansion cannot be carried out without increased operational and administrative staff and funding.

(1) Externally-funded programs related to petroleum exploration

An average of 90 operational days per year are potentially available for externally-funded programs in addition to the "core" CMP. The options for this extra time include Antarctic margin geoscience, semi-commercial activities around Australia, and foreign development assistance programs in Asian and Pacific waters.

(i) Antarctic marine geoscience

Cabinet consideration of a detailed proposal for a 10 to 12 year, 5 or 6 cruise program along the margin of the Australian Antarctic Territory has been deferred until 1989. This proposal involves increasing the ice-worthiness of the Rig Seismic, providing extra operations funds and staff (16), and increasing the Division's computer capacity to handle the extra data processing load. A regional program of research and reconnaissance surveys of the Antarctic margin is essential if Australia is to have any meaningful or influential participation in the Antarctic Minerals Convention or any voice in resource development of the AAT. (*see next page)

(ii) Semi-commercial activities around Australia

Opportunities for semi-commercial activities, including cooperative surveys and research in conjunction with industry, are limited by the fixed staff numbers in the Operations Section of the Division and the fixed operations budget. With greater flexibility (eg. to employ contract staff) it would be possible to take short-term commercial opportunities as they arise, without disrupting core program. Flexibility would be required to transfer some contribution from the joint research trust

account to the cost recovery account, in order to contribute directly to cost-recovery, as well as provide the extra staff and cover financial costs associated with the additional program. *

(iii) Overseas foreign development assistance programs

A number of proposals (involving suggested programs in the People's Republic of China, Philippines, Indonesia and PNG) have been canvassed and are currently under external consideration for 1990 and beyond. Each of these proposals involves funds for additional staff, operations and data processing. *

(2) Reprocessing of seismic data

A large quantity of old seismic data (both BMR and industry) is available for reprocessing. In certain areas around the Australian margin, these data would be of considerable interest to industry provided that they are reprocessed using modern techniques and released in a timely fashion. It is estimated that approximately 3000 km of data could be reprocessed each year, requiring 3 extra processing staff. Principal attention would be paid to areas indicated for exploration permitting. *

(3) Future climate prediction

The recent predictions of irreversible global environmental change are of international concern. National planning in Australia for agriculture, demography and coastal development and urban reconstruction are dependent upon predictable climate and sea level. Climate research should, therefore, be a national priority. The degree to which meaningful and reliable prediction can be made depends entirely upon the quality of the

* These projects all require time on the BMR Seismic Processing Centre. As the Centre is fully committed to production requirements of the current CMP, it will be necessary to expand its capabilities to handle additional work. This is seen as occurring in two consecutive stages:

- through expansion of working shifts from 5 days to 7 days per week, requiring two additional computer operators.
- through a major upgrade to the hardware which will cost \$1 m. This has been included in the Antarctic marine geoscience proposal. However, in the event that the proposed Antarctic program does not proceed, it may be necessary to raise these funds in some other way.

historical record of climate/sea level baseline and variations. Key questions which must be addressed include the carbon dioxide balance between atmosphere and ocean and the relationship between current atmosphere levels and the burning of fossil fuels, as well as recent global warming and sea level changes; and the relation between the shorter term El Nino/Southern Oscillation phenomenon and global climatic change.

Data to answer these questions lies almost entirely within the oceanic sedimentary record, and the Australian region is well located for deciphering this record. Shelf and slope carbonate rocks hold a sensitive record of environmental change, particularly sea level, ocean temperatures and chemistry, atmospheric carbon dioxide, annual and seasonal rainfall, and the periodicity of wet and dry episodes. Some climate studies have been carried out on CMP core material collected from Rig Seismic. However, a more comprehensive program of climate studies would require 2 additional staff for a comprehensive program of laboratory analysis.

(4) Thermogenic hydrocarbon seep detection

In many parts of the world, oil and gas accumulations at depth are known to leak to the surface and release trace amounts of lighter hydrocarbons into surface sediments and seawater. The CMP has included some studies of hydrocarbons in seabed sediments, including the detection of anomalous trace occurrences in the Otway and Gippsland Basins. These results provided encouragement for a number of companies to apply recently for exploration permits in these areas. Detection of hydrocarbon anomalies in seawater, however, requires a more advanced system. Such systems are not yet available commercially; indeed, the whole technique is still in its infancy as an exploration tool. Considerable research is required to establish the validity of the method, including migration path studies, distribution controls, subsurface maturation studies and repeatability experiments.

Once developed, the system could be run either as part of a specific geochemistry cruise, or as a reconnaissance program run simultaneously with underway geophysics. Either way the potential to complement CMP objectives, stimulate exploration and achieve an enhanced measure of cost recovery is considerable, possibly enormous, depending upon how successful the method proves. The estimated cost of developing the equipment is approximately \$250 000.

(5) Towards a comprehensive margin stratigraphy

Petroleum exploration in deeper water is hampered by the paucity of stratigraphic core samples from the continental slope. While acquisition of high quality seismic data is essential in exploration, drillhole control is required for quantitative prospectivity analysis. However, offshore stratigraphic drilling is extremely expensive; the cost of stratigraphic holes being approximately \$5m (or more) per hole in water depths greater than 500 m. A low cost substitute would potentially lead to a vastly improved understanding of the development of the deep continental margin of Australia, including the distribution of source, seal and reservoir rocks.

A rotary drill, capable of drilling to 50 m in 2000 m of water, is currently being tested in the USA. The cost of purchase of this equipment and modification of Rig Seismic is estimated at around \$1m. A program of stratigraphic coring could be developed which would provide a more comprehensive offshore database with cost recovery potential.

(6) Improved assessment of petroleum prospectivity

In many sedimentary basins the BMR data is the principal, high-quality framework data set available from which to investigate regional prospectivity and subsequently assess resource potential. In order to obtain maximum benefit from these data they need to be integrated with existing data sets (primarily previous seismic and drilling data) to yield a comprehensive review and analysis of basin prospectivity. Given the existing staff levels and the large volumes of existing data in some basins, this is often not possible.

The CMP should carry out more comprehensive assessment of the petroleum prospectivity of the areas in which it is working. This could be more achieved by much closer involvement of suitable staff from the related basin review function in RAD.

(7) Continental margin basin geothermal and fluid database

Because of its national role, BMR, and Marine Division in particular, are in a unique position to establish and maintain a national database of all geothermal and fluid information from Australia's offshore region. Initially, this could be constructed using the ODP database from around Australia.

Continental margin sedimentary basins consist of a matrix of sedimentary grains and a dynamic fluid system, which includes water, oil and gas. Burial, compaction, structuring and generation of hydrocarbons (by the maturation of source rocks) mean that evolving basins contain dynamic fluid systems. Studies of such system dynamics will lead to the next breakthrough in predicting oil accumulation and this database will promote its application to the Australian margin as soon as possible. It is estimated that construction of such a database could be achieved by 2 to 3 additional scientific and technical staff.

RECOMMENDATIONS

That the Continental Margins Program be continued along the lines agreed by the Government in March 1988, and strengthened in order both to more effectively achieve its current program and to extend its operations to include more commercially oriented seismic processing, prospectivity assessment and petroleum fluid/geothermal database programs.

That cost recovery on industry oriented strategic programs be primarily an indicator of program relevance and not a means of obtaining a significant component of offsetting revenue. The practical target of cost recovery is recommended to be limited to 5% of the total cost of those programs, with revenues in excess of that target being available for investment in advanced technology, which would extend the capacity and relevance of those programs.

1C DIVISION OF PETROLOGY AND GEOCHEMISTRY

BACKGROUND TO ROLE, FUNCTION AND PROGRAM

The Division of Petrology and Geochemistry has had since 1982 the primary carriage of the geological (as distinct from geophysical) research program into mineral provinces and into the setting and origin of their contained deposits. In mid-1987, this minerals-related program was strengthened by the transfer of the small, but high priority Regolith and Remote Sensing functions from the Division of Continental Geology.

In addition, the Division has housed the Structural Geology discipline group since its inception, and that group has had significant input into the study of the structural and tectonic evolution of Australia's onshore and offshore sedimentary basins, in collaboration with the Divisions of Continental Geology and Marine Geosciences.

This primary responsibility for structural and tectonic research led to the transfer of the Explosion Seismology group to the Division, to better integrate the geophysical and geological activities associated with the deep seismic profiling program.

In summary, the Division of Petrology and Geochemistry has the primary responsibility for strategic research into:

- . The geology of mineral provinces
- . The regional setting of mineral deposits and deposit types
- . The large scale structure of the continent

The Division currently fulfils this responsibility via 3 program components

- 3.1150 - Mineral Province Studies
- 3.1160 - Regolith, Related Resources and Remote Sensing
- 3.1170 - Regional Structure and Tectonics.

The development (and indeed ongoing revision) of this program has been based on the following factors:

- . Issues of national significance - e.g., strategic commodity priorities, land use issues, gaps in the national information/knowledge base.
- . Industry priorities - e.g., shorter term commodity priorities, regional data sets (e.g., maps), priority regions or provinces (e.g., Yilgarn, N.E. Qld), gaps in knowledge (e.g., regolith).
- . New research developments and directions - e.g., technology (image processing, deep seismic profiling, specialised geochemistry, geochromology), leading edge research (zircon geochronology, extension tectonics, granite geochemistry, hydrothermal geochemistry).
- . Availability of skills and knowledge within BMR - e.g., emphasis on geochemistry, Proterozoic provinces, weaknesses in regolith, remote sensing and application of information technology, severe shortage of younger geoscientists to build field programs.

Above all, there has been an increasing emphasis on regional, multidisciplinary research that utilises the unique range of skills within the Division and the BMR at large.

RELEVANCE AND QUALITY OF CURRENT ROLE

The outcomes of the Divisional research program since 1982 are detailed by Component in this submission. The following selection illustrates separately (although they are not independent) the relevance and quality of our current role.

Relevance

Mineral Province Studies - These regional, multidisciplinary studies are the natural extension of the earlier 1:250 000 and 1: 100 000 mapping programs. They provide an information and knowledge base of increasing quality and detail for mineral exploration, rather than lead directly to discoveries. The major products from the first of the modern province studies will be released over the next two years, but a measure of their relevance to date has been the substantial industry enrolment at the three workshop/conferences organised by the Division to present interim results. The province studies provide the basis for numerous informal contacts with industry geoscientists, in the field and the office.

Structural Development of Sedimentary Basins - The development of new concepts of sedimentary basin development, and their application to hydrocarbon exploration has been taken up widely in the industry. BMR research has contributed to a new conceptual basis for play development in a major class of basins (including virtually all of Australia's offshore basins and the Canning Basin onshore). The application to exploration is evidenced by (i) direct contact with exploration companies, (ii) the recent invitation to a member of the Division to present these concepts as the Petroleum Exploration Society of Australia's Distinguished Australian Lecturer for 1988, and (iii) the large enrolment of the 1987 BMR Symposium on Applied Extension Tectonics.

Deep Seismic Profiling - BMR is a world leader in the acquisition and processing of seismic reflection data to depths of 50 km or more. At first strictly a research tool, deep seismic profiling is now being undertaken by the petroleum industry, and BMR data is routinely acquired by explorers in the relevant regions. There is a correspondence between BMR deep seismic profiling programs in sedimentary basins and an upsurge in exploration activity in those basins. Interest in deep seismic profiling has most recently extended to the mineral exploration

industry, with specific requests to extend one of the current Canning Basin profiles over the Ellendale diamond fields. Deep seismic data have required development of new processing techniques within BMR. Some of these techniques are also applicable to the more routine industry shallow profiles. Following specific industry interest, processing software packages are being prepared for commercial release.

Geochemistry - As part of its regional studies, the Division has been acquiring multi-element geochemical data for a wide range of rock types from many of Australia's mineral provinces. These data provide a basis for assessing the prospectivity of major rock suites, enable improved interpretation of magnetic, radiometric and satellite imagery, and provide a baseline against which exploration geochemical anomalies can be measured. A database comprising over 15,000 rock analyses classified according to location, province and rock type is in the final stages of preparation for public release in late 1988. There has been extensive industry interest in this database, following outline of it at a number of recent conferences.

Geochronology - BMR has been at the forefront of the application of the ion - microprobe dating technique to regional geological problems. The technique was developed at the Australian National University, with whom BMR has cooperative research agreement. What is primarily a fundamental research tool has been so successfully applied to BMR's strategic research program that we are undertaking limited dating of specific mineral deposits, funded by industry. Industry is also contributing funding (\$10,000) towards the development of a national geochronological database.

Gold Research - The Division has recently commenced a mineral province study in NE Queensland in collaboration with GSO and BHP Gold. In particular, the close collaboration with BHP Gold, involving access to BHP's extensive exploration database, demonstrates industry's interest in this type of research.

Diamond Research - A collaborative project between BMR, GSWA and GRAE established new criteria for diamond exploration, following recognition of a new class of diamond - bearing host rocks.

Platinum Research - In collaboration with university groups, an efficient geochemical method for regional assessment of the prospectivity of potential host rocks has been developed, and is currently being applied in the Pilbara region of WA.

Uranium Research - Through a variety of International Atomic Energy Agency working groups and publications, BMR has made a major contribution to the understanding of both the regional setting and depositional controls on Australia's inconformity - related uranium deposits, which constitute a major world resource.

Quality

Measurement of the inherent quality of a strategic research program, especially within 6 years of its inception, is a complex and somewhat subjective task. Publications, citations and invitations to present papers at conferences represent the traditional means of evaluating research, and some information on these for the Division's components is given in the following sections.

Specific indications of the quality of the Division's strategic research since 1982 include:

Frequent invitations to present the results of the research at both national and international conferences, commonly as keynote papers. These conferences include those specifically organised for or by industry.

Frequent approaches by both Australian and overseas researchers/organisations to participate in collaborative projects. A number of very successful collaborations have been organised, always on a particularly cost-effective basis for BMR.

The Division has organised or played a major part in organising a number of national and international symposia on specific topics within its program (eg., extension tectonics, research in gold exploration, Proterozoic tectonics, deep seismic profiling). In all cases, these conferences have attracted large attendances from the local and

international research communities as well as from industry (eg., recent deep seismic conference attracted 85 overseas registrants out of a total of 180).

The frequency of citations of the Division's research in the major national and international research journals. A number of the Division's scientists are among the most highly cited in geoscience research in Australia.

COMPONENT 3.1150 - MINERAL PROVINCE STUDIES

Current Program

This component has evolved over the past 6 years from one in which there was substantial emphasis on mineral deposit/genesis studies, to one that is almost entirely devoted to mineral province studies and research into the regional setting of high priority mineral deposit types. The commodities on which the program currently focuses are gold, platinum, diamonds, chromium, nickel, base metals and the high-tech rare earth elements. An example of a substantial shift in program priority has been away from tin/tungsten towards gold over the past three years, in response to both short and long term international commodity priorities and industry interest.

The current program in this component has two broad thrusts, both of which are primarily designed to assist in the discovery of high priority commodities.

Regional evaluation of a range of related rock suites derived from the earth's mantle. These rock suites intrude the crust as molten liquids, and the melting and crystallisation processes can concentrate metals of economic interest (e.g., platinum, chromium, nickel, diamonds, rare earth metals).

A multidisciplinary province study in one of Australia's most prospective regions for precious and base metals. The province study is based in northeastern Queensland, and is supported by reconnaissance evaluations of the prospectivity of neighbouring regions in eastern Australia, and by specific research into deposit-forming processes.

The first program is based on field activities in the Pilbara and Musgrave region of Western Australia. The Pilbara research has led to procedures that allow regional assessment of platinum potential to be made from relatively limited mapping, sampling and chemical analysis. Such regional prospectivity assessments will markedly improve the efficiency of exploration by prioritising rock bodies on the regional scale.

Diamonds occur in most parts of the world in a rare rock type known as "Kimberlite". Research by BMR in collaboration with industry and GSWA has demonstrated that the Argyle and Ellendale diamonds occur in a different rock type called "Lamproite". This discovery and follow-up research has led to the development of new exploration guides for diamonds, and expanded the range of prospective regions and rock suites. Lamproites and related rocks also contain potentially economic concentrations of rare earth and precious metals. Current research is devoted to a broad, national prospectivity assessment of these rocks, and will help to define the more promising exploration targets.

The northeast Queensland province study is being carried out in collaboration with GSQ, and with industry. BMR is directly contributing to the GSQ regional mapping program, and in a specific part of the province has entered into an information exchange agreement with a major company to carry out an intensive study of the regional setting of gold mineralisation. The information exchange allows BMR to incorporate hundreds of thousands of dollars worth of industry geophysical, geological and drilling data in a study which will greatly improve the regional basis for exploration throughout much of eastern Australia. The province study is based in part upon extensive BMR involvement in regional mapping in neighbouring areas, and takes advantage of the specific expertise gained from that mapping. It has already resulted in significant extension of the most highly prospective region, as well as providing an improved understanding of the geological processes involved.

In addition, the component contributes to the Canning Basin Project. An innovative technique has been developed for fingerprinting and potentially tracing on a regional scale the fluids that gave rise to the lead - zinc deposits, and for comparing them with the petroleum-bearing fluids. This research will impact on both petroleum and mineral exploration in this prospective basin.

Products (1983/84 to 1987/88)

<u>Maps</u>	- Published and in preparation	-	3
	Planned	-	3

These rather low figures reflect the earlier emphasis of the component on deposit/process studies; they will increase significantly as the regional programs become established.

Publications

BMR Bulletins, Reports, Records	-	4
BMR Research Newsletter Articles	-	15
Papers in outside Journals	-	30
Papers presented at conferences	-	67

Costs (1988/89)

Salaries	-	\$819,000	
Operational	-	\$429,000	
	TOTAL COST	-	\$1248,000

The operational costs for this component are dominated by field and laboratory expenditure. The component is the cost centre for the geochemical laboratories.

Cost Recovery

There is only limited cost recovery for this component, from the sales of products (~ \$1,000/annum). However, future sales of the geochemical and geochronological databases (see component 3.1170, but shared by this component) are expected to generate revenue of \$50,000 to \$100,000 over the next 2 to 3 years. In addition, the new regional projects will result in integrated province datasets on electronic media, which will result in increased income. Note also that data/information/personnel exchange arrangements with GSQ and industry have effectively added hundreds of thousands of dollars worth of information at no cost to BMR.

Strategic Plan

The component planning committees for 3.1150 and 3.1170 recently proposed amalgamating the mineral province and regional mineral deposit framework projects from both components under 3.1150, thus completing the transition to a regionally based minerals research program. Only the seismic profiling program and related structural/tectonic research will remain in 3.1170.

A strategic plan for a Minerals Division is outlined in a following section. That plan is built around the main functions of this (enlarged as above) component - mineral province and regional framework studies.

The basis of the strategic minerals research program for the next decade should be a limited number of (4 or 5) intensive, multidisciplinary province studies, integrated with multi-province regional syntheses and prospectivity assessments. The provinces for intensive study would be chosen on the basis of prospectivity, industry priorities, and particularly to provide the knowledge base for the regional syntheses.

The outcome of these two functions would include maps; integrated data sets on a standard GIS base; geochemical, geophysical, etc attribute databases; increased knowledge in the form of concept and models to provide the basis for more efficient exploration; and enhanced ability to provide advice to government and respond to land-use issues.

The range of geoscientific skills and technology is broadly available within BMR to accomplish this program. However, there is a severe and potentially limiting shortage in two areas.

First, additional technical and computer support staff with a range of information technology skills are required to ensure efficient input, management, manipulation and production of the wide range of data that have to be integrated in a GIS base. 4 additional staff in this area will substantially improve efficiency by permitting geoscientific staff to maximise their time for data acquisition and interpretation.

Second, the age profile of our geoscientific staff is strongly skewed towards the middle age ranges. The efficiency of our field programs, and the input of new ideas would be greatly enhanced if we were able to take on recent geoscience graduates, initially on 2 to 3 year contracts, to expand the field component of the program. By effectively providing intensive field training for these young geologists we would also be providing a valuable service to industry, by whom most would be employed following completion of their contracts.

COMPONENT 3.1160 - REGOLITH, RELATED RESOURCES AND REMOTE SENSING

Current Program

The Regolith and Remote Sensing responsibilities were transferred to the Division of Petrology and Geochemistry in mid-1987, in order to integrate them more closely with the minerals research program. Because both activities have been identified as high priority by BMR management and the Advisory Council, they were placed in a specific component to focus attention on their programs and resources.

The regolith (the weathered layer overlying bedrock) program for the past 3 or 4 years has been devoted entirely to the development of the principles and procedures of Regolith Terrain Mapping, and to the production of two 1:1 000 000 Regolith Terrain Maps. Both maps (Hamilton in Victoria, and Kalgoorlie in WA) have been produced in preliminary form, and full colour map sheets will follow. The principles of Regolith Terrain Mapping at the 1:1 000 000 scale have been firmly established, enabling an ongoing mapping program to proceed efficiently.

The regolith both conceals and contains important mineral deposits. For example, Australia's extensive bauxite and much of its iron ore resources owe their origin to the weathering process, and are, in fact, part of the regolith. In addition, much of Australia's new found gold wealth, especially in WA, occurs within the regolith, although the deposits were largely formed within the bedrock.

Efficient exploration for and discovery of further mineral wealth demands an improved understanding of the distribution, character and genesis of the regolith. The Division's 1:1 000 000 Regolith Terrain Mapping Program provides the regional basis for more detailed and specific studies being undertaken by CSIRO, State instrumentalities and universities. However, our ability to achieve acceptable progress is severely hampered by a shortage of expertise in what is a relatively new research field. A senior research appointment currently in train and limited redeployment are planned to boost this high priority activity (see below).

The remote sensing program primarily provides specialist support to projects in other components, by way of data processing and interpretation, and the development of specific applications techniques. It is a key part of the regolith project, because the Landsat data provides the prime source of information on the distribution of regolith terrain units. It also provides input into field-based projects in Mt Isa, central Australia and the Pilbara province.

In each of these projects, the remote sensing research has improved the efficiency of field programs, enabled the identification of subtle variations of rock types that proved difficult to discriminate in the field, and provided processed images of future value to exploration. However, the most important research activity in the group is in developing data processing procedures that maximise the value of the spectral data for a specific area or purpose. The global application of spectral (e.g., Landsat) data to mineral exploration has been disappointingly slow, largely because each problem requires specific processing and applications procedures. We are concentrating our research in this applications area, complementary to the techniques and instrumentation development in CSIRO, by very closely integrating it with multidisciplinary field studies.

Products (1983 to 1987/88)

<u>Maps</u>	Published and in preparation	-	3
	Planned	-	5

Publications

BMR Bulletins, Reports, Records	-	5
BMR Research Newsletter Articles	-	4
Papers in outside journals	-	9
Papers presented at conferences	-	30

Costs (1988/89)

Salaries	-	\$164,000
Operational	-	\$134,000
Total Cost	-	\$298,000

Cost Recovery

There is only limited cost recovery from this component, from the sales of products (<\$1,000/annum).

Early in 1988, a major proposal for funding of an accelerated, 3-year Regolith Terrain Mapping project in the Yilgarn Province, WA was submitted to AMIRA. Funding requested was about \$350 000/year, approximately 60% of the total cost of the project (40% balance from BMR funds). It now appears that this funding proposal has been unsuccessful. The main reason given by potential sponsor companies for rejection of the proposal is based on a fundamental resistance to funding BMR to carry out (even accelerate) what they see to be a high priority strategic research program in the national interest (see section on COST RECOVERY elsewhere in submission).

Acquisition of the new image processing and raster scanner/plotter systems will allow integration of processed Landsat (or other spectral) images with GIS and other geoscientific data into packages which are likely to attract considerable sales. BMR is unable to sell Landsat data that has not been processed by us for a specific purpose.

Strategic Plan

The regolith program will continue to be expanded and upgraded as resources allow, and emphasis will continue to be placed on Regolith Terrain Mapping, primarily in conjunction with other mineral province studies. The preferred scale for RTM remains at 1:1 000 000, but more detailed work at 1:250 000 or even 1:100 000 in key areas within the Kalgoorlie 1:1 000 000 sheet has been suggested by industry, and is being investigated. Joint projects with CSIRO are also being investigated.

The small remote sensing group will continue to provide an applications focus and service for project-based utilisation of satellite and aircraft imagery. BMR's new image processing system will allow broader access to these facilities, and it is proposed that each major regional project team include a geoscientist designated as the remote sensing applications specialist. That person will be trained on the new equipment and processing procedures, thereby effectively multiplying output in this key area.

Regolith and Remote Sensing are both high priority areas in which recruitment has been limited both by contraction of ASL and unavailability of specialist staff (both within and outside BMR). Limited redeployment and retraining has and will continue to be implemented, but there is a clear need for additional resources to acquire specialist expertise. Given the 3 to 5 year lead time to effectively train a specialist, retraining of existing staff is not generally cost-effective.

An additional 6 to 10 staff are needed in these specialist areas to raise the effectiveness of the programs to an acceptable level.

COMPONENT 3.1170 - REGIONAL STRUCTURE AND TECTONICS

Current Program

Objectives: To determine the regional structural and tectonic evolution of Australia's petroleum and mineral provinces and major crustal components; to produce integrated geological and geophysical data sets; and to develop concepts and models for the tectonic setting of mineral and petroleum accumulations.

There are two main functions within this component:

- . Mineral province and regional framework studies that have a significant component of structural geology and tectonics (projects 3.1170.1, 3.1170.2, 3.1170.3).
- . Deep seismic profiling and seismic refraction studies, which are principally designed to determine regional crustal structure.

The major mineral province study is in the Mt. Isa Province, and is planned for completion in 1990. The Mt. Isa province was chosen for intensive multidisciplinary study in 1983 because

- . it contains a large mineral resource and is prospective for a wide range of metals
- . it is the best known of the early to middle Proterozoic mineral provinces that host so many of Australia's largest and richest mineral deposits
- . BMR had recently completed 1 : 100 000 mapping of the entire province, and consequently held a substantial bank of information and expertise.
- . it represented an excellent "natural laboratory" to test and apply some newly developing concepts relevant to the tectonic evolution and mineral prospectivity of Australia's Proterozoic provinces.

The Mt. Isa project has involved extensive collaboration with university research groups (both Australian and overseas), and some collaboration with industry and GSQ. It has involved approximately 30 man-years of effort by BMR scientists and perhaps 50 man-years by external collaborators, illustrating the labour-intensive nature of such mineral province studies.

It has or is about to produce a large array of data, maps and publications which complement the 1 : 100 000 map series, and will provide the basis for the next generation of exploration in this and all similar provinces. Approximately 30 maps, at scales from 1 : 25, 000 to 1 : 500 000 are in various stages of preparation and production. These maps are thematic and problem - oriented, and both complement and enhance the 1 : 100 000 series.

The Mt. Isa Province study is closely related to the regional, multi-province Proterozoic framework synthesis of project 3.1170.02. This synthesis is built upon the previous BMR mapping programs in the Halls Creek, Pine Creek, Granites - Tanami, Tennant Creek, Davenport, Arunta, Mt. Isa and Georgetown Provinces, and aims to synthesise existing data, acquire fill-in data, and develop a regional framework for effective exploration.

Output from the project includes very large geochemical and geochronological databases (both to be released late 1988), maps and syntheses. In addition, the project has played a major coordination role for Proterozoic research throughout Australia. We produce a newsletter summarising research projects for the exploration and research communities, and have recently compiled and edited a 600-page volume of papers on the Australian Proterozoic, to be published by the journal Precambrian Research.

A further province-based study is being undertaken in collaboration with GSWA in Australia's premier gold province, the Eastern Goldfields of the Yilgarn Province, WA. BMR is producing two 1 : 100 000 map sheets as part of the GSWA regional mapping program, and is jointly developing structural models for localisation of gold deposits. These two map sheets are the pilot areas for development (in collaboration with CSIRO) of an integrated electronic spatial database system that will eventually replace conventional map/commentary/image production.

Since 1982, the deep seismic profiling program has concentrated almost exclusively on sedimentary basins (Eromanga - Surat, Amadeus Basin, and currently Canning Basin, WA). A total of 3 700 km of deep (50-60 km below surface) seismic data will have been collected by November, 1988.

These data, in the form of basin-wide networks and long, regional traverses, provide the means by which the more localised industry grids can be connected to provide regional correlations. Without them, it would be difficult (or even impossible in some basins) to undertake the complete basin analyses that form the basis of effective exploration and assessment. In addition the greater depth of the seismic profiles (~50 km vs 6-10 km by industry) provides fundamental information on the mechanisms of basin formation and their influences on the accumulation of minerals and hydrocarbons.

Virtually every developed nation supports a deep seismic profiling program, because of its importance in understanding many aspects of crustal evolution. From a narrow and solely basic research beginning about 20 years ago, the application of deep seismic profiling expanded rapidly through the 1980's with increasing application to petroleum and minerals exploration.

It has recently developed to the stage where there is limited acquisition by the industry for direct exploration purposes. Deep seismic profiling is a clear example of successful strategic research, and BMR is at the forefront of international developments and their applications to petroleum and minerals research (see section 2 on Relevance and Quality of Current Role).

In addition to the current program in this component, the Structural Geology group within the Division has been involved, with other Divisions, in research into the tectonic evolution of sedimentary basins and structural controls on their contained hydrocarbons. This research has led to the development of models and concepts which are currently being applied in both onshore and offshore petroleum exploration.

Products (1983/84-1987/88)

Maps

Published and in progress	-	50
Planned	-	20

Publications

BMR Bulletins, Reports, Records	-	82
BMR Research Newsletter Articles	-	17
Papers in outside journals	-	122
Papers presented at conferences	-	86

Seismic Data

Acquired and processed	-	3000 km
1987-1988 Acquisition	-	700 km

Costs (1988/89)

Operational	-	\$768 000
Salaries	-	\$1769,000
Total Cost	-	\$2537,000

Cost Recovery

Cost recovery from the mineral province studies within this component has been from map and publication sales, and is approximately \$1 000/annum. We expect a substantial increase in cost recovery over the next 2-3 years following release of the geochemical and geochronological databases in late 1988 (estimated gross income of ~\$100 000 over two years). Release of a wide range of products from the Mt Isa and Yilgarn projects will also increase revenue.

There has not been a major seismic data release since BMR took over the copy service, so no accurate records exist of income from data sales. However, we would expect revenue of the order of \$10 000/annum from future sales of Amadeus Basin and Canning Basin data. It is emphasized that BMR obtains many thousands of km of industry seismic data (some of it confidential at zero or very low cost for each of its projects. These data are then synthesised with the BMR profiles to produce basinwide interpretations. There is a substantial cost saving (hundreds of thousands of dollars) in this arrangement which would be endangered if BMR either priced its products too highly, or attempted to attract advanced industry funding for the seismic acquisition, with the inevitable confidentiality provisions.

Strategic Plan

Comments under "Strategic Plan" for component 3.1150 apply to the mineral province and related projects in this component. See also next section for general comments on the future of an integrated minerals research and assessment program.

A proposal is currently under consideration to undertake a regional synthesis and prospectivity assessment of the Proterozoic provinces of northern Australia. Such a project would follow naturally from projects 3.1150.1 (Mt. Isa) and 3.1150.2 (Proterozoic Framework). This region contains a significant number of Australia's largest and richest mineral deposits, but has not seen the same intensity or success of exploration in the last decade as, say, the Yilgarn Province and northeast Queensland. The project aims to stimulate and provide direction for exploration, by synthesizing data and information, producing regional geological and geophysical maps, acquiring new data in critical or poorly known regions, and researching into the origin of and prospectivity for new and known mineral deposit types. It would also as a matter of course, build up the knowledge base for provision of timely and effective advice to Government on land use and/or resource matters.

The deep seismic profiling program currently acquires, processes and interprets between 300 and 400 km of data per year. However, it has the acquisition capacity for twice that amount, at relatively modest extra cost (\$1000-1500/km), provided that agencies outside BMR undertake the bulk of the processing and interpretation. The mechanism for such collaboration exists via the Australian Committee for Reflection Profiling (ACORP), on which each state is represented. A five-year ACORP program has already been formulated.

Within the BMR program, future deep seismic profiling is planned for the prospective sedimentary basins and gold provinces of eastern Australia, and proposals for projects in northern and southwestern Australia are under consideration. Since 1982, the onshore seismic program has been largely directed to the more traditional targets within sedimentary basins and therefore to petroleum search. Recent research in BMR and overseas has, however, demonstrated the value of deep profiles in even complexly structured mineral provinces. Future BMR seismic programs should therefore alternate between petroleum and minerals provinces.

Costing of BMR Seismic Acquisition versus Contract

It is very difficult to make a direct comparison between BMR surveys and those undertaken by contractors for exploration companies, because BMR surveys are usually targetted at problems deep in the crust while exploration companies are concerned only with the top few kilometres. The recording parameters used are different.

Companies usually use vibroseis as the energy source for petroleum surveys, and they prefer high fold. For studies of the deep crust, low fold dynamite surveys are better.

The attached table compares the cost of the present BMR survey in the Canning Basin with estimates of company surveys in the Canning and Cooper Basins. The following points are relevant:

- (a) The costs attributed to a company were obtained from a seismologist who works for one of Australia's largest exploration companies.

- (b) The costs attributed to a State Government were obtained from the Chief Geophysicist of a State Government which has control over much of the Cooper Basin Permitting.
- (c) Costs are usually for Vibroseis surveys. Only one estimate was provided for dynamite. See the notes for how other estimates of dynamite surveys were costed.

BMR survey costs compare favourably with current industry costs.

Industry costs have been at rock bottom for the last few years, and the prices in the table reflect this. Contractors would be expecting to break even on these prices, but when the industry picks up, prices will rise considerably to what the market will bear.

There are three main reasons why BMR costs should be less than commercial prices:

- (a) BMR does not expect to make a profit.
- (b) BMR depreciates its equipment over its useful life (5-10 years). Industry depreciates it at between 7% per month in bad times and 15% per month in good times.
- (c) BMR generally pays its people less than industry, relying on security of tenure through the bad times as a carrot to keep them in good times.

The flexibility of BMR's own crew to adapt to changes in program, and indeed to changes in the objectives of projects as they emerge, should not be underestimated. Thus BMR is able to (a) add extra line-kilometres to the Canning Survey at the request of companies (and has also done this in the past in other surveys), (b) shift lines as appropriate to change the emphasis of the research direction, or even (c) completely rearrange its research projects without having to consider alterations to contracts, etc.

Company #1 Basin	\$/km Vibroseis	\$/km Dynamite
Cooper	2700 *1	4000 *1
Canning	3400 *1	5000 *1,*3
State Gov. Estimate	\$/km Vibroseis	\$/km Dynamite
Cooper	2700 *1,*5 3200 *1,*6 3800 *1,*7	4000 *4,*5 4700 *4,*6 5600 *4,*7
BMR Basin	\$/km Vibroseis	\$/km Dynamite
Canning	N.A.	2800 *2a 3000 *2b

Table: Comparison of BMR field costs with those for a major Australian petroleum explorer and producer.

Notes:

- *1 Includes processing; mobilisation costs included but would be minimised by sharing with other companies using same contract crew.
- *2a Includes processing to final stack of 4 s data. Full processing costs of 20 s data depend on research goal. Also includes all salaries and wages with overheads, equipment depreciation, vehicle hire, etc. Does not include mobilisation charges.
- *2b As for 2a, but includes mobilisation charges.
- *3 No figures for dynamite surveys in the Canning Basin were available. Estimated from cost of vibrator survey assuming ratio for Vibroseis/dynamite in Canning is the same as in Cooper.
- *4 Based on Company #1's estimate of Vibroseis/Dynamite costs
- *5 For large jobs, where the client can argue a good price. Mobilisation costs extra.
- *6 Jobs of 200-300 km. Many BMR projects would fall into this category. Mobilisation costs extra.
- *7 Jobs where there is a large amount of permitting over small land holdings. Mobilisation costs extra.

THE FUTURE OF MINERALS RESEARCH IN BMR

It is recommended that the minerals research and at least some of the minerals resource assessment functions within BMR be coordinated into a single Minerals Division. The Division should incorporate all of the geological, geochemical and geophysical expertise and facilities required to mount a genuinely multidisciplinary, regional minerals research program. In addition, it would have primary responsibility for the assessment of the nation's undiscovered mineral resources, and for provision of advice to government on land use issues concerning the minerals (sensu stricto) industry. It would be complementary in function to an onshore fossil fuels (and groundwater) division.

A Minerals Division so constituted would have two main functions

Carriage of multidisciplinary province studies. With current resources, only two such studies could be undertaken at any one time, and they would be selected according to the priorities outlined earlier, and, as now, following consultations with industry and the states. The province studies would continue to form the basis of the Division's primary role in support of the exploration industry, and represent the logical strategic research extension of the regional mapping program of the 1960's and 70's.

A national synthesis and prospectivity assessment role. This would be carried out partly in conjunction with the province studies, and would involve synthesis of available information, some new data acquisition to fill gaps, and maintenance of an overview of exploration and lands use. It would be accomplished by dividing the continent into geologically and geographically coherent regions for which an individual or a small group would have ongoing responsibility. Many of these individuals would also be working in the province studies. Input would be required from mineral commodity assessment specialists, whether from within or outside the Minerals Division. This function would provide the major minerals link to NRIC, and would provide the basis for advice to government on undiscovered resource assessment and competing land - use questions. It would also provide multi-province regional syntheses in support of the prospect evaluation component of the exploration industry.

These two functions would overlap and support each other, both operationally and in terms of information and output. In terms of strategic outcomes, the province studies program component would result in 4 or 5 thorough analyses of high priority mineral provinces per decade. The national assessment role could be expected to produce syntheses/assessments of the major mineral prospective regions of Australia by the year 2000, although it must be recognised that the primary function of this component would be the maintenance of a continuously upgraded national information/knowledge base.

The successful carriage of an integrated minerals strategic research and assessment program requires that planning, management and implementation of the program be organised to maximise the efficiency of the function. We therefore need to move somewhat away from our more discipline - oriented structure to one which is more functional, and to vertically integrate all of the disciplines required to achieve the function.

A proposed objective for a Minerals Division is as follows:

To provide a regional and national basis for improved exploration for and assessment of Australia's undiscovered mineral resources, by means of an integrated strategic research and prospectivity assessment program; to provide the technical basis for a national management policy for minerals.

It is suggested that the Minerals Division would be responsible two components:

. Mineral Province Studies

. National Regional Synthesis and Assessment

In both components, primary output would be in the form of integrated spatial data sets on electronic media, from which various types of maps, attribute databases, and reports could be produced.

RECOMMENDATIONS

That a Minerals and Land Use Division be established, with responsibility for an integrated geological, geophysical and undiscovered resource assessment program in the minerals area. The Division should include all of the relevant specialist groups (or parts of them) required to carry out this function.

That BMR be granted additional contract funds to enable it to retain a pool of 2-3 year contract geologists without ASL consequences, primarily to boost its capacity to undertake regional field programs. The contract geologists should be mostly recent graduates hired at junior levels. An important secondary training benefit would be that, a completion of their contracts, most of these geologists would be keenly sought by the industry.

That the deep seismic profiling program be maintained at its current staffing level, but that additional operational funds of about \$500 000/annum be allocated to double the data acquisition rate. Processing and interpretation of the additional data to be carried out largely by State ACORP groups.

1D DIVISION OF GEOPHYSICS

The function of the Division of Geophysics is to undertake airborne magnetic and radiometric surveys as an aid to mineral exploration; carry out research into methods of interpreting regional geophysical data; monitor seismic waves from earthquakes and nuclear explosions; carry out assessments of earthquake risk, and research methods to forecast earthquake occurrences; chart and model the geomagnetic field as an aid to navigation and mineral exploration; carry out observatory functions; and undertake geological and geophysical surveys in Antarctica.

In terms of fulfilling this function, the Division is responsible for the carriage of five components in BMR's program. What follows outlines the national needs, and program objectives to meet these needs, and the strategic plans. There is also a description of the products and the costs relating to each component.

Relevance and Quality

Component 3.1180 : Geophysical Mapping - Continental and Offshore

The geophysical mapping program has relevance to the mineral and petroleum industries and provides high quality products for the exploration industries. During 1987/88 these amounted to nearly 3000 maps and 400 magnetic tapes to over 125 companies.

Component 3.1310 : Earthquake and volcanic hazards

Earthquake risk assessment is most relevant to the development of Australia, as more and more of the land surface is occupied and as the structures being built become more technically complex, the potential risk from earthquake attack is increasing. This component is therefore becoming more relevant as time passes. It is important that the quality of the product be maintained so that risk assessments are of high standard.

Component 3.1320 : Monitoring of Nuclear Explosions

This component is most relevant in the development of a seismic system to monitor nuclear explosions. The BMR has in the last 2 years developed a world class detection system for identifying underground nuclear explosions. It has the capability to detect all coupled underground explosions with yields down to a few kilotonnes within the hemisphere centred on Australia.

Component 3.1330 : Geomagnetism

Geomagnetic data and models produced from this component are in demand for navigation, mineral prospecting, and fundamental geoscientific research for understanding the interior of the Earth. The palaeomagnetic apparent polar wander curves are essential for framework studies to delineate the spatial history of the Australian craton. BMR's geomagnetic products are renowned worldwide for their quality and reliability.

Component 3.1340 : Antarctic Onshore Surveys This work is relevant to the assessment of resources in the Australian Antarctic Territory and to the understanding of the geology of the region. The work is also relevant to Australia's territorial claims on the continent.

COMPONENT 3.1180: GEOPHYSICAL MAPPING - CONTINENTAL & OFFSHORE

National Needs

There is a national need for an integrated database of aeromagnetic, gravity and radiometric information covering the Australian continent and its margins. Regional geophysical data are of fundamental importance in developing an understanding of the geology of the Australian continent. As the surface geology becomes better known and exploration targets become deeper, there will be a greater reliance on geophysical data and geophysical techniques to determine geological structure and composition. It is, therefore, essential that BMR maintain a strong and identifiable geophysical capability.

Regional geophysical data are an essential requirement for petroleum and mineral exploration and resource assessment. The data are used by industry to assess resource potential, select prospective areas and plan more detailed exploration. Government uses the data to assess resource potential and determine land use policies.

Initial interpretations of the geophysical data are critical in targeting follow-up mapping and developing an understanding of the geology of the Australian continent.

Objectives

In terms of the national needs the current objectives are:

- To develop and maintain national magnetic, radiometric, and gravimetric databases for use in obtaining an understanding of the geology of the Australian continent.
- To ensure that the information is in a readily accessible and useful format for those involved in mineral and petroleum exploration and resource assessment.

- To provide interpretations of these databases in conjunction with other geological and geophysical information to study the geology of Australia.
- To enhance the value of the products by developing improved research methods of interpretation and data processing.

Strategic Plan

The strategic plan through 1992 is to provide systematic geophysical coverage of the Australian continent for gravity, magnetics and radiometrics. The airborne coverage has been flown according to contemporary priorities and the processing and release of data have been done as soon as possible after completion of the flying.

Since 1951 BMR has been systematically building the airborne geophysics database and from 1959 through 1986 it has operated two aircraft for this work. To speed up the rate of the availability of data, one aircraft was disposed of in 1987 and resources were reallocated to process the backlog of data obtained previously and to acquire data flown by industry and the States.

- In 1988 the magnetic database covers 90 percent of the onshore area, and at the present rate of progress a full survey cover will be provided onshore by 1993.
- Interpretation work has shown that about 17 percent of the existing data are not up to current standards and will require re-flying.
- The attached maps (pp 86-89) show the present position.

Gamma-ray surveys have been operated concurrently with many of the more recent magnetic surveys. By 1992, 45% of Australia will be covered with reasonable quality gamma-ray spectrometric data, 15% with poor quality analogue gamma-ray spectrometric data, and 5% with very poor quality scintillometer data.

The regional gravity survey on onshore Australia is complete to reconnaissance standards and is being improved on an opportunity basis using industry and State surveys and data from BMR research projects.

Because of the cost effectiveness of BMR's airborne operation (see later analysis) BMR will continue to operate its own aircraft to complete the first-pass airborne geophysical program at the end of 1992.

Strategic Plan Beyond 1992

Airborne Geophysics

The intention is to provide a fully digital data set suitable for the modern era of exploration, and to extend this coverage offshore.

After 1992 it is proposed that the strategic plan comprises a mix of the following:

Onshore

- (i) Refly the areas of substandard aeromagnetic coverage on land to modern specifications. With present resources this would take seven years to complete.
- (ii) Fly detailed airborne surveys to support key BMR projects, e.g., studies for land-use and critical areas for understanding the geology of Australia.

Offshore

- (i) Systematic coverage of the Australian continental shelf, to determine the depth to magnetic basement, the position of volcanics in the sedimentary pile, and in areas of thin sediments (such as the Gulf of Carpentaria) to extend the aeromagnetic coverage to map basement geology.
- (ii) Carry out aeromagnetic surveys in marine areas prior to major ship surveys, in order to better define structure, and determine optimum orientation for the ship traverses.

When an airborne gravity system is available it would be attractive to carry out combined magnetic gradiometer, gamma-ray spectrometric, and gravity surveys over the 55% of Australia without reasonable quality gamma-ray spectrometric surveys.

By 1992 the BMR's aircraft will be coming to the end of its useful life. The range of programs, including offshore work, required after 1992 will require upgrading of equipment, and different aircraft specifications.

At present an analysis of options with appropriate costings is being prepared, but it is clear that upgrading the areas covered by substandard data must be a high priority.

Australian National Gravity Database

An accurate knowledge of the gravity field over Australia is important to our National interest for :

- i) Mineral exploration - a complete set of gravity anomaly maps enables exploration companies to define areas of potential interest.

A complete set of gravity anomaly maps which have been adjusted to the international gravity datum and are error free are needed by exploration companies to define target sites for mineral and oil searches. The gravity anomaly maps can be used in conjunction with magnetic, radiometric and seismic data to construct geological models of the Earth's crust so that areas of potential mineralisation can be identified.

- ii) Defence - the gravity field is required to accurately plot the course of satellites and ballistic missiles over Australia and to calibrate inertial navigation systems.

A major uncertainty in the prediction of satellite orbits and rocket or missile paths is variation in acceleration due to irregularities in the earth's gravity field caused by density variations in the earth's crust and mantle. The long wavelength anomalies are determined by the orbital paths of past satellites, the short wavelength anomalies are determined over oceans by laser altimeter measurements from satellites and over land by gravity observations. The input required over land is accurate values for $1^{\circ} \times 1^{\circ}$ square means.

- iii) Surveying - accurate gravity anomalies are required to accurately map the geoid and determine the deflection of the vertical positions and elevations and to accurately define the physical ellipsoid.

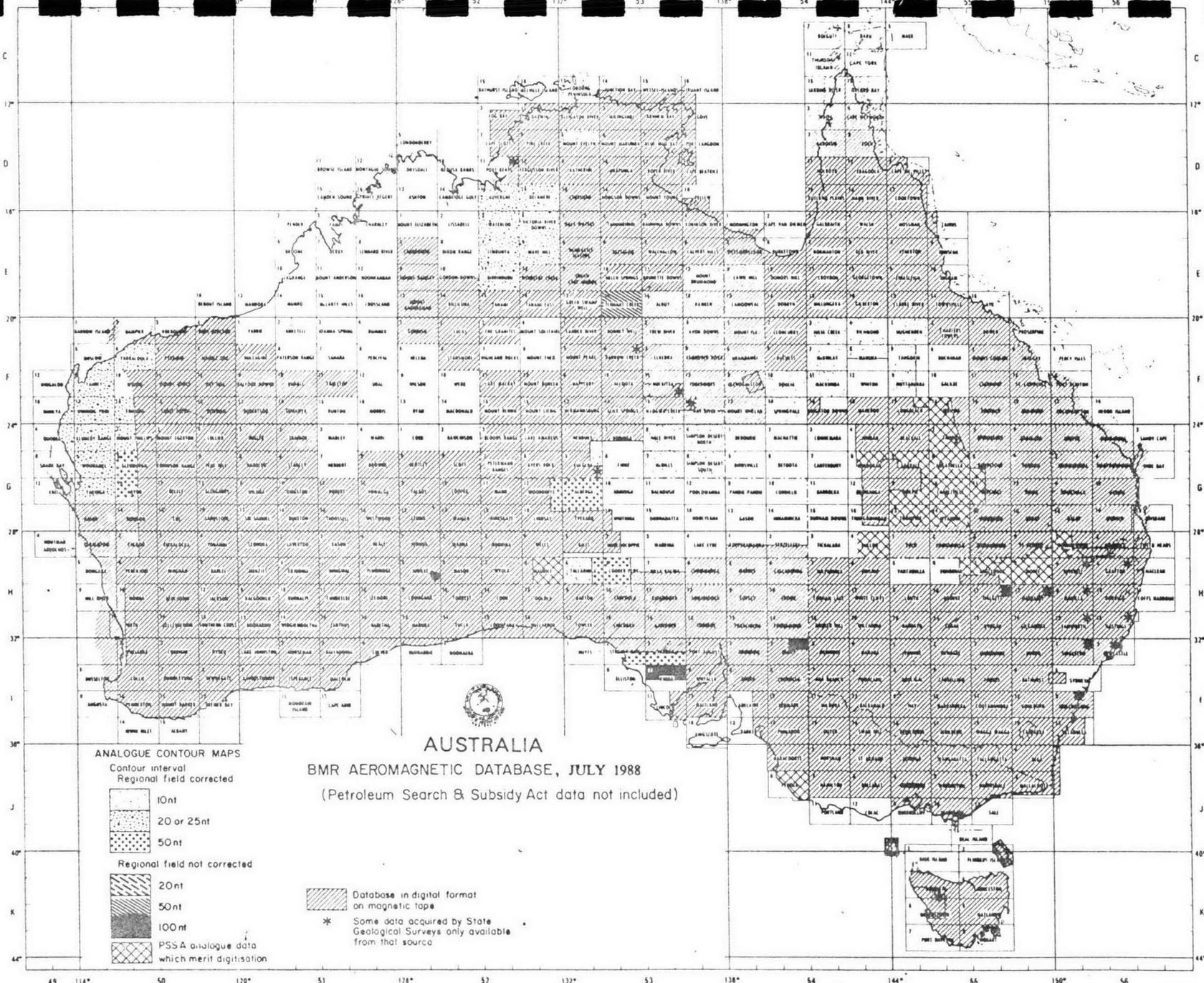
Modern GPS and Doppler transit satellite receivers measure position on a reference ellipsoid. The latitude and longitude are relatively easily transformed to the land geodetic reference frame but the heights cannot be transformed to altitude above sea-level without knowledge of the geoid/spheroid separation. This can be roughly modelled from measuring deflections of the vertical but is most accurately derived from gravity anomalies. Hence to get precision results from GPS receivers a geoid map will have to be calculated using gravity. The gravity observations have been collected by BMR but additional manpower is required to remove all systematic and spot errors from the database and to produce accurate maps of the continental and offshore areas of Australia.

- iv) Metrology - accurate acceleration values are required to calibrate instruments dependent on mass and pressure measurements.

A knowledge of absolute acceleration at locations where precise engineering is carried out is necessary to calibrate deadweight pressure standards to obtain an accurate standard of force. We routinely get requests from air and seaports for accurate estimates of gravity acceleration.

In the period 1959 to 1974 BMR carried out helicopter gravity surveys of continental Australia with a station density of one station per 130 km^2 or better. These data combined with much other data from BMR, the States and companies are now on computer tape, and are available for purchase. Marine gravity data in the Australian region are mainly collected by BMR. These data are generally available on computer tape from the organisation that collected the data, but only on a ship cruise basis, not integrated.

The national need is for all gravity data to be available from one place, and for the data to be reduced, so the surveys are compatible and free of data errors. There are at present only two people working on the gravity database. The provision of two extra staff would enable the national objectives to be achieved in a reasonable timeframe.



AUSTRALIA

BMR AEROMAGNETIC DATABASE, JULY 1988
 (Petroleum Search & Subsidy Act data not included)

ANALOGUE CONTOUR MAPS

Contour interval
 Regional field corrected

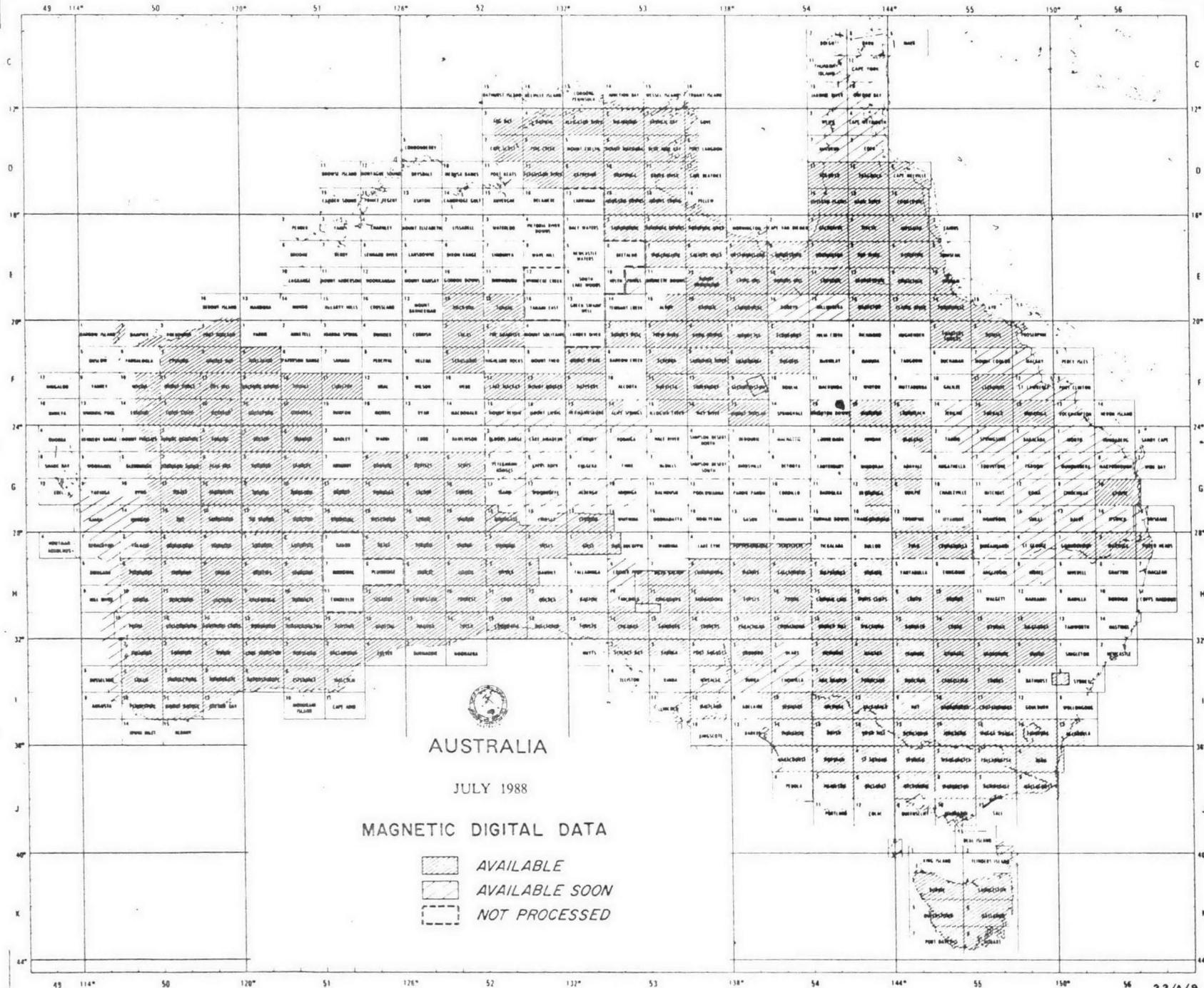
- 10nt
- 20 or 25nt
- 50nt

Regional field not corrected

- 20nt
- 50nt
- 100nt
- PSSA analogue data which merit digitisation

Database in digital format on magnetic tape

* Some data acquired by State Geological Surveys only available from that source



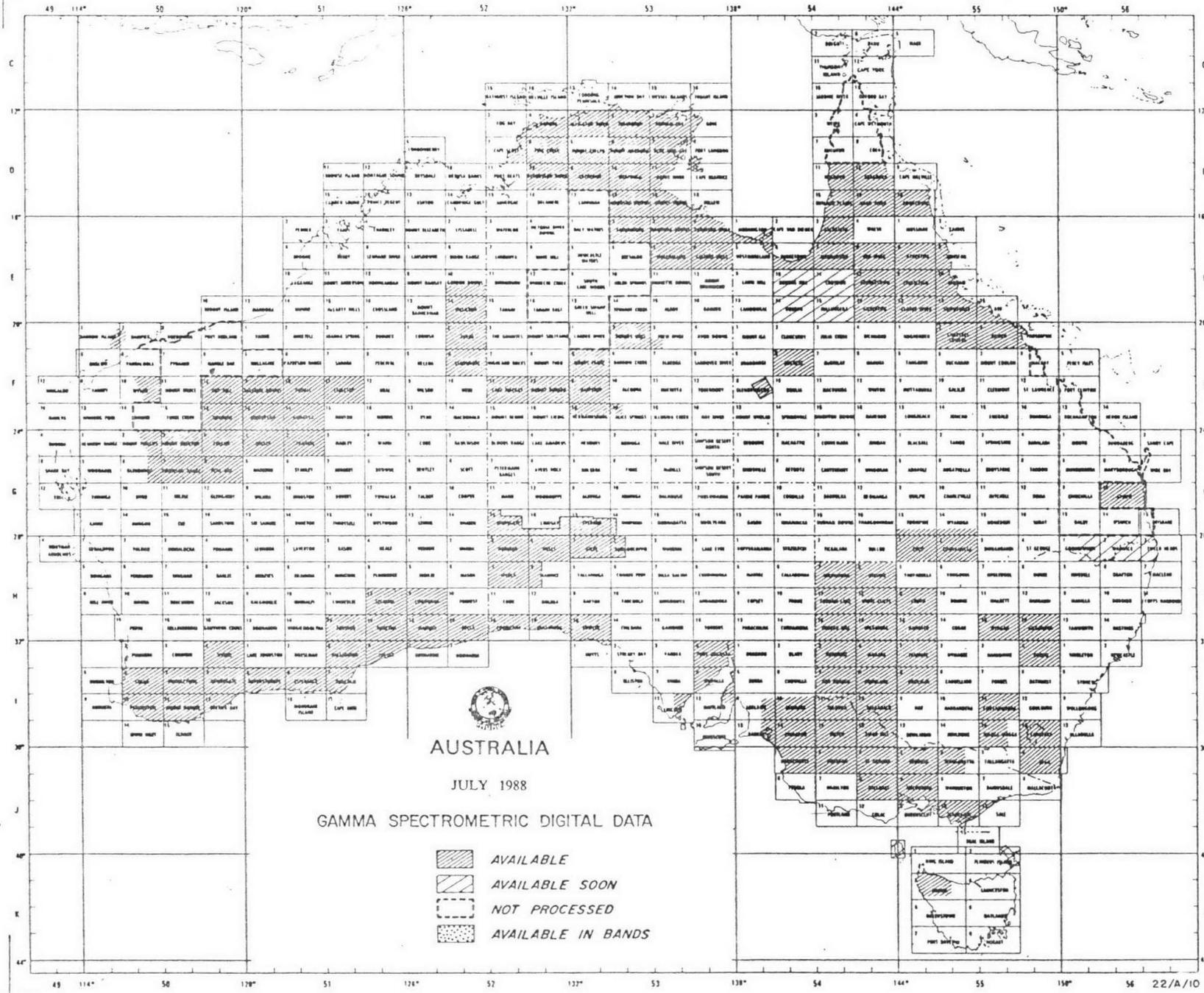
AUSTRALIA

JULY 1988

MAGNETIC DIGITAL DATA

- AVAILABLE
- AVAILABLE SOON
- NOT PROCESSED

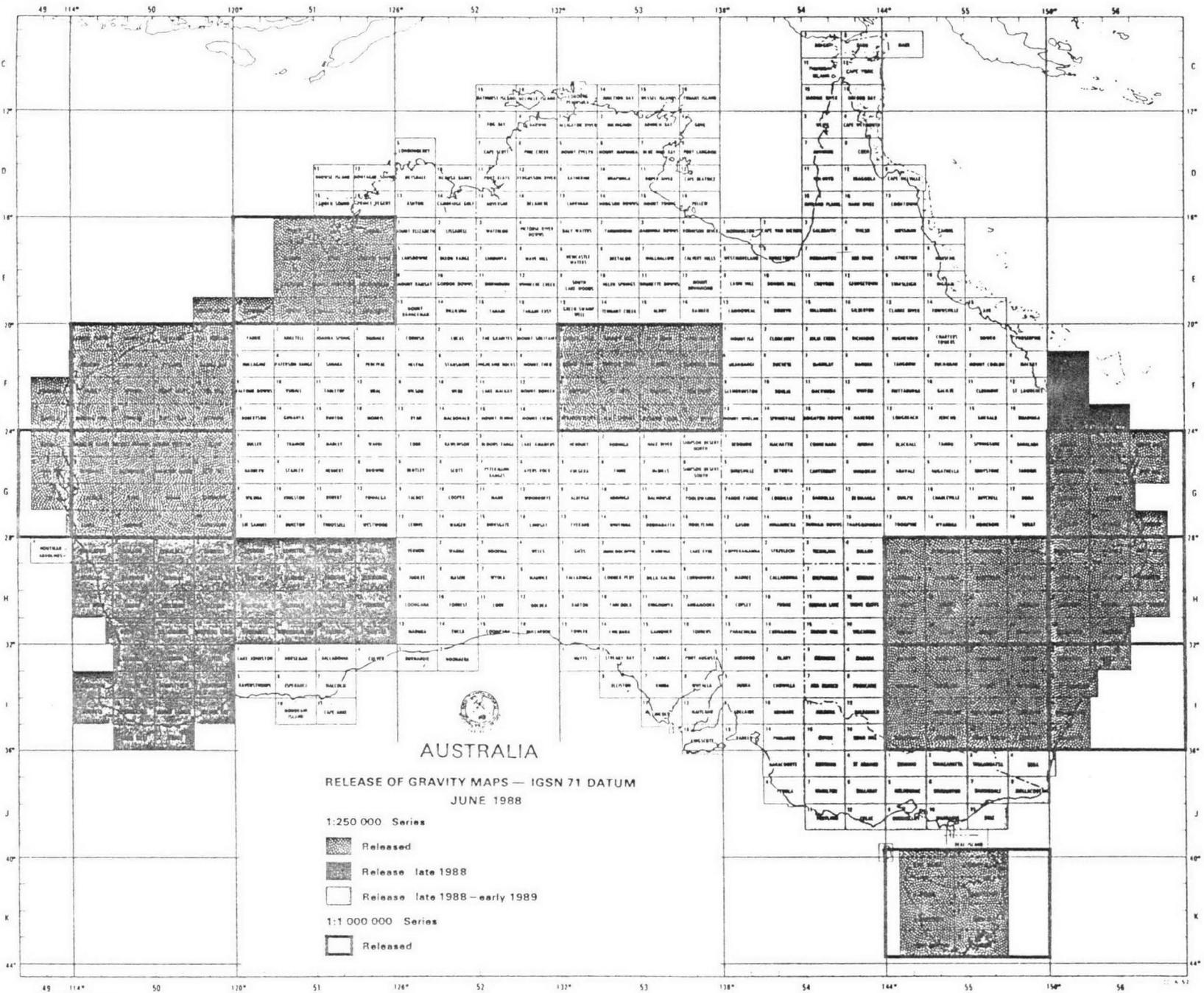
Close Line 7/88 (FORMAT)
 DATE Aug 7/86 (FORMAT)




AUSTRALIA
 JULY 1988

GAMMA SPECTROMETRIC DIGITAL DATA

-  AVAILABLE
-  AVAILABLE SOON
-  NOT PROCESSED
-  AVAILABLE IN BANDS



AUSTRALIA

RELEASE OF GRAVITY MAPS — IGSN 71 DATUM
JUNE 1988

- 1:250 000 Series
- Released
 - Release late 1988
 - Release late 1988 — early 1989
- 1:1 000 000 Series
- Released

Based on 10-12/7

Estimated Financial and Human Resources for 1988/89:

Operational Staff	32.0
Salaries	\$1.060 million
Operational Funds	\$1.758 million
Total Expenditure	\$2.818 million

Products

<u>Product</u>	<u>Sales 1987/88</u>
----------------	----------------------

Hard Copy

Airborne geophysics contour maps	1,912
Airborne geophysics profile maps	781
Gravity contour maps	116 *
Pixel maps	16 **
Other maps	356
Reports, Bulletins	39

Total of 3,181 maps sold to 125 companies, numerous individuals and universities. Total proceeds in 1987/88 were \$56,000.

Digital Data

Airborne geophysical data	398 Sheets
Gravity data	6 Sets

Sold to 30 companies. Total proceeds in 1987/88 were \$130,500.

Timeliness

At present airborne geophysical data processed in-house are available about 6 months after contractors supply flight path recovery fixes i.e., available about 12 to 18 months after flying has finished. Data processed by contract are available usually 2-3 years after flying has finished. Incorporation of a radio-navigation system will improve timeliness so that data processed in-house will be available within six months of the finish of flying.

* No new releases of pixel maps or gravity maps in 1987/88 resulting in depressed sales.

** 37 pixel maps sold in the period 1 July - 15 August 1988 following release on 1 July 1988.

Prices

<u>Hardcopy</u>	<u>Item</u>	<u>Price</u>
From Copy Service: (NRMA Building)	airborne geophysical contours	\$25 - paper
	(magnetics & radiometrics)	\$75 - film
	gravity contour maps	
	Flight line maps and stacked profiles	\$5 - paper \$15 - film
From Information Sales (BMR)	Magnetic pixel maps	\$100 greyscale \$150 colour \$400 - set of 4 (3 greyscale, 1 colour)
	Gravity, magnetic printed maps	\$6
	Magnetic domains, dykes	\$6
<u>Digital Data</u>		
	Airborne geophysical data	\$500/Sheet area/ Survey
	Gravity database -	
	- position located	\$500
	- grids	\$500

Philosophy for Rate of Cost Recovery

Regional Geophysical Data

A major objective in the Corporate Plan of the Department of Primary Industries & Energy is to optimise the contribution of Australia's petroleum and mineral industries to the Australian economy and the wellbeing of Australians.

Specifically the plan indicates that it is part of the Department's mission to enhance productive capacity and develop a productive industry structure, with emphasis on the encouragement and facilitation of more efficient productive industries which will encourage new income creation activities, and export activities.

To this end the provision of regional geophysical data has made and will continue to make a significant contribution to meet this objective.

Since 1968, BMR's magnetic, radiometric, and gravity surveys, and consequent publication of maps have resulted in some of the anomalies being drilled by private enterprise and the discovery of the important Savage River (Tasmania) iron ore deposits, the Galilee Basin (Queensland) coal deposits, Olympic Dam (Roxby Downs, (South Australia) copper-uranium-gold deposit, the Nabarlek and Ranger (Northern Territory) uranium deposits, the Yeelirrie (Western Australia) uranium deposit, the Mayningee Channel (Western Australia) uranium deposits, and the Agnew-Mount Keith (Western Australia) nickel deposits.

Petroleum exploration companies, having used BMR's geophysical results, carried out further exploration and found more oil and gas deposits onshore in Queensland (Cooper Basin and Surat Basin) and Western Australia (Canning Basin); and offshore from Western Australia and the Northern Territory.

The royalties and taxes from these deposits would have paid for the regional geophysical operations many times over.

In recent years we have raised the levels of cost recovery to approximately five percent of the total budget. This can be achieved with the present digital data, Copy Service, and pixel map pricing. Printed maps from Information Sales should be increased in price to be consistent with the Copy Service prices.

However, we are receiving indications of consumer resistance from the recent price increase and we believe that if rates of cost recovery were increased significantly in this sector then the exploration effort in Australia would be inhibited. Small companies may not purchase data which could provide the key to finding new orebodies, only the large multinational companies would use the data and the overall revenue to Governments from royalties and taxes may be reduced.

Therefore, if any significant increases are proposed over and above the present levels, it is recommended that an indepth economic analysis be made to set an appropriate pricing policy that is consistent with maximizing overall national benefits.

Comparisons of BMR Costs and Contract Costs for Airborne Geophysical Data

As outlined above the present strategy is to operate BMR's Aerocommander until the end of 1992 rather than complete the task by contract flying.

Attached are (1) an analysis of present BMR costs; (2) an analysis of a proposal for further cost reduction; (3) an analysis of contract overhead costs and (4) a comparison between contract and BMR costs obtained during 1987/88. There are six main reasons why BMR rates are significantly lower than contractors:

- (1) No profit margin is included in BMR's costs. For example, in 1986/87 Aerodata reported a profit of \$191,000 and Austirex reported a profit of \$770,000.
- (2) BMR probably gets more kilometres of surveying a year from its aeroplane. For example, in 1987/88 BMR surveyed 147,000 km. We understand Aerodata would consider 100,000 km a good annual coverage from one aircraft.

- (3) We believe that BMR has a more cost effective arrangement for its aircraft maintenance and crewing contractor than do the main contractors.
- (4) Gross incomes of BMR staff are probably less.
- (5) BMR has fewer crashes and incidents.

Apart from the straight cost benefits of flying BMR's aircraft, there are a number of other advantages in operating in this way.

- (1) There is better control over the final results, because the management of a survey from start to finish is contained in one organisation.
- (2) Surveys can be tailor-made for BMR's requirements and there is flexibility to change survey designs or extend surveys at short notice, without having to re-negotiate contracts.
- (3) For land use surveys, such as those flown over the Kakadu Conservation Zone, it is better for BMR to fly them rather than letting the surveys to open tender, because of the sensitivity of the land issues involved.
- (4) Maintaining airborne geophysical expertise within the Commonwealth allows effective involvement by the government in such things as the COSMOS 1900 re-entry problem.

Finally, one major unknown is the trend of contract prices for BMR if we did not have our own facilities. Without these our position is weakened in any contract negotiations.

Airborne Survey Cost Estimates - 23 August 1988

BMR Costs

Based on 1987/88 financial year - 147,000 line kilometres surveyed in regional surveys.

<u>Item</u>	<u>Total Cost</u>	<u>Cost/km (\$)</u>
Aircraft maintenance and crewing and running costs	330,000	2.24
Staff costs - 15 staff (see Attachment 1)		
- salaries, including recreation and sick leave	469,010	3.19
- AIILOT	30,000	0.20
- overtime	9,000	0.06
Stores and incidentals	35,000	0.24
Travelling allowance, fares	85,000	0.58
Equipment replacement (\$30,000/year)	30,000	0.20
Flight path recovery (\$5,000/Sheet/13000km)		0.38
Data General costs (\$2,600/sheet)		<u>0.20</u>
		<u>\$7.29</u>

Staff Costs

Acquisition

- 1 - OIC (Sc. 3)
- 1 - Flight path planning & mapping (D02)
- 3 - field operations (Sc.2, T02, TA2)
- 1 - flight path recovery (ST01)
- 1 - data acceptance, editing (T02)
- 1 - technical backup (ST01)

Processing

- 1 - OIC, problem solver (Sc.3)
- 3 - Analysts (Sc.2)

Map Annotating

1 - DO2
1 - DA2

Administration

2/3 - Section Manager)
1/4 - Divisional Administration) say 1 x Sc.4

<u>Level</u>	<u>Number</u>	<u>Salary</u>	<u>Contract</u>
Science 4	1	42,170	42,170
Science 3	2	38,125	76,250
Science 2	4	32,956	151,824
ST01	2	30,484	60,968
T02	2	28,160	56,320
DO2	2	28,160	56,320
TA2/DA2	2	22,579	<u>45,158</u>
			<u>469,010</u>

AILOT + Sunday Duty: 9 months of year, Sc.2, T02
 $3/4 (30,125 + 28,160) \times .6 = \$30,000$

Overtime $\$22,527 \times 2/3$ (year) $\times \underline{14 \text{ hrs/week} \times 1.5}$
 36.75 =-\$9,000

Opportunity for Operational Cost Reduction

Further savings can be obtained by using a radio navigation system, this would cost approximately \$100,000 and would reduce expenditure in flight path recovery (contracts and processing) by nearly \$0.80 per kilometre (see below). Thus full savings can be achieved with one year's flying.

Savings:

Item	Total Cost (\$)	Cost/km (\$)
Planning and recovery staff		
- ST01, D02	58,644	0.40
Flight path recovery (\$5,000/Sheet/ 13000 km)		<u>0.38</u>
		<u>0.78</u>

i.e., surveying costs \$6.51 per km.

Contract Overheads

If all BMR's airborne survey acquisition and processing were done by contract, additional costs would be incurred in leading the project and in administering and supervising the contracts.

Tasks would include

- Survey planning
- drawing up survey specifications
- drawing up tender documents and contracts
- evaluating tenders
- supervising acquisition operations
- supervising processing
- checking incoming data
- regriding and re-contouring data to check validity, and producing BMR standard contours and maps
- adjusting data
- adding BMR title panels and annotations
- archiving data.

In addition, map annotation would have to be done (as for BMR surveys).

COMPONENT 3.1310 EARTHQUAKE AND VOLCANIC HAZARDS**National Needs**

As part of BMR's national role to be a primary source of geoscience data and information for government, industry, and the general public, it operates a network of seismographs throughout the Australian region, including the Australian Antarctic Territory. The data obtained from these seismographs are used to fulfil national and international obligations, and as a basis for seismological research programs.

There is a significant earthquake risk in Australia; it is important that the assessment of this risk is known as accurately as possible to minimise building damage and human injury.

Australia occupies a considerable land area of the globe, it is important that we fulfil our obligations to provide seismological information from worldwide and local earthquakes that are recorded in the Australian region.

There is as yet no model which will adequately describe the occurrences of intra-plate earthquakes. If we can make progress in determining such a model it will benefit Australia and the rest of the world because it will then be possible to obtain forecasts on the occurrences of these potentially damaging earthquakes.

Volcanic eruptions are hazardous to aircraft, it is important that these hazards are mitigated in the Australian region.

Objectives and current strategic plan

In terms of the national needs the current objectives are:

- . To assess earthquake risk throughout the Australian continent.
- . To monitor and interpret seismic waves from near and distant earthquakes and make these data available, as a contribution to national and international seismology.

To develop an understanding of the structure and tectonics of the Australian region, with particular emphasis on intra-plate seismicity.

To assess and mitigate the hazard to aircraft caused by volcanic eruptions.

Strategic Plan

To achieve these objectives BMR operates a national network of seismographic and strong motion stations. The long term goal is to locate all earthquakes in the Australian region with magnitudes of three or greater. Over the next three years it is planned to complete the national network by installing seven new stations and upgrading seven key stations with new broadband sensors.

At present BMR operates 27 stations and two have been upgraded already with broadband sensors.

The seismographic stations are supplemented by strong motion accelerographs in areas of higher than normal earthquake risk, so that the ground motion close to earthquake epicentres can be measured. The plan is to deploy these instruments in Western Australia, southeastern Australia, and in aftershock zones associated with large earthquakes.

The data from BMR's permanent national seismographic network are supplemented by data from regional networks operated by the States (Geological Survey of Queensland, South Australian Department of Mines and Energy, Western Australian Water Authority) and Educational Institutions (Australian National University, Phillip Institute of Technology, University of Queensland, St. Ignatius College, Riverview, and the University of Tasmania).

In the context of improving the assessment of earthquake risk in Australia, new earthquake magnitude scales will be developed over the next few years, micro-zonation studies will be completed for the Perth urban area, and damage and surface deformations from significant earthquakes will be studied where appropriate.

The definitive earthquake database for the Australian region will be maintained and data will be supplied on a regular basis to the International Seismological Centre for final hypocentral determinations and the US Geological Survey for preliminary determinations. Special requests involving data for large and significant earthquakes will be processed for national agencies such as the National and State Disaster Organisation; and the media. Similar requests from overseas institutions such as the Tsunami Warning Center in Hawaii, seismological centres in Indonesia, New Zealand, Papua New Guinea and other countries, and international news services, will also be dealt with.

PRODUCTS

Database

Data from all earthquakes recorded by Australian seismographs are distributed regularly both in Australia and around the world.

A database of earthquakes in the Australian region is maintained for use by engineers, the media, seismologists, insurance companies, research institutions, etc. This database includes the results of analyses of the more important Australian earthquakes.

Publications

BMR Bulletins containing isoseismal maps (133 in total) of Australian earthquakes for the period 1875-1983, have been published. These are standard texts for those requiring information on earthquake risk in Australia.

Annual seismological reports are produced annually. These contain definitive information on all earthquakes of Richter magnitude 3 or greater that were located in the Australian region for the calendar year concerned. They also provide information on Australian seismicity and on the effect of earthquakes both nationally and globally.

BMR produces two monthly lists of earthquakes, mainly for insurance companies. These are (A) a national list covering the whole of the Continent and (B) a detailed list of earthquakes for Western Australia.

The Western Australian list contains all earthquakes known to have occurred in Western Australia for the month concerned. The national list contains all earthquakes known to have occurred in Australia with Richter magnitude 3 or greater. Each list is on sale for \$25 per month or \$250 per year.

Special Requests

Special requests are dealt with on a user-pays principle. The earthquake data file contains over 20,000 earthquakes that have occurred in the Australian region (0-90°, 100-165°E) since 1875. Data searches, printouts and plots can be provided for a minimum charge of \$50 per printout.

Timeliness of Products

The monthly list of earthquakes are produced within eight weeks after the end of the month; the seismological reports are published within three years after the end of the relevant year. The delay in publication of the reports is due mainly to a lack of resources. The hiring of one extra scientist would rectify this situation.

Cost Recovery

The opportunities for direct cost recovery are few. At present the cash recovery from the sale of annual reports, special publications and seismological data is about \$5,000 per annum. The actual but hidden cost benefit is more substantial. As a result of improved seismic zoning techniques and the introduction of an earthquake building code (SAA 2121-1979) incorporating the BMR's seismic zoning map of Australia, the damage and injuries resulting from an earthquake in a recognised seismic zone should be substantially less than would otherwise have been the case. In the eventuality of a major natural disaster, the Government normally pays a large portion of the cleanup and rehabilitation costs and compensation. Substantial savings should, therefore, accrue to the Federal Government as a result of appropriate zoning regulations.

The potential damage from earthquakes is increasing as the continent is developed and as buildings occupy more of the land area. The table below indicates the known damage caused by earthquakes in Australia since 1950.

Damaging Australian earthquakes, 1950-1988.

Date	Place	Magnitude	Damage	
			"A"	"B"
03/01/54	Adelaide, SA	5.4	\$8.8M	\$58M
22/05/61	Robertson/Bowral, NSW	5.5	\$0.5M	\$2.8M
14/10/68	Meckering, WA	6.8	\$5.0M	\$23.6M
10/03/73	Picton, NSW	5.5	\$0.5M	\$1.8M
02/06/79	Cadoux, WA	6.2	\$3.7M	\$7.0M
13/02/86	Lithgow, NSW	4.3	\$65k	\$70k
22/01/88	Tennant Creek, NT	6.8	\$1M	\$1M

Note: Column "A" is in contemporary dollars, Column "B" is in 1988 dollars.

Clearly, a moderately sized earthquake near a large population centre could cause very large damage if buildings are not designed and constructed to withstand earthquakes.

As part of BMR's national role, it should continue to operate seismographic observatories throughout the Australian region, including the Australian Antarctic Territory. The level of resources for this work should not be reduced below current allocations.

One avenue for cost recovery that could be explored is that of imposing a levy on earthquake insurance policies (often included in the fire or home owner's policies) sufficient to cover the complete running costs of the earthquake and volcanics program at BMR's Australian Seismological Centre. A small percentage (say 0.2%) of the annual premium could probably be sufficient to cover the costs and would not be too burdensome to the insured. The collection could be accomplished by the insurance companies.

Financial and Human Resources

For 1988/89 the resources allocated to this component are:

Staff

ASC operations (including Mundaring)	10
ESU	5.5
Geophysics Management & Cartography	<u>1.5</u>
	<u>17.0</u>
Total cost 17 x \$35,000	595,000
Operations	292,500
* Plant and equipment	<u>200,000</u>
	<u>\$1,087,500</u>

* This figure is larger than normal because this year's allocation includes a large component for a major equipment upgrade.

COMPONENT 3.1320: MONITORING OF NUCLEAR EXPLOSIONS**National Needs**

This work is carried out as part of the Government's Policy to limit the spread and extent of nuclear weapons by developing appropriate treaty verification monitoring systems, so that the threat of nuclear war is reduced.

Objectives

To establish and operate a national facility to detect and provide information on underground nuclear explosions, and an international seismological data centre, as a contribution to the attainment of a Comprehensive Nuclear Test Ban Treaty (CTBT), in accordance with Cabinet Decision 3996 of 30 July 1984.

Strategy

There are two basic goals in this work. The first is the development of a national seismographic facility to identify underground nuclear explosions and the second is to develop an International Data Centre (IDC) in Canberra which will be an integral part of an international system to be developed under the auspices of the Conference on Disarmament, to monitor seismic events world-wide.

The first stage, that of upgrading the national seismographic network, is about 2/3 complete and should be finalised by 1990. This relies on telemetering digital data to the Australian Seismological Centre, Canberra from the Warramunga and Alice Springs Seismic Arrays plus the output from stations in the upgraded national network.

The second stage (to set up an IDC) is progressing slowly but an experiment to test a fully fledged monitoring system is scheduled for 1990. If this is successful and political agreement can be obtained to implement treaty verification procedures, the Australian IDC will become operational. This stage will probably require more resources, but the extent of these resources cannot be assessed at this time because the specifications defining the responsibilities and operational procedures of the IDCs have not yet been determined.

The nuclear monitoring and earthquake seismology activities will remain strongly linked because of the common resources and facilities needed for both components.

Products

Timely information on the detonation of underground nuclear explosions, and provision of advice to the Australian Government and, in the near future, the UN Secretariat.

Estimated Financial and Human Resources for 1988/89:

Staff

10 from Geophysics Division (ASC)

1 from ESU

1 Management from Division of Geophysics + Cartography

12 x 35,000

420 000

Operations

402 000

Plant and Equipment

105 000

\$927 000

There is no cost recovery for this component.

COMPONENT 3.1330: GEOMAGNETISM**Introduction**

The program in geomagnetism is designed to help develop and exploit applications of geomagnetic phenomena and to assess geomagnetic "risks".

The first part of the program relates to the present-day and recent (historical) behaviour of the Earth's magnetic field. The second relates to the pre-historical (paleo) magnetic field. There is considerable overlap between these areas, particularly in studies of the nature and origin of the field, which demand accurate information about the modern as well as the palaeomagnetic field.

As the primary national geomagnetism organization, BMR has an obligation to provide certain services and advice to the Government, industry, defence, academic institutions and the general public.

Present-Day Geomagnetic Phenomena**National Needs**

We need the capability to exploit geomagnetic phenomena for the following applications.

Direction finding

- * Charts and numerical models of the geomagnetic field over the Australian region to provide compass information for navigation and direction finding (aviation, nautical, land survey and mapping applications)

Mineral exploration

- * Regional (Australian) and international geomagnetic reference field models as a basis for identifying magnetic anomalies associated with crustal structure and mineral deposits.

- * Secular variation information (numerical models) to permit magnetic survey data collected at different times to be compared.
- * Strategic research into geomagnetic methods for mineral exploration, e.g. correction for time-dependent fluctuations of the field during aeromagnetic or marine magnetic surveys.

Military applications

- * Navigation and direction finding (as above).
- * Magnetic detection of ships, submarines, targets, etc. based on their associated magnetic anomalies.
- * Geomagnetic risk assessment (see below).

Geomagnetic risk assessment

- * There are certain geomagnetic risks, mostly related to solar induced disturbances of the field, which can
 - disrupt radio and satellite communications and perturb the orbits of satellites
 - induce voltages in pipelines, and overhead & underground cables
 - accidentally trigger magnetic detection devices
 - influence the shielding properties of the Earth's magnetic field against incoming radiation, and hence modulate weather patterns.

Special Antarctic Science

- * Australia has a policy of maintaining an active scientific program in the Australian Antarctic Territory (AAT). Geomagnetic observatory and survey programs take advantage of Antarctica's unique setting and are conducted by all "Antarctic" nations.

Geomagnetic services

- * A national service facility and centre of expertise (for training, instrument testing and calibration, advisory service).

Program and Objectives

The objective of the program is to provide the geoscientific framework which will serve directly, or help indirectly, to satisfy the above national needs. The emphasis is on solid-earth geoscientific applications, although some consideration of external magnetic field effects is essential. Development of an understanding of the nature and origin of the geomagnetic field and its transient, daily and long-term variations is necessary in order to achieve the program objectives.

Geomagnetic monitoring

BMR operates the Australian (and AAT) network of permanent magnetic observatories, and conducts a regional magnetic survey every 5 years to re-occupy 80 stations throughout the Australian continent, AAT, and the South West Pacific region. This activity accounts for approximately 80% of staff-years and a somewhat larger proportion of the budget for "present-day" geomagnetism.

Geomagnetism research

Research focuses on three themes.

- * Mathematical modelling of BMR and other magnetic survey data to obtain, and regularly update, a regional picture of the geomagnetic field over Australia (for navigational, military and scientific purposes, as well as for distinguishing between core and crustal fields for mineral exploration).

- * Investigation of the daily and transient time-dependent fluctuations of the magnetic field over Australia as a means of tackling the long-standing aeromagnetic diurnal correction problem (see below), and the distortion of magnetic observatory and repeat station records caused by electric currents in the oceans surrounding Australia.

- * Synthesis of data and analysis of the long-term variations of the geomagnetic field (on time scales of decades to millions of years) to gain an understanding of the origin and behaviour of the Earth's field. Such an understanding is essential for predicting the secular variation (the monthly to yearly gradual changes in the field that affect all our observations, field models and charts), and is the physical basis of all magnetostratigraphic and palaeomagnetic reconstruction studies.

The program has been developed after extensive consultation with Government scientific organizations, the Australian Defence Forces, Aviation and Mapping organizations, interested BMR groups, and particularly with the aeromagnetic exploration industry. Workshops have been held to facilitate this process; the program is modified in the light of developing trends.

Geomagnetic services

BMR provides a nucleus of expertise in geomagnetism and applications of geomagnetic phenomena, a database of geomagnetic observatory and survey information, accurately maintained magnetic standards for instrument calibration, an instrument calibration and testing service, a magnetic materials testing service, and training in magnetic observatory and survey methods.

Strategic Plan

To provide an appropriate service to meet national and international obligations, it is our intent to perform the following during the next 5 years.

- Achieve a balanced observatory network by bringing an observatory on-line in Alice Springs and upgrading the Darwin station to a full observatory.
- Complete the upgrade of all observatory equipment to modern digital standards and install full telemetry of data to Canberra from all observatories.

- Increase the level of automation of magnetic observatories and regional survey methods to reduce demands on staff without compromising data quality.
- Provide automatic computation and real-time availability of geomagnetic activity indexes. (This work will complement the results from the Ionospheric Prediction Service). In concert with British, U.S. and other networks this will provide warning of disruption to world-wide radio and satellite communications and blinding of over-the-horizon radars.
- Improve models and charts of the geomagnetic field and its annual variations for navigation, defence, reduction of aeromagnetic and marine magnetic survey data etc.
- Exploit the potential of satellite magnetometry for providing accurate regional models of the geomagnetic field and its secular change.
- Further investigations of the time-dependent fluctuations of the magnetic field.
- Improve our understanding of the behaviour and origin of the geomagnetic field, as a basis for all geomagnetic investigations, and particularly to improve predictive models of the field.

There are long-standing international traditions about the free exchange of magnetic observatory data. The Earth's magnetic field does not recognize national boundaries, and investigation and exploitation of geomagnetic phenomena often necessitates a global perspective. It is recognised internationally that Australia (including the Australian Antarctic Territories, AAT), is particularly important because of its dominant position in the Southern hemisphere (the Australian region covers approximately one-eighth of the Earth's surface).

As part of BMR's national role, it should continue to operate geomagnetic observatories throughout the Australian region, including the Australian Antarctic Territory. The level of resources for this work should not be reduced below current allocations.

Palaeomagnetism (pre-historical geomagnetism)

Certain rocks preserve a record of the ancient geomagnetic field. This can be exploited to investigate tectonic relationships between crustal blocks, the evolution of mineral provinces, as a geological dating tool, and also to determine the long-term behaviour of the geomagnetic field.

National Needs

In terms of developing a comprehensive understanding of the geology of the Australian continent, its offshore areas and the Australian Antarctic Territory, it is essential to find out when and how the continent was assembled. Palaeomagnetism has a major role to play in determining the tectonic relationships both between the constituent parts of the continent and with its geological neighbours (particularly Antarctica).

Specific needs exist for the following.

- * A knowledge of Australia's drift history and palaeogeographic evolution.
- * Palaeomagnetic dating and magnetostratigraphy as a tool for solving geological problems.
- * Information about geologically recent climatic oscillations as a means of understanding modern trends.
- * A palaeomagnetic database, both Australian and global (as a reference frame)
- * A national palaeomagnetic laboratory facility for use by the Australian earth science community.

Program and objectives

The program is designed to develop and apply palaeomagnetic and rockmagnetic techniques to relevant geological problems (continental reconstructions, tectonic history, evolution of sedimentary basins, the regolith, palaeogeographic and palaeoenvironmental (palaeoclimatic) changes in Australia, stratigraphy, and dating). An understanding of how the continent was assembled is crucial to both the minerals and petroleum industries. Research of this nature is, by necessity, of a strategic nature.

The magnetostratigraphic work is aimed at developing a chronological framework for Australia and offshore regions; application is to studies of the evolution of sedimentary basins (onshore and offshore), the regolith, and palaeoenvironmental reconstructions.

The projects tackled fall into two categories.

- (a) other BMR projects, which require palaeomagnetic input, and
- (b) framework studies which form the essential background for all palaeomagnetic studies - notably the definition of apparent polar wander paths for Australia, and refinement of the magnetic reversal polarity and secular variation timescales.

The scale of the important problems to be tackled in Australia is beyond the capabilities of the BMR palaeomagnetic group, which has only two dedicated research scientists. The approach being adopted is to concentrate on key problems that are tractable and that are most relevant to other BMR programs, industry programs, and State Geological Survey and academic programs.

Strategic Plan

The programming strategy will continue to be along the lines described above. Continuing and new directions for research include the following.

- * Research into specific tectonic problems in the Tasman Fold Belt
- * Understanding tectonic evolution of Australia's active northern margin
- * Improving the apparent polar wander path for the stable cratonic regions of the continent, as a base reference for tectonic studies and dating
- * Making greater use of drill core material in palaeomagnetic studies to try to overcome the problem of very thick weathered layers.
- * Magnetostratigraphic studies of sedimentary basins (including the Murray Basin), the Australian regolith, marine sediments, and Late Tertiary and Quaternary sediments

- * Antarctic palaeomagnetism - studies of both a "unique" nature and ones which are directly relevant to Australia because of its intimate geological and tectonic relationship with the Antarctic continent.
- * More involvement in the study of marine sediments, and Quaternary and late Tertiary sequences as a response to the growing relevance of, and interest in climatic oscillations, exploitation of the regolith and hydrological problems.
- * Improve the level of automation of laboratory measurements and data processing to reduce the pressures on staffing.
- * Providing a national palaeomagnetic facility, and advisory and training service.

Two important areas of research have been left out of the program - palaeomagnetic studies in the Pre-Cambrian (Australia is one of the best places in the world to do this), and rock-magnetism. Unfortunately there is little prospect of making much impact in these areas without additional staff resources.

There will continue to be considerable overlap in the modern geomagnetism and palaeomagnetic programs, as well as between the scientists who work on these programs. It is essential that the present working relationships developed within the combined geomagnetism group are maintained.

Products from the Geomagnetism Section

Data

Data from permanent observatories and regional surveys are provided in the form of field values, magnetograms (continuous analog records), and indices of geomagnetic disturbance activity.

As for all other countries, data are supplied free-of-charge to the World Data Centres (principally WDC-A, Colorado) whence they can be distributed internationally. Data lodged with the World Data Centres provide the basis of our knowledge about the global pattern of the geomagnetic field and are used to generate global field models. We have a strong vested interest in ensuring the accuracy of these models over the Australian region.

A database of Australian palaeomagnetic data is kept. We maintain access to the new global palaeomagnetic database which is now being established, as well as to other national databases.

A certain amount of rock magnetic information is available, which is used for "ground truth" studies. CSIRO Division of Exploration Geoscience holds a more complete catalogue.

Reports and scientific papers

- Monthly Magnetic Observatory Reports.
- Annual geomagnetism report (1988 start).
- First-order magnetic repeat station survey reports.

- Scientific papers in refereed journals.
- Working reports as BMR Records.

- A series of all published material put out by the Geomagnetism Section, called "Geomagnetism Notes".

Models and charts

Early field models and charts

Australian Geomagnetic Reference Field package (software package, explanatory notes, set of charts)	\$195.00
Set of AGRF charts of 7 field elements on paper	\$ 25.00
on film	\$ 75.00
Bicentennial magnetic variation chart, 1988.5	\$ 15.00

Services

Geomagnetic and palaeomagnetic information service.

Geomagnetic and palaeomagnetic training service.

Instrument calibration and testing - as part of the national standards role.

Advice on matters of geomagnetic interest, magnetic direction finding (navigation and compasses), regional and global reference fields, magnetic storms, magnetic risks.

Timeliness of Products

	Timely Production	Actual Production	How late
K-indices			
Weekly indices	weekly	weekly	0
Fortnightly indices	fortnightly	fortnightly	0

We now provide these data in accord with international observatory standards: because a week's (or fortnight's) data are all sent on the same day the actual delay from observation to sending the data is from 1 day to 7 (14) days. Although this has been sufficient in the past, it is clear that in the near future we will need to produce on-line computer generated indexes of geomagnetic activity in real-time to provide the predictive service that is becoming required for commercial and military communications. We are moving towards this capability with the equipment upgrade that is at present in progress, but shortage of manpower resources is severely restricting our rate of progress.

Monthly Observatory Report

Monthly Obs.Report	3 month later	5-6 months	2-3 months
--------------------	---------------	------------	------------

Turn around time at the printers is 2-3 months.

Australian Geomagnetic Reference Field models

Numerical model	Jan 1985	Sep 87	2yr 9mth
Magnetic Declination Chart	Jan 1985	Sep 88	3yr 9mth
Other charts	Jan 1985	Oct 88	3yr 10mth

Previous models of the field in the Australian region were not consistent electromagnetic principles, were internally inconsistent, and had their structure and detail restricted by the modelling method rather than by the data. This was recognised by the research

scientists who were brought in to the Geomagnetic Group and it was decided that it would be better to produce a useful model late than to produce another unreliable model on time. Consequently a research program was created to produce viable models of the field, and the charts from the first stage of this program are now becoming available. In that the basic structure for correct modelling has now been set up, it will be possible to produce future models on time.

Miscellaneous

Hourly mean value requests	<1 month	1-9 month or referral to WDC	up to 9 mth
Tests & Calibrations	<1 month	<1 month	0

We are at present unhappy with our response to miscellaneous MHV (mean hourly value) requests. However, given the constraints of our present resources there is little that we can do about this.

Mean Hourly Values to World Data Centre

Standard international observatory practice is that these values should be sent to the WDC by the end of the year succeeding the year in which the observations are made.

If the data are not available for the WDC they are not included in global models of the field. Australian data were not being sent in a timely fashion and so were not being included in the current global models. The consequence was that the global models were less accurate than necessary over the Australian region and this substantially reduced the utility of aeromagnetics in the minerals industry. Subsequent to the restructuring of BMR and the creation of the Division of Geophysics, a research scientist has been Head of the Geomagnetism Section and an operations manager has been appointed. A concerted effort has since been made to rectify the previous failure to supply data on time, and through improved efficiency this is now being achieved, despite cuts in staff

numbers. However, there is still a large backlog of data from previous years, and these must be sent to the WDC for inclusion in retrospective global models that are known as "Definitive" models: this work is gradually being performed but it is very difficult with our present manpower resources.

Financial and Human Resources

As listed in draft program for 1988/89

Salaries	\$0.769 million
Operational funds	\$0.766 million
Total expenditure	\$1.535 million

The operational figures were based on a peak expenditure that occurred in 1986/87. Equipment was old (much of it more than 20 years old) and required a large amount of technical support to keep it running. The upgrade has already decreased the manpower salary costs by about \$166,000 per year, and it is anticipated that increased savings will be achieved. Actual annual costs (including upgrade costs distributed over the years between upgrades) are as follows.

	Geomagnetism*	Palaeomagnetism
Operational staff	15.5	8.4
Salaries	\$0.504 million	\$0.273 million
Operational funds	\$0.123 million	\$0.091 million
Total expenditure	\$0.627 million	\$0.364 million
Component total	\$0.991 million	

*Geomagnetism costs include the costs of observatory activity in Antarctica.

Cost recovery is currently at \$5,000-\$10,000 per annum.

COMPONENT 3.1340: ANTARCTIC ONSHORE SURVEYS**National Interests**

Australia's national interests in Antarctica have been defined as:

- . maintaining Antarctica free from strategic and political contention; specifically, ensuring that no activity or development in Antarctica threatens Australia's security or other interests;
- . protecting the Antarctic environment, having regard to its special qualities and its effects upon Australia's region;
- . maintaining Australian access to the Antarctic so as to be able to take advantage of the special opportunities Antarctica offers for scientific research and to derive possible economic benefit from its living and non-living resources;
- . being informed about and able to influence developments in a region geographically proximate to Australia; and
- . maintaining Australia's sovereignty over the Australian Antarctic Territory (AAT), including over adjacent offshore areas.

Objectives:

In the context of Australia's national interests, the component objectives are to determine the geological composition, structure and evolution of the Australian Antarctic Territory (AAT), and monitor seismic events and the Earth's magnetic field in the Antarctic region as part of Australia's international responsibilities.

Strategic Plan

- (a) To maintain Geophysical observatories at ANARE stations as a contribution to Australia's Antarctic presence.

- (b) Reconnaissance geological exploration of the Australian Antarctic Territory in the 1950's and 1960's has given way to systematic regional and detailed studies by BMR and university earth scientists. It is intended that the major outcrop areas of the AAT be examined in this manner. For the next five years (1989 - 1993), field operations will concentrate on the Prince Charles Mountains, inland from Mawson Station. BMR scientists will not necessarily be involved in all these field programs, but they will assist and monitor the work of other groups in the area. This will facilitate the compilation of a regional geological synthesis at the end of the operational sequence. The Antarctic earth science activities of other countries will also be monitored, so that Australia remains well informed about the progress of Antarctic earth science research in the context of the 1988 Antarctic Minerals Convention.
- (c) BMR will maintain a prominent role in onshore geology and geophysics in the Australian Antarctic Territory.

Outcomes:

- Enhanced ability to assess and provide scientific advice on Antarctic affairs and in particular the question of mineral resources.
- Contributions to the national Antarctic presence and research program.
- Appropriate participation in international Antarctic research activities.

Products:

Since 1948 BMR activities in the AAT have resulted in the publication of:

- 170 BMR Records
- 14 BMR Reports
- 3 BMR Bulletins
- 13 Preliminary Edition 1:250 000 Scale geological maps
- 2 Full colour 1:500 000 Scale regional geological maps.

In addition, 39 research papers have been published since 1982.

Observatory geophysical data have been supplied to World Data Centers and thereby made available to the international community.

Estimated Financial and Human Resources for 1988/89:

Operational Staff	5.5
Salaries	\$0.179 million
Operational Funds	\$0.033 million
Total Expenditure	\$0.182 million

There is no cost recovery from this component.

1E ENGINEERING SUPPORT FOR RESEARCH PROGRAMS

It is common for research establishments, whether government, academic or industrial to have their own electronics and mechanical support facilities.

Within BMR there is a need for a high level of engineering support because several of the research programs require innovative engineering solutions not immediately available commercially. Engineering specifications frequently evolve as research proceeds and rapid interactive responses are needed. Consequently it is often impractical to compile firm specifications at the start of a project that would be needed by outside contractors if they were to do the work.

There is a high level of data gathering in BMR that uses equipment-intensive field and laboratory systems. Specialised skills are required to operate these systems and these can best be obtained through in-house training programs because the systems are tailor-made for specific purposes and often do not exist elsewhere.

The in-house engineering support for BMR's research programs is provided by an Engineering Services Unit (ESU). This Unit supplies the technical staff to operate the equipment on the "Rig Seismic" and the BMR's aircraft, as well as the staff needed to operate the land seismic party and to maintain the seismographic and geomagnetic observatories.

The Unit currently has a staff allocation of 59 and is managed by the Chiefs of the main user Divisions - Geophysics, Petrology and Geochemistry, and Marine Geosciences and Petroleum Geology.

ESU also operates the drilling section that is used in the explosion seismic program for drilling shot holes and for other shallow drilling requirements in BMR.

It is not proposed to change the method of operation of the ESU. At present the Unit's resources are concentrated on the essential operations and maintenance programs. Major design and development work is only carried out when it is clear that this would be cost effective and that no commercially available equipment is capable of doing the job.

2. THE RESOURCE ASSESSMENT FUNCTION

OVERVIEW

The activities of the petroleum and minerals sector of the Australian economy account for 9% of GDP and provide nearly half of the nation's exports. In this context the objectives of the resource assessment function, which is carried out by the Resource Assessment Division, are:

To undertake resource assessment in order to provide independent scientific and technical advice and information about the occurrence, exploration for, extraction and future availability of Australia's petroleum and mineral resources in a world context as a basis for policy formulation and administration by Government and industry.

Access to independent information and advice on the quantity, quality, distribution, and availability of the nation's petroleum and mineral resources is required not only by government in the national context, but also by industry in terms of the resource base and operating environment, and by the public which provides the capital base upon which industry is founded.

The staff of the Resource Assessment Division are largely engaged in studies and activities designed to provide information on some 70 mineral commodities considered likely to be of economic or strategic importance to Australia. Greater emphasis is given to the study of energy minerals - in particular petroleum - because of their economic and strategic importance. However, considerable effort is also directed towards studies of other important commodities such as aluminium, copper, fertiliser minerals, gemstones, gold, iron, lead, manganese, nickel, tin, titanium, tungsten, zinc, and zircon. Increased attention has also been given recently to some minor commodities, including rare earths and the 'electronic metals' such as gallium and germanium.

The process of resource assessment within the Division can be sub-divided into four broad stages.

Collection of basic data from all available sources, including exploration drilling, company reports, state geological surveys, other government agencies, BMR and universities.

Geoscientific and technical interpretation of all available data and studies, to provide a quantitative appraisal of identified resources and a quantitative or qualitative appraisal of undiscovered resources.

Analysis of engineering and commercial factors to determine the availability of these resources.

Dissemination of assessment results to government agencies, mineral and petroleum companies, geoscientific research projects, international bodies and the general public.

Most of the effort in resource assessment is directed towards the study of known mineral deposits because information about these resources is of prime importance to the Government and of major interest to industry and the public. Nevertheless there is a growing demand for information about the petroleum and mineral potential of Australia and its territories as a basis for Government policy formulation and land-use planning.

Although most of the staff are directly engaged in resource assessment and the development of associated databases, the Division is also engaged in research to improve its efficiency and effectiveness. Research programs are planned or in progress with a view to improving the methodology of resource assessment and to investigating the possibility of improving utilisation and interaction between the various geoscience databases in BMR.

Outputs

It is of prime importance that the results of RAD assessments and studies are made available to the appropriate users in a timely manner. Much of the Division's advice to Government is of course given confidentially. However, much of the data compiled and many of the reports prepared are made available to the public via either the appropriate BMR series publications or outside scientific and technical journals.

The Resource Assessment Division has developed a comprehensive range of outlets for its products, and these range from regular Petroleum & Mineral Resource & Industry Information Sheets and annual Preliminary Summaries of major mineral commodities to BMR Resource Reports and the very comprehensive Australian Mineral Industry Annual Review. The AMIAR is an authoritative summary of the activities of the industry for the year under review, and while other RAD publications provide the most recent information available, definitive summaries can be made only after all the relevant data, including final corrected statistics, have been analysed and assessed. Some of these data become available from other organisations only after considerable time has elapsed following the end of that year. Compilation and publication of the information and statistics in a timely manner is a continuing objective.

The Division contributes to international studies such as the International Strategic Minerals Inventory, the mineral sand resources in the ESCAP region, OECD studies on petroleum and uranium resources, regulation and viability of deep sea bed mining, and to Antarctic minerals regime negotiations and international boundary negotiations.

Summaries of the outputs of the petroleum and minerals branches are given in Appendix 1.

The Relevance and Quality of Resource Assessment Division Outputs

- . Australia's petroleum and mineral resources underpin some 9% of the GDP and are the basis for nearly half of the nation's exports.
- . The outputs of Resource Assessment Division are independent information and advice on Australia's identified and undiscovered petroleum and mineral resources in terms of their quantity, quality, distribution and availability in a world content.
- . They are required by
 - government, for policy formulation, and administration
 - industry, as an input in terms of the resource base and operating environment

- the public, which provides the capital base for industry, as a guide to investment decisions and planning.

The quality of outputs of the Resource Assessment Division can be judged by

- the continuing demand for the range of publications by which the information is made available (Appendix 1)
- the continuing high level of specific requests for information and advice which are made to the division
 - .. in response to such requests during 1987/88 from government, over 220 papers and reports were prepared. Many brief informal responses were also provided
 - .. in addition, several hundreds of requests from industry, academia and the public requiring responses at various levels of detail were met during the year.
- the number of invitations to give papers and make presentations at conferences, and contribute to international studies such as the International Strategic Minerals Inventory, ESCAP studies, OECD studies and conferences on petroleum and uranium resources
- the continuing demand for Divisional staff to participate at a technical level in international negotiations such as those on deep seabed mining regulations, and Antarctic minerals regime and international boundary negotiations.

Complementarity of RAD activities with those of other BMR Divisions

The term 'resource assessment' covers a wide range of activities which lead to a number of different types of output. These range from (1) quantitative estimates of identified resources based on detailed information, to (2) quantitative estimates of undiscovered resources, which for example in the case of petroleum can be given as cumulative probability curves expressing the considerable uncertainties involved in the estimates, and to (3) broad, qualitative statements about the prospectiveness or exploration potential of areas.

Resource assessment as practised in Resource Assessment Division involves the synthesis and analysis of existing knowledge and data (mostly derived from industry operations) to provide quantitative estimates of both identified and undiscovered resources, and the likely future production of those resources. It also involves qualitative assessment of the petroleum or mineral potential of particular regions.

Other divisions in BMR, on the other hand, undertake field and laboratory work and research studies aimed at providing information to extend the knowledge needed for the assessment of resource potential. Frequently they work at or near the frontiers of knowledge where quantification of potential resources is either not practical, or at best extremely tentative. For example, reconnaissance geophysical surveys have been undertaken of outer areas of the Australian continental margin and of areas offshore from Australia's external territories where there was no pre-existing information.

Such research studies provide the geoscientific basis for the assessment of the potential petroleum and mineral resources of such regions. While differing considerably in nature, they are complementary to the assessment work carried out by RAD. Indeed assessments of the resource potential of specific sedimentary basins or metallogenic provinces requires close cooperation between RAD and the relevant research Division, which provides the main input.

RAD activities in relation to the functions of the policy divisions of DPIE and other agencies

In order to carry out the resource assessment process effectively and independently a wide variety of skills and expertise is employed in RAD. Much of the required expertise is generally available only as a result of specialist scientific training, together with industry experience. The people who carry out the resource assessment function, are also, as a result of their background, able to provide technical advice to policy divisions of the Department and to other agencies in relation to a number of aspects of these organisations' responsibilities. They are able to maintain their scientific and technical expertise by continuing to work within the geoscientific environment in BMR. Ready access to the large amounts of data available in BMR enables their continuing work on assessment and the provision of technical advice to be carried out in an efficient way.

Structure of the Division

The assessments of petroleum and of minerals resources are carried out under two components of the BMR Program within the Division, and these components are the responsibility of the Petroleum and of the Minerals Branches respectively. The staff of these Branches include geoscientists, engineers, commodity specialists, and computing and database specialists. Because the majority of these staff have had considerable exposure to industry during the course of their careers, there is a strong commonality of approach within the Division to the whole question of resource assessment.

The roles, activities and outputs of the Petroleum and the Minerals Branches are set out in more detail below. Staff and expected expenditure for 1987/88, and proposed staff and expenditure allocated to petroleum and minerals resource assessment for 1988/89 are summarised as follows:

	<u>Staff</u>		<u>Expenditure, \$ Million</u>					
	87/88	88/89	87/88	88/89	87/88	88/89	87/88	88/89
Petroleum Res Assm't	46.0	45.3	1.45	1.48	.55	.35	2.00	1.83
Minerals Res Assm't	<u>34.5</u>	<u>35.8</u>	1.09	1.17	.35	.35	<u>1.44</u>	<u>1.52</u>
	80.5	81.1					3.44	3.35

A more detailed summary of the current staff structure is given in Appendix 2. It should be noted that the two Branches shown as Mineral Project Evaluation Branch and Mineral Commodities Branch, whose functions are complementary to each other, are in the process of being combined into one Minerals Branch, and the proposed structure for the combined branch is given in Appendix 3.

THE ROLE, ACTIVITIES AND OUTPUT OF PETROLEUM BRANCH

The functions of the Petroleum Branch are carried out through the Component 'Petroleum Resource Assessment and Availability'. The objectives of this component are:

- . to provide independent advice and information to Government and industry on the quantity, quality, distribution and availability of Australia's petroleum resources; and
- . to provide scientific and technical advice and information to Government and industry relevant to the exploration for and development of Australia's petroleum resources.

This work is carried out through five continuing projects.

1. Identified petroleum resources; the objective is to provide up-to-date assessments of petroleum resources in known fields, the characteristics of each reservoir and field, and the possibilities for improved or enhanced recovery of oil in place, as a basis for advice to Government, industry and the public.

Petroleum engineers, reservoir engineers, reservoir geologists and supporting technical staff comprising the Engineering/Production Section are engaged on this project. The senior professional staff in particular have extensive experience of working in the petroleum industry, which is an essential qualification for their role.

The project involves the analysis, integration and aggregation on a national basis of company estimates of identified petroleum reserves and resources for individual fields. Resources are aggregated in several categories representing different degrees of certainty with regard to existence and likelihood of economic extraction. This task requires that the staff involved have a thorough knowledge of petroleum fields, reserves estimation and petroleum engineering. With the aid of a computer database, commercial-in-confidence reports on the resources of all of Australia's oil and gas fields by field are compiled twice annually. Summary reports listing the nations's petroleum resources, aggregated by basin or area and nationally, are published twice per year.

Independent assessment of the resources of selected individual fields are carried out in cooperation with Regional Assessment Section in cases where company estimates are unavailable or contentious.

A systematic study directed towards the characterisation of all known petroleum accumulations in Australia is in progress. Reports on four basins have been published to date and a considerable number of copies of these have been sold. The study makes a valuable contribution to BMR's assessment of resources, and serves as a useful guide for explorationists to the locations, ages and other characteristics of known petroleum occurrences.

The group coordinates Australian research on enhanced oil recovery (EOR) and represents Australia in the presentation of results of the research to the International Energy Agency EOR Group. A NERDDC-funded research project is currently being coordinated which is aimed at determining the amount of oil potentially recoverable in Australia using EOR processes. This work is important because much of the oil in some Australian fields will not be extracted unless appropriate EOR techniques can be applied.

Technical advice is provided on various engineering aspects of the petroleum industry.

2. Petroleum technology for exploration and development; the objective is to monitor and assess technological aspects of the petroleum exploration and development industries as a basis for the provision of technical advice to Government.

Advice on development technology is provided for assessments of identified and potential resources. In addition, technical advice is provided on offshore drilling and development operations, compliance of these with safe operating practices and Directions issued under petroleum legislation, and other matters such as the metering of petroleum for excise purposes.

This project is a relatively minor aspect of the work carried out by the Engineering/Production Section, being covered essentially by one engineer with input from other staff as required.

Inspections of offshore facilities in Australia, and of drilling operations in Papua New Guinea and other southwest Pacific countries (expenses are borne by those countries) are carried out as required.

3. **Petroleum exploration and resource potential;** the objective is to establish and maintain an up-to-date assessment of the petroleum resource potential of the sedimentary basins of Australia and its territories as a basis for advice to Government, industry and the public.

The project is carried out by some nine geologists and geophysicists in the Regional Assessment Section, most of whom have had considerable exposure to the petroleum exploration industry. They are divided into three small groups, each of which is responsible for one of three geographical regions of Australia.

Activities include the monitoring of petroleum industry exploration results in order to update knowledge of petroleum occurrences and prospectiveness. Information on exploration activities offshore is obtained mainly through data supplied under the provisions of the Petroleum (Submerged Lands) Act in the form of daily well telex reports, quarterly and annual reports on exploration permits, and final reports and associated data on drilling, geophysical and other operations, studies and laboratory analyses. These staff contribute professional input to the checking for quality and completeness of reports required to be submitted to the Commonwealth under legislation. Petroleum exploration in the onshore basins of Australia and, to a lesser degree, elsewhere in the Southwest Pacific region is followed through the study of media reports, industry newsletters, and other sources of information, including material provided by some companies.

This group provides the major input to quantitative assessments of Australia's undiscovered petroleum resources, which are updated by BMR on a national basis about every two or three years. These assessments are carried out using methodology developed by the Potential Resources Section within the Branch and using input from all sections of BMR with relevant knowledge. BMR and Esso are the only organisations which publish credible assessments of Australia's undiscovered petroleum resources.

In this connection the desirability of the independence of the advice is reinforced by the sentiment expressed in Mr Kerin's speech to the House, reported in Hansard of 15 May 1980 (pp 2796-2799) where he queried government reliance almost exclusively on oil companies for information affecting government revenue. In that same speech, he proposed an improved role and support for the Bureau of Mineral Resources to allow it to act as an independent source of information on the oil industry. He also stated the intention of a Labor government to improve the ability of BMR to evaluate oil industry claims.

Technical advice is also provided to Government on the administration of the Petroleum (Submerged Lands) Act, petroleum pricing policy, significance of petroleum discoveries (in cooperation with Engineering/Production Section), resource aspects of international boundary disputes, land use, and other matters as required.

In additions, contributions are made to petroleum-related projects in other BMR divisions.

4. Petroleum potential and future production; the objectives are to carry out research into improved methods for quantitative assessment of the amount and future rates of production of Australia's undiscovered petroleum resources.

This group has developed methodology for the assessment of undiscovered petroleum which has received wide international recognition. A quantitative model of future exploration for petroleum and the discovery and production of crude oil from undiscovered resources has also been developed and used to prepare a revised estimate of future production to the Year 2000 as a contribution to the Commonwealth Government's 'Energy 2000' National Energy Policy Paper.

In addition to continuing to document, test and refine the methods which have been developed, and providing advice to other groups in BMR which are applying the methods, the group is also conducting research to quantify characteristics of generative sedimentary basins as a basis for improved assessment and basin modelling.

5. Petroleum databases; the objective is to develop and maintain documentary, computer-based and physical (cores and cuttings) databases which are essential to the functions of other projects within the branch, and to BMR's national geoscience (petroleum) database role.

The project, carried out by the Special Projects Section, covers several databases and data systems. The Petroleum Exploration Data Index (PEDIN) is a large database containing basic information and statistics on petroleum exploration and development drilling and on geophysical surveys which have been carried out in Australia and its territories. Reports on open file information in PEDIN are available from BMR on a request basis.

The Identified Petroleum Resources database holds information on the estimated petroleum reserves and resources of some 400 individual fields and the basins of Australia and its territories. This database is linked to the PEDIN database and it is updated twice-yearly to produce commercial-in-confidence reports on Australia's identified reserves, and information sheets for publication which summarise information on petroleum resources on a national basis.

Three staff on this project receive, check, index, store, and retrieve as required reports and data provided to the Commonwealth under the provisions of the Petroleum (Submerged Lands) Act, and other petroleum data supplied to BMR by industry. Some 10 000 documents are managed by the group. Exploration data in the Petroleum Branch data system relating to many thousands of operations are used extensively by officers of Petroleum Branch, other BMR divisions, and by industry.

A further three staff at the Core and Cuttings Repository are responsible for the receipt, checking, storage and retrieval of drill cores and cuttings provided to the Commonwealth under the provisions of the Petroleum (Submerged Lands) Act, other drill samples supplied to BMR by industry, and samples obtained as a result of stratigraphic drilling by BMR. Facilities in the repository are used extensively by industry, the public, and the BMR divisions. Associated databases facilitate access to material in the repository.

A small group of three staff within this project acts as a service group to the other sections within the branch, compiling and providing industry information and statistics which are essential input to the assessment of resources. Compilation of reliable industry information and statistics requires close liaison not only with industry but also with RAD geoscientists and engineers who have an intimate knowledge of the industry.

THE ROLE, ACTIVITIES AND OUTPUT OF MINERALS BRANCH

The functions of the Minerals Branch are carried out through the component entitled 'Mineral Resource Assessment and Availability'. The objectives of this component are:

to provide independent advice and information to Government and industry on the quantity, quality, distribution and availability of Australia's mineral resources; and

to provide technical, scientific and economic advice and information to Government and industry relevant to the exploration for, extraction and processing of mineral commodities of economic and/or strategic importance to Australia.

This work is carried out through four continuing projects.

- (1) Mineral commodity advice and information; the objectives are to provide scientific and technical advice and information to government, industry and the public concerning the nation's mineral resources, their assessment, development and likely future availability.

Work on this project is carried out primarily by the staff of the Mineral Commodities and Mineral Statistics Sections.

Ongoing commodity studies are conducted to establish and maintain an up-to-date knowledge of the broad range of factors essential for assessing Australia's resources of and the likely future availability of some 70 different mineral commodities. Commodity specialists have continuing responsibility for particular commodities so that they can develop the background knowledge and experience required for such work and can therefore respond quickly and authoritatively to requests for information and advice. They are required to know the scientific and technical detail about mineral commodities and mineral deposits: the nature of the deposits and the concepts and techniques used to find them, and the properties, uses and potential uses of the commodities. Familiarity with exploration activity, new discoveries, geological setting, economic mining and metallurgical aspects is

required. Most of the staff have industry experience. In order to maintain up-to-date estimates of resources and their likely availability, they must be aware of production levels, consumption patterns, and price trends. This project has prime responsibility for compiling and classifying Australia's identified mineral resources and for providing input for assessments of undiscovered mineral resources. Annual quantitative estimates of Australian resources of 31 mineral commodities are published each year.

Information for these studies is gathered routinely, commonly on a confidential basis, from a variety of sources: ABS, technical and industry publications, press reports, and discussions with relevant people in industry and other sectors. Statistical data, especially production data, needed for commodity studies are obtained mainly from mines departments and industry. Most of these data are also published and thus available to industry. By agreement with ABS, the Branch is the major source of national commodity-oriented statistics on the mineral industry. Since BMR does not have statutory power to require industry to provide information, the Branch relies on goodwill. In return results are made available to industry where practicable.

Some data collated for resource assessment studies is published as the Australian Mineral Industry Annual Review, which is an authoritative reference used extensively by government departments and by the mining industry; other periodic compilations include the Preliminary Annual Summaries and the Australian Mineral Industry Quarterlies.

- (2) Mineral prospectivity and resource appraisal; the objectives are to provide advice and information on mineral resource potential and prospectivity for land use planning; develop appropriate methodology for estimating undiscovered mineral resources within specific areas or regions; and to provide advice on, and assessments of, Australia's uranium resources.

This project is the responsibility of the Mineral Prospectivity and Database Development Section.

The project involves the development of methodology for assessing Australia's undiscovered mineral resources and the assessment of the mineral resources of specific areas for consideration in land use planning. Information on which such assessments are prepared is drawn from BMR and State mines departments' records and publications and from wherever expertise exists within BMR; in most instances some of the information is provided by officers in the research divisions. These assessments are usually required within a limited time. The project also includes uranium as a mineral commodity. Uranium differs from other mineral commodities in that assessments are made using the basic exploration and feasibility data provided by companies by virtue of the Atomic Energy Act, 1953.

- (3) Mineral project assessments and advice on regulations; the objectives are to prepare publications, information and advice to Government on the technical, economic and regulatory aspects of the exploitation of mineral deposits.

Mining engineers and a geotechnical engineer, within the Mining Engineering Section, are engaged on this project. All have extensive recent experience working in the mining industry which is an essential qualification for their role. The project involves the implementation of computer systems for mineral project evaluation, ore reserve calculation, cost estimation and minerals availability and the development of appropriate databases for those systems. This requires liaison with United States Geological Survey and United States Bureau of Mines, the developers of many of the applications programs used in this work. The project also involves compiling information on and drafting of Australian and foreign legislation and regulations relating to the mining industry, providing technical comment on the environmental impact of mining operations and providing the Secretariat for the Chief Inspectors of Mines Annual Conference.

- (4) Minerals databases; the objectives are to establish, maintain and improve databases containing data on exploration and discovery, mineral deposit geology, mineral resources, mineral production, consumption and trade, and commodity prices, and to integrate these databases with other relevant databases.

The database group comprises geoscientists and support staff with training and experience in geoscience database design, development and management and computer operations.

The group is developing mineral databases to facilitate the assessment of both discovered and undiscovered resources and to assist mineral exploration. The needs of other parts of BMR are taken into account in development of the databases.

A major database is MINDEP - mineral deposits database - which provides information on the geological setting and economic geology of individual Australian Mineral deposits.

Information in Branch databases is released publicly, subject to confidentiality requirements. Data on 116 gold deposits in WA and Queensland is already available on microfiche, diskette, tape or hard copy and as summary publications. It is intended to make the statistical databases publicly accessible also. A database containing comprehensive mineral commodity price data can be accessed now via a commercial network.

OPTIONS FOR THE FUTURE

Most countries rely on assessments of their resources as a basis for the formulation of sound policies. Assessments of undiscovered resources are used in preparing predictions of petroleum and mineral availability, but in recent years there has developed an increasing demand in connection with land use decisions.

Assessments of undiscovered resources of an area are prepared by a consideration of the available geological, geophysical and geochemical data and interpretations of the area combined with a consideration of features of known resources both within the area and elsewhere in Australia. The assessment of undiscovered resources necessitates close linkages between the resource assessment function and the research function. As discussed earlier the two functions interact in a complementary way and require access to data which is common to both.

The full spectrum of resource assessment, from quantitative assessments of known deposits to the assessment of resource potential forms a continuum. Knowledge of the entire spectrum is required for the function of resource assessment to be carried out, and the concentration of this knowledge within one organisation is the most efficient way of carrying out the function.

It is also important that information and advice be delivered in as effective and timely a manner as possible. One important development in this area is the establishment of the National Resource Information Centre under the management of BMR and BRR.

In Part I, Section 3 of this submission, on Program Formulation, it is also proposed to establish two intra-departmental committees, one on minerals and one on petroleum resource assessment, in order to improve interaction with policy areas of the department.

In Part I, Section 4 of this submission, on organisational structure and staffing, it is recommended that the present petroleum and minerals resource assessment functions be reorganised into two independent branches headed by Chief 1 officers. This would enable the professional leadership and expertise of these areas to be strengthened without increased costs.

It is believed that these proposals will allow the resource assessment functions to be carried out with improved effectiveness in order to provide timely information and advice of high quality.

The recent internal departmental review of BMR (the Carlson Report) examined the Resource Assessment function and recommended that it be fragmented by transferring staff to policy divisions.

Details were not specified and no analysis of the assumed advantages was provided.

The report and responses from BMR are available to the review if required.

In summary, BMR's response has been:

- . The professional nature of the function has not been understood. In BMR's view, resource assessment in BMR is a form of scientific and technical applied research, just as the work of ABARE, for example, is applied economics research.
- . The value of a clear separation of functions between the policy functions and a professional resource assessment function providing an independent source of high-level advice has not been appreciated.
- . It has not been understood that high quality professional advice on specific issues can come only as a product of a coherent multidisciplinary group undertaking the total resource assessment function. It is not practical to fragment the group.
- . The proposed fragmentation of the function would lead to a serious degradation of the quality of advice to government, industry, and the public.
- . The proposed fragmentation would destroy the professional career structure and would inhibit future recruitment.

The proposed fragmentation would be far less efficient and flexible than the present system, in which a small, highly professional organisation can meet the needs of policy divisions in DPIE as well as the needs of ABARE, other departments and industry. (As an example, it can apply its expertise to both petroleum and mineral resource, and land-use issues which are dealt with in different policy areas.)

The review team acknowledged that it had not been able to make an in depth review, and in particular that detailed reviews would be required to investigate BMR's view that the Resource Assessment Division pursues a coherent set of professional functions which should not be fragmented.

It may be added that the present mode of carrying out the geoscientific and technical resource assessment functions in the Resource Assessment Division of BMR is entirely consistent with the parallel arrangements for biological sciences in BRR and for economic analyses in ABARE. In BMR there is also the advantage that the resource assessment function is closely linked to the research function in other divisions of BMR. This advantage is lacking in BRR where the research base is in CSIRO institutes.

It should also be emphasised that the data base role of the division in the development and maintenance of petroleum and mineral databases is essential to the resource assessment function and needs careful professional monitoring. To transfer part of this function to another area would be illogical and inefficient and would require that any such area provide a professional service function to BMR.

It is believed, therefore, that the present organisational arrangements for the resource assessment function are the best available, and that no case to the contrary has been made.

It is recommended that the resource assessment functions, as defined at present, remain in BMR.

RESOURCE ASSESSMENT DIVISION PRODUCTS AND TIMELINESS OF RELEASE

A. MINERALS BRANCH

1 Regular Publications

	<u>From End of Time Period to Release</u>
(a) Monthly Bulletin of Metal, Ore and Concentrate Prices	3-4 wks
(b) Quarterly Bulletin of Base Metal Statistics	7-8 wks
(c) Quarterly Bulletin of Mineral Sands Statistics	6 mnths(a)
(d) Australian Mineral Industry - Quarterly Summary Statistics	7-8 wks
(e) Australian Mineral Industry Quarterly	4-5 mnths
(f) Preliminary Summaries - Major Mineral Commodities (annually)	2½ mnths
(g) List of Principal Mineral and Metal Producers (annually)	4 wks
(h) Australian Mineral Industry Annual Review - Preprint Chapters	6-8 mnths
(i) Australian Mineral Industry Annual Review	20 mnths(b)
(j) Australia's Identified Mineral Resources (Annual Information Sheet)	2½ mnths
(k) Australia's Uranium Resources (Annual Information Sheet)	2½ mnths
(l) Extended Abstracts - Petroleum and Minerals Review Conference (annually)	(c)
(m) Triennial Review of Australian Mineral Industry - ESCAP	3 mnths

(a) Period results from respondent delay; procedures are to be reviewed.

(b) AMIAR is the official record of the Australian mineral industry. Some time elapses before information becomes available. Information gathering and publishing procedures are being streamlined to improve timeliness of publication.

(c) Released at Petroleum & Minerals Review Conference.

2. Other Publications

BMR Resource Report Series

This series describes the Australia-wide occurrence and resources of particular commodities.

Papers in scientific and industry journals.

3. Mineral Data Bases

MINPRI (Daily metal prices for 129 price series, 41 monthly price series for industrial minerals and 44 annual average unit values of exports and imports for 35 mineral commodities)	weekly update
MINDEP (Australian Mineral Deposits, containing comprehensive data on 116 major gold deposits in WA and QLD)	update when new data are available
MININD (Australian Mineral Industry Statistical Data)	annual update
COAL (compositional analysis and geology of over 200 coal seams)	being developed

4. Scientific and Technical Advice to Government

A total of 70 separate papers and reports were prepared in 1987/88 on a variety of subjects to meet enquirer's deadline

5. Enquiries for data on the Australian mineral industry

304 requests for statistical data on the Australian mineral industry were serviced during 1987/88 - about 50% were from government, 40% from industry and 10% from academia and the public. At least another 250 requests for minor amounts of data were also serviced during the year. usually one day

6. International Commitments

Data on the Australian mineral industry and resources is provided on a regular basis to a number of overseas organisations including:

UNCTAD Tungsten Study Group (quarterly)	3-4 mnths
Association of Tin Producing Countries (monthly)	4 wks
International Tin Council (monthly)	4 wks
International Lead and Zinc Study Group (monthly)	4 wks

Regular contributions are also provided to the following organisations for use in international mineral industry publications.

Nuova Samin	Calendar
Metallgesellschaft Ag	Year data
World Bureau of Metal Statistics Inc	available
United States Department of the Interior, Bureau of Mines	6 months
American Bureau of Metal Statistics Inc.	after end
Societe Miniere et Metallurgique de Penarroya	of year
Austrian Embassy, Canberra	

B. PETROLEUM BRANCH1 Regular Publications

Timeliness is particularly relevant to the following regular publications

	From end of time period to release
(a) Australian Petroleum Exploration and Development Statistics (quarterly)	3-4 weeks
(b) Summary of Australia's Petroleum Reserves and Resources (six monthly)	6 months
- BMR relies on the provision of data on many petroleum fields by operating companies and mines departments, and there is little that can be done to expedite the provision of data from all sources in order to ensure earlier publication.	

- (c) Petroleum Exploration and Development Titles Map and Key (six monthly) 3-4 months
 - the map for 31 December 1987 has been the subject of an extraordinary series of delays and has not yet been received from the printers.
- (d) The Petroleum Newsletter (six monthly) 20 months
 - publication of this report has been tardy for some years, since a backlog developed about seven years ago due to staff shortage. The introduction of the quarterly exploration and development statistical summary in 1982 removed some of the need for timely publication of the Newsletter, which has since been given low priority in times when staff resources were lacking. Backlog on the Newsletter is currently 20 months. A review of demand for the Newsletter two years ago revealed strong industry support despite the fact that it has become a 'historical record' rather than a 'newsletter'.
- (e) Undiscovered Petroleum Potential (every 2 or 3 years) 3-6 months
 - timing of release of the results depends on the occurrence of a suitable conference which will provide publicity for the results and an opportunity to explain them e.g. Petroleum and Minerals Review Conference or BMR Research Symposium.

2 Other Publications

- (a) Petroleum Accumulations Report Series
 - individual reports describe all known petroleum accumulations in a particular basin. Reports on four basins have been published in the last two years and four more reports are in preparation.
- (b) BMR Records on assessments of the resources of individual fields
 - most assessments are based on commercial-in-confidence company data and are not publicly available.
- (c) Papers in scientific and industry journals.
- (d) Petroleum chapter of Australian Mineral Industry Annual Review. 6-8 months
- (e) Contributions to Government publications - e.g. Energy 2000, ABS Yearbook of Australia. as required

3 Petroleum Databases

- | | | |
|-----|--|---------------------------------------|
| (a) | PEDIN, the Petroleum Exploration Data Index, will contain information on all petroleum exploration operations.
- reports on open file data in PEDIN available to public on request. | being developed on a continuing basis |
| (b) | Identified Petroleum Resources database
- contains reserves and resources data on all Australian fields, used to prepare six-monthly summary for publication. | updated six-monthly |
| (c) | Australian Petroleum Accumulations
- listing of reservoir and fluid properties. | being developed progressively |

4 Scientific and Technical Advice to Government

A total of about 150 papers and reports were prepared on a variety of subjects.	to meet 1987/88 enquirer's deadlines
---	--------------------------------------

5 International Commitments

Data on the Australian petroleum industry and resources are provided on a regular basis to a number of overseas organisations including: World Oil Magazine ESCAP Triennial Review of Mineral Resources	as required
--	-------------

PETROLEUM AND MINERALS RESOURCE ASSESSMENT
SUBPROGRAM 9400
(77.5)

Resource Assessment Division
9430
(4.7)

- 1 - SES4
- 1 - AS08
- 1 - AS03
- 1.7 - AS02

PETROLEUM RESOURCE ASSESSMENT
AND AVAILABILITY
9410
(40.8)

MINERAL RESOURCE ASSESSMENT
AND AVAILABILITY
9420
(32)

Petroleum Branch

Mineral Project Evaluation Branch
9420A

Mineral Commodities Branch
9420B

- 1 - SES1
- 1 - AS02

- 1 - SES2
- 1 - AS02

- 1 - SES1
- 1 - AS02

Potential Resources (3.8)	Regional Assessment (11)	Special Projects (15)	Engineering Production (9)
1 - PRS	1 - SC5	1 - SC5	1 - SC5
1 - SRS	3 - SC4	1 - SC3	1 - SC4
0.8 - RS	4 - SC3	1 - CS02	3 - SC3
1 - SC2	3 - SC2	6 - Clerical	2 - SC2
		6 - Technical	1 - SC1
			1 - TSC1

Mining Engineering (4)	Mineral Potential (1)	Geological Evaluation (4)
1 - Eng5	1 - SC4	1 - SC4
2 - Eng4		1 - SC3
1 - Eng3		1 - TA2
		1 - DF1

Mineral Commodities (9)	Special Studies (2)	Mineral Information and Statistics (8) + 1 ABS
4 - SC4	1 - SC5	1 - SC5
3 - SC3	1 - SC2	1 - SC3
2 - SC2		1 - SC1
		5 - Clerical

MINERAL RESOURCE ASSESSMENT AND AVAILABILITY

COMPONENT 9420

Minerals Branch

(30.5)

1 - Chief 1
1 - AS02
0.5 - AS08

Mineral Commodity Studies (12)	Mineral Prospectivity and Database Development (8)	Mining Engineering (4)	Mineral Statistics (4) + 1 ABS
1 - Sc5	1 - Sc5	1 - Eng5	1 - AS08
4 - Sc4	2 - Sc4	2 - Eng4	1 - AS05
3 - Sc3	2 - Sc3	1 - Eng3	1 - AS04
3 - Sc2	1 - Sc1		1 - AS03
1 - AS02	1 - TA2		
	1 - DF1		

Appendix 3

3. THE DATABASE FUNCTION

BMR's present database activities stem from its role: To be the primary national source of geoscience data and to publish and provide data. In satisfying this role, BMR coordinates the development of databases in collaboration with State Geological Surveys and has itself developed a range of databases covering most areas of geoscience. These databases both arise from, and are used in BMR's own research and resource assessment programs, and are made available in various forms to other areas of government, industry and the public.

Data collection and management

BMR expends considerable effort in collecting data, both as a consequence of its own scientific activities and also arising out of the requirements of legislation. These databases include:

Airborne geophysical data	Hydrogeological data
Coal seam data	Land geophysical data
Commodity price data	Marine geological and
Commodity trade data	geophysical data
Earthquake data	Mineral deposits data
Geochemical and geochronological data	Palaeogeographic data
Geomagnetic data	Palaeontological data
Geoscience bibliography	Petroleum exploration data
	Petroleum resources data

Collection of these data is a multi-disciplinary activity that uses the skills of geoscientists (who have a thorough understanding of the collection processes and of the data themselves), computer specialists and librarians. BMR has that expertise and has been carrying out a data gathering function efficiently for many years. This function has a regional and national perspective and consequently it is appropriate for BMR - as a federal agency - to continue to be the primary national source of geoscience data.

Resource assessment, research in policy divisions and geoscientific research require large, complex data sets, and the increasing power and sophistication of today's technology permits this. The ability to properly manage these data sets is an essential requirement.

Data management is not a simple activity and requires similar expertise to that required for data gathering. Again, BMR has that expertise and so it is appropriate that it also have a geoscience database role - to complement its data-gathering and interpretation activities - by which it can facilitate government policy and decision making, geoscientific research, and mineral and petroleum exploration.

Another aspect of data management is the need for proper management of physical data: samples, cores and cuttings, reports, etc. These data have been acquired at considerable cost and have a value that extends well beyond their initial examination or assessment. In similar organisations, for example, the NSW and SA mines departments and the British Geological Survey, this requirement has been recognised and resources and special-purpose storage have been provided. BMR has made some progress in this area (e.g. the Palaeontological Repository); however, further development is required, particularly in relation to the storage, retrieval and use of material received as a requirement of Commonwealth legislation.

Database coordination

Considerable database activity takes place in the geological surveys and mines departments of the states and the Northern Territory. Because the types of data collected and the purpose for its collection are similar among the States and BMR, there are many advantages in coordinating such activity. Such a coordinating agency should have geoscientific skills, database skills, and a national perspective. This situation was recognised in 1986 when the Australian Minerals and Energy Council endorsed a recommendation that BMR should coordinate geoscience database activity among government geoscience organisations in Australia. BMR has been supported in this function by a Government Geoscience Database Policy Advisory Committee.

The continuing role of government agencies in geoscience data collection and dissemination and the increasingly-sophisticated use of information technology in its management indicates that there is a continuing requirement for the coordination of such activity and that active liaison between such agencies should be maintained and strengthened. BMR has the expertise and the national reputation to continue to carryout this task.

In addition it is important for Australia to play its part in international database activities. These activities enable Australian expertise to be disseminated to similar organisations in other countries and for Australian geoscience information specialists to learn from overseas experiences. Much of this activity takes place in government organisations. At present BMR is the primary Australian contact for these organisations and it is proper that such an arrangement should continue in order to provide a national perspective in international liaison.

Another aspect of database coordination relates to the need for research and development of methodologies for the integration and use of disparate data sets. BMR is already applying its expertise in this area and it is appropriate for this activity to continue, both in support of BMR's scientific projects and to provide leadership in this area among the state geological surveys.

Geoscience Computing and Database Branch

The Geoscience Computing and Database Branch, which is currently incorporated within the Resource Assessment Division, was established in 1986 with the objectives:

- . to coordinate database activity within BMR and among government geoscience organisations in Australia and to liaise with other appropriate national and international organisations;
- . to provide an efficient and effective computing environment in BMR;
and
- . to carry out research relevant to the use and integration of geoscience data.

The Branch, comprising 22 staff, participates in BMR's scientific program through three sections:

Database Coordination and Liaison Section; which is responsible for the coordination of geoscientific database activity both within BMR and nationally, and to be the major contact point for international coordination;

Computing Operations Section (as Computer Systems and Computer Applications Sub-Sections); which is responsible for providing BMR officers with efficient computing facilities, enhancing computer systems (including Local Area Networks) as required, providing user-training and tuition, and encouraging users to become near self-sufficient in the use of computers;

Geoscience Computing and Database Research Section; which is responsible for undertaking research into the integration of disparate geoscientific datasets.

The Branch also provides expertise and training for computing specialists from other countries. During 1987-88 the Branch organised and provided significant input to a visit by two Chinese specialists as part of an exchange arrangement between BMR and the Chinese Non-ferrous Metals Corporation. A return visit by BMR specialists to China in the next year will establish a joint research project. The Branch also provided database training to two Vietnamese under a UN Fellowship program. At present the Branch is providing three months' training to two Indonesian computing specialists as part of an AIDAB-funded program.

National Resource Information Centre (NRIC)

It has recently been recognised that there is a need to improve the information base for national policy formulation and government decision making in areas of natural resource management. This has come about because of the increasing complexity of issues relating to competition for land-use. The establishment of the National Resource Information Centre (NRIC) in May 1988 is a response to this national need.

NRIC will be a joint facility of the Bureau of Mineral Resources (BMR) and the Bureau of Rural Resources (BRR) and will draw upon, expand and complement the existing facilities and expertise of these bureaus. Data held by these bureaus will need to be augmented substantially by accessing information which is held in Commonwealth and State agencies as well as other organisations. NRIC will use modern information technology to access and retrieve this information in a geographic information system (GIS) framework so that better-informed judgements can be made on the wide range of resource-management issues that come before the federal government.

It is appropriate for BMR to participate in NRIC in this way and BMR's involvement is a reflection of the organisation's reputation as a source over many years of high-quality geoscientific and mineral, petroleum and groundwater resource data.

The core of NRIC will be a computer-based inventory of sources of natural-resource information. Consequently it is proper that BMR delegate to NRIC the role of maintaining such inventories and that BMR retain the role of coordinating geoscientific database activity.

Database strategy

BMR's database strategy over the next five years will be:

- . to develop and enhance the usefulness of geoscientific and resources databases by coordinating BMR's database activities and carrying out appropriate database research, and by collaborating with the Bureau of Rural Resources in the development of NRIC
- . to properly manage physical data, particularly that received by the Commonwealth as a consequence of legislation.
- . to increase the effectiveness of the Government Geoscience Database Policy Advisory Committee as a means of developing greater coordination and cooperation in database activity between BMR and its state counterparts
- . to develop the number and range of database products for marketing to industry.