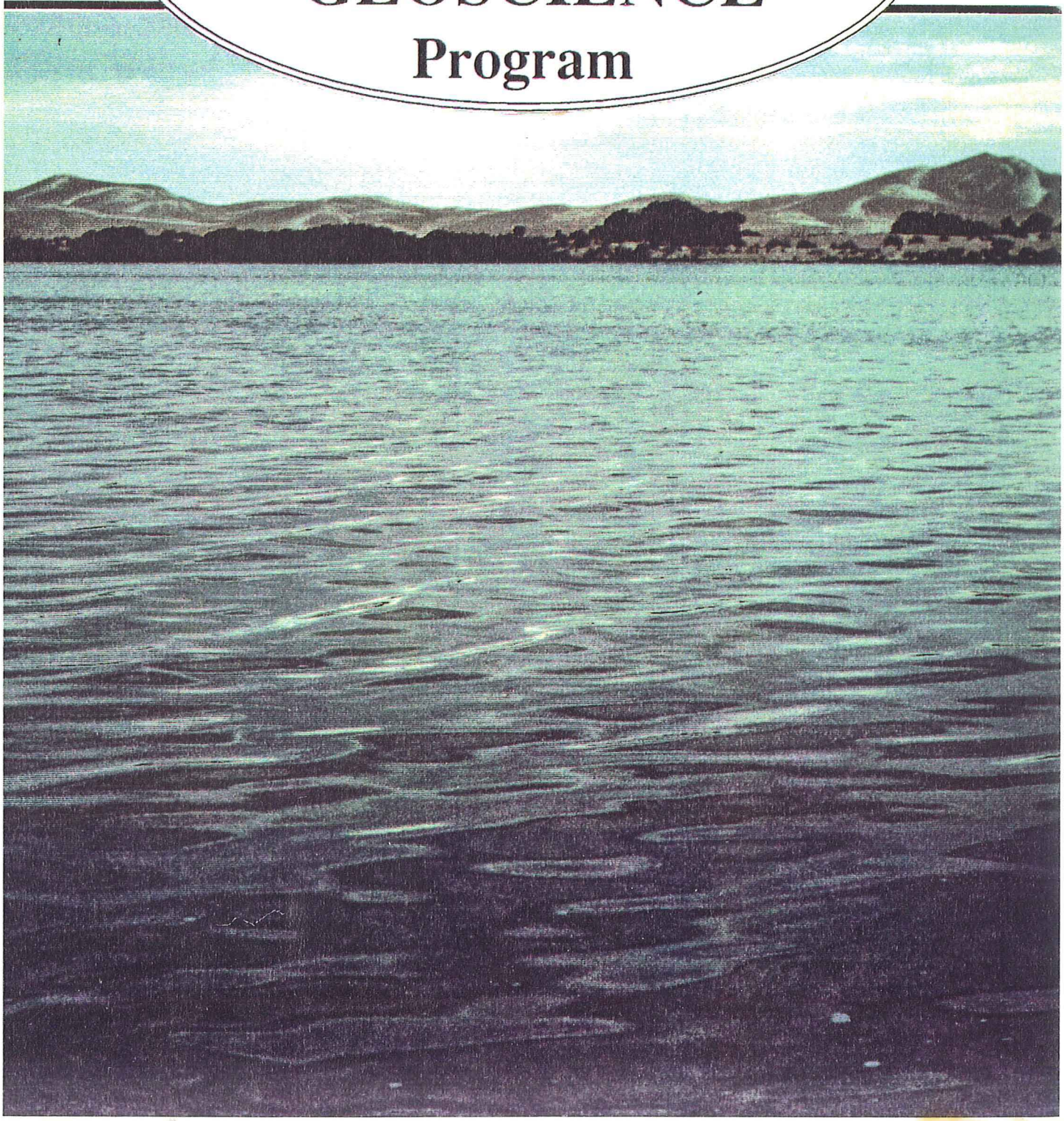
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

Draft ENVIRONMENTAL GEOSCIENCE Program



BUREAU OF MINERAL RESOURCES, GEOLOGY &
GEOPHYSICS

Draft

ENVIRONMENTAL GEOSCIENCE

Program

Report of The Environmental Geology Committee of the
Bureau of Mineral Resources,
Geology & Geophysics

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Secretary to the Committee

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ENVIRONMENTAL GEOSCIENCE IN BMR

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Executive Summary

Community concern about changes in the earth's environment has intensified during the past decade. The Government's response is reflected in the Prime Minister's statement on the Environment, in the setting up of the Resource Assessment Commission to investigate the developmental and environmental use of resources, and in the ASTEC review of environmental research in Australia.

There is increasing recognition that science provides the framework for the protection of the Australian environment and for the responsible use of its resources.

The geosciences are vital for the **understanding** of the environment, the **development** of essential resources, and the simultaneous **conservation** of environmental quality and diversity.

The Government's new charter for BMR, tabled in the Senate in June 1989, recognised the need for BMR to provide the knowledge base for the resolution of environmental issues.

For BMR to respond to the increasing demand for geoscientific base line data and advice in the context of sustainable development for Australia, it needs to identify the areas of geoscience necessary to take on a new role in understanding and conserving Australian earth resources in parallel with its traditional role of guiding the development of those resources.

It is proposed that new environmental projects should be managed under a new Unit of Environmental Geoscience.

For 1989/90 the development of the program will require approximately 1% of BMR resources - in professional staff and funding. In 1990/91, expenditure should be close to 2%. For fully operational programs in 1991/92 we estimate costs will be around 5-6% of total BMR resources.

A. Program development

In order to develop the program further in 1989/90, and to liaise with relevant State and Commonwealth authorities, staff resources of three scientists are required, and an operational budget of approximately $75k.

B. New program areas

1. **Land/environmental degradation.** This project is designed to improve understanding of the geological controls on soil erosion and salinisation. It would involve field operations to describe the physical properties and geomorphological setting of surficial units, and the timing and frequency of changes which have affected those units in the geologically recent past.

This form of mapping compilation will at be closely related to existing projects in Groundwater and Regolith. There is a need to co-ordinate with CSIRO, and with the national Soils Conservation Program; some funding will be sought from the latter.

Resources:

3 scientific staff, 2 technical support staff
Together with drilling and operational costs the total budget would be approximately $424 per annum.

2. Compilation of high resolution records for the Australian Quaternary. There is a need to co-ordinate and compile data from the Australian Quaternary into a single data set to provide answers to questions concerning the way in which the Australian continent has responded to climatic changes in the relatively recent geological past, and to provide a test for models of global circulation presently being developed. The most appropriate time interval to test such models is the Holocene, viz, the last 10,000 years.

It is important, however, to have an understanding of climatic events over a longer time frame, at least back to 150,000 years BP, because that time frame encompasses a full glacial/interglacial cycle, and provides insights into the major factors controlling climate, and to the response of physical and biological systems to climate change.

One outcome of the comprehensive database would be a sequence of palaeogeographic maps for the Australian Quaternary.

Resources required would be: (from 1991)

5 staff and a total budget of around $500k per annum.

3. The Coastal Zone. A major project is required to determine the geoscientific framework of the Australian coastal zone in order to evaluate its resources, understand its history, develop strategies for its management and sustainable development, and assess the impact of global change on it. BMR, because of its national role, its prior experience in coastal zone studies, and its involvement with NRIC as a geoscientific information centre, is the logical organisation to undertake this task.

Envisaged is a 10 year project, providing a national assessment of geoscientific aspects of the coastal zone, including the distribution of mineral resources, factors relating to the degradation of coastal wetlands, those influencing coastal erosion and accretion, recent sea-level history, hazard risk maps, groundwater maps of coastal aquifers, and zoning maps for engineering development. GIS systems will be used to produce integrated data sets. There will be a need to establish some coastal monitoring sites.

Staff resources of 6-7 are required. Together with a field cost, a total budget of approximately $600k per annum is required.

Enhancement of existing programs:

In addition to the setting up of new programs, the enhancement of a number of current BMR programs, which have an environmental content, is recommended.

Antarctic geoscience. With the move towards the setting up of a Wilderness Park in Antarctica, there is an ongoing need to provide an inventory of geological features of the continent, and to develop research to understand the history of the Antarctic icecap, which exerts a dominant control on modern climatic patterns. BMR's Antarctic research should be carried out

under the aegis of its environmental geology program and should include, in addition to the traditional studies of bedrock geology, studies of landforms and glacial geology designed to understand the recent behaviour of the icecap.

The onshore programs would complement proposals being developed in Marine Geology to sample sediments on the Antarctic continental shelf, which should provide independent evidence for climatic change. The proposed Antarctic marine program would need $2-3 million annually and 16 new staff.

Other areas of program enhancement are as follows:

. Projects in marine geology to understand the past record of El Nino, and how its frequency may change in periods of global warming; evidence is to come from coral reef cores. Projects are also planned to examine the effects of sea-level change on coral reef growth, and to provide input into climatic modelling for the Cainozoic. The development of marine geochemical programs is designed both to monitor pollution and provide data pertinent to understanding climatic change.

. As part of the groundwater program, a survey of low lying islands is the Indian and Pacific oceans should be considered, to evaluate how groundwater supplies would be at risk should sea-levels rise.

. The program of regolith mapping, designed to document the distribution of regolith materials in Australia, and the processes involved in the formation of the weathered mantle, should be expanded.

. Consideration should be given to the development of baseline geochemical studies documenting the occurrence in nature of a number of elements which may be ecologically harmful.

ENVIRONMENTAL GEOLOGY IN BMR

Preamble

Community concern about changes in the earth's physical environment has intensified during the past decade. Response to the need for action is reflected in the Prime Minister's statement on the Environment released in July, and in its recommendations, including the review of environmental research in Australia being conducted by ASTEC, and the setting up of the Resource Assessment Commission.

Environmental stress is not just related to the "Greenhouse Effect", it is now with us all the time. In areas such as soil degradation, salinisation and coastal zone utilisation it is apparent that the basic research necessary for our current living needs has not yet been undertaken. There is a need for a consistent national approach to this research; they are national problems that require a national focus.

There is an increasing demand that science in Australia should provide a framework for the protection of the environment and the responsible use of natural resources. The earth sciences have a unique and crucial role to play in understanding the issues of change and in providing solutions to a variety of environmental problems. They provide a basic understanding of the processes involved in issues such as salinization, soil erosion, and degradation, and they provide, through the medium of the geological record, a time perspective which allows natural changes to be separated from those which have an anthropogenic cause. This dual role of the geosciences is vital for the understanding of the environment, the development of essential resources, and the conservation of environmental quality and diversity while the development is taking place. Development and conservation are traditionally seen as opposing forces that serve to polarise public, political, and scientific opinion. The concept of sustainable development demands harmony between the three elements of

understanding, conservation and development. As the national geoscience agency, BMR has a responsibility to provide the necessary geoscientific understanding to allow this harmony to be achieved. The recommendations of the Brundtland Report with regard to "sustainable development" have been embraced by the Australian Government, and a range of committees and inquiries are currently investigating ways and means of applying this concept to the future development of Australia.

The current structure of the BMR is built around the priorities of resource exploration and development. However, the Prime Minister has pointed out that, in research institutions generally, there must be flexibility and a capacity for redeployment as new areas of interest emerge and other areas become of lessening interest. If BMR is to respond to the increasing demand for geoscientific base-line data and advice with regard to sustainable development for Australia there needs to be fundamental re-allocation of resources within the organisation.

The Environmental Geology Committee was set up by the BMR Board of Management early in June 1989, to "propose a research program on environmental geology for BMR". The committee was convened because of the need to reorganise BMR in the light of the Wood's Review.

The Government's response to the Wood's Review was tabled in the Senate and announced on June 16 1989. The Government's new charter for BMR included significant changes to those proposed by Woods. One effect of these changes was to add a responsibility for providing advice on environmental issues. This charter establishes the BMR as a significant player in the field of environmental geoscience.

The new BMR charter does not identify the relative importance of environmental concerns within BMR, but it is clearly intended that it should be a significant undertaking. With this in mind the Environmental

Geology Committee proposes significant new programs in addition to some enhancements to existing programs to enable BMR to meet its new responsibilities.

This committee considers that a program of environmental geoscience should be undertaken in BMR which would fill a current gap in providing earth science input relevant to understanding the major areas of environmental change on a national and global scale. The program should maximise and build on skills and resources already available within BMR, and identify areas where new skills, expertise and resources are required.

We propose that new programs/projects be developed within 3 main themes, viz. 1) a project involving the mapping of the surficial cover of the continent, to contribute to the understanding of land degradation, 2) the compilation of high resolution records of environmental change in the recent geological past aimed at providing a time perspective for changes occurring now, and 3) the initiation of a detailed survey of the Australian coastal zone to provide base-line data against which future changes may be measured.

Programs should be developed in close co-operation with the National Resources Information Centre. NRIC is perceived as providing the "engine" for the construction of data bases and their management by GIS as recommended in appendix 3 of the Woods Review. Relevant data sets may be exported from this system for further analysis in BMR, for instance using Intergraph. It is important that a common format for data be established as soon as possible to allow for comparison of Commonwealth and State data on the one hand and geoscientific and ecological and climatic data on the other.

Products from these programs would be data sets and maps synthesizing information at a variety of scales, as well as scientific reports focussing on particular aspects of environmental change and management. The data sets should allow the rapid preparation of briefings where necessary.

NEW PROJECTS

The proposed new program areas, with rationale for their development, are as follows:

1. LAND/ENVIRONMENTAL DEGRADATION

Aims and rationale: In order to address some of the more fundamental questions regarding land degradation, such as soil erosion and salinisation, and in order to place the issue into a broader regional context to facilitate management of Australia's land/environmental resources, there is a need to provide geological input into the national land/environmental degradation program. To develop a new program addressing issues in this area, interactions between this and the two existing programs of Groundwater and Regolith need to be strengthened. Both existing programs will have an input into the program and both will require some form of enhancement to enable all three elements to function efficiently.

Currently, the Groundwater program focuses on two problem areas; land salinisation and river water quality in the Murray-Darling Basin, and resource management in the Great Artesian Basin (GAB). In the GAB an objective of the work program is to understand groundwater processes as a basis for better management of water resources. In the Murray-Darling Basin, most effort is directed toward the establishment of a knowledge base of groundwater processes to facilitate the management of the Basin's natural resources and salinity problems. This base will be built around a Hydrogeologic Map Series with associated database, and a predictive capability to numerically simulate the groundwater systems.

The current groundwater program has defined how regional groundwater systems react to change, based on the regionalisation of very detailed site specific process studies. In the Murray basin, these site specific studies have been used to give an indication of palaeoclimatic and palaeohydrologic

variation as a guide to the long term sustainability of groundwater resources. As well, this information implies that the current resource degradation in the Murray Basin is similar to that brought about by climatic change at times in the recent geologic past. We therefore have a good model of how other groundwater systems may react in the future, given the current climatic change scenarios.

It is felt that the initial environmental degradation program should be closely allied with work in the Murray-Darling Basin Hydrogeology Project, and specifically the Darling Basin program. Such a program should be two-fold;

a) to understand, in detail, the framework (environmental setting) of existing and potential soil degradation problems in the Darling Basin at a number of sites. This information can be used to describe the physical properties of the surficial units, as well as log the timing, style and frequency of past change, and

b) to regionalise the site specific models/information, utilising data gained from the Regolith Terrain Mapping program where available. The physical attribute information gained at the detailed level can be used at the regional level to predict catchment scale behaviour of the 'regolith' with respect to erosional- and salinisation-related processes. As well, catchment-wide paleoclimatic records can be deduced.

The program should target the major areas at risk from land degradation (not necessarily just salinisation) in Australia. The program will take a number of years to produce meaningful results, due to the need to start from 'scratch' in this discipline.

Resources, staffing and budget: Such a mapping program cannot be done without a substantial committment of resources. The program would require highly skilled scientific and technical staff. The site specific studies would be field intensive and would require sophisticated laboratory backup

at BMR. Drilling programs would also be required. Skills needed include sedimentary geology, palynology, age dating, pedology, geochemistry and Quaternary stratigraphy.

A rough estimate of resources would be;

3 scientific staff ($216 k/yr)

2 technical support staff ($108 k/yr)

= Total salaries around $300 k/yr (includes on-costs)

Drilling and operational costs could total $100 k/yr.

A viable program should have one scientist in place within twelve months, and be fully resourced (to 5 staff) at the end of 3 years.

Because land degradation is currently perceived as being of fundamental national importance, the Commonwealth Government is providing funds through a number of initiatives. These include the National Soil Conservation Program. These initiatives would be appropriate funding bodies for certain aspects of a catchment scale behavioural model of the regolith, provided that BMR was perceived as acting in partnership with NSCP.

Relationships with other BMR program elements: This type of program will be, initially, closely linked to work in both the Groundwater and Regolith areas. The detailed process studies provide key information on how the groundwater systems interact with the ground-surface. This in turn, coupled with paleoclimatic information, enables predictions to be made regarding the impact of environmental change on water and land resources.

Relationships with outside organisations: The linkages with organisations outside BMR are many and varied. The major linkage is with CSIRO. It is felt that this work complements the soil work already undertaken, and currently underway, within CSIRO. BMR definitely has skills that can produce relevant results in this area.

Products/Markets: Results for the program would be expressed in terms of a data base providing basic knowledge for use in hydrological programs, in regolith mapping and process studies and in understanding past climates and predicting future changes. Expression of the information in terms of a 1:500,000 scale map of the Darling Basin is anticipated. Use of the information, or its 'market' is primarily within government, as essential input in decision making regarding the sustainable management of natural resources.

2. COMPILATION OF HIGH RESOLUTION RECORDS FOR THE AUSTRALIAN QUATERNARY

There is a clear need to compile and co-ordinate data on the Australian Quaternary for application in a variety of resource and land use assessment areas. In addition, the Quaternary holds the key to understanding the major controls, both external and internal, on the earth's climate. The most appropriate interval to provide a test-bed for models of future change is the Holocene, viz., the last 10,000 years of earth history, because physical conditions were at times similar to those of today. It is important, however, that we have a clear understanding of climatic events over a much longer scale, to at least 150,000 years before the present, because that time span, encompassing a full glacial/interglacial cycle, provides insights into the major factors controlling climate, and to the response of physical and biological systems to both glacial and interglacial conditions. It is only by appealing to the geological record that we can determine the trends and directions of global change, the frequency and magnitude of events, the mechanisms of global change, and the rates of response of physical and biological systems to climatic events.

Aims: The compilation of presently scattered data from the Australian Quaternary into a single database should provide answers to questions concerning the way in which this continent has responded to climatic changes in the recent geological past, how it is coupled to global systems,

and how past events have shaped the present landscapes and distribution of resources within the surfical cover. This will provide basic information on processes, amplitudes and rates of environmental changes and will allow the separation of natural changes from those which have a human cause. The compilation of a data base for Quaternary information is seen as a necessity by workers in the active Quaternary community in Australia, which is supported by CSIRO, the universities and to a degree, by the mineral exploration industry. One outcome of such a database would be a set of palaeogeographic reconstructions for the Quaternary, but the work would include too the collection of new data in key areas, or areas from which no data are as yet available.

This concept has the support of a large number of workers and the view has been expressed that BMR is the appropriate agency to undertake such a compilation. There is a clear need to integrate data from the marine realm with that from the continent, a need which was expressed by the Australian National Committee for the Quaternary in a submission to Astec in 1988. Data collected under environmental progams in Marine Science will contribute directly to this project.

The data base will consist of a set of site specific parameters (available mainly as stratigraphic columns) recording radiometric and other dates, lithostratigraphy, biostratigraphy, weathering events, and specialist geochemical and palaeobiological data as appropriate. Expression of this data base as a set of palaeogeographic maps would provide a means of understanding the links between events occurring in different areas of the continent, and would enable testing of models of atmospheric circulation already in use or being developed. At present very little concrete information on past climatic changes is available to modellers.

Such maps would document areas of sediment accumulation, lacustrine, fluviatile and coastal environments, sediment type on the continental

shelves, areas of erosion, tectonism, vegetation in terms of major formations, and lake level. These could be translated into critical ecological boundaries, humidity and other palaeoclimatic parameters. A sequence of maps would show changes in the boundaries through geological time. Each would be a document summarising work from a number of researchers in multidisciplinary fields, as well as incorporating the results of new studies.

Scheduling: The International Geosphere Biosphere Program, a major project designed to understand the causes of changes, natural or man-made, in the earth's environment is in its planning phases and destined to commence in earnest in 1990. Workshops are being held to determine an Australian input. One of the these concerns the analysis of high resolution records from the past, and is planned for late 1990. This would be an appropriate time to firm up planning for the BMR data set, especially in terms of which time intervals should be considered.

The present Phanerozoic Geohistory of Australia project terminates in 1991; a successor project commencing then with a focus on the Quaternary would utilize expertise developed during the course of that project and its predecessor, the Palaeogeographic Atlas of Australia project.

Resources, staffing, organisation: A three year project commencing in 1991 should allow the setting up of the database and the production of data sets and maps for the Australian Quaternary. Such a project would require;
Three professional scientists for stratigraphic data collection and interpretation
One draftsperson
One TA

At salary and travel of around $40k this would be $200,000 per year. With on-costs, annual costs would be $320,000. Printing and publication costs

would be additional in a fourth year.

Organisationally, it is proposed that BMR should play a pivotal role, but a variety of scientists outside BMR should be encouraged to participate, using outside funding, in an organisational style similar to that adopted for PHOSREP in 1988.

A number of funding sources outside BMR have become available through recent environmental intiatives. Important among these is the IGBP through which funds may be available for the decade beginning in 1990. Participants from universities may obtain ARC support. The possibility of some support from industry will also be investigated.

Relationship to other BMR projects: It is anticipated that this project would have close links with environmental aspects of the Marine Geolgoy Program, with the Regolith Program, and with a range of projects developed under the Mapping Accord. All of these would generate data for incorporation into the Quaternary database.

Relationship to International projects: The links to an Australian IGBP Project have already been mentioned. In addition, there are a number of international projects already underway involving Quaternary maps for palaeclimatic purposes. Notable is COHMAP, which is a consortium of scientists studying late Quaternary environmental changes as recorded in geologic data and simulated by numerical models. Australian input to COHMAP has been confined to land-based data on lake levels and vegetation history: there is a need for input of marine information into this project. The Australian co-ordinator for COHMAP has offered BMR the existing data base.

Other relevant projects include IGCP Project 296, The Quaternary of South East Asia, which is currently seeking input from Australia in the form of

Quaternary stratotypes, and the WESTPAC Project on Late Pleistocene Paleogeographic maps. The aims of this project are the compilation of palaeogeographic maps for the region in two time slices, viz. 15-20 K and 120 K, to include the modern seas plus the coastal part of the surrounding continents.

Products/Markets: Products would be in the form of a data base summarising onshore and offshore data in terms of lithologies, age control, environments, palaeoclimatic data etc. A basic format as a series of stratigraphic columns is vizualised. A series of continent-wide palaeoclimatic maps and associated scientific papers would be another product, as would be palaeogeographic maps or data presentations of small, typical areas, and a limited number of continent wide palaeogeographic maps. The identification of the most appropriate time intervals would be firmed up at the IGBP workshop.

Clients for the products are primarily scientific in the first instance, viz. climatic modellers and others with an interest in climate change. There may be a market for data base products among environmental planners and consultants and a substantial public and education market as well: with increasing awareness of conservation issues people have an interest in the history of where they live. This is a market that the earth sciences have yet to tap.

3. THE COASTAL ZONE

Aims: This is a proposal for a major research project to establish an urgently needed geoscientific knowledge base to provide a proactive context for sustainable development in the coastal zone. It is based on the proposals developed at a Workshop convened by the Government Geologists' Conference and held at the Coastal Studies Institute, University of Sydney

in June 1985, and at an IGBP Planning Meeting on Sea Level Change held in Melbourne in October 1989.

At the moment, with the lack of an integrated approach to coastal geoscience, Australia lags behind other developed nations in not having national base-line data to guide the exploitation of coastal resources. Indeed, the basic research necessary for our current living needs has not yet been undertaken. The matter is particularly important since 90% of the Australian population live and work close to the sea, creating enormous pressure on the coastal zone. This is also the zone most likely to be affected by global climate change, particularly sea level rise.

In view of the importance of the coastal zone to the Australian community, there is an urgent need to make a nationwide synthesis of the geoscientific nature and evolution of the coastal environment in order to assess its resources, to understand its history, to develop strategies for its future mangement and sustainable development, and to evaluate the impact of global change on it.

Because of its technical expertise in coastal studies, its role as the national geoscience organisation, and, through NRIC, its function as the national geoscientific resource information centre, BMR is the logical organisation to undertake this task on a national scale through field studies as well as through the provision of a focus for assembling and cross correlating data gathered by State organisations, Universities, and other Commonwealth bodies.

The major conclusions of the 1985 Workshop on Coastal Geoscientific Studies recommended the assessment of the nature and distribution of economic minerals in the coastal zone, analysis of information relating to past relative changes in sea-level, studies of coastal groundwater exploitation, and an assessment of the factors effecting sediment movement in the coastal

zone. These factors should be taken into account in the compilation of a synthesis of coastal processes, stratigraphical correlation, trends of sea level change etc. to guide coastal management and resource exploitation policies.

In 1989 an IGBP planning meeting on Sea Level Change identified the BMR as the only organisation potentially capable of co-ordinating a national network of coastal monitoring sites, and of operating a national geoscientific coastal-zone data base.

The commissioning within NRIC of systems capable of managing such a data base, together with the increasing activity in the area of coastal science in Australia, partly under the aegis of IGBP and IGCP projects mean that this is an appropriate time to initiate this study. The BMR input into the new South West Pacific sea-level monitoring network would be incorporated into this new project.

We propose to review existing information and collect new data to enable the construction of a national geoscientific coastal zone data base and to establish and operate a suitable GIS style management system for the data base and produce, among other products, environmental geology maps of the coastal zone. The data base would be constructed in such a way as to be expandable to include data on biology, climate and other relevant areas, and to compliment the FIMS data base on Australian tides and sea-level. The ultimate aim of the data base is to provide an interactive geoscientific inventory of the entire coastline on a scale of 1:100,000.

The data base will then be analysed to provide baseline proactive information to guide the sustainable development of the coastal zone, and to assist in planning for impacts such as the effects of potential sea-level rise. It is also proposed to establish a network of representative sites for long-term monitoring of coastal change. This

network would compliment the proposed national super-tide-gauge network to be established by the Australian Permanent Committee on Tides and Sea Level. Together the two networks will provide invaluable base-line data for the future management of the coastal zone.

Construction of the data base and establishment of the monitoring program will involve close cooperation with AUSLIG, NRIC, DASETT, various State instrumentalities and the academic community.

Scheduling: Data gathering will have two focii: the compilation and cross-correlation of geoscientific data collected from the coastal zone by State Instrumentalities, Academia, and other Commonwealth Organisations, and the gathering of data in key areas not covered by other studies, including strengthening State investigations by the provision of specialist expertise and high technology equipment.

Emphasis will also be placed on the importance of monitoring and process studies of representative areas to provide calibration for modelling based on the data base sets. The project is aimed at providing an interactive data base that will form a permanent cornerstone for coastal resource and environmental mangement in Australia. Coverage of the entire coastline in some form will be achieved by 2000. The following is a suggested timetable for the first five years of the project.

Year 1: Establishment of the database, compilation of existing data, review of existing long-term monitoring sites and identification of new sites, identification of priority areas in consultation with State Instrumentalities, establishment of a common protocol for data gathering and coastal monitoring with State Instrumentalities and Academia.

Year 2-4: Continue with data compilation. Undertake image analysis on a regional and local scale, undertake field operations to ground-truth image

analysis and to gather data in priority areas.
Establish a coastal monitoring network.

Year 5: Completion of an interim national assessment of geoscientific aspects of the coastal zone, emphasizing:

distribution of mineral resources
environmental conservation and degradation of coastal wetlands
factors influencing the nature and rates of coastal erosion and accretion
Quaternary sea level history
hazard risk maps
Groundwater maps of coastal aquifers
Zoning maps for engineering development

Year 6-10: Complete the first comprehensive set of base-line data for the Australian coastal zone.

Resources and Staffing: This is a significant project and although details of staffing and budget are not proposed at this stage, it is anticipated that the project would involve an equivalent investment to, say Geomagnetism, Murray Basin Hydrogeology, or the Canning Basin Study: ie. staff numbers of about 15 and an annual budget of the order of $1,500,000.

In the first year of operation a staff level of 5 and a budget of $3-400,000 is sought. It may also be necessary to provide further resources to NRIC.

Many of the skills needed are already represented in BMR, including scientists with strong backgrounds in coastal zone research gathered either through former BMR programs, or as a result of postgraduate university experience. It is suggested that positions with the project be advertised internally, and that the project be given sufficient priority to allow

suitable staff to transfer into it from other areas of the BMR.

Relationship to other BMR Programs: Close co-operation will be required between the project and other BMR programs in areas of overlapping regional interest or methodological approach, eg. the proposed Northern Australia Project, the Regolith Project, Groundwater, the proposed Quaternary Mapping Project. Strong links need to be established with the BMR Image Processing Facilities and NRIC.

Relationship to Outside Organisations: The study is best set up within the context of the National Mapping Accord and following the recommendations of the 1985 Chief Geologists' Workshop. However, in addition to Geological Surveys, some of which are not active in Coastal Zone studies, the project will involve liason with a number of State Instrumentalities. These include the following bodies (note that this list may not be complete).

Victoria: Conservation, Forests and Lands (Management of Public Lands), Planning and Environment (Strategic responsibility for the coastal zone, management of Port Phillip), Environmental Planning Authority, Ministry of Transport (Ports and Marine erosion), and the Ministerial Council for the Coastal Zone.

Queensland: Department of Harbours and Marine, Beach Protection Authority, Department of Conservation, Department of Local Government.

New South Wales: Department of Public Works, Coastal Engineering Board (Coastal erosion), Department of Planning (Coastal Council), Soil Conservation (Dune revegetation), Department of Agriculture (Estuarine research)

South Australia: Department of Environment and Planning, Coastal Management Branch (Ecology, engineering, physical processes and hazards),

Planning Division (Assessment of major projects), Coastal Protection Board (Statutory Authority), Fisheries (Ecology of coastal wetlands), Lands Department (Crown Lands, Shacks), Electricity Trust (Mangrove ecology)

Western Australia: Marine and Harbours (Coastal engineering), Conservation and Land Management (Marine and Coastal Parks), State Planning Commission (Coastal Management Plan), Environmental Protection Agency (Monitoring and review of development), Agriculture (Coastal vegetation)

Tasmania: (Data being obtained)

Northern Territory: (Data being obtained)

Other Commonwealth bodies to be involved would include AUSLIG, AIMS, GBRMPA, DASETT, The Permanent Committee for Tides and Sea Level, and CSIRO.

The Australian Academy of Sciences would be involved through liason with the Australian IGBP program.

Close co-operation is envisaged with Universities, particularly the Institute of Coastal Studies, Sydney Univ., Geography Dept. Wollongong University, Melbourne University, Monash University, Department of Geography and Oceanography, ADFA, Department of Geology, Adelaide University, Flinders Institute of Marine Science, and Dept. of Earth Sciences, Flinders University, School of Environmental Sciences, Murdoch University, Departments of Geography, Geology, and Botany, University of Western Australia, Department of Geology and the Sir George Fisher Institute, James Cook University, Department of Civil Engineering, Queensland University, Department of Geology, University of New England. Dept of Biogeography and Geomorphology, Australian National University.

Products/Markets: The Data Base will include the following levels of

information:

Hydrogeology

Geomorphology

Mineral Deposits

Stratigraphy

Sea Level History

Sedimentology

Ecology

Wave Climate

Tidal Setting

Climate

Anthropogenic Structures

Palaeoenvironments

The GIS will be used to produce integrated data sets for information such as mineral resources, age structure, erosion/degradation assessments, and pollution modelling. Detailed studies, necessary to calibrate the data base, will generate specialist papers and synthesis reports.

Markets for these products would include State Instrumentalities, Shire Councils, Private Sector Engineers and Consultants, Developers, Mining Companies, Academia, other Commonwealth Bodies, and International Organisations. The Products will be viewed as a major national data resource.

ENHANCEMENT OF EXISTING PROGRAMS

The environmental aspects of a number of programs already underway can readily be enhanced to meet demands for environmental information. There is a need to link these aspects closely with the proposed environmental program. For instance, data acquired during the marine geoscience program needs to be integrated with onshore information through the medium of palaeogeographic maps, in order to provide a comprehensive picture of

changes affecting the Australian environment through the past 2 million years.

1. Marine Geosciences

Marine studies will impact upon two aspects of environmental studies, namely, understanding global climatic change and detecting and defining marine pollution.

Marine sediments contain a high resolution record of climatic and environmental change effecting Australia throughout the Quaternary and Cainozoic, and are an essential information repository for understanding climatic change. Marine studies will effect an understanding of palaeoclimatic, palaeo-oceanographic and palaeo-sealevel variations and the chemical and physical responses of the modern ocean/sediment system. Such programs will therefore markedly reduce present uncertainties relating to sealevel and the cause and effect relationship between CO2, temperature and climate. Marine studies will have the following principal objectives:

. To define the essential database i.e. long, reliable and geographically dispersed time series data, necessary for defining the frequency, magnitude and causes of past climatic and sealevel change at scales of 10^1 to 10^6 years.
. To reduce the uncertainties particularly with respect to distinguishing short term climatic variability and long term climatic change.
. To better understand mechanisms of change, in particular the duration and predictability of change.
. To provide crucial verification of modelling experiments.

Marine pollution will become an extremely important factor in defining future sustainable growth, and it is intended that continuous monitoring of seawater for pollutants becomes a routine part of Rig Seismic operations.

Future Marine Division contributions to environmental studies will arise from projects currently in train as well as from projects currently in

planning phases. Current projects are, and future projects will, be undertaken in conjunction with the Ocean Drilling Program, the Research School of Earth Science and Department of Geology at the Australian National University, and the University of California-Santa Cruz.

Studies presently in progress include:

Northeast Australia

Cores collected on Rig Seismic Cruises 50/51 and 70/71 provide a history of climatic change for the past 300,000 years. These studies have however been hampered by a lack of time resolution. This will be remedied on Leg 133 of the Ocean Drilling Program which will drill off Northeast Australia in August/September 1990 with the intention of sampling an ultra high resolution Pleistocene section on the slope of the Great Barrier Reef and a series of 300 m sections bottoming in top Pliocene to define the climatic and sealevel signature.

Cores collected from the Queensland and Marion Plateau will penetrate Miocene reef sequences at shallow depth. Climatic signatures within corals in these sequences will define "weather" in the Miocene and the relations of El Nino to high and low temperature variations and the possible relations of both to the sunspot cycles. Leg 133, off Northeast Australia will provide a principal database for understanding past climatic change off eastern Australia, and will be compared with climate signals off Western Australia obtained from the Exmouth Plateau.

Exmouth Plateau

The Quaternary sections of ODP cores from drill sites 760 and 762 on the Exmouth Plateau are being analysed for grainsize, isotopic variations and pollen record so as to help define climatic changes in this period. Results to date show five major periods of desertification in the last 500,000 years. In addition new trace metal data in ostracods may prove to

be excellent sea water palaeo-thermometers. These studies are being conducted jointly with the Department of Geology, and RSES, ANU.

Sydney Basin Maryborough Basin

During the Rig Seismic cruise to the Sydney Basin/Maryborough Basin in November 1989, the opportunity will be taken to collect sediment cores in a crucial part of the Australian margin. The continental slope off Bundaberg and Gladstone is currently transitional between temperate and tropical climates and will show the maximum change during past climatic events. The cores will be studied by staff and students at the Australian National University.

Geochemical data collection

Shipboard and onshore laboratory facilities exist which can provide a monitoring capacity to detect a variety of marine pollutants. These can be used to distinguish natural hydrocarbons from seepages from pollutants resulting from spillages and industrial discharge. There is too the capacity to measure radio isotopes in seawater, as well as in soils and groundwater.

As well as routine monitoring of background levels of metals and other elements, two aspects of the current and proposed marine geochemistry program have direct application to greenhouse and climatic change research: (1) Monitoring of methane in sediments and in the water column will impact on consideration of whether the ocean is a source or a sink for Greenhouse gases. The contribution of marine methane to atmospheric methane is currently unknown. (2) Studies of the preservation of organic carbon will help define variations in primary productivity which are palaeoclimatically and paleo-oceanographically controlled. These latter aspects are being conducted in conjunction with other Australian and USA institutes.

Verification of Modelling

Climatic modelling of the Cainozoic of Australia is being conducted at the University of Adelaide. A Marine Division scientist is a co-investigator on this program. The BMR database of climatic change for the Cainozic will be used to verify the validity of modelling assumptions. In particular the natural palaeoclimatic database will;

- Permit observational and modelling studies of the interactions between carbon and climatic cycles.
- Permit improvements in the general knowledge of the processes of large scale climatic change, for example spatial modes, time scales, feed backs and non-linearities, and provide a foundation for climate theory that may help in the study of CO2 effects on climate.

Through the accurate simulation of past climate scenarios, the "verification" achieved will provide a basis for estimating the reliability of scenarios for future climatic change.

Total Marine Division involvement in above projects is approximately 3 1/2 staff years over a 3 year interval.

Planned projects include the following:

Further projects, based on reefs as archives for past climatic changes, identifiable at timescales of 10^1 to 10^6 years, are envisaged to facilitate prediction of climatic changes in the next 100-1000 years.

Project 1. Studies of the frequency of high energy, low frequency events i.e. El Nino. This project will examine the past record of El Nino encapsulated in coral reef cores to define whether the frequency and magnitude of El Nino events increase or decrease with global warming. The answer will define the basis for climatic modelling in the Pacific. Current models take little account of the phenomenon in spite of the fact that unpublished reef data show a strong correlation between climate change

and El Nino intensity. BMR currently possesses the best Australian coral reef core record. This should be supplemented by similar cores obtained from the Abrolhos reefs of Western Australia so that a climatic signal of El Nino from both sides of the continent can be used in defining predictive models.

The development of this program is currently being investigated through collaboration with staff of the University of California, Santa Cruz who have experience and expertise with El Nino phenomena in the East Pacific where it has a history of being extremely destructive. Two additional BMR staff per year for 3 years would ensure a successful outcome.

Project 2. The effects of sea-level rise on the growth of coral reefs - Co-operation with French scientists working on the atoll of Mururoa. France, as a result of her nuclear testing program at Mururoa, has performed the ultimate Greenhouse experiment i.e. a 1.5 m sea-level rise was induced on the atoll as a consequence of rapid subsidence. French scientists have been monitoring the biological and physical effects of the subsidence for twenty years. Much of the data necessary to answer concerns of the island nations of the Pacific is therefore available albeit confidential.

Informal discussions were held with leading French scientists during 1988. Recently, the French Prime Minister, Mr Rocard, invited Australian scientists to work with French scientists on Mururoa. Discussions are continuing with French scientists which will hopefully lead to a commitment by the French to release the data, which together with data from the Great Barrier Reef should provide a powerful statement of the predicted effects of a Greenhouse type sea-level rise on reef growth, fish stocks, and coastal erosion.

Resources	1989/90	90/91	91/92	92/93
Proposed				

Program ($k)	10	5	5	
Staff years	0.1	0.2	0.5	0.1

This project will make a substantial contribution to predicted management practices off northeast Australia and to advice and aid to the island nations of the Pacific.

Further proposals for marine programs relate to Antarctica (see below)

2. Groundwater

BMR's current programs are directed towards establishing the hydrochemistry of Australia's major groundwater resources in sedimentary basins, as a basis for resource development and management options. Its role in assessing groundwater resources has involved both continent-wide overviews of groundwater systems and of groundwater pollution, in addition to the detailed focus on important basins. Some groundwater studies on the islands of Cocos, Nauru, Kirabas and Niue have also been undertaken.

Concern about rising sea-levels in the context of a greenhouse effect imposes a need to further understand groundwater systems on low islands. A number of islands obtain much of their water supplies from a freshwater lens of groundwater (the Ghyben-Herzberg layer) that underlies many of the coral islands or sand cays. In some cases these lenses of freshwater are as little as 2m thick. Consequently a change of 1m sealevel would probably make the entire water resource brackish and non-potable.

Studies already undertaken by BMR could form the basis of an exercise to theoretically model the effects of rising sealevel on the freshwater lens. Alternatively, some islands which presently rely on rainwater may have to increasingly turn to groundwater if the climate becomes more arid.

What is required is a survey to identify those islands where a problem may arise as a result of the deterioration or destruction of the freshwater

lens through rising sealevels. This will then need to be followed by a program of drilling, and monitoring of groundwater levels and quality, in parallel with monitoring of sealevels in order to develop definitive groundwater models for forecasting the impact of the greenhouse effect of this vital island resource.

3. Antarctic Earth Science

During 1989 the Australian Government significantly adjusted its policy stance towards Antarctica. Of relevance to this are the Prime Minister's statement 'Protection of the Antarctic environment', dated 22 May 1989, which explained why Australia had decided not to sign the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA), and his policy statement on environmental issues in which the concept of Antarctica as a 'Wilderness Reserve' is raised. The Antarctic Science Advisory Committee (ASAC) has responded to these developments by abolishing its Research Priority Area 'Science to provide a sound basis for mineral resource assessment and for mineral resource and environment management' (commonly known as the Minerals priority area), and has recommended that 'Minerals' research projects, and indeed all geoscientific research in the ANARE program, be accommodated in a new priority area entitled 'The Natural Environment'. In this context it is appropriate for BMR to place the Antarctic component of its research program within the organizational framework of Environmental Geoscience.

BMR activities in Antarctica

BMR has lead the earth science component of the science program of the Australian National Antarctic Research Expeditions (ANARE) since 1947; logistic support for ANARE operations is the responsibility of the Antarctic Division of the Department of the Arts, Sport, the Environment, Tourism, and Territories. BMR currently devotes about 1% of its research effort to Antarctic studies. Antarctic activities differ from other elements of the BMR research program in that BMR does not, for the most

part, control the means to "make the program happen".

BMR's Antarctic activities comprise four main elements:

1) regional geological investigations onshore;
2) operation of geophysical observatories;
3) marine geophysical and geological investigations of the continental margin;
4) 'consultancies' whereby BMR specialists become involved with Antarctic research projects on account of their individual standing.

The first three elements relate directly to the ANARE and tend to be focussed on the Australian Antarctic Territory (AAT), but the fourth one is commonly more international.

Regional geological investigations of outcrop areas in the AAT are carried out in conjunction with specialist studies by University scientists. BMR contributes geochemical and geochronological expertise and compiles maps and regional geological syntheses. These investigations have previously had a 'hard rock' bias but increased attention needs to be given to environmental aspects of Antarctic geology, in particular to the history of Antarctic glaciation. Nevertheless the successful bedrock geology studies should be continued for the purposes of 1) developing a scientific inventory and documenting the attributes of the proposed Antarctic Wilderness Reserve; 2) contributing to scientific knowledge of Antarctica, and to the national Antarctic research commitment; and 3) coordinating the detailed research projects of University geoscientists and placing them in a regional context so as to obtain maximum scientific benefit from expensive ANARE field operations.

Geophysical Observatories are maintained at the Mawson and Macquarie Island ANARE stations. Mawson is especially well sited for seismically monitoring earthquakes- both natural and man made- that cannot, for technical reasons, be monitored within Australia.

In marine geoscience, a BMR marine geophysical survey of the Prydz Bay area in 1982 was of fundamental importance to scientific drilling in that part of the Antarctic margin in 1988 by the Ocean Drilling Program (ODP). The BMR ship 'Rig Seismic' is suitable for operating on the AAT continental margin, and there are plans for investigations in particular areas. This new program, which will be aimed at environmental issues, will need additional finance and personnel.

Consultancies These have involved specialist BMR staff examining material collected by Australian or international agencies. One example of this is Dr E Truswell's palynological study of cores recovered by the ODP drilling in Prydz Bay.

Antarctica and the Greenhouse effect

There seems to be agreement that for the next few decades at least 'Greenhouse' induced atmospheric warming will result in increased precipitation over, and consequent expansion of the Antarctic ice cap. This implies extraction of water from the oceans and counteraction of the expansion of the water mass that global warming will cause. Antarctic geoscientific research relevant to the 'Greenhouse' effect includes:

1) Investigation of the structure and dynamics of the modern ice cap;
2) Elucidation of the 150 000 year or longer climatic record of the ice cap's annual ice layers so as to provide a reference for global, and for Australian late Quaternary events;
3) Deduction of the longer term history and palaeoclimatology of the icecap from studies of marine sedimentary sequences, and onshore glacial landforms and moraines, including dating by paleontological and isotopic methods.

Topic 1 is the province of the Glaciology Section of the Antarctic Division, as is Topic 2 although this is also of interest to Quaternary

geologists. Topic 3 has been addressed by University scientists working within the Australian or other national Antarctic Programs, and provides an opportunity for BMR involvement in Antarctic environmental geoscience. It corresponds to the work of the Group of Specialists on the Cenozoic Palaeoenvironments of the Southern high latitudes, established in 1986 by the international Scientific Committee on Antarctic Research.

Future additions to the BMR Antarctic program

BMR is developing a proposal for an Antarctic marine geoscientific program that will address Topic 3 above. This will include study of the mechanisms, rate, and timing of glaciation and its relationship to sea level change. The program will relate to the need to understand past and present global climate systems as a basis for predicting greenhouse-induced changes, and will need to be coupled to Ocean Drilling Programs in the Antarctic so that the long term (1-60 million years) glacial and climatic signal can be deciphered. There should also be linked investigations into onshore glacial sedimentary sequences and their record of glacial evolution and variation. Both the marine and onshore studies of Antarctic glacial history will require additional resources, with the proposed marine program (which would be independent of Antarctic Division logistic arrangements) would need $2-3 million annually for the first three years and 16 new staff. The onshore program would require more modest resources.

Direct costs to BMR of developing a new program of onshore glacial geology investigations would initially be of the order of 1-2 additional research and support staff with a possible annual operating budget of $150 000. However the major expenses of travel to Antarctica and general support in the field would be borne by the Antarctic Division and would, under present arrangements only be available on a competitive basis. BMR would not be certain that an onshore glacial geology and palaeoenvironmental program could come about whereas the projected marine program would be self contained.

4. Regolith

The current regolith program is aimed at defining the distribution and characteristics of regolith materials throughout the continent, and at understanding the processes and evolution of regolith formation. The Regolith program is divided into regional and systematic studies. Regional studies provide routine Regolith Terrain mapping at 1:1 million scale, complemented by Morphotectonic mapping at the same scale. This program requires support from application of a variety of dating techniques and from laboratory sedimentological analyses as an integral part of deriving maps. It is necessary to understand the regional setting in order to target areas where detailed studies are most urgently required.

Within the program, systematic studies involving the development of concepts, mapping methodology and geomorphic modelling will be pursued. In mapping methodology, pilot maps at various scales larger than 1:1 million will be pursued. Both regional and systematic studies will input into a national regolith data base from which will be produced maps - factual, interpretive and derivative - and reports.

There remains a need to increase resources in this area in order to complete the anticipated mapping. Increased pressures on regolith mapping from the environmental area may create a need for further expansion.

5. Geochemical sampling in association with land use

BMR's involvement with specialised land use projects such as the Kakadu Conservation Zone and, in the future, with the Cape York area, has highlighted a number of information gaps in the provision of geoscientific knowledge relevant to issues of competing land use. One of the obvious gaps is in geochemical sampling in order to undertand base levels and distribution patterns of a range of elements.

This demand for regional information can be translated into the need for national databases showing the natural distribution of harmful elements, including selenium, arsenic, beryllium, thorium, uranium, cadmium, mercury and lead. Such databases could be the outcome of soild and stream sediment sampling undertaken in conjunction with BMR mapping programs. Data could be obtained also by collaboration with other instrumentalities involved in soil sampling. Consideration might be given in future to airborne geophysical surveys for potassium, thorium and uranium. NRIC offers an appropriate database facility.

The preparation of such national databases is a role that could be filled by BMR in the future. At present it is only flagged as a potential area for development, without costs of manpower needs being evaluated. Clients for databases and maps would come from the mineral exploration industry, from public health bodies and from conservationists.

Another obvious gap is in providing geoscience information on specialist land use areas to a range of clients, including the general public and scientists from other disciplines, notably biologists. Provision of maps and information aimed at a popular, public education level would enhance the image of BMR as a broadly based geoscience survey organisation, not as one solely concerned with the interests of mineral exploration. In the case of Kakadu, for instance, there is at present no popular account of the geology of the park, this is a real gap in an area where landforms are a prominent aspect of the reserve, and where they exert a major control on the distribution of the fauna and flora. This information gap contrasts markedly with the large quantity of popular information available on biological aspects of the national park. A similar information gap exists with respect to Uluru. Both of these areas are of the World Heritage List, hence it is appropriate that the national geoscience organisation be concerned with providing basic information on them. As most of the relevant information already exists within BMR, this could be done at

minimal cost, and on a cost recovery basis.

6. Earthquakes, Volcanic Hazards and Nuclear Explosions

Earthquakes and volcanic eruptions are natural hazards of a catastrophic kind; nuclear explosions constitute a similar risk, but with a human origin. BMR has a major role in monitoring this kind of risk, with a view to mitigating the potential impacts. The way in which these ongoing projects, which are directly concerned with aspects of the Australian environment, will related administratively to new Environmental Geoscience Unit, is yet to be determined.

Current projects in earthquake seismology involve the operation of a national network of seismographs and accelerographs which serve to monitor and interpret seismic waves as a contribution to international seismology, and make these data available. They are used to make assessments of earthquake risk throughout the Australian continent and to understand the structure and tectonics of the region, with particular regard to intra-plate seismicity. Although the level of seismicity in the Australian region is lower than in places on active plate boundaries, large, significant and potentially damaging earthquakes do occur in the Australian region. A long term goal of this component is to locate all earthquakes in the region with magnitudes of three or greater, to provide improved assessments of earthquake risk, and to understand current tectonic processes associated with the Australian continent.

Another component of BMR's geophysical monitoring activities concerns geomagnetism. Its objectives are to monitor, model, understand and eventually predict the geomagnetic field in the Australian region, including the Australian Antarctic Territory, as an aid to navigation, mineral exploration, directional drilling, crustal studies, geomagnetic risk assessment and environmental monitoring. The palaeomagnetic

laboratory is maintained so that palaeomagnetic and rock magnetic techniques can be applied to solve geological problems associated with continental reconstructions, tectonic history and the evolution of sedimentary basins. The use of palaeomagnetic techniques as dating tools in regolith and Quaternary studies offers a valuable facility within BMR in support of proposed projects in these areas.

In order to detect and provide information on underground nuclear explosions, data recorded at Australian seismic stations are analysed at the Australian Seismological Centre in BMR. Currently it is planned to complete the national facility and develop the facilities necessary to establish an international data centre to monitor a Comprehensive Test Ban Treaty. Australia has been a member of the Geneva Group of Scientific Experts (GSE) since its inception in 1976, and has already provided an important input into the efforts to achieve a global system for monitoring such a treaty.

The monitoring of hazards relating to volcanic activity in the Australian region is another BMR contribution to the mitigation of environmental hazards. The aim of this ongoing project is to assess and mitigate the hazard to aircraft entering and leaving Australia posed by volcanic ash clouds and aerosols from active volcanoes, particularly in the Indonesian region. Part of the project involved the compilation of a database on the impact of volcanic eruptions on the middle atmosphere, which now has some 450 entries, as well as charts showing the distribution of volcanoes on major airline routes.

STRUCTURE OF PROPOSED ENVIRONMENTAL RESEARCH IN BMR

The new initiatives proposed, viz. the land degradation studies, the Quaternary high resolution studies, and the coastal zone project, would be appropriately administered initially as an Environmental Geology Unit.

This unit should have a core staff, and secondment of additional staff from other divisions could be made as demands arose and environmental priorities shifted. As the Unit became more developed it would acquire Branch or Division status.

The incorporation of BMR's Antarctic programs also under an Environmental heading makes much sense in a political climate which is moving away from resource development in Antarctica.

The Environmental Geoscience unit would of necessity maintain close ties with a number of existing projects which are of environmental concern. There are links with the Groundwater Program, which would be maintained through the land/degradation project. There are clear links too with the Regolith Program, which is presently administered by the Division of Minerals and Land Use. In the longer term there may be benefits derived from including all of the Regolith Program within Environment. Studies in that area, and those in groundwater concerned with surficial mapping, share common aims and methodology.

The operation of Environmental Geology as a separate unit would allow close contact to be maintained with environmental issues across a wide spectrum BMR progams. It would also function as a clearing house for environmental information, and, importantly, as a contact point for the plethora of environmental committees currently active in Government and the community.

RESOURCES REQUIRED

The following represents a summary of the resources required to undertake the proposed environmental geology programs. Estimates are given of the costs of new programs, and for the onshore Antarctic component of existing programs only. These are the program elements which it is proposed will fall under the Environmental Geoscience Unit. Enhancement of other

existing programs will be the responsibility of parent divisions.

Resources for 1989/90

In order to establish the new programs, the environmental unit requires the formal allocation of a core staff of 3 scientists, with supporting secretarial and technical assistance, viz. 1 steno-secretary and 1 technical assistant. Operating costs for the 1989/90 fiscal year, which is viewed a period of program development and feasibility studies, are of the order of $75 k, which includes travel and contract funds. In this interim phase, scientists tasked with the development of the unit should retain equivalent support to that previously provided by their former divisions. These resources are required to enable the development of new programs, to facilitate contact with outside organizations, which need to be established and systematized, and to respond to the demands of various environmental enquiries and committees.

Resources for 1990 and beyond

Resources required for the longer term development of programs are summarized in the accompanying table.

NEW PROGRAMS	FY	ASL	Salaries/ on costs	Field Drilling Computing etc.
1. Land degradation	1990/91	1 Sci	$72 k	$50,000
	1991/92	3 Sci) 2 Tech)	$324 k	$100,000
2. High resolution records for the Quaternary	1990/91	0.5 Sci	$55 k	$50,000
	1991/92	3 Sci) 2 Tech,) draft)	$320 k	$125,000
3. Coastal zone	1990/91	4 Sci) 1 Tech)	$335 k	$50,000
	1991/92	5 Sci) 2 Tech)	$491 k	$250,000

ENHANCEMENT OF
EXISTING PROGRAMS

Antarctica (onshore)	1990/91	2 Sci	$158 k	$125,000
	1991/92	2 Sci	$158 k	$125,000
(offshore)	Proposal being developed by Marine Division			

	TOTALS			
	Prof. Staff	(% of BMR Prof. Staff)*	Support Staff#	Total Funding	(% of BMR Funds)*
1989/90	3	1%	2	$448 k	1%
1990/91	7.5	2.7%	2	$895 k	2.0%
1991/92	13	5.2%	8	$1,893 k	4.6%

* Relative to 1988 figures # Includes Secretary

SUMMARY AND RECOMMENDATIONS

To institute a credible program in environmental geoscience, with the aim of providing a secure knowledge base for decisions concerning land use and sustainable resource development, it is proposed that a number of new initiatives be undertaken. These can be summarized into recommendations as follows:

- That a program of environmental geoscience be instituted in BMR, administered initially as a separate unit. This unit should oversee new projects as set out below, should provide co-ordination with current programs which have environmental concerns, and provide effective liaison with Government and community environmental bodies.

- Under these new initiatives, a project be instituted to provide insight into the geological controls on land degradation/soil erosion. This project should be closely linked to current groundwater and regolith programs.

- That a project be initiated to provide a comprehensive database for the Australian Quaternary, with a view to understanding the controls on climate and other aspects of environmental change. This database can be used to provide direct answers to problems concerning climatic change, and to generate palaeogeographic maps which document geologically recent changes and provide a test for models of global circulation.

- That BMR undertake a major program of study into the Australian coastal zone, involving the construction of a national geoscientific database, and to produce from that, environmental geology maps of the coastal zone. The ultimate aim of the database is to produce an inventory of geological features of the entire coastal zone at a scale of 1:100,000. The proposal includes a network of representative sites for the long term monitoring of coastal change.

In addition to new programs, current programs which have environmental content should be enhanced. These include:

- Marine projects designed to examine the past record of El Nino, as evidenced in coral reef cores, and examination of the effects of sea level rise on coral growth.

- As part of the groundwater program, a survey of low lying islands in the Pacific and Indian Oceans, where groundwater supplies may be at risk from rising sea levels.

- A broadening of BMRs program of onshore mapping in Antarctica to include study of landforms and glacial geology in order to understand the recent behaviour of the Antarctic icecap.

- The program of regolith mapping, to provide baseline information on surficial deposits and the nature of the weathered mantle in Australia.

- In order to provide a databse on the occurrence of a variety of elements in nature, consideration should be given to programs of geochemical sampling in areas of competing land use. The issue of public education in the geology of national Parks or reserves should also be addressed.

- Programs of gephysical monitoring for environmental hazards and other purposes should expand as necessary.