DEPARTMENT OF
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1974/198

THE ROLE OF THE NATIONAL GEOLOGICAL SURVEY IN AUSTRALIA, 1946 TO 1974

Compiled by R. Thieme

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Contents

Introduction

This paper was prepared under the title "Geological Survey in Australia" as briefing material for a "country-position" statement to the 8th Meeting of the Commonwealth Scientific Committee (Lusaka, Zambia, 8-19 July 1974).

The paper was prepared under the following guide-lines given by the CSC:

1.	The need for National Geological Survey Organisations	(see Paragraphs 1-8 of paper)
2.	The role of the National Survey in -	
i)	provision of basic geological knowledge of adequate standard and scope required for all aspects of national development related to the geology of the country.	(Para. 9)
ii)	provision of systematic geological, geophysical, geochemical and other earth science data on a country-wide basis.	(Para. 10-20)
iii)	advice and co-ordination of earth science activities.	(Para. 21)
iv)	advice to government in the exploration and development of mineral resources.	(Para. 22)
v)	prospecting on behalf of government and relationship with private sector activities.	(Para. 23)
vi)	advice to government on environment management control.	(Para. 24)
vii)	research in geology development of survey methods and techniques.	(Para. 25)
viii)	provision of ancilliary services with regard to information, records, data processing and management.	(Para. 26)
xi)	education and training, stimulation of public interest, public appreciation of the role of earth science in modern life.	(Para. 27)

A list of mineral discoveries in Australia and Papua New Guinea in which the Bureau of Mineral Resources was involved is given as an Appendix.

GEOLOGICAL SURVEY IN AUSTRALIA

1. The primary function of a Geological Survey Organization is to study and map the geology of the country and publish the results. A knowledge of the geology provides a basis for all kinds of industrial and regional development; in particular it constitutes the basic data required in the search and development of mineral resources as a component of a country's economic development and provides a basis for assessing the magnitude of both known and potential resources as a basis for formulation of policies governing competing demands for exploitation and conservation i.e. for long term policy development and resource management.

2. In countries with little mineral development, the provision of basic data for the exploitation of mineral resources is the primary objective of the Geological Survey. As the country's mineral industry and economy become more advanced, a gradual change in objectives occurs so that more emphasis is placed on providing data for long-term policy formulation. In Australia, this diversification has commenced only recently and we are still developing techniques to meet the second objective.

3. In Australia, Geological Survey organisations are operated by the seven regional administrations (six State Governments and one Territory Administration) and by the Australian Government. At the time that the Federal body - the Bureau of Mineral Resources - was set up in 1946, the State Geological Surveys had been in operation for over 75 years, during which time they had been engaged mainly on assessing known mineral fields and advising prospectors and the smaller mining companies on how to follow up prospects after their discovery. Several earlier attempts had been made to establish a Federal Geological Survey, but they were unsuccessful because of (i) failure to appreciate the magnitude of the problems of geologically surveying Australia, (ii) too narrow a conception of the importance of geological studies in mineral discovery, and (iii) concern on the part of some States that their own Surveys would languish.

4. The Bureau of Mineral Resources (BMR) was established at a time when Australia's mineral industry was in urgent need of revitalization; very few major discoveries had been made in the preceding half century, prospecting was at a low ebb, and few known prospects were awaiting development. Attempts during the 1941-45 period to develop new sources of strategic minerals had not resulted in new discoveries of any importance and had illustrated again that orebodies are hard to find.

5. Among the major functions of the newly created Bureau were:-

(i) To provide technological and technical advice to the (mining) industry and to undertake geological and geophysical and other forms of research.

(ii) To undertake market surveys and other economic investigations in relation to mining and development of the industry.

6. The early activity of BMR was directed towards production of quick discoveries with emphasis on prospecting-type activities, following leads based on earlier private-enterprise discoveries of petroleum shows or mineral occurrences, or nearby mining operations. Individual projects tended to arise in an ad hoc manner and to be limited to specific problem-solving operations. However, it was quickly realized that such operations, whether carried out by BMR, State Survey, or private operations, required a sound base of both surface and sub-surface regional geological knowledge which was completely lacking at that time. Consequently, in the period from the mid-1950s onwards systematic regional geological and geophysical surveys formed the major effort in BMR's field program. In this period also, the State Surveys expanded both their staff and scope of work, and the combined Federal/State effort in regional geological mapping should result in total coverage of Australia in the near future.

7. The dramatic development of Australia's mineral industry in the last 10-15 years has created an additional role for the National Federal Survey. Mineral resources are finite and non-renewable; any government formulating a

policy of mineral resources management for long-term economic objectives and for strategic consideration must operate with some notional sense of dimension of the resource it is dealing with. Decisions may need to be made about the point at which exploitation of resources of any particular commodity should flatten and taper off, and be considered at the national level rather than the sectional or regional levels represented by the mineral industry and State authorities respectively. The national government needs to formulate its policies on the soundest possible basis, and it is the role of the national survey to provide the required information. To achieve this aim it will be necessary to engage in periodic comprehensive reviews of mineral potential, ranging from studies of the geological controls on mineralization and their portent for future discoveries through to accurate assessments of reserves controlled by the mining industry and to future projections of market and consumption trends. In the absence of an Australian Department of Mines, the Bureau of Mineral Resources carries some roles related to the mineral industry which are commonly the responsibility of a Bureau of Department of Mines.

8. The continuing functions of a national geological survey are seen to be:

(i) To undertake such geological and geophysical surveys as are required for the continuing development and assessment of the nation's resources. These surveys form the basis for more detailed investigations for petroleum, minerals, underground water, construction materials, etc.

(ii) To systematically review and synthesize all available information on sedimentary basins and metalliferous areas.

(iii) To undertake specific commodity studies, including metallogenic studies of their occurrence, assessment of potential for new discoveries, inventories of reserves, and market trends.

(iv) To carry out basic research into the earth sciences including participation in international projects. Many of these

activities have no immediate relevance to the nations's development, but they add to the fund of basic knowledge about the earth; feedback is through the formulation of new geological concepts leading to the discovery of new resources.

9. As indicated above, basic geological knowledge of adequate standard was deficient at the time of BMR's formation. In the 28 years of its existence the Bureau has played a key role in promoting the development of Australia's mineral resources. Many major mineral prospects have been discovered by BMR in the course of its field work or as a result of its recommendation that an area was highly prospective; BMR geological and geophysical maps have made significant contributions to other discoveries. The increasing demand for the Bureau's services has meant that professional staff has expanded from about 50 in 1947 to 280 today. Likewise the Bureau's scope has expanded until today it has groups engaged in the following activities (the number in brackets indicates the number of professional and technical staff involved).

Sedimentary mapping (33)
Sedimentary review (13)
Sedimentology (4)
Palaeontology (19)
Petroleum Technology (13)
Seismic (23)
Gravity (8)
Marine geology (7)
Marine geophysics (13)
Engineering geology (10)
Engineering geophysics (9)

Metalliferous mapping (23)
Geochemistry (11)
Metalliferous geophysics (19)
Petrology (8)
Geochronology (4)
Geobiology (4)
Volcanology (1)
Photogeology (2)
Drafting (97)
ADP (12)
Instrument/systems (44) design and development

Airborne geophysics (25)	Observatories (30)
Drilling (13)	Regional structural (13)
Administration (17 + 116 clerical)	Mineral Economics (10)
Information and Editing (32)	Mining engineering (3)
Subsidy Act administration (16)	

10. BMR geological mapping has been carried out by two groups of geologis representing the two main disciplines in economic geology - those concerned with deposits of the metallic minerals which are found mainly in metamorphic and igneous rocks, and those concerned with sedimentary basins and their contained minerals and fluids. From the beginning, basins were mapped systematically and the results produced as 1:250 000 scale maps. The earliest approach in the metalliferous provinces was to map in detail selected mineral fields and known mineral deposits in order to determine the relationships of the mineral occurrences to the geology, but it was soon realized that a much greater contribution would be made to national mineral resources survey by systematicall mapping the whole of these provinces and eventually filling in the complete geological picture for the whole continent. Many of the provinces tend to be more complicated in their geology than the sedimentary basins, necessitating more detailed mapping at larger scales (currently 1:100 000 scale) to properly elucidate and portray the significant geological features.

11. The combined effort of BMR and the State Geological Surveys has resulted in about 85% coverage at 1:250 000 scale of Australia's total area of 7.7×10^6 km^2; the remaining 15% is expected to be completed by 1980. BMR has begun more detailed mapping at 1:100 000 scale in a number of metallifer u provinces; this detailed mapping involves 3 to 4 times the effort in both manpower and cost of regional (1:250 000) mapping and no end to this work is in sight.

12. Geochemical work has been mainly confined to broad reconnaissance undertaken with the geological mapping, and to specific geochemical investigations of mineralized districts. However, systematic surveys are being undertaken in conjunction with 1:100 000 mapping and will figure increasingly in BMR programs.

13. When BMR was founded, it was practically the only organization in Australia with geophysical competence. Much of its earlier geophysical work was devoted to solving specific problems, to testing geophysical methods and introducing new ones (e.g. airborne magnetic and radiometric surveys), and generally to developing the use of applied geophysical methods in the search for mineral deposits and in providing geological information. As the search for oil and minerals in Australia gathered momentum, and contracting geophysical organizations became available to carry out prospecting type surveys, the Bureau turned more and more to regional geophysical surveys aimed at systematic measurement of gravity, magnetic, and radiometric data, and seismicity and crustal structure over the whole of the Australian continent; the aim is to add, as far as possible, the third dimension to the surface geological mapping, and to provide a sounder basis for regional and continental studies.

14. Systematic aeromagnetic surveys were started in the late 1950s and currently involve two BMR aircraft and contractors engaged by the Bureau. Line spacing has not been standardized, and ranges between 1.5 and 6.0 km, depending on the geological complexity of the area being surveyed; data are published at standard 1:250 000 scale. To date some 65% of Australia has been surveyed, 40% either by or for BMR, and 25% by private companies mainly in sedimentary basins where the large size of leases makes it feasible for private enterprise to undertake regional surveys. The Bureau's aircraft are each capable of covering up to eight 1:250 000 Sheet areas (1 Sheet area covers about 15 000 km^2) per year and it is estimated that it will take until the mid-1980s to achieve complete coverage of Australia.

15. Radiometric surveys have in the past been carried out only in selected areas; however, the present practice is for all surveys flown by BMR aircraft to record both magnetic and radiometric data.

16. The early 1960s saw the development of a reconnaissance gravity program using helicopters to obtain a regional gravity coverage of the Australian continent at an 11 km grid spacing; this survey was completed in late 1974. The first part of the program was aimed at assisting in outlining the main basinal structural and tectonic history in sedimentary areas. Considerable success was achieved along these lines, as is exemplified in the discovery of greater thicknesses of sediments than had been expected in a number of sedimentary basins. Later parts of the program have covered largely Precambrian areas, where it has outlined large-scale tectonic trends. Mineral deposits are known to be associated with some of these trends and the gravity indicated further areas of interest for mineral search.

17. BMR is responsible for the collection of geomagnetic and seismological data in Australia and its Territories. It operates two observatories and twelve unmanned outposts in Australia and two outpost observatories in Antarctica. In addition it currently operates an observatory and a number of unmanned outposts in Papua New Guinea. The Bureau is further responsible for the provision of basic regional gravity data, the establishment of standards for gravity measurement in Australia, and their relation to the world network. As a result virtually all gravity measurements within Australia can be integrated into a single unified map of consistent and known accuracy. The preparation of isogonic charts also comes within the Bureau's responsibilities.

18. Systematic marine geophysical surveys were commenced in 1965; these surveys record seismic, gravity, and magnetic data simultaneously, at a ship speed of near 10 knots and line spacing generally about 15 km. Up to 1970 the continental margin off northwest Australia had been surveyed out to a water depth of 2000 m.

Such surveys map sedimentary structure down to the first few thousand metres and aid the interpretation of regional tectonic features; they also aid the integration of previous surveys and guide the planning of future surveys. On a line-mile basis they are fairly cheap and are considered good value for money. Great interest has been shown in the results of these surveys both by the companies operating the leases and by companies studying the area with the possibility of future participation.

19. The regular program was interrupted in 1971-1972 by an accelerated program designed to provide bathymetric and geophysical data at a line spacing of 40 km over the continental margin out to the 4000 - m isobath. An area of some 6 x 10^6 km^2 was surveyed and all but the continental margin bordering northern Australia and the area between Tasmania and the mainland was covered.

20. Marine geological surveys of the continental shelf out to a water depth of 500 m are also being undertaken systematically. They study the general nature and morphology of recent ocean sediments with special reference to their origin and current diagenesis and with emphasis on possible economic potential. Bottom sampling is carried out on a 15 km grid and near surface seismic profiling at 15 km line spacing. BMR has already surveyed some 800 000 km^2, but this represents only about 1/3 of the total area; and this program will continue into the 1980s.

21. Earth-science activities in Australia are co-ordinated through a series of intra- and inter-governmental committees and national scientific committees. BMR is represented on many of these by virtue of its role as national geological survey and specialist earth-science organization. Australian data for the international network monitoring the earth's seismicity and magnetic and gravity fields are co-ordinated by the Bureau.

22. The Bureau has no policy role; it is a technical advisor on mineral resources and on mineral policies to the national government and carries out such surveys and investigations as may be required for government policy decisions. Of vital importance in this regard is the accurate assessment of reserves controlled by the mineral industry and the projection of long-term market and consumption trends; mineral statistics for these are collected and published jointly with the Australian Bureau of Statistics. Technical administration of various mineral industry assistance and controlling legislation is also carried out on behalf of the Australian Government.

23. The Bureau in its first few years of activity directed much of its efforts to prospecting types of activity, and on its own or in conjuction with prospecting companies was instrumental in discovering a number of new mineral deposits as well as major extentions to existing deposits. However, as outlined above this policy gave way to one of systematic regional surveys in which BMR concentrated in the provision of basic data for mineral search, principally to delineate areas and geological environments in which exploration companies could concentrate detailed prospecting with most chance of profitable returns; results have proved the success of this policy, which BMR continues to follow. The Australian Government is currently proposing to establish a Petroleum and Minerals Authority which will have wide-ranging functions relating to exploration, mining, and marketing of mineral resources. It is also intended that the Australian Industry Development Commission will have an increasing funding involvement to maximize Australian participation in exploration and development undertakings. The BMR role will remain that of the national survey described above.

24. Environment management control requires extensive local knowledge of conditions, and the role of the national survey will need to be one of close co-operation with the State Geological Surveys in providing adequate technical advice. The Bureau's specialist engineering geology and geophysics groups have already carried out some surveys related to problems of waste disposal, pollution of underground water, rehabilitation of exploited ground, and coastal-

erosion, in addition to their main program of geotechnical studies on hydrological, soil mechanics, and engineering geological aspects of urban development and major engineering projects undertaken by the Australian Government.

25. Research carried out by BMR has mainly been oriented towards subjects which have direct application to field surveys and mineral search. The main effort has been in geophysics, where the laboratory and workshop groups, in conjunction with individual discipline specialist groups, have developed a range of techniques and equipment for use in seismic, gravity, magnetic, and electrical investigations. Much of this work has been primarily for the purpose of adapting geophysical methods to various geological conditions and providing incentives for companies to continue their own investigations. Considerable effort has recently been spent on developing computer-based data acquisition and data processing systems for airborne and marine surveys; these automated systems have enabled a much faster rate of coverage and accuracy of final presentation in the regional survey program. Geological research has concentrated on palaeontology and on studying the factors controlling the formation of ore deposits, particularly strata-bound deposits.

26. BMR has accumulated a vast amount of data as a result of its own investigations and the legal requirements on private companies covering work carried out under government subsidy. To date some 5000 technical reports have been produced and are widely distributed; only a nominal charge is made for published maps and reports. BMR contains probably the most extensive earth-science library in Australia, and in addition operates a core and cuttings laboratory where rock samples from the Bureau's work and subsidized company work may be examined. Moves are currently under way to establish an integrated information system within BMR, as much of the data is currently in a disseminated form and relatively inaccessible. For some years now attempts have been made to establish a national earth-science information system, but this still appears to be some way off; such a system would probably consist of a central bibliographi reference with detailed data held by the various generating bodies throughout Australia.

27. Formal education in the earth sciences is carried out by tertiary institutions and technical colleges; however, BMR does run in-house training schemes for its technical and drafting staff as an adjunct to their formal education. Vacation employment is given to some 25 university students each summer, and training is provided each year to 5-6 overseas persons studying in Australia under various international fellowships or under Australian assistance schemes such as the Colombo Plan. With regard to the general public, BMR produces a range of pamphlets describing earth-science activities and distributes these to schools and other interested bodies.

Sources

1. Early Attempts to form a Commonwealth Geological Survey. H.G. Raggatt, September 1956. (BMR Record 1956/150)

2. Surveys for Mineral Resources Assessment. N.H. Fisher, October 1972. (Paper presented at CSIRO-Commonwealth Scientific Committee Seminar on "Survey and Assessment of National Resources as a Basis for Science Planning" held in Canberra 23-28 October 1972).

3. Mountains of Ore. H.G. Raggatt. Lansdowne Press, Melbourne, 1968.

4. Interim report of the BMR Re-organisation Working Party, 1972.

APPENDIX

AUSTRALIAN MINERAL DISCOVERIES

Involvement by the Bureau of Mineral Resources in mineral discoveries in Australia and Papua New Guinea can be divided into four categories:

1. New mineral prospects discovered by BMR in the course of field work; these were subsequently followed up by private enterprise to establish their economic value.

2. New mineral prospects discovered by private enterprise as a result of recommendations by the Bureau that the area was highly prospective.

3. Major extensions to known mineral deposits discovered by private enterprise as a direct result of BMR field work and recommendations.

4. Discoveries made by private enterprise in which geological and geophysical information provided by BMR made a significant contribution.

Category 1

Groote Eylandt, NT (Manganese) : Outcrops of manganese ore were discovered on the island by BMR geologists during regional geological mapping of the area in 1960. Limited test pitting by BMR in the following year confirmed the possibility of a major deposit. Subsequent testing by BHP has indicated large reserves and the deposit is currently being worked.

Gove, NT (Bauxite) : In the late 1940s BMR geologists realized that the widespread lateritic deposits along the north Australian coast were likely to contain bauxite. This led to the discovery in

1949/50 of bauxite deposits on Marchinbar Island in the Wessel Group, and this further led to samples being obtained from the Gove area, by which the potential of the area was recognized. Reconnaissance sampling was then undertaken under BMR supervision. The deposit is presently being mined by Nabalco Pty Ltd.

Constance Range, Qld. (Iron Ore) : Ferruginous beds were first noted in the area by geologists from BMR and the Geological Survey of Queensland in 1950; however, it was not until the beds were mapped in the course of regional geological mapping in 1954 that their possible economic importance was realized and they were drawn to the attention of BHP geologists. A considerable amount of testing was subsequently done by BHP; BMR and GSQ gave further assistance in 1958 by detailed mapping of the environs of the deposits. These deposits have now been overshadowed by the Western Australian iron ore discoveries.

Frances Creek, NT (Iron) : The deposit was discovered by BMR geological staff in 1954 and investigated further in 1958 by BMR Resident Geological staff from Darwin (now part of the Dept. of the Northern Territory). Further investigations were carried out in 1961 by prospectors assisted by Darwin BMR staff and the deposit was worked between 1967 and 1974.

Mt Bundey, NT
(Iron)

: Iron mineralization was first noted by BMR geologists in 1956. It was subsequently proved to be an economic deposit by the NT Mines Branch, and Morgan Mining and Industrial Co Pty Ltd, who worked the deposit for a number of years.

Rum Jungle, NT
(Uranium, Base metals, phosphate)

: Systematic geological, geophysical, and geochemical investigations at Rum Jungle have resulted in the BMR discovering uranium orebodies at Dysons and Mt Fitch, a lead-zinc orebody at Woodcutters, and 16 minor deposits of phosphate rock.

South Alligator River NT
(Uranium)

: The first uranium discoveries in this area were made by the BMR in 1953 at Coronation Hill and Saddle Ridge; both deposits were later mined. Numerous prospects were subsequently found in this area, and BMR geophysical work was directly responsible for the discovery of the El Sherana West orebody. A total of 13 orebodies have been mined.

Westmoreland Uranium Field, Qld
(Uranium)

: This initial discovery of radioactivity was made by BMR airborne survey in 1957. In recent years, follow-up work by Queensland Mines Ltd has found extensive uranium reserves in the area.

Greenvale, Qld
(Nickel)

: Lateritic nickel was first noted by BMR geological staff during regional geological mapping in 1958/59. The deposits are currently being developed by Metals Exploration Pty Ltd in a

joint venture with Freeport of Australia Inc.

Southern Queensland (Bentonite)	:	BMR field parties discovered bentonite deposits near Springsure, Yuleba, and Miles in southern Queensland in 1965, 1966, and 1967 respectively.
Amadeus Basin, NT (Phosphate)	:	During regional geological mapping in 1961, BMR geologists noted the occurrence of phosphatic beds in the Stairway Sandstone Formation. Further investigations by BMR in the following years indicated the presence of low-grade phosphate deposits which are currently not economic prospects.
Frieda Prospects, PNG (Copper)	:	BMR geological mapping in the Sepik River area in 1966/67 discovered this prospect and recommended it for closer evaluation as a possible porphyry copper deposit. Subsequent investigations by Carpentaria Exploration Ltd have confirmed that it is an economic deposit. Testing is continuing.
Other prospects, PNG (Nickel, copper, gold)	:	During the course of regional geological mapping in PNG, BMR field parties have found a number of mineral prospects including: Doriri nickel sulphide prospect; found in 1966; subsequently tested by private enterprise, but the volume of ore is apparently not sufficient to warrant development at this stage.

Yanderra prospect; cupriferous calcite veins assaying up to 4 dwt gold/ton were first found at Yanderra in 1957; further BMR mapping in 1962 showed copper mineralization to be widespread and the area was recommended for further evaluation.

Marum area; nickeliferous soils, assaying 0.3 to 1.3% Ni, overlying ultramafic rocks were discovered in the Ramu Valley in 1962; an area of 100 sq. miles was recommended for exploration and a lateritic nickel deposit was proved in 1968 by International Nickel.

Sepik region; several areas in this region were recommended for prospecting as a result of gold and nickel mineralization found in 1966-67.

Category 2

Nabarlek and Ranger Prospects, NT (Uranium) : Both these recent uranium discoveries are in areas recommended for uranium search by BMR in 1968.

NW Queensland (Phosphate) : In early 1966, a BMR sponsored assessment of the phosphate potential of the Australian continent was carried out by Dr R.P. Sheldon of the US Geological Survey. One of the areas recommended for further consideration was the lower Palaeozoic sedimentary rocks of the Georgina Basin, where a BMR study of samples from oil wells penetrating these rocks

had shown phosphate values.

In late 1966, Broken Hill South Ltd, after further detailed studies of oil-well samples held by BMR and using BMR regional geological maps, made the first discovery of phosphorite at Duchess.

Subsequently, BMR 1:250 000 scale geological maps have assisted in indicating other areas containing possible phosphate deposits; the Yelvertoft and Lady Annie deposits were found using this approach.

Bougainville, PNG (Copper) : After a visit by a BMR geologist (PNG Resident Staff) in 1961, the Panguna area was considered a potential porphyry copper environment and strongly recommended for further mineral search. This led to the discovery and proving by C.R.A. of the large Panguna porphyry copper deposit.

Lateritic nickel, PNG : In 1957 and again in 1961, BMR geologists drew attention to the lateritic nickel potential of large areas of ultramafic rocks in the Papuan Ultramafic Belt. A number of prospects have been tested by various companies since that time; however, none are apparently economic at the present time, although investigations are continuing, e.g. in the Lake Trist area.

Perth Basin, WA (Petroleum) : Aeromagnetic and gravity surveys by the BMR indicated a much thicker section of sedimentary rocks than previously thought and stratigraphic drilling by BMR at Beagle Ridge culminated in the first evidence of oil in this Basin. This resulted in the petroleum prospects of the basin being upgraded. Seismic work by the BMR in 1956 led to the discovery of the Gin Gin anticline near Perth on which WAPET, after further seismic work and drilling, discovered gas in 1969.

Surat Basin, Qld (Petroleum) : The BMR did the first seismic work in this Basin and showed that a thick section of prospective sedimentary rocks was present and also discovered the Cabawin anticlinal structure. Union-Kern-A.O.G., after further seismic work, discovered oil in their first drill hole, Cabawin No. 1. This discovery had a marked effect in accelerating oil prospecting throughout Australia; it led to the discovery of commercial oil at Moonie in the same area.

Bowen Basin, Qld (Coal) : The Bowen Basin was geologically mapped at 1:250 000 scale by joint BMR-Geological Survey of Queensland teams from 1960 to 1965; this mapping has been used extensively by many companies searching for coal in the basin.

In 1965 the Bureau commenced a more detailed study of the Upper Permian stratigraphy and sedimentation and this resulted in the discovery of a previously unknown structural basin at Hail Creek.

In 1968 the Bureau recommended exploration for coking coal in the northern part of the Bowen Basin and, in particular, advocated the Hail Creek area. The latter area was subsequently investigated by Mines Administration Pty Ltd and reserves of 750 million tons of coal were established. In August 1971, directors of Associated Australian Oil Fields, Interstate Oil Ltd, and Western Mining Corporation announced plans to develop the deposit.

Category 3

Latrobe Valley, Vic (Coal) : After earlier drilling had failed, drilling guided by the results of BMR gravity surveys of 1949/50 was successful in finding an extension of the high-grade brown coal deposits in the Latrobe Valley.

Collie, WA (Coal) : Gravity work by BMR in 1946 led to the discovery of extensive new coal reserves in the eastern part of the Collie coal field; new collieries were subsequently developed.

Cobar, NSW (Copper-gold-zinc) : In the period from 1947 to 1957 the BMR was involved in a co-operative program with mining companies and the NSW Geological Survey. This program involved extensive geological and geophysical surveys as well as some drilling and led to the formation of Cobar Mines Pty Ltd and to the subsequent re-opening of the C.S.A. mine.

Tennant Creek, NT (Copper-gold)	:	A geological survey of the Peko mine area was carried out by the BMR in 1950. Associated with this survey was some exploratory diamond drilling which intersected a new ore-shoot at depth. The discovery of this new orebody subsequently enabled the mine to re-open. BMR aeromagnetic maps and ground magnetic surveys have been very successfully used in indicating further targets for exploratory drilling in the Tennant Creek area. The Warrego, Ivanhoe, Juno, and Orlando mines have been found in this manner.
Mt Lyell, Tas (Copper-gold)	:	BMR ground geophysical surveys in 1955/56 and 1966 outlined anomalies which led to the discovery of the Corridor and Cape Horn orebodies respectively.
Mt Cleveland and Renison Bell, Tas (Tin)	:	The testing of anomalies indicated by BMR geophysical surveys resulted in the discovery of further tin orebodies, leading to a considerable increase in reserves.
Savage River, Tas (Iron)	:	An aeromagnetic survey by the BMR in north-western Tasmania in 1956 gave results which indicated that the Savage River iron deposit, which had until that time been considered to be a number of relatively small discontinuous orebodies of no economic importance, was likely to be a major iron deposit. Drilling guided by BMR ground magnetic surveys confirmed the size of the deposit.

Category 4

Rum Jungle, NT (Uranium, copper, Lead, zinc) : The original discovery of uranium was made by Jack White, who recognized minerals illustrated in a BMR brochure prepared to assist prospectors in the search for uranium. Subsequent investigations by BMR led to the discovery of a number of orebodies (see under Category 1) and provided basic information for the discovery of further uranium, copper, lead and zinc orebodies, including Rum Jungle Creek South, Browns, and the Intermediate copper prospect, by private companies.

Fitzroy, Canning and Carnarvon Basins, WA (Petroleum) : In 1948, BMR commenced detailed investigations into the stratigraphic succession in these Basins. This resulted in the Caltex organization setting up the West Australian Petroleum Pty Ltd to explore for oil, and the subsequent finding of oil at Rough Range in November 1953. The discovery touched off extensive oil oil exploration in Australia.

Amadeus Basin, NT (Petroleum) : BMR regional geological mapping provided basic information for the petroleum exploration which resulted in the discovery of the Mereenie and Palm Valley gas fields.

Gippsland Basin, Vic. (Petroleum) : BMR aeromagnetic surveys over the offshore extension of this basin have provided basic information for petroleum exploration. Areas covered include the locality of Esso Gippsland Shelf No. 1 well - Australia's first offshore well and first offshore petroleum discovery.

West Australian Nickel Discoveries : BMR aeromagnetic maps have assisted in delineating likely targets for detailed geological investigation and exploratory drilling.

West Australian Uranium Discoveries (1972) : BMR radiometric maps produced as a result of BMR airborne reconnaissance surveys have assisted in delineating likely targets for further investigation. The Yeelirrie uranium prospect was found as a result of a detailed airborne survey undertaken by Western Mining Corporation over an anomaly shown on the Sandstone 1:250 000 Radiometric Map.

Galilee Basin, Qld (Coal) : In 1971, a BMR seismic survey across the eastern margin of the basin indicated the presence of Upper Permian coal measures at relatively shallow depth below Quaternary sediments west of the Belyando River. The Qld Mines Dept subsequently announced that it had delineated several billion tons of sub-bituminous coal north of Alpha.