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REVIEW OF ACTIVITIES OF THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS (1946-1967)

by

D.A. WHITE, G.F. CLARKE & K.H. SMITH

(Planning and Co-ordination Section, Operations Branch)

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Figure 1 : Graph showing output of Records, Reports, and Bulletins, and expenditure on publications.

APPENDICES

Appendix 1 : Notes on the functions of the Bureau of Mineral Resources, Geology and Geophysics.

Attachment 1 : Statement of functions of the Bureau of Mineral Resources, Geology and Geophysics, which have been generally accepted since its inception.

APPENDICES (Cont.)

Attachment 2: Functions of the Bureau of Mineral Resources, Geology and Geophysics, as approved by Cabinet Sub-Committee (Agendum No. 14) on 20th March, 1946.

Attachment 3: Terms approved by Cabinet (Agendum No. 1280) on 21st December, 1946, for Bureau of Mineral Resources, Geology and Geophysics, to work in Territory of Papua - New Guinea

Attachment 4: Exchange of letters in 1949 between Premier Queensland and Commonwealth Prime Minister on joint mineral survey of North Queensland.

Appendix 2 : Progress of staff ~~appointments~~ ESTABLISHMENT in the Bureau of Mineral Resources.

Appendix 3 : List of overseas visits by Bureau officers.

Appendix 4 : List of specialists engaged by the Bureau.

Appendix 5 : List of subjects and their totals dealt with in Bureau Bulletins, Reports, and Records up to September, 1966.

Appendix 6 : Details of B.M.R. expenditure 1950/51 to 1966/67.

INTRODUCTION

Periodical reviews of activities are an essential part in the operations of most organisations; they help to point to future avenues of work which may have not been apparent before or to certain aspects of work which may need revision in the light of changing circumstances. Such reviews are particularly relevant to the Bureau's activities because they are essentially geared to the Australian mineral industry, which historically is a volatile, but nevertheless important, part of the economic growth of Australia. The present expansive period of exploration and development of the mineral industry in Australia, the extent of which has surpassed all previous levels of achievement, has many ramifications on the present and future activities of the Bureau.

In the time and from the information available it was not possible to examine the Bureau's activities in the detail which we would have desired, but rather they were reviewed from the broad activities of each Branch. Thus there are main sections on geological, geophysical, petroleum exploration, mineral resources, and operational activities. In addition publications are reviewed, and overseas visits and specialists engaged by the Bureau are listed in the concluding sections. Preceding these sections on the broad activities of the Bureau there is a brief historical review of the major events of government activity in the mineral industry which took place in the 1927-44 period, and which includes events culminating in the formation of the Bureau in 1946; finally the historical section concludes with the important events of the Bureau's growth.

In addition this review contains a substantial Appendix 1 on notes on the functions of the Bureau, which the reader is advised to examine if further information is required beyond that listed in the historical review section. For completeness some parts in the historical review are repeated in Appendix 1.

For obvious reasons the review does not present any conclusions, but the Section believes that there is some merit in attempting to consolidate information on activities of the Bureau in a single document, not only for planning its future operations, but also as a useful piece of history. To this end the Planning & Co-ordination Section presents this review of the Bureau's activities.

HISTORICAL REVIEW

Several attempts to form a Commonwealth Geological Survey were made between 1910 and 1935, but it was not until 1946 when the Bureau of Mineral Resources, Geology and Geophysics, was established that this was finally achieved.

Before the establishment of the Bureau in 1946 Commonwealth geological and geophysical activities consisted mainly of:

(i) advice from the Commonwealth Geological Adviser, Dr. W.G. Woolnough, in the search for oil carried out under the Petroleum Prospecting Act - 1925 and - 1936, and in the 1938 survey of iron ore resources. Dr. Woolnough was assisted by two palaeontologists, Dr. F. Chapman and Miss Irene Crespin, who were both appointed in 1927; Dr. H.G. Raggatt was appointed Assistant Commonwealth Geological Adviser in 1940, and Commonwealth Geological Adviser in 1941;

(ii) the Imperial Experimental Geophysical Survey which arose from the Geophysical Survey Act (1928). Mr. J.M. Rayner, the present Director of the Bureau of Mineral Resources, was a member of the Survey;

(iii) the Aerial, Geological and Geophysical Survey of Northern Australia (AGGSNA) from 1934 to 1942 which arose from the Northern Australia Survey Act (1934);

(iv) the Geological Branch of the Department of the Interior, which in 1941 was transferred to the Department of Supply & Development;

(v) the Mineral Resources Survey which was formed in June, 1942, and incorporated the Commonwealth Geological Adviser and his staff, the geophysical section of AGGSNA, and the Geological Branch of the Department of the Interior;

(vi) the Copper and Bauxite Committee in 1941 under the chairmanship of Sir Colin Fraser, and its replacement, the Commonwealth Mineral Committee under the same chairmanship;

(vii) the Controller of Minerals Production, Mr. J. Malcom Newman, which was established in 1942, and thus the Copper and Bauxite Committee lapsed;

(viii) the Mining Industry Advisory Panel of the Secondary Industries Commission which was established in 1944 with Dr. H.G. Raggatt as Chairman.

It was against this background of Commonwealth geological and geophysical activities that the Bureau of Mineral Resources was established. On 20th March, 1946, a Cabinet Sub-Committee approved a recommendation arising out of a report from the Mining Industry Advisory Panel of the Secondary Industries Commission. The function of the Panel was to advise on post-war mining policy. This recommendation outlined the functions, 9 in number, for setting up a Commonwealth Bureau of Mines incorporating the Mineral Resources Survey and the Minerals Production Directorate. The approved functions are listed in Appendix 2. These functions apparently formed the basis of what have been the generally accepted functions of the Bureau of Mineral Resources, which are set out in Appendix 1.

Broadly the functions recommended by the Advisory Panel emphasised the need for increased geological and geophysical services in Australia, the need to provide funds for rehabilitation of mines closed during the Second World War and of providing technical and financial assistance for exploration and development of the mineral resources of Australia.

It is important to note that the members of the Mining Industry Advisory Panel consisted of representatives from both industry and government, which included the Permanent Heads of all the State Mines Departments and Acting Director of Mines for the Northern Territory; and on 27th March, 1946, the Panel passed a resolution recommending that greatly increased geophysical work should be done and because of the cost and special equipment involved this should be primarily the responsibility of the Commonwealth upon whom the States would rely to meet their requirements for geophysical surveys.

To carry out the Government policy as expressed in Appendix 1, the Public Service Board in 1946 issued certificates for 55 positions which included 24 geophysicists, 17 geologists, a mining engineer and a petroleum technologist. In 1947 these officers were joined by a mineral economist in fulfillment of the findings of a British Commonwealth Scientific Conference held in London, which stressed the necessity "to institute in concord with the various Governments of the British Commonwealth standard methods of recording figures of mineral resources and production" and for close study to be made of the "economic aspects of mineral resources and production".

By 1947 with a professional staff of 55 the Bureau began to carry out its functions as expressed in Appendix 2. The Bureau was organised under two Branches, one Geological and one Geophysical, and the Mining Engineering, Mineral Economic and Petroleum Technology Groups were in the Administrative Section of the Bureau. This organizational structure of the Bureau continued until about 1960 when the Bureau reorganized its head office or central upper structure to create three new Branches - first a Mineral Resources Branch, then an Operations Branch, and finally a Petroleum Exploration Branch - to keep pace with demands. The Petroleum Exploration Branch was set up in 1962 to administer the Petroleum Search Subsidy Act and to gather geological and geophysical information of sedimentary basins; the Mineral Resources Branch incorporated the previously established Mining Engineering, Mineral Economics, and Petroleum Technology groups; the Operations Branch incorporated the previous Administrative Section and included new sections to assist in the planning and coordination, of the Bureau's programme, and the publication and dissemination of information.

By the end of this major reorganization in 1964 the Bureau's total establishment was 559 of which half the positions were professional. In 1965 the Public Service Board provided 10 temporary positions to cope with additional services required when the Bureau occupied its new building in Parkes.

On 20th July, 1965, Cabinet approved up to 15 additional positions to enable the Bureau to carry out investigations for phosphate. By the end of September, 1966, the Bureau's establishment was 577 which included 285 professional officers.

On 2nd March, 1967, following a Departmental submission for additional staff for the Bureau, most of which were non-professional, Cabinet approved a total of 60 positions over the next two years. With this additional staff the Bureau's establishment will rise to 637 including about 290 professional officers. Thus the Bureau's total staff has increased at an average annual rate of about 30 since its inception in 1946 to March, 1967. The major increases of staff were 55 professionals in 1946 - the establishment of the Bureau - 45 professionals in 1948; 79 professionals (103 combined staff) in the uranium and petroleum exploration boom of 1950-53; 73 professionals (144 combined staff) in the petroleum and base metal exploration boom of 1959 to 1962, andthe 60 (combined staff) in 1967.

GEOLOGICAL ACTIVITIES

Geological activities of the Bureau have been mostly concerned with field and laboratory investigations in fulfilment of the Bureau's role to survey and assess the mineral resources of the Commonwealth and its Territories. Geological field investigations have been mostly mapping to which the laboratory has supplied the necessary petrological, chemical, and palaeontological services. Generally mapping has been on a systematic basis involving coverage of 1:250,000 sheet areas on the Australian National Grid and has been carried out in sedimentary and metalliferous areas of Australia, although detailed mapping of 1:50,000 sheet areas has been used in some metalliferous investigations, and greater detail on all engineering investigations.

Regional mapping has formed the major effort in the Bureau's geological activities and in effect it has formed a sound framework upon which a number of other activities and investigations, e.g. geochemistry and geochronology, are based. In the 1946-1956 period attempts to systematise regional mapping whether it was on 1:250,000 or 1:50,000 scale were delayed because of the lack of controlled base maps. However such delays have now been reduced and the whole programme has advanced rapidly to the end of 1965 when there are only about 30 1:250,000 sheet areas, including those mapped by the State Geological Surveys, which have not been mapped either at 1:250,000 or smaller scale north of the 26 degree latitude. And at the 1965 rate of regional mapping these remaining sheets could be completed by 1968, and certainly by 1970.

1:50,000 scale mapping was used in the 1950-56 period to cover the uranium potential areas of the Katherine-Darwin area where a total of 25 sheets were mapped. Other areas which are covered by 1:50,000 scale mapping are at the Tennant Creek (2 sheets), Chillagoe (3) and Herberton (2) mineral fields, and in

New Guinea. It is difficult to assess the mapping in New Guinea in terms of 1:50,000 sheets mapped since the maps produced are at a range of scales and the map boundaries seldom coincide with sheet boundaries; however about 30 sheets were mapped.

Mapping at scales smaller than 1:50,000 is confined to certain mineralized areas and engineering projects. Such detailed mapping of mineralized areas formed a major part of the Bureau's geological investigations in its initial activities, but later particularly from 1956 onwards detailed mapping gave way to mapping at 1:250,000 scale as a major geological activity in metalliferous areas, and sedimentary basins. Detailed mapping of engineering projects was carried out particularly in investigation of dam sites for water supply and hydroelectric power in the Australian Capital Territory, Northern Territory and the Territory of Papua and New Guinea.

Geological laboratory activities are designed primarily to assist the geological mapping projects. Initially the laboratory work consisted of routine chemical, petrological, mineralogical, and palaeontological determinations of samples submitted by Bureau field geologists, but over the past 10 years the investigations have been intensified and become more specialized and to some extent more intergrated with the field mapping than before; specialized chemical work has been greatly assisted by the development of new instruments such as the automatic x-ray spectrograph, direct-reading optical spectrograph, atomic absorption spectrophotometer, which are used in geochemical studies. The emphasis is now on spectrographic techniques in place of standard wet techniques. The geochemical studies are far reaching and are not confined to geochemical prospecting, but include silicate analyses, absorption phenomena, formation of minerals, and age determination studies. Examples of the application of some of the spectrographic instruments are: the use of the direct-reading optical spectrograph in a study of trace element assemblages in the Urquhart Shale at Mount Isa; the study of trace element haloes around gold ore-bodies at Kalgoorlie which involves the analysis for specific elements such as Hg and Te by atomic absorption spectrometry; the development of a rapid technique for silicate analyses of rocks by the use of the automatic x-ray spectrograph.

The Bureau began age determination studies about 1956 when it cooperated with Department of Geophysics, the Australian National University, in dating rocks by the lead method. Later the joint programme involved the extensive use of the potassium-argon and rubidium-strontium methods in regional geochronology studies in the Precambrian Shield and Palaeozoic Tasman Geosynclinal zone. Besides providing geological services both in the field and laboratory the Bureau contributed to the programme by purchasing a 12" Nuclide Mass Spectrometer. Up to the end of 1965 about 480 samples involving about 650 mineral ages were determined in the joint Bureau and University programme; the results of these ages have greatly assisted the geochronology of the Precambrian and Palaeozoic in Australia.

Geological laboratory techniques became further intensified and diversified when in 1958 the late Dr. Baas-Becking was seconded to the Bureau from C.S.I.R.O. to study the production of a number of ore sulphides by bacterial means in artificial sea water at room temperature. This original biological study by Dr. Baas-Becking and later by his replacement - Dr. Temple - together with the mineragraphic studies in the production of sulphides at low temperatures and the chemical studies on absorption and desorption of metals on clay minerals as a possible means of transport for some of the metals - the transport study was initially supervised

from 1958-61 by Professor Breyer, Department of Agricultural Science, Sydney - eventually culminated in the formation of the Baas-Becking Geobiological Research Group in 1964 by agreement between the Bureau, C.S.I.R.O., and A.M.I.R.A. (Australian Mineral Industries Research Association). The aim of the study of the Geobiological Research Group is to study biological and mineral transformational factors in the formation of sulphide deposits. The results of the study are expected to lead to a better understanding of ore occurrence and also have some bearing on the use of bacteria in extraction of metal from low grade ores.

Palaeontology has been widely used both in the laboratory and field ever since the inception of the Bureau of assist determinations of stratigraphy during regional geological mapping. Since 1956 methods have been successfully developed in the determination of marine micro-organisms and more recently spore and plant remains (palynology). Palaeobotany is carried out by contract for the Bureau.

Other geological laboratory activities besides those mentioned above are sedimentary petrology and photo-interpretation, which have been widely used to assist mapping of sedimentary areas in the search for oil and lately of metalliferous areas. The Bureau began systematic photogeology in 1960 when the Institut Francais du Petrole (I.F.P.) working under contract to the Commonwealth Government began a photogeological study of the Amadeus Basin. Since then several officers of the Bureau have worked with the French photogeologists and up to the end of 1965 have produced photomaps of about 75 1:250,000 sheet areas in Northern Territory, Queensland and Western Australia.

Geological engineering and hydrology surveys have been conducted since 1946 and up to 1965 some 50 surveys were recorded for the Northern Territory, 40 for the Australian Capital Territory, 25 for the Territory of Papua and New Guinea, 10 for New South Wales, 5 for Queensland and 2 for Victoria. Unrecorded surveys were made in all these areas and South Australia.

In the Northern Territory groundwater investigations were predominate with some 40 recorded surveys since 1946. Surveys were conducted at Alice Springs, on the Barkly Tablelands, at Bathurst Island, on Channel Island, around Darwin, the Finke region, in the Hermannsburg area, in the Petermann Ranges and around Tennant Creek, and recent investigations were carried out in the Utopia irrigation area. There was from time to time appraisals of groundwater in various rock units of Central Australia, for example that of the Dulcie Sandstone in 1965. Some half a dozen surveys of dam sites have been recorded, earlier investigations including those of the proposed Mexican dam site 1955 and the Wigleys Gorge dam site of 1957, and since 1963 the dam site for the Darwin River has been investigated. Other surveys include a record of a powerhouse site at Stokes Hill, Darwin, 1959 and one of construction materials, 1965.

In the Australian Capital Territory some 14 surveys of dam sites mainly on the Cotter and Queanbeyan Rivers were recorded from 1946 to 1965. The sites of various public buildings were examined and in 1958 the first survey of the Canberra Lake scheme was recorded, followed in 1962 by a report on foundation conditions for the dam. Some 4 investigations of weirs were recorded and surveys of various construction materials including sand, gravel, brick shale, clay and limestone were made. Recently the Woden development and Belconnen development scheme sites were mapped and information collected on foundation, excavation and drainage conditions. Property owners were advised from time to time concerning the

feasibility of drilling for water on their properties.

Over half the recorded geological engineering surveys conducted in the Territory of Papua and New Guinea were concerned with power schemes and hydro-electric developments. The first survey was recorded in 1959 and involved the Laloki River hydro-electric project, since then investigation has been concentrated on the Upper Ramu hydro-electric project and recently at the Lower Warangoi and Towanokoko-Pondo hydro-electric schemes. In 1963 a geological investigation of the route of the Kainantu-Goroka road was conducted and recorded in 1966. In 1965 groundwater surveys on Mirivase Island, Papua and Marshall Lagoon, Papua were recorded. Some 6 surveys of damsites, mainly involving the Laloki River were recorded, and in 1949 and 1950 the occurrence of raw materials for the manufacture of cement in the Port Moresby area were investigated and recorded.

In New South Wales geological investigations on the hydro-electric scheme in the Kosciusko area were first recorded in 1946 and reports followed in 1948; the geological investigation of Tumut-Upper Murrumbidgee scheme was reported in 1949. Damsites were investigated at Naronga, 1946, Googong, 1963 and Ballinfold Creek, 1964 and investigations of building materials at Queanbeyan 1957 and Sydney, Mudgee and Wombeyan 1961 were recorded.

In Victoria brick-making quarries were surveyed in 1948 and in the same year a site for a borehole for disposal of effluent water from the Commonwealth flaxmill at Ballarat was surveyed. In 1964 investigations were conducted to determine foundation conditions for the proposed buildings and underground railway at the Commonwealth Centre, Melbourne.

Investigations in Queensland have been restricted to hydrological surveys including borelogging.

Engineering geological investigations by the Bureau have been restricted in South Australia, but in 1964 the site of the Reserve Bank of Australia at Adelaide was inspected.

GEOPHYSICAL ACTIVITIES

The Bureau is the largest employer of geophysicists in Australia - about 100 are employed - and has been the leading exponent of geophysical exploration and regional geophysical surveys in this country since its inception in 1946. Besides exploration and regional geophysics the Bureau has maintained and developed geophysical observatories for recording and studying magnetic, ionospheric and seismic (earthquake) data. The operation of these observatories is essential in providing basic data for the Bureau's regional magnetic surveys, and also for preparation of navigational and geodetic maps by other organizations. The Bureau geophysical Observatories are at Melbourne, Darwin, Port Moresby, Mundaring (W.A.) Mawson, Wilkes and Macquarie Island. In addition to these activities the Bureau applies geophysical techniques to assist engineering and hydrological investigations.

The Bureau has carried out geophysical exploration to assist in the search for metals and petroleum.

Metalliferous geophysical surveys have made use of the magnetic, electrical (conductive, inductive, and self potential methods), radioactive, and to a lesser extent gravity and seismic methods. Metalliferous surveys have been conducted in all States, particularly in the mineral fields of northern Tasmania, Northern Territory, Northern Queensland, and New South Wales.

The magnetic method was successfully applied in locating gold and copper at Tennant Creek where it is associated with magnetic or pyrhotite; also the method was proved useful at Renison Bell and Mt. Cleveland (tin), Rye Park (Scheelite) Baryugli (asbestos), Cobar (copper and gold).

The Bureau developed magnetometers for use in aeromagnetic surveys by DC-3 (fluxgate-type magnetometer) and Cessna - type aircraft (proton-precession magnetometer). Most of the major metalliferous areas were covered by 1/4, 1 - or 2 - mile spaced traverses by DC-3 aircraft flying at about 500 feet above the ground level; the lighter aircraft is used mostly to define anomalies located by the DC-3 or in areas where the structures and formations are complex. The aeromagnetic surveys are generally carried out in conjunction with scintillation counter surveys.

The electrical methods (electro-magnetic, self-potential and induced potential) are widely used and developed by the Bureau in their search for metals. They are generally applied in conjunction with the magnetic method to assist the interpretation of anomalies. Notable successes with this method are at Mt. Lyell (copper) and Dugald River (lead and zinc).

The gravity and seismic methods have limited application in metalliferous prospecting; the Bureau applied these methods to assist in defining channels for locating placer deposits in Kalgoorlie, central New South Wales, Tasmania and north Queensland. In the 1946-56 period the Bureau used the gravity method extensively in delineating coal basins at Collie (W.A.), Leigh Creek, Latrobe Valley, Oaklands, and Blair Athol. Since then the gravity method has been applied extensively to locate likely sedimentary areas for the discovery of petroleum and which point to closer investigation by seismic surveys.

The Bureau has been active in applying and developing geophysical techniques to assist the search for petroleum in Australia since 1949 when gravity surveys were carried out in the Lake Frome Embayment and at Roma. This was followed by a seismic reflection survey in 1949-50 by the Bureau in the Roma area, which was the first seismic reflection survey to be carried out in Australia. Since then the Bureau has used the seismic method, involving both reflection and refraction, in selected parts of the Carnarvon, Fitzroy, Perth, Bonaparte Gulf, Carpentaria, Bowen, Officer and Great Artesian Basins.

After the introduction of the vibroseis method of seismic exploration in Australia in early 1963 the Bureau employed a contractor in 1964 to demonstrate the effectiveness of the method in areas where conventional shot-hole methods were impractical or where previously good quality reflections had not been obtained. The areas chosen for the comparison survey were volcanic, limestone, and sand-covered parts of the Otway Basin and sandstone and built-up areas of the Sydney Basin.

In 1965 the Bureau extended its experimental seismic surveys to offshore areas of the Bonaparte Gulf Basin where a sub-bottom profiler (Spark-Array) survey was conducted in conjunction with a surface-Shipborne gravity survey. This survey is planned to continue in 1967 and 1968 and magnetic data will also be obtained during the survey.

Regional gravity surveys are extensively used by the Bureau to provide basic data for petroleum prospecting and in particular to determine regional geological structures which are targets for more intensive methods of investigations. Since 1959 the coverage of gravity surveys has been significantly increased by the use of helicopter transport. The helicopter gravity survey technique has been so perfected that now about 40 to 60 one degree squares each year are completed with a station density of about 90 per degree square. By the end of 1968 the northern part of Australia above the 28^{0} latitude and a considerable part of the western portion of Western Australia will be covered by regional gravity surveys of this station density. The Bureau tends to use gravity surveys to supplement aeromagnetic surveys, which have played a major part in the Bureau's petroleum search programme. In these surveys a DC-3 aircraft is used at about 500 feet above the ground and traverses are generally either spaced at 1 or 5 mile intervals. To date systematic aeromagnetic coverage has been achieved of the Perth, Carnarvon, Bonaparte Gulf, and Gippsland Basins, and part of the Bowen, central Great Artesian.

Engineering and hydrological geophysical surveys have formed a major part of the Bureau's geophysical activities. Since 1946 and up to 1965 some 50 surveys were completed in Tasmania, 50 in Victoria, 32 in Queensland, 10 in the Australian Capital Territory, 10 in the Northern Territory, 5 in New South Wales, 3 in Western Australia, 2 in South Australia and 2 in the Territory of Papua and New Guinea.

In Tasmania 26 recorded surveys of dam sites were carried out since 1955 including those of the Nive River, (1955) Mackintosh River (1959) and Risdon Brook (1965) with seismic refraction methods being used. Power development and hydro-electric schemes account for 10 surveys including the Lake Echo power development scheme (1956), the Wilmot power development survey of 1963, and the Murchison - Sophia, Upper Pieman hydro-electric scheme of 1963. Some 10 geophysical investigations were conducted on tunnels, e.g. Cleveland Tunnel Line 1956 and the Hobart Tunnel site of 1960. Surveys were also made of building sites, bridges, and an acqueduct.

In Victoria more than 30 vibration tests have been recorded since 1957, mainly on buildings in the Melbourne area. Tests of 1965 were made in connection with the proposed location of an underground railway system beneath the Commonwealth office block. There were also 7 investigations of damsites, 3 of tunnels, 3 of power station sites and 1 of groundwater. These range from the seismic refraction survey of No. 1 Power Station site Kiewa 1956 to Lake Bellfield dam site vibration tests of 1963. In 1965 a resistivity survey was conducted on a 70 square mile area of the Kerang irrigation district to determine whether resistivity methods could be used to detect shallow aquifers, and if so, to indicate their extent in the trial areas.

In Queensland 22 damsites were tested and recorded by geophysical means including the Flaggy Creek damsite survey of 1962. Investigations of underground water were conducted with activity in 1964 and 1965 being centered on Stradbroke Island and the Burdekin River Delta. At the latter locality radioactive tracers were used and the general aim of the survey was to discover the position and movements of the fresh and saline water in an area to assist the delineation of areas required for irrigation of sugar. Up to the time of writing this report there were 2 investigations of bridge sites and one of an hydroelectric scheme at Kuranda in Queensland.

In the Australian Capital Territory seismic surveys of the Upper Cotter River damsite were conducted in 1956, 1957 and a seismic refraction survey in 1961. Seismic and resistivity surveys were carried out on various bridge and building sites.

In the Northern Territory groundwater investigations were conducted at Alice Springs, Yuendumu and Cabbage Gum Basin. Dam sites were investigated on the Darwin River. Other projects include investigation of the Tindall airstrip, Darwin observatory sites and foundation investigations for the E.L.D.O. project at Gove Peninsula 1964.

Damsites were investigated by geophysical surveys in New South Wales at Googong and Spencer Creek and a crustal investigation in co-operation with the Australian National University was conducted in 1965.

In Western Australia geophysical investigation of water deposits was undertaken in the early nineteen fifties at Lake Grace, Kulin, Wubin, Cue and Big Bell.

Some reservoir sites in South Australia were investigated, but geophysical engineering projects were generally limited in this State.

In 1963 geophysical investigation was applied to the Territory of Papua and New Guinea when the Upper Lamu hydroelectric project was investigated, and in 1964 a resistivity survey was conducted at Lae to assist underground water studies.

The Bureau maintains geophysical observatories at Toolangi (Vict.), Mundaring (W.A.), Darwin (N.T.), Port Moresby (Papua), Mawson and Wilkes (Antarctica) and Macquarie Island where observations are recorded on terrestrial magnetism, seismology and ionospherics. In 1962 seismic refraction investigations were made at five sites in the vicinity of Alice Springs, Northern Territory to select the most suitable site for a seismological observatory.

The Bureau occupied the Toolangi observatory in 1946 to record magnetic observations and a seismic observatory was operated in Melbourne until it was moved to Toolangi in 1962. A normal programme of geomagnetic recording uses a normal run La Cour whilst seismic recording is achieved using short-period Benioff and long-period Press-Ewing seismometers.

From 1958 to 1959 observations were recorded from the Watheroo Observatory (W.A.), but early in 1959 this observatory was superseded by the Mundaring Observatory. In 1963 a micropulsation recorder was constructed and put into operation during the year while seismic waves from six depth charges exploded from H.M.A.S. Diamantina were successfully recorded. The equipment used during a normal programme of seismic recording include a World Standard set of seismometers and a short period Benimore. Details of all observations are included in the annual reports of the observatory.

At Darwin a magnetic observatory operated from 1957 to 1959 and a seismic observatory has operated from 1961 to the present.

The observatory at Port Moresby was occupied in 1957 and magnetic, ionospheric and seismic recording were carried out. The normal programme of

geomagnetic recording uses normal and rapid-run La Cour magnetographs whilst seismic observations are recorded using a World Standard set, two long-period low-magnification horizontal Sprengnethers, two Wood-Anderson seismometers and a Wilson-Lamison vertical seismometer. Ionspheric recording is conducted but the quality of ionograms is kept low by the signals from nearby broadcast and aviation transmitters. In 1965 radio transmission from an artificial satellite is recorded twice daily for Sydney University. Advice has been given on seismicity and earthquake risk to several organisations.

The observatory at Mawson was established in 1955 becoming fully operational the following year, the observatory at Wilkes was taken over by the Bureau in 1959 having been formerly under American control, but it is proposed to abandon this observatory at the end of 1967. At Mawson normal geomagnetic and seismic recording uses normal La Cour magnetographs of high and low sensitivity, A Selzer type fluxmeter, long-period horizontal, and a short period vertical, Benioff seismometers. At Wilkes normal geomagnetic and seismic recording is carried out using Ruska normal and rapid-run magnetographs, a Grenet short-period vertical and three Press-Ewing long-period seismometers. Annual reports record the work carried out at Mawson and Wilkes.

There has been a geophysical observatory at Macquarie Island since 1951 where magnetic and seismic observations are recorded using normal-run and rapid run La Cour magnetographs and a short-period vertical Benioff seismometer.

The results of magnetic observations from all observatories operated by the Bureau are published monthly in the Geophysical Observatory Report. Earthquake data from the Bureau's observatories are published in a weekly seismological Bulletin. The reports are issued chiefly on an exchange basis to international authorities.

RESIDENT GEOLOGICAL AND GEOPHYSICAL ACTIVITIES

The Bureau has Resident geologists and geophysicists employed in the Territory of Papua-New Guinea and the Northern Territory.

Before 1942 the New Guinea Administration employed two geologists and a vulcanologist, but there were no geological staff in the Administration of the Territory of Papua. These positions were temporarily absorbed by the Geological Branch of the Department of Interior (the predecessor to the Mineral Resources Survey and the Bureau of Mineral Resources) after the Japanese had over-run New Britain.

After the formation of the Bureau of Mineral Resources in the latter part of 1946, Cabinet considered the appropriate way in which geological and allied work should be performed in the Territory of Papua and New Guinea and by decision dated 21.12.46 approved Cabinet Agendum No. 1280 (Attachment 2, Appendix 1). This submission stated "that to ensure maximum efficiency and continuity of service it is desirable that the technical oversight of geological and geophysical activities should be brought under the Commonwealth's permanent geological and geophysical organization, which is the Bureau of Mineral Resources in the Department of Supply and Shipping". The recommendations were:

1. The classification of the Public Service of the Territory of Papua-New Guinea to make provision for the staff considered necessary to carry out the normal geological work of the Territory including vulcanological work.

2. Technical Staff (Geologists and Vulcanologists) to be officers appointed by the Commonwealth Public Service Board to the Bureau of Mineral Resources and to be seconded to the Territorial Administration for services as officers of the Territorial Mines Department for specified periods. Officers so seconded to remain on the strength of the Bureau, but whilst in the Territory to be subject to the direction of the Administrator and to make their reports to the Administrator through the Secretary for Mines. (Other staff such as Inspector of Mines etc. to continue to be appointed direct to the Administration).

3. Special geological and geophysical investigations including oilfield mapping and the establishment of a Geophysical Station (if it were decided to locate one in the Territory) to be under the direct control of the Bureau of Mineral Resources.

4. Purchase and installation of instruments to be arranged by the Bureau.

5. Expenditure on the foregoing matters to be allocated as follows: Papua-New Guinea Administration to meet the cost of

(a) normal geological work including salaries and other expenses of seconded staff and;

(b) instruments required for use in connection with normal geological work in the Territory.

And the Bureau of Mineral Resources (at that time Department of Supply and Shipping) to meet the cost of:

(a) all instruments other than those used in connection with the normal geological work of the Territories;

(b) special investigations as recommended in (3) above.

These arrangements are substantially those which apply at present except that the geological staff seconded from the Bureau to the Administration of Papua and New Guinea now comprises one Geologist Class 3, five Geologists Class 2 and four Geologists Class 1.

In 1957 the Bureau of Mineral Resources established a Geophysical Observatory in Port Moresby for observation on terrestrial magnetism, seismology and ionospherics and this is staffed by Bureau geophysicists and supporting technical personnel.

A vulcanological observatory is maintained at Rabaul, the observatory includes temperature measurements in and around the harbour, tiltmeter readings and seismic interpretations forwarning purposes with a network of seismic stations.

In the Northern Territory the appointment of two geologists were approved to the Mineral Resources Survey for service in the Northern Territory before the Second World War, but before action could be finalised war had broken out and the positions were filled by temporary appointees. Owing to urgent demands elsewhere in Australia these appointees were employed only part-time on work in the Northern Territory.

Arrangements for geological and allied work in the Northern Territory were finalised in 1946 by exchange of memoranda between the Minister for Territories and the Minister responsible for the Bureau of Mineral Resources.

On the 30th November, 1945, the Minister for Supply and Shipping wrote to the Minister of Interior suggesting that geological and allied work in the Northern Territory should be organized along the following lines:

1. A Senior Geologist with an assistant be seconded (to the Northern Territory Administration) from the Mineral Resources Survey for specified periods up to say, three years. While seconded these officers would have access to the technical resources of the Mineral Resources Survey and have the benefit of discussions with the professional officers of that Survey, but they would be available to attend to the day-to-day requirements of the Administration and would be subject to the direction of the Administrator whilst seconded.

   These geologists would have two main functions:

(a) to give geological advice to the community and to the Administration on prospecting and mining; and

(b) to furnish advice of the selection of sites for bores and wells put down for water.

It was further proposed that major geological and geophysical investigations such, for instance, as the detailed survey of a goldfield or possibly of an area thrown open for settlement, to be done by field parties from the Headquarters staff of the Mineral Resources Survey.

In his reply of the 16th January, 1946, the Minister for the Interior informed the Minister for Supply and Shipping that the proposal outlined in his memorandum of the 30th November, 1945, was considered entirely satisfactory and asked that steps be taken to implement the proposed arrangements in the near future.

No appointments to the Resident Staff had been made by 1950; there was a considerable amount of correspondence at this time which dealt mainly with office space and housing for married officers and whether the Resident Geologist should be responsible to the Administrator or to the Director of Mines. It was pointed out in this correspondence that the Bureau had compensated for the lack of resident staff by increasing the amount of regional work which was carried out in the Northern Territory by parties based in Canberra; in fact, three field parties were working in the Northern Territory at that time.

On 25th August, 1950, the Minister for the Interior wrote to the Minister for National Development and agreed to the Resident Geologist being responsible to the Administrator for a trial period. The Resident Staff were appointed in 195

In February 1954, the Secretary of the Department of Territories wrote to the Department of National Development and stated that the Administration "appreciates the valuable service and co-operation of skilled geological staff of the Bureau operating in the Northern Territory and welcomes the secondment of senior geologists to the Administrator as resident staff". At the same time he asked again that control of the Resident Geologist should be exercised through the Director of Mines.

In 1956 a conference between Department of National Development, Department of Territories and the Public Service Board was held to consider a proposal by Territories that the organization of the Mines Branch be revised to provide for positions of geologists. The meeting agreed for the provision of two separate geological services:

(a) what may be called permanent services, to do the regular geological surveys and investigations incidental to the day-to-day requirements of the N.T. Administration;

(b) special investigations of Commonwealth-wide importance, e.g. regional geological surveys and detailed surveys of mineral fields which require teams of specialists organised for the purpose and backed by special laboratory services.

To give the Administrator his own organization would only meet the requirements of (a) and the Bureau of Mineral Resources would still have to accept the responsibility for (b). The meeting decided that any difficulties then existing appeared to stem from one or other of the following causes:

(a) inadequacy of staff numbers;

(b) clear understanding and/or definition of the degree of control exercised by the Administrator over Resident Staff and the co-ordination of the geological requirements of the several branches of the Northern Territory Administration.

In regard to (a) the Board had already provided for the creation of additional positions and it was left to the Secretaries of the two departments to confer and take such action as was necessary.

At present the Bureau is supplying Resident Staff in Darwin, Tennant Creek and Alice Springs consisting in total of one Geologist Class 3, two Geologists Class 2 and seven Geologists Class 1. In addition to this the Bureau has staffed the special group in Darwin - known as the Darwin Uranium Group - consisting of one Geologist Class 3, one Geologist Class 2 and one Geologist Class 1, one Geophysicist Class 2 and two Geophysicists Class 1.

There has been correspondence between 1954 and 1960 on the manner in which the expense of maintaining the Resident Staff should be paid. By agreement between Territories and National Development the present situation is that the Bureau pays their salaries and operating expenses and provides motor vehicles, operating equipment and field assistants, while the Administration provides office accommodation and some office services.

The activities of the Bureau's Resident Staff in the Northern Territory have consisted of detailed inspection of mineral deposits, particularly in areas for which application for assistance has been made under the Mines Branch Ordinance; investigations of groundwater including the selection of bore sites for landholders particularly those constructed under the Water Supplies Development Ordinance; detailed mapping and advice to assist engineering projects. The activities of the resident staff in Papua-New Guinea is similar to that performed in the Northern Territory, except for the vulcanological work carried out at the Rabaul office where a Vulcanological Observatory is maintained, and the operation of the Geophysical Observatory at Port Moresby.

ANTARCTIC ACTIVITIES

Scientific investigations by the Bureau in Antarctica date from 1947-48 when a party visited Kerguelen Island, Heard Island and Macquarie Island to carry out geomagnetic observations and to examine the geology. Since then the Bureau's activities have consisted of systematic regional and reconnaissance geological mapping, and geophysical observations (geomagnetic, seismology, and gravity), some of which were applied to measuring the thickness of the ice.

Geological mapping by the Bureau in Antarctica began in 1954. To date the sector from 45°E to 80°E, as far south as known rock exposures, to 75°S, has been mapped at reconnaissance scale, and a reconnaissance made of the remainder of the coastal parts of Australian Territory. The Windmill Islands in Vincennes Bay were examined in rather more detail.

The region from about 50 km east of Mawson to about 60 km west and 80 km south-west of Edward VIII Gulf, including the offshore islands, and extending inland for about 70 km, has been geologically mapped at 1:250,000 scale. Paleomagnetic studies, age determinations, bottom sampling on the continental shelf, and a study of the composition and origin of saline lakes in the Vestfold Hills have been undertaken in association with this mapping.

The Bureau has operated geomagnetic (and seismological) observatories for varying periods since 1950 at the bases established in Antarctica by A.N.A.R.E.

On Macquarie Island continuous recording of the horizontal intensity of the earth's magnetic field began in 1950. In 1951 a normal magnetograph was installed and full observatory operations began in the following year and have continued to date. An insensitive magnetograph was installed in 1960 and a rapid-run magnetograph was added in 1963.

Continuous seismological recording has been maintained since 1950 when a 2-component Wood Anderson seismograph was installed. This was replaced by a 3-component Benioff seismograph which was reduced to a single component in 1963. In March, 1967 a Willmore instrument was provided to determine if a lower noise level site could be found.

On Heard Island a normal magnetograph was installed in 1951 and continuous magnetic recording carried out from 1952 to 1955 when the base was closed. A 2-component Wood-Anderson seismograph was operated continuously from 1951 to 1954.

At Mawson the building and equipment used at Heard Island were transferred to Mawson in 1955. Recording commenced late in the year and has continued to the present time. A bar-fluxmeter was added in 1957 and an insensitive magnetograph in 1960. A 3-component Leet-Blumberg seismograph operated intermittently from 1956 to 1960 when it was replaced by a 3-component Benioff Seismograph, which has operated ever since.

At Wilkes the normal and rapid-run magnetographs which were operating when the U.S.A. handed over the station in 1959 were kept operating until the end of 1966 when the observatory was closed down. A 3-component Columbia (Long-period) seismograph installed by the U.S.A. was maintained in continuous operation until the closing of the observatory at the end of 1966. A short period vertical seismograph was added in 1962.

Gravity observations have been made in Antarctica by the Bureau since 1953. Much of this work has been carried out in association with seismic observations as part of ice thickness investigations. Between February 1953 and March 1963, 14 Gravity ties to Antarctica and sub-Antarctic bases were made. Kerguelen Island, Heard Island, Macquarie Island, Mawson, Davis, Mirny and Wilkes were included in the stations occupied.

During the period 1957-58, the Bureau in conjunction with the A.N.A.R.E. based at Mawson, carried out a series of ice thickness measurements over the Antarctic ice cap, as part of the scientific programme for the International Geophysical Year. This work was extended in 1959. Seismic and gravity observations were made along traverses extending several hundred kilometers from Mawson.

In 1961 ice thickness measurements began at Wilkes. The work continued during the period 1962 to 1965 and included a 890-mile seismic and gravity traverse from Wilkes to Vostok, and a number of semi-detailed seismic and gravity traverses over the ice dome to the south-east of Wilkes.

PETROLEUM EXPLORATION ACTIVITIES

Before the introduction of the Petroleum Search Subsidy Act in 1957 the Bureau's activities in Petroleum exploration consisted entirely of regional geological mapping and geophysical surveys and their associated laboratory studies. These aspects have been dealt with in the preceding sections on geological and geophysical activities.

In addition to these activities on petroleum exploration the Bureau now administers the Petroleum Search Subsidy Act which involves the following activities:

- inspection of subsidised operations in the field;
- assessment of results obtained from subsidised operations;
- editing of final reports on subsidised operations for publication;
- preparation of advice on and reviews of petroleum exploration in Australia and Papua-New Guinea for the Government;
- collection, collation and publication of all available data on the sedimentary basins of Australia and Papua-New Guinea;
- storage, classification and examination of samples of cores and cuttings from all subsidised and other available wells drilled in Australia and Papua-New Guinea.

The results of applications for subsidy are published in the Petroleum Search Subsidy Act's Annual Statement and the totals of applications from 1957-58 to 1965-66 are shown on the next page.

Petroleum Search Subsidy Act Publications embody the results of operations subsidised under the Petroleum Search Subsidy Acts 1957-58 and 1959-61. Publications in this series are reports on stratigraphic drilling operations, geophysical and borehole surveys.

An important part of the Bureau's petroleum exploration activities is the complete geological and geophysical study of sedimentary basins, which involves the collection, collation, integration, review and re-interpretation of all geological, geophysical and drilling data on the sedimentary basins of Australia and Papua-New Guinea, which are all required to be reviewed at regular intervals to assess the petroleum prospects of each basin. Reviews of the collected data can indicate, deficiencies in data areas where additional exploration is justified and areas where oil and gas pools may be expected. A report on the study of the Bonaparte Gulf Basin was completed; studies of the New Guinea Basin and the Otway Basin are completed and in 1967 a study of the Sydney Basin began.

To assist the petroleum exploration activities the Bureau operates a Core and Cuttings Laboratory at Fyshwick, Canberra, where samples of cores and cuttings from oil wells drilled in Australia and Papua-New Guinea are stored and catalogued. Laboratory facilities exist to enable examination of the material by private companies and others.

APPLICATIONS FOR SUBSIDY (P.S.S.A. 1957-58; 59-61)

Year	Approved	Refused	Withdrawn	Deferred	Pending	Total
1957-58	13	9	-	-	-	22
1958-59	12	3	-	-	-	15
1959-60	47	11	-	9	-	67
1960-61	53	31	-	5	-	89
1961-62	89	5	-	-	-	94
1962-63 Applications Received before 30.6.62 App. 19 Ref. 1	149	6	3	-	27	205
1963-64 Applications Received before 30.6.63 App. 23 Ref. 5	172	20	3	-	22	245
1964-65 Applications Received before 30.6.64 App. 17 Ref. 5	154	16	4	-	20	216
1965-66 Applications Received before 30.6.65 App. 18 Ref. 2	124	2	4	-	24	174
					Grand Total :	1127

MINERAL RESOURCES ACTIVITIES

In 1959/60 the Bureau's principal sections dealing with certain aspects of mineral resources, which could be regarded as developmental rather than investigational, were brought together under the one Branch, known as the Mineral Resources Branch. The sections were Mineral Economics, Mining Engineering, and Petroleum Technology.

The general function of the Mineral Economics Section is the study and investigation of resources, mining, transport, treatment, marketing and utilization of minerals and metals for the purpose of appraising national and international mineral resources and developing and recommending policies thereon.

During 1961, for example, the Section examined the role of the mineral industry in the balance of payments situation and the likely effects on the mineral industry of the proposed entry of Britain into the European Common Market. Field work in the programme of commodity studies has been concerned with beach sands, tin, industrial minerals and iron and steel. The Section has been involved in mining taxation, petroleum taxation and restrictive trade practices. International commodity problems involving the section included meetings of the International Lead and Zinc Study Group and investigations carried out for the International Tin Council, the United Nations ad hoc Committee on Tungsten, and the International Monetary Fund.

The Mineral Economics Section prepares periodic estimates of export income and advises Departments (Trade, Customs & Excise, Primary Industry) and industry on mineral export trends and prospects generally. In 1964 for example particular attention was paid to developments in exports of beach sands and aluminium, alumina and bauxite. The Section also advises the Joint Intelligence Branch of Department of Defence on the selection and grading of key points and maintains liaison with the Planning Branch of Department of Supply with regard to assessment of resources, production and consumption of raw materials. Numerous discussions are held with interested parties, both government and industry, regarding taxation, mineral development policy, export policy, and costs and investment opportunities in industry.

The Mineral Economics prepares the Annual Review of the Australian Mineral Industry and the Quarterly Review of the Australian Mineral Industry both of which have been issued since 1948. Summary Reports were published at intervals and deal with individual minerals and metals and designed to provide a summary of information concerning their sources, uses, production, consumption, prices and trade. But as mentioned in the Section on Publications these Reports have been supplanted by Bulletins on the Australian Mineral Industry on the Deposits and the Production and Trade from 1842 to 1964.

In association with the Commonwealth Bureau of Census and Statistics statistical data concerning all aspects of the mining and mineral industry is compiled.

The Mining Engineering Section prepares reports and submissions on technical aspects of the mineral industry in connection with operation of controls, or assistance or government action which had been requested or proposed. These reports have necessitated examination of mining operations, e.g. at Kalgoorlie (W.A.) Rum Jungle (N.T.) Mount Morgan (Q'ld) and Whipstick (N.S.W.).

The Section assists the administration of the Gold-Mining Industry Assistance Act and the Gold Mines Development Assistance Act (which lapsed on 30th June, 1965), processes applications for permission to export iron ore and manganese ore and reports on the operation of the control on export of manganese ore.

Another activity of the Mining Engineering Section is the co-ordination of sponsorship of research projects at the Australian Mineral Development Laboratory by interested Commonwealth Departments and Authorities in connection with the Commonwealth Government's guarantee to the Laboratory. As part of this programme work on the recovery of bismuth from tailings dumps in the Tennant Creek district, N.T. was completed in 1963. In 1964 surveys of mineral resources in tailing dumps in New South Wales and Tasmania were recorded and in 1965 a record of Queensland's tailings dumps were added to the list. Other projects submitted by the Section to AMDL were the separation of chalcopyrite from bismuthinite in gravity concentrate from the Pioneer Mill, and leaching tests on Jervis Range copper sulphate recovery.

In 1964 reports were prepared on the development of the Rum Jungle Intermediate Copper prospect, Frances Creek iron ore deposits, Gove bauxite deposits and silicosis legislation for the Northern Territory.

Until about August 1962 most of the administration of the Petroleum Search Subsidy Acts 1957-58 and 1959-64 was the responsibility of the Petroleum Technology Section. As from the end of July 1962 the administration of the Petroleum Search Subsidy Acts became the responsibility of the Petroleum Exploration Branch, and from this date the Petroleum Technology Section assisted with advice effecting general petroleum policy and provided technical services to the Bureau's petroleum exploration activities and to a lesser extent technical advice and service to the petroleum industry. The Section is responsible for shot-hole drilling for Bureau seismic parties and supervises contract stratigraphic and corehole drilling for the Bureau. Between 1st April 1964 and 30th October 1964 for example, the drilling units attached to the Bureau's No. 1 Seismic Party drilled 3360 holes which involved a total of 181,215 feet. The drills operated by the Section are Mayhew "1000" and Carey shot-hole drilling rigs.

In addition the Petroleum Technology Section deals with some technical matters concerning the administration of the petroleum ordinances of the Northern Territory and the Territory of Papua and New Guinea. The Chief Petroleum Technologist is a member of the Oil Advisory Committee appointed under these ordinances. In 1963 draft regulations relating mainly to safety aspects of exploration for, and exploitation of petroleum were prepared as a basis for discussion at a meeting of State and Territory Inspectors of Mines in Melbourne. In July 1964 the Chief Petroleum Technologist and Supervising Petroleum Technologist discussed with officers of the Department of National Development Secretariat uniform code of petroleum legislation in respect of the continental shelf of Australia.

The Petroleum Technology Section operates a Laboratory where cores or samples from side-wall cores, conventional plugs cut from cores, whole cores and outcrop samples are analysed. Routine analyses consist of tests for water saturation, oil saturation, core water salinity, acid solubility, porosity,

permeability, and bulk and grain densities. The laboratory was reorganised in 1962 to cope with these analyses and in that year some 400 core samples and 115 outcrop samples were tested whilst in 1964 the figures were 1225 and 185 respectively. New apparatus connected with advanced petrophysics was constructed and early in 1964 the final modifications to the gas chromatograph were completed and tested. There is now a full compliment of laboratory equipment suitable for petroleum technology including high-temperature gas chromatograph, high temperature and pressure mud testing equipment and a full range of core analysis equipment, variable speed viscometer and spectophotometer.

The Petroleum Technology Section collects, collates and prepares for publication the following:- Petroleum Tenement Map and Key-biannually; Petroleum Newsletter-quarterly; Rig activity, wells and footage drilled-monthly; Breakdown of exploration activity and expenditure - annually; List of drilling contractors, service companies and consultants - usually twice a year.

OPERATIONAL ACTIVITIES

The main operational administration of the Bureau is carried out in the Operations Branch, which with the Mineral Resources and Petroleum Exploration Branches was one of the three new Branches established in the general reorganisation of the Bureau's upper or head office structure in the period 1959-1960. The Branch incorporated the then existing Administrative Section of the Bureau and created two new Sections - the Planning & Coordinating Section and the Publications Section.

The activities of the Operations Branch consist of planning and control of the Bureau's (field) programme, coordination of projects involving more than one Branch, distribution of information resulting from the Bureau's work, control of publications programme and library services, general internal administration, and preparation of estimates and periodical review of estimates and expenditures.

The Administrative Section is the largest Section in the Branch and consists of some 85 non-professional officers; it is responsible for the provision of management and general office services, administrative assistance to all Branches and the preparation of Bureau estimates. The management services consist of staff matters such as appointments, promotions, transfers, resignations, staff instructions, travel movements, and employment of students; registry, typing, receptionists and telephonists. The general office services consist of office accommodation, furniture, stationery, work proposals, repairs and maintenance, vehicle hire and their modification and maintenance, sale of publications and copying. The preparation of estimates includes periodical reviews of estimates and expenditure during the year. The Administrative Section is also responsible for negotiations with the Contracts Board concerning the calling of public tenders for Bureau contracts.

The Planning and Coordination Section is staffed with 4 professional officers and its activities consist of a number of matters concerning the Bureau's programme of work and involves:-

- liaison with Under Secretaries of State Mines Departments (and to a lesser extent other State authorities such as water authorities) and the Administrators of the two Territories;

- negotiation with private companies and individuals concerning their requests for surveys;

- chairing and organising meetings of supervisors to discuss proposals for Bureau's draft programme for next year and proceeding year. Attendance at meetings of Chiefs of Branches on Bureau's proposed programme;

- preparation of Pictorial Index and final document setting out Bureau's field programme.

Besides these activities the Planning and Coordination Section assists the Assistant Director (Operations) in preparation of high-level correspondence, e.g. Ministerial enquiries, seeking approval of Secretary and Minister to projects beyond the Director's delegation, seeking approval for overseas visits by Bureau officers. In addition the Section assist the Director in his capacity as member of a number of Committees, e.g. as Deputy Chairman of the Technical Committee on Underground Water of the Australian Water Resources Council - the Section provides the Secretary for this Committee; and the Baas-Becking Geobiological Committee.

The Publication and Information Section has a total of 4 professional officers and its activities consist of:

- planning and control of the Bureau's publication programme;

- examining, for the Director, all Records, and manuscripts submitted for publication in the Bureau or outside journals;

- arranging and controlling printing contracts;

- disseminating technical information arising from Bureau's publications and replying to enquiries from the public and private enterprise;

- preparing technical reports on the mining industry for the Press and for addresses by senior officers;

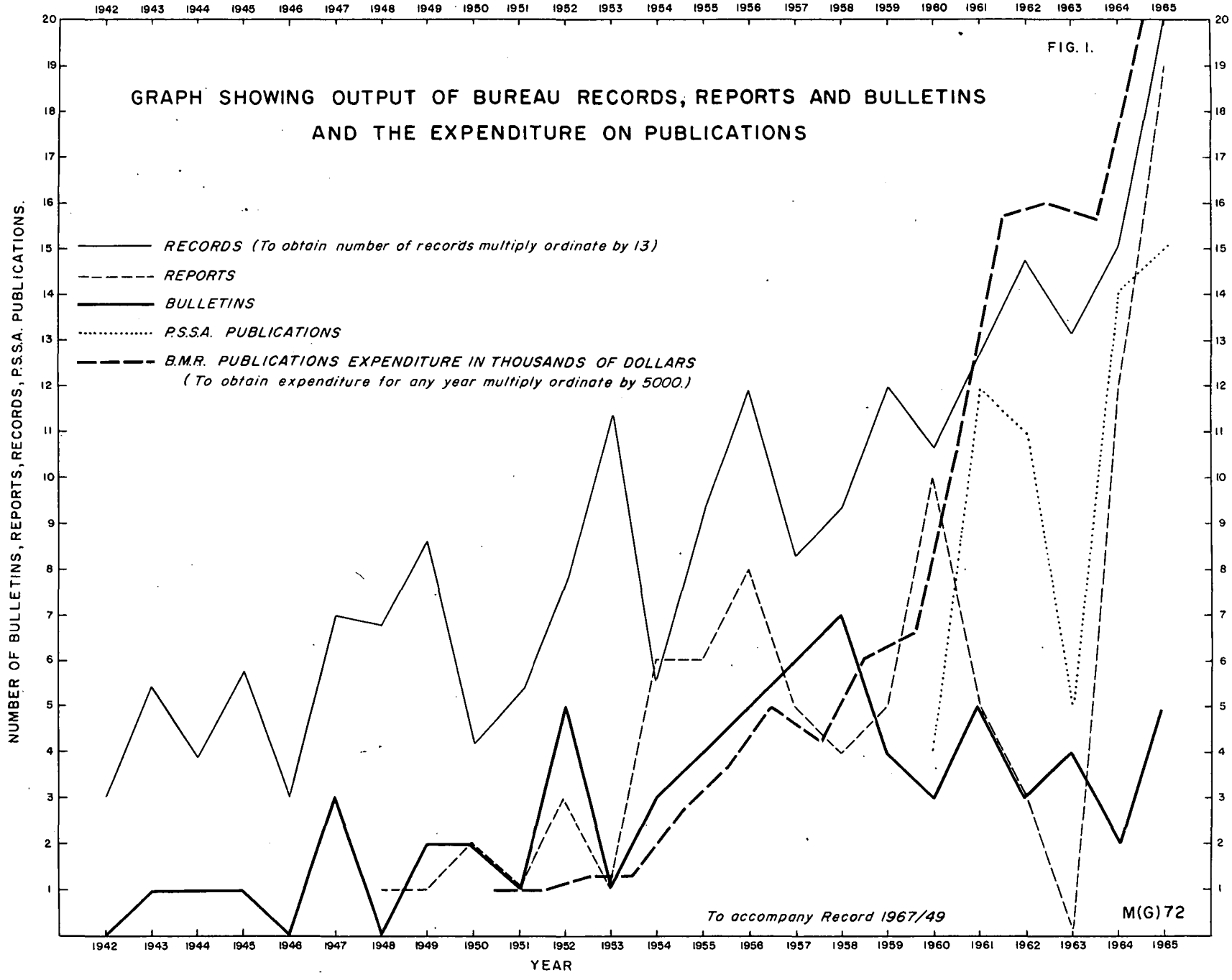
- preparing circulars on Bureau's publications, including supervising the Open File System;

- supervising the Library.

Because of the importance of publications in the activities of the Bureau they will be discussed further in the next Section.

FIG. 1.

GRAPH SHOWING OUTPUT OF BUREAU RECORDS, REPORTS AND BULLETINS AND THE EXPENDITURE ON PUBLICATIONS



To accompany Record 1967/49

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PUBLICATIONS

The Bureau's publications are its most important activity as it is the only means of conveying to the public and interested parties the results of its field activities and related studies. The measure of publication output is depicted graphically in Figure 1 which shows the number of some of the main publications printed each year and the total expenditure on publications each year as far back as the records allow. The graph may not be a true measure of the Bureau's publication effort because of the time gap between compilation and the complexities of editing and printing. This lag partly accounts for the pulses in the graphs of Figure 1. But the overall result can be readily seen from the graphs. For instance the expenditure on publications increased steadily from about $5,000 in 1950-51 to about $80,000 in 1963-64, which then nearly doubled up to 1966-67 when about $150,000 were expended. This level of expenditure on publications is expected to continue in 1967-68 because $120,000 is set aside in the Bureau's draft estimates for publications and the possibility of additional estimates being required during the financial year.

Appendix 5 lists the subjects and their totals of Bulletins, Reports and Records issued by the Bureau up to September, 1966. The totals should be treated with caution because some publications and records are listed under more than one subject. About half of the total (by subjects) of Bulletins have been devoted to geological sedimentary, metalliferous, and palaeontological subjects, and these also make up about one third of the Reports and Records.

The publications of the Bureau are primarily of a specialist nature and are designed to;

- record the results of geological and geophysical field, laboratory and observatory investigations;
- provide easily accessible general information on minerals and to assist those connected with development of the mining and mineral industries;
- provide a continuous review of the mineral industry in Australia.

The publications consist of:

Bulletins. Bulletins are confined to reports on investigations, or on particular phases of investigations, regarded as complete, and to reports on comprehensive investigations that may not be complete, but that are not likely to be continued and completed in a reasonable time. The number of Bulletins increased from 1 in 1943 to 6 in 1958, and to 5 in 1965 (Figure 1). By October 1966 a total of 88 Bulletins were published, of which 11 were in press.

Reports. Reports include the results of important preliminary investigations, or some phase of a major investigation, which are desired to publish as soon as possible, either because the particular phase is of immediate interest or because the investigation of which it forms a part may not be complete for several years. In 1948 one Report was published, in 1960 ten and in 1965 nineteen, and by October 1966 a total of 120 reports were published, of which 17 were in press (Figure 1).

Petroleum Search Subsidy Act. Petroleum Search Subsidy Act Publications embody the results of operations subsidized under the Petroleum Search Acts 1957-58 and 1959-61. These publications report on stratigraphic drilling operations, geophysical and borehole surveys. By October 1966, 81 of these publications were published, of which 14 were in press.

Records. Records are not strictly publications because of their limited distribution and nature of contents. But they are typewritten or multilithed documents which set out the preliminary results of an investigation on the more important internal papers on specific subjects; and as such contain a considerable amount of valuable information. The records are not reproduced in large numbers and wide distribution is not possible as they are intended primarily to disseminate information as quickly as possible to the mineral industry and interested individuals, but certain records are available on loan or for copying. They are distributed as far as possible, to centres in capital cities in Australia and New Guinea and the "Open File Circular" is issued quarterly listing records that are available and the centres at which they are held.

Since 1942 about 3,000 records have been produced; in 1942 39 records were produced, which rose to 261 in 1965 (Figure 1) and this upward trend is expected to continue.

The Bureau has in hand a scheme designed to increase thepublication of some of the material now lodged in Records. The scheme envisages publication of this material as a Report which would be classified separately from the present Report Series. In this way the gap between the Open File System and the Report Series is expected to be shortened and more information distributed quicker to the public and the interested personnel than was previously possible.

Summary Reports. Summary Reports deal with individual minerals and/or metals and are designed to provide a summary of information concerning their sources, uses, production, consumption, prices and trade. To date 43 Summary Reports have been published, but they were superseded by the publication of Bulletin 72 - Australian Mineral Industry : the Mineral Deposits - in 1965 and its companion, Bulletin 81 - Australian Mineral Industry : Production and Trade, 1842-1964.

Pamphlets. Pamphlets are intended to provide information of use to prospectors and miners regarding prospecting, treatment and marketing of minerals. Since 1943 four pamphlets have been produced.

Observatory Reports. The results of magnetic observatories from all observatories operated by the Bureau are published monthly in the Geophysical Observatory Report. Earthquake data is published in a weekly Seismological Bulletin. The reports are issued chiefly on an exchange basis with observatories throughout the world. Ionospheric data from Mundaring and Port Moresby are published by the Ionospheric Prediction Service, Sydney.

Pictorial Index. A Pictorial Index of Activities first published 1961 illustrates pictorially the activities of the Bureau in Australia and Territories. Editions are meant to be produced annually, but owing to delays in printing are normally published every 18 months, and show the work completed to 31st December and programmed for the following year.

The Australian Mineral Industry, Annual and Quarterly Review. The Annual Review has been issued continuously since 1948. Information is presented in three parts - general review of the industry, review by individual metals and minerals, and general statistics review.

The Quarterly Review was first issued in 1948 and since the first quarter of 1954 it has been prepared and issued in conjunction with the Commonwealth Bureau of Census and Statistics. Part I of the Review is prepared by the Bureau and contains a feature article covering some aspect of the mineral industry, a current review of metals and minerals, and current metal and mineral prices; Part 2 is prepared by the Commonwealth Bureau of Census and Statistics and it includes production, import and export statistics.

Lexicon. In 1957 a Lexicon of the Stratigraphy of Tasmania was published.

Maps. The Bureau has published a Tectonic Map of Australia at a scale of 40 miles to one inch, which shows geology as well as tectonics, and is published in 4 sheets. A geological map of Australia and New Guinea at a scale of 1:5,000,000 (in 4 sheets) in the International Geological Map of the World - Australia and Oceania series has been published recently by the Bureau. Isogonic maps of Australia and Territories, which show the variations in magnetic declination, are accompanied by brief notes and are published in the Report series.

The Bureau assists the Resources Information and Development Branch (now the Water Power and Geographic Branch) of the Department of National Development to prepare resources maps of Australia. The Department has issued the Atlas of Australian Resources, a series of 30 map-sheets with accompanying booklet commentaries. This Atlas includes Geology (1958), Mineral Deposits (1965), and Mineral Industry (1959) as single sheet maps of Australia at a scale of 1:6,000,000. Special resources maps of the Fitzroy Region in Queensland were recently prepared.

In addition to publishing general maps, the Bureau compiles a series of geological maps (with explanatory notes) corresponding to the Australian National Index. Each sheet covers an area of 1° latitude by 1° 30' longitude (with minor variations in some coastal areas). Maps in this series are at a scale of 1:250,000, except for some early maps at a scale of 4 miles to 1 inch (1:253,440). Some 76 maps of the standard 1:250,000 series have been published.

For areas of exceptional interest, such as the uranium areas in the Katherin - Darwin area N.T., geological maps at a scale of 1 mile to 1 inch (now 1:50,000) are issued. Some 30 maps of this scale have been issued, the majority covering parts of the Northern Territory and 3 cover Queensland.

For the convenience of company and State Government geologists who may need early information of the progress of a survey, the Bureau prints black and white or two colour line work preliminary editions of 1:250,000 maps as soon as the field geologists initial compilations are ready. Some 90 preliminary maps at this scale have been issued together with a few at 1:500,000 and 1 inch to 1 mile.

Maps are also produced to show the results of geophysical surveys, and depict magnetic, radiometric and gravity data. The majority are printed maps in not more than three colours or dyeline maps in one colour. Some of the radiometric maps have marginal air photographs showing the location of anomalies in detail. Geophysical maps do not constitute a formal series, but they are published in a format appropriate to the different surveys.

A Petroleum Exploration and Development Titles Map of Australia and the Territory of Papua and New Guinea, accompanied by a Key to Petroleum Exploration and Development Titles, is revised and published twice yearly to show the position at 30th June and 31st December.

A complete and up-to-date list of the Bureau's publications is included in the catalogue of publications issued annually. Recently lists of the Records were produced and issued, which show the author, title, and Record number.

OVERSEAS VISITS

The Bureau's activities necessitates visits by selected officers to other countries to:-

- attend international conferences which generally involve presentation of papers and participation in discussion groups;
- study operations, including techniques, of similar organizations to the Bureau or the mineral industry.

Up to May 1967, a total of 90 officers visited overseas organizations and/or conferences, which is an average of 4 officers a year. 1966 was the peak year for visits when 15 officers travelled overseas. Appendix 3 lists the officers, the country visited and purpose of each visit in chronological order.

In recent years most overseas visits were restricted to about 8 weeks whereas previously they were generally of longer duration.

ENGAGEMENT OF SPECIALISTS

The activities of the Bureau have involved the engagement of specialists mostly for short term, and generally for projects which the Bureau requires guidance. Some specialists are engaged on projects, palaeontology for example, for which Bureau staff is not available, or in other cases to release staff for more urgent and less routine tasks.

The projects and their total numbers for which specialists have been engaged by the Bureau up to May, 1967 are listed below:

Palaeontology	15
Stratigraphic Studies	2
Oceanography (includes 1 phosphate project)	3
Geochemistry	2
Vulcanology	2
Uranium	2
Petroleum (not including the I.F.P.)	1
Seismology	1
Mica	1
Geobiology	1
Editorial	1
Mineral Resources Statistics	1
Geomorphology	1
Tin treatment	1
Phosphate (1 included in oceanography)	1
Geophysics	1
Groundwater	1

Appendix 4 lists in chronological order the 40 specialists engaged by the Bureau from 1948 to (May) 1967 and the purpose of the project. The peak years for engagement of specialists were in 1964 when 11 were employed and in 1965, 8.

APPENDIX 1

NOTES ON THE FUNCTIONS OF THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

The functions of the Bureau of Mineral Resources (Attachment 1) which have been generally accepted since its inception apparently originated from proposals submitted to Cabinet by the Secondary Industries Commission and approved by a Cabinet Sub-Committee on 20th March, 1946 as the functions (Attachment 2) of the then newly formed Bureau of Mineral Resources, Geology and Geophysics.

The evolution of the Bureau's functions is perhaps more readily appreciated if the period just prior to and immediately after the establishment of the Bureau in 1946 is reviewed on an historical basis, then indicating the basis upon which the functions were undertaken and what the Bureau is doing in performing these functions.

At the end of this paper are some comments on the activities at present listed in the Bureau's functions, but which are not now being carried out, and listed are some specific surveys which the Bureau has been authorised to carry out.

1. HISTORY

The present organisation developed from the amalgamation of the office of Commonwealth Geological Adviser and the Commonwealth Advisory Committee in the Geological Branch of the Department of the Interior. That Branch was principally concerned with the search for oil, but it also made other mineral resources investigations, notably of iron ore.

In August 1941, the Geological Branch of the Department of the Interior was transferred to the Department of Supply and Development. Early in 1942, in anticipation of the disbanding of the North Australia Survey, Cabinet agreed to some additional appointments to the Geological Branch, including a Chief Geophysicist and geologists for surveys in the Northern Territory. In 1942 the name of the Branch was changed to Mineral Resources Survey to indicate its main function during the war. The Branch devoted its whole activities during the war to strategic mineral investigations and various aspects of applied geology and geophysics directly related to the war.

On 19th February 1945, Cabinet decided (Agendum No. 723A) on a radical change in its policy concerning the search for petroleum. It had been found that the policy of granting financial assistance to small companies had proved ineffective, and it was decided that a more effective means of furthering the search for oil would be for the Commonwealth to intensify its efforts in carrying out geological and geophysical surveys supplementing this work, where necessary, by scout and test drilling. To give effect to this policy the appointment of additional geologists and geophysicists was approved and the Petroleum Technology Section created.

By exchange of letters between the Prime Minister and the Premier of Western Australia in 1945, the Commonwealth assumed responsibility for the geological and geophysical survey of two large areas in Western Australia, namely, the Fitzroy and Carnarvon Basins, both of which were investigated in 1948-1952 primarily for their petroleum possibilities.

By discussion between the Minister for Supply and Shipping on the one hand and the Ministers and Administrators of the Territories on the other, a scheme was worked out whereby the Bureau undertook to provide a resident geological staff which would be available to carry out the day to day requirements of the Administrators of the Territories; the more important investigations and those of a regional type to be carried out by a special staff provided by the Bureau from Canberra based personnel. On 21st December, 1946 Cabinet approved Agendum No. 1280 relating to the Territory of Papua-New Guinea and Bureau staff (Attachement 3).

In keeping also with Cabinet's decision that the Bureau should engage in regional investigation of the type indicated above, a proposal was placed before the States for putting in hand the compilation of geological maps on uniform standards and scales, with the objective of finding out what was known, as a basis for planning what remained to be done, in the geological mapping of Australia. Agreement was reached with all States, except South Australia, in this connection and considerable progress has been made on the indexing of available data.

On 20th March, 1946 Cabinet Sub-Committee approved proposals as set out in Agendum No. 14 - Attachment 2 - and as submitted by the Secondary Industries Commission based on recommendations of the Mining Industry Advisory Panel emphasising the need for greatly increased geological and geophysical services in Australia, the necessity to provide funds for rehabilitation of mines closed during the war and of providing technical and financial assistance for exploration and development of the mineral resources of Australia. These proposals were accepted as the functions of the newly formed Bureau of Mineral Resources.

To carry out the policy of the Government as expressed in Agendum No. 14 a Mining Engineer was appointed and additional positions created in the Geological and Geophysical Branches of the Bureau.

On the 27th March, 1946 the Mining Industry Advisory Panel, which included the Permanent Heads of all the State Mines Departments, passed a resolution recommending that greatly increased geophysical work should be done and that because of the cost and special equipment involved this should be primarily the responsibility of the Commonwealth upon whom the States would rely to meet their requirements for geophysical surveys. The State of South Australia has subsequently set up a small geophysical unit, but the Commonwea th is still required to meet major geophysical commitments in that State.

In June-July 1946, a conference was held in London known as the British Commonwealth Scientific Official Conference at which the United Kingdom and other British Commonwealth countries and colonies were represented. Important resolutions were agreed to at the conference concerning the carrying out of geological surveys and the assessment of mineral resources throughout the British

Commonwealth. In particular, stress was laid upon the necessity "to institute in concord with the various Governments of the British Commonwealth standard methods of recording figures of mineral resources and production" and for close study to be made of the "economic aspects of mineral resources and production".

Serious notice was taken of these resolutions by the British Commonwealth Governments and to give effect to them so far as Australia is concerned the Minister for Supply and Shipping (on 8th May, 1947 Cabinet Agendum No. 1377) approved the appointment of a senior officer in the Bureau with the designation of Mineral Economist. The Public Service Board gave its approval for this appointment on 10th July, 1947.

Since his appointment the Mineral Economist has made considerable progress in placing the collecting of statistical data on all aspects of the mineral industry on a sound basis. In particular on 21st-22nd July, 1948 a conference was held of Commonwealth and State officials (South Australia excepted) and agreement reached on the basis on which mineral production statistics will be collected by the State Mines Departments and supplied to the Bureau.

On the 28th October, 1947 Cabinet approved a submission providing for the purchase of diamond drilling plant which was used to supplement its technical investigations and which was available for hire to the mining industry. The diamond drilling plant was disposed of in 1958 and since then diamond drilling has been carried out by contract.

The 1950-60 period was essentially one of intensification of the Bureau's activities due mainly to the need to discover supplies of uranium and petroleum. The Bureau advised the Government through the Australian Atomic Energy Commission on all investigations relating to uranium including the applications for rewards for the discovery of uranium. In 1957 with the introduction by Cabinet of a subsidy act to assist the search for petroleum, the Bureau's activities were broadened to enable it to administer the Act - Petroleum Search Subsidy Act. Finally to meet the requirements of Cabinet Decision 1459(m) of 19th July, 1961 which "endorsed the principles for a continuation and an extension of the Government's Oil Search Subsidy arrangements" the Bureau established a Petroleum Exploration Branch in 1962.

Subsequently Cabinet decided on 20th July 1965, to increase the Bureau's staff by 20 to cater for increase activities in the search for phosphate; and recently 2nd March, 1967, Cabinet approved of an additional 60 positions for general expansion of the Bureau's activities. The Cabinet Submission resulting in this decision also put forth recommendations concerning the functions of the Bureau's other matters concerning its working relationship with that of the State authorities and private industry. The results of these recommendations cannot be disclosed here.

2. FUNCTIONS AND AUTHORITY FOR THEM

The statement of functions of the Bureau of Mineral Resources which have evolved from the Cabinet Agendum No. 14 of 20th March, 1946 - Attachement 2 - are set out on Attachment 1.

The following notes set out the status of the more important functions as set out in Attachment 1 and indicates the basis upon which they have been undertaken :-

(1) Investigation of and exploration for mineral deposits; Survey and assessment of Mineral Resources:

(a) Summary of Available Data. The primary object of the survey is to find out what is known about Australia's mineral resources, and with this as a basis to consider and recommend what steps should be taken by way of exploration, increased production and the use of substitute minerals, to ensure a sound mineral economy.

The first step in this systematic survey was taken in 1942 when a card index system was introduced to record all factual data, and agreement was reached with all State Mines Departments on the basis on which information in their possession would be made available for recording and publication.

The publication of Summary Reports was then commenced. These reports set out concisely the salient facts, sources, use, production, consumption, prices and trade about each metal and economic mineral, and are in strong demand both locally and abroad; 43 Summary Reports have been published, and 5 are in preparation. Since investigation and development of mineral resources are continuously adding to out store of knowledge, the Summary Reports require constant revision. The sources, production and trade sections of the Summary Reports have been revised and extended into two Bulletins, one on the deposits (No. 72) and the other (No. 81) on production and trade which were published in 1965 and 1966 respectively.

(b) Mineral Economics and Statistics. It became apparent early in this survey that in addition to the fact that information concerning some minerals was very sketchy action was required on the following points before real progress could be made in preparing a statement on mineral resources :-

(i) it was essential that statistics of production, export and import of minerals should be placed on a uniform basis throughout Australia.

(ii) that the Bureau should have adequate facilities for surveying the consumption side of the mineral industry and for keeping in touch with price, trade trends and new developments in the industry at home and abroad.

At about this time also the British Commonwealth Scientific Official Conference (1946) had stressed the necessity "to institute, in concord with the various Governments of the British Commonwealth, standard methods of recording figures of mineral resources and production" and for close study to be made of the "economic aspects of mineral resources and production". It was known that effect had been given to the Conference's resolutions in the United Kingdom and Canada and it was considered that Australia should take similar action. Accordingly on 10th July, 1947, the Public Service Board approved the appointment of a Mineral Economist.

On statistical matters relating to minerals and metals the Bureau co-operates with the Commonwealth Statistician (e.g. on the re-indexing of exports and imports) and with the State Departments of Mines. The Conference of Commonwealth and State Officers on Mineral Statistics held on 21st - 22nd July, 1948 agreed to a plan for the collection of mineral production statistics on a uniform basis throughout Australia. These statistics have been published continuously by the Bureau since 1948 in quarterly and yearly reviews which consist of production, consumption, prices and trade trends, and new developments in the Australian mineral industry, and a comparison of the Australian mineral industry with that overseas.

Besidesmaking economic investigations into the mineral industry, the Bureau co-operates with other Commonwealth Departments in providing advice on all matters related to the economics policy and administration of the mineral industry.

(c) Field Investigations. The Geological and Geophysical Branches of the Bureau carry out most of its field investigations throughout Australia in connection with mineral resources. The Bureau's responsibilities in Commonwealth Territories, generally speaking, need little discussion, but it may be pointed out that geological work is carried out in accordance with an agreement with the Territorial Authorities, the terms of which so far as the Northern Territory is concerned are set out in letters which have been exchanged between the responsible Ministers. Arrangements regarding work in the Territory of Papua-New Guinea cover vulcanological as well as geological work and have been approved by Cabinet (Attachment 3).

Field surveys and investigations are mostly made by the Geological and Geophysical Branches of the Bureau in State territory, but those carried out by the Geophysical Branch are on a different basis from other types of work.

On the 27th March 1946, the Mining Industry Advisory Panel, which included the Permanent Heads of all the State Mines Departments, passed a resolution recommending that greatly increased geophysical work should be done and that because of the cost and special equipment involved this should be primarily a responsibility of the Commonwealth upon whom the States would rely to meet their requirements for geophysical surveys. The State of South Australia subsequently decided to set up a small geophysical unit, but the Commonwealth is still required to meet major geophysical commitments in that State.

Investigations by other Sections of the Bureau of mines and mineral deposits in State territory are all of a special kind. They are made (i) because the Commonwealth has provided, or has been asked to provide, financial assistance; e.g. assistance to petroleum exploration; gold mines; (ii) because the Commonwealth interest is paramount from a defence or other National viewpoint; e.g. uranium and thorium survey; (iii) by arrangement with a State to obtain new information or supplement work done by a State; e.g. mapping of sedimentary basins in Western Australia considered to have petroleum possibilities; and mappingof north Queensland for metals. (These surveys are mentioned here as examples of regional field investigations which have economic objectives, but because of the large areas involved are more appropriately discussed under the heading of "Geological Survey" - see page 11).

It is becoming increasingly difficult to find mineral deposits, hence the emphasis all over the world on the necessity for more general and at the same time more rigid application of scientific geological and geophysical methods to the search for orebodies. It is apparent, therefore, that in supplementing work done by the States, the Bureau makes an important contribution to National development by building up groups of geologists and geophysicists specialised in various branches of mining geology, e.g. structural interpretation, air photo survey, geophysical and geochemical methods, petrology, mineralogy, mineragraphy, spectrography and geobiology and geochronology. It is beyond the technical and financial resources of the States to undertake this type of work on the scale required.

Since many of the geological and geophysical investigations of the Bureau are directed to the search for concealed mineral deposits, it is logical that they should be followed by drilling. Indeed if these investigations are to have maximum value, it is essential that promising areas suggested by them should be drilled either by companies or Government. Cabinet had specifically approved this principle in relation to the search for petroleum and by its approval of the 28th October, 1947 (Agendum No. 1402) had recognized the necessity for the Bureau to own and operate diamond drilling plants in connection with other mineral exploration. The Bureau operated its own diamond drilling plant until about 1958 when it was found more economical to carry out its drilling by contract

and the Bureau's plant was sold. However the Bureau owns and operates drilling plant capable of drilling shallow holes required for seismic shot holes, testing of geochemical anomalies, and stratigraphic purposes.

Diamond drilling is carried out by the Bureau to - (i) obtain basic subsurface information to augment geological mapping and to provide information on mineral genesis; (ii) test structural hypotheses based either on surface geological or geophysical surveys;

(iii) to provide boreholes in which geophysical logging may be carried out to obtain basic scientific information on earth properties; and (iv) to test mineral deposits where such testing is considerably desirable in the national interest. This includes the search for and testing of strategic or essential minerals for which a low price gives no incentive to private enterprise, but for which it is necessary to know the extent of our resources; it includes the drilling of ore deposits where the possible consequences are important, but where private enterprise is not likely to undertake the work. In general drilling is carried out to encourage private companies to do further work and not for the purpose of assessing ore reserves, which the Bureau maintains is the function of private enterprise. However, there has been cases in which drilling was carried to the point of making an assessment of ore reserves. This applied particularly to minerals which are of strategic importance, but are low-priced, and the Bureau's drilling of the phosphate deposits at Rum Jungle in 1963-64 and to some extent the gold deposits at Union Reefs in the Northern Territory are examples.

(d) Laboratory Investigation. In normal course of field investigations surface specimens and bore-hole cores are collected which must be examined by various techniques to ensure positive identification and obtain maximum information. The techniques used are specialised and most of them involve the use of delicate instruments; it is apparent that adequate laboratory facilities must be provided in support of the Bureau's field activities.

The application of chemical and physical methods to geology has progressed very markedly in the past 20 years and any geological organisation which attempted to do its work at anything less than the high standards set in, for example, England and America would be discredited. The Bureau has modern chemical and mineralogical laboratory facilities which enable it to complete its own investigations satisfactorily. Since 1959 the Bureau has co-operated with the Australian National University and the State Geological Surveys in an extensive programme of dating rocks by radiometric methods - known as geochronology. The application of this technique has greatly assisted the geological mapping of Precambrian rocks which occupy about two thirds of the area of the Australian

continent and account for the majority of Australia's known mineral deposits. In 1964 the Minister of National Development approved of the Bureau's participation in a joint geobiological research project with C.S.I.R.O. and AMIRA (Australian Mineral Industry Research Association), and reasonable progress has been made on this research project.

For many years the Commonwealth has provided a specialised service in micro-palaeontology, for which there is continually increasing demand. Most of this work bears directly on the search for oil or sub-surface water supplies.

The Bureau has a modern well equipped geophysical laboratory and specialist workshop. Specialised geophysical equipment is available for testing, development and research in connection with gravity, magnetic, seismic, electrical and electronic investigations. Facilities are available for testing the magnetic, and electrical and other physical properties of rocks and minerals; the radio-active properties of samples, the orientation of bore cores; the response of minerals to ultra-violet light, etc., many of these testing facilities are not available anywhere else in Australia. Geophysical methods are developing rapidly and constant attention to research and improvements in techniques is required.

The Petroleum Technology laboratory of the Bureau undertakes routine examination of porosity, permeability, saturation and other properties of cores and borehole samples; determines the physical properties of rotary drilling mud; and to identify crude oil and natural gas samples, and undertakes research in relation to these matters.

The Bureau established a laboratory in 1962 to assist petroleum subsidy and sedimentary basin studies in the search for petroleum by cataloguing and storing, all cores and cuttings from bore holes throughout Australia and Papua - New Guinea and by examining the material.

(2) Promotion of Development of Mineral Industry:

The Bureau promotes the development of the mineral industry in many ways. The assistance rendered by its professional branches through the facilities outlined in this statement are obvious. The fact that the Bureau is equipped to provide these facilities means that its services are available from day to day to give advice to those who require it. A large number of written and verbal enquiries are received from individuals, comapnies and Government Departments and, in addition, the advice of the field officers is sought throughout Australia.

For a few years after the Second World War it was a function of the Bureau to assist the mineral industry in procurement of plant and equipment and in facilitating transport and distribution of production. During that period there was strong competition for plant equipment and materials for all purposes, and the mineral industry looked to the Bureau as its point of contact to ensure that the industry obtained a fair share of available supplies. This involved dealing with a wide variety of requirements, e.g. from heavy-earth-moving equipment to such items as cyanide and flotation reagents. However, in about 1950 the supplies of plant and equipment improved to an extent where the Bureau was not required to carry out this function.

Under the Petroleum Oil Search Act of 1936 the Commonwealth purchased rotary drilling plant for hire to small companies engaged in prospecting for petroleum in Australia and the Territories of New Guinea and Papua. The Bureau controlled this plant from 1946 to 1953 and in addition provided trained personnel and field laboratory equipment on loan to facilitate the observation and recording of scientific data as drilling proceeds. The Bureau now does not own rotary drilling plant for petroleum prospecting but it continues to provide technical advice in the drilling for petroleum and loan of field laboratory equipment. The Bureau operates its own shot-hole drilling plant for its seismic surveys and other drilling plant for shallow-hole testing.

In 1951-54 the Bureau assisted the survey of coal resources in New South Wales carried out in conjunction with the State Survey and the Joint Coal Board. This survey concluded the operation of the Bureau's own drilling equipment.

Government policy as expressed by Acts, Ordinances and Regulations has an important bearing on the development of the mineral industry, and the Bureau renders an important service to the community by tendering to the Government expert advice in the framing of legislation to ensure efficient development and conservation of mineral resources. Some examples are given below :-

(i) Petroleum Search Subsidy Act.

(ii) Petroleum Ordinances of Papua - New Guinea and Northern Territory.

(iii) Offshore Petroleum Mining Code.

(iv) Gold Mining Industry Assistance Act.

(v) Gold Mines Development Allowance Act. (This Act expired in June 1965 and most of the benefits are now incorporated in the Gold Mining Industry Assistance Act.)

(vi) States Grants (Water Resources) Act.

(vii) Codes in safe working in Mines.

(viii) Income Tax Assessment Act (special tax concessions to the mining industry).

(ix) Export of iron and manganese ore.

(3) Conservation of Mineral Resources:

Conservation as applied to the mineral industry may be taken as summarising the Bureau's function "to interpret the results of completed surveys and recommending ways to remedying or meeting deficiencies that may become apparent in the mineral economy of Australia".

The statistics and other information on the mineral industry which is produced by the Bureau enables it from time to time to classify the reserves of minerals and metals under the following categories:-

A-Reserves Adequate.

1. Production sufficient for Domestic Requirements and export.

2. Production sufficient for Domestic Requirements.

3. Production not sufficient for Domestic Requirements. Imports are necessary at present.

B-Reserve position uncertain.

1. Production sufficient for Domestic Requirements and Export.

2. Production sufficient for Domestic Requirements.

3. Production not sufficient. Imports are necessary.

C-Reserves Negligible

1. Production negligible. Imports necessary.

It must be emphasised that conditions affecting the production and marketing of minerals may change rapidly and that any plan for assessment of resources may have to be radically modified because of some important new development. For example, prior to 1945 uranium-bearing minerals were something of a mineralogical curiosity, but during 1945 to 1956 they were eagerly sought and discovered in sufficient quantities all over the world. And a recent announcement (10th April, 1967) by the Minister, National Development, anticipates a rapid increase in the world demand in the early 1970's.

During recent years also some metals such as tantalum, tungsten, titanium and beryllium have assumed an importance which they did not possess prior to the outbreak of the Second World War. Another example is the effect of the relaxation of the export embargo on iron by the Commonwealth in 1960 which resulted in the discovery of major iron deposits in Western Australia and Tasmania and thus increasing our iron reserves by several thousand of million tons. These remarks are introduced here to demonstrate the fact that because of the changing conditions a mineral survey can never be said to be complete. Changes in concepts and techniques also require that resources surveys be frequently reviewed.

Mineral surveys may reveal resources which if developed may make the Commonwealth self contained. An example of this was the establishment of an aluminium industry at Bell Bay, Tasmania immediately after the Second World War.

Surveys of mineral resources may, on the other hand, reveal that there are serious deficiencies in the country's mineral resources and this will enable steps to be taken to conserve minerals in short supply. One effective method of conservation is to prohibit exports. However this embargo can have the effect of reducing exploration for additional deposits of our mineral resources. The question of distribution of our mineral resources from the point of view of currency requirements in another important factor which can be regulated to some extent by export control; the Bureau acts in association with the Department of the Treasury, Trade and Primary Industry, and the Atomic Energy Commission (for uranium) to ensure that metals and minerals are exported to the best advantage.

The current (1966-67) increase in the search for phosphate deposits in Australia is the result of the Bureau's recognition some years ago of the short-comings of our island supplies.

(4) Geological Surveys:

(a) General. The primary objective of a Geological Survey is economic, but it is obvious that before the economic possibilities of the country can be assessed from a geological point of view, complete geological coverage is necessary. For this reason the systematic geological mapping and preparation of a geological map of Australia proceeds concurrently with investigation of areas known, or believed to be, mineral bearing. Some geological information of general value is available through investigations made primarily in connection with the mineral industry, but geological data particularly in the form of maps, is valuable for all purposes which involve the use of land, e.g. water resources, engineering, etc. To this end the Bureau is the central Commonwealth authority for the collection, storage, synthesis and publication of geological and geophysical data, and mineral statistics. (See Section 6 "Publications").

(b) Commonwealth Territories. The Bureau has full responsibility for geological surveys in Commonwealth Territories. It has an obvious obligation to do all the geological work required in A.C.T. and the Australian Antarctic Sector and its geological work in the Northern Territory and in the Territory of Papua-New Guinea is carried out in accordance with the agreements with the Territorial Authorites, the terms of which are quoted on Attachment 3 of this Appendix. It will be noted from this agreement that provision has been made for the day to day requirements of the local administrations as well as for general geological work.

(c) Oilfield Mapping. In February, 1945 Cabinet approved that the Bureau engage in detailed geological mapping of sedimentary basins considered to have petroleum posibilities. In carrying out this function, agreement was reached in 1946, with the Western Australian Government for mapping the Carnarvon Basin (50,000 square miles) and the Fitzroy Basin (80,000 square miles). The mapping of these two basins was completed in 1952. Under the same agreement the Canning Basin was mapped in 1952 to 1958. Similar arrangements with the Queensland Government has enabled the Bureau to map the Great Artesian Basin in Queensland which is still in progress.

(5) Geophysical Surveys:

(a) General. The general remarks made under the heading "Geological Surveys" apply also to Geophysical Surveys. Geophysical data are required for many purposes and geophysical methods are used to assist in the solution of many problems. The fundamental principles involved in geophysical investigation of engineering and military problems are the same as those involved in many types of mineral investigation, hence the same instruments and similar methods may be used in both types of work.

Whilst the activities of the Geophysical Branch are primarily directed towards mineral investigation and other problems in applied geophysics it is impossible to draw any hard and fast line between such work and determination of the basic data upon which their successful application ultimately depends. Hence the carrying out of regional magnetic and gravity surveys of Australia and its Territories are basic to the other operations of the Branch. In addition to other uses, this data is essential for the preparation of navigational and geodetic maps, and there is a continual demand for it from civil and military organisations and from private geophysical companies which come to this country under contract to the various mining and oil groups.

The operations of observatories is inseparable from the carrying out of this function, and it was for this reason that the Department of Terrestrial Magnetism of the Carnegie Institution of Washington agreed to hand over the Watheroo Magnetic Observatory in Western Australia to the Bureau in July 1947. (This transfer was arranged by exchange of letters between the Prime Minister and the President of the Institution).

The Bureau operated the Watheroo Observatory until 1959 when it was relocated at Mundaring in W.A. Other observatories operated by the Bureau are at Rabaul (vulcanological), Melbourne, Toolangi, Darwin, Port Moresby, Mawson, Wilkes and Macquarie Island.

(b) Sedimentary Basins. The objective of geophysical surveys of sedimentary basins is to assist in the search for deposits of coal, petroleum, natural gas, underground water, etc. and although these investigations form part of the mineral resources work of the Bureau, they are appropriately referred to here because they are regional in character. Delicate gravity, magnetic and seismic instruments are used to outline rock structures beneath the surface, and thus indicates places favourable for the accumulations of mineral deposits, such as those indicated above. In 1946 geophysical methods were responsible for the discovery of about half of the oil found each year in the U.S.A. These methods have also been used successfully by the Bureau in Australia and are making valuable contributions to exploration for coal deposits at Collie (W.A.), Blair Athol (Q'ld.), Oaklands (N.S.W.) and Latrobe Valley (Vic.) and in the search for oil in the Surat Basin and Perth Basin.

(6) Sedimentary Basins Studies:

In order that the Commonwealth Government be properly informed of the progress of petroleum exploration and of the development of prospects in all sedimentary basins in Australia and Papua - New Guinea, the Government decided in 1962 to establish within the Bureau of Mineral Resources a Subsurface Section consisting of (i) Sedimentary Basins Study Group, and (ii) Core and Cuttings Laboratory.

The Sedimentary Basins Study Group collects, catalogues and examines as much available information as possible on each sedimentary basin, and collates the information, re-interprets the basic data where necessary, and prepared a review of the petroleum geology.

The Basins Study Group is assisted by the Core and Cuttings Laboratory which was dealt with above under 1 (d) "Laboratory Investigations".

(7) Publications:

An important part of the Bureau's functions is the publication of results of its surveys and investigations, and surveys carried out by private enterprise under subsidy for petroleum search. This is achieved by publishing :

(i) Bulletins - Bulletins are confined to reports on investigations, or on particular phases of investigation, regarded as complete; or reports on comprehensive investigations that may not be complete but that are not likely to be continued at an early date.

By October, 1966 the Bureau has published 88 Bulletins, of which 11 are with the printer.

(ii) Reports - Reports include the results of important preliminary investigations, or some phase of a major investigation, the results of which it is desirable to publish as soon as possible, either because the particular phase is of immediate interest or because the investigation of which it forms a part might not be complete for several years.

By October, 1966 the Bureau has published 120 Reports, of which 17 are with the printer.

(iii) Petroleum Search Subsidy Acts Publications - Petroleum Search Subsidy Acts Publications record the results of operations subsidized under the Petroleum Search Subsidy Acts 1957-58, 1959-61, and 1962-65. Publications in this series are reports on stratigraphic drilling operations, geophysical surveys and borehole surveys.

By October, 1966 the Bureau has published 81 P.S.S.A. reports, of which 14 are with the printer.

(iv) Summary Reports - Summary Reports deal with individual minerals and/or metals and are designed to provide a summary of information concerning their sources, uses, production, consumption, prices and trade.

So far the Bureau has published 43 Summary Reports. But these Reports have now been superseded by the publication of Bulletins 72 and 81.

(v) Pamphlets - Pamphlets set out information of use to prospectors, miners and the public on prospecting, treatment or marketing of minerals.

So far the Bureau has published 4 pamphlets.

(vi) Pictorial Index of Activities - The Pictorial Index of Activities illustrates on index maps the field activities of the Bureau in Australia and its Territories. The Index has been produced ~~three~~ four times - in 1961, 1962-63, ~~and~~ 1964, 1965 ~~Activities for 1965 is with the printer~~.

(vii) Records - Records are not strictly publications, but they are typewritten or mimergraphed documents which set out the preliminary results of an investigation or the more important internal papers on specific subjects. They are not produced in large numbers as they are intended primarily to disseminate information as quickly as possible to the mineral industry and interested individuals. To this end certain Records are available on loan or for copying at centres in capital cities in Australia and New Guinea and these Records are listed in a circular at quarterly intervals.

So far the Bureau has produced about 3,000 Records, of which about 500 are available for loan or copying in centres throughout Australia and about 750 are available in Canberra to the public.

(viii) The Australian Mineral Industry, Quarterly Review - The Australian Mineral Industry, Quarterly Review contains a feature article covering some aspect of the mineral industry, a current review of metals and minerals, current metal and mineral prices, and production, import and export statistics. It has been produced since 1948.

(ix) The Australian Mineral Industry, Annual Review - The Annual Review is presented in three parts - general review of the industry, review by individual metals and minerals, and general statistics review. The Annual Review has been produced since 1948.

(x) Maps - Maps are produced at various scales depending on their purpose. Maps which accompany Reports and Bulletins are generally on scales smaller than 1:250,000, but they may include some 1:250,000 scale maps produced in black and white which in the case of geological maps are preliminary maps to those produced later in colour and issued separately with Explanatory Notes.

The coloured 1:250,000 geological maps issued with Explanatory Notes correspond to the Australian National Map Index. So far the Bureau has published 66 1:250,000 geological maps in the Explanatory Notes Series.

For areas of exceptional interest and where detailed surveys have been carried out maps are produced either in colour or black and white at scale of 1: 50,000 or greater.

The Bureau has published special maps of Australia such as the Tectonic Map at scale of 1:2,534,400 and maps at scale of 1:6,000,000 depicting the geology, mineral deposits and mineral industry for the Atlas of Australian Resources.

A Petroleum Tenements Map of Australia and the Territory of Papua and New Guinea is revised and published twice yearly.

Geophysical maps are also produced to show the results of magnetic, radiometric and gravity surveys; these maps do not constitute a formal series but are published in a format appropriate to the different surveys.

A summary of the petroleum exploration activities in Australia and the Territory of Papua and New Guinea is produced each quarter in a Petroleum Newsletter.

(8) Comments on activities at present listed, but not now being carried out , or to a limited extent, by the Bureau.

1. "When specifically directed by Cabinet undertake the mining, treatment, purchase, sale or control of any mineral" - Function '8) on Attachment 1.

Past activities in this category would be:-

(i) the alluvial tin mining at Dorset in Tasmania where the Bureau successfully operated a tin dredge.

(ii) the uranium mining of White's deposit at Rum Jungle and George Creek deposit in the Northern Territory.

(iii) the monazite beach sand deposits at Southport, Queensland.

2. "-undertake research into mining, ore-dressing and petroleum technology, fuels etc." - Function (4) on Attachment 1.

The Bureau is engaged to a limited extent in research into mining and petroleum technology, but it does not carry out research into ore-dressing and fuels which are now the responsibility of C.S.I.R.O. (ore-dressing) and Division of Fuel, Department of National Development (fuels).

(9) Specific projects which the Bureau has been authorised to carry out.

(i) Phosphate survey (1957 - 1960) in the South-West Pacific and Australian Waters by the Australian Government.

(ii) Phosphate survey of Christmas Island (1965) - by the British Phosphate Commissioners.

(iii) Bauxite survey (1945 - 1952) - by the Australian Aluminium Production Commission.

(iv) $300,000 special mineral survey in the Northern Territory (1963) - by the Department of Territories.

(v) Manganese survey in W.A. (1957 - 1958) - assistance to the W.A. Department of Mines.

(vi) Assessment of iron ore reserves in the Pilbara and Hammersley areas, W.A. (1961) - by Minister, Department of National Development.

(vii) Assessment of iron ore reserves at Mt. Bundey and Francis Creek (1964-65) - by Administrator, N.T.

The projects listed above could be regarded as activities carried out by the Bureau which are rather deeper or more detailed than the basic survey role.

APPENDIX 2

PROGRESS OF STAFF ~~APPOINTMENTS~~ ESTABLISHMENT IN THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Year	Professional	Non Professional	Combined Establishment
1946	55	?	?
1947	55		
1948	100		
1949	100		
1950	102	96	198
1951	127	173	300
1952	163	104	267
1953	181	120	301
1954	195	172	367
1955	196	194	390
1956	204	202	406
1957	204	203	407
1958	205	203	408
1959	207	206	413
1960	242	228	470
1961	244	226	470
1962	280	277	557
1963	281	278	559
1964	281	278	559
1965	281	288	569

APPENDIX 3

LIST OF OVERSEAS VISITS BY BUREAU OFFICERS

(not necessarily complete,
e.g. does not include Director's visits)

Year	Name of Officer	Country Visited	Purpose of Visit
1946	R.F. THYER	U.S.A.	Study tour and purchase of seismic equipment.
1947	N.H. FISHER	U.S.A. Canada	A.I.M.E. Meeting. Visit asbestos mines Quebec, ilmenite New England, beach sand deposits and phosphate Florida U.S.G.S, Canadian Geological Survey.
1948	N.H. FISHER	U.K.	International Geological Congress.
1949	R.F. THYER	New Zealand	Pacific Science Congress.
1950-51	R.F. THYER	India	Indian Ocean Science Congress.
1951	M.A. CONDON	India	Pan-Indian Ocean Science Congress.
1951	I. CRESPIN	U.S.A.	Study Micropalaeontology and visit palaeontological laboratories.
1952	I.C.H. CROLL	U.S.A. and U.K.	International Materials Conference.
1952	K.R. VALE	New Zealand	D.S.I.R. Conference on Seismology.
1953	C.J. SULLIVAN	U.S.A., Canada, South Africa	Study of major ore deposits.
1953	N.H. FISHER	Japan	E.C.A.F.E. Conference.
1954	R.F. THYER	Italy (Rome) U.K., U.S.A.	4th World Petroleum Congress
1956	M.A. CONDON	U.S.A.	Oil exploration techniques.
1956	N.H. FISHER	British Solomon Islands	Discussions on phosphate search.
1956	A.H. DEBNAM	U.K., U.S.A., Canada	Developments in geo-chemical prospecting

16.	1957	K.R. VALE	U.S.A.	Study recent advances in seismic methods.
17.	1957	A.A. OPIK	Mexico	20th International Geological Congress
18.	1957	W.M.B. ROBERTS	U.K. and U.S.A.	X-ray diffraction and X-ray fluorescent spectrometry studies.
19. & 20.	1957	L.C. NOAKES and E.K. CARTER	New Zealand	32nd meeting of A.N.Z.A.A.S.
21.	1957	R.F. THYER	U.S.A., France Germany, U.K.	International Gravity Commission
22.	1958	N.J. MACKAY	Canada and U.S.A.	6th Empire Mining and Metallurgical Congress.
23.	1958	H.S. TAYLOR-ROGERS	India New Delhi	1st E.C.A.F.E. Petroleum Symposium.
24.	1958	J.H. MORGAN	Geneva	Lead Zinc Study Group
25.	1958	N.G. CHAMBERLAIN	India	E.C.A.F.E. Symposium on Petroleum Resources Development.
26.	1959	J.N. CASEY	U.S.A., Canada	Study petroleum Industry.
27.	1960	J.H. QUILTY	Bangkok	E.C.A.F.E. Seminar on aerial survey methods and equipment.
28.	1960	D.O. ZIMMERMAN	U.S.A.	Study trends in mineral exploration
29.	1960	J.H. MORGAN	Geneva	Lead Zinc Study Group.
30.	1960	J.C. DOOLEY	France, Holland U.K. Belgium U.S.A.	Investigate the processing of geo-physical data by automatic computing machines.
31.	1961	W.J. PERRY	U.S.A.	Observations on photogeology.
32.	1961	J.H. MORGAN	Mexico City	Lead Zinc Study Group.
33.	1961	M.A. REYNOLDS	U.S.A.	Study trends in the oil industry.
34.	1961	E.R. SMITH	U.S.A.	Seismic equipment and progress in seismic methods.

35. 1961	D.A. WHITE	Greece and Italy	Symposium of the International Association of Scientific Hydrology on "Groundwater in the arid zones" (Greece). International Association of Vulcanology Symposium on Ignimbrites and Hyaloclastites (Italy).
36. 1962	W.D. PARKINSON	Japan	International Conference on Cosmic Rays and the Earth Storms
37. 1962	J.H. QUILTY	U.S.A. and Canada	Study Methods of aeromagnetic interpretation.
38. 1962	J.G. BEST	Malaya	Tour of Malayan tin-mining areas.
39. 1962	H.S. TAYLOR-ROGERS	Tehran	2nd E.C.A.F.E. Petroleum Symposium
40. 1962	E.J. MALONE	Sumatra and Middle East	Study geological and geophysical techniques employed in oil exploration.
41. 1962	R.F. THYER	Canada	SEG International, Calgary.
42. & 43.	C.D. BRANCH and G.A. TAYLOR	Japan	International Symposium on Vulcanology
44. 1962	K.R. VALE	Tehran	E.C.A.F.E. Symposium on Development of Petroleum Resources.
45. 1962	J.H. MORGAN	Geneva	Lead Zinc Study Group.
46. 1963	C.S. ROBERTSON	Europe and North America	Study seismic noise and large-scale seismic refraction work.
47. 1963	A. TURPIE	U.S.A.	Training in the operation and maintenance of seismic equipment which was being purchased by BMR.
48. 1963	B.P. WALPOLE	Bangkok	E.C.A.F.E. Symposium on geochemical prospecting.
	P.R. DUNN	Canada	Study tour with Canadian Geological Survey.
49. 1963	J.H. MORGAN	Geneva	Lead Zinc Study Group.
50. 1963	J.E. THOMPSON	U.S.A.	Study of oilfield geology.
51. 1963	W.J. LANGRON	Japan	Training in the use of gravity pendulum apparatus.

52.	1963	M.A. CONDON	Europe	World Petroleum Congress.
53 & 54.	1963	McLEOD, I.R. and D.C. TRAIL	South Africa	SCAR Symposium on Antarctic Geology.
55.	1963	E.K. CARTER	U.S.A., U.K., France, Italy	Engineering Geology Study Tour Technical Mission Atomic energy.
56.	1963	J.A. BROOKS	Hawaii and California	10th Pacific Science Congress.
57.	1963	K.G. SMITH	U.S.A.	Study techniques in oil exploration.
58.	1964	J.M. DICKENS	India and Pakistan	22nd International Geological Congress New Delhi Geological Survey Calcutta visit. Visit Geological Survey Pakistan.
59.	1964	W.M.B. ROBERTS	U.K. and Europe	Inspection of spectrographic equipment.
60.	1964	D. O'DRISCOLL	Madrid London	Lead Zinc Study Group International Tin Council
61.	1964	A.J. BARLOW	Europe and U.S.A.	Study developments in geophysical methods and instrumentation used in oil exploration.
62.	1964	K.A. TOWNLEY	India	International Geological Congress.
63.	1964	P.R. EVANS	India, France, Holland, U.K. U.S.A.	Techniques related to oil exploration.
64.	1964	L. PRIOR	U.S.A.	I.U.G.G.
65.	1965	A.J. FLAVELLE	U.S.A. and Canada	Latest developments in gravity interpretation.
66.	1965	H.S. TAYLOR-ROGERS	Japan	3rd E.C.A.F.E. Petroleum Symposium.
67.	1965	D. O'DRISCOLL	Geneva	Lead Zinc Study Group
68.	1965	N.H. FISHER	Geneva	Iron ore market study group (UNESCO)
69.	1965	N.H. FISHER	New Zealand	International Symposium on Vulcanology.

70.	1965-66	K.B. LODWICK	U.S.S.R. Persian Gulf	Sedimentary Basins Study.
71.	1966	J.A. BROOKS	New Zealand	3rd World Conference on Earthquake Engineering.
72.	1966	R.J. SMITH	U.S.A. and Canada	To study developments in metalliferous geophysical techniques.
73.	1966	R.F. THYER	Japan	Pan Pacific Science Congress
74.	1966	Z. KALIX	Canada	Visit producers of industrial minerals.
75.	1966	N.H. FISHER	Bangkok	E.C.A.F.E. meeting Senior-Geologists Working Committee.
76.	1966	D. O'DRISCOLL	Geneva	Lead Zinc Study Group
77.	1966	J.M. RAYNER	U.S.A., U.K. Europe	Visit overseas authorities
78.	1965-66	P.J. JONES	U.K., and Europe	Study conodonts
79.	1966	T. QUINLAN	U.S.A.	Study use of Computers in geological work.
80.	1966	P. CROHN	Canada	Study base metal developments. (Exchange visit with Dr. K. Eade, Canadian Geological Survey).
81.	1966	H.G. ROBERTS	South Africa Rhodesia	Study Precambrian
82.	1966	R. VINE	U.S.A. and Canada	Study oilfield exploration and laboratory techniques.
83.	1966	A. WELLS	U.S.A. Iran	Study basis with similar environment and age to Amadeus Basin.
84.	1966	F. LEPINE	Canada France	Visit Alberta oil and gas fields to study recent developments.
85. & 86.	1967	J.N. CASEY & K.R. VALE	U.S.A.	7th World Petroleum Congress.
87.	1967	K.M. KENNEDY	Canada U.S.A. U.K.	Organisational structure and techniques of publications and information services.
88.	1967	J. D'ADDARIO	Europe	Studies in Vulcanology.
89.	1967	J. HAYS	U.S.A. Canada	Oil Symposia and Geochemical Techniques.

APPENDIX 4

SPECIALISTS ENGAGED BY THE BUREAU

(not necessarily complete)

	YEAR	OFFICER'S NAME	PURPOSE
1.	1948	Dr. D.E. Thomas	Study graptolites from the A.C.T.
2.	1948	Dr. C. Teichert	Petroleum studies N.W. Basin of W.A.
3.	1950	Dr. D. Hill	Study Upper Palaeozoic coral from Kimberleys.
4.	1950	Dr. R.W. Fairbridge	Review of stratigraphic nomenclature
5.	1952	Mr. J. Beattie	Study Permian bryozoa from N.W. Basin (Kimberley area)
6.	1953	Mr. J. Finch	Mica in Harts Ranges, Northern Territory
7.	1953	Mr. B. Allen	Uranium exploration
8.	1954 -1957	Mr. R.J. Frost	Vulcanological observer New Hebrides
9.	1955	Mr. J. Byrne	Vulcanological observer British Solomon Islands Protectorate.
10.	1955	Dr. J.P. Webb	Seismological work, Rabaul.
11.	1956	Dr. B. Breyer	Origin of uranium mineralization
12.	1957	Dr. D. Hill	Determination corals in Broken River area, northern Queensland.
13.	1958 -1961	Dr. L.M. Baas-Becking	Geobiology research
14.	1959	Mr. C.E. Carter	Examination of slide material of fossil woods.
15.	1959	Mr. P.B. Nye	Consulting editor Geophysical Branch
16.	1960	Mr. L.M. Fraser	Publication of a Bulletin on Statistics of production, imports and exports of minerals.
17.	1961	Mr. G.M. Philip	Description of Bureau's collection of crinoids and echinoids.
18.	1961 to 1966	Dr. I. Crespin	Palaeontological research, preparation of catalogue of fossil types.
49.	1962	Dr. M. Bik	Geomorphology, northern Queensland.
20.	1963	Dr. R.H. Tedford	Examination Tertiary outcrops central Australia for fossil remains.

21.	1964	Dr. C. Phipps	Marine sediment sampling - Gulf of Carpentaria
22.	"	G.H. Davies	Collection of bottom samples on cruise of H.M.A.S. Diamantina Perth to Darwin.
23.	"	Dr. A.A. Opik	Study of Lower Palaeozoic fossils
24.	"	Mrs. M. White	Determination of Fossil plants
25.	"	Dr. K. Crook	Study sedimentary petrology and structures of sections in basin
26.	"	Mr. R. Day	Study Mesozoic macrofossils from Great Artesian Basin.
27.	"	Dr. I. Crespin	Catalogue of Permian faunas.
28.	"	Dr. S.R. Taylor	Assist during working up of the automatic optical spectrograph to routine operation.
29.	"	Dr. C. Rann	Assist laboratory staff in atomic absorption techniques.
30.	"	Professor White	Metallurgical research into tin ore treatment N. Queensland .
31.	"	Dr. K. Crook	Study of Ordovician Stairways Sandstone near Alice Springs.
32.	1965/66	Dr. I. Crespin	Compilation of a Catalogue of fossils held by BMR.
33.	"	R. Day	Continuation of a study of Mesozoic macrofossils from Great Artesian Basin.
34.	(1958/66)	Mrs. M. White	Report on plant fossil collections
35.	1965/66	Dr. A.A. Opik	Palaeontological studies of lower Palaeozoic of N. Queensland.
36.	"	Dr. Sheldon	Assist in formulation of a long-range programme of phosphate exploration on Australian mainland.
37.	"	Dr. van Andel	Assist in formulation of a long-range programme of phosphate exploration on offshore areas of Australia.

38.	1965/66	McPhar Geophysics	Participation of the Bureau in a programme of investigation being conducted by McPhar into certain aspects of the interpretation of I.P. Surveys.
39.	"	Dr. C.G. Adams	Specialist micropalaeontologist Australian Foraminifera.
40.	1967	S. Lohman (U.S.G.S.)	Groundwater

SUBJECT AND TOTALS OF BUREAU BULLETINS, REPORTS AND RECORDS, UP TO - SEPTEMBER, 1966

Listed below are the subjects dealt with in the Bulletins, Reports and Records of the Bureau together with the totals.

Note:- Some publications and records are listed under more than one heading as they deal with more than one subject.

SUBJECT	Bulletins	Reports	Records
ACTIVITIES - Summaries	-	-	92
CHEMISTRY	2	1	12
CONFERENCES AND SYMPOSIA	-	-	21
EARTHQUAKES	-	1	11
GEOCHEMISTRY	3	3	44
GEOCHRONOLOGY	2	1	7
GEOLOGY - General	-	-	10
GEOLOGY - Engineering	-	-	92
GEOLOGY - Metalliferous	18	21	521
GEOLOGY - Sedimentary	12	32	257
GEOLOGY, Laboratory - Biochemistry and Metalliferous	-	-	17
GEOLOGY, Laboratory - Macropalaeontology	27	6	132
GEOLOGY, Laboratory - Micropalaeontology	8	4	304
GEOLOGY, Laboratory - Petrology	3	1	91
GEOMORPHOLOGY	-	-	8
GEOPHYSICS - General	-	-	10
GEOPHYSICS - Engineering	-	1	168

	Bulletins	Reports	Records
GEOPHYSICS - Gravity	4	6	96
GEOPHYSICS - Laboratory	-	1	32
GEOPHYSICS - Magnetics	3	24	290
GEOPHYSICS - Metalliferous	3	6	297
GEOPHYSICS - Observatories	-	8	41
GEOPHYSICS - Sedimentary	3	8	149
GEOPHYSICS - Seismic	2	3	211
GLACIOLOGY	1	-	13
HYDROLOGY - Geology	-	-	68
HYDROLOGY - Geophysics	1	1	19
INFORMATION RETRIEVAL	-	-	4
MINERAL RESOURCES	9	1	70
OCEANOGRAPHY	1	-	5
OVERSEAS VISITS	-	-	26
PALAEOGEOGRAPHY	-	-	2
PALAEOMAGNETISM	-	-	1
PALYNOLOGY	-	-	22
PETROLEUM EXPLORATION	5	23	222
PHOSPHATE	1	1	25
PHOTOGEOLOGY	-	-	13
RADIOACTIVE MINERALS - Geology	1	-	119
RADIOACTIVE MINERALS - Geophysics	-	1	155
RESIDENT GEOLOGISTS	-	-	19
STRATIGRAPHY	2	4	31
VULCANISM AND RELATED PHENOMENA	1	2	50
GRAND TOTALS (as at September, 1966)	112	160	3777

DETAILS OF B.M.R. EXPENDITURE (in $'000)

from 1950/51 to 1966/67

APPENDIX 6

Financial Year	Salaries	Administrative Expenses		Field Operations		Capital Works and Services	Other Services	Oil Subsidy	Total Expenditure	
		Other than Publications	Publications	Contract Investigations	Total including Contracts				Including Oil Subsidy	Excluding Oil Subsidy
1950/51	333	38	5	Nil	188	312	-	-	876	876
1951/52	452	38	5	"	437	660	26	-	1,621	1,621
1952/53	553	38	7	"	798	203	-	-	1,600	1,600
1953/54	592	43	7	"	629	225	-	-	1,526	1,526
1954/55	630	77	13	"	593	221	-	-	1,536	1,536
1955/56	817	78	19	"	790	450	-	-	1,105	2,105
1956/57	907	92	25	"	742	180	-	-	1,946	1,946
1957/58	991	124	22	"	981	178	-	527	2,825	2,298
1958/59	1,007	135	30	"	794	142	2	926	3,038	2,112
1959/60	1,164	150	33	296	1,096	185	2	719	3,352	2,633
1960/61	1,281	194	54	414	1,275	251	53	2,798	5,902	3,104
1961/62	1,458	228	79	388	1,629	198	80	5,086	8,758	3,672
1962/63	1,645	274	32	890	2,146	388	29	10,000	14,515	4,515
1963/64	2,268	268	78	1,102	2,314	376	2	9,500	14,741	5,241

Financial Year	Salaries	Administrative Expenses		Field Operations		Capital Works and Services	Other Services	Oil Subsidy	Total Expenditure	
		Other than Publications	Publications	Contract Investigations	Total including Contracts				Including Oil Subsidy	Excluding Oil Subsidy
1964/65	2,371	268	102	996	1,964	326	2	8,937	13,873	4,936
1965/66	2,223	381	100	1,050	2,053	320	18	11,381	16,478	5,097
1966/67 (Est.) (Vote)	2,372	315	100	1,300	2,354	460	2	11,900	17,504	6,504

LIST OF ATTACHMENTS TO ACCOMPANY NOTES ON THE FUNCTIONS OF THE BUREAU OF MINERAL RESOURCES

ATTACHMENT 1 : Statement of functions of the Bureau of Mineral Resources, Geology and Geophysics, as has been accepted.

ATTACHMENT 2 : Functions of Bureau of Mineral Resources as approved by Cabinet Sub-Committee (Agendum No. 14) on 20th March, 1946.

ATTACHMENT 3 : Terms approved by Cabinet (Agendum No. 1280) on 21st December, 1946, for Bureau of Mineral Resources to work in Territory of Papua-New Guinea.

ATTACHMENT 4 : Exchange of letters in 1949 between Premier Queensland and Commonwealth Prime Minister on joint mineral survey of North Queensland.

ATTACHMENT 1.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

STATEMENT OF FUNCTIONS

The functions of the Bureau of Mineral Resources, Geology and Geophysics may be broadly stated as follows:-

To investigate and carry out exploration for mineral deposits, to survey and assess the mineral resources of the Commonwealth and its Territories and promote their development, to interpret the results of completed surveys and recommend ways of remedying or meeting mineral deficiencies that may become apparent and advise on all aspects of the mineral economy of Australia; to carry out geological and geophysical surveys and investigations, and to advise on all aspects of applied geology and geophysics. To discharge these functions the Bureau will be required to -

(1) Make geological surveys and investigations, and carry out research relating thereto.

(2) Make geophysical surveys and investigations, and carry out research relating thereto; obtain basic data by maintaining geophysical observatories and by carrying out regional magnetic and gravity work.

(3) Supplement geological and geophysical investigation by drilling or other means.

(4) Make technical and technological surveys of the mineral industry, carry out investigations and undertake research into mining, ore-dressing, petroleum technology, fuels, etc.

(5) Make economic investigations into the mineral industry, including production, consumption, prices, trade trends, etc., and maintain statistics relating thereto.

(6) Provide technical and technological advice to the mineral industry.

(7) Furnish advice to the Government on scientific, technical and administrative aspects of the mineral industry.

(8) When specifically directed by Cabinet undertake the mining, treatment, purchase, sale or control of any mineral, and for this purpose obtain and maintain equipment.

(9) Maintain necessary libraries, equipment, laboratories, museums and workshops; prepare and publish reports, maps, and plans relating to the above functions.

The foregoing functions will be exercised with particular reference to the defence and economic development of the Commonwealth and, where necessary, in co-operation with Commonwealth and State Departments, especially State Mines Departments.

COMMONWEALTH BUREAU OF MINERAL RESOURCES
FUNCTIONS

As set out by Cabinet Sub-Committee on Secondary Industries approved Agendum No. 14/1946, Supplement No. 1 on 20th March, 1946.

(i) To make recommendations to the Commonwealth Mining Industry Committee on mining policy in general, with special reference to the defence requirements and economic development of the Commonwealth.

(ii) To prepare, in co-operation with the State and Territorial mining authorities, an overall programme of mining development, exploration and conservation of the whole Commonwealth.

(iii) To undertake in co-operation with the State and Territorial mining departments, geological and geophysical surveys and other work associated with exploration.

(iv) To recommend to the Commonwealth Mining Industry Committee the manner in which particular projects should be undertaken, whether -

(a) directly by the Commonwealth;

(b) as a joint Commonwealth-State venture - and in this case the extent of the Commonwealth's responsibility; or

(c) as a State project, and in this case, the extent to which the Commonwealth should provide financial assistance and the conditions under which such assistance should be given;

(v) To examine applications for loans from private ventures, to make such technical investigations as may be necessary either independently or in conjunction with the State mining authorities, and to recommend to the Commonwealth Mining Industry Committee the conditions under which loans should be made, the terms of repayment and the rate of interest.

(vi) To take such action as may be necessary to ensure that the funds provided by the Commonwealth, as set out in the two preceding paragraphs (iv) and (v), are expended in accordance with the conditions laid down.

(vii) To provide technological and technical advice to the industry and to undertake geological, geophysical and other forms of research;

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

(ix) To undertake such further investigations as may be required by the Commonwealth Mining Industry Committee.

TERRITORY OF PAPUA-NEW GUINEA

GEOLOGICAL AND GEOPHYSICAL SURVEYS

Before 1942 the New Guinea administration employed two Geologists and a Vulcanologist but there was no Geological staff in the Administration of the Territory of Papua. The Mineral Resources Survey (now Bureau of Mineral Resources Geology and Geophysics) of the Commonwealth Department of Supply and Shipping functioned in an advisory capacity to both New Guinea and Papua in regard to petroleum prospecting and development and was actively associated with field work in Papua. Otherwise the Administrations functioned as independent units in regard to Geological matters.

Discussions as to the appropriate way in which Geological and allied work should be performed in the Territories in future have taken place between the Director and officers of the Bureau of Mineral Resources, the Department of External Territories and the Administrator of Papua-New Guinea. Out of these discussions it is evident that it would be to the advantage of the Territory to have its Geological work associated with and supervised by the special branch of the Commonwealth Service which has been established to perform such duties in relation to the Commonwealth itself. In arriving at a suitable working basis two major points have been kept in view.

(1) That to ensure maximum efficiency and continuity of service it is desirable that the technical oversight of geological and geophysical activities should be brought under the Commonwealth's permanent geological and geophysical organisation, which is the Bureau of Mineral Resources in the Department of Supply and Shipping.

(2) That Officers appointed for service in the Territory of Papua-New Guinea should be responsible to the Administrator from the point of view of discipline and that the Administrator should be able, when necessary, to call directly upon the services of geologists and geophysicists appointed for duty in the Territory.

The matters to be covered are:

1. Normal geological work of the Territorial Administration, including examination of mining properties and new gold discoveries, geological reconnaissance etc.

2. Vulcanological observations at Rabaul and other volcanic centres as required.

3. Geophysical observations. This would include facilities for observations on terrestrial magnetism, seismology, gravity, the ionosphere, etc. and would provide important data for air navigation, oil prospecting, radio communication, and location of points of origin of earthquakes.

4. Special Geological and Geophysical investigations including oil field mapping. (These are undertakings which can only be carried out by specialists).

Cabinet approved in January, 1945, that the Bureau of Mineral Resources should be responsible for oil field mapping in Australia and its Territories.

It is recommended that -

1. The classification of the Public Service of the Territory of Papua-New Guinea make provision for the staff considered necessary to carry out the normal Geological work of the Territory including vulcanological work.

2. Technical Staff (Geologists and Vulcanologists) to be officers appointed by the Commonwealth Public Service Board to the Bureau of Mineral Resources and to be seconded to the Territorial Administration for service as officers of the Territorial Mines Department for specified periods. Officers so seconded to remain on the strength of the Bureau but whilst in the Territory to be subject to the direction of the Administrator and to make their reports to the Administrator through the Secretary for Mines. (Other staff such as Inspector of Mines etc. to continue to be appointed direct to the Administration).

3. Special geological and geophysical investigations including oilfield mapping and the establishment of a Geophysical Station (if it is decided to locate one in the Territory) to be under the direct control of the Bureau of Mineral Resources.

4. Purchase and installation of instruments to be arranged by the Bureau.

5. Expenditure on the foregoing matters to be allocated as follows -
   (1) Papua-New Guinea Administration - to meet cost of
   (i) normal Geological work of the Territories including salaries and other expenses of seconded staff - estimated annual cost is £3,000.

   (ii) instruments required for use in connection with normal Geological work of the Territory.

   (2) Bureau of Mineral Resources (Department of Supply and Shipping) - to meet cost of

   (i) all instruments other than those used in connection with the normal geological work of the Territories

   (ii) special investigations (vide recommendation 3 above).

(W.P. Ashley)
Minister for Supply and Shipping

(E.J. Ward)
Minister for External Territories

ATTACHMENT 4

Premier's Department,
Brisbane.

19th October, 1949.

EXCHANGE OF LETTERS BETWEEN PRIME MINISTER AND QUEENSLAND PREMIER ON AGREEMENT FOR BUREAU TO SURVEY IN QUEENSLAND

Ref. 49.8470 Mines.

My dear Prime Minister,

You will recall that at the Conference of Commonwealth and State Ministers in August last, during the discussion on the subject of mineral statistics, I promised to make available for the information of the Director, Commonwealth Bureau of Mineral Resources (Dr. H.G. Raggatt), data which is held in the Queensland Mines Department, which would indicate the immensity of the mineral resources of Queensland, particularly in the Far Northern and North-Western areas.

You will also recall that I suggested it was desirable to ascertain what deposits of copper, tin, gold, iron and other metals and minerals were available in Queensland, and which would lend themselves to large scale development. I also suggested that perhaps the Commonwealth Government would assist my Government to undertake a complete survey of the mineral areas of North Queensland with a view to encouraging their development on a large scale.

You very kindly informed me that you would have the suggestion examined by Dr. Raggatt, who would submit a recommendation to your Government at an early date in respect of this matter.

The information required by Dr. Raggatt has now been collated by the Mines Department, two copies of which I enclose herewith, and which it is hoped will assist Dr. Raggatt in the preparation of his submission to your Government. It will be noted that North Queensland has been taken in this case to refer to the area North of 22 degrees South Latitude, and that coal, oil-shale, petroleum and natural gas are not included in this statement.

I shall be glad if you will advise me, as early as practicable, whether it will be possible for the Commonwealth Bureau of Mineral Resources to co-operate with the Mines Department of Queensland in the manner suggested by me at the recent Conference of Commonwealth and State Ministers.

Yours faithfully,

(Sgd.) E.M. HANLON.
Premier

The Right Honourable
the Prime Minister of the Commonwealth,
CANBERRA. A.C.T.

PRIME MINISTER,

Y.373/1/1. CANBERRA, 18th November, 1949.

Dear Mr. Gair,

I desire to refer again to Mr. Hanlon's letter of 19th October, 1949, No. 49/8470 Mines (and enclosures), regarding, inter alia, the question of having a complete survey made of the mineral areas of North Queensland.

Recently considerable thought has been given to divising a programme of mineral resources investigation throughout the Commonwealth giving special attention to Defence requirements. A draft plan prepared by the Bureau of Mineral Resources is being examined by a Committee representative of the Departments of Treasury, Post-War Reconstruction and Supply and Development, who will report their findings to Cabinet, the objective being that the approved scheme will then be taken up with the States.

I agree with the statement made by Mr. Hanlon at the August conference that the great variety of demands made upon State Geological Surveys for investigations mainly of a short term nature largely precludes them from undertaking long term regional surveys.

It is recognised also that there is an increasing necessity to apply scientific methods of prospecting to the search for mineral deposits, and having regard to the statement made in the preceding paragraph, and to the fact that only a limited number of adequately trained persons are available, it is believed that the Commonwealth can best supplement the work of the States in the field of mineral exploration by having specially trained and organised teams of experts who would carry out regional investigations in a systematic manner. The regional work would include both geological and geophysical surveys and provision would be made for such surveys to be followed by testing, either by drilling or other means. It is considered further that State officers should be attached to the Commonwealth parties so as to ensure that the State will be fully informed of the work being done and be in a position to keep in touch with any more detailed work such as drilling or shaft sinking which might follow the regional investigations. Laboratory investigations ancillary to the field work might be carried out by either organisation depending upon which is better equipped for a particular type of work.

I may say that the Commonwealth has an agreement along the foregoing lines with the State of Western Australia with regard to the search for oil in that State. It is also carrying out, in co-operation with the Mines Department of New South Wales, a regional geological and geophysical investigation of the Cobar-Nymagee copper-gold province in the central part of New South Wales.

Hon. V. C. Gair, M.L.A.,
Acting Premier of Queensland,
BRISBANE. QUEENSLAND.

It appears from Mr. Hanlon's letter, and the remarks he made to me in Canberra, that he agrees that the metalliferous mineral resources of Northern Queensland might be investigated by the respective Commonwealth and State organisations along the lines I have indicated; accordingly I have directed that a detailed plan be devised for submission to the respective Commonwealth and State Ministers, based on the great amount of information which Mr. Hanlon has supplied and on information in the possession of the Bureau of Mineral Resources.

Yours faithfully,

(Sgd.) E.J. HOLLOWAY
for Prime Minister.