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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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RECORD No. 1966/59



SUMMARY OF ACTIVITIES 1963-1965

Compiled by P.M. STOTT

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PREFACE

Prior to 1963, an Annual Summary of Activities of the Bureau of Mineral Resources was included in an annual Summary of Activities published by the Department of National Development. A Summary for 1963 was issued as BMR Record 1965/199.

This year (1966) the Department intends to publish a Summary for the period 1963-1965 and this Record is the Bureau's contribution; it includes material contained in Record 1965/199. It has been compiled from Branch reports, all issued as Records, prepared for the programme meeting in November of each year. The draft was circulated to all Branches and amendments have now been incorporated.

Foreword

J.M. Rayner

In the three years under review the Australian Mineral industry has expanded at a progressively increasing rate. A number of new projects have been brought into production in the period and construction or advanced testing is under way on others. New discoveries continued to be made, encouraging more and more companies to join the search.

The industry had an overall growth rate of 5 per cent per annum during 1963 and 1964. In 1965 the growth rate increased to 9 per cent per annum. In view of the current expansion programme of the industry it is considered that an expansion rate of 10 per cent per annum will be reached in 1966 and maintained for at least the next five years. There is a very strong possibility that this expansion rate will be sustained to 1975 or longer.

Increased output which has resulted from the expansion has in part been absorbed by increased domestic requirements and in part by increased domestic requirements and in part by increased export outlets. During the first half of the period increased domestic consumption predominated and during the latter, as self-sufficiency was reached and surpassed in many commodities, the emphasis shifted to exports. It is expected that the value of exports will overtake the value of domestic consumption in the early 1970's.

In keeping with the growth of the mineral industry, and in many cases facilitating it, the Bureau of Mineral Resources has expanded its operations. Increased areas mapped each year is a significant feature of the Bureau's programme as are the increased geophysical surveys undertaken and the research investigations conducted. The number of Bureau publications, the end product of all the work of the Bureau, have accordingly shown a marked increase.

There have been no increases in Bureau staff during the period, the increased output has resulted from improved transport facilities; use of helicopters, light aircraft and jet boats, and also improved equipment. Increasing use has been made of contractor services for such operations as seismic, aeromagnetic and gravity surveys and for drilling and drafting services.

Increasing demands for geologists and geophysicists by industry have made it difficult to maintain a full staff in the Bureau. However, as it is a condition that is symptomatic of a successful and healthy industry, it is a difficulty that has been accepted philosophically.

The attached table shows the past, present and expected future behaviour of the Australian mineral industry in terms of volume of production of the major components and the overall value of its various aspects.

Production of Selected Minerals and Metals

Mine Production

	<u>Unit</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965(a)</u>	<u>1966 (b)</u>	<u>1967 (b)</u>	<u>1968 (b)</u>	<u>1969 (b)</u>	<u>1970 (b)</u>	<u>1975 (b)</u>
Bauxite	ton	69,435	15,976	29,547	354,206	783,900	1,157,789	2,000,000	3,000,000	4,000,000	4,000,000	4,000,000	5,000,000
Coal - Black	'000 tons	22,569	24,006	24,470	24,856	27,402	31,355	33,000	34,000	35,000	36,000	37,000	40,000
Brown	"	14,967	16,279	17,137	18,456	19,033	20,678	22,000	24,000	24,000	25,000	25,000	30,000
Copper	ton	109,435	95,626	106,972	112,967	104,050	89,819	93,000	97,000	120,000	130,000	135,000	180,000
Gold	'000 f. oz.	1,087	1,076	1,069	1,024	964	877	800	800	700	750	750	750
Ilmenite cons	ton	106,586	166,400	178,867	200,983	303,628	449,719	550,000	600,000	700,000	700,000	700,000	700,000
Iron Ore	'000 tons	4,355	5,342	4,843	5,515	5,669	6,642	8,000	12,000	16,000	24,000	27,000	35,000
Lead	ton	308,000	269,656	370,110	410,291	374,856	355,439	350,000	360,000	360,000	360,000	360,000	450,000
Natural Gas	'000,000 c.ft.	-	-	-	-	-	143	170	180	1,000	5,000	10,000	35,000
Petroleum, crude	'000 bbls	-	-	-	-	1,491	2,619	3,500	10,500	14,000	14,000	14,000	50,000
Rutile cons	ton	88,637	101,431	119,195	183,260	182,371	214,951	220,000	250,000	250,000	250,000	250,000	250,000
Silver	'000 f. oz.	15,215	13,059	17,554	19,642	18,427	16,800	17,000	18,000	18,000	18,000	18,000	25,000
Tin	ton	2,202	2,745	2,715	2,860	3,642	3,950	4,500	5,000	6,000	6,000	6,000	6,000
Tungsten cons (65% WO ₃)	"	1,551	2,159	1,603	1,477	1,532	1,810	2,000	2,000	2,000	2,000	2,000	2,000
Uranium oxide	"	1,150	1,400	1,227	1,084	376	n.a.p.	-	-	-	-	-	1,000
Zinc	"	317,489	311,157	337,532	351,470	344,600	347,998	350,000	400,000	400,000	400,000	400,000	550,000
Zircon cons	"	102,362	136,462	133,844	184,830	184,082	224,241	230,000	240,000	240,000	240,000	240,000	240,000
TOTAL VALUE OF OUTPUT OF AUSTRALIAN MINERAL INDUSTRY													
	000 '000 \$	469	477	511	562	667	726	795	870	930	1,000	1,100	1,700
VALUE OF EXPORTS (C)	"	158	186	188	198	254	307	350	410	480	550	620	1,000
VALUE OF IMPORTS (D)	"	199	198	213	230	246	290	260	260	270	270	270	270
VALUE OF APPARENT CONSUMPTION	"	510	489	536	594	659	709	705	720	720	720	750	970

(a) Preliminary figures

(b) projected production

(c) Includes gold production

(d) Excludes gold shipments.

INTRODUCTION

In 1965, the Bureau of Mineral Resources moved to its new building on the shores of Lake Burley Griffin. This has enabled all Branches of the Bureau to operate under one roof for the first time since it was established in 1946. The transfer of the Geophysical Branch from Melbourne was completed in December.

The summary of activities for the period 1963-65 that follows is arranged under several headings. The General Section deals with the activities of the Operations, Mineral Resources, and Petroleum Exploration Branches. The section on Field Activities deals with the field operations of the Geological and Geophysical Branches, State by State; Observatories, Laboratories, and Common Services sections deal with other activities.

GENERAL

The primary function of the Bureau is to provide the basic geological and geophysical information necessary for the exploration and exploitation of the mineral (metallic, non metallic, petroleum and water) resources of Australia and its Territories. Where appropriate this is done in co-operation with State and Territorial authorities.

In support of the primary function of obtaining such basic information the Bureau conducts experimental studies and research in the sciences of geology and geophysics. Investigations are also made of the earth's magnetic and gravitational fields and in seismology and volcanology. Studies concerning mining engineering and petroleum technology are undertaken.

The Bureau is required to advise the Government on the mineral industry in both the national and international sense and also to provide and publish information relevant to the industry generally. As directed by the Government, the Bureau administers schemes for the assistance of sectors of the mineral industry.

The Bureau provides the four members of the Oil Advisory Committee, with the Director as Chairman, set up under the Petroleum Ordinances of the Territory of Papua and New Guinea, and the Northern Territory. This

Committee examines the technical aspects of applications for oil permits, licences, and leases in the Territories, and examines reports of activities of companies to ensure that conditions of permits have been fulfilled.

The Director of the Bureau is co-ordinator for the preparation of the Geological Map of Australia and Oceania, one of the series of maps being prepared under the auspices of the Commission for the Geological Map of the World. Compilation of the Geology of the four sheets covering Australia and New Guinea has been completed by the Geological Branch, and the sheets are now printed. Work on the remaining nine sheets is proceeding. The Director attended a meeting of the Commission in Paris, in November, 1965.

The Bureau advised the Policy Secretariat, as required, regarding export controls on minerals and metals for which the Department is responsible, and carried out special investigations in connection with the operation of these controls.

Operations Branch

The Operations Branch carried out functions in connection with the Bureau's scientific work, including long term and short term planning and control of programme, co-ordination of field, laboratory and publications activities, liaison, and distribution of information. Assessment of the results of field work forms an important function of the Branch. It also provided administrative services for the Bureau.

The Planning and Co-ordination Section carried out duties in connection with the programme of the Bureau, and maintained liaison with State authorities and companies on matters related to the field activities of the Bureau. Pictorial Indexes of Activities of the Bureau to 31st December each year were prepared. The Section acts as Secretariat to the Technical Committee on Underground Water (T.C.U.W.) of the Australian Water Resources Council.

During the period 1963-65 T.C.U.W. held its first meeting on 6th/7th April, 1964, in Melbourne and its second meeting on 6th May, 1965, in Sydney. Matters discussed were - financial requirements for an

accelerated 5-year programme of underground water investigations; the preparation of text and map for the "Review of Australia's Water Resources, 1963", which was published in November, 1965; legislation; publication of information; hydrogeological study of the Great Artesian Basin; the Groundwater School held in Adelaide from 29th March to 9th April, 1965; exhibition of international hydrogeological maps; central underground water library; and automatic data processing. Assistance was given to the Education Sub-Committee in preparation of a report on training of professionals and sub-professionals for underground water investigation; a report on the 1965 Groundwater School, and organisation of a Groundwater School to be held in Adelaide in 1967. The Secretary, T.C.U.W., attended meetings of the Editorial Panel of the Council's Hydrological Series publication of the Australian U.N.E.S.C.O. Committee of the International Hydrological Decade (A.U.C.I.H.D.) in connection with water activities in Papua and New Guinea for the I.H.D. programme.

The Publications and Information Section supplied information on Australia's mineral resources and geology in response to numerous enquiries. Articles on various aspects of the mineral industry and statements on Bureau activities and publications were prepared.

The outstanding publication during the period was Bulletin 72, on Australian Mineral Deposits, which was publicised in Australia and overseas and was an immediate "best-seller". The 55 chapters of Bulletin 72 are in the form of summarized studies of individual minerals or groups of minerals. The treatment is necessarily brief but the reader who wishes to know more of any particular aspect of the subject finds a guide to detailed published descriptions in the comprehensive list of references contained in the volume.

Production of the volume was a co-operative effort. The work of the Bureau's team which assembled and wrote the chapters was supplemented by data and comments received from the Mines Departments of the States and Territories. As a result the compilation represents a combined Commonwealth and States contribution to the propagation of information on the extent and variety of Australia's mineral resources.

A second printing has been ordered.

In response to an increasing number of requests from school children for information on minerals, a series of information sheets on nine minerals and one on earthquakes, were prepared for free distribution.

During the period, an open file system was started. This system is a means of making known to the public information which is contained in the Bureau's Record Series.

The results of the Bureau's field and laboratory investigations are first reported in the Record Series but as these are unpublished, and it may be several years before the information is contained in a formal publication, the open file system provides a useful function in the interim period.

The open file system involves placing copies of each unclassified Record in the Bureau's Canberra library and at the State and Territory Mines Departments in each capital city where they may be inspected. Short term loan is also available from the Canberra office; copies may be made if required.

An open file Circular is printed and widely distributed to all interested parties whenever a group of Records is lodged in the system. Five Circulars were issued during 1963-65 and another issue dated July, 1966 has subsequently been printed. There are now 674 Records on open file and 214 Reports of the Aerial Geological and Geophysical Survey of Northern Australia.

A policy of continual improvement in publications has resulted in improved typography on the covers and title pages of Reports and P.S.S.A. Publications.

Expenditure on publications during the three years totalled \$270,000 rising from \$79,000 in 1963 to \$100,000 in 1965.

The Bureau maintains a comprehensive technical library of publications on geology and related subjects. The annual intake of serials is 2,400 titles and there are about 6,000 monographs.

In addition to an extensive exchange of publications with other equivalent organizations in Australia and overseas, the library has an annual procurement vote of about \$16,000.

When the Branches of the Bureau came together in 1965 the three existing libraries were amalgamated. The floor space occupied by the library is over 5,000 square feet; additional space is provided for archival storage.

The Administrative Section provided services in the fields of finance, staff, accommodation, stores, transport, and the like. The organization of the move to the new building occupied much of the Section's time during 1965.

Mineral Resources Branch

The Mineral Resources Branch is concerned largely with those aspects of the Bureau's work which involve study of the mineral industry as a whole or by sectors, the collection of relevant information, and the preparation of advice and reviews for the Government, the Industry, and the public.

In the Mineral Economics Section, field work in the programme of commodity studies was concerned with gold, aluminium, mineral sands, base metals and certain industrial minerals such as asbestos, barite, salt, sillimanite, and talc.

A continuing liaison was maintained with other Branches and Departments on most aspects of the mineral industry. Papers were examined and prepared in connection with several international organizations, including GATT, ECAFE, International Tin Agreement, U.N. Tungsten Committee, and the International Lead - Zinc study group.

Each year the Annual Review of the Australian Mineral Industry was prepared and four issues of the Quarterly Review were published. Monthly bulletins of copper, lead and zinc statistics, and monthly price sheets of metals and minerals were issued. Work was completed on Bulletin 81 - 'Australian Mineral Industry: Production and Trade 1842 - 1964'; this volume complements Bulletin 72 and is expected to be equally popular when available.

Particular subjects dealt with by the Mining Engineering Section included the operation of the Gold Mining Development Assistance Act, bauxite reserves, and processing of applications for permission to export iron ore and manganese ore. Advice on various other technical matters in the fields of mining, ore dressing, and primary metallurgy was given as required.

The Section also co-ordinated the sponsorship of research and analytical projects at the Australian Mineral Development Laboratory by interested Commonwealth Departments and Authorities in connection with the Commonwealth Government's financial guarantee to the Laboratory. The final report on an electrolytic refining cell for crude bismuth from tailings at Tennant Creek was received. Work on a survey of mineral resources in tailings dumps in Australia continued on dumps in Queensland, New South Wales, Tasmania, and Western Australia. The laboratory work for this survey is also being carried out at the Australian Mineral Development Laboratories.

Other metallurgical test work sponsored by the Section at AMDEL was in connection with Jervois Range sulphates and Hatches Creek tungsten ore. A project on North Queensland tin ore was carried out by the Mineral Industry Research and Testing Service of the University of Queensland.

The Petroleum Technology Section dealt with various technical and scientific matters in connection with 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, and has been Convenor/Secretary since October, 1962.

The Chief Petroleum Technologist attended several meetings with State Attorneys-General and Under Secretaries for Mines in connection with legislation on off-shore exploration for and development of petroleum. Agreement was reached and the terms were announced by the Minister in November, 1965.

The Chief Petroleum Technologist was the leader of the Australian Delegation at the Third Symposium on the Development of Petroleum Resources of Asia and the Far East organized by the ECAFE Committee on Industry and Natural Resources from 10th to 20th November 1965 in Tokyo, Japan.

An officer of the Section attended as the Australian representative the Seminar on the Development and Utilization of Natural Gas Resources, organized between 1st and 12th December 1964 in Tehran, Iran by the ECAFE committee on Industry and Natural Resources.

The Section arranged and supervised contract drilling for stratigraphic and structural information required by the Geological Branch of the Bureau and carried out seismic shothole drilling for the Geophysical Branch.

The Section compiled statistical information on petroleum exploration and development activity in the Commonwealth and issued periodical publications such as Petroleum Newsletter; Petroleum Tenement Map and Key; List of Operating Companies, Contractors etc.; List of Wells and Footage Drilled; List of Drilling Rig Activity, etc.

The Section dealt with matters of general petroleum policy and, as the need arose, advised the government on specific problems related to such policy.

Petroleum Exploration Branch

The Petroleum Exploration Branch is concerned mainly with the Bureau's responsibilities in matters relating to petroleum exploration and associated activities in Australia, and Papua and New Guinea for the Government; the collection, collation and publication of all available data on the sedimentary basins of Australia, and Papua and New Guinea.

The Subsurface Section completed the compilation of geophysical data from the Bonaparte Gulf Basin. The review of the Otway Basin is nearing completion and a study of hydrodynamics of the Bowen and Surat Basins has commenced. A study of the Northern New Guinea - Sepik Region continued.

The Core and Cuttings Laboratory continued the storage and cataloguing cores and cuttings and examination of material from selected wells.

The Subsidy Group handles all applications for subsidy and, after technical assessment, makes recommendations to the Minister.

To encourage the search for oil in Australia and the Territory of Papua and New Guinea, the Australian Federal Government makes generous taxation provisions and has, since 1957, subsidised approved types of oil search activities as a further incentive for petroleum exploration by companies or individuals. The original Petroleum Search Subsidy Act which became law in 1957 covered only stratigraphic drilling. The 1959-1961 amendments to the Act increased its scope to cover stratigraphic drilling, off-structure drilling, detailed structure drilling, bore-hole surveys and geophysical exploration employing magnetic seismic, gravimetric or "other physical methods of obtaining information in connection with the search for petroleum in Australia". The original Act provided for a 50 percent subsidy on all operations other than off-structure drilling for which the subsidy was 66-2/3 percent.

In the 1962-1963 Budget the rates of subsidy were reduced although the total allocation for subsidy was greatly increased. This reduction in subsidy was to give the many applicants a share in the funds available. The Government then paid up to 30 per cent of the cost on approved projects for all geophysical surveys and rotary drilling, apart from off-structure drilling, for which subsidy did not exceed 40 per cent.

The Petroleum Search Subsidy Act 1959-1961 was amended in June, 1964 to become the Petroleum Search Subsidy Act 1959-1964; the new Act widened the scope of "test drilling" by amending the definition to remove the requirement that a structure must be established. It also amends the definitions to combine the "stratigraphic drilling" and "off-structure drilling" of the former Act into one category of "stratigraphic drilling" which will be subsidised at relatively higher rates than "test drilling". It also extends the scheme basically along the existing lines until June, 1968; also provision is made for the introduction of off-shore operations under the Act.

Success of the scheme is evident in all mainland States and, with the exception of Antarctica, in the Territories. Production of oil in Queensland commenced officially on March 25, 1964, marking Australia's entry into the ranks of oil producing countries. Further Australian production is planned for 1967 from Western Australia and it is likely that oil will be produced from areas off shore Victoria in the near future. Valuable occurrences of natural gas have been found in South Australia, Northern Territory, Papua, Queensland, Victoria and Western Australia. Exploitation of most of these occurrences is expected to commence before 1970. Tables 1-6 show the applications dealt with during the three financial years 1962-1965.

TABLE ISTATUS OF APPLICATIONS, YEAR 1962-63

<u>Category</u>	<u>Approved</u>	<u>Refused</u>	<u>Withdrawn</u>	<u>Total</u>
<u>Drilling</u>				
Stratigraphic	34	3	-	37
Test	21	-	1	22
Off-Structure	12	1	-	13
Detailed Structure	1	-	-	1
<u>Geophysical</u>				
Seismic	64	2	1	67
Seismic/Gravity/ Magnetic	1	-	-	1
Seismic/Gravity	1	-	-	1
Gravity	12	-	1	13
Gravity/Magnetic	1	-	-	1
Magnetic	20	1	-	21
Borehole	1	-	-	1
<u>TOTAL</u>	168	7	3	178

TABLE 2STATUS OF APPLICATIONS FOR ADDITIONAL SUBSIDYYEAR 1962-1963

<u>Drilling</u>				
Stratigraphic	4	2	-	6
Test	9	3	-	12
Off-Structure	1	1	-	2
<u>Geophysical</u>				
Seismic	34	4	-	38
Magnetic	2	1	-	3
<u>TOTAL</u>	50	11	-	61

The 168 applications and 50 applications for additional subsidy, shown as approved in Tables 1 and 2, became the subsidy programme for 1962-1963 under the 1959-1961 Act.

At 30th June 1963, the total expenditure incurred or committed by the Commonwealth under the Petroleum Search Subsidy Legislation since 1957-1958 amounted to £12,614,221.

TABLE 3
STATUS OF APPLICATIONS, YEAR 1963-1964

<u>Category</u>	<u>Approved</u>	<u>Refused</u>	<u>Withdrawn</u>	<u>Total</u>
<u>Drilling</u>	-	22 ⁺	-	22
Stratigraphic	33½*	-	1	34½
Test	61	-	-	61
Off-Structure	12½*	-	1	13½
Detailed Structure	-	1	-	1
<u>Geophysical</u>				
Seismic	60	-	1	61
Seismic/Gravity/ Magnetic	1	-	-	1
Seismic/Gravity	2	-	-	2
Gravity	13	-	1	14
Magnetic	10	-	-	10
Borehole	2	1	-	3
<u>TOTAL</u>	<u>195</u>	<u>24</u>	<u>4</u>	<u>223</u>

⁺The drilling applications which were refused, or not finalized by 30th June, 1964, are not divided into categories.

*Fractions appear because three applications were approved partly as stratigraphic and partly as test drilling and one as partly test and partly off-structure drilling.

TABLE 4
STATUS APPLICATIONS FOR ADDITIONAL SUBSIDY
YEAR 1963-1964

<u>Category</u>	<u>Approved</u>	<u>Refused</u>	<u>Withdrawn</u>	<u>Total</u>
<u>Drilling</u>				
Stratigraphic	8	-	-	8
Test	15	4	-	19
Off-Structure	2	-	1	3
<u>Geophysical</u>				
Seismic	33	-	-	33
Gravity	4	1	-	5
Magnetic	1	-	-	1
<u>TOTAL</u>	<u>63</u>	<u>5</u>	<u>1</u>	<u>69</u>

The 195 applications and 63 applications for additional subsidy, shown as approved in Tables 3 and 4, became the subsidy programme for 1963-1964 under the 1959-1964 Act.

At 30th June, 1964, the total expenditure incurred or committed by the Commonwealth under the Petroleum Search Subsidy Legislation since 1957-1958 amounted to £16,929,664.

TABLE 5
STATUS OF APPLICATIONS, YEAR 1964-1965

<u>Category</u>	<u>Approved</u>	<u>Refused</u>	<u>Withdrawn</u>	<u>Pending</u>	<u>Total</u>
<u>Drilling</u>	-	16 ⁺	-	4	20
Stratigraphic	31	-	-	-	31
Test	51*	-	-	-	51
<u>Geophysical</u>					
Seismic	64**	4	3	6	77
Seismic/Gravity	7	-	-	2	9
Gravity	10	1	1	3	15
Magnetic	8	-	-	5	13
<u>TOTAL</u>	<u>171</u>	<u>21</u>	<u>4</u>	<u>20</u>	<u>216</u>

⁺The drilling applications which were refused, or not finalized by 30th June, 1965, are not divided into categories.

*Includes three operations which were approved but later withdrawn by the operators.

**Includes one operation which was approved but later withdrawn by the operator.

TABLE 6

STATUS OF APPLICATIONS FOR ADDITIONAL SUBSIDY

YEAR 1964-1965

<u>Category</u>	<u>Approved</u>	<u>Refused</u>	<u>Withdrawn</u>	<u>Pending</u> <u>30.6.65</u>	<u>Total</u>
<u>Drilling</u>					
Stratigraphic	8	-	1	-	9
Test	17	-	-	3	20
Off*Structure	1	-	-	-	1
<u>Geophysical</u>					
Seismic	30	1	-	1	32
Seismic/Gravity	1	-	-	-	1
Gravity	1	2	-	-	3
Magnetic	-	1	-	-	1
<u>TOTAL</u>	<u>58</u>	<u>4</u>	<u>1</u>	<u>4</u>	<u>67</u>

The 171 applications and 58 applications for additional subsidy, shown as approved in Tables 5 and 6 became the subsidy programme for 1964-1965 under the 1959-1964 Act.

At 30th June, 1965, the total expenditure incurred or committed by the Commonwealth under the Petroleum Search Subsidy Legislation since 1957-1958 amounted to £22,319,270.

FIELD ACTIVITIES

(Geological and Geophysical Branches)

Australia-wide Surveys

Gravity Surveys

The first phase of the Isogal Survey commenced in 1964 and was completed early in 1965. Provisional observed gravity values have been issued as the 'May 1965 Isogal Values'. Stations are being marked progressively with brass disks.

In 1963, gravity meter connexions were made by road between pendulum stations at Townsville and Cloncurry (Q), and Tennant Creek (N.T.) (23).

Stations were added to the '1 degree square files' of the Gravity Map of Australia. Data were obtained from either regional surveys or from the reduction of Bureau and subsidized sedimentary work to density 2.67 cm^3 . No additional analysis of these data was made. A composite gravity map of Australia at 1 inch to 40 miles has been assembled using all available data.

In 1963, the observations for the tie: Melbourne - Tokyo (51), using the new G.S.I. pendulums, were almost completed, and in 1965, one geophysicist, with a Bureau gravity meter, joined a party of I.U.G.G. observers to obtain readings over the Australian portion of the West Pacific Calibration Line (52).

Programmes for the automatic reduction and adjustment of elevation and gravity data and reorganization of the filing system were completed. All computing programmes for the reduction of field data to free-air and Bouguer anomaly values have been converted and improved for use on the C.D.C. 3600 machine at Canberra.

Magnetic Surveys

Isomagnetic maps of Australia and Antarctica and a secular variation map of Australia for 1915-65 have been prepared. A first order survey covering 14 stations in N.S.W. and Queensland was carried out in 1965 (53).

Earlier, five first-order stations were read in the south of Western Australia (44) and two in Papua and New Guinea; their main purpose is to furnish accurate field measurements for the determination of secular variation. Four second order magnetic stations were established in Papua and New Guinea and third order declination stations read every five miles, along 750 miles of traverse in New South Wales (28), and 750 miles of traverse in South Australia (37).

Map Compilation

Sheets 6, 7, 11 and 12 of the Geological Map of Australia and Oceania, scale 1:5,000,000, part of the International Geological Map of the World, were compiled and drawn, and printing was well advanced. Final compilations of sheets 3, 4, and 5 were completed; compilation of sheet 2 was almost completed.

A metallogenic map of Australia and New Guinea, scale 1:5,000,000 was planned. A groundmeter map of Australia, scale 1:5,000,000 was compiled by the Bureau and published by the Water Resources Council. Maps of the Geology and Mineral Deposits of Australia, scale 1:6,000,000, have been fair drawn.

Regional Oil Studies

A group of oil specialists from the French Petroleum Institute (IFP) undertook, under contract, a study of the oil potential of the sedimentary basins of Australia, and completed their report. Specialists from the Institute have continued to work with the Bureau on photogeological sedimentary, and seismic studies.

Queensland

Geological mapping in the Great Artesian Basin continued as a joint operation with the Queensland Geological Survey. The Winton, Muttaborra, and Tangorin 1:250,000 sheet areas were mapped in 1963, together with the sedimentary part of the Hughenden Sheet area (2); helicopters were used for access to rugged country on the Hughenden Sheet. In 1964, Maneroo, Longreach, the western halves of Buchanan, Galilee, and Jericho, and part of the Tambo Sheet areas were mapped. The rest of Tambo was mapped in 1965, together with the Blackall, Augathella, and northern part of Mitchell Sheet areas.

Core drilling was done in the northern Eromanga Basin to obtain fresh samples for palynological, macropalaeontological and lithological study, and to provide stratigraphic control in the Lower Cretaceous.

Seven scout holes on Mitchell were drilled and gamma-ray logged. These gave information on lithologies and formation boundaries, and provided samples for spore analysis. Gamma-ray logging by contractors for the Bureau, of over 200 water bores in Queensland has made it possible to use these bores for accurate stratigraphic control in the Great Artesian Basin.

A gravity survey, using helicopters, has been made over that part of the Great Artesian Basin lying between 20°S and 24°S (3). This survey extends also east and west, and links with earlier surveys made to the south, as far as the New South Wales border. Several thousand gravity meter readings have been taken along seismic traverses in the Great Artesian and Surat Basins.

In the Queensland part of the Georgina Basin, (5) aeromagnetic surveys were made of the Mount Isa, Urandangi, and Glenormiston sheet areas (see also: N.T. - Oil). An aeromagnetic traverse: Roma - Boulia - Cloncurry (7), was made when the aeroplane was travelling to a new base.

Seismic reflexion and refraction work was carried out in the south-east Georgina Basin, in the area covered by the Springvale Mount Whelan, and Bedourie 1:250,000 sheets (6). The main work was a 30 mile reflexion traverse from Yarrandilla Yard south-west to beyond Pulchera Waterhole across a trough indicated by earlier gravity surveys.

In the Yarrol Basin, a combined Bureau and GSQ party mapped the Rockhampton and Port Clinton 1:250,000 sheet areas (54). This work covers the northern part of the Yarrol Basin.

Geological mapping of the Bowen Basin was continued as a joint project with the Geological Survey of Queensland.

In 1963, three parties mapped the Taroom, Springsure, and Baralaba 1:250,000 Sheet areas, the western third of the Mudnubbera Sheet area, and adjacent corners of the Duaringa, Rockhampton, and Monto Sheet areas (9). This work extended the regional mapping of the Bowen Basin to south of latitude 24°S. In addition, further work was carried out in the Duaringa and St. Lawrence Sheet areas as a follow-up to mapping during 1962, and a shallow drilling and coring programme was completed during October, in the area mapped during 1963 (31 holes, 4415 feet drilled, 186 feet cored). These holes were located to give cuttings and cores from important parts of the Lower Permian-Mesozoic section, where outcrops are rare. The Eddystone sheet was mapped in 1964 and in 1965, parties remapped some areas where further study seemed necessary, and another party examined the Upper Permian sequence, especially the Upper Bowen Coal Measures, in the south-eastern, south-western, central, and northern parts of the Bowen Basin. Tentative lithological correlations have been made and palaeocurrent directions determined. These suggest that an Upper Permian delta advanced east and south-east from the north-west side of the basin, and that the sea gradually withdrew towards the south where there was active vulcanism.

A three year project to link up previous geological mapping of the Cairns - Townsville Hinterland, the Eromanga Basin, and the Bowen Basin, was completed by the joining BMR - GSQ North Bowen party (26). Mapping of the Bowen and Proserpine sheets was completed in 1965. Several areas previously mapped were re-examined in the light of new information. One hundred and twenty samples were collected for isotopic dating from the Ayr, Bowen, and Proserpine Sheet areas. The area consists of intrusive complexes, volcanic rocks and sediments. The Ayr 1:250,000 Sheet was sampled on a regional basis, to provide data for the compilation of a regional geochemical map. About 750 sample sites were chosen in an area of about 800 sq. miles, excluding alluvial and cultivated areas. In all, 1,064 samples were collected, 270 from rock outcrops, 235 of soils, 503 of stream sediments, and 56 heavy mineral concentrates.

The aeromagnetic survey of the Bowen Basin was completed in 1963 by surveys of those parts of the Taroom, Roma, Mitchell, and Eddystone 1:250,000 Sheet area (8) lying between 148 and 149 degrees of east longitude.

Geological mapping of the Laura Basin completed the systematic reconnaissance of this area (1).

A joint BMR - GSQ drilling programme in the Herberton-Mount Garnet area (48) commenced in 1964 and will be completed in 1966. Seven holes were put down at the United North Australian area, Watsonville, and three at the Extended Mine, Coolgarra. During 1965, 1,914 feet were drilled, bringing the total for the area to 3,166 feet. The holes were all designed to test geophysical anomalies and were successful in establishing that the anomalies were due to sulphide mineralization, but, unfortunately the tin and copper content is below economic grade. Only the first hole, drilled in 1964, intersected encouraging mineralization (7 feet of 7% Cu and 3% Sn). About 100 stream sediment samples were collected for geochemical testing, from

the Gurrumba, California Creek, and Return Creek areas.

At Mount Isa (25), an experimental geochemical study was begun, a detailed aeromagnetic survey was carried out over an area of over 400 square miles centred on Mount Isa, and a test gravity survey was carried out in the Leichhardt Valley. Geophysical work was also done in the Mount Cuthbert - Dobbryn area (24).

Geophysical work in the Burdekin River Delta (55) continued from 1962. This involves gravity surveys, resistivity depth probes, seismic depth probes, and gamma ray logging of drill holes. The aim was to discover the position and movements of the fresh and saline water in this area of about 100 square miles in which sugar worth \$30 m annually is produced.

The Stradbroke Island (56) hydrological survey began in 1964 and was continued in 1965. The survey was made to test the hydrological conditions of the southern part of the island with a view to supplying water to Brisbane. In all, 13,800 feet of seismic refraction traverse, 30 resistivity depth probes, and 78 gravity stations were measured. Resistivity results indicate that salt or brackish water is only present close to the shore.

Thirty-five miles of Sonar-Boomer traversing and 12,000 feet of seismic traverses were recorded in the Lower Brisbane River (56) area to investigate sites for new bridges over the river. At Hamilton Crossing, an old river valley was found buried under 137 feet of alluvium about 1,000 feet north of the present river.

New South Wales

The Canberra 1:250,000 Sheet area (A.C.T. & N.S.W.) (30-) was mapped by a party of Bureau and New South Wales Geological Survey geologists, to produce a second edition of the map in time for the 1964 meeting of ANZAAS. New South Wales geologists mapped the eastern third of the area; work previously carried out by the Bureau and the Survey at Captains Flat, by the Bureau in the A.C.T., and by universities and others is incorporated.

A geophysical survey of three areas in the Gibsonvale Alluvial tinfield was made, using gravity, seismic, and resistivity methods to search for extensions of the known Gibsonvale and Kikoirra leads. (29).

An experimental aeromagnetic survey, using a proton procession magnetometer in the Cessna VH-GEO, took place over the Cobar area (27) in 1963. Eight small areas, known to have magnetic anomalies of widely differing types, were investigated to test the equipment in the field, to develop flying techniques and data reduction procedures, and to estimate the accuracy attainable. The results showed that the Cessna is able to survey with such detail and accuracy that it would be possible to replace many ground magnetic surveys.

An aeromagnetic survey of the Goulburn 1:250,000 Sheet area (31), flying E-W traverses, one mile apart, was completed late in 1965. The recording of depth charges exploded off the N.S.W. South Coast (57) by the Royal Australian Navy, was made in co-operation with the Australian National University. The shots were recorded up to 136 kilometres and two refraction spreads at right angles were used to enable calculations to be made of dip and true velocity of the refracting layers. As a follow-up to the experimental 'Vibroiseis' survey in the Sydney Basin in 1964 (58), four traverses in the Hawkesbury Sandstone were surveyed by shot-hole methods in 1965.

Australian Capital Territory

A second edition of the Canberra 1:250,000 geological map was printed for the 1964 ANZAAS Meeting (See N.S.W.).

Engineering geologists provided services in the investigations of damsites, building and bridge foundations, and in the Canberra Lake Scheme (30). This work included investigations of the new Bureau building site and the Woden Valley area now being developed. Considerable time was spent on the search for and testing

of sources of construction materials - brick, clay ~~and shale~~, concrete aggregate, building stone, and building sand and gravel.

The systematic study of groundwater in and around the Australian Capital Territory was maintained. Advice was given on possible sources of water to farmers and public authorities. Seven boreholes were drilled to find the effect on the piezometric surface of filling Lake Burley Griffin.

Mapping of the route for the Bendora Water Main was completed. Design investigations for the Corin Dam were completed. Advice regarding other water supply, drainage, and other problems was given.

Victoria

The experimental 'Vibroseis' survey in the Otway Basin (59) in 1964 was followed by an experimental shot-hole seismic survey in the same area in 1965. (See also South Australia). In Victoria, two traverses over basalt covered areas in the Portland Sunklands were surveyed. One shot-hole traverse gave results slightly better than the 'Vibroseis' survey, the other gave somewhat poorer results; the 'Vibroseis' survey is considerably cheaper.

Self-potential, magnetic, electromagnetic, and induced polarization (IP) methods were used in a survey over the Gem and Surprise Gully mines at Hoddles Creek. The survey was to provide drilling targets for an exploration programme to test for economic extensions of the gold-stibnite lode.

Test IP surveys over the Wattle Gully mine showed encouraging results; test surveys to compare results from DC and AC resistivity depth probes were made in the Kooweerup area.

Seismic surveys were made to find the nature and thickness of overburden and of the nature of the bedrock at Nillahcootie dam site, for the State Rivers and Water Supply Commission. About 19,500 feet of traverse was shot and five cores were obtained for laboratory measurements.

Also in Victoria, two boreholes were logged for the Mines Department and vibration due to explosions was measured at the Bellfield dam site for the State Rivers and Water Supply Commission.

Tasmania

A geophysical survey was carried out in the Oonah Hill-Queen Hill area (34), at the request of the Tasmanian Mines Department. Electrical and electromagnetic methods were used, and anomalies were recorded over extensions of the Stannite and Bradshaws Lodes; three holes have been drilled and confirm these results.

At Mount Lyell (32), Turam and IP surveys were made in the Comstock valley. The results show an interesting anomaly, probably due to sulphide mineralization, which is to be tested by drilling in 1966. A test IP survey was made over the Blocks area; the results need more geological information for a proper evaluation.

Magnetic and SP surveys north-east of Mount Cleveland (36) extended previous work in 1953 and 1954. No evidence of any ore-bodies was found.

Seismic refraction surveys were carried out at four possible damsites being considered along the Gordon River (33) on the west coast, and at the Meadowbanks damsite (35) - this latter survey was to determine the elastic constants of the Triassic mudstone and sandstone.

Seismic refraction traverses totalling 18,000 feet were surveyed at the proposed dam, saddle dam, and borrow pit at Risdon Brook (60), for the Mines Department, to determine the thickness and character of the overburden, and character of the bedrock. At Launceston, 10 traverses were made to investigate for the foundations of the proposed King's Bridge.

South Australia

An aeromagnetic survey in the Great Artesian Basin covered the area of Maree, Callabonna, and Frome 1:250,000 Sheets, and the southern halves of the Kopperamanna and Strzelecki Sheets (14). Traverses were spaced 2 miles apart at 1,500 feet nominal altitude and total distance was about 14,500 miles. The field work was carried out under contract, and reduction and publication of results will be done by South Australian Department of Mines.

An airborne magnetic and radiometric survey of the Orroroo and Parachilna 1:250,000 areas was made at the request of the Mines Department. The area is in the Central and Southern Flinders Ranges (61) and the survey was aimed at assisting geological mapping, detecting structures associated with mineralization and determining the regional subsurface structure. Two distinct magnetic horizons were recognised, a deep basement underlying the sedimentary sequence at depths of 3,000 - 27,000 feet, and magnetic bodies at or near the surface. Various zones of near-surface disturbance were recognised and a partial correlation with known geology is possible. Six areas have been proposed for ground investigation.

The radiometric results show ten anomalies worthy of investigation on the ground.

At Coober Pedy (62), single point resistivity, SP, and gamma logs were obtained in a 1850 feet bore which produces brackish water.

In the South Australian part of the Otway Basin (59) (see Victoria), two traverses were surveyed, by 'Vibroseis' in 1964 and shot-hole seismic in 1965, one over the Gambier Limestone outcrop areas, and one over sand dunes, both in the Gambier Sunklands. The shot-hole results were equal to, or slightly better than 'Vibroseis', but at greater cost; in particular, large quantities of explosives were used.

Western Australia

The regional geological mapping of the Kimberley Region (38) of Western Australia, a joint project with the Geological Survey of Western Australia, began in 1962 and will be completed in 1966.

In 1963, two parties mapped the Dixon Range, Lissadell and Cambridge Gulf Sheet areas and in 1964 a further two parties mapped Mount Ramsay and Lansdowne Sheet areas. During 1965, a single party of nine geologists, using two helicopters, mapped the Ashton, Camden Sound, Drysdale, Londonderry, Medusa Banks, Montague Sound, Mount Elizabeth, Prince Regent, and parts of Charnley and Lennard River Sheet areas. In the previous three years, six Sheet areas were mapped. The work of the Party was facilitated by the use of a camp manager.

The Kimberley Basin is a broad basin in which the record of a major period of Precambrian sedimentation is preserved. The succession has been sub-divided into three major units - Speewah, Kimberley, and Bastion Groups. Bauxite has been discovered to the south of Admiralty Gulf.

Samples for age determination were collected from the Cambridge Gulf, Dixon Range, Gordon Downs, and Lissadell Sheet areas.

For details of mapping in the Bonaparte Gulf Basin, see under N.T.

A seismic refraction traverse was made across the widest point of the Carnarvon Basin, at about latitude $26^{\circ} 45' S$ (15). Reflexion work was tried without success.

A detailed aeromagnetic survey was made in 1964 and 1965 in the area immediately surrounding Kalgoorlie and Boulder (63), to the north and to the south-south-east, to assist in the geological mapping in the survey area. The results give a contour map of about

200 square miles. From the magnetic profiles, beds have been delineated and a tentative identification made on the basis of geology known from mine workings and drilling results. At Kalgoorlie also, trace element studies in co-operation with mining companies were carried out.

A ground geophysical survey was conducted in the Ravensthorpe area (64), using magnetic, electromagnetic, SP, and IP methods. The main object was to find extensions to the Elverdton - Desmond copper orebody, or to find new, similar orebodies nearby. After preliminary tests, the SP and E.M. Gun methods were discarded. The whole survey area was covered using a magnetometer and Turam equipment, and the main Turam anomalies were tested with IP equipment. There appears to be an extension of the Elverdton - Desmond shear to the north and significant Turam anomalies were found in areas to the south and near the Ironclad workings, but these were not accompanied by IP anomalies. Several magnetic bodies were detected, but the magnetic survey did not prove very effective in mapping greenstones, the commonest rock for copper mineralization.

No significant anomalies were found in the Gap area, but there were some promising Turam and IP results at Marian Martin, and IP anomalies at Mount Cattlin.

Northern Territory

Geological mapping continued in the Amadeus Basin (16); the Ayers Rock, Finke, Henbury and Kulgera 1:250,000 Sheet areas were completed in 1963, together with about half of the Petermann Ranges and a small part of the Scott Sheet areas. In 1964, Illogwa Creek, Rodinga, Hale River, and McDills Sheet areas were mapped, with parts of Hermannsburg and Alice Springs, completing mapping in this Basin.

In the Georgina Basin, (20) the Sandover River, Frew River (excluding Davenport Ranges - mapped previously), and about a quarter of the Bonney Well 1:250,000 Sheet areas were mapped in 1963.

In 1964, Barrow Creek and parts of Bonney Well Sheet areas were mapped, and in 1965, Helen Springs, Beetaloo, and parts of Tennant Creek Sheet areas. Many scout holes have been drilled in the Georgina Basin area, seven in 1965, to elucidate the geology in areas of poor outcrop. Three deep holes, BMR 11, 12 and 13 have also been drilled.

A water supply study in the Barkly Tableland has shown the presence of two sub-basins of characteristic hydraulic gradients and salinities. One sub-basin, which contains salinities up to 11000 p.p.m., approximately coincides with the Barkly Internal Drainage Basin; and the other, with salinities up to 2,500 ppm is generally coincident with the surface drainage of the Georgina River Basin.

Mapping commenced in the Wiso Basin (13) in 1965. Using a helicopter, mapping was completed on Winnecke Creek, South Lake Woods, Tanami East, Green Swamp Well, Lander River, and parts of Tanami, Tennant Creek, and Bonney Well Sheet areas. This completes mapping of most of the Wiso Basin. Ten scout holes were drilled. Cambrian to Devonian sediments are present.

Aeromagnetic surveys were made over the Elkedra, Sandover River, and Tobermory 1:250,000 Sheet areas (5) of the Georgina Basin and adjacent areas in Queensland in 1963. The survey was made flying along east-west lines, two miles apart, at 2,000 feet above sea level. The area surveyed lies north of the Simpson Desert survey, made under contract in 1962.

In 1963, a party was engaged in geological mapping in that part of the Bonaparte Gulf Basin south of Queens Channel (17); this included about half of the Cambridge Gulf, and parts of the Medusa

Banks 1:250,000 Sheet areas in W.A., and of the Auvergne Sheet area in the N.T. Close liaison was maintained with a party from an oil company and the two parties jointly aimed at solving several problems left as a result of geological and geophysical activities since the reconnaissance survey by Traves (BMR Bull. 27, published in 1955).

In 1965, further detailed geological mapping was done in the southern part of the Basin (partly in Western Australia). Attention was concentrated on the Carboniferous rocks. A reconnaissance was made of Permian and Mesozoic rocks on the Port Keats and Cape Scott Sheets.

Compilation of the last six Arnhem Land 1:250,000 regional geological maps in the Carpentaria region was completed during 1963.

The Rum Jungle (39) geochemical survey, started in 1961, was completed in the Area 55 - Browns West area.

At Tennant Creek (41), samples for geochemical analysis were collected by the Resident Geologist, from several mines and prospects. In 1964, detailed geochemical surveys were made at the Northern Star mine and Aeromagnetic Ridge by a party from Canberra, which also completed the detailed mapping of the Mount Woodrock 1-mile Sheet area.

Test IP surveys were made over several areas in the Rum Jungle area, in which strong electromagnetic anomalies had been discovered previously. Other electromagnetic and magnetic surveys were done in this area, mainly west of the railway line between Castlemaine Hill and Mount Fitch.

A magnetic survey was made over a broad aeromagnetic anomaly in the Quart Bowl area, about 14 miles west of Tennant Creek, also, a single traverse over Red Bluff Anomaly some 22 miles west of Tennant Creek.

The Darwin Uranium Group continued quarterly inspections of uranium mines in the South Alligator River area, assisted geological, geochemical and geophysical parties in the area, and provided drafting and plan printing facilities. In 1965, the Group manned the Bureau exploration programme at Rum Jungle.

During the whole period 1963-1965 exploration for uranium-bearing deposits continued in the Hundred of Goyder and surrounds. Compilation and synthesis of information obtained since the discovery of Rum Jungle was continued.

A programme of core drilling was completed in the Amadeus Basin (16) to test the Ordovician Stairway Sandstone for bedded phosphate rock; phosphatic beds were found in outcrop by Bureau field parties. Although many thin phosphate-rich beds were found, the grade and thickness seems too low to be economic.

A special mineral survey programme was carried out on behalf of the Northern Territory Administration. Copper at Rising Tide, gold at Union Reefs, base metals and phosphate at Rum Jungle, and base metals at McArthur River were studied. At Rising Tide an electromagnetic and associated copper anomaly was tested by diamond drilling, and 1100 feet of waggon drilling were completed. Results suggest that continuous and large gold-bearing lodes are unlikely to be found. At McArthur River 31,000 feet of auger drilling/geochemical sampling further delineated the Barney Creek Shale Member, the host for base metal mineralization in the area. Rotary percussion and diamond drilling were used to test phosphate prospects at Rum Jungle. Geochemical anomalies for copper and a small copper deposit were outlined at Mt. Fitch. One diamond drill hole at Area 55 intersected copper and lead mineralization.

Electromagnetic and electrical ground surveys were done in the Union Reefs and McArthur River areas (65), by a contractor. At Union Reefs, an area 13,000 feet by 2,000 feet was surveyed along traverses 200 feet apart; in the McArthur River area, 88 miles of traverse at 400 feet intervals in three areas was surveyed.

A detailed aeromagnetic survey was made of 55 square miles of the Mount Harris Tinfield (40), 90 miles S.E. of Darwin, in 1965. The object was to assist in the location of tin bearing bodies or extensions of known bodies or extensions of known lodes, by evaluating the geological structure. To increase the resolution of anomalies, flight lines were 1/10 mile apart at a nominal 350 feet above the ground. The contour pattern forms a zone of disturbed magnetic field, 3 to 4 miles wide, encircling the Cullen Granite.

In the Davenport Range (66) area, a detailed aeromagnetic survey was carried out over 87 square miles adjacent to Whistleduck Creek. The aim was to obtain greater resolution of the anomaly recorded previously by a regional aeromagnetic survey, and to define the structure of the metabasaltic block causing the anomaly. Minor copper mineralization has been found within the block.

A detailed aeromagnetic survey was also carried out over five small areas in the Strangways Range, where copper mineralization occurs.

The Granites - Tanami and Victoria River areas were visited prior to planning field work in both regions and a sketch map of the region at 1:1,000,000 has been prepared.

Geological mapping, seismic surveys, and drilling were carried out at possible damsites on the Darwin River (39); seismic surveys were made also at possible observatory sites at Winnellie and Manton Dam (39).

The resident geologists at Darwin, Alice Springs, and Tennant Creek provided geological services for the Northern Territory Administration. Water supply investigations made up a large proportion of the work; this consisted of advice regarding bore sites to provide water for human and animal use, and for irrigation and investigation of possible damsites and catchments.

Mineral deposits were examined, generally at the request of prospectors and leaseholders. Some of the principal minerals studied were iron and manganese ores, gold phosphate, and bauxite, and deposits of building materials.

Information obtained by companies and by Bureau field parties working in the Territory was recorded and background information on regional geology was supplied wherever possible.

Some recent projects have been: Town Water Supply, Alice Springs and Tennant Creek; proposed damsites near Darwin; irrigation water at Willowra; Mount Bundey (iron ore); Tennant Creek (gold and copper). Close liaison was maintained with companies investigating manganese deposits on Groote Eylandt, and bauxite at Gove, in eastern Arnhem Land.

Territory of Papua and New Guinea

A field party engaged in regional geological mapping of the Wabag and Lagaip Sub-Districts of the Western Highlands (43). The area mapped is about 1/3rd of the Wabag 1:250,000 Sheet area in New Guinea, immediately north of the boundary with Papua, bounded by longitudes 143° and 144° E and latitudes 51° and 54° S. A helicopter was used in the more inaccessible parts of the region.

A three year programme of geological mapping, geochemical sampling, and petrological study of the Papuan Basic Belt (67) commenced. This is a belt of ultrabasic rocks which form a chain of mountain ranges on the north-eastern side of the Owen Stanley Range; it is 240 miles long and up to 25 miles wide and extends from Salamaua in the north-west to the Onibu River, south of the Goropu Mountains.

Regional geological mapping was carried out on Bougainville and Buka Islands (68). These are politically part of New Guinea, but are geographically the northernmost islands of the Solomon group. An ocean-going launch and high altitude helicopter were used during the survey.

Geological mapping was completed and a design investigation report compiled preparatory to calling tenders for the construction of an underground hydro-electric power station and associated works at Port Moresby. An engineering geologist now resides at the site to provide documentation and advice during construction.

In the Upper Ramu Valley, (47) geological mapping, geophysical surveys (seismic, magnetic and resistivity,) and test drilling continued in connexion with the proposed hydro-electric scheme. Investigation of a damsite on the Warangoi River, New Britain, was also commenced.

The Bureau maintains resident geologists at Port Moresby, Wau, and Rabaul, to provide geological services to the Administration of the Territory. The staff at Rabaul operates the Vulcanological Observatory.

Apart from geological work connected with the hydro-electric schemes, the staff was engaged mainly on detailed investigations of specific mineral prospects, but underground water work is becoming increasingly more important.

Antarctica

Seismic and magnetic observations were made continuously at Macquarie Island (49), Mawson (46) and Wilkes (45). Seismic observations were made along a traverse which extended to 100 miles south-east of Wilkes. Four gravity stations were established during this traverse.

A party of four geologists spent January and February 1965 continuing the 1:250,000 geological mapping of MacRobertson and Kemp Lands (46). Work was hampered by the poor performance of the helicopters, and the loss of the Beaver aircraft, but mapping of four sheets begun earlier, and of another two sheets was completed. Parts of another three sheets were mapped in less detail. Samples were collected for radiometric and palaeomagnetic work, and sea-bottom

sediment samples were collected from the continental shelf (46, 69). Reconnaissance of the Vestfold Hills (69) was continued and vertical profiles of water samples were collected from several of the saline lakes of the Vestfold Hills.

A compilation of the geology, at a scale of 1:1,000,000 of the sector 45°E to 80°E was prepared for the American Geographical Society for its Folio Atlas of Antarctica. Notes to accompany the maps were written.

OBSERVATORIES

The Bureau maintains a vulcanological observatory at Rabaul (TPNG), and geophysical observatories at Mundaring (W.A.), Port Moresby (TPNG), Toolangi (Vic), Mawson and Wilkes (Antarctica), and Macquarie Island. In addition, seismic events are recorded at Darwin (NT).

At Mundaring Geophysical Observatory the three disciplines of geomagnetism, seismology, and ionospherics are studied. A standard Eschenhagen-type magnetograph has been in operation during 1963-1965 at the Gnangara site, about ten miles north of Perth. An induction coil for micropulsation recording was built during 1963 and has been operated on "regular world days" since then. The Mundaring seismograph comprises one set of the World-Wide Standard Seismic network supplied by the US Coast & Geodetic Survey, augmented by a short-period vertical seismograph for studies of local earthquakes. An intensive study of local seismicity has been made, for which temporary seismic recorders were operated at field stations in southern Western Australia during the latter half of 1963. In 1964 a Willmore seismograph was installed at Kalgoorlie and has been in operation since then. A Cossor ionosonde has been in continuous operation.

The same disciplines are studied at Port Moresby Geophysical Observatory. This observatory also has a set of World-Wide Standard Seismographs; for recording strong local earthquakes it operates low-sensitivity Sprengnether horizontal and Wood-Anderson seismographs. During 1964 two seismic field stations were established and used for a programme to determine the crustal thickness from surface wave dispersion. An IPS ionosonde has been operated throughout; some circuit modifications were made in 1965.

At Toolangi Geophysical Observatory, geomagnetism and seismology are studied. A normal-run La Cour magnetograph made continuous recordings throughout the period. An inductometer that records on to magnetic tape has been operated for the University of Queensland for most of the period. Benioff short-period seismographs have been in operation throughout, but late in 1963 the long-period Benioff seismograph was replaced by Sprengnethers supplied by Columbia University. During the latter half of 1965, the signal from a vertical seismometer in the Melbourne Domain has been telemetred into the Melbourne Office to monitor local earthquakes and permit immediate press releases when required.

At Mawson Observatory two normal-run La Cour magnetographs are in continuous operation, one of low sensitivity and the other of normal sensitivity. Also a Selzer-type fluxmeter was operated throughout. A set of three-component Benioff seismographs with short-period vertical and medium-period horizontals was operated throughout the period.

The instruments at Wilkes Observatory comprise normal- and rapid-run Ruska magnetographs, three-component long-period Press-Ewing seismographs, and a short-period vertical Grenet seismograph. All these were in operation throughout the period.

Macquarie Island Observatory is one of the conjugate pair of magnetic observatories, the other being in Alaska. Normal- and rapid-run La Cour magnetographs were operated throughout. Only a short-period vertical Benioff seismograph is operated. The micro-seismic noise level is abnormally high.

At Darwin a Willmore short-period seismograph was kept in continuous operation.

LABORATORIES

Laboratories are maintained in the Bureau to provide ancillary services for field investigations, to carry out basic research work, and to provide services to the public where appropriate. In recent years these laboratories have undertaken an increasing number of research projects designed both to acquire basic information and to develop more efficient techniques and equipment for field work.

Geological Laboratories

The Geological Laboratories in Canberra carry a staff of petrologists, mineralogists, chemists, and palaeontologists. Numerous examinations, analyses, and assays are made throughout the year, and specialist interpretative work is undertaken to assist in the final conclusions drawn from surveys. Original research is also carried out, particularly in those fields which will assist the interpretation of Australian mineralogonesis and stratigraphy.

Age Determination

The Bureau co-operates in age determination projects with the Australian National University. Three Bureau geologists work at the University carrying out potassium/argon and rubidium/strontium determinations, and mineral separation and petrological studies of the samples are done at the Acton Laboratory of the Bureau.

During the field seasons two of the geologists were attached to field groups in the Bowen Basin (9) and Kimberley regions, (17, 38) the concept being to use their skills in the same manner in which palaeontologists are employed. Another member of the group collected from the Pine Creek Geosyncline and the Carpentaria region.

By 1965, laboratory results were forthcoming in considerable numbers. In that year, a total of 234 age determinations were made on 162 rocks. In the field, 250 samples were collected from North Queensland and the Kimberley region of Western Australia.

In the Bowen Basin, 56 concentrates from 42 samples were dated, virtually completing the work on the western margin. The eastern part is more complicated and the intrusion of the Urannah complex is now well established as extending from 305 m.y. to 125 m.y. age. Most of the rocks dated have ages between 390 m.y. and 235 m.y., but it has not yet been possible to correlate distinct intrusive and/or metamorphic episodes with the dates obtained.

In the Kimberley region, Rb/Sr determinations range from about 2000 m.y. to 600 m.y. Rocks from the Hodgkinson-Laura Basin (1) gave granite ages from Carboniferous to Lower Permian.

Chemistry and Geochemistry

A wide variety of samples was analysed, including auger cuttings, rocks and soils from geochemical prospecting programmes, phosphate, water and miscellaneous materials.

Spectrochemical analyses totalled 4000 in 1965 and included drill cores, cuttings, sludges, stream sediments, heavy mineral concentrates, rocks, and mineral specimens.

Atomic absorption spectrophotometry (A.A.S.) techniques were developed and used to analyse geochemical samples. Tellurium and gold were studied to determine their lower limits of detection by A.A.S. methods.

The Direct Reading Optical Spectrograph was set up in the new building and experimental work was directed towards determining analytical parameters, and effecting mechanical adjustments prior to calibration.

Efforts were continued in the development of fusion techniques for silicate analysis by X-ray Spectroscopy. An Automatic X-ray Spectrograph was installed and is being used for silicate and other analyses.

The work has included:

Phosphate investigation - chemical analysis of drill cuttings, core and rock samples for phosphate content from Rum Jungle and Amadeus Basin, Northern Territory and Bowen Basin, Queensland; Water analyses - water samples from the A.C.T. and brine samples from Antarctica for complete or partial chemical analysis; Studies of the behaviour of base metals in the Molonglo River, downstream from Captains Flat Mine show that recent sediments in the river, some miles downstream from the mine, contain up to 1% of lead and zinc, although the river water contains only 1 ppm of lead and somewhat higher values of zinc. Some highly efficient concentrating mechanism is operating and more detailed study is planned.

Work on about 4,000 samples collected during the Mount Isa Geochemical Survey continues.

X-Ray Spectrography

Continued use was made of this method for identification and analyses of materials. Efforts during 1965 were concentrated on various sample preparation techniques for silicate analyses, and methods for the determination of barium from 30 ppm to 1%, this latter method being applicable to many other elements in a similar concentration range. Routine analytical analyses and X-ray powder and diffraction determinations were carried out as required. One hundred and eighty one marine bottom samples were analysed for sodium and magnesium, and 130 Rb/Sr ratios determined for age determinations.

Geobiological

The Baas-Becking Geobiological Research Laboratory was set up in 1965 in co-operation with C.S.I.R.O. and Australian Mining Industry Research Association. The mineral transformation group will work on the effect of temperature, pressure, and impurities on the diffusion, plastic deformation, and re-combination of sulphide minerals. Another group will work on the biological origin of sulphides. The establishment of this laboratory consolidates some of the work previously carried out in chemical and mineralogical laboratories and in C.S.I.R.O.

Mineralogy and Mineragraphy

Sundry mineragraphic investigations were carried out on samples submitted by field parties, and a detailed investigation of the origin of the tin in the North Queensland tinfields was undertaken. Ores were studied from the Astrolabe and Kalgoorlie fields, the Davenport Ranges, Bowen area, and the Herberton area.

Palaeontology

The Palaeontological staff is divided into two groups, one dealing with macrofossils and the other with microfossils. Both groups carry out studies of material submitted by Bureau field parties, oil companies, and others, and of material especially collected for study.

Macropalaeontology

Many new localities for shelly Ordovician fossils were discovered in the Amadeus Basin and the known extent of Ordovician sediments has been greatly enlarged. The faunal sub-divisions of the Permian Middle Bowen beds were further elaborated and extended.

Work has continued on Cambrian and Ordovician fossils from the Georgina, Amadeus and Bonaparte basins, from the Permian of the Bowen Basin, on the Devonian and Carboniferous fossils from the Bonaparte Gulf Basin and New England, on upper Cambrian fossils from

Tasmania, on Mesozoic fossils from Western Australia and New Guinea, and numerous other miscellaneous investigations.

Micropalaeontology

Foraminiferal, ostracod, conodont, and palynological work was continued on oil well samples and outcrop samples from throughout Australia and New Guinea; over 2,000 samples were processed during each year. In 1965, 2,011 samples were washed, picked and prepared for the study of their microfaunal content. Four hundred and seventy four thin sections were made, 72 polished rock surfaces prepared, 382 samples (weighing about 2,728 lbs.) were treated with acetic acid and monochloroacetic acid to extract conodonts, and 376 samples were processed for their spore and microplankton content. A new system of cataloguing was introduced.

Petrology

Work included petrological descriptions as required of samples collected by field parties and others, the description and testing of engineering materials, the preparation of mineral concentrates for age determination, and a statistical study of zircon size and morphology in selected age determination samples. One important outcome of a petrological study of igneous rocks from the Astrolabe field (Papua) was recognition of differentiation of the gabbro in the vicinity of the mines.

Sedimentary Petrology

A wide range of surface and sub-surface problems in the Bowen Basin was studied. The Upper Permian Peawaddy Formation shows widespread occurrences of feldspar grains and volcanic detritus, with abundant kaolinite in the lower half. Several widespread lithological markers were traced in subsidized wells in the Surat Basin. Other work included studies of the carbonate rocks from the Northern Territory, and of many oil well sections and core hole samples from the Georgina, Amadeus, Artesian and Bowen-Surat basins.

Photogeology

Photogeological maps were prepared in advance of geological field work in nearly all the areas mapped. During the period 1963-65 the areas covered comprised the Kimberley Plateau and the Pilbara area in Western Australia, the Bonaparte Gulf Basin, the Wiso and Ngalia Basins in Northern Territory, the Bowen Basin and the eastern part of the Artesian Basin in Queensland, a total area of 204,000 square miles.

Geophysical Laboratories

The Geophysical Laboratories formerly at Footscray (Vic), moved to Canberra in 1965. The laboratories undertake basic research in geophysics, research into new geophysical field techniques, and the design, development, and construction of new instruments. Routine determinations of the physical properties of rock samples are made.

The Design and Development Group continued its work in devising new geophysical techniques and equipment and modifying existing ones. Problems submitted by various groups were attacked, and assistance and supervision were provided from staff from these groups temporarily working with the Development Group.

An advisory service in electronics was provided for all sections of the Branch and on occasions, assistance was given to the Geological Branch.

Schematic layout circuit diagrams prepared by the Group are used for construction by the Branch and by contractors, and are included in equipment operating and maintenance handbooks.

Work continued on proton precession and fluxgate magnetometers for use in airborne surveys and at observatories. Improvements were made to crystal clocks at Toolangi and Port Moresby.

Preliminary design of the photocell feedback system for digital output of magnetic observatory equipment was completed. A project was commenced to study the use of solar cells for battery charging.

The Maintenance and Testing Group did maintenance, repair, and modification of geophysical equipment throughout the period.

'Sonar-Boomer' and 'Sparkarray' marine equipment was received and field tested in Port Phillip Bay. A telemetry system was developed whereby the output from a seismometer at Melbourne Observatory in the Domain could be recorded at Wentworth House.

The Workshop continued to operate to capacity constructing new equipment, and repairing and modifying existing equipment.

Petroleum Technology Laboratory

The Petroleum Technology Laboratory in Canberra carried out routine tests and some research investigations in connexion with the physics of petroleum reservoir rocks, composition and properties of petroleum reservoir fluids, thermodynamics of reservoir fluids and their flow through porous media, the nature, composition and application to drilling, and development of drilling fluids and materials. The Laboratory also concerns itself with the determinations and investigations of the organic content of finely-grained sediments as potential source "rocks" of petroleum.

Continuous routine core analysis continued and consisted of some or all of the following tests: fluid saturation, core water salinity, acid solubility, permeability porosity and densities. The tests were carried out on side wall cores, plugs out from cores, whole cores or outcrop samples. Approximately 1,500 samples were examined each year.

New work introduced consisted of the study of the effect on permeability of various liquids (fresh water, brine, oil) through plugs taken from various oil reservoir sands. Future work will consist of all the above plus capillary pressure and core size distribution determinations. The new apparatus for these measurements has now been installed.

The most important increase in operations recently was in the bentonite field. This commenced with the preparation of a paper on

Australian bentonites which was written to satisfy a demonstrated need of obtaining local bentonites suitable for use in pelletizing iron ore.

Bentonites tested during the period were from the Yarraman-Rosedale areas Qld. and from the Permian Black Alley shale north of Roma, Qld., Bentonite from Mosambique used in foundry sands in Australia was also tested with respect to its usefulness in drilling muds. The Yarraman bentonites proved to be unsuitable for drilling muds and further investigations into the possibility of beneficiation of these clays, and their suitability for use in other industries was taken over by the C.S.I.R.O.

A pH meter and a high temperature - high pressure filter press have recently been received and these will be utilized in further investigations of Australian bentonites. The receipt of a Fann resistivity meter, built specifically for the measurement of the resistivities of formation water, mud, mud cake, and mud filtrate has facilitated the more accurate determination of these values.

Miscellaneous testing such as sand, sieve analysis, and the determination of the effectiveness of various acids on water well scales and accumulations were made periodically.

Analysis of 78 gas samples was accomplished. Duplicate analysis was made on some of the samples. Efforts to discover commercial quantities of helium in natural gases, have been unsuccessful; the highest proportion of this elementary gas so far observed is 0.1%.

Seven low to medium pressure condensates were analyzed, under some difficulty, by gas/liquid, liquid/solid chromatography, and spectrophotometry.

Routine tests and analyses were made on a number of crude oils; one contained very high amount of organic sediments. The sediments were partially characterized. Semi-detailed characterization and analysis was made on three suspected oil-seep samples and one on fuel oil.

Suitable control instruments and apparatus were selected or designed for use with the recently received Spinning Band Fractional Distillation Unit.

Feasibility study has been made into the case construction of apparatus for determination of "SP potentials" of aqueous formation fluids.

The move from the old Acton laboratory to the new laboratories in the B.M.R. Building was completed on 25th September, 1965.

COMMON SERVICES

In order to keep its various field parties and laboratories properly equipped and supplied, the Bureau maintains services which are common to all groups. The specialized services included the drawing offices, libraries, and geophysical workshop.

The Geophysical and Geological Drawing Offices prepare maps, the main media by which the results of field investigations undertaken by the Bureau are conveyed to organisations such as State Mines Departments, oil companies, and mining companies, and to the general public. Both offices prepare all the necessary plates and maps required to illustrate the publications issued by the Branches.

The three Branch libraries were amalgamated under the Operations Branch during 1965, to form a unified Bureau library. The Central Register of Stratigraphic Names was maintained in the Geological Branch.

APPENDIX

PUBLICATIONS OF THE BUREAU

A complete list of publications issued by the Bureau may be obtained free, on application to the Director, Bureau of Mineral Resources, Box 378, Canberra City, A.C.T. A brief description of the types of publications issued by the Bureau follows.

The publications of the Bureau are primarily of a specialist nature and are designed for three purposes :-

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

The scope of the various types of publications is given below.

BULLETINS are confined to reports on major investigations, or on particular phases of investigations regarded as complete, or reports on comprehensive investigations that may not be complete, but are not likely to be continued at an early date.

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 of its immediate interest or because the investigation of which it forms a part may not be completed for several years.

PETROLEUM SEARCH SUBSIDY ACTS PUBLICATIONS embody results of operations subsidized under the Petroleum Search Subsidy Acts 1957-58 and 1959-61. Publications in this series are reports on drilling operations, geophysical surveys, and bore hole surveys.

THE AUSTRALIAN MINERAL INDUSTRY, QUARTERLY REVIEW is prepared and issued in conjunction with the Commonwealth Bureau of Census and Statistics. Part 1 of the Review contains feature articles concerning some aspect of the mineral industry, a current review on metals and minerals, and current metal and mineral prices. Part 2 includes production, import and export statistics.

THE AUSTRALIAN MINERAL INDUSTRY, ANNUAL REVIEW presents information on the mineral industry in three parts - general review, review by metals and minerals, and statistics by States.

SUMMARY REPORTS provide a summary of information concerning individual minerals or metals, giving sources, uses, production, consumption, prices and trade.

MAPS published by the Bureau include :-

The standard series of geological maps at a scale of 1:250,000 (Previously 1:253,440); geological maps at other scales;

Geophysical maps, which do not constitute a formal series and are published in format appropriate to the different surveys;

A Petroleum Tenements Map of Australia and the Territory of Papua and New Guinea, accompanied by a list of tenement holders, is revised and published twice yearly to give the position at 30th June and 31st December.

MISCELLANEOUS publications include pamphlets, catalogues and Open File Circulars.

The publications outlined above may be purchased from :- the offices of the Bureau in Canberra; the Department of National Development in Melbourne and Sydney; or through the State Controllers, Department of Supply in the other capital cities.

Publications issued or reprinted in 1963-65 are listed below :-

Bulletins

1963 -

- No. 63 Permain pelecypods and gastropods from Western Australia; by J. M. Dickins.
- No. 65 Chemical analyses of Australian rocks, Part 1 - Igneous and metamorphic rocks; by Germaine A. Joplin.
- No. 66 Lower Cretaceous arenaceous Foraminifera of Australia; by Irene Crespin.

1964 -

- No. 64 Early Upper Cambrian Fossils from Queensland, by A. A. Opik.
- No. 67 Australian Mesozoic Trigoniids, by S. W. Skwarko.
- No. 69 A Survey of the Phosphate Deposits in the South-West Pacific and Australian Waters, by W.C. White and O.N. Warin.

1965 -

- No. 49 "The Cambrian Geology of Australia", ed by A.A. Opik (reprint)
- No. 68 "Australian Permian Terebratuloids", by K. S. W. Campbell
- No. 70 "The Geology and Mineral Deposits of the Chillagoe District, Queensland" by F. de Keyser and K. Wolff. (also issued as GSQ Publ. No. 317)
- No. 72 "The Australian Mineral Industry: The Mineral Deposits", ed by I. R. McLeod
- No. 78 "Chemical Analyses of Australian Rocks, Part II : Sedimentary Rocks", compiled by Germaine A. Joplin

Reports

1963 -

- No. 52 The Geology of the Musa River area, Papua; by J. W. Smith and D. H. Green, with appendix by N. H. Ludbrook.
- No. 57 Misima Island - geology and gold mineralisation; by F. de Keyser.

1964 -

- No. 60 Stratigraphic Drilling in the Canning Basin, by S. D. Henderson and M. A. Condon.
- No. 69 Catalogue of Fossil Type and Figured Specimens in Tasmania.
- No. 71 Catalogue of Fossil Type and Figured Specimens in Western Australia, by I. Crespin.
- No. 75 The Geology of the Bowutu Mountains, New Guinea, by D. B. Dow and H. L. Davies

1965 -

- No. 64 "The Geology of the Mt. Coolon 1:250,000 Sheet Area, Queensland," by E.J. Malone, D.W.B. Corbett and A.R. Jensen.
- No. 65 "Geological Reconnaissance of the Rawlinson-Macdonald Area, W.A.", by A.T. Wells, D.J. Forman, and L. Ranford
- No. 66 "The Geology of the Clermont 1:250,000 Sheet Area, Queensland", by J.J. Veevers, M.A. Randal, R.G. Mollan (B.M.R.) and R.J. Paten (G.S.Q.)
- No. 67 "Geology of the Huckitta 1:250,000 Sheet Area, N.T.", by K. G. Smith
- No. 68 "The Geology of the Emerald 1:250,000 Sheet Area, Queensland," by J.J. Veevers, R.G. Mollan, I. Olgers (B.M.R.) and A.G. Kirkegaard (G.S.Q.)
- No. 70 "Subdivision and Correlation of the Permian Middle Bowen Beds, Bowen Basin, Queensland," by J.M. Dickins, E.J. Malone and A.R. Jensen.
- No. 73 "Gravity Surveys of the Great Barrier Reef and Adjacent Coast, North Queensland, 1954-1960" by J. C. Dooley.
- No. 74 "Earthquake Activity and Seismic Risk in Papua and New Guinea", by J. A. Brooks
- No. 76 "The Geology of the Bismarck Mountains, New Guinea," by D.B. Dow and F. E. Dekker.
- No. 79 "Geology of the Kainantu Goldfields", (New Guinea) by D. B. Dow.

1965 (Cont.)

- No. 80 "Well Completion Report, BMR 10 and 10A Beagle Ridge, W.A.", by R. A. MacTavish.
- No. 81 "Completion Report, Stratigraphic and Structural Bores B.M.R. 6 and 7, Muderong, W.A." by W.J. Perry
- No. 82 "The Geology of Fergusson and Goodenough Islands, Papua", by H.L. Davies and D.J. Ives
- No. 84 "Completion Report, Stratigraphic Bore BMR 5, Giralalia, Western Australia", by L. V. Bastian and S.P. Willmott
- No. 85 "The Geology of the North -western Part of the Amadeus Basin, N.T." by A.T. Wells, D.J. Forman and L. C. Ranford
- No. 89 "The Geological relationships of the Rum Jungle Complex, N.T." by J. M. Rhodes.
- No. 90 "Middle Proterozoic Volcanic Rocks in the Katherine-Darwin Area, N.T." by J. R. Stewart
- No. 92 "Errors and Limitations of the Magnetic Compass", by W. D. Parkinson
- No. 93 "Geophysical Exploration for Underground Water", by W. A. Wiebenga and E.E. Jesson
- No. 95 "Gippsland Basin Airborne Magnetic Surveys, Victoria, 1951-52 and 1956", by J.H. Quilty
- No. 96 "Geophysical Surveys at Captains Flat, N.S.W." by E. Sedmick
- No. 97 "Poole Range Gravity Survey, W.A. 1953", by I. B. Everingham
- No. 98 "Isogonic Map of Australia and New Guinea for the Epoch 1965-0", by J. van der Linden

Petroleum Search Subsidy Acts Publications

1963 -

- No. 15 Queensland American The Overflow No. 1, Queensland, of Queensland American Oil Co.
- No. 23 Conorada Ooroonoo No. 1, Queensland, of Conorada Petroleum Corporation.
- No. 35 East Roma Seismic Survey, Queensland, 1959-60, by Associated Australian Oilfields N.L.
- No. 36 Blue Hills-Logue Seismic Survey, Western Australia 1959-1960; by West Australian Petroleum Pty. Limited.
- No. 39 Longreach-Silsoe Seismic Survey, Queensland, 1960, by Cree Oil of Canada Limited.

1963 (Cont.)

- No. 41 Phillips-Sunray Buckabie No.1, Queensland of Phillips Petroleum Co. and Sunray-Mid-Continental Oil Co.
- No. 42 O.D.N.L. Penola No. 1 well, South Australia, by Oil Development N.L.

1964 -

- No. 23 Conorada Ooroonoo No. 1 Queensland of Conorada Petroleum Corp.
- No. 38 Barlee Gravity Survey, W.A., by West Australian Petroleum Pty. Ltd.
- No. 40 Reconnaissance Geology of the Surat Basin, Queensland and New South Wales, by J.E. Mack, Jr.
- No. 42 O.D.N.L. Penola No. 1 Well, South Australia, of Oil Development N.L.

1965 -

- No. 12 "Drilling Operations in the Sydney Basin, N.S.W., 1958-1962".
- No. 31 "Tambo-Augathella Aeromagnetic and Gravity Surveys, Q'ld. 1959".
- No. 43 "Union - Kern - A.O.G. Cabawin No. 1 Queensland".
- No. 44 "Union - Kern - A.O.G. Cabawin East No. 1 Queensland".
- No. 45 "Union - Kern - A.O.G. Moonia No. 1 Queensland".
- No. 47 Bonaparte Gulf Gravity Survey, W.A.
- No. 49 Summary: Exmouth Gulf Marine Seismic; Whaleback Seismic, Carnarvon Basin, W.A.
- No. 52 Summary of Data and Results, drilling in Murray Basin.
- No. 53 "Union - Kern - A.O.G. Wandoan No. 1, Union - Kern - A.O.G. Burunga No. 1".
- No. 56 "Exmouth Gulf Marine Seismic Survey, Western Australia, 1961".
- No. 57 "Union - Kern - A.O.G. Middle Creek No. 1, Union - Kern - A.O.G. Southwood No. 1".
- No. 58 "Summary of Data and Results, P-S-Q.A. Durabilla No. 1, P-S-Q.A. Kogan No. 1, P-S-Q.A. Kogan South No. 1, Surat Basin, Queensland".
- No. 61 Summary: U.K.A. Flinton No. 1; U.K.A. Coomrith No.1, U.K.A. Wunger No. 1, Surat Basin, Q'ld.

1965 (Cont.)

- No. 62 "Summary of Data and Results, Flaxmans No. 1 Well, Otway Basin, Victoria.
- No. 64 "Mt. Salt No. 1 well, S.A."
- No. 65 "Summary of Data and Results, Geltwood Beach No. 1 well".

The Australian Mineral Industry Reviews

1963 -

- Quarterly Review, vol. 15, nos. 2, 3 and 4.
- Quarterly Review, vol. 16, no. 1.
- Annual Review for 1962.

1964 -

- Quarterly Review, vol. 16, nos. 2, 3 and 4.
- Quarterly Review, vol. 17, no. 1.
- Annual Review for 1963.

1965 -

- Quarterly Review, vol. 17, nos. 2, 3 and 4.
- Quarterly Review, vol. 18, no. 1.
- Annual Review for 1964.

Summary Reports

1963 -

- No. 42 Salt

Geological Maps1963 - 1:250,000 with explanatory notes

- W.A. Stansmore (4 miles to 1 inch)
- N.T. Alligator River, Mount Evelyn, Pine Creek.

1964 -

- Q. Atherton, Clarke River, Duches, (4 miles to 1")
Einsaleigh, Georgetown, Gilberton.
- A.C.T./N.S.W. Canberra (2nd Edition) - no notes
- W.A. Balfour Downs, Boorabbin, Glenburg,
Kennedy Range.
- N.T. Calvert Hills, Hay River, Katherine,
Mount Drummond, Tanumbirini.

1965 -

Q. Birdsville, Brighton Downs, Cairns, Innisfail, Julia Creek, Machattie, McKinlay, Mackunda, Mossman.

N.T. Barrow Creek, Bauhinia Downs, Hodgson Downs, Huckitta, Junction Bay, Mt. Young, Pellew, Robinson River, Roper River/Cape Beatrice, Urapunga, Wessel Islands/Truant Island.

1:63,360 without notes

1963 -

N.T. Batchelor, Burnside, Daly River, Katherine, Lewin Springs, Mount Gould, Mount Tolmer, Muldiva Creek, Reynolds River, South Alligator River Area (non-standard Sheet area)

1964 -

Q. Almaden, Chillagoe, Mungana

N.T. South Alligator, Mount Hayward, Tipperary

1965 -

N.T. Waterhouse, Black Cap, Diljin Hill

Other geological maps (coloured)

(1:500,000 maps)

1963 -

Q. Georgetown - Clarke River

W.A. Carnarvon Basin (2 sheets)

N.T. Katherine - Darwin Region

Geophysical Maps

Gravity Maps: standard 1:250,000 Sheet areas, at scale 1:500,000

1963 -

W.A. Bentley, Cambridge Gulf, Geraldton - Yalgoo, Helena, Medusa Banks, Minilya - Winning Pool, Mount Bannerman, Ningaloo - Yanrey, Onslow, Stansmore.

N.T. Auvergne, Bloods Range, Cape Scott, Elkedra, Henbury, Hermannsburg, Huckitta, Kulgera, Port Keats, Sandover River, Tobermory.

1965 -

Q. Brighton Downs, Bowen, Buchanan, Charters Towers, Clermont, Duaringa, Emerald, Galilee, Hughenden, Jericho, Julia Creek, Longreach, Mackay, McKinlay, Mackunda, Maneroo, Manuka, Mt. Coolon, Muttaborra, Port Clinton, Proserpine, Richmond, Rockhampton, St. Lawrence, Tangorin, Winton.

W.A. Ajana, Murgoo.

(Gravity contours do not cover entire sheet in some cases).

Magnetic Maps: 1:250,000

- 1964 - Q. Baralaba, Jericho, Mackay, Mount Coolon,
St. Lawrence, Springsure, Tambo.
- Vic. Gippsland Basin
- N.T. Bauhinia Downs, Hale River, Hay River,
Illogwa Creek, McDills, Simpson Desert
North, Simpson Desert South.
- 1965 - Q. Roma, Taroom, Mitchell, Eddystone.

Magnetic Maps: 1:63,360

- 1964 - N.T. Ban Ban, Batchelor, Burrundie, Marrakai,
Mt. Bunday, Woolwonga.

Magnetic and Radiometric Maps: 1:250,000

- 1963 - Q. Clermont, Duaringa, Emerald.
- W.A. Byro, Edel, Edmund, Glenburg, Kennedy Range,
Ninilya - Winning Pool, Mount Phillips,
Ningaloo - Yanrey, Onslow, Quobba, Shark
Bay, Wooramel, Yaringa.
- 1964 - W.A. Ajana, Cocanarup, Murgoo, Ravensthorpe,
Yarraloola.

Magnetic and Radiometric Maps covering 1:250,000 Sheet areas, at 2 mi. to
1 inch (each in 4 sheets)

- 1963 - W.A. Lake Johnston.
- N.T. Tennant Creek
- also N.S.W. Narrandera - Cootamundra, N.S.W. at same
scale, but on one sheet, covering part of
these sheet areas only.
- 1964 - N.S.W. Bathurst, Narromine.
- 1965 - N.T. Tanami, - The Granites.

Radiometric Map, 8 mi. to 1 inch, with marginal photographs

- 1963 - Mount Isa region, Queensland (G181-22)

Miscellaneous

Petroleum Tenements Map for 30th June and 31st December each year.
Pictorial Index of Activities, 31st December 1963 and 31st December 1964.
Catalogue of Publications October 1963, January 1965, and October 1965.
Open-file Circulars Nos. 1-5. Canberra Excursion Booklet (for ANZAAS, 1964).
Lists of Petroleum Exploration Companies, Contractors, etc., twice yearly.
Observatory Reports, monthly.



