COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS

1958/83

GEOPHYSICAL WORK OF THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS DURING THE INTERNATIONAL GEOPHYSICAL YEAR

GEOPHYSICAL WORK OF THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS DURING THE INTERNATIONAL GEOPHYSICAL YEAR

1. INTRODUCTION

This communication is intended to give a brief review of the geophysical work performed by the Bureau of Mineral Resources, Geology and Geophysics during the period of the International Geophysical Year (1957 July 1 to 1958 December 31). The work is divided into four disciplines, geomagnetism, seismology, gravity and ionospheric physics. When different types of work fall within the same discipline, further sub-divisions are made.

Each discipline is discussed from the following aspects:-

1. Extent and continuity of observations.
2. New equipment obtained.
3. Results already published or distributed.
4. Results to be published or distributed in the future.
5. Important results - where applicable

Maps, showing the locations at which geophysical observations were made, are included.

2. GEOMAGNETISM

A. OBSERVATORY GEOMAGNETISM

1. The Bureau of Mineral Resources, Geology and Geophysics operated six magnetic observatories and two temporary recording stations during all or part of the I.G.Y.

Toolangi Observatory operated continuously throughout the period. The recorder is a normal run La Cour magnetograph. It was standardized weekly by absolute measurements.

Watheroo Observatory operated continuously throughout the period. Records from a normal run Eschenhagen and a rapid-run La Cour were obtained. The former were standardized by weekly absolute measurements.

A normal run La Cour magnetograph has been in continuous operation at Mawson Observatory throughout the period of the I.G.Y. It has been standardized by weekly absolute observations. A three component bar fluxmeter was installed in November, 1957. It was in operation throughout World Days, and for certain hours on all other days.

A normal run La Cour magnetograph has been in continuous operation at Macquarie Island throughout the I.G.Y. It was standardized by weekly absolute measurements.

The operation of a normal run La Cour magnetograph at Port Moresby Observatory was started in March 1958 and continued without interruption through the rest of the I.G.Y. It was standardized by weekly absolute measurements.

A normal run La Cour magnetograph has been in operation at Cnangara throughout the I.G.Y. Standardization was achieved by weekly absolute measurements. This observatory is only 110 miles from Watheroo, and can be considered as a satellite station of that observatory.

An Askania variograph was used as a temporary magnetic station at Darwin throughout the I.G.Y. However recording was only intermittent from June, 1957 to May, 1958. It has been continuous since then. Standardization observations have been made weekly throughout the I.G.Y. period.

A temporary magnetic station was in operation at Alice Springs from July to October, 1957. Standardization measurements could be made only at the commencement and conclusion of recording, therefore absolute values of the elements cannot be obtained from these traces. However, the scale values are fairly well known, and relative values can be derived from the recordings.

2. The only observatory geomagnetic equipment purchased especially for I.G.Y. investigations is the bar fluxmeter installed at Mawson. The instrument consists of three mu-metal bars installed perpendicular to each other in the north-south, east-west and vertical directions. Around these bars, coils are wound, and currents induced in these coils are fed into sensitive galvanometers. A time scale of about 1 inch per minute can be used.

3. The scaling of hourly mean values of the three magnetic elements has been carried out for Toolangi and Watheroo for the entire period, and up to September, 1958, for Macquarie Island. About half of the Toolangi scalings have been converted to absolute magnetic values.

K-indices, a description of magnetic storms, S.F.E. and other magnetic phenomena are reported monthly in a publication called the "Geophysical Observatory Report". This has a wide circulation including WDC A, C_1 and C_2. Also K-indices and some magnetic phenomena are sent directly to the WDC's from Toolangi and Watheroo.

4. We expect to have a semi-automatic trace reader in operation soon. This will be used for scaling traces from Mawson, Gnangara, Port Moresby, and Darwin, and those from Macquarie Island since September, 1958. This will also facilitate conversion to absolute values and calculation of mean values by using punched card techniques. We hope to have scalings of all mean hourly values converted to absolute values by the end of 1959. Publication of these should follow soon afterwards.

Magnetograms from Toolangi, Mawson and Macquarie Island are being copied photographically at present. These, together with copies of magnetograms from Watheroo, Gnangara, and Port Moresby, will be transmitted to WDC A as they become available. The copying should be completed by the end of 1959.

Q-indices will be scaled from Mawson and Macquarie Island magnetograms, but no estimate of the time of completion of this task can be made at present. So far no plans have been made to publish fluxmeter data on a regular basis.

B. FIELD GEOMAGNETISM

1. A total of 124 field magnetic stations were occupied during the period 1 July, 1957 to 31 December, 1958, by the Bureau of Mineral Resources, Geology and Geophysics. Fifty-two of these were new stations. The locations are shown in Fig.1. Five separate surveys were made, as follows:-

Northern Territory and northern South Australia - June - November, 1957.

Tasmania - February, 1958.

Southern South Australia -

Northern and central Western Australia -- May - October, 1958.

South western Western Australia -- October - November, 1958.

Field magnetic measurements were made at 9 locations in Antarctica during the I.G.Y. These are shown in Fig.2.

2. No new equipment was obtained for the field magnetic work carried out during the I.G.Y.

3. An isogonic map of Australia and New Guinea for the epoch 1960.5 has been issued, and copies will soon be sent to WDC A, B, C_1 and C_2.

4. The results of field magnetic observations made before, during, and since the I.G.Y. are being incorporated in a series of maps, covering Australia and New Guinea, showing contours of the three observed elements (D, H and I) and two derived elements (Z and F), for the epoch 1957.5. Secular variation maps of these elements are included as insets. These maps should be available about the middle of 1959.

A report is in preparation summarising the Antarctic field magnetic results. No attempt will be made to produce isomagnetic maps of Antarctica until results from other organisations become available.

3. SEISMOLOGY

A. OBSERVATORY SEISMOLOGY.

1. Continuous seismic recording has taken place at Melbourne and Macquarie Island throughout the I.G.Y. period. Melbourne seismic observatory contains three Benioff seismometers (two horizontal and one vertical) each coupled to two galvanometers, of periods 14 sec. and 0.25 sec. respectively. At Macquarie Island there are two Wood-Anderson horizontal seismographs and a Grenet vertical seismograph.

Mawson observatory is equipped with a three-component Leet-Blumberg seismograph. Satisfactory seismograms have been obtained only intermittently during the I.G.Y. period.

A Benioff vertical seismometer and Willmore recorder have been in continuous operation at Watheroo from April, 1958, to December, 1958.

At Port Moresby recording with two horizontal Sprengnether seismographs was started in December, 1957 and with a vertical Sprengnether in February, 1958. In June, 1958, a Wilson-Lamison vertical seismograph was added. All were in continuous operation until the end of 1958, except for June and July, 1958, when the E-W Sprengnether was not working.

2. The Wilson-Lamison seismograph installed at Port Moresby was borrowed from the U.S. Coast and Geodetic Survey for this purpose. Otherwise no new equipment was obtained especially for the observatory seismic I.G.Y. programme.

3. A preliminary analysis of earthquake phases has been made for the whole period for Melbourne, until June, 1958, for Mawson, until November, 1957, for Macquarie Island and from December, 1957 to July 1958, for Port Moresby. The results have been forwarded to WDC A, B and C.

A preliminary analysis of earthquake data has been made from the Watheroo seismograms, and the results sent to WDC A.

Microseisms have been scaled from the Melbourne seismograms up to March 1958, but have not yet been forwarded to data centres.

4. We intend to make a final analysis of earthquakes recorded at all five seismic observatories and to send the results to WDC A, B and C. The scaling of microseisms will be completed for Melbourne and Watheroo and possibly for Mawson and Macquarie Island, but at the moment no target date can be set for this.

B. ANTARCTIC FIELD SEISMOLOGY (ICE THICKNESS).

1. From 9th November, 1957, to 16th February, 1958, a traverse extending about 400 miles southwards from Mawson was made. Its location is shown in Fig.2. Gravity observations and seismic measurements were made along the traverse.

The object of the traverse was to determine the thickness of the ice-cap and hence the height above sea level of the underlying rock. A total of 23 seismic sites were used to give direct depth determinations.

2. A twelve channel seismograph, model 7000B, made by Texas Instruments Inc., was purchased for this work.

3. A preliminary report (B.M.R. Records 1958/40) has been issued giving a profile obtained from the seismic results. This report has been transmitted to WDC A, B and C.

4. Further analysis will be made when gravity results become available.

5. Preliminary interpretation of the results indicates an ice-rock interface close to sea level in most places, i.e. about 8,000 feet below the top of the ice-cap. A range of mountains reaching 7,000 feet above sea level lies buried below the ice about 160 miles south of Mawson (i.e. about 70°S, 62°E). A profile of the ice thickness is shown in Fig.3.

4. GRAVITY

A. ICE-CAP GRAVITY MEASUREMENTS.

1. To obtain more detailed information on the thickness of the Antarctic ice-cap, gravity measurements were made every 5 miles along the traverse south of Mawson (see Section IIIB), which was carried out between November 1957 and February 1958. The results of the seismic measurements will act as controls for the gravity readings.

2. No new equipment was obtained for this work.

3. The analysis of the gravity data is not yet complete. We expect to complete the analysis and issue a report containing results by July, 1959. This will be sent to WDC A, B and C in due course.

B. REGIONAL GRAVITY.

1. Gravity measurements on a regional scale were made during the I.G.Y. in Antarctica, on the mainland of Australia and on the continental shelf.

As well as the measurements along the ice-cap traverse, gravity measurements were made at 16 places in Antarctica during the I.G.Y. The positions are shown in Fig.2.

Underwater gravity measurements, in which a self-levelling instrument is lowered to the bottom from a surface vessel, were made on several traverses along the northern and eastern coasts of Australia, extending to New Guinea. The locations of these traverses are shown in Fig.1.

Gravity measurements were made along a network of traverses (shown in the inset of Fig.1) covering Port Philip Bay.

Land gravity measurements were made on Mornington Peninsula and in northern Queensland. These were intended to assist in standardising the underwater gravity results. Their locations are shown in Fig.1.

2. No new equipment was purchased for this work.

3. No results have been distributed to date.

4. Reports on gravity measurements are in preparation. When completed they will be distributed to the WDC's.

5. IONOSPHERIC PHYSICS

1. The only ionospheric observatory operated by the Bureau of Mineral Resources, Geology and Geophysics during the I.G.Y. was at Watheroo, where an ionosonde was kept in continuous operation, apart from minor interruptions due to instrumental failure.

Absorption measurements based on the field strength of cosmic noise were planned for the I.G.Y. However, due to delays in acquiring all necessary equipment, it was impossible to start satisfactory recording until after the end of the I.G.Y.

It was intended to start operation of an ionosonde at Port Moresby during the I.G.Y. However, neither the equipment or the buildings were available by December, 1958.

2. The cosmic noise recorder at Watheroo was purchased for an intended I.G.Y. project. The recorder consists of a tuned antenna system with vertical directivity, an Eddystone 680X receiver, a D.C. amplifier, and an Evershed and Vignoles recording milliammeter.

The Port Moresby ionosonde, also ordered for I.G.Y. work, is being constructed by the Ionospheric Prediction Service. It is a multi-frequency pulsed transmitter and receiver covering a frequency range of 1 - 25 Mc., feeding a C.R.O. display which can be recorded on moving film. The frequency sweep is completed in 20 seconds.

3. Hourly values of the following variables were scaled from the Watheroo ionograms:-

Minimum frequency
E layer critical frequency
E layer virtual height
Type of sporadic E
Sporadic E upper frequency
Blanketing frequency of sporadic E

F1 layer critical frequency
Minimum usable frequency (3000 Km) F1 layer
Minimum virtual height F1 layer
Critical frequency F2 layer
Minimum virtual height F2 layer
Height of maximum ion density F2 layer
Maximum usable frequency (3000Km) for F2 layer

Scalings were kept current. Tables of these variables were sent to the Ionospheric Prediction Service every month, from where the results were published and distributed to WDC's and other interested institutions.

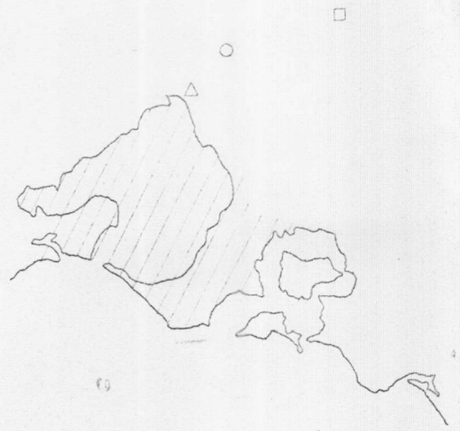
F-plots were made for regular world days and special world intervals and sent currently to the Ionospheric Prediction Service.

4. We have no plans for extracting further information from the ionograms.

FIG. 1

SCALE IN STATUTE MILES

0 100 300 500



SCALE IN MILES

32 0 32

See Inset

LEGEND

AREA COVERED BY GRAVITY NETWORK

GRAVITY STATION

GRAVITY TRAVERSE

FIELD MAGNETIC STATION

MAGNETIC OBSERVATORY

SEISMIC OBSERVATORY

Geophysical Section, Bureau of Mineral Resources, Geology and Construction

FIG. 2

LOCATION OF GRAVITY MEASUREMENTS BY BUREAU OF MINERAL RESOURCES IN ANTARCTICA TO JUNE 1958

SCALE IN MILES

100 0 100 200 300 400 500 600 700 800

- GRAVITY STATIONS
- FIELD MAGNETIC STATIONS
- MAGNETIC OBSERVATORIES
- SEISMIC OBSERVATORIES

AUSTRALIA

TASMANIA

NEW ZEALAND

MACQUARIE IS.

SOUTHERN OCEAN

LEWIS ISLAND

DUMONT DURVILLE BASE

THOMPSON ISLAND

NELLY ISLAND

HEARD IS.

MIRNY

DAVIS

LARSEMANN HILLS

LICHEN ISLAND

MT CAROLINE MIKKELSON

DOUGLAS ISLANDS

OLDHAM IS.

MAWSON

TAYLOR

FOLD ISLANDS

MAGNET BAY

TRAVERSE

KING EDWARD VIII GULF DEPOT

ROSS SEA

ROSS ICE SHELF

G 265-8