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RECORD No. 1966/36

MUNDARING GEOPHYSICAL OBSERVATORY.

ANNUAL REPORT 1963

by

P.M. McGREGOR

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CONTENTS

SUMMARY

The normal recording programme in geomagnetism, seismology, and ionospheric sounding was continued at the Mundaring Geophysical Observatory during 1963. A network of field seismographs was operated during most of the year. Some other special projects in geophysics were also undertaken.

No routine scientific data are given here, as they are distributed currently or will be the subject of separate reports.

1. INTRODUCTION

The establishment, programme, and activities to the end of 1962 of the Mundaring Geophysical Observatory have been outlined in the first annual report of the observatory (McGregor, 1964). This, the second such report, covers the calendar year 1963. Plans of sites, buildings, etc., mentioned here may be seen in the first report.

2. STAFF

The designations of geophysicists given below are those introduced in September. Occupants of staff positions were:

Geophysicist Class 3 (Observer-in-Charge)	P.M. McGregor
Geophysicist Class 2	I.B. Everingham
Geophysicist Class 1	G.L.S. Carrard. (11th March - 20th November)
Technical Officer Grade 2	A. Parkes
Technical Officer Grade 1	G. Woad
Clerical Assistant Grade 1	Miss D.M. Belcher
Assistant Grade 1	N. Keating
Gnangara Assistant	L.K. Eastcott (to 30th March)
	R.N. Gaskell

Others stationed at the observatory were:

Geophysicists Class 1 (Antarctic trainees)	J.R. Wilkie (29th July to 28th October)
	G.R. Small (12th November to 12th December)
University students (vacation 1962/63)	P.J. Browne-Cooper
	S.S.W. Hui
(vacation 1963/64)	P.J. Browne-Cooper
	S.S.W. Hui (part)
	C.J. Kosina

Annual recreation leave was taken by most officers. Sick leave absences totalled 44 man-days; details of other absences were:

Officer	Reason	No. of days
Everingham	Arbitration witness	3
Keating	Accident on duty	28
McGregor	Overseas travel	37
Woad	Military leave	20
	Official duty at sea	7
	Total	95

During his overseas travel McGregor attended an IGY symposium (Los Angeles) and the 13th General Assembly of the IUGG (Berkeley), as a member of the Australian delegation. At the Assembly he accepted an invitation to join the working group on magnetic indices, Commission IV of the IAGA. He later visited eight geophysical establishments in the USA and Canada.

3. OBSERVATORY ESTABLISHMENTS

Changes in the establishments included the addition of a machine-shop at the office site and the provision of a water supply at Gnangara. The first is in the form of an extension on the northern side of the garage, and provides 200 square feet of floor space. A quarter of it is used for storing large equipment items, and the remainder for the machine shop. Access is by means of double sliding doors in the east and west walls. The previous workshop has since been devoted to the repair of instruments and final assembly of constructed items.

The Gnangara water supply consists of a bore and pump. The supply is at a depth of about 45 feet and can provide up to 2000 gallons per hour. A jet pump delivers the water to a 500-gallon storage tank and is actuated by a float switch in the tank. From here it is proposed to reticulate water through plastic piping to outlets near the main buildings, using a centrifugal pump. The water supply will allow improvement of the grounds and of the fire precautions.

4. ORGANISATION AND OPERATIONS

Scientific programme

Minor changes in the "general" and "monthly" routines were made in October when a 16-mm microfilmer was received. Contact and 35-mm microfilm copying by Technical Officers was abandoned as completely as possible. Except for the production of two 35-mm films of the monthly magnetograms (for the DTMCIW, and WDC A) all copying (16-mm) became the duty of the Clerical Assistant.

Administration

Stores accounting. The annual stocktake of accountable stores was made in October with assistance from the Department of Supply. Several surplus items were treated by a Board of Survey at the same time.

Fire precautions. The usual fire precautions at all locations were taken. In the evening of 17th March a fire occurred in the powerhouse when the alternator on duty (No. 1) failed. The probable cause was that burning insulation ejected from the machine set fire to a box of cleaning rags some nine feet away. Fortunately the fire expired after charring some wall studs and a window frame. Appropriate steps have been taken to prevent the repetition of such an accident.

Library. Three textbooks and thirty-two journals were received and accounted for; seventy-eight volumes of journals were bound. Many other donated publications were received including over a hundred volumes of researches of the Carnegie Institution (via the Smithsonian Institute). After seismological work ceased at Perth Observatory, the Observatory sent all its records and files on this subject to Mundaring.

Visitors. Observatory establishments were visited by ten members of No. 8 Tracking Station (Muchea), several local residents, and: Mr B. Shaw (Ionospheric Prediction Service, Cocos Is. 1963, for familiarisation with the ionosonde); Messrs R.F. Thyer, J. Latter, L. Cook, and J. Simmonds (BMR); Department of Supply and Commonwealth auditors; Prof. S.K. Runcorn (King's College, Newcastle on Tyne) and Dr. G.J.H. McCall (University of W.A.); Fr P.N. Mayaud (IAGA Commission IX); Mr F. Taylor (IPS, Mawson 1964, for ionosonde familiarisation); Mr. F. Hewitt (Telecommunications Research, Johannesburg).

Works programme and equipment

Works programme. Jobs executed under the programme were:

Job	Completed
Office: painting (rooms O.I.C., seismic magnetic, general; passage; residence; boundary fence)	January
insulation to ceiling	January
supply of magnetogram and seismogram storage cabinets	June
Ionospheric house: painting	January
Powerhouse: repair fire damage	May
Gnangara: Test bore	January
Final bore, with pump and motor	October
Repair 2 electrical outlets	November
Office: erect machine shop	October

Equipment. Major items purchased were: a rotary drier (darkroom); 16-mm portable microfilmer; archival film reader (12x and 24x); transistor checker; bench grinder; workbench (6 ft); and two electric motors (0.5 hp, machine tools).

Items constructed from semi-consumable stores included: a low-tension power supply (ionosonde); two radio time-mark programmers; and two DC power supplies (14-V, 20-V).

Power plant and vehicles

Power plant. A major failure of No. 1 alternator occurred on 17th March. After four attempts by period contractors, it was finally repaired by the Stores & Transport Branch and returned to operation in July. Similar failures had occurred to this armature in 1960; it was therefore decided that the unit could not be relied on, and headquarters was requested to purchase a replacement.

Vehicles. A Holden station sedan and a Holden sedan were on weekly hire (Type 6) from the S & T Branch. Both were replaced by later models in September. In addition utilities were hired for periods of up to a week during the establishment and dismantling of the seismic field stations.

Vehicle mileage totalled some 27,000 miles, an increase of 28 percent over 1962. The greater part of this increase was due to the field seismology activities. The sedan suffered minor accidental damage twice.

5. GEOMAGNETISM

Normal magnetograph

Normal magnetograms (20 mm/hr) were obtained throughout, using the Eschenhagen magnetograph; 4 days' record was lost through accidental exposure of the magnetograms. The H variometer was raised on 23rd October to increase the trace intensity; previously the quality of the record during severe disturbance was sub-standard. There were no other variometer adjustments.

Scale value observations were made as before. Adopted H scale values (So) were 2.50 and 2.51 gammas per mm with a standard error of 0.002 gammas per mm; adopted Z scale values ranged from 5.26 to 5.29 with a standard error or 0.003 gammas per mm.

Temperature coefficients were checked by baseline value analysis; the previous values of qH = 1.5 and qZ = 2.5 gammas per degree C were confirmed.

The orientations of the variometer magnets were not determined; from the recording ordinates and the annual change of D it is known that the magnets are suitably oriented.

The variometers performed satisfactorily as indicated by baseline and scale values. H base values drifted by 3 gammas (excluding an abrupt change of 9 gammas at the October adjustment), and the standard error of the adopted values was 0.3 gammas. Adopted Z values ranged through 6 gammas, with standard error 0.4 gammas. D values showed an annual wave as in 1962, but reduced to 0.4 minutes; the standard error was 0.04 minutes.

Visual variograph

The IQSY World Days programme includes the declaration of "Alerts" as solar and geophysical events occur. One type of Alert is the "Magcalme" which is included so that advantage may be taken of the especially quiet conditions expected during the years 1964/65. The requirements for Magcalme are that during the preceding 24 hours there were at least four 3-hour periods with K = 0, and none of K greater than 1, and that no disturbance is expected in the next 24 hours.

In August the Associate Regional Warning Centre (IPS Sydney) asked the observatory to supply the magnetic advice necessary for the declaration of Magcalme intervals. This could be given if K_H indices derived from the variograph were reliable, so the instrument was thoroughly overhauled to attain this performance. By November it was producing reliable variograms with uniform sensitivity over the entire chart width. The scale value was adjusted (by means of the sensitivity magnet) to 1 gamma per mm (7 gammas per microamp). Variogram indices agreed with those from the normal magnetograph over a 4-week period. Magcalme conditions did not occur during November and December.

Magnetometers

Weekly observations for baseline determinations were made. Standard deviations of base values showed that the QHM was reliable to $\pm$ 2 gammas, the BMZ to $\pm$ 3 gammas and the magnetometer to $\pm$ 0.2 minutes.

Comparisons and standards

H and Z comparisons were made with QHM 293 and BMZ 120, and proton vector magnetometer MNZ-1 No. 1 in May and June. The results were:

H standard = PVM
= QHM 293 - 1 gamma

Z standard = PVM
= BMZ 120 + 316 gammas

In the H comparisons, QHM determinations were made between PVM determinations of F and Z. In the Z comparisons the BMZ and PVM were read simultaneously.

The H result was considered satisfactory, the deduced (and adopted) correction being +1 gamma. Adopted corrections for the other two instruments, derived from the weekly observations, were: QHM 291, -11 gammas; QHM 292, -18 gammas.

The Z result conflicts with the 1962 determination (correction + 323 gammas), and is 9 gammas smaller (numerically) than that deduced from the history of the BMZ. The preliminary correction of +325 gammas has been used on data distributed; a final correction awaits further comparisons.

The correction applied to declinometer Askania 508810 was + 0.5 minutes.

Data and publications

Routine data were distributed as in 1962. In addition 35-mm copies of the magnetograms, with control data, were sent to NASA in connexion with the proposed World Magnetic Survey, and to the Stanford Research Institute (until 30th September) in connexion with its v.l.f. experiment between the USA and Gnangara. From October the requirements of both NASA and WDC A were met, by arrangement, by provision of one monthly film to the data centre.

Miscellaneous data or magnetogram copies were supplied at the request of institutions in Germany, Alaska, W.A., and Hungary. There were also several minor local requests for information, and two overseas requests for Watheroo mean hourly values, which are not yet available.

Annual Means and secular change

Preliminary annual mean values, based on the five local quiet day ordinates, and the changes from 1962.5, were

H:	23,931 gammas	(- 14 gammas)
D:	-2°52.3'	(+ 0.5')
Z:	-53,497 gammas	(-7 gammas)

These support the previous indications that H is decreasing from its peak in about 1957 and that the rate of increase of Z has diminished markedly since about that time. The annual change in D (easterly) may be increasing slightly.

Projects

Sq variability. The study of Sq variability (H) continued during the university vacations. Monthly mean curves were drawn for the years 1958 to 1960 to illustrate the annual phase and amplitude changes. As a result of these some revision of the earlier estimate of the percentage of occurrence of the three main types (McGregor, 1966) will be necessary. Type I probably occurs only 10% of the time, and type P about 80%. Classification of all quiet days from 1919 will give more reliable results.

Induction loop. The induction loop (dH/dt) for recording micropulsations was completed in January and, using a 14-second galvanometer and 30-mm/min helical recorder (ex Benioff seismograph) recordings were made until mid-March. The response of this system was inadequate at periods shorter than about 5 seconds. In June recording was resumed using a 9-second galvanometer (Kipp, ex Mawson fluxmeter) and one channel of a Wood-Anderson seismograph recorder. This combination was too sensitive using the full loop output, which was therefore reduced to about one-third. Recordings were made until mid-December. Pulsations pc and pt were recorded for a large percentage of the time; none of these data have been published, because of their almost continuous occurrence. It is obvious that more sophisticated techniques would be required if continuous recordings over any length of time were contemplated. At this stage a reasonable scheme for studying pulsations using simple equipment appears to be to limit recording to certain days, such as Regular World Days and Alert Days. It is proposed to do this during IQSY.

Watheroo data

The compilation of magnetic control data, 1950-1958, in the form required for mean hourly values reductions by "Silliac" computer, was completed and the lists were sent to headquarters. Preparation of control data tables for inclusion in the Mean Hourly Values Report was commenced.

Wilkes Z variometer

Because of poor performance of the Ruska Z variometer at Wilkes, headquarters decided to replace it by the ex-Watheroo La Cour variometer. Antarctic trainee Small received instruction in its installation by setting it up in the laboratory. The original lens was replaced by one of focal length 218 cm, to suit the Ruska array. (Some confusion over the actual focal length was caused through initial focussing from a warped base-line mirror). The variometer and a CIW Helmholtz coil were transferred to Wilkes in December.

6. IONOSPHERIC PHYSICS

Ionosonde

The Cossor ionosonde was maintained in almost continuous operation. A total of 21 days' recording was lost. This was due to: equipment or power failure (13 days); camera failure or film run-out (3 days); clock and programme failure (3 days); and observer errors (2 days). For the remainder, generally good quality ionograms were obtained, resulting in data output for over 90 percent of the time.

A regulated low tension power supply was installed in January; the (daily) tuning of the fixed frequency oscillator was facilitated by the fitting, in July, of a slow motion adjustment (planetary drive) to its coil.

Data and publications

Data were derived and published as in 1962. From October, the beginning of the trial period for IQSY, additional parameters were scaled. These were: for all days - fb Es, h'Es, h'E and Es type; and for Regular World Days - the profile heights h_1 and h_2 (see U.R.S.I. Handbook of Ionogram Interpretation and Reduction, p. 146).

From 24th April weekly F2 data were sent to the U.S. National Bureau of Standards. This entailed the transmission by telegram (to IPS, Sydney) of foF2 at 00, 06, 12, and 18 hours UT for the previous seven days. The purposes of these data reports are:

> ".....to follow current trends of the ionosphere and to prepare a new series of revision factors....."
>
> and
>
> ".....for use in a long term study of the possibility of obtaining a reasonably accurate current description .....on the basis of reports from a limited number of geographically distributed ionosphere stations:"

Requests for Watheroo or Mundaring data were received from France and Argentina and were met as far as was practicable.

7. SEISMOLOGY

Standard system

The World Standard seismographs were operated continuously, except during adjustments, with record losses totalling 8 days on one or all records. There were also several occasions when poor quality seismograms resulted through improper handling and processing.

Routine tests and adjustments were made, on the average, every three months.

From January to May the long-period system magnification was 1500; it was reduced to 750 with the onset of winter and it will probably be kept at this figure throughout the year in future. No extra information is obtained from recordings at the higher sensitivity.

A replacement frequency standard was inserted in the console in January and reasonable timing resulted thereafter. In November the LP-N seismometer-galvanometer wiring was replaced to eliminate changes of trace position during the application of calibration pulses. Some trouble was experienced with the stroboscope but this was corrected by attention to the commutator.

Benimore system

This remained in routine operation except during use of the Willmore recorder in the field (see below). Its records continued to be valuable for the detection of first arrivals.

Some changes in time-mark provision were introduced; these are described in the section on timing and programming.

Data and publications

Preliminary data were published on schedule to the same institutions as in 1962. From the end of May analyses were sent to the USCGS twice weekly. Bulletins (final analyses) and ISS mark sense cards to September were distributed by the end of the year. These contained information on 503 earthquakes.

Projects

Local seismicity. The study of local seismicity was extended to the end of the year and a draft record was written by Everingham. Eighty-one local or regional shocks were recorded, all being of magnitude greater than 3.5. One of these, of magnitude 5 and felt in Perth, with epicentre at Nourning Springs was studied by macroseismic methods. From the replies to a standard questionnaire an isoseismal map was drawn which allowed a depth estimate (18 km) to be made.

Confirmation of the reliability of location of local tremors from single observatory recordings was obtained during the operation of field stations.

Phase-velocity network. The tripartite network of short- and medium-period seismographs proposed in 1962 was established by 7th June, and recordings were made until 17th December. The stations, with matched seismometers and galvanometers, were located at Mundaring (laboratory), Grass Valley (post office), and Narrogin (Agricultural High School). The outstation equipment was housed in plywood cabins, placed in sheds for weather protection. Timing was provided by chronometers and programmers which allowed the recording of the hourly radio time-signals. At Narrogin the commercial electricity supply was 40 c/s, so a battery charger/

inverter system was required for the drum motors. The installations were attended daily by local residents, and were visited by observatory staff as required for adjustment (twice) or repairs (eight times). The Appendix summarises the network sites and instrumentation.

During the period suitable Rayleigh wave trains were recorded from five earthquakes which will provide data in the period range 10 to 22 seconds. Analysis of the records was in progress at the end of the year.

Explosion studies. Refraction measurements were made using depth charges exploded over the continental shelf, and large quarry blasts.

The first project was made with the co-operation of the Royal Australian Navy and the CSIRO, the cruises of HMAS Diamantina having been arranged for CSIRO's Division of Fisheries and Oceanography.

During August, six 300-lb depth charges were exploded at a depth of 70 fathoms between Cape Naturaliste and Beagle Island. The shot-points were near those previously determined at the observatory to provide suitable source-to-seismometer distances, as governed by the seismograph sites. Additional distances were obtained by using the Willmore seismograph at various locations for different detonations.

Shot instants were recorded on the vessel by means of a hydrophone and pen-recorder, with associated chronometer and radio time-mark control. Of the possible 24 recordings, 23 were obtained, giving data on distances from 85 to 430 km.

The quarry blast recordings were made through the co-operation of Australian Blue Metal Ltd, which commenced using infrequent large charges (rather than small daily charges) at their Gosnells quarry.

On 4th October, waves from an 11,200-lb charge were recorded at the Observatory, at Grass Valley, and at an intermediate Willmore station; i.e. at distances from 20 to 86 km. The shot instant was recorded at the source, as on the Diamantina.

A second large explosion on 22nd November was recorded at Narrogin (thus extending the distance to 143 km) and at an intermediate Willmore station.

The data from these recordings on the Shield will be combined with those to the west of the Perth Basin, to derive a model of the crustal structure in the south-west of the State. The results will be the subject of a separate Record.

Timing and programming

At the end of 1962, timing and programming systems (Weir site) were:

(a) Standard console system: provided minute marks (00-02 seconds) and hour marks (00-04 seconds) except at the Greenwich hours 00, 06, 12, and 18, when radio time-marks were programmed on.

(b) Landis system: pendulum clock and programme machine facility for provision of pulses at any minute (pulse start was changed from 59 to 00 seconds in December 1962); pulse lengths of 1 or 5 seconds available.

Until November the Standard system was used only on the Standard seismograph; all other timing (Benimore seismograph, ionosonde, and repeater clocks) was derived from the Landis system.

In November 1963, all timing was put on the same basis, with the console (crystal) timer as the primary source and the Landis pendulum clock (LPC) as a "secondary" (emergency) source. Because the standard source does not provide pulses at multiples of Greenwich 6 hours, these had to be provided when using the console. This was achieved by:

(1) At the required 59th minute Landis programme machine pulse starts a 1-rev.-per-72-seconds synchronous motor.

(2) At 00 minutes a cam-operated microswitch on the motor shaft produces a pulse to advance the LPM.

(3) The motor stops (at $00^{m}12^{s}$).

The LPC was kept operating with the same tolerances in correction and rate as before. It can replace the console timer by the throw of a switch. Further, in the event of failure of both primary and secondary sources, provision has been made for connexion of a chronometer.

8. ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the assistance given by: the State Controller and staff (Department of Supply), Mr. E. Brophy (Grass Valley), Mr. J. West and staff (Narrogin Agricultural High School), personnel of the Department of the Navy and CSIRO (Divison of Fisheries and Oceanography), Captain and crew of HMAS Diamantina, and staff of Australian Blue Metal Ltd.

9. REFERENCE

McGregor, P.M. 1966 Mundaring geophysical observatory, annual report 1962. Bur. Min. Resour. Aust. Rec. 1966/35 (unpubl.)

APPENDIX

Seismological Field Stations 1963

	Station A Mundaring Office (MGO)	Station B Grass Valley (GVY)	Station C Narrogin (NGN)
Latitude (S)	$31^{\circ}\ 54.1_5'$	$31^{\circ}\ 38.1_5'$	$32^{\circ}\ 58.3_5'$
Longitude (E)	$116^{\circ}\ 09.0_0'$	$116^{\circ}\ 47.6_0'$	$117^{\circ}\ 06.9_5'$
Recorder	Wood-Anderson	Benioff	Benioff
Drum rate, mm/min	30	60	30
Commenced	12 June 1963	19 Apr 1963	30 May 1963
Finished: (a)	14 Nov 1963	14 Nov 1963	14 Nov 1963
(b)		17 Dec 1963	19 Dec 1963
Operator:	M.G.O.	E. Brophy	J. West

(a) Refers to long-period system
(b) Refers to short-period system

SEISMOGRAPHS	Seismometer Type	Seismometer Period	Galvanometer Type	Galvanometer Period	Purpose
Short-period	(c) Benioff H*	1.0	Benioff	0.25	Location of local tremors
Long-period	Willmore Z	1.0	Benioff	14	Phase velocity

(c) At Grass Valley and Narrogin only.

* Horizontal seismometers directed to Beverley-Brookton region

INTER STATION	DISTANCE (km)	BEARING	BACK BEARING
MGO-GVY	66.4_6	$63^{\circ}\ 38'\ 14"$	$243^{\circ}\ 18'\ 24"$
MGO-NGN	148.5_0	$143^{\circ}\ 22'\ 35"$	$322^{\circ}\ 51'\ 59"$
NGN-GVY	151.2_7	$348^{\circ}\ 23'\ 50"$	$168^{\circ}\ 34'\ 10"$

NETWORK ANGLES	MGO:	GVY:	NGN:
	$79^{\circ}\ 44'\ 21"$	$74^{\circ}\ 44'\ 14"$	$25^{\circ}\ 31'\ 51"$