COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/46

PORT MORESBY GEOPHYSICAL OBSERVATORY

ANNUAL REPORT, 1963

by

J.A. BROOKS and C.L. COOKSON

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SUMMARY

Routine and special collection, calibration, and distribution of observatory seismic, geomagnetic, and ionospheric data were maintained.

The seismic recording equipment was improved and research into seismicity and crustal structure was extended.

The magnetic rapid-run equipment was made more sensitive both for general and for specific research purposes. Electronic computation was applied to some of the problems of base-line value adoption. The 1962/63 regional magnetic survey was completed.

The ionosonde continued to be troublesome, and an improvement in data recording was offset to some extent by interference from the new Australian Broadcasting Commission transmitters nearby. Equipment for recording scintillations of Earth satellite signals was installed and checked in readiness for the 1964 NASA space vehicle launching.

In parts of the main island that were both remote and difficult of access regional gravity readings were made possible by a helicopter chartered by the Division of National Mapping.

1. INTRODUCTION

A description of the activities of the Port Moresby Geophysical Observatory to the end of 1962 is given in an earlier Record (Observatory Staff, 1965).

This Record describes the programme undertaken by the Observatory in 1963. The programme was largely a continuation of work begun in previous years but with two main exceptions:

(a) At the request of the Radio Research Board Laboratory of the Electrical Engineering School, University of Sydney, the Observatory undertook to install radio receiving equipment to assist in a new ionospheric research project. The work is outlined in Section 4.

(b) Although not part of the normal programme, circumstances made it convenient for the Observatory to help promote and coordinate the regional gravity observing programme outlined in Section 5.

A list of the scientific staff engaged in Observatory work in 1963 is given in the Appendix.

2. SEISMOLOGY

The recording capability of the Observatory was increased during 1963 and, on an average, ten earthquakes a day were read.

Instrumentation

Additions to the seismograph vault (Observatory Staff, 1965, Plate 10) were completed early in March and an installation team from the United States Coast and Geodetic Survey (USCGS) then reinstalled the standard seismic recorders in Recording Room No.1. This work was completed in the first week of April.

In July, the Wood-Anderson torsion seismometers were transferred from the temporary recording room in the Lawes Road Office to Recording Room No.2. The Wilson-Lamison short-period vertical instrument was installed in Recording Room No.2 in November and is being used as an emergency short-period vertical instrument.

The Series-H Sprengnether horizontal component seismographs began recording in November and are being calibrated against the corresponding long-period instruments of the standard seismograph system.

During August, attempts were made to reduce drift, which has affected standard seismograph long-period horizontal records since installation. Although the malfunction was traced to thermal instability within the instrument covers and partial success was achieved by changing the location of the seismometer heaters, the instability is difficult to remove entirely as indicated by the USCGS, who is conducting research into the problem. Our efforts enabled satisfactory recording to be maintained in one component only, at a gain of 6000 and a free period of seconds. Drift in the second component was reduced but not eliminated. This permitted long-period gain to be permanently raised to 3000 in September, from the initial figure of 1500. Details of the layout of instruments in the new seismograph vault are given in Plate 10 of the annual report for 1962 (Observatory Staff, 1965).

Data distribution

Routine. During the year, a total of 3654 earthquakes were analysed. The analyses were included in bulletins of provisional earthquake phases sent to the USCGS. Distribution of these was continued at the rate of two airmail letters per week, together with one weekly bulletin to a restricted mailing list. Distribution of data by telegram to USCGS was begun in December, on request.

Original standard seismograms were forwarded regularly to USCGS.

Special requests. During 1963, special requests for seismological data were of three types:

(a) Requests for copies of seismograms or for lists of phases for various investigations, e.g. source motion studies. These requests originated chiefly from the Dominion Observatory in Ottawa, Canada, and information was provided in every case.

(b) Requests for comments on particular aspects of seismic risk. These requests originated chiefly from insurance companies or construction authorities and information was provided as required.

(c) Requests for information on large local earthquakes for news releases. The two events that aroused most interest during the year occurred on February 27th, when a particularly large earthquake was felt throughout the Territory of Papua and New Guinea, and on November 4th when a large eqrthquake in the Banda Sea was felt widely in Australia.

Seismological research

Regional seismicity. Further research into regional seismicity was continued in order to evaluate relations between magnitude, epicentral intensity, and depth of focus. The earthquake of February 27th 1963 provided an excellent opportunity to obtain such data and 800 questionnaires were distributed throughout the Territory seeking information of felt effects. Response to these requests was excellent; more than 200 replies were received. It is believed that this earthquake is themost thoroughly investigated in Territory history from this viewpoint. Results (to be published) indicate that the centre of the isoseismal pattern was displaced more than 100 miles north of the epicentre.

<u>Crustal structure studies</u>. Further preparations were made for the crustal thickness project described in the previous annual report but equipment for this is not expected until 1964.

3. GEOMAGNETISM

The routine programme of data recording, analysis, and distribution was continued during 1963.

Approximate mean values of the three field components at epoch 1963.5 (Table 1) were:

H: 0.36380 gauss, decreasing by about 0.00020 gauss annually.

D: 06° 06'.5E, increasing by about two minutes annually.

Z: -0.22940 gauss, increasing (negatively) by about 0.00030 to 0.00050 gauss annually.

<u>Instruments</u>

Standard La Cour (15 mm/hr)		Rapid-run La Cour (180 mm/hr)		
Element	Scale Value	Element	Scale Value	
H	3.0 gammas/mm	H	1.4 gammas/mm	January to September
D	4.7 gammas/mm (0.44 minute/mm)	D	4.2 gammas/mm (0.40 minute/mm)	
Z	3.2 gammas/mm	Z	0.7 gammas/mm	
		H	1.2 gammas/mm	September to end of 1963
		D	0.3 gammas/mm (0.03 minute/mm)	
		Z	0.4 gamma/mm	

Both recorders operated continuously throughout the year, although mechanical failures of the rapid-run recorder resulted in much record loss.

The method of time marking discussed previously (Observatory Staff, 1965) remained unchanged during the year. Standard La Cour records are within ±30 seconds of GMT. Rapid-run times are within ±5 seconds of GMT.

To help detect possible oscillations of the Earth's magnetic field resulting from a future major earthquake (Observatory Staff, 1965), the decision was made to increase the rapid-run D variometer sensitivity. Part of the technique for accomplishing this involved the use of an auxiliary magnet, which was so oriented that an appreciable increase in the rapid-run Z variometer sensitivity was achieved simultaneously. The H, D, and Z rapid-run variometer scale values were redetermined in September (see the Table above), following these changes.

Routine weekly calibrations of the H, D, and Z normal-run variometers were continued, using QHMs 187, 188, 189, Askania declinometer 580333, BMZ 68, and three Helmholtz coils permanently oriented over each variometer. In May, the orientations of the H and D variometers were checked.

From February to May, the Observatory series QHMs (Nos. 187, 188, and 189) were intercompared with the 460 series QHMs (Observatory Staff, 1965).

Neither the BMZ 68 nor the Askania declinometer 580333 were checked against independent instruments during the year, and previously established corrections to these instruments (Observatory Staff, 1965) remained unaltered at zero gammas and -0.6 minute respectively.

Regional magnetic survey data (see below)were obtained using QHM 173, BMZ 221B, and Askania declinometer 580339, which were intercompared with Observatory instruments before and after the field programme.

Data

Routine. Transient magnetic effects, including storms, pulsations, and K-Indices were listed from the records and distributed to eleven recipients including World Data Centres A, B, C, and C_2.

Copies of magnetograms were also forwarded to World Data Centre A and the National Aeronautics and Space Administration (NASA).

Special requests. The main requests for data were received from the following authorities and were fulfilled:

Chairman IAGA Committee No.10	(transient effects 1960)
Dr P.N. Mayaud	(magnetograms)
NASA	(mean values)
Professor K. Runcorn	(magnetograms)
IAGA Committee on Observatories	(station and instrumental data)

Baseline adoptions

Analyses of observed variometer baseline data for the period 1959-1962 were continued, preparatory to the scaling and subsequent publication of hourly magnetic values.

Two features of baseline data that complicate these analyses are:

(a) The small annual range in variometer temperature (about 29°C to 32°C), which renders temperature coefficient determination difficult. It is possible to ignore the coefficient under some circumstances, e.g. when it is small, and adopt H and Z baselines at 'daily temperature'. 'Daily temperature' fluctuations are a few tenths of a degree at the most.

(b) The H variometer baseline has 'drifted' consistently since initial installation. This drift has been maintained despite changes of the magnet suspension. The superimposed effects of temperature coefficient and baseline drift are difficult to separate by desk calculation methods when the drift is other than linear.

At the suggestion of Mr D.E. Winch (Applied Mathematics Department, Sydney University), attempts were made to separate these two effects by processing the baseline and temperature data with an IBM 1620 computer using an iterative process that permitted close approximations of the two unknown effects.

If we let:

y_i = observed baseline value (in gammas)

x_i = time (in weeks)

t_i = variometer temperature

where i varies from 1 to n in a data sequence of n days, the computer can first be made to fit an expression for drift, $y = f(x)$, to a sequence of time versus baseline data at daily temperature (x_i, y_i) by least squares. $f(x)$ was chosen to be a polynomial in x and separate analyses were computed for different expressions $f(x)$ up to the fourth power. The residual baseline plot of x_i versus Y_i $(y_i - y)$ can then be correlated with x_i versus t_i to deduce a temperature coefficient C. New values of y_i' $(y_i - Ct_i)$ are then formed and the process repeated until differences between successive determinations of C become small enough to ignore.

The program tested several sets of data chosen from a three-year period during 1959-1962 with the following conclusions:

(a) Drift lines were inconsistent for different sets of data.

(b) Linear drift lines did not fit the data well. Non-linear drift was most pronounced following changes of magnet suspension.

(c) The temperature coefficient was small for this period. This would allow baselines to be adopted at 'daily temperature, but in view of non-linear drift it would be necessary to reanalyse new sets of data in this way if the coefficient increased.

This work was still in progress at the end of 1963.

Regional magnetic surveys

Five selected regional magnetic stations in the New Guinea Islands were occupied in July. The station at Lae on the New Guinea mainland was occupied in lieu of Kandrian, which could not be reached because of bad weather.

Stations occupied were:

Pomio (New Britain)

Lorengau (Manus)

Kavieng (New Ireland)

Sohano (Buka)

Aropa (Bougainville)

Lae (New Guinea)

General

The magnetic vault was flooded to a depth of several inches during a heavy downpour in January. The subsequent high humidity, which lasted several days, so affected the record and time-lamp circuits and the photographic paper that the quality of the records fell considerably. Such heavy rain is unusual.

Tables for use when computing QHM results have been compiled and were found to reduce the labour considerably.

The Observatory will participate in the IQSY data collection programme in 1964 and 1965.

4. IONOSPHERICS

The normal programme of vertical incidence soundings at quarter-hourly intervals was continued throughout the year, and the required data output was maintained. The quality of recording improved after changes, designed and constructed by Observatory technical staff, were made to sections of the receiver.

Data

The usual parameters were regularly scaled for Ionospheric Prediction Service (IPS) purposes throughout the year and forwarded to that organisation. Medians are not computed in Port Moresby. From April 1963, six-hourly values of foF2 were telegraphed weekly to the IPS in response to a request for these data from the National Bureau of Standards.

Trial scalings of f-plots and F2 profile heights were commenced in October in preparation for regular requests for these data during the IQSY beginning January 1964.

Despite the decreasing and relatively low sunspot number, foF2 frequencies of 13-14 Mc/s were occasionally still being tabulated in November-December. foF2 monthly medians at six-hourly intervals for 1963 are listed in Table 2.

Equipment

Rather more record than usual (amounting to an average of two to three days per month) was lost during the year because of equipment faults, but on the whole the quality of records was better than in 1962. The high average of record loss does not accurately reflect the rate of component failure, which was not excessive for this type of equipment. Much of the loss was incurred in the first two months of the year through sporadic failure of the film drive mechanism of the recorder camera until this was corrected in February.

On one or two occasions, delays incurred pending the arrival of parts also contributed to the record loss already mentioned.

A significant improvement in the performance of the recorder was made in September. It had been known for some time that small-amplitude echoes discernible at the receiver output were not being recorded on film. The cause was ultimately traced to distortion of the display wave form by the large-amplitude transmitter pulse and the effect of d.c. restoration in the video amplifier stages. The solution consisted of redesigning and simplifying the video amplifier unit.

Two failures in the h.t. and v.h.t. circuits were chiefly caused by faults in the mercury vapour rectifier tubes. By the end of the year, all v.h.t. and h.t. circuits had been modified by replacing gas rectifiers with silicon diodes. These modifications resulted in a larger voltage to the final power amplifier section and a higher transmitter power output, which improved still further the quality of records.

Severe interference to the ionospheric records was noticed in July after the relocation and increase in power of Australian Broadcasting Commission (ABC) transmitters. These units were formerly located about 5 miles from the Observatory, but in June were shifted to a new location barely two miles away. Effects became so marked in the 3-5 Mc/s range during transmission hours that it was thought necessary to examine the possibility of moving the recorder to an alternative site. The assistance of the Department of Posts and Telegraphs was sought to carry out special field intensity tests to determine the level of interference. These confirmed that the ionosonde was being affected by strong fields from the ABC transmitters.

The situation was relieved in November when the ABC brought a new unidirectional antenna system into service, which modified the interference effects at the ionosonde to an acceptable level. At that stage, plans were in hand to increase the recorder signal-to-noise ratio by raising the transmitter power output, but these were postponed.

Requests for data

One important request for data was received in 1963, when the Administration of Papua and New Guinea broadcast station at Rabaul reported that broadcasts were not being received with usual clarity in the area. It was found that these effects could be attributed to ionospheric storm conditions, but the investigations concurrently revealed that IPS predictions for vertical incidence transmission in the Territory were erroneous. Discussions with personnel of IPS revealed that Port Moresby sounding data were not, at that stage, being incorporated in the prediction data because of the relatively short time sequence of these data. The prediction problem was attributed to lack of knowledge of the shape of the foF2 frequency profile with latitude in the New Guinea region and its variation during an eleven-year cycle. IPS was using only war-time results from the Cape York Peninsula station. To improve predictions the IPS procedure was modified to include Port Moresby sounding data. These results will be extrapolated for a full sunspot cycle until a more extensive sequence of scalings, made over a longer period, become available.

On the basis of the revised predictions, IPS reached the conclusion that the Rabaul broadcast frequencies would just be satisfactory during the period of sunspot minimum in mid-1964 and no recommendations were made to the Administration of Papua and New Guinea to change broadcast frequencies.

Scintillation recorder

Equipment used to record intensity fluctuations of c.w. radio signals transmitted from artificial Earth-satellites was installed in the ionospheric building in September 1963.

This installation is part of a north-south chain of similar recording stations from Port Moresby to Macquarie Island, which are operated by various authorities for the Radio Research Board Laboratory of the School of Electrical Engineering, University of Sydney.

A block schematic diagram of the installation is shown in Plate 2.

The purpose of the experiment is to provide data for studies of the ionosphere, which causes intensity fluctuations (scintillations).

The recording equipment is designed initially to monitor signals to be transmitted for a period of one or two years from the NASA satellite S 66, to be launched in 1964. Recording frequency is 20,005 kc/s.

In December 1963, signals from a Russian satellite 'Cosmos 23' were successfully monitored for test purposes.

General

Observatory operations require maintenance of a wide range of recording and test equipment and its occasional modification. Repetitive maintenance is required of the transmitting, receiving, and display sections of the ionospheric recorder, the seismograph control system, seismograph and magnetograph recorders, and the Observatory timing systems.

In 1963, additional facilities for the mechanical workshop were installed when the workshop and storage area was enlarged. Thereby, mechanical and electrical maintenance facilities were separated.

Equipment modifications that required the use of workshop facilities during 1963 have already been mentioned in Sections 1 and 4.

In addition, timing and programming facilities were installed at the Observatory site, the uniselector for the scintillation recording equipment was designed and constructed, test equipment was repaired, a small internal communications system was constructed for the seismograph vault, and radio receiving equipment was serviced.

Repairs were effected to Bureau of Mineral Resources (BMR) field equipment.

5. GRAVITY

Between May and December, 200 regional gravity stations were occupied on the mainland of Papua and New Guinea (Plate 1). The programme of observations was planned at rather short notice when it was found that use could be made of a helicopter under charter to the Department of National Development for mapping purposes. By integrating gravity observations with the high altitude geodetic survey programme of the Division of National Mapping, it was possible to obtain readings in unusual locations with accurate altitude control.

Although the work was initiated by the BMR and although a small number of readings in the early stages were taken by Observatory personnel, the observing programme was executed chiefly by observers from the University of Tasmania Geology Department and the U.S. Army Mapping Service (Far East).

Two meters were used:

(a) Master Worden No.548 belonging to the BMR.

(b) La Coste and Romberg No.G-24 belonging to the Gravity Branch of the U.S. Army Mapping Service (Far East).

Prior to this survey, few gravity readings had been made in New Guinea other than in basins surveyed by oil companies. Early in 1963, the University of Tasmania tied many of these data to the International gravity network. Although data are still lacking for some areas, principally in the Sepik, Western, and Madang Districts, a broad regional gravity coverage has now been obtained of most of mainland area.

Results are being reduced by the University of Tasmania Geology Department and will be published elsewhere.

In the course of the survey, a gravity meter calibration range was established in Port Moresby and preliminary differences between each station and PMCS/1 (Geophysical Office station and future pendulum site) are listed in Table 3. The most recent value of g adopted by the University of Wisconsin for three of the calibration range stations tied to their international network are also listed. These data were received by the Observatory in a communication dated 31st January 1964.

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6. MISCELLANEOUS

A new official residence was completed and handed over to the Observatory by the Commonwealth Department of Works during the year.

Visitors to the Observatory, in either official or private capacities, during 1963, included:

Professor S.W. Carey, University of Tasmania

Professor G. Kennedy (private visit) University of California, Los Angeles

Dr L. Slaucitajs and Mr D.E. Winch, Department of Applied Mathematics, University of Sydney

Dr M.B. Dobrin (private visit) and Mr W. Rimmer, United Geophysical Corporation

Dr Kujiraoka, Japan Petroleum Exploration Company

Mr R.F. Thyer, Assistant Director, B.M.R.

Messrs J. Turner and L. McGarry, Ionospheric Prediction Service

Dr T.S. Laudon and Mr P. Parks, University of Wisconsin

Mr B. Saini, Research Officer, Commonwealth Department of Works.

Various officers of the U.S. Army Mapping Service (Far East) concerned with gravity measurements.

7. REFERENCE

OBSERVATORY STAFF 1965 Port Moresby Geophysical Observatory, Annual Report 1962. Bur. Min. Resour. Aust. Rec. 1965/45 (unpubl.).

TABLE 1

Port Moresby Magnetic Observatory

Approximate monthly mean values

1963

Month	Element		
	H (gammas)	D (°East)	Z (gammas)
January	36,388	06° 05!3	-22,930
February	36,393	06° 05.1	-22,937
March	36,388	06° 05.4	-22,932
April	36,388	06° 06.0	-22,930
May	36,382	06° 06.4	-22,937
June	36,373	06° 06.5	-22,938
July	36,378	06° 06.4	-22,944
August	36,376	06° 06.5	-22,945
September	36,367	06° 06.9	-22,943
October	36,356	06° 06.7	-22,956
November	36,354	06° 07.0	-22,954
December	36,369	06° 07.3	-22,963
Epoch 1963.5	36,376	06° 06!3	-22,942
Epoch 1962.5	36,402	06° 04.6	-22,891
Epoch 1961.5	36,414	06° 02.6	-22,858
Epoch 1960.5	36,431	06° 00.8	-22,826

TABLE 2

Monthly median foF2 frequencies

Port Moresby, 1963

Month	00h E.S.T. (Mc/s)	06h E.S.T. (Mc/s)	12h E.S.T. (Mc/s)	18h E.S.T. (Mc/s)
January	6.2	4.4	9.0	8.6
February	6.3	3.3	10.1	7.9
March	5.8	2.9	11.5	8.9
April	4.4	2.8	9.9	8.4
May	3.6	3.0	8.8	7.0
June	3.3	2.7	6.8	6.4
July	3.2	2.4	6.9	6.0
August	3.8	2.4	8.6	6.0
September	5.0	3.2	9.0	7.6
October	7.2	4.4	10.8	8.2
November	7.4	4.9	11.4	9.3
December	6.2	4.4	9.2	7.6

TABLE 3

Gravity meter calibration range,

Port Moresby town area

Station No.		Location	Identification	Provisional Δg * from PMCS/1 (milligals)	g ** (gals)	Established by
BMR	Wisconsin University					
PMCS/1	-	Geophysical Observatory Office garage	Wisconsin University IGS brass marker	0	978.2169	Laudon 1961
PMCS/2	-	D.C.A. Distance Measuring Equipment Station, Burns Peak	Concrete block with 6-in square BMR brass plate flush with ground	-48.89		BMR 1963
PMCS/3	-	Main entrance gate to overseas wharf north of north wall of Customs Office.	T.P.N.G. survey mark flush with ground.	+ 9.33		BMR 1963
PM 4	-	Australian Petroleum Co. Pty Ltd (APC) Geological Office, outside door.	Concrete block with brass plate about 1 ft above ground.	+ 7.32		APC ?
PM 5	WA 3069	Main airport terminal entrance, on concrete floor by P.O. box.	Wisconsin University IGS brass marker.	- 4.02	978.2129	Laudon 1961
PM 6	WA 3046	Old airport terminal near NW end of strip 2 ft to right of steps at NW end of building.	None	- 2.03	978.2149	Muckenfuss 1950

* As advised by Department of Geology, University of Tasmania, May, 1964.

** Communication from Wisconsin to Port Moresby Geophysical Observatory, 31st January 1964. Based on observations with La Coste & Romberg G-1.

APPENDIX

Geophysical staff, 1963

Name	Classification	Remarks
Brooks, J.A.	Geophysicist Senior-Class 3 *	
Cookson, C.L.	Geophysicist Grade 3-Class 2 *	
Merrick, R.W.	Geophysicist Grade 2	Until 27th July
Jones, M.S.	Technical Officer Grade 1	
Ciszek, M.	Technical Officer Grade 1	
Noah, C.E.	Geophysical Assistant	Seconded from T.P.N.G. Administration
Lodwick, G.D.	Geophysicist Grade 1-Class 1 *	26th April - 18th October
Hoggard, J.S. (Miss)	Computing Assistant	11th March - 18th October
Glen, P.	Vacation Student	Until 15th February
Fitzherbert, W.	Vacation Student	Until 8th February Also from 5th December
Greville, P. (Miss)	Vacation Student	From 28th November

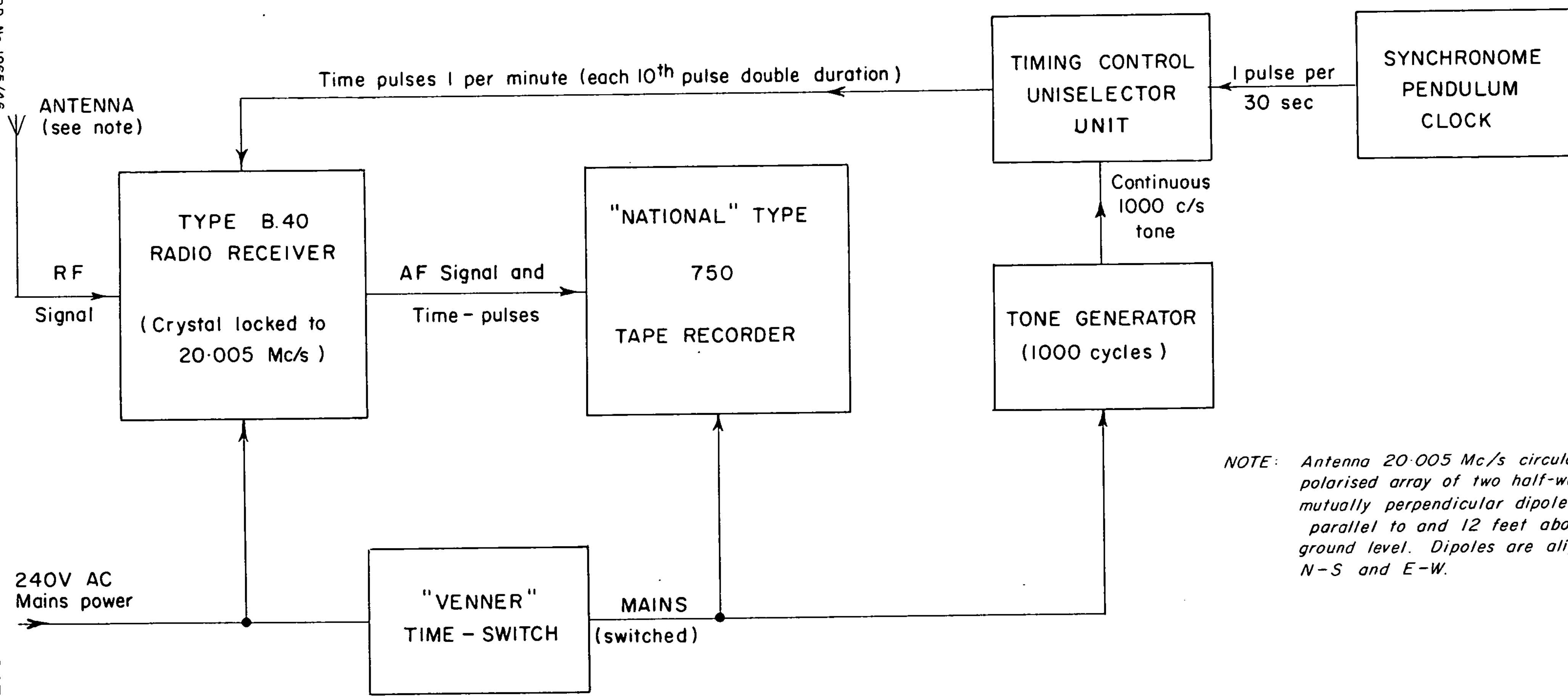
* Classification changed at 9th September 1963.

TO ACCOMPANY RECORD No 1965/46

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G82/1-25

TO ACCOMPANY RECORD No. 1965/46
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

PORT MORESBY GEOPHYSICAL OBSERVATORY
SCINTILLATION RECORDING EQUIPMENT



NOTE: Antenna 20·005 Mc/s circularly polarised array of two half-wave mutually perpendicular dipoles parallel to and 12 feet above ground level. Dipoles are aligned N-S and E-W.

G82/3-62

PLATE 2