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Record No. 1969 / 21

# Port Moresby Geophysical Observatory Annual Report 1967



by

*D. Denham*

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CONTENTS



ILLUSTRATION

## SUMMARY

1967 was the tenth year of operation of the Port Moresby Geophysical Observatory, where regular magnetic and seismological observatory programmes, and ionospheric recordings, are carried out. All commitments to national and international organisations in the supply of data were fully met during 1967.

A crustal thickness project was terminated in June and the seismographs located at Lae and Goroka were converted for short-period recording. This will enable a study to be made of local earthquakes. Sites were selected and secured at Wabag, Vanimo, and Manus for future seismograph stations.

The 460 series QHMs were used to recalibrate the Port Moresby QHMs, and the BMZ was calibrated using a proton magnetometer supplied by a visiting French geophysical contracting company.

## 1. INTRODUCTION

This report contains a brief description of the work carried out at the Port Moresby Geophysical Observatory during 1967. It follows the form of the previous annual report, for 1966 (Observatory Staff, 1967); separate accounts will be published of specific aspects of the observatory's work.

Early in the year the crustal study project involving the recording of long-period Rayleigh waves was terminated; the stations at Kerema and Tapini were closed down; the Lae instrumentation was converted for short-period recording and a new station was opened at Goroka.

Apart from the normal observatory programme the group was involved in the Rabaul Crustal Study Project. This was an extensive project in explosion seismology and involved a number of field parties from both inside and outside the Bureau of Mineral Resources.

There were no changes of personnel at the Observatory during the year and Table 1 gives the staffing position for 1967.

## 2. SEISMOLOGY

### Instrumentation at Port Moresby

Table 2 lists the characteristics of the seismographs at Port Moresby and outstations during 1967.

Routine seismological recording was maintained throughout the year. Regular calibration checks were made on the World-wide Standardised Seismographs, the Wood Andersons, and the DTM equipment.

A USCGS maintenance team visited the station in March. The visit was most unsatisfactory; none of the calibration records were left at Port Moresby, and immediately following the visit, large bays appeared at frequent but irregular intervals on the long-period east-west seismograph. Tests indicated that the fault was in the seismometer and this has since been rectified.

During the year the USCGS ceased to supply spare parts for the WWSS equipment. This had not affected its operation by the end of the year, and at the time of writing (April 1968) the service had been restored.

### Collection and distribution of data

During 1967, 5430 seismic events were recorded at Port Moresby. Distribution of data was by way of weekly bulletins listing the preliminary analysis, and supplementary bulletins containing the results of re-analysing the original seismograms in the light of the USCGS data reports. First arrival data for large earthquakes were telegraphed to USCGS for their epicentre determinations.

Up to July 1967 the WWSS records were posted to World Data Centre A for copying so that the records would be available to any institutions requiring them. This service was discontinued in August owing to shortage of funds at the Centre, but at the time of writing it was being restored.

Many special requests were received for original seismograms, seismogram copies, scalings, earthquake risk information, and general information arising from the distribution of questionnaire forms. All these requests were processed.

The following reports in seismology were completed - "A study of short period background noise amplitudes at Port Moresby from 1962-1966" by D. Denham and P. Rupa (BMR Record 1968/3); "The seismicity of Papua and New Guinea for the year 1966" by D. Denham, W.M.J. Byrne, and J.R. Wilkie (BMR Record 1968/87); and "New Guinea P-wave residuals" by I. D. Ripper.

Short-period stations

In June the crustal thickness project (Brooks and Ripper, 1966) involving the recording and analysis of phase velocities of Rayleigh waves was terminated, and the recorders were converted to short-period operation. The project was stopped for two reasons. In the first place it proved virtually impossible to keep all the three field stations in operation at the same time. This was because of the lack of a spare set of equipment at Port Moresby to repair unserviceable components and because of the unreliablility of the ER230 pen recorder.

Secondly the validity of the whole project as originally envisaged became questionable when it became evident that the wave fronts crossing the three-station array were not plane Rayleigh waves but resulted from some interference pattern.

For these reasons it was decided to abandon the project and set up a network of permanent short-period stations throughout the Territory. The main object of this project is to determine more exactly where the earthquakes in the Territory are occurring and to provide better earthquake statistics in connection with earthquake risk problems.

Prior to the installation of permanent stations, temporary stations were established at Lae and Goroka. The co-ordinates of these stations and all other observatory sites occupied in 1967 are listed in Table 3.

The ER230 pen recorders used on the surface wave investigation were converted from a period response of 90 seconds to a response of less than one second. This set up is not entirely satisfactory as the ER230 is more complicated than necessary for this type of operation. Maintenance is therefore needed more often than could be expected for a more conventional short-period recorder. For example, the intricate servomotor-slidewire potentiometer system is unnecessary, as a simple pen galvanometer giving a curved reflection on the paper would be sufficient.

Both recording sites are poor, but choice was limited because of power requirements and by the shortage of personnel to make the daily record change and time correction. The NCD2 crystal clock has proved to be a very accurate time standard, as its drift rate can be reduced to a few milliseconds per day, but it has experienced more failures than was hoped, mainly owing to breakdowns in the mechanical time display unit.

It is recommended that permanent stations be chosen for good seismic reponse alone, that suitable staff be trained to operate them, and that accommodation be provided.

At the end of 1967, sites had been located at Wabag in the Western Highlands District, Vanimo in the West Sepik District and Momote in the Manus District. Land at each of these places had been secured at the time of writing.

Territory seismicity

A full report on the seismicity of the Territory will be prepared when all the relevant data have been received. Two large earthquakes with Ms values of at least 7 occurred during the year, but the most damaging series of shocks occurred on August 14th on the Gazelle Peninsula. The two largest were of magnitude 6.2 and 6.4 as measured at Port Moresby on the Richter scale ($M_L$). Over 150 aftershocks were recorded from these events by Rabaul Observatory and approximately $200,000 worth of damage was done to buildings in the Kokopo area. The worst hit areas were the Teachers' Training College at Kabaleo and the Vunapau Catholic Mission. A preliminary report on the earthquakes was issued (Skinner and Denham, 1967) and a fuller account is to be published by Heming of the Vulcanological Observatory at Rabaul.

Response to the felt intensity questionnaires during 1967 was good. The practice of sending questionnaires out for particular earthquakes was found to be more efficient than the general distribution of the forms beforehand and relying on the community to respond when an earthquake occurred. Over 600 felt report forms were returned during the year. All these data will be stored on the IBM 1130 computer in Port Moresby. The maximum reported intensity was IX on the Modified Mercalli Scale at Kabaleo, Vunapau, and Rainnau, where considerable damage occurred during the Gazelle Peninsula earthquakes.

During the year the Observer-in-Charge attended meetings of the Territory's Advisory Committee on Seismology and Earthquake Engineering. Among the main topics discussed were the establishment of a building code for the Territory, the tsunami warning system, and earthquake engineering instrumentation.

Rabaul Crustal Study Project

In October and November the Observatory participated in the Rabaul Crustal Study Project.

The Observatory contributed two stations in each stage of the operation. On the E-W profile Ciszek and Wilkie occupied stations at Doilene and Lassul Bay, and on the N-S line Ciszek and Ripper operated stations at Namatanai and Ullupatur;

One station consisted of a Willmore seismometer coupled to an ER230 pen recorder, converted to short-period response with a drum speed of 180 mm/min. The other comprised a Willmore seismometer coupled to a paper strip pen recorder provided by the Department of Terrestrial Magnetism, Carnegie Institution of Washington. Good results were obtained, and apart from smaller shots in the Rabaul harbour, 74 out of 76 possible shots were recorded. Of the 74 recorded shots, 59 arrivals were clear and the rest emergent.

All data and copies of records have been sent to the data collection centre at BMR, Canberra.

Storage and retrieval of seismic data

The introduction of an IBM 1130 computer to Port Moresby has enabled a data compilation system to be developed that would otherwise have been very difficult.

Two forms of data are being stored on a magnetic disc:

1. All epicentre information for earthquakes occurring between latitudes 0-12°S and 130-165°E, except for the Banda Sea events contained within 4-12°S and 130-132°E.

2. All felt reports sent in by observers throughout Papua and New Guinea.

At the end of 1967, felt reports for 1965 and 1966 and epicentre information for 1964, 1965, and 1966 had been stored on the disc. The file will go back to 1958 when the Port Moresby Geophysical Observatory was commissioned and it became possible to determine magnitudes and epicentres of Territory earthquakes to a much better order of accuracy than before. The report by Brooks (1965) is adequate for the period before 1958, because the epicentres were not located very accurately owing to the lack of stations close to the earthquakes.

During the year a programme was written to retrieve any combination of data from the disc.

Focal mechanism studies

The first phase of focal mechanism studies by the Observatory has been completed and a report is in preparation. It is planned to investigate all future earthquakes which occur in the New Guinea/Solomon Island region and which have a magnitude greater than six.

Generally speaking, useful solutions are obtained only for earthquakes involving horizontal source motion, as the critical epicentral distance for earthquakes involving vertical motion is approximately ten degrees, and at this range the distribution of seismic stations is hopelessly inadequate.

Installation of permanent stations at Goroka, Manus Island, Wabag, Kavieng, and Bougainville would provide a better coverage for focal mechanism studies.

Crustal thickness from P-wave spectra

The crustal thickness at Port Moresby, Rabaul, and Honiara have been computed by the method of Fernandez (1965). This considers the motion recorded at the Earth's surface to be a result of the incident seismic energy, the elastic properties of the layers of the Earth's crust beneath the recording station, and the response characteristics of the recording instruments. Using a matched three-component system the response of the instruments is eliminated by dividing the spectrum of the vertical component of motion by the spectrum of the horizontal component. The result is a ratio which depends on the angle of incidence of the ray and the system of layers beneath the recording station. The ratio values obtained in this way are compared with a set of master curves.

A short paper giving the preliminary results of this work was submitted for publication in the Australain Journal of Science (Denham, 1968). Collection and interpretation of data is continuing.

Crustal structure from P-wave residuals

An analysis was made of earthquake travel-time residuals in the New Guinea area and a regional P-wave mantle velocity variation was inferred. The velocity was higher than normal in West New Guinea, New Guinea Highlands, Banda Sea, and Solomon Islands region, and lower than normal in the Solomon Sea, Bismarck Sea, and Coral Sea between Cape York and the south-east tip of Papua. These results are regarded only as preliminary because of the anomalous nature of the region and the resolution of the method used.

Tectonics of the New Guinea region

Seismic research at the Port Moresby Geophysical Observatory is aimed at the eventual understanding of the tectonics of the area. New Guinea is marginal to the Australian continental crustal block and the South-west Pacific Ocean basin. Since the beginning of the Tertiary the region has undergone active orogeny (Thompson and Fisher, 1965). New Britain and Bougainville are island arc structures with an adjoining deep trench in the Solomon Sea, but the structure is not typical of island arcs and trenches around the Pacific because they appear to face the wrong way.

A possible factor complicating the region is a sinistral shear, trending east-west (Carey, 1958). Although ocean trenches are commonly considered as downturns of convection currents, the tectonics of the region do not appear to favour this interpretation because of the geometrical arrangement of the ocean trenches.

Two papers are in preparation on New Guinea and Global Tectonics.

Earthquake Engineering

During the year a considerable interest was generated in many quarters on the problems of earthquake risk in the Territory. It is thought that this particular subject will become more important as the Territory develops and more costly engineering projects are undertaken.

The highlight of the year in this field was a visit (sponsored by the BMR) by Mr. R. I. Skinner, a world expert on earthquake engineering, from the DSIR, Wellington, New Zealand. A comprehensive tour was arranged for Mr. Skinner with visits to the site of the Higher Technical Institute at Lae, the Upper Ramu Dam site near Kainantu, the Round No. 2 Hydroelectric scheme and Sirinumu Dam at Port Moresby, the new hospital at Goroka, the new wharf site at Madang, the Palm Oil Project at Cape Hoskins, and other minor engineering projects in Rabaul, Goroka, Lae, and Port Moresby.

Sites were selected for accelerographs at the Upper Ramu Dam location and two were installed at Kieta on Bougainville for Con Zinc Riotinto. At the end of the year another was installed at the Upper Ramu.

A preliminary report on earthquake problems in the Territory of Papua and New Guinea by Mr. Skinner (1967) has been published as a BMR Record.

It appears that work in this field will expand in the near future. A post should be created as soon as possinle for an officer primarily responsible for the collection and analysis of data related to strong motion earthquake problems. He should ensure that these data are processed and reduced to form meaningful statistics suitable for use by structural design engineers.

## 3. GEOMAGNETISM

Mean values

The routine programme of data recording, analysis, and distribution was continued during 1967. Preliminary mean values of the three field components at epoch 1967.5 were:

H : 0.36270 gauss decreasing by about 0.00020 gauss during the first six months and remaining fairly constant over the second six months.

D : $06^{\circ}$ 10.6' E remaining approximately constant throughout the year.

Z : -0.23059 gauss remaining approximately constant for the first six months and becoming more negative by about 0.00020 gauss during the second six months.

Table 4 contains a list of the values of the Earth's magnetic field since 1960.

Instrumentation and calibration

The characteristics of the magnetographs in operation at the Observatory during 1967 are given in Table 5.

Weekly calibrations of the normal-run variometer were executed using QHMs 187, 188, and 189; Askania declinometer 580339; and BMZ 68. Scale value determinations were also carried out weekly.

Intercomparisons of the Port Moresby QHMs with the Toolangi QHMs 460, 461, and 462 were carried out in February. The preliminary corrections applied to QHM 189 were found to be in error by 8 gammas, as had been suspected from the normal weekly calibrations.

BMZ 68 was calibrated by using a proton magnetometer used as a base instrument by Compagnie Generale de Geophysique and the QHMs that were recalibrated in February. It was found that it was necessary to apply a correction of -30 gammas to the Port Moresby BMZ.

Orientation tests were also carried out during the year on the normal-run and rapid-run variometers. The ex-orientation angles are listed below:

| Magnet | | N Pole |
|---|---|---|
| Normal-run | D | N $0.3^{\circ} \pm 0.1^{\circ}$W |
| | H | E $0.5^{\circ} \pm 0.3^{\circ}$N |
| | Z | N $0.3^{\circ} \pm 0.2^{\circ}$ down |
| Rapid-run | D | S $0.5^{\circ} \pm 0.1^{\circ}$E |
| | H | E $1.8^{\circ} \pm 0.3^{\circ}$N |
| | Z | S $0.2^{\circ} \pm 0.2^{\circ}$ up |

| | | |
|---|---|---|
| Reference meridian | (1967.5) | = $6^{\circ}$ 10.6'E |
| Reference H field | (1967.5) | = 36,270 gammas |
| Reference Z field | (1967.5) | = -23,059 gammas |

Only the rapid-run Z magnet needed any adjustment. This was ground slightly to reduce the ex-orientation angle, from S $1.2^{\circ}$ up, to the value given in the table above. Scale value determinations on the rapid-run magnetograph were carried out during the year and the values obtained are listed in Table 5.

Reduction of data

The text for the mean hourly value Report for 1965-66 (by Wilkie and Connelly) was forwarded to Canberra in August.

Least squares analyses of H scale-values for several periods from 1958 to 1966 resulted in the adoption of new H baseline scale-values (So) and ordinate factors (a). The mean hourly value reports for 1961-62 and 1963-64 are being currently revised to accomodate the new parameters.

K Indices and transient phenomena including storms and pulsations were listed from the magnetograms and distributed monthly to nine recipients. Micro-films of magnetograms were sent monthly to Melbourne for processing and onforwarding to USCGS for digitising as part of the continuing project carried out in conjunction with NASA.

The average K Index for the year was 1.88 compared with 1.79 in 1966 and 1.73 in 1965, showing the increasing magnetic activity as the peak of the sunspot cycle approached. Indicative of the increased activity was a large magnetic storm which occurred in May. This had a K maximum of 8 and was strong enough to unwind the rapid-run H variometer.

4. IONOSPHERIC

Contract No. AF19 (604) - 7399.

The performance of the ionosonde throughout the year was reasonably good. An abnormally high average record loss of 71 hours per month was caused by several major factors:

(a) During most of 1967 the electricity supply for Port Moresby was heavily overloaded, resulting in frequent mains power break-downs and systematic mains load shedding periods.

(b) The single-phase mains transformer supplying the Observatory was replaced by a three-phase transformer with inevitable interruptions to the mains supply during this operation.

(c) In August a v.h.t. transformer broke down before the delivery one that had been requisitioned earlier. Records for almost a week were lost before a replacement transformer was obtained from IPS and installed.

(d) Faults in the operation of the synchronome clock or slave clock, the camera drivemotor, and the VFO cam drive motor.

After the installation of the three-phase mains supply had been completed, voltage from the STABILAC voltage regulator was as low as 190 volts. Adjustments to the STABILAC increased the voltage to a normal 240 volts.

Occasionally a power interruption occurred after the triple gain unit had commenced its run but before the locking switch was operated. This resulted in a condition which, when the power was restored, caused the ionosonde to sweep continuously and prematurely run out of film.

Minor record losses were also due to film jamming in the camera and occasional valve or component failures. In some instances the ionosonde failed to programme itself back on after a mains power cut and it remained inoperative until the next routine inspection when it was manually restored.

No major modifications were made to the ionospheric equipment during the year.

Reduction of ionospheric data values for f min, foE, foEs, foFs, and M(3000) F2 for each hourly sweep continued; data sheets were forwarded to the Ionospheric Prediction Service Division headquarters each month. Also a telegram to IPSO was lodged each Wednesday giving coded foF2 values at 0000 hrs, 0600 hrs, 1200 hrs, and 1800 hrs UT each day of the preceding week for transmission to the ESSA Research laboratories, Boulder, USA.

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## APPENDIX

### TIMING ARRANGEMENTS AT PORT MORESBY

Plate 1 is a diagram of the timing arrangements that were in operation at Port Moresby during 1967. The complete timing circuits have never been fully documented and this is a good opportunity to make a permanent record of the present arrangements.

The timing requirements are as follows:

Ionospheric building

(i) 1 per second impulses to operate iono slave clock (from synchronome master clock).

(ii) 1 per second impulses to operate magnetic vault slave clock (as above).

(iii) 1 per minute contact closures (4 seconds duration) to operate minute stepping relay in DTM equipment in seismic vault (from iono slave).

(iv) Contact closure for 15 to 25 seconds at 15, 30, and 45 minutes past the hour to operate ¼ hourly ionospheric sweeps (from iono slave).

(v) Contact closure for 25 to 30 seconds between 58th and 59th minute after the hour to operate the triple gain unit which programs low gain, medium gain, and high gain ionospheric sweeps at 59, 00, and 01 minutes respectively (from iono slave).

Magnetic vault

(i) 1 per second voltage steps to provide 1-second impulses for DTM equipment in seismic vault (from M/V slave).

(ii) Contact closures each hour from 00 to 04 seconds to operate hour stepping relay in DTM equipment (from M/V slave).

(iii) Contact closures from 56 to 00 seconds each 5th minute plus closures at 59, 00, and 01 minutes each hour. To provide time marks for normal-run magnetographs (from M/V slave).

(iv) As for (iii) to provide time marks for normal-run magnetographs (from La Cour Pendulum Clock).

(v) 1-minute contact break to operate 1-minute check light (from relay in seismic vault).

Absolute building

Contact closures as required during absolute determinations to put time marks on normal-run magnetograph.

<u>Seismic vault</u>

(i) Contact closures from 00 to 02 seconds each minute; from 00 to 04 seconds each hour, with each 6th hour omitted to provide time marks for all seismic records except supplementary short-period vertical (from WWSS programmer).

(ii) Contact closures from 00 to 02 seconds each minute with each hour omitted (from iono slave via minute and hour series contacts in DTM equipment). To provide time marks for supplementary short-period vertical and emergency time marks for all other seismic records.

TABLE 1

STAFF AND ASSISTANTS

| Name | Classification | Duration |
|---|---|---|
| Denham, D. | Geophysicist Class 3 (O.I.C.) | Continuous |
| Wilkie, J.R. | Geophysicist Class 2 | " |
| Ripper, I.D. | Geophysicist Class 1 | " |
| Jones, M.S. | Technical Officer Grade 2 | " |
| Ciszek, M. | Technical Officer Grade 1 | " |
| Byrne, W.M.J. | Technical Officer Grade 1 * | " |
| Connelly, J.B. | Geophysicist Class 1 + | July-October |
| Rupa, P. | Geophysical Assistant Grade 2 | Continuous |
| Tom, A. | Geophysical Assistant Grade 2 | " |
| Sevese, F. | Geophysical Assistant Trainee | " |
| Kaila, A. | Groundsman | " |

* Held against Geophysicist Class 1 position.

\+ Antarctic trainee.

TABLE 2

SEISMOGRAPH STATIONS AND INSTRUMENTS

| Seismometer | | | Recorder | | | Magnif- ication | Remarks |
|---|---|---|---|---|---|---|---|
| Type | Comp | Ts | Type | Speed | Tg | | |
| **Port Moresby** | | | | | | | |
| World-wide Standardised Seismography | (Z,N,E | 1.0 | Photodrum | 60 | 0.75 | 50,000 at 1s | |
| | (Z,N,E | 15.0 | Photodrum | 30 | 100 | 3000 at 15s | |
| Sprengnether, Series H | N,E | 15 | Photodrum | 30 | 15 | 700 max at 4.8s | Overdamped |
| Wood Anderson | N,E | 0.8 | Photodrum | 30 | - | 2000 | |
| DTM | Z | 4 | Photodrum | 30 | 1.7 | 11,000 | |
| | | | Photodrum | 30 | 15 | 700 | |
| **Goroka** | | | | | | | |
| Wilson-Lamison | Z | 1.0 | UED ER230 | 60 | 1 | 5000 | ER230 modified for SP recording |
| **Lae** | | | | | | | |
| Willmore | Z | 1.0 | UED ER230 | 60 | 1 | 5000 | ER230 modified for SP recording |
| **Kerema** | | | | | | | |
| Willmore | Z | 1.0 | (UED | 60 | 1 | 5000 | (ER230 modified for SP recording |
| Press-Ewing | | 15.0 | ER230) | | | 800 | |
| **Tapini** | | | | | | | |
| Wilson-Lamison | Z | 1.0 | (UED | 60 | 1 | 10,000 | (ER230 modified for SP recording. |
| Press-Ewing | | 15.0 | ER230) | | | 800 | |

Ts = seismometer free period (seconds)

Tg = galvanometer free period (seconds)

TABLE 3

CO-ORDINATES OF OBSERVATORY BUILDINGS AND OUTSTATIONS

| Station | Code | Lat. S | | | Long E | | | Elevation (metres) | Foundation |
|---|---|---|---|---|---|---|---|---|---|
| Port Moresby | PMG | | | | | | | | |
| Seismograph Vault | | 09° | 24' | 33" | 147° | 09' | 14" | 67 | Eocene cherts |
| Absolute Magnetic Building | | 09° | 24' | 37" | 147° | 09' | 17" | 70 | |
| (Geomagnetic | | -18.7 | | | 218.0°) | | | | |
| Ionospheric Building | | 09° | 24' | 26" | 147° | 09' | 31" | 40 | |
| Goroka | GRK | 06° | 04' | 32" | 145° | 23' | 43" | 1579 | Alluvium |
| Lae | LAE | 06° | 40' | 23" | 146° | 54' | 48" | 100 | Alluvium |
| Kerema | KRG | 07° | 57' | 35" | 145° | 46' | 08" | 14 | Clay |
| Tapini | TPN | 08° | 21' | 24.7" | 146° | 59' | 01.4" | 1000 | Clay |

TABLE 4

GEOMAGNETIC MEAN VALUES 1960-1967

| Epoch | H (gammas) | D (East) | Z (gammas) | F (gammas) | Average K Index |
|---|---|---|---|---|---|
| 1960.5 | 36431 | 06° 00.8' | -22826 | - | |
| 1961.5 | 36414 | 02.6 | -22858 | 42994 | - |
| 1962.5 | 36402 | 04.6 | -22891 | 43001 | 2.12 |
| 1963.5 | 36376 | 06.3 | -22942 | 43006 | 1.92 |
| 1964.5 | 36356 | 07.4 | -22967 | 43003 | 1.85 |
| 1965.5 | 36334 | 08.4 | -22990 | 42996 | 1.73 |
| 1966.5 | 36311 | 09.4 | -23024 | 42995 | 1.79 |
| 1967.5 | 36270 | 10.6 | -23059 | 42979 | 1.88 |

TABLE 5

MAGNETOGRAPH CHARACTERISTICS 1967

| Component | | Scale value (gamma/mm) |
|---|---|---|
| Normal-run | (15 mm/hour) | |
| | D | 4.65 ± 0.08 (0.44'/mm) |
| | H | (2.70 ± 0.013) ± (0.0032 ± .0007)h |
| | Z | 3.43 ± 0.08 |
| Rapid-run | (180 mm/hour) | |
| | D | 0.5 (0.04'/mm) |
| | H | 1.6 |
| | Z | 0.4 |

h is H trace ordinate in mm


TO ACCOMPANY RECORD No 1969/21

PORT MORESBY GEOPHYSICAL OBSERVATORY TIMING AND PROGRAMMING SYSTEMS

G82/3-128