COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1958, No. 52

SEISMIC WORK AT MELBOURNE, MACQUARIE ISLAND, MAWSON AND PORT MORESBY DURING THE I.G.Y.

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ABSTRACT

This record gives a brief account of the seismic installations at Melbourne, Macquarie Is., Mawson and Port Moresby Observatories. The last is given in more detail since it is a new station which will become one of the major geophysical observatories controlled by the Bureau of Mineral Resources, Geology and Geophysics.

The installations at Watheroo and Mundaring are described in a separate record.

I. INTRODUCTION

At the beginning of the I.G.Y. three of the geophysical observatories operated by the Bureau of Mineral Resources, Geology and Geophysics were equipped with seismographs, namely Melbourne, Macquarie Island and Mawson. Continual instrumental difficulties have reduced the usefulness of the installation at Mawson; the other two stations have operated continuously since the beginning of the I.G.Y. Seismic recording was started at Port Moresby and Watheroo early in 1958 and it is expected that recording will start at Mundaring (near Perth) some time this year.

The installations at Watheroo and Mundaring are described in a separate record.

II. MELBOURNE SEISMIC OBSERVATORY

(i) Introduction The first seismograph was installed in Melbourne in 1902 and commenced operation in April of that year. Except for a few years during the second world war, the observatory has been operating continuously and thus was in full operation at the beginning of the I.G.Y.

The seismic observatory is located in a small building in the grounds of the old Melbourne Observatory, about 2 miles from the city. The latitude is 37° 49' 53" S and the longitude 144° 58' 24" E, and the height is 28 meters above sea level.

The foundation is Silurian sand-stone and mudstone. The building is close to heavy traffic, and with the new high sensitivity instrument now in operation, much disturbance is caused by this traffic if the instrument is operated at high magnification.

Plans are now in hand to build a new observatory about 40 miles from Melbourne.

(ii) Instruments Seismic equipment now in operation consists of three Benioff seismometers, with a long and a short period recorder for each component. Galvanometers for the long period instruments have a period of 14 seconds, and for the short period 0.25 sec. The short period recorders can be run at only half their maximum sensitivity because of the disturbance from nearby traffic. Writing speeds of 30 mm/min (long period) and 60 mm/min (short period) are used.

The Benioff seismographs have been in operation continuously during the I.G.Y. From 1902 to 1917 a Milne seismograph was operated using a narrow strip of photographic paper, on which a single trace was recorded. In 1917 this instrument was modified by replacing the single trace recording by a drum on which a sheet of photographic paper was wound. The instrument was later replaced by a Milne-Shaw seismograph, which was used until the installation of the Benioffs, and can still be used when required.

(iii) Building. The building at present used was formerly the Melbourne Magnetic Observatory. It consists of an entrance porch, office and dark-room, and a vault underneath in which the seismographs are installed. Concrete pillars are free of the floor and are sunk about two feet into the ground. The vaults used to be very moist. A dehumidifier was installed in 1955, and no more trouble with moisture has been experienced since then.

III. MACQUARIE ISLAND SEISMIC OBSERVATORY

The seismic observatory operated on Macquarie Island by the Bureau of Mineral Resources, Geology and Geophysics is part of the scientific programme conducted by the Australian Antarctic Research Expedition. Wood-Anderson horizontal component seismographs have been in operation since 1950. The damping co-efficients and mean free periods of these instruments are maintained at 0.85 and 1.0 seconds respectively.

A short-period Grenet vertical component seismograph was installed in 1956.

The piers on which the seismometers stand are laid on bedrock, which is a recent basalt.

The large number of local earth tremors recorded indicates that the submarine ridge from which the island rises is a continuation of the circum-Pacific seismic belt. More than eighty near and local tremors were detected in 1957.

IV. MAWSON SEISMIC OBSERVATORY

The seismic observatory operated at Mawson by the Bureau of Mineral Resources, Geology and Geophysics is part of the scientific programme conducted by the Australian Antarctic Research Expedition.

The equipment comprises a set of three Leet-Blumberg seismometers with electronic amplifiers and a pen-and-ink recorder. Although the basic design of these instruments is sound, their operation has been most unsatisfactory owing to poor construction, and maintenance difficulties. This has meant that, to date, such a small fraction of record is available, that it is of little value. However, this record seems to indicate that the area is quiet, as far as local seismic activity is concerned, although very strong microseismic development can accompany storms in the area.

IV. PORT MORESBY GEOPHYSICAL OBSERVATORY

(i) Introduction Construction of a Geophysical Observatory at Port Moresby, Papua, was begun in 1957. The Observatory was designed, and is operated by, personnel of the Australian Commonwealth Bureau of Mineral Resources, Geology and Geophysics, Department of National Development.

It is situated in low hilly country approximately 5 miles north of Port Moresby township (see figs 1 and 2) and consists of two underground vaults which house equipment for recording geomagnetic field variations and seismic phenomena, an absolute magnetic building, and a fourth building which will house ionospheric sounding apparatus and a photographic darkroom.

The observatory site is divided into two sections (fig 3), the western section containing the buildings for magnetic and seismic recordings situated on interbedded Eocene cherts and argillites, and the smaller eastern section containing only the ionospheric installations sited on tuffs and flows which unconformably overlie the above formations.

It is expected that the observatory will become fully

operative towards the end of 1958 or early in 1959 when all magnetic, seismic and ionospheric recording equipment should be installed.

(ii) Seismic Installations

(a) Vaults

The location of the seismic vault with respect to other observatory buildings is shown in fig. 3.

The vault was constructed in a site excavated from bedrock and is entirely below ground level. It is entirely concrete and has internal floor dimensions of 10 feet by 23 feet. The walls are 7 feet high and are topped by an arched concrete roof which reaches a height of 10 feet. Entrance is by concrete steps through a small porch which houses a pendulum clock for time control. See figs 4 and 5. The building was completed in September, 1957.

A floor plan of the vault (fig 4) illustrates the layout of the instruments.

(b) Seismographs.

The seismic vault is designed to accommodate two three component seismographs. These are

(i) A three-component Sprengnether seismograph consisting of two long period horizontal seismometers of period 15 seconds, and galvanometer period 15 seconds, and a 1.4 sec. vertical seismometer and galvanometer also with period 1.4 seconds.

Damping is critical on all seismometers and galvanometers.

This instrument records on a three channel Sprengnether recorder and is installed at the eastern end of the vault.

(ii) A set of short period instruments consisting of two horizontal component Wood Anderson torsion seismometers and a 1-second period Kew type vertical component. A second Sprengnether three channel recorder will be used with these instruments.

No tests to determine the magnification of any of the Sprengnether components have yet been possible. The two horizontal components have been adjusted to have equal magnifications.

Electrical power (230 v. 50C.AC) has not yet been connected to the observatory from the main high tension line several miles distant. It is expected that power will be available late in June or ea rly in July, 1958.

Therefore only one set of seismometers, the Sprengnether instruments, have been in operation to date. These are operated using lead-acid accumulators and a vibrator as a source of power.

The lack of electrical power has meant that control or reduction of humidity in the vault has not been possible.

In these tropical regions this is an important factor influencing the operation of electromagnetic instruments.

A dehumidifier unit is ready for use immediately power becomes available.

(c) Time Control.

Time control is maintained by a Synchronome pendulum clock which applies time marks of 4 seconds duration to the record each minute in the conventional manner.

The correction to the pendulum clock is obtained daily by manual comparison with WWV. The rate of the pendulum clock is now sufficiently low (less than ½sec per day) to permit its correction to be known to within ½ second at any time. This is considered quite satisfactory in view of the low drum speed and variations in it due to the present method of supplying power. It is hoped to record WWV time signals automatically at a later date.

(iii) Interpretation of Records.

(a) Method.

To date, standard Jeffreys-Bullen travel time tables have been used as a basis for tentative identification of phases, with reasonably good results.

Artificial noise at the site is non-existent, and the amplitudes of microseisms recorded have been sufficient to prevent analysis of earth tremors on a few days only during the six months of operation so far.

(b) Comments on Results.

It is well known that seismic activity in the New Guinea - New Britain - Solomon Islands region is intense, and ample evidence of this is exhibited by Port Moresby records. On one occasion, evidence of 30 tremors in a single day was recorded.

Although situated in such a region, very few tremors are felt in Port Moresby. This makes it an ideal recording station for the local earthquakes, as high magnification instruments can be operated without fear of damage occuring to them.

The S phases of the closer earthquakes have been difficult to observe on the long period horizontal Sprengnethers. It is expected that the Wood Anderson seismometers will eliminate this difficulty.

Some difficulty has also been experienced with the vertical Sprengnether seismometer, the magnification of which ha s been lower than anticipated. As a result, the P phases of the weaker tremors has been difficult to identify.

Using U.S.C.G.S. preliminary origin times, travel times for the first impulse recorded at Port Moresby have been derived for a selected number of shocks. The records used are ones where the first impulse has been clear and unmistakeable, and for which time corrections are known to within ½ second beyond doubt. The shocks examined occurred mainly at two epicentral distances viz 5 - 10° (New Britain region) and 17 - 25° (Solomon and Santa Cruz islands).

For the nearer group, the travel times conform closely with the Jeffreys-Bullen Pn phase times and in every reliable case examined so far for tremors up to 30° away, the travel times are greater than those given by Jeffreys-Bullen. This result is by no means conclusive as only a limited number of selected shocks have been examined, and the origin times used are provisional.

Some good recordings of earthquakes at epicentral distances of 130 - 140° have been obtained. These have occurred in South America.

V. DISTRIBUTION OF RESULTS

(i) Current information Seismograms from the Melbourne Observatory are processed every morning (except during the week-end) and examined immediately. Data on preliminary phases of the main earthquakes are transmitted by air mail to the U.S.C.G.S. (Washington) to be used for the preliminary determination of epicentres.

Bulletins are distributed from Port Moresby Observatory weekly by air mail to the U.S.C.G.S. and to local stations.

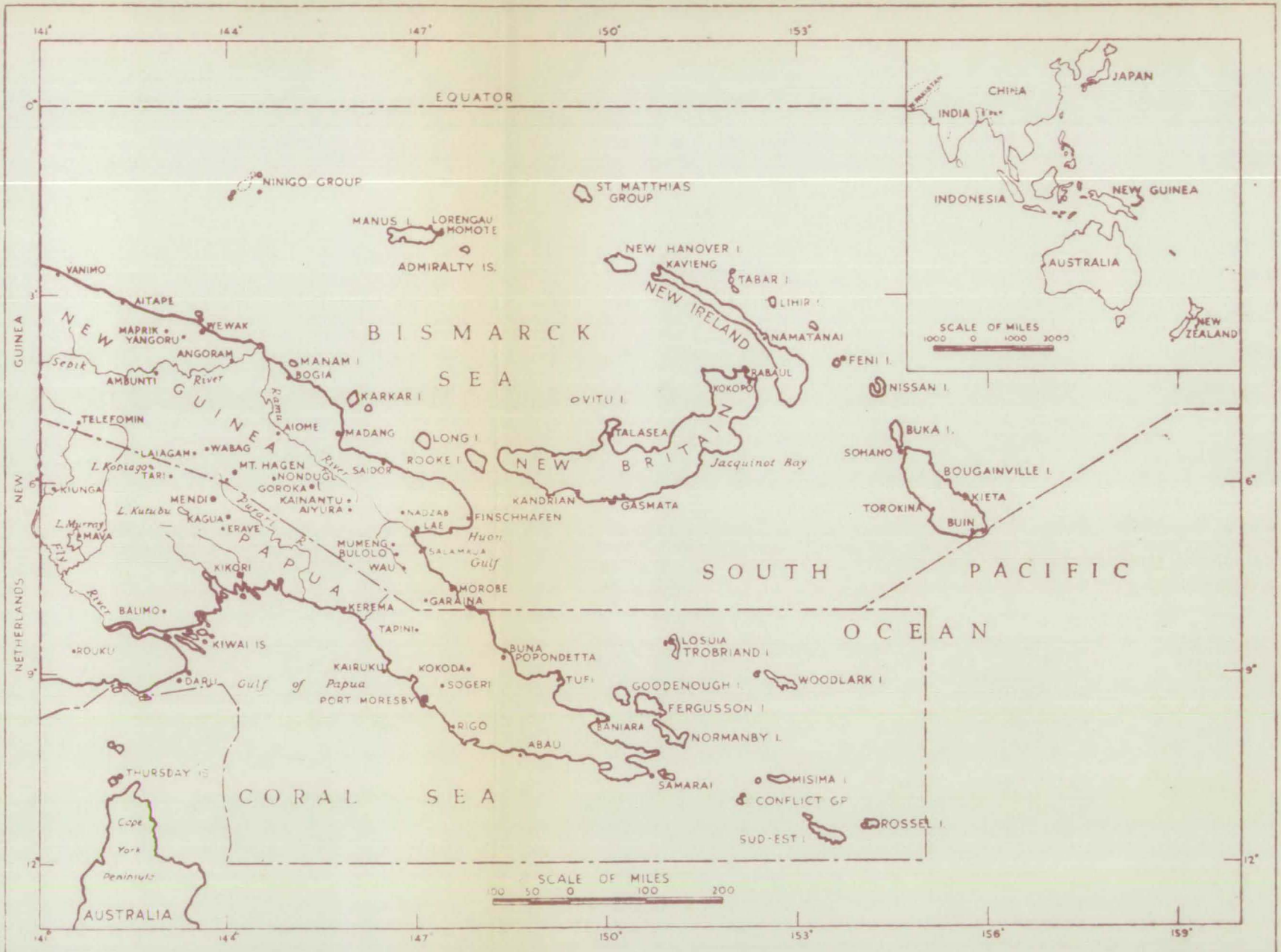
(ii) Monthly Bulletins Monthly bulletins of preliminary seismic data from Melbourne, Macquarie Island and Mawson (when available) observatories are sent by air mail to WDC A (Washington), WDC B (Moscow) WDC C(Strasbourg) and other interested organisations. Data from Port Moresby will be included in these bulletins in the future.

Final data has not been published so far because of shortage of staff.

(iii) Microseisms Data on microseisms has been scaled only from the long period vertical seismograms from Melbourne, and from these only for a 40 minute interval every 6 hours. It is found that this takes a great deal of time and that, with the staff available, it has been impossible to carry out the complete programme of microseismic scaling recommended in the I.G.Y. instructions.

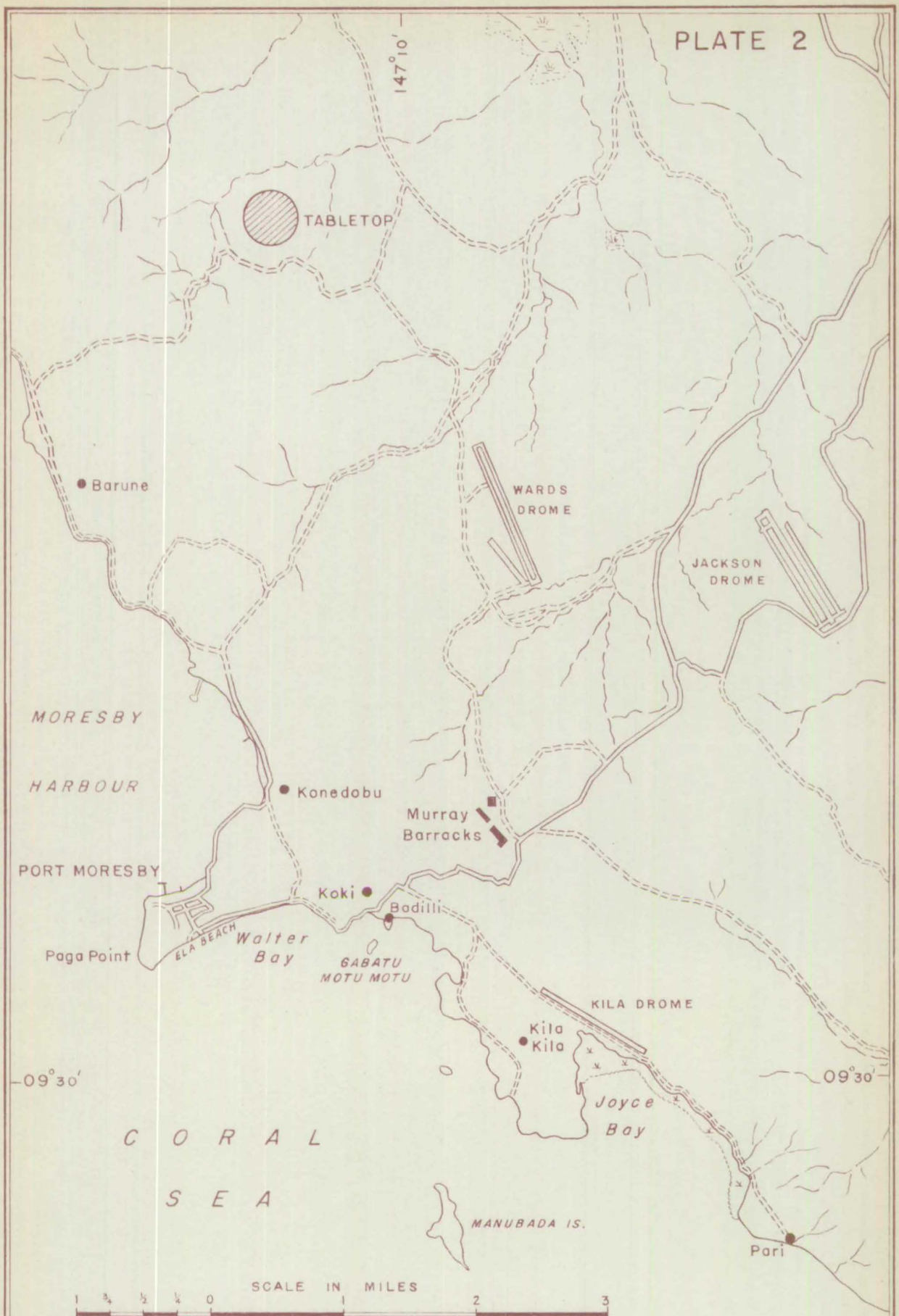
MAP OF THE TERRITORY OF PAPUA AND NEW GUINEA

PLATE I



G 82-65

PLATE 2

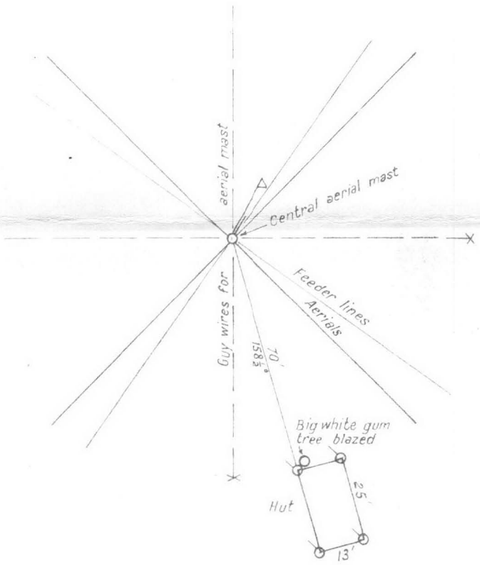


GEOPHYSICAL OBSERVATORY SITE, TABLE TOP, PORT MORESBY

LOCALITY MAP

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G 82—56

PLATE 3



DETAIL OF IONOSPHERIC LAYOUT

SCALE FOR DETAILS

40 0 40 80 FEET

LEGEND

- Reference point not marked
- " " marked with red and white steel peg about 18" high
- " " marked with wooden stake about 6' high
- " " marked with flagged wooden stake
- " " marked with flag tied onto tree
- Old roads
- Roads to be constructed
- " " " " over route of old road
- Fencing required
- Gate "

GEOPHYSICAL OBSERVATORY SITE,
TABLE TOP, PORT MORESBY

SKETCH PLAN
LOCATIONS OF PROPOSED BUILDINGS

BASED ON TAPE AND COMPASS SURVEY, FEB. 1956

SCALE IN FEET

200 0 200 400 600

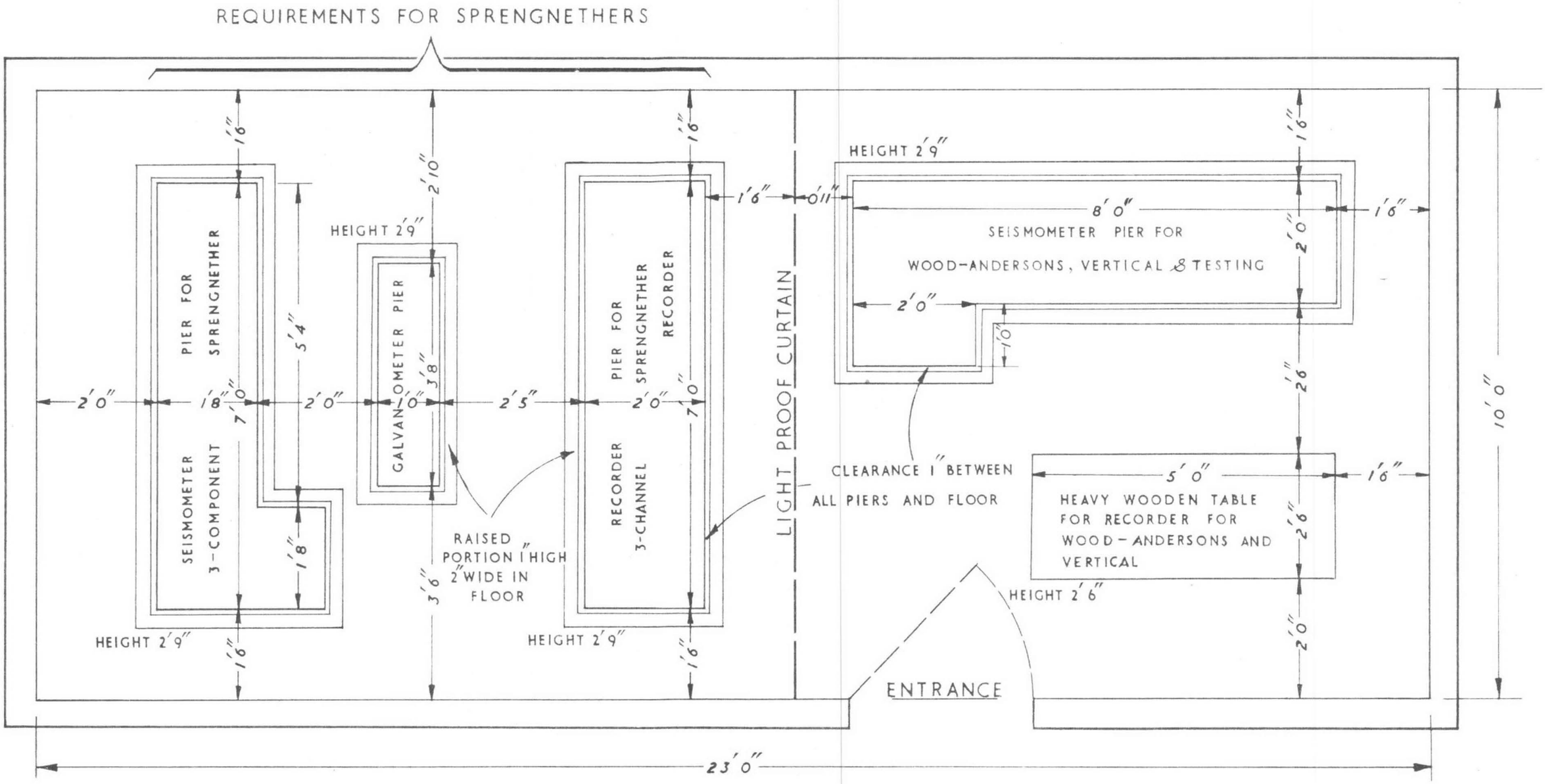
ALL BEARINGS ARE MAGNETIC

J. A. Dooley
GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G82-66

LAYOUT OF PORT MORESBY SEISMOGRAPH VAULT

(AS MODIFIED FROM DRAWING G 82-12)



SCALE ½ Inch = 1 Ft.

T.N.

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G 82-29

PLATE 5

SEISMIC VAULT