COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1958 NO. 56.

SEISMOLOGICAL REPORT OF THE WATHEROO OBSERVATORY

by

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PLATES.

1. INTRODUCTION:

Watheroo Magnetic Observatory is 120 miles North of Perth, Western Australia, and has been associated with studies of geomagnetism, earth currents, the ionosphere, atmospheric electricity and cosmic noise since its inception in 1918. To obtain recordings for the study of earthquakes, crustal structure and microseisms a seismograph was installed in October, 1954. After numerous tests and modifications the instrument proved unsatisfactory and was removed to the B.M.R. laboratories for rebuilding. No routine recordings were obtained with this instrument at Watheroo.

As plans for building a seismological station at Mundaring (25 miles E of Perth) were in an advanced stage no further seismological work was contemplated for the Watheroo Observatory. However, when in 1958 another instrument became available a special effort was made to produce some seismic data during the I.G.Y. A short period, vertical component high magnification seismograph was then installed at a temporary site 10 miles E of Watheroo on the pre-cambrian shield area. Recording was commenced on April 1st, 1958.

Given in this report are details concerning both the Watheroo Magnetic Observatory and proposed Mundaring station.

2. THE W.M.O. STATION:

Instrumentation: The first instrument installed was the Leet-Blumberg seismograph, which has a variable capacitance seismometer coupled by an amplifier to a pen recorder. As no routine recordings were obtained with this instrument it will not be further described.

The instrument installed at the site 10 miles E of the Observatory is a vertical component short period (Benioff) variable reluctance seismometer coupled to a standard Willmore portable recorder. The set is shown in Fig.1 and the particulars of the component parts of the seismograph are as follows:-

Seismometer free period 1.0 second. Critically Damped.

Galvanometer free period 0.25 second. Critically Damped.

Magnification - Estimated maximum available (D) 30,000 at 1 c.p.s.

Paper - Photographic - KODAK High Speed Normal RP.30. 300 x 450 mm.

Paper speed 52 mms/minute

1/3 full available magnification was normally used as the microseism amplitudes were generally too great to permit full gain.

Time marks were put on the record by deflection of the galvanometer at minute intervals by a Mercer Chronometer with electrical contacts. This time mark was omitted at each hour. To find the correction to be applied to the chronometer time to obtain G.M.T. aural comparison with W.W.V. radio signals were made once each day. For greater accuracy in this correction a morse key was manually operated simultaneously with the W.W.V. second pips, and galvanometer deflections were caused each time the key was depressed. Thus the chronometer correction could then be obtained by comparison of the chronometer time marks

and the manual time marks. The accuracy of timing an event was estimated to be approximately ±0.2 seconds, mainly owing to observer error in comparing W.W.V. with chronometer, and slight unmeasured changes in chronometer rate.

The recorder was powered by two 6V accumulators, one of which was exchanged and charged daily. Thus the daily routine consisted of changing the photographic record and the battery, and aural time comparison.

(b) The Site: The W.M.O. lies within the Perth Coastal basin about five miles west of its eastern margin - namely the Darling Scarp. At the Observatory it is probable that 20,000 ft. of sedimentary rocks exist, whilst to the east of the Darling Scarp is the vast Australian pre-Cambrian shield where outcrops are the typical igneous and metamorphic rocks associated with such shield areas. Being situated on such a deep sedimentary section the W.M.O. is not a good site for a seismological station, hence a site (on the shield area) about 2 miles east of the Darling Scarp was selected. The station is situated on a low ridge formed by outcropping quartzite. The ridge is less weathered than surrounding areas, is very stony with occasional massive boulders and has practically no soil cover. No trees are growing in the area, the only vegetation being scrub up to 10 feet high.

The position of this station is 30°18.6'S 116°00.9'E, the elevation is approximately 800 feet above sea level, and the distance from the nearest coastline is 60 miles. No interference from traffic on the nearest railway (2 miles distant) or nearest road (1/2 mile distant) was noted on seismograms from this station.

(c) The Seismograph Installation: A concrete slab 6' x 4' x 3" was poured onto an outcrop of quartzite rock, which is either a very large boulder or is solid rock unweathered below the land surface. After first putting the Benioff vertical seismometer in position on the slab a small plywood box 6' x 4' x 3' was built around it. To surround this box structure a galvanised iron shed was built such that the walls of the two structures were 18" apart. This gap between inner and outer walls was subsequently filled with loosely crumpled paper, straw etc. to provide insulation for the inner instrument compartment on the concrete slab.

To reduce the diurnal temperature variation further in this compartment, the building was situated close to a small cliff face which shielded it from the direct sunlight during the afternoon. In the southern end of the building a small door was provided for access to the inner chamber.

Although intended only as a temporary structure this building has been most satisfactory. Thermograph records from within the seismic hut showed temperature ranges only one third of the corresponding ranges measured in a nearby standard screen. During the first two months operation with varying weather conditions the seismograph only once recorded wind vibration, when wind velocities were approximately 35 knots.

3. THE MUNDARING STATION.

(a) The Testing of Site for Seismic Vault.

The area available for a site for the seismic vault to be built at Mundaring, Western Australia, is in the catchment

area of the Mundaring Weir. The site is 30 miles from the ocean, 5 miles from the nearest railway, 2-1/2 from road and has an elevation of approximately 600'. It is 10 miles east of the Darling Scarp, which was referred to in conjunction with the report on the Watheroo station. No detailed geological examination was made at the time of selection of the site some years ago, but several large granite outcrops are visible in the area, and geological advice was to the effect that there would be no great difficulty in finding solid rock at shallow depth, on which to set foundations for the instrument piers. The proposed structure is a concrete vault, with piers isolated from the floor and mounted directly on the rock.

In the first place a site was selected by Works Department, mainly for convenience in construction, and this was agreed to subject to test drilling. The test hole showed no rock to a depth of 21 feet. Further tests near outcropping granite showed steep slopes of the sub-surface rock surface, and doubt arose as to whether the outcrops were isolated boulders.

Therefore it was planned to carry out an electrical resistivity survey to locate continuous sub-surface rock.

A geological reconnaissance of the area showed that a lateritic cap covers most of the northern part of the area. This generally indicates deep weathering (60-100 feet) over granite. Granite is exposed in the southern and western sections; it is extensively sheared, and is intersected by basic dykes. Basic intrusive rocks occur along the southern limit of the area remote from any granite outcrops.

These basic rocks are generally fairly deeply weathered and offer no firm foundations.

As the result of the ground resistivity surveys it became apparent that granite in the shear zones has been cemented with hard weather resistant material, thus welding the separate boulders into an extensive and coherent mass protected from decomposition. The unsheared granite on the other hand has been subject to normal weathering, with subsequent formation of a large depth of clay covered by a thin cap of laterite.

It was decided to build the pier on the cemented shear zone as this was the only solid rock in the area. The position selected is $31^{\circ}58.7S$ $116^{\circ}12.7E$

(b) Proposed Vault.

The proposed seismological building consists of an underground concrete vault, with piers isolated from the floor and mounted directly on the rock. The dimension of the room to house both recorders and seismometers is 25' x 10'. This building is fully described in Plate 2.

(c) Instrumentation:

Installation of one vertical component and two horizontal component variable reluctance Benioff seismometers with a free period of 1 second, is planned. Each seismometer is to be coupled to a long period (14 second) galvanometer, and a short period (1/4 second) galvanometer. Benioff recorders will be used in conjunction with the seismometers. The paper speed will be 60mm/minute for short period records and 30 mm/minute for the long period record.

An automatic radio time signal will print standard times on the records several times daily.

4. PUBLICATIONS

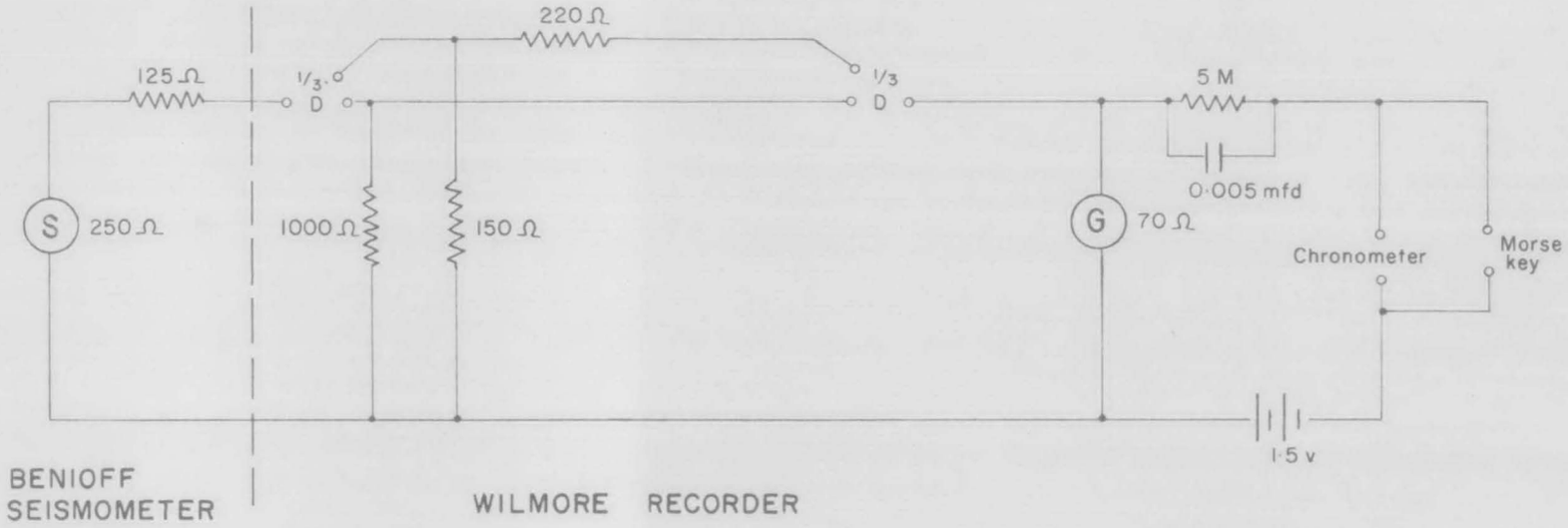
Provisional bulletins will be issued monthly to the International Central Seismological Bureau and to Australian Seismological Stations. These should be completed within a month of the period for which analyses are made and will include times and identities of most obvious phases, direction of initial ground motion and relative amplitude of the major phases. Plans for a final Bulletin are not yet complete.

5. RESULTS TO DATE

At the time this report was written the seismograph had been running for 2-1/2 months. In this period the only missing record was due to the time taken for record changing and to a minor breakdown of the film cassette, which allowed light to enter and spoil parts of a record.

Seismograms show local activity in two regions within 200 kms of the observatory. Tremors, which probably originate at a region near Brookton have occurred on an average of once per day, and preliminary examination of the records from these tremors indicate a normal crustal thickness in the region SE of Watheroo. With roving seismic stations it would be possible to use this source of activity to establish time -distance curves and measure the earth's crustal thickness.

Another interesting feature of the seismograms are the records of several earthquakes with small magnitude which occur in the range 10° - 20° from Watheroo. The position of these has yet to be established, but the most probable location is in the Indian Ocean. The T-phase from two earthquakes with unknown origin has been noted on seismograms, and will also provide an interesting study when more data is available.



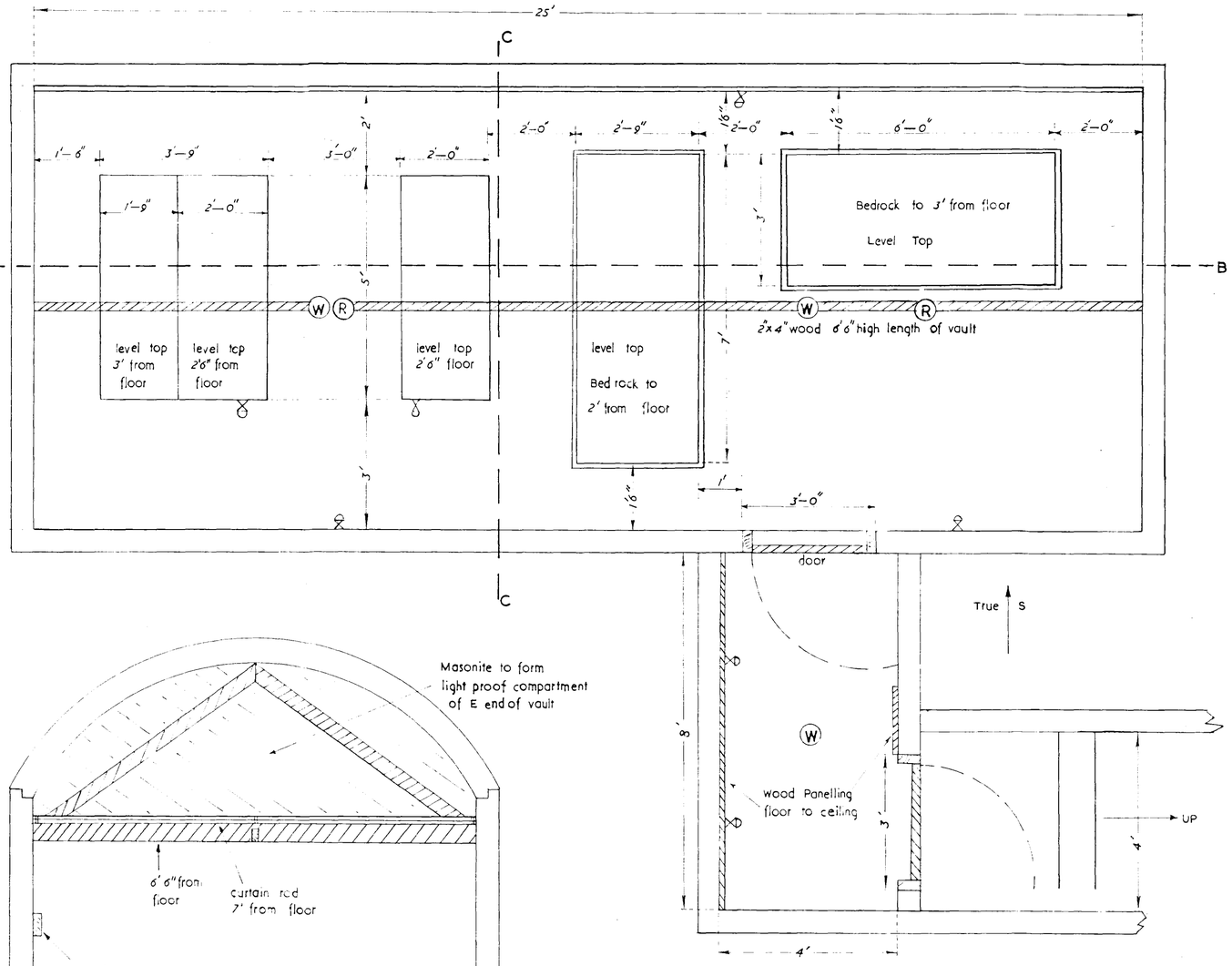
WATHEROO OBSERVATORY

SEISMOGRAPH CIRCUIT DIAGRAM

PLATE 1

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G82-67

PLATE 2



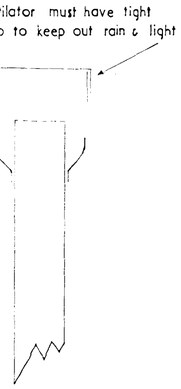
SECTION CC

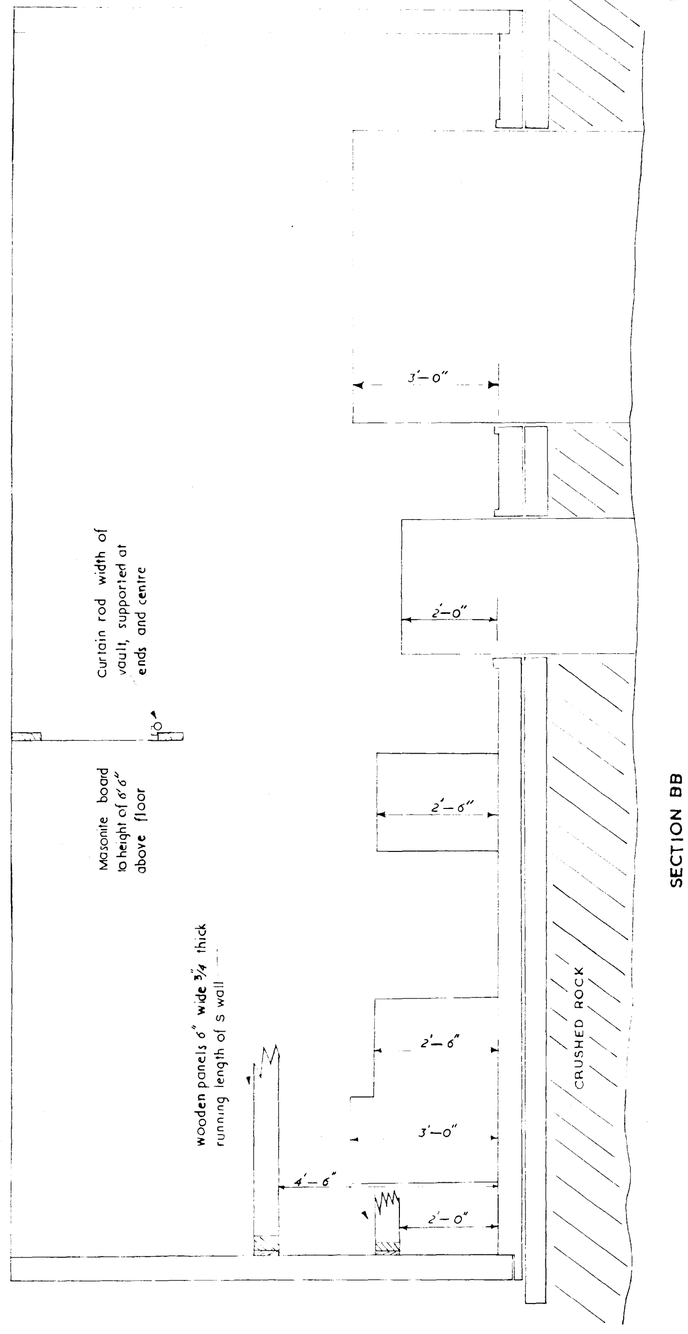
240V. A.C. Power outlets [4ft. from floor]

(W) White light [overhead]

(R) Red light [overhead]

Note: Switches for red lights in vault to be in lobby; for white lights in vault to be in vault; for white lights in lobby to be outside outer lobby door.





SECTION BB

MUNDARING OBSERVATORY W.A

SEISMOGRAPHIC VAULT

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G82-41