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GEOMAGNETIC WORK AT GNANGARA AND WATHEROO, WESTERN AUSTRALIA.

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ABSTRACT.

The Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, Commonwealth of Australia, operates two magnetic observatories in Western Australia. The Gnangara Magnetic Observatory will be operated by the new Mundaring Geophysical Observatory which will replace the Watheroo Magnetic Observatory in 1959.

This record gives a brief description of the two observatories, their equipment and the geomagnetic data obtained at them.

CONTENTS.

INTRODUCTION

The Watheroo Magnetic Observatory commenced operation in 1918 and was established and maintained by the Department of Terrestrial Magnetism of the Carnegie Institute of Washington. It was transferred by gift to the Commonwealth of Australia on 1st July, 1947 and is now operated by the Geophysical Section of the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development.

A complete description of the observatory site, magnetographs and methods of operation has been given by Fleming et al (1947) and essential details are included in "Description des Observatories geo magnetiques" (1957).

For a variety of reasons it was decided that the location of the observatory at Watheroo was restricting the geophysical work that could be done in W.A. and a new geophysical observatory closer to Perth was planned.

The Mundaring Geophysical Observatory is described in Record No. 56 (1958). The Gnangara Magnetic Observatory was the first section of the new establishment to be completed and began regular recording in June, 1957. It is operated by the staff of the Watheroo Observatory.

WATHEROO MAGNETIC OBSERVATORY.

1. OBSERVATORY SITE AND BUILDINGS.

The observatory co-ordinates are 30°19'.1 south, 115°52'.6 east. The site is on the Perth coastal basin, an extensive area of deep sediments, which appears on the surface as a slightly undulating, scrub covered sand plain. The pre-Cambrian basement rocks outcrop at a north-south running scarp some eight miles east. The Midland railway line is a further three miles to the east and the site is therefore free of artificial and natural magnetic disturbance.

The magnetic buildings consist of a variation observatory, an absolute observatory and visual-recording variometer house. A general office is used for reduction work in all branches of the observatory programme. The floor plans of plates I and 2 show the main features of the two principal magnetic buildings.

2. VARIATION INSTRUMENTS.

(a) Normal-run magnetograph. This comprises Eschenhagen variometers for declination (D), horizontal intensity (H) and vertical intensity (Z) and a 20 mm per hour recorder. The sensitivities of the variometers are such that the scale values on the magnetogram are 1'.03/mm, 2.5γ/mm and 4 - 5γ/mm for D, H and Z respectively. The layout of the magnetograph is shown on the floor plan of plate I.

The variometers are not compensated for temperature. The insulation around the variometer room restricts temperature range of the magnetograph to less than 0°.2C daily and about 10°C annually. The temperatures of the H and Z variometers are read twice daily. The magnetogram ordinate temperature coefficients are 13.0γ/°C for H and 13.5γ/°C for Z.

A time-mark lamp-lens system is located on the east wall, near the Z variometer. This is operated every ten minutes by a programme machine controlled by a master-clock; the time marks appear as lines the full width of the record. The parallax corrections to the time marks are measured monthly.

(b) The rapid run magnetograph: The La Cour type rapid-run magnetograph was installed in 1933 during the second Polar Year. It consists of La Cour variometers, multiple lamp and 180 mm/hour recorder. The magnetograph scale values are 1'.0 /mm, 4.3γ/mm and 1.6 γ/mm for D, H and Z respectively. The layout of the magnetograph is shown on the floor plan of plate 1.

The time mark lamp is lit every five minutes by the programme machine, whose error is kept less than one-tenth of a minute. Parallax corrections to the time marks are made periodically.

(c) The Visual Recording Variograph: The recording H variograph is an Askania and consists of a standard H variometer fitted with a light source and photographic cell, and an ink-on-paper recorder. The variometer is located in a small house near the office where the recorder is mounted. The variometer is fitted with a sensitivity control magnet, and this is adjusted to give a chart scale value close to that of the normal-run H variometer.

The variograph is used as a visual indicator of the disturbance level, principally for selecting suitable times for making control observations for the normal recorder.

3. ABSOLUTE INSTRUMENTS AND OBSERVATIONS.

Askania theodolite-magnetometer No.508810 is used weekly for making the absolute observations of horizontal intensity and declination. Occasional semi-absolute determinations of H are made with the Quartz Horizontal-Force Magnetometers (Q.H.M) Nos. 291, 292 and 293 of the Gnangara Observatory. With their higher relative accuracy the Q.H.M's have proved useful at times of adjustment to the variometer for early determination of magnitudes of base-line changes.

For the last few years vertical intensity has been measured with Magnetometric Zero Balance (B.M.Z.) No.120. At present (June, 1958) Askania earth-inductor No.5111079 is being standardised and will shortly be used to control B.M.Z. No.120.

The weekly absolute observations consist of two separate determinations of each element made by standard methods (Hazard, 1947; La Cour 1936 and 1942). For evaluation of the magnetogram base-line values, chronometer times of the observations are noted. Since the observations are made at selected quiet times no manual time mark system is employed (see Gnangara, 3, below).

4. SCALE - VALUE DETERMINATIONS.

(a) Normal run magnetograph. The D scale value is measured every few years by determining the effect of torsion in the fibre and using the known optical lever (McComb 1952).

The H scale value is observed monthly using a small deflector magnet on the D and H variometers (McComb, loc.cit.), and the Z scale value is observed daily by the Helmholtz coil method. A first grade milliameter is used to measure the current during these observations.

The D scale-value has remained constant over many years, and the H scale value has shown only slow changes, but the Z scale value shows large rates of drift and sudden changes. This is one of the reasons that periodic adjustments, described below, are required on the Z variometer.

(b) Rapid-Run Magnetograph. The D scale value is re-determined every few years as for the normal run magnetograph. Monthly determinations of the H and Z scale values are made by the Helmholtz coil method.

5. ORIENTATION TESTS.

Measurements of the ex-orientation angles of the magnets of the two magnetographs are made about once every three years. A large deflector magnet is used in a similar manner to that described by McComb (loc.cit.). Adjustments are made as required to keep the ex-orientation angles within the prescribed limits. Seasonal adjustments to the Eschenhagen Z variometer are required to keep its axis within half a degree of the horizontal, when the ex-level angle exceeds this amount through the effect of temperature.

6. PERFORMANCE OF MAGNETOGRAPHS.

The H and D variometers have behaved most satisfactorily, giving consistent base-line values and scale values. Adjustments, when necessary, were easily made. Unfortunately the Z variometer has been troublesome. The Z scale value has drifted considerably in a random manner so that many adjustments have been necessary to keep the Z scale value within prescribed limits. The needle type pivots are probably the major source of the trouble. They have been overhauled but the scale-value still changes suddenly or drifts fairly rapidly. As the Z variometer has no temperature compensation, bi-annual adjustments to the Z magnet balance-screw have also been made to maintain the Z trace in the correct position on the magnetogram.

7. DATA OBTAINED FROM MAGNETOGRAMS.

The data extracted from the magnetograms for regular publication and distribution are preliminary monthly mean values of the three elements, three-hourly K indices of geomagnetic activity, daily indices Ck, monthly lists of phenomena (commencements, bays, pulsations etc.), quarterly lists of geomagnetic storms, and provisional hourly mean values of H for the hours 12 - 21 U.T. as part of the Equatorial Ring Current project. Details of the distribution of data are given in Record No. 59 (1958).

Mean hourly values, centred on the half hour U.T., of the ordinates of the three elements are scaled and tabulated. No final reduction of the hourly values has been made in recent years but work is progressing on the adoption of baseline values and scale values. The reductions will be completed by electronic computing equipment in Melbourne.

GNANGARA MAGNETIC OBSERVATORY.

1. OBSERVATORY SITE AND BUILDINGS.

The observatory co-ordinates are 31° 46.9 south and 115° 57.2 east. As with the Watheroo Magnetic Observatory the site is on the Perth coastal basin five miles west of the pre-Cambrian shield area. When selecting the site, many tests were made on areas of pre-Cambrian rocks as it would have been advantageous to have adjacent magnetic and seismological Observatories. However, no suitable anomaly-free site could be located on the shield area. The Observatory is twelve miles north-east of the city of Perth and is located in an extensive pine plantation run by a State Government authority.

Buildings include an underground vault to house the magnetographs (Plate 3), a temporary absolute hut and a small tool shed. When Watheroo Observatory closes down, the Watheroo absolute house (Plate 2) will be shifted to replace the temporary absolute hut at Gnangara.

2. VARIATION INSTRUMENTS.

(a) Normal-run magnetograph: The magnetograph is a standard normal-run La Cour type with scale values of 0.94'/mm, 3.25 gammas per mm and 5.5 gammas per mm for D, H and Z respectively. The Z value was originally 1.6 gammas per mm but, subsequent to a magnet change, has been increased to 5.5 gammas per mm. The layout is shown on the floor plan of Plate 3.

H and Z variometers have optical temperature compensation. The temperature within the vault has no measurable daily variation and thermometers are read at weekly intervals. The annual temperature during the first year of operation ranged from 13° - 26° C.

(b) Future plans: Once the Watheroo Magnetic Observatory has been closed down it is planned to instal the visual Askania variometer at the Mundaring observatory office. The Watheroo Eschenhagen variometer will be transferred to Gnangara with the rapid run La Cour so that the set up will be similar to that at Watheroo at present. The Eschenhagen variometers will be on the eastern pier whilst the quick run recorder will replace the normal run recorder at present in use. (Refer to plate 3).

3. ABSOLUTE INSTRUMENTS AND OBSERVATIONS.

The absolute observations of H. D. and Z are made at weekly intervals.

The horizontal intensity is determined by two separate observations with QHMs 291, 292, 293. Similarly the declination is determined by two readings of QHM 291 and vertical intensity by two readings of BMZ 120.

To enable accurate scaling of ordinates to be made for baseline value computation, a manual time mark system was installed. By means of this system time marks may be recorded on the magnetogram by pressing a button at the relevant times of observations, instead of the normal time marks.

The instrumental constants are checked periodically by comparison with the standard magnetometers at the Watheroo Observatory.

4. SCALE VALUE DETERMINATIONS.

The H and Z scale values are measured weekly by the Helmholz coil method (McComb Loc.cit.) A substandard milliameter is used to measure the current.

The D scale value was measured by determining the effect of torsion on the fibre and using the known optical lever. (McComb Loc.cit.).

The H scale value has been very consistent, but several changes have occurred in Z scale value. These were due to (a) change of Z magnet and (b) bad pivots on the second magnet. The second fault has been remedied, so that further changes of the Z scale value (5.5 gammas per m.m.) are not expected.

5. ORIENTATION TESTS.

At the time of installation orientation tests were carried out by the standard methods. (McComb Loc.cit.). Helmholz coils were used to measure ex-orientation of the D and H magnets, and a magnet used in the case of Z.

An undesirable feature of the vault is the lack of space available between the pier and the walls for carrying out Z orientation tests. The maximum distance at which it is possible to situate the deflection magnet is about 700 m.m., so that a small error in the height of the deflecting magnet causes considerable inaccuracy in orientation of the magnet.

6. PERFORMANCE OF MAGNETOGRAPH.

The H and D variometers have behaved satisfactorily. Trouble with the Z variometer was due to faulty magnet pivots. At present this appears to function correctly but should the trouble re-occur new parts for the variometer will be installed.

The magnetograms have occasionally shown effects of ground vibration due to strong winds, particularly on the H magnet. It is believed that the area as a whole is subject to microseisms generated by strong winds. A portable seismograph will be installed near the Observatory site to obtain more information about these un-desirable ground movements. They may be overcome by suitably damping the magnets in the variometers.

DATA OBTAINED FROM MAGNETOGRAMS.

Base line computations have been made in order to check the operation of the variometers, but to date no magnetograms have been scaled. All records are sent to the office in Melbourne where the data from them will be extracted and published.

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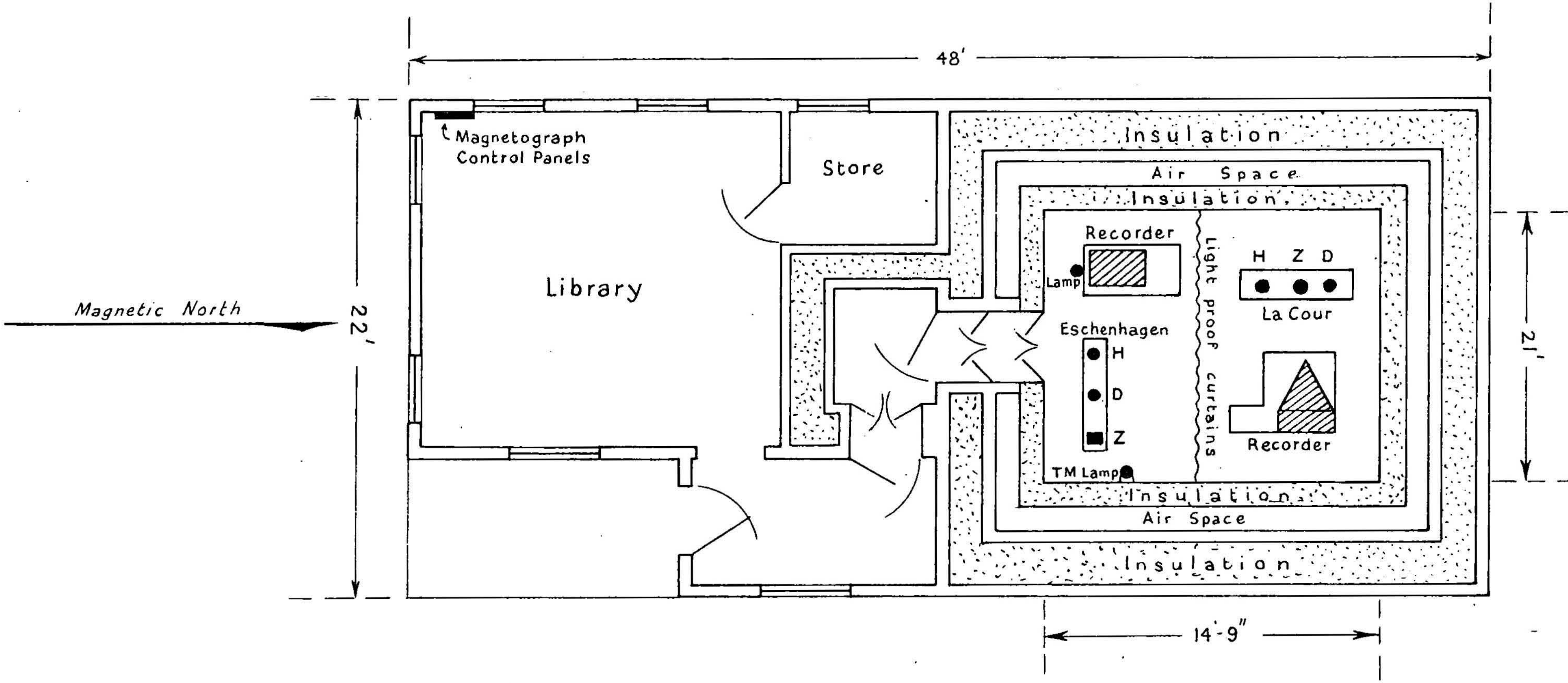

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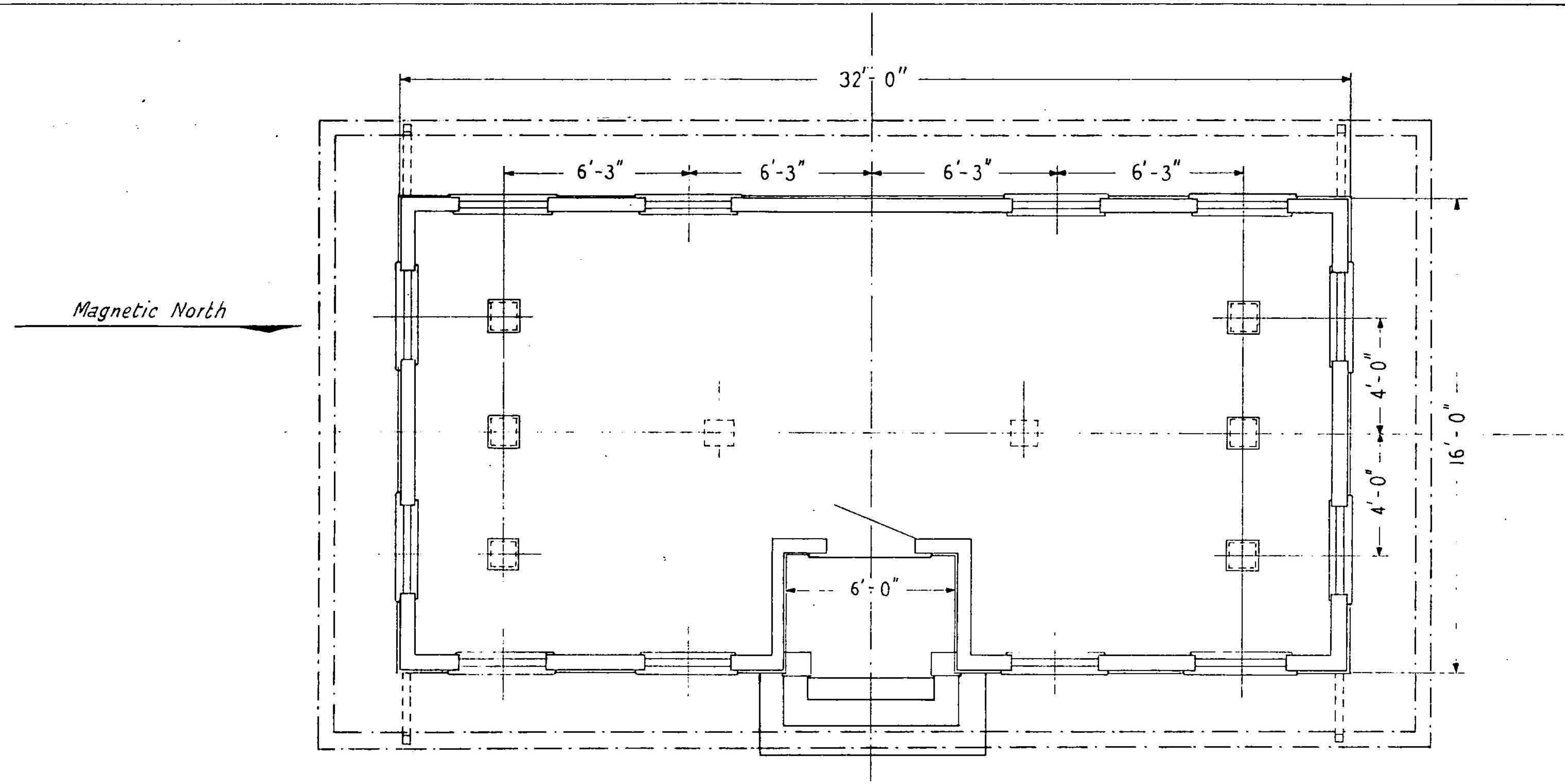
PLATE I

MAGNETIC OBSERVATORY, WATHEROO, W. A.

MAGNETIC VARIOMETER ROOM

FLOOR PLAN



MAGNETIC OBSERVATORY, WATHEROO, W. A.

ABSOLUTE HOUSE

FLOOR PLAN

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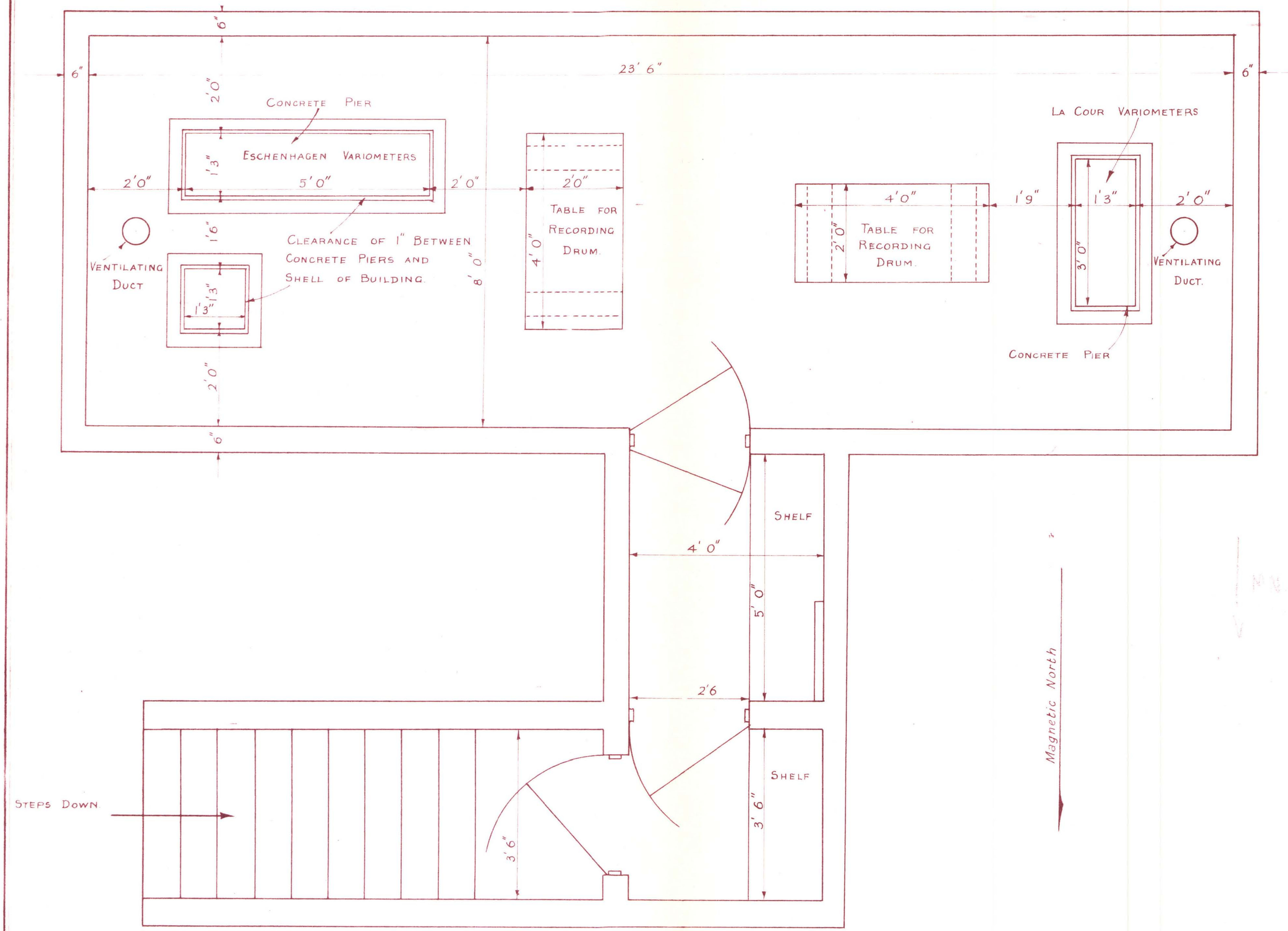
PLATE 2

PLATE 3



MAGNETIC OBSERVATORY, GNANGARA, W. A.

MAGNETIC VARIOMETER VAULT

FLOOR PLAN

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