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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1954, No. 32

GEOPHYSICAL WORK AT
MACQUARIE ISLAND

APRIL 1952 - APRIL 1953

by

P. M. McGREGOR

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ABSTRACT

1952-53 was the third successive year of geophysical work at Macquarie Island. During the previous year Mr. W.H. Oldham was mainly concerned with the preparation of the establishment for future operation as an observatory. This record outlines how, as a consequence, 1952-53 was devoted to full-time technical proceedings in both geomagnetism and seismology. It does not present the results of the scientific observations in full. These will be presented in a further report, but it does give in tabulated form absolute magnetic values observed and seismic phases recorded.

1. INTRODUCTION

The writer was geophysicist to the Australian National Antarctic Research Expedition at Macquarie Island during its operations there from April 1952 to April 1953. This sub-antarctic island south-west of New Zealand has much to offer in both geomagnetism and seismology; its position is 54° 30' S, 158° 57' E, geomagnetic latitude -61° and it lies only a few degrees north of the southern "auroral zone". Magnetic measurements, of importance to secular variation work, have been made there intermittently since 1911. That the submarine ridge from which the island rises is a continuation of the circum-Pacific seismic belt is demonstrated by the number of local earth tremors recorded there during the past three years.

A seismological observatory was put into service at this base in 1950 and a magnetograph installed in 1951; the greater part of 1952 was spent in establishing a fully operational magnetic observatory. The two observatories are manned and equipped by the geophysical section of the Bureau of Mineral Resources. The map of the isthmus area (Plate 1) shows the location of the magnetic and seismological observatories with respect to the main station.

2. CONDITION OF ESTABLISHMENT, APRIL 1952

The existing establishment at April 1952 has been described in detail by W.H. Oldham (1953). An outline will be given here of the additions and alterations deemed necessary to handle the observatory and office programme for 1952-53.

(A) Magnetic section

The magnetic observatory buildings were in very satisfactory condition, considering their obviously poor erection and exposed position. There was ample shelf space in both huts and mains 230V A.C. power and appropriate D.C. power were laid on. The only alterations necessary were some minor changes in wiring and lighting in the variometer room.

The magnetograph had recently been set up (Oldham, 1953) and was producing good records. Absolute magnetic observations were being made on a tripod resting on dabs isolated from the floor, but an essential skylight, instead of being above the station, was in the opposite roof section. This necessitated the use of artifical illumination which was not very satisfactory. There was no provision for storing the absolute instruments, other than dismantling and packing them in their boxes.

(B) Seismological section

These buildings were also in good condition, except that the junction between the concrete and wooden sections, especially in the darkroom section, was not adequately light proof and water proof. The water storage tank (a 44-gallon drum) was too small and rather rusty, but otherwise there was a neat and efficient darkroom for processing records. With the increased stock of photographic material and spares for the magnetic work, further shelf space was desirable, but in general, this part was very well fitted out. The seismograph was producing good records and was in good condition, although there was a slight but steady drift on one component.

(C) Office section

As stated by Oldham (1953), there was no provision for office accomodation and Mr. P.G. Law suggested at the change-over that this could be made available in the cosmic-ray building, which offered the only suitable space.

3. GENERAL CONSTRUCTION AND MAINTENANCE

Some time was spent in building office essentials in the cosmic-ray house, to enable magnetic office work to be done there, but because of its location and the nature of routines this arrangement proved very inefficient, as much time was wasted in walking to and from the various buildings. After six months it was decided to do all work in the seismic office. As this entailed putting more equipment in an already crowded space, an annexe was planned to take the workbench, tools and larger stores. This could only be erected when material became available from demolished huts and when the carpenter was free to do the essential construction. The excavation of the site against the east wall of the concrete hut was completed before this, and the store was not occupied until late February, 1953. As soon as the annexe was erected a 180-gallon "Furphy" tank was hauled up from the main station, placed at the side of the annexe and connected to the existing plumbing in place of the original 44-gallon drum. Combined with the increased catchment from the additional roof area, this should provide sufficient water to tide over a longer dry period than was experienced during the summer of 1952-53.

In the darkroom, the lay-out was changed slightly. Another bench was built below the sink to accomodate one of the processing trays containing a gelatine bath for the magnetogram. A short-stop bath, to increase the life of the fixer, was also put into use.

Early additions to the office were seismogram storage shelves and an increase in the length of the office table to facilitate work on seismograms. Later, when magnetic work was also done in the seismic office, additional shelf space and a cabinet became necessary. In the end, a very compact and comfortable office resulted.

Constant attention to the weatherproof of all buildings was essential. The magnetic huts in particular are subject to severe sand blasting. Leaks developed in the Absolute Hut during the winter, when little could be done to deal with them, but when the roof panels were interchanged in November to improve the lighting arrangements, all joins and cracks were filled with PC49 before cover strips were fastened. This proved very effective and very few leaks were noticed subsequently. During the drier months of December and January all huts were painted and the roof of the office darkroom structure tarred. Liberal applications of PC49 proved very effective in improving the junction of the darkroom to the concrete hut, but it will probably never be completely water-tight. It would be desirable to paint the buildings every six months, but the only suitable time is at mid-summer.

4. MAGNETIC SECTION

A. The Observatory

The observatory comprises an Absolute Hut, a Variometer Hut and a battery charging structure which is an elevated box housing a 6-volt battery with charger operating continuously off the 230V.A.C. mains. The box also serves as power distribution point to the other buildings. All power lines are underground and are of lead-covered cable.

(1) Site

Located on that part of the isthmus surveyed and recommended by A. Bunbury in 1949 (Jacka, 1953), the observatory is on a well-grassed area clear of tussock and comparatively uniform magnetically. It is about 300 yards from the main ANARE station and 25 feet above sea level. The lay-out of observatory and environs is shown on Plate 2.

(ii) Construction

Both huts are built of pre-fabricated sections, 2½" thick, of plywood and "onazote" (an insulting material). They are securely guyed to prevent movement during high wind. Plans of the huts are shown on Plate 3.

(a) Absolute Hut. This is 12 ft. square, and is well lit by seven windows and two skylights, all three feet square. Until 1952, all magnetic observations were made over a tripod stand (Station E), but this was replaced during the year by two wooden piers. The first, Station Ew, with mounting for the vertical intensity magnetometer, was completed by September. It was placed west of the tripod, under the skylight, which gave such excellent illumination that it was decided to interchange the other roof panels so that the second skylight would be directly above the projected pier for the measurement of the other magnetic elements. This second pier was not completed until mid-December. The excavation of holes for both piers proved very difficult, as the floor of the hut is about 2 ft. above ground level. The piers, set in nearly 3 ft. of cement, are sections, 9 inches in diameter, cut from a spar of a wrecked sealing vessel and proved well worth the effort to erect them. The second pier does not occupy the same position as the original Station E, being about 18 inches to the west, but as there was no detectable station difference between the two positions, and to reduce confusion, it has continued as Station E since its inception. Full benefit of the skylight is obtained in the new position, good illumination being essential in the operation of the QHM magnetometer.

(b) Variometer Hut. A windowless hut 12' x 18' comprises the variation building. It is divided into the following sections: "porch" (6 ft. x 6 ft.), "control room" (6 ft. x 6 ft.) and "variometer room" (12 ft. x 12 ft.). The porch serves as an entrance and light trap, a door leading from it to the control room and another from there to the variometer room. In the control room are the pendulum clock, combined variometer and scale-value panel, and bench for spares, variometer room log, chronometer and forms for recording. The magnetograph is in the northern half of the variometer room. Two safelights, one over the recorder and one over the bench, provide ample illumination for record changing and, with the Wratten screens removed, for adjustments.

(iii) Instruments

Apart from the instruments used during the year there were others used earlier, mainly by W. Flower in 1950. These were a dip circle, Kew pattern magnetometer and Watts vertical intensity variometer. The first two instruments were returned to Australia in 1953, not having been used during the period 1952/53.

(a) "Absolute" magnetometers. Two "quartz horizontal-force magnetometers" (QHMs), Nos. 177 and 178 were used for semi-absolute determinations of horizontal intensity (H) and declination (D). Vertical intensity (Z) was obtained with "magnetometric zero balance" (BMZ) No. 64. Corrections to international magnetic standard (IMS) for H and D were obtained by intercomparison work at the relief operation, 1952 (Ervin, 1952). QHM No. 179, the third of the set, was returned to Australia for periodical calibration at the Toolangi Magnetic Observatory during 1952. This system of replacing one QHM each year is the only practical means of checking the instrumental drift. The IMS correction for the vertical intensity observations has not been determined but is expected to be of the order of ± 10 gammas.

(b) Magnetograph. This is of the La Cour pattern, normal run (15 mm per hour) and low sensitivity and is comprised of recorder, Declinometer No. 76, H variometer No. 76 and Z balance No. 94. Helmholtz-Gaugain coils are placed around the H and Z variometers for scale-value determinations, the necessary controls being on the panel in the control room. Thermometers above the bench and in the H and Z instruments were read each morning and provided control for the temperature trace. Time-marks were made by the standard pendulum clock which was maintained correct to within half a minute of GMT. The circuit had been modified by the inclusion of a resistor, thus allowing the time-mark lamp to glow continuously, and improved German silver contacts were used in place of the originals. Until these contacts were installed, the originals gave a great deal of trouble as the damp, salt air rapidly caused poor contact between the pairs.

Adjustments during the year were mainly to the H variometer. A series of absolute magnetic observations combined with a test with a room heater revealed a temperature effect and the fact that the thermal compensating strip was acting in reverse. Following the first adjustment to the strip, some days were spent in improving the appearance of the magnetogram. This required successive adjustments between the three variometers to obtain the desired relative intensities of the several spots. A further adjustment to the H compensator was necessary after several months' observations had revealed a small temperature coefficient in the baselines.

The quality of the records was affected in two ways by the climate. Firstly, the high average relative humidty (85% - 90%) required the recorder intensity to be high, and any decrease in humidity produced over-exposed, dense records. The dampness affecting the photographic paper also probably explains why the reserve-spot intensities were not as high as expected. The second effect due to the climate was the fading of all records for periods of up to 6 or 8 hours at irregular intervals. At first sight this appeared to be due to faulty recording paper but was eventually correlated with sharp increases in temperature associated with unusual N.N.W. to N. winds. These rises in temperature caused condensation on the glass surfaces of the optical systems with resultant decreases in intensity on the magnetogram. A de-misting compound for the surfaces was suggested for the following year as a possible means of reducing the effect.

Because of the high sensitivity of the declinometer (0.89 minutes/mm) the original fibre was replaced by a heavier one, resulting in only a slight decrease in sensitivity. The optical path length is much greater than that required for a declinometer of scale value 1 mm =1 minute and in the latitude of Macquarie Island a scale-value of $1\frac{1}{2}$ or 2 minutes per mm would be preferable. For periods of high disturbance the D trace was very often not decipherable, with consequent loss of maximum and minimum ordinates.

(c) Accessories. These include chronometers and surveying equipment. A pocket chronometer (Ditisheim 50098) was used for chronometer and clock comparisons and a marine type chronometer (Brockbank and Atkins 1437) for absolute observations. The theodolite proved very useful in transferring azimuths for magnetic, meteorological and auroral purposes.

(iv) Azimuth Marks

The azimuths of various marks were obtained by transference from those known at Station A (see below). Since the absolute pier and its marks were not completed until late January 1953, no direct determinations by sun observations were made.

The new position of Station E meant that new azimuth marks were required; the rocks previously used for azimuth marks could no longer be sighted through the doorway and holes had to cut through the hut walls. Unfortunately, it was not possible to sight on the original main mark or that used at Station A (Seaward Nugget) and a third mark (Inner Nugget) had to be used. Also, the target and post previously set up for use in foggy conditions had to be moved into the line of view through the sight-hole. Directly on the line from Station E to the Inner Nugget mark (the "South Mark") a wooden block was sunk into the ground to serve as an azimuth station. It is about

70 yards from Station E and by observing the sun from this point and sighting on the "South Mark", the required azimuth can be determined directly. The bearings of the "Target Post" and "North Mark" (Anchor Rock) from the pier can then be obtained by making a round of angles between the three. The bearings of the marks and the "Auxiliary azimuth station" are shown on Plate 1.

As mentioned below, Reference Station 1 is useful for theodolite work and the bearings of Anchor Rock and the Seaward Negget were transferred to this point from Station A. Determinations of azimuth for the meteorology and auroral sections were based on the Reference Station values.

B. Procedures

It was not until late in the year that it was possible to put procedures on a regular routine basis. Final daily and weekly procedures are outlined as follows:

(i) Daily routines

Each morning the record was changed at 0956 - 0959 hours EST (2356 - 2359 GMT), intensities, time-marks and operation of magnetograph checked, chronometer wound and records processed and dried.

In the afternoon, at about 4 p.m. the time signal and time-mark clock comparison, and magnetograph check were made.

(ii) Absolute, base-line and scale-values

For the first few months H and D were observed with QHM 177. This was done to obtain uniform results in H until a large temperature coefficient (about 13 gammas per degree C) in the H variometer had been accurately determined and adjustments made. Thereafter, absolute measurements were made alternating QHM's 177 and 178. Z was observed throughout with BMZ 64.

In order to determine base-lines within a few gammas, it was found necessary to do absolutes only on days which, from the appearance of the freshly developed magnetogram, promised to be quiet. This meant that the observations were made rather irregularly but on the average once a week, sufficient to give reasonable control of the magnetograph.

A set of absolutes consisted of observations in the order Z, D, H, H, D, Z and occupied a little over an hour. To increase scaling accuracy for determination of base-lines all magnetometer settings were made exactly on the minute according to the magnetograph time-marks, the chronometer and pendulum clock being compared before starting. More extensive absolute measurements were not made for the following reasons:- (a) Pressure of work in general. (b) Sufficient base-line control resulted from two values of each element per week. It was considered more satisfactory to obtain accurate base-lines by short observations than to prolong the determinations and risk magnetic conditions becoming disturbed during the process. Especially during winter, daily disturbances commenced early in the afternoon. (c) For the first few months the determination of the H variometer temperature coefficient was of prime importance. Accent was placed on H determinations over as wide a range of temperature as possible. For a period at this time, D values were obtained from the H observation zeros combined with mark readings. Although giving only two scaling times the results were quite satisfactory.

The BMZ and QHM proved particularly suitable instruments for measurement of Z and H. For D, the comparatively poor horizontal circle and high scale-value of the QHM telescope combined to limit the accuracy of determinations. D values are probably accurate to only plus or minus half a minute of arc.

Scale-values were of use only if determined on quiet days. A first grade meter capable of measurements up to 100 mA was to have been used for this work, but was damaged either during the voyage from Australia or during the rugged unloading operations. The existing 15 mA meter allowed only a reversal field of 240 gammas at the variometers, with resultant double deflections (2u) of about 16 mm (Z) and 18 mm (H). Small differences in 2u produced quite large differences in the scale-values, which were 13.6 gammas per mm for Z and 12.4 gammas per mm for H. The values showed a fairly even scatter about these means which were used for all conversion work.

The D scale-value was determined by the torsion method and with the Helmoltz coil, both results being in close agreement. The optical lever was calculated from the dimensions of the lenses and prisms, together with the drum-declinometer distance, measured with a stiff copper wire. The adopted D scale-value was 0.89 minutes per mm (equal to 3.5 gammas per mm). This value meant that the instrument was much too sensitive for the latitude, and the records for periods of high disturbance are too confused to allow interpretation.

Much trouble was experienced with the potentiometers and selector switches on the scale-value board. The original ceramic, double-bank, selector-cum-reversing switch was replaced early by the conventional DPDT knife switches and from time to time the wire-wound potentiometers had to be renewed. At no time were they wholly satisfactory, undoubtedly due to the moist and salt-laden atmosphere. Quite often scale-value observations were abandoned to effect replacements and this, combined with onsets of storminess, explains some relatively long gaps between successive measurements. Two large circular potentiometers sent on the M.V. Tottan in January 1953 proved more suitable and up to the change-over in April had given no trouble whatever.

(iii) Magnetic values

The main procedures in computing magnetic data were the derivation of provisional monthly mean values of the three magnetic elements H, D and Z, and the three-hourly K indices of geomagnetic activity. Further, "final" hourly values of H were supplied to the cosmic-ray physicist.

(a) Provisional means. These required the mean values of base-line, scale-value, ordinate scaling and temperature correction (if any) for each element. Daily scaling of the magnetogram (mean hourly values) and calculations of the daily mean meant that the monthly mean ordinate could be calculated a day or so after the end of the month. Mean base-line and scale-value determinations were a simple matter and, provided the variometer was temperature compensated, the mean values of H and Z for the month were easily obtained. However, the procedure was much lengthier when temperature corrections had to be determined (fortunately only for H). The three mean values i.e. of D, H and Z, together with the mean scale-values, were transmitted to Melbourne within a few days of the end of the month.

(b) K Indices. To obtain the K index measure of activity the quiet day variation (Sq) curves are necessary. Lacking previous data it was decided for each individual month to base Sq on the 5 quietest days for the month and these were supplied to the island from inspection of the Toolangi magnetograms. When the quiet days were known the Sq curves were drawn and transferred to transparent celluloid for superposing on the record to be measured. The whole process, including the subsequent scaling of the month's indices, required about two days, so that the K data were generally sent about the 5th or 6th day of the following month.

(c) "Final" hourly values of H. These were required by the cosmic-ray physicist. It is not possible to obtain final magnetic values until a long series of base-lines and scale-value observations has been made. Only then can values of base-line and scale-value be used to make the final calculation. Similarly, if there is a temperature coefficient, a series of base-line determinations is required before it can be computed with accuracy. However, as the values were required within 10 gammas only, it was felt that it would be safe to compute H provided a reasonable overlap of base-lines was used.

This requirement meant that as hourly temperature corrections were necessary for months when the H variometer was uncompensated, mean hourly values of the temperature ordinate had to be scaled and the necessary hourly correction read off a graph. The graph, calculated by the method of least squares, was that of temperature (morning readings of the thermometer) against temperature ordinate; by applying the temperature coefficient, the graph was converted to one of temperature ordinate versus temperature correction, enabling a great saving in calculation without loss of accuracy.

(d) Abstract. Since all original observations were to be returned to Australia, an abstract of absolutes, base-lines, scale-values and K indices was commenced for future reference at the island. Similarly, the observatory log containing details of adjustments was duplicated.

C. Magnetic stations and field observations

In addition to the observing piers of the magnetic observatory there is a number of magnetic stations on the island. A brief description of four of these will be given, the remainder (all on the north end isthmus) being of historical interest only.

(i) Station A

This was established in 1911 by Webb and Kennedy of the Australian Antarctic Expedition, closely re-located when the island was visited by the expedition of 1930 and made permanent by N.G. Chamberlain in 1948 (Chamberlain, 1952). Its position is latitude 54° 30' 11" south, longitude 158° 56' 58" east. These co-ordinates, and the true azimuths of several prominent marks from this station, were determined by ANARE surveyor Mr. R. Dovers (see Plate No 1). Azimuths known at this station have been the basis for azimuth determination elsewhere on the isthmus.

(ii) Reference Station 1

This is Station B of Bunbury's variometer survey. Although no longer used for magnetic purposes it is a convenient starting point for any theodolite work required on the isthmus and for this reason the bearings of two prominent marks were obtained in 1952.

(iii) Station F

An auxiliary station about 20 feet east of the absolute pier, Station E. It was set in a concrete block by Oldham for intercomparison work.

(iv) Caroline Cove

In 1911 Webb and Kennedy made absolute observations at a station at the head of Caroline Cove on the extreme south-west tip of the island. In 1948 Dovers, unable to locate the original station, put in another very close to the first and determined two azimuths by sun observations. A visit was made to the Cove in November, 1952 with QHM 178 and BMZ 64 with the object of occupying Dovers' station. After a thorough search it was given up as lost, apparently through the activities of wallowing sea elephants. Because of this factor the new station was established on somewhat higher ground than the previous two, within 15 ft. of the original. It was marked by the block carried to the Cove in 1951 and covered with a cairn of stones.

Magnetic field observations during the year were made at Station A and Caroline Cove (see Appendix 1). During the 1952 relief, differences between Station E and Station A were obtained accurately in H and D and approximately in Z. A series of observations with the BMZ at Station A in 1953 yielded this difference more accurately, through the base-lines. Similarly, at Caroline Cove, observations giving four values of each element, combined with the observatory base-lines, enabled the differences between these two stations to be obtained.

5. SEISMOLOGICAL SECTION

A. The observatory

(i) Site

The north-end isthmus connects the main part of the island to the steeply rising Wireless Hill-North Head mass. Wireless Hill offers the closest bedrock to the expedition station and the seismological observatory is set into an excavation on its lower slopes. The instrument pier is 45 ft. above sea level at latitude 54° 29' 55" S, longitude 158° 57' 22" E. The basement rock is basalt.

(ii) Construction (see Plate 4)

There are three structures at the observatory:

(a) Concrete hut. This is the seismometer room, measuring 12 ft. x 18 ft. with a T-shaped concrete pier 8 ft. x 5 ft. The interior is lined with wood, the whole being comparatively weather-proof. Water does enter down the southern wall, apparently via the roof, but it was difficult to locate this leak. A wooden bench for storing unexposed recording paper was built just inside the door below the safe-light.

(b) Wooden structure. Against the south side of the concrete hut is one of the prefabricated wooden units, 6 ft. x 12 ft. This is divided into the "office" and "darkroom". The door to the seismometer room opens into the office, which can be darkened to allow entry to the seismograph during the day.

The remainder of the office not occupied by seismograph accessories, is taken up by office fittings. A long table with cabinet below and stationery shelves above, is under the window in the west wall. Further benches and shelves around the walls provide adequate space for forms, magnetograms, seismograms and spares.

What was originally intended as a porch had been fitted out as a darkroom for processing magnetograms and seismograms. Sink and benches to carry the trays of developer, short-stop, fixer, glycerine bath and water are arranged against the walls in one corner and there is further shelving for small stores.

(c) Annexe. This was erected during the year and contains the tools and work bench as well as providing space for larger stores. It is 8 ft. x 6 ft., and is built on the sheltered (eastern) side of the concrete hut. It greatly reduces the congestion in the wooden structure. The extra roof area also increases the water catchment and should eliminate the necessity of carrying water from time to time.

(iii) Instruments

Two Wood-Anderson torsion seismometers and recording drum comprised the seismograph. The instruments responded to horizontal vibrations in the E-W and N-S directions. The light sources set in front of the cylindrical lenses of the recorder had in the optical system a 45° prism attached to a relay. A contact system on the minute hand of the chronometer operated this relay for a few seconds every hour, providing the hourly identification in the form of a slight displacement of the record. Minute marks, produced through the built-in contacts in the chronometer which short circuited a resistor in the normal circuit, were in the form of 5-second increases in intensity. These minute marks, although giving times within an accuracy of 1 second were not very sharp in commencement on the record and the time marking would have been improved by interchanging the minute and hour marking systems. The drum was driven by a synchronous motor from the 230v A.C. mains and gave a record at the rate of 30mm per minute. Close to the drum and working continuously, was a 300 watt strip heater to eliminate humidity effects on the photographic paper.

Most of the controls for the seismograph were in the office. The 6v battery for the light sources was trickle-charged by a 0-6 amp charger, the power being drawn via a control board and switch. The individual intensities of the two spots were controlled by potentiometers on each source. To maintain a steady rate on the Mercer chronometer the office was kept, as far as possible, at a constant temperature (16° to 18° C) by means of a strip heater and thermostat.

B. Procedures

(i) Routines and analysis

Although it is unnecessary to change a seismogram near 24.00 GMT, as with a magnetogram, this was done as a matter of convenience. By changing the seismograph record at about 09.45 hours and then proceeding to the magnetic observatory to change the magnetogram, followed by processing of the records, this aspect of the daily routine was completed by mid-morning. The resultant effect of having nearly all of one Greenwich day on one seismogram was a minor convenience in marking the record.

Time signals from WWVH (Honolulu) could usually be heard only during the afternoon so the Mercer chronometer was compared at about 15.45 hours. The correction and rate were obtained and the correction at the time of commencement of the record calculated for marking the trace. These data, together with the "on" and "off" times were noted in the "Seismometer Room Log".

A preliminary analysis of each tremor recorded was made, to give the origin time and epicentral distance (based on the Jeffreys-Bullen Tables). At the end of each fortnight the results were transmitted in code form by radio-telegraph to Melbourne. Whenever a teleseism was recorded, with possible identification of major phases, data on the earthquake were obtained from Melbourne. With the known origin time and epicentral distance, the seismogram was closely inspected for the expected phases. In most cases the response of the Wood-Anderson instruments to long distance shocks was not sufficient to produce identifiable movements.

(ii) Constants and adjustments

Apart from routines and maintenance little was done to the seismograph during the year. Constants were determined twice in the last part of the stay, the methods used being:-

(a) Free Period, T_o. The damping was removed from each seismometer in turn and the inertia system made to oscillate. The time of 100 central passages of the spot on a white sheet on the drum was noted by stop-watch; the mean of five such observations gave the period sufficiently accurately.

(b) Static Magnification, V_o. Owing to the construction of the seismometers, the usual "tilt-test" method for the determination of V_o could not be used. The less satisfactory evaluation by measuring the optical lever (L) and the equivalent pendulum length (l), gave

$$V_0 = L/l = 2,900.$$

(c) Damping coefficient, h. Decay curves, obtained with the damping magnets in position, allowed the computation of h. It is shown by Anderson and Wood (1925, p. 37) that, if the ratio of the amplitude of the first swing to that of the nth is Ao/An, the damping coefficient is given by

$$h = \frac{\log_{10} Ao/An}{1.862\, n^2 + (\log_{10} Ao/An)^2}$$

To put this method into practice required an increase in the drum rate of rotation and some means of controlling the zero position of the spot after twisting a footscrew to cause the oscillations. A knowledge of the exact speed of rotation was desirable though not essential.

The drum speed was increased to five times normal i.e. to about 2½ mm per second, by coupling the synchronous motor directly to the drive roller thus by-passing the normal 5:1 reduction gear. A mirror was mounted on the footscrew used to start the oscillations and with a scale and crude point source of light, formed an accurate means of resetting the instrument in its original torsion free position. The drum rate was determined by exposing the trace and measuring the recording time. This was done for each decay curve because the mains frequency was highly variable. From the curves thus obtained the damping coefficient was, until February 1953, h = 0.09; thence, after adjustment, with maximum obtainable damping, h = 0.11.

From the above, it may be seen that the damping was much too low, thus explaining the unsatisfactory recording of local tremors (a value of h = 0.6 was the optimum for this work). Attempts were made to determine the cause and hence a possible remedy for this. The magnet systems were dismantled, checked for rusting between the pole-pieces and reversed polarity of the magnet pair. All appeared to be in order. The flux between the pole-pieces seemed very high but lacking any experience or data, this could only be estimated as being of the right order. The pole-piece gap, although slightly larger than in the design, was not enough to account for the very low damping value but spacing strips to reduce the gap to a minimum were ordered for 1953 in the hope that this may have been the cause.

6. AURORAL OBSERVATIONS

An extensive observing programme on the aurora polaris was planned by the ANARE. The cosmic-ray physicist was in charge of the work and four other observers shared the nightly watches in addition to normal duties.

The plan was to obtain a systematic record of the distribution of the aurora in time and space. To do this a "sectoriser" was built by the three physicists in the party. The sky was divided by this into 96 parts, each part defined by sixteen 22½° horizontal sectors (1-16) and six 15° vertical divisions (A-F), the observer being at the origin of the system. Commencing on each quarter hour in the dusk to dawn period, a note was made of aurora (type and intensity) and cloud in each "sector". To obtain the distribution of cloudiness, it was essential to sectorise the sky on all nights, noting "clear", "cloud" or "part-cloud". Thus, even on fairly overcast nights, the watch had to be carried out in the same manner as for display nights, so that most of the day following auroral watch was lost for main duties. It was considered however, that this loss of time (every sixth day) was compensated for by the experience and the close connections noted between the aurora and certain types of magnetic disturbance.

7. EXPEDITION DUTIES.

All members shared in the work necessary to maintain and improve the station. Kitchen and mess duties were taken a week at a time and although this meant an interval of 12 weeks between each round, there was little time for other than essential work during this week. Other regular station duties required only an hour a day, one week out of twelve. From time to time occasions would arise which required all hands and which often took up most of a morning or afternoon. Such tasks were the assembly of new buildings, shifting of fuel drums, etc.

The writer's activities as expedition photographer were restricted but in order to keep the required filing system for negatives up to date and to handle the printing of photographs for the various party members, quite a lot of time and effort was necessary. After the existing darkroom was destroyed by fire, a week's work was devoted to painting, wiring and fitting of the new darkroom. Operation of the projector for the weekly picture show was in the form of relaxation.

Early in 1953 a field trip with another party member was made to Prion Lake, one of the larger lakes on the central plateau. This was in response to a suggestion from the Antarctic Division and has been described in a report by McGregor (1953).

8. RESULTS

As stated previously, many of the results of immediate value obtained during the year, such as the geomagnetic K indices, the monthly mean values of the elements, and the preliminary analyses of the earth tremors, were radioed to Australia and subsequently published in Reports of the Bureau of Mineral Resources. Since returning to the mainland the magnetograms have been inspected for "sudden commencements" and principal magnetic storms and lists of these have been published. A considerable amount of time has still to be spent on the final adoptions and calibrations of the several quantities involved before mean hourly values of the magnetic elements can be published in final form. When the computation of these is completed they will be published as a Report of the Bureau of Mineral Resources.

All the tremors and teleseisms recorded have been checked and the resultant final analysis will be published as a Bureau report. A qualitative analysis of the microseisms has been made and a possible connection of the regular type with atmospheric front passage, as distinct from low pressure systems, has been noted, but the subject is too complex to make any conclusions from a simple inspection.

The appendices have been added to this Record to indicate the general magnetic and seismological nature of the region.

9. CONCLUSIONS

The year's work, spent primarily on adjusting and putting the magnetograph into controlled operation, proved very full and at many times tedious for one observer. However, the scientific interest of the region and of the problems compensated for the heavy programme. The most important lesson learned was that with the QHM for the temperature adjustment of a variometer, a few base-line determinations spread over a range of three or four degrees will give a sufficiently accurate coefficient to allow an immediate adjustment to be made. Had this been realised in April, 1952 much subsequent computation work could have been eliminated. In the same way the corresponding speed and accuracy of the BMZ would doubtless enable a temperature effect in a Z balance to be measured with two or three observations.

Credit must be given to H. Oldham, whose foundation work in the establishment of the observatory allowed the greater part of the time to be spent on scientific matters, with the result that controlled records were obtained over practically the whole year. Several members of the ANARE party gave assistance when possible and their help is hereby acknowledged. In particular, recognition is due to F. Soucek who acted as relief for record changing, E. Macklin and R. Arnel for copying and recording tabulations, G. Major for general assistance and, with D. Sweetensen, for sharing in the transport of the magnetometers to the southern end of the island.

10. REFERENCES

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APPENDIX 1.

MACQUARIE ISLAND.

ABSOLUTE MAGNETIC OBSERVATIONS

Horizontal Intensity (H) and Declination (D) corrected to I.M.S.
Vertical Intensity (Z) correction to I.M.S. unknown.
Values are means of two observations except where noted.

Date	Horizontal Intensity	Declination East	Vertical Intensity
1952	(Gammas)	(Degrees)	(Gammas)
Apl.16	13,474	24°05'.3*	
21			-64,652*
24	13,377	24°02'.8	-64,568
May 14	13,380	24°06'.0	
15	13,382	24°04'.2	-64,563
22	13,382		
23	13,379	24°03'.5	-64,560
June 5	13,364	24°06'.3	-64,566
9	13,380		
16	13,344		
18	13,375	24°06'.5	
24	13,376	24°08'.6	-64,574
27			-64,602
29	13,368	24°04'.4	
July 3	13,366	24°06'.4	-64,560
11	13,372	24°06'.1	-64,592
Aug. 5	13,350	24°04'.6	-64,559
20	13,358	24°06'.8	-64,566
	13,420	24°05'.6	
23	13,362	24°06'.8	-64,578
26	13,359	24°08'.8	-64,544
29	13,352	24°06'.9	-64,540
			-64,550
Sep.12	13,358	24°05'.1	-64,607
16	13,370	24°05'.5	-64,566
18	13,356	24°08'.1	-64,555
24			-64,552
			-64,570
25	13,362	24°11'.6	
	13,364	24°10'.3	
Oct. 3	13,366	24°05'.2	-64,508
13	13,357	24°09'.4	-64,557
23			-64,540
30	13,360	24°03'.6	-64,588
	13,496	24°05'.0	
		24°05'.6	
		24°03'.4	
Nov. 4	13,355	24°08'.2	-64,558
		24°11'.0	
11	13,357	24°08'.0	-64,540
	13,360		
25			-64,542
26	13,376	24°08'.6	

MACQUARIE ISLAND

APPENDIX 1. (C'td.)

Date	Horizontal Intensity	Declination East	Vertical Intensity
1952	(Gammas)	(Degrees)	(Gammas)
Dec. 1	13,368	24°09'.0	-64,555
8	13,354	24°03'.7	-64,540
11			-64,588
16	13,345	24°09'.0	-64,553
	13,362		
19	13,348		
23	13,372	24°05'.3	-64,563
1953			
Jan 5	13,364	24°05'.2	-64,548
13	13,361	24°14'.5	-64,550
22.	13,374		-64,544
23		24°10'.0	
Feb. 2	13,360	24°09'.9	-64,562
9	13,350	24°17'.7	-64,552
16	13,342	24°21'.2	-64,548
		24°19'.3	
28	13,348	24°13'.2	-64,564
Mar. 11	13,344	24°12'.3	-64,579
14	13,352	24°13'.4	-64,553
19	13,329	24°11'.3	-64,542
31	13,380	24°14'.4	-65,549

* One observation only.

CAROLINE COVE STATION

Date	Horizontal Intensity	Declination East	Vertical Intensity
	(Gammas)	(Degrees)	(Gammas)
Nov. 19	12,818	22°47'.6 Ø	-64,040
	12,814	22°44'.4 Ø	-64,042

Ø Provisional Value only

APPENDIX 2.

FINAL ANALYSIS OF EARTHQUAKE PHASES

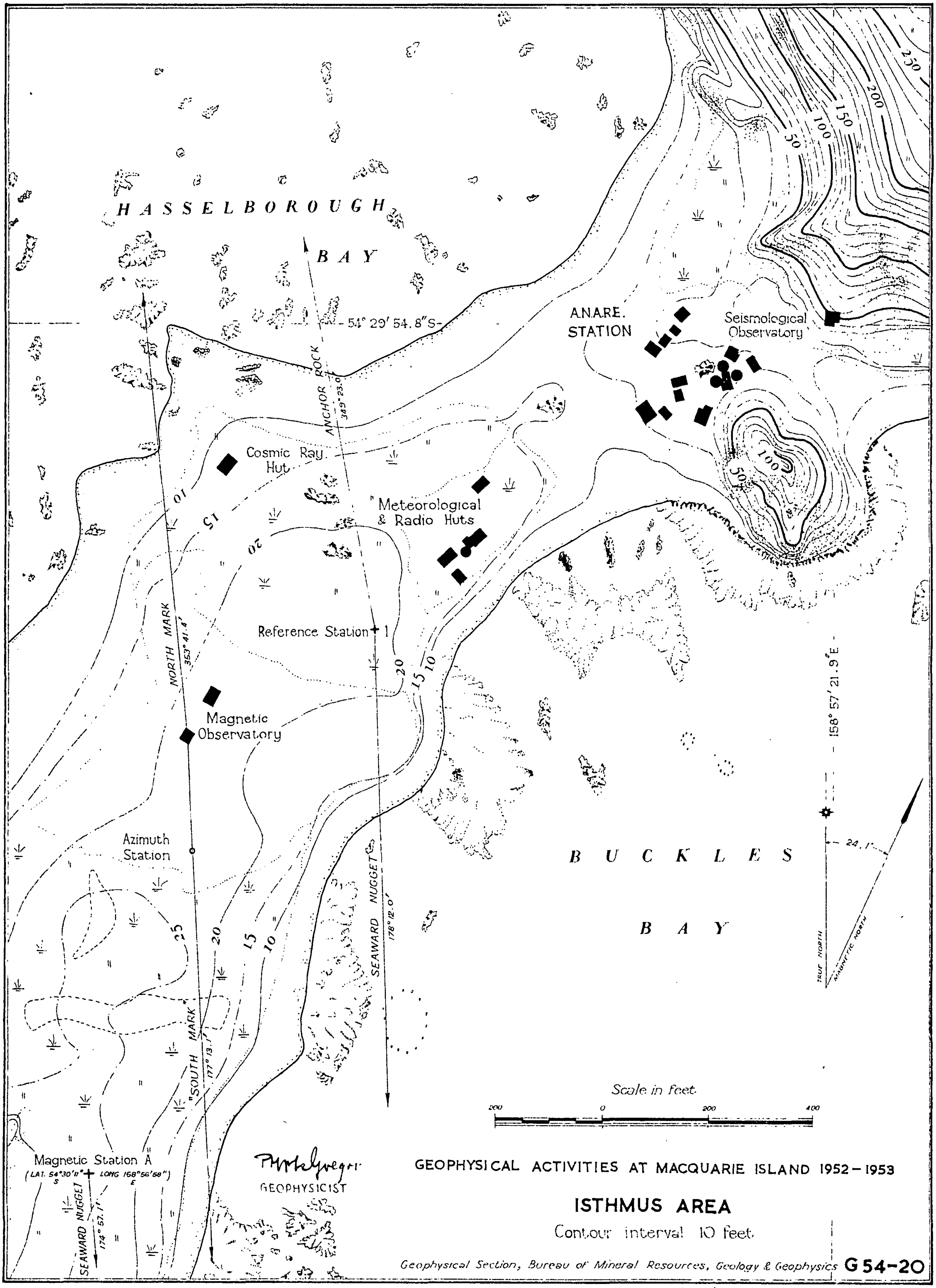
MACQUARIE ISLAND

Date	Phase	G.M.T.	Epicentre	Origin Time	Remarks
1952		h m s	Degrees	h m s	
April 7	iPg	10 23 17	0.4	10 23 09	
	iSg	23 22			
12	iPg	07 35 16	0.6	07 35 04	
	iSg	35 24			
	i	35 51			
14	eL	06 21.5			
	M	23			
16	iPg	06 16 25	0.2	06 16 21	
	iSg	16 27			
16	iPg	14 18 13	0.2+	14 18 09	
	iSg	18 16			
20	iPg	21 22 04	0.3	21 21 58	
	iSg	22 08			
25	iPg	12 31 34	0.2	12 31 30	
	iSg	31 36			
May 4	M	06 31.1			
4	eL	14 44.6			
5	iPg	06 34 14	1.1	06 33 52	
	i	34 21			
	i	34 24			
	iSg	34 29			
6	iPg	06 32 17	0.7	06 32 03	
	iSg	32 27			
	i	32 28			
8	iPg	21 21 10	0.2+	21 21 06	
	iSg	21 13			
9	iPg	17 56 23	0.6	17 56 11	
	iSg	56 31			
16	iPg	12 11 11	0.2-	12 11 08	
	iSg	11 13			
20	iPg	00 57 35	0.2	00 57 31	
	iSg	57 38			
31	iP	04 56 22	6.5		Brisbane: h = 04 54 44
	iPP	56 33			Riverview:h = 04 54 49
	eL	57.6			
	M	59.1			
June 3	iPg	16 21 56	0.3	16 21 50	Very heavy microseisms
	iSg	22 00			
	i	22 47			
17	iPg	09 11 14	0.3	09 11 08	Microseisms
	i	11 17			
	iSg	11 18			
	i	11 20			
19	ePg	19 03 40	0.6	19 03 28	
	iSg	03 48			
29	iPg	22 39 17	0.8	22 39 01	Very heavy microseisms
	iSg	39 27			
	i	39 29			
July 6	i(Pg)	02 40 47	0.15	02 40 44	
	iSg	40 49			
25	i	14 19 14			Obscured by "local" Microseisms
	eLe	20.3			
	eLn	20.4			
	M	21.3			

Date	Phase	G.M.T.	Epicentre	Origin Time	Remarks
1952		h m s	Degrees	h m s	
August 7	iPg	23 30 14	1.1	23 29 52	
	iSg	30 28			
11	iPg	14 13 16	0.3	14 13 10	Microseisms
	i	13 18			
	iSg	13 20			
12	iPn	23 21 06	1.6	23 20 36	
	i	21 20			
	iSn	21 28			
15	iPg	20 02 09	0.2+	20 02 05	
	i	02 11			
	iSg	02 12			
21	iPg	19 44 33	0.5	19 44 23	
	iSg	44 40			
23	iPg	06 46 24	1.3	06 45 59	
	iSg	46 41			
31	iPg	11 26 01	0.3	11 25 55	
	iSg	26 05			
31	i(S)	18 21 12			
	eL	21 30			
Sept. 3	iPg	12 43 47	0.15	12 43 44	
	iSg	43 49			
14	iPg	09 12 23	1.0	09 12 03	
	iSg	12 36			
15	ePg	13 36 33	0.6	13 36 21	
	e	36 34			
	iSg	36 41			
20	i(S)	12 59 58			Brisbane: h = 12 57 33
	eLn	13 00.5			Riverview:h = 12 57 38
	eLe	02.0			
20	iPg	22 03 06	0.15	22 03 03	
	iSg	03 08			
28	iPg	02 52 28	0.8	02 52 12	"Local" microseisms
	e	52 29			
	iSg	52 38			
Oct. 7	iPg	23 15 15	0.6	23 15 07	Heavy "Local" "
	iSg	15 23			
12	ePn	14 21 21	1.5	14 21 00	
	i	21 27			
	i	21 40			
	iSn	21 42			
14	iPg	16 34 46	0.15	16 34 43	Felt by party members
	iSg	34 48			
20	ePg	01 35 58	1.0	01 35 38	
	iSg	36 11			
27	iPg	00 15 47	1.4	00 15 20	
	iSg	16 07			
Nov. 2	ePg	13 08 13	0.7	13 07 59	
	iSg	08 22			
3	ePg	03 49 16	0.5	03 49 06	
	iSg	49 22			
4	ePP	17 17 22	109.4		U.S.C.G.S.h=16 58 20
	eSKS	23 22			ϕ=52-1/2° N
	iSS	32 42			λ=159° E.
	eLQ	43.2			Magnitude = 8-1/2
	eLR	48.8			
6	i(P)	19 56 33	(54.1)		U.S.C.G.S.h=19 47 20
	eS	20 04 06			ϕ=05.0°S
	eLQ	13.5			λ=145.5°E.
	eLR	15.5			

Date	Phase	G.M.T.	Epicentre	Origin Time	Remarks
1952		h. m s	Degrees	h m s	
Nov. 10	iPg	04 09 44	0.15	04 09 41	
	iSg	09 46			
11	iPg	11 25 15	0.1	11 25 13	
	iSg	25 17-			
12	iPg	17 46 13	0.1	17 46 11	
	iSg	46 15-			
13	iPg	09 51 31	0.15	09 51 28	
	iSg	51 33			
15	iPg	08 08 22	0.15	08 08 19	
	iSg	08 24			
20	iPg	20 16 16	0.2-	20 16 12	
	iSg	16 18			
Dec. 3	ePg	15 55 38	0.15	15 55 35	
	iSg	55 40			
4	ePg	21 42 22	0.2	21 42 18	
	iSg	42 25			
	i(S+)	42 28			
6	iPg	18 49 01	0.15	18 48 58	
	iSg	49 03			
7	iPg	01 50 59	0.3	01 50 53	
	iSg	51 03			
7	ePg	01 51 54	0.3	01 51 48	
	i	51 55			
	iSg	51 58			
11	ePg	09 19 48	0.4	09 19 40	
	iSg	19 53			
21	iPg	07 33 50	0.2	07 33 46	
	iSg	33 53			
28	iPg	13 47 14	(6.1)	(13 47 12)	2nd Phase under bar
	(iSg)	47 15			
30	e	18 38 31			USCGS: h=18 28 42.
	e	38 35			ϕ=19° S.
	i	39 49			λ=178° W.
	eL	39.9			Depth = 500 Km.
1953					
Jan. 1	iPn	10 02 26	4.2	10 01 19	Small surface waves at 10 04.3
	iP+	02 32			
	iSn	03 16			
	i	03 24			
	iS+	03 27			
9	ePg	15 57 42	1.2	15 57 18	
	iSg	57 56			
10	iPg	08 23 04	1.2	08 22 44	
	i	23 10			
	iSg	23 19			
11	iPg	14 10 09+	0.2	14 10 05	
	iSg	10 12-			
13	iPg	12 44 54	0.4	12 44 46	
	iSg	44 59			
20	iPg	22 34 37	0.2	22 34 33	
	iSg	34 40			
24	iPg	16 42 32	0.2	16 42 28	
	iSg	42 34+			
24	ePg	19 49 44	0.15	19 49 41	
	iSg	49 46			
	i	49 48			
Feb. 1	iPg	12 18 23	1.0	12 18 03	
	iSg	18 36			
9	iPg	07 45 55	0.3	07 45 49	
	iSg	45 59			

Date	Phase	G.M.T.	Epicentre	Origin Time	Remarks
1953		h m s	Degrees	h m s	
Feby.12	ePg	11 44 00	0.15	11 43 57	
	iSg	44 02			
16	ePg	13 53 25	0.3	13 53 19	
	iSg	53 29-			
18	ePg	14 25 06	0.15	14 25 03	
	iSg	25 08			
19	iPg	18 08 53	0.15	18 08 50	
	iSg	08 55			
21	iPg	21 38 12	0.2	21 38 08	
	eSg	38 15			
March 16	iPg	17 29 12	0.6	17 29 00	
	i	29 14			
	iSg	29 20+			
	i	29 23			
	i	30 02			
April 2	ePg	04 04 55	0.2	04 04 51	
	iSg	04 58			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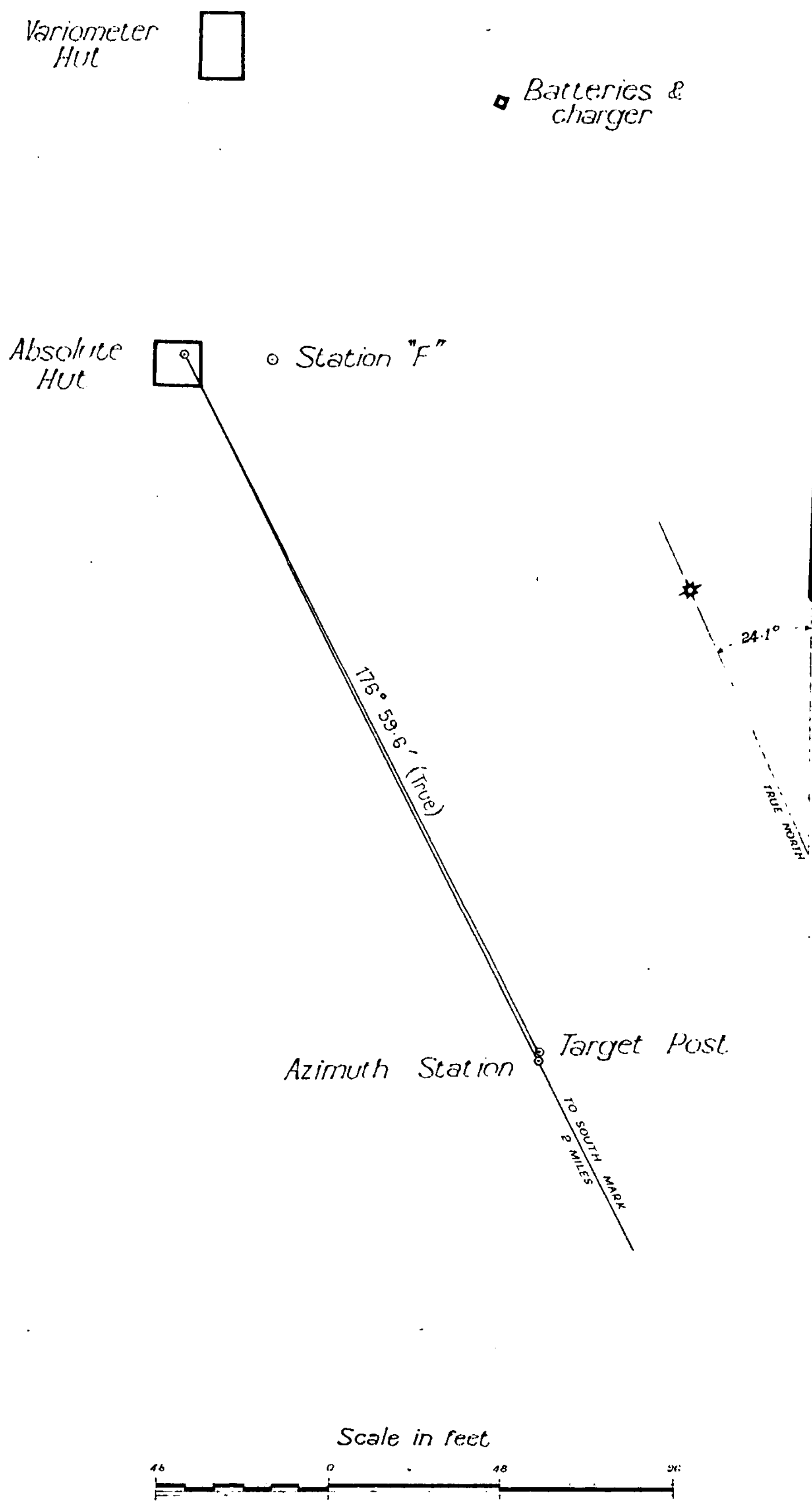
54° 29′ 54.8″S
ANCHOR ROCK
349° 23.0′
A.N.A.R.E. STATION
Seismological Observatory
Cosmic Ray Hut
Meteorological & Radio Huts
Reference Station 1
NORTH MARK
353° 41.4′
Magnetic Observatory
Azimuth Station
SEAWARD NUGGET
178° 12.0′
BUCKLES BAY
158° 57′ 21.9″E
24.1′
TRUE NORTH
MAGNETIC NORTH
"SOUTH MARK
177° 13.1′
Magnetic Station A
(LAT. 54°30′11″S LONG 158°56′58″E)
SEAWARD NUGGET
174° 57.1′
Scale in feet
200 0 200 400
P.M. McGregor
GEOPHYSICIST
GEOPHYSICAL ACTIVITIES AT MACQUARIE ISLAND 1952–1953
ISTHMUS AREA
Contour interval 10 feet
Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics
G 54-20

PLATE 2



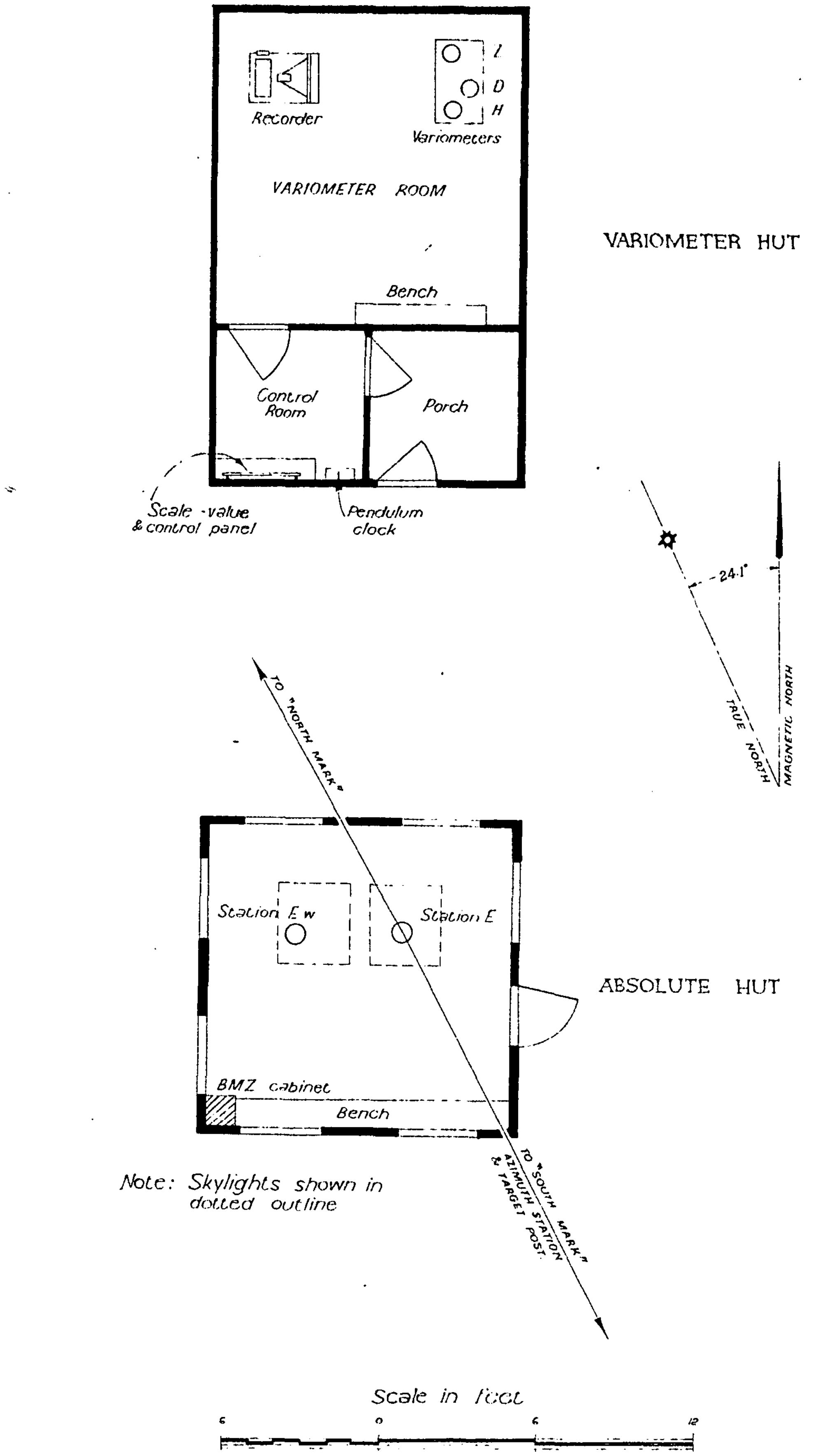
GEOPHYSICAL ACTIVITIES AT MACQUARIE ISLAND 1952 – 1953

MAGNETIC OBSERVATORY AND ENVIRONS

GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics **G54–21**

PLATE 3



GEOPHYSICAL ACTIVITIES AT MACQUARIE ISLAND 1952 – 1953

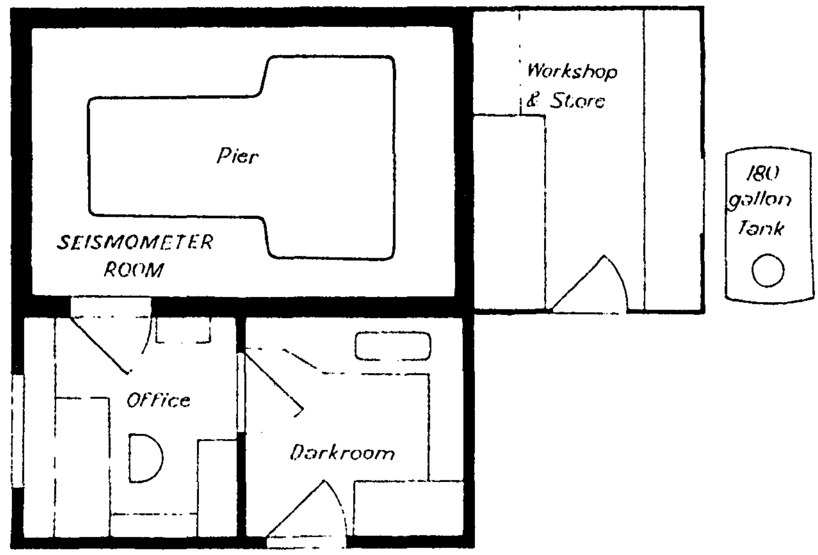
MAGNETIC OBSERVATORY BUILDINGS

FLOOR PLANS

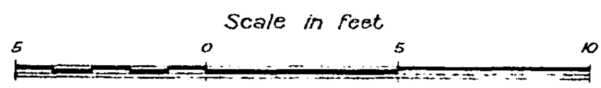
GEOPHYSICIST

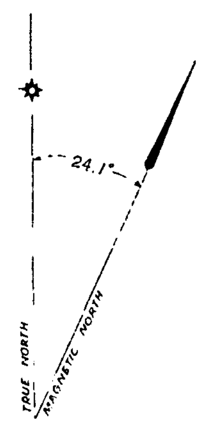
Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics **G54–22**

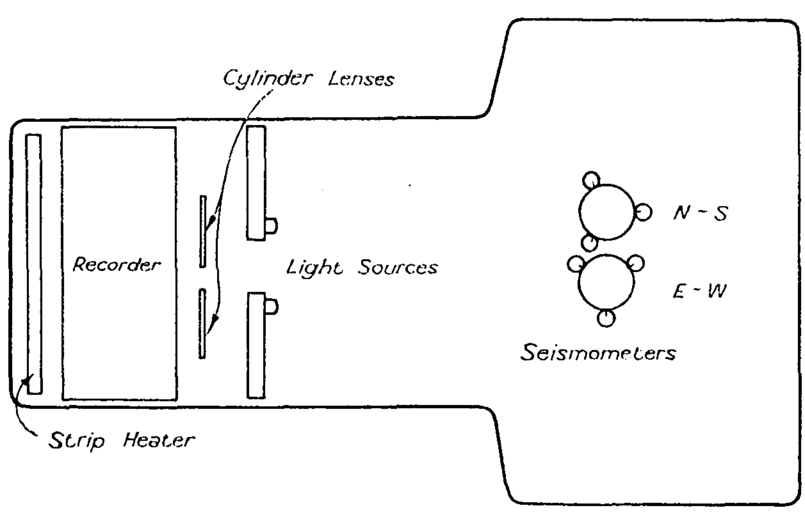
PLATE 4



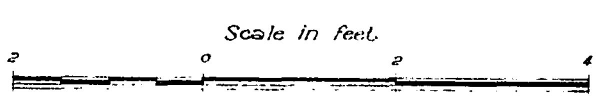
FLOOR PLAN







SEISMOGRAPH PIER (SCHEMATIC)



GEOPHYSICAL ACTIVITIES AT MACQUARIE ISLAND 1952—1953

SEISMOLOGICAL OBSERVATORY

GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics G 54-23