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WILKES GEOPHYSICAL OBSERVATORY WORK, ANTARCTICA 1960

by

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ABSTRACT

This Record describes the operation of the magnetic and seismic observatories at Wilkes, Antarctica, during 1960.

Some of the problems met are discussed and some recommendations are made.

Tabulated results of the scientific work will be published later in separate reports.

1. INTRODUCTION

The magnetic and seismic observatories at Wilkes were set up by the U.S.A. in 1957 as part of the International Geophysical Year programme in Antarctica.

The author was Geophysicist-in-Charge of the two observatories with the 1960 Australian National Antarctic Research Expedition.

Some of the problems mentioned in this Record have been discussed in greater detail by Underwood (1960).

2. MAINTENANCE

Buildings

Early in the year, the magnetic buildings were tied down with ropes running across the buildings and attached to boulders on either side. During a severe blizzard in mid-winter some boards securing the canvas covering over the passageways between the magnetic buildings were pulled off, allowing the canvas to flap violently. After the blizzard these were replaced and all other boards checked and extra aluminium nails added where necessary. The magnetic buildings in general are in good condition and very little snow or wind penetrated either into buildings or connecting passageways.

Because of its location on the leeward side of the main camp, the seismic building rapidly became drifted up with snow and by May was completely covered. This effectively protected it from wind vibration but caused severe problems in December when the snow cover melted and had to be pumped away. A pump was built for this purpose, as the one used in the previous summer was required for general camp use during the year.

Normal maintenance and painting were done in the Geophysical Office and darkroom. A new apron was installed on the print-drying machine after a stalled motor caused scorching of the existing apron.

Magnetic power lines

There were three rubber-covered power lines running along the surface of the ground between the Geophysical Office and the magnetic buildings, a distance of about 200 yards. They were:

(1) a 3-cored cable for 5-minute and hourly time marks,

(2) a 2-cored cable carrying 8 volts D.C. for the recording and time-mark lamps,

(3) a 2-cored cable carrying 110 volts A.C. for the rapid-run recorder, safeguarded against power failure by a battery and inverter.

A fourth cable ran directly from the generator building, supplying two 110-volt A.C. circuits for lights and heaters in the magnetic building. For most of the year these cables were well covered with compacted snow but during the summer months the snow melted away and they became exposed. Where they cross the main camp roadway, the cables had been partially protected by running them through a length of water pipe.

On 24th February the safeguarded 110-volt A.C. line was cut by a tractor. It was repaired and a length of angle iron was installed to protect the cables. On 2nd March all three rubber-covered cables were cut in the same area. Consideration was given to making a permanent replacement by digging a trench and laying the lines with adequate protection over them, but the idea was abandoned because of the lateness of the season; snow was already accumulating and the ground was frozen and too hard even for the rock drill to penetrate. A temporary repair was made by inserting lengths of armoured cable and covering them as well as possible with boards and gravel. It was intended to make a permanent replacement in the following summer, but as the station was relieved much earlier than expected, insufficient melt had taken place and the job had to be left for the incoming geophysicist.

Lamp circuits

To maintain 6 volts D.C. for the recording lamps in the magnetic building it had been found necessary to provide 8 volts D.C. at the Geophysical Office, to allow for the drop in the line. This had been accomplished by using a 6-volt accumulator in series with one cell of another accumulator, the whole system being trickle charged by a 6-volt charger. A second set of accumulators was installed, and the circuit was arranged so that either set could be switched into the lamp circuit alternately, allowing the other set to be charged at a higher rate. However, it was found early in the year that the 6-volt chargers were incapable of bringing the batteries up to full charge. Two new 12-volt chargers had been supplied by U.S.C.G.S., but the thermal cutout incorporated in their circuit came into operation when they were used to charge the 8-volt batteries. The problem was solved by dropping the mains input voltage to the 12-volt charger to about 85 volts. This was done by connecting a 100-watt lamp in series with the 110-volt mains; this arrangement also provided some regulation of the input voltage. With two new accumulators installed, this system operated quite satisfactorily.

Time-marking unit

As explained by Underwood (1960), time marks for both magnetic and seismic records were derived from a 3-channel Simplex programme machine, driven by a chronometer. With this unit there were recurring troubles due to :

(a) High resistance of the minute-contacts in the chronometer,

(b) Low voltage across the minute impulse solenoid,

(c) Burning and pitting of relay contacts,

(d) Jamming of the programming bead chain in its reservoir.

It was eventually necessary to use the standby chronometer to cure (a). (b) was rectified when the new battery-charging system was used, as the Simplex voltages were derived from the same batteries. Various relay contacts were cleaned at intervals throughout the year. Most of these malfunctions were minor ones and did not cause much loss of time marks, but the bead chain system will always be unreliable and likely to jam.

A complete diagram of the lamp and time mark circuits was drawn, including all modifications. A copy of this was retained at Wilkes.

The receiver (National NC 183D), supplied by the California Institute of Technology for receiving standard time signals, was thoroughly overhauled and realigned by radio operator G. Burkett.

3. MAGNETIC OBSERVATORY

Absolute instruments

In February 1960, new semi-absolute instruments were brought into service, replacing the C.I.W. No. 28 Field Magnetometer and Earth Inductor set. BMZ No. 236 was used for Z and QHM Nos. 493 and 494 for H; the C.I.W. 28 magnetometer was retained for D observations.

The scatter in H and Z baseline values was much reduced after the new instruments were used in this way.

Intercomparisons

During changeover 1960 the existing C.I.W. No. 28 set was compared with the new Wilkes semi-absolute instruments and also with long-range BMZ 221A, Askania Declinometer 509320, QHM 492, and Askania HTM 5010154, all of which had previously been standardised at Toolangi observatory.

In January 1961 a similar set of intercomparisons was made between the station instruments and long-range BMZ 221A, Askania Declinometer 580339, QHM 492, and HTM 5010154. QHM 493 was then returned to Melbourne and QHM 492 left at Wilkes.

Although there are two instrument piers in the absolute building, they are too close together to allow simultaneous observations to be made with two instruments. Therefore all intercomparisons were made through the magnetogram baselines. Because of the generally high level of daytime magnetic disturbance, only the period from about 2000 LST to 0400 LST was undisturbed enough for absolute observations; for this reason, and because the changeover period was not very long, it was not possible to alternate instruments very frequently during the intercomparisons.

Orientation tests

Orientation tests by deflector magnet were made in August for both standard and rapid-run variometers.

The calculated orientations of the variometer magnets were as follows.

Variometer	Observed Orientation with respect to 82° 50.45' W of N
Standard D	N end 0.1° E of N
" H	N end 0.3° N of E
" Z	N end N & 0.4° below horizontal
Rapid-run D	N end 0.6° W of N
" H	N end 0.4° S of E
" Z	N end N & 0.3° above horizontal

These results appear to be reasonably consistent with those obtained by previous observers. The above orientation angles for the D and H magnets are with respect to the nominal meridian established by Berkley in 1957, which was 82° 50.45' west of true north. However, owing to secular change the mean magnetic meridian for Wilkes in 1960 was approximately 83.9° west of north. The true orientations of the recording magnets therefore become:

Variometer	Orientation
Standard D	N end 1.1° E of N (magnetic)
" H	N end 0.7° S of E (magnetic)
" Z	N end N & 0.4° below horizontal
Rapid-run D	N end 0.3° E of N (magnetic)
" H	N end 1.3° S of E (magnetic)
" Z	N end N & 0.3° above horizontal

According to McComb (1952) the recording magnet should be adjusted if the calculated ex-orientation angle exceeds 1 degree or, in the case of a D-variometer if a correction magnet is used (as at Wilkes), 20 minutes of arc. The above results indicate that the orientations of the standard D and the rapid-run H magnets probably require adjustment.

Scale values

Scale values were determined at approximately weekly intervals by the Helmholtz-Gaugain coil method. The coil currents were supplied by three large 1.5-volt dry cells in parallel. These batteries were kept in the office in a cardboard box which insulated them somewhat with rubberised horsehair packing, and taken across to the magnetic building whenever determinations were made. During very cold weather it was found that their voltage dropped steadily during a determination. To remedy this, a line was run from the control panel to the heated absolutes room, and after testing the batteries to ensure that they were non-magnetic, they were permanently installed in the absolutes room.

Standard variometers

As described by Underwood (1960), the variometers were likely to become mislevelled owing to warping of the wooden pier. There were also several sudden changes in the Z baseline, some of which occurred in the form of a jump on the Z trace. A process (known as caging) of lifting the Z movement from its seat with the clamping device and carefully replacing it, had been carried out before each record change. This had the effect of correcting any tendency of the movement to shift its position on its bearing surfaces.

In September and October a series of Z-baseline observations were made to check whether this caging was of any value. Observations were made before and after caging each day for a week, then each day for a further week without caging. These observations did not indicate any significant difference in baseline stability due to caging. However, further observations made after a further week without caging revealed a sudden change of about 30 gammas in Z baseline. This was rectified by caging. An inspection of the Z movement and its knife edges and bearing surfaces might throw some light on this erratic behaviour.

An annual wave in baseline values, amounting to about 40 gammas in H and 9 minutes in D, had been noticed in the 1959 results (Underwood, 1960) and attributed to warping of the pier. To check this hypothesis, two sensitive spirit levels were installed on the pier top between the standard D- and H-variometers, and were read at each record change. They confirmed the warping of the pier. The installation of concrete piers and a slate slab pier top should rectify this trouble in 1961.

Rapid-run variometers

A total of 61 hours of rapid-run record was lost during the year owing to breaks in power lines to the recorder drive and lamp. Apart from occasional relevelling of the Z-variometer, no adjustments were made to the installation.

4. SEISMIC OBSERVATORY

Calibration

Calibration tests on the three-component long-period Columbia-type seismograph were made at approximately 2-monthly intervals by the method described by Underwood (1960).

Galvanometer free-periods all remained within 10 seconds of the nominal 90 seconds and were not adjusted. Galvanometer sensitivities were of the order of 10^{-10} A/mm and damping was judged by inspection to be critical.

Seismometer periods were adjusted whenever they differed from the nominal 15 seconds by more than $\frac{1}{2}$ second. The vertical seismometer was adjusted in May, and both vertical and east-west seismometers were adjusted in October.

Temperature drift

As in earlier years, temperature drifting of the traces was a problem, mainly on the vertical component. Continuous temperature records taken in the vault indicated that the drift depends on the rate of temperature change. By interchanging galvanometers, the main part of the drift was shown to originate in the seismometer. When a seismometer was clamped the trace showed very little drift.

A blanket was draped over the case of the vertical seismometer and this reduced the drift considerably.

Pumping thaw-water from under the vault again caused severe disturbance to the records in the summer months.

5. COMMENTS AND RECOMMENDATIONS

Considerable use was made of explosives in the camp area, particularly in summer time during excavations for the unloading ramp, when it was necessary to use demolition charges at a distance of only about 500 ft from the magnetic building. Underwood (1960) has described the jarring effect this has on the Z-magnet assemblies. The author was always consulted when blasting was to be done and the practise was to clamp the Z movements both of the standard and rapid-run sets during the blast. This was not an ideal arrangement and when the new piers are built and the instruments reinstalled it will be desirable to disturb them as little as possible. It is recommended that the alternative ramp site at the western tip of the island be used. Some work was done on preparing this site, and the records showed that the site is sufficiently remote from the magnetic building for blasting to have no noticeable effect on the instruments. This site appears much superior to the present Frogmans Beach ramp and its use would also help to keep heavy traffic from the vicinity of the magnetic buildings.

It was found very difficult to keep even a minimum radius of 200 ft around the magnetic buildings clear of magnetic materials and vehicles, especially during the changeover. The main roadway runs within about 200 ft of the magnetic buildings, and the nearest permanent building is only about 240 ft away. This problem will increase as the base expands. Ideally the magnetic installation should have been farther from the main camp, but because of the narrow width of Clarke Island the choice of locations was limited.

6. REFERENCES

UNDERWOOD, R.,	1960	Wilkes geophysical observatory work, Antarctica 1959. Bur. Min. Resour. Aust. Rec. 1960-114.
McCOMB, H.E.,	1952	MAGNETIC OBSERVATORY MANUAL. U.S. Dept. of Commerce, Special Publication No. 283.