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# Wilkes Geophysical Observatory, Annual Report 1966



by

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## ILLUSTRATIONS



## SUMMARY


Routine geomagnetic and seismological work at Wilkes continued smoothly during 1966. Several changes were made to the time and power distribution unit. Quite a few attempts were made to improve the long-period seismic recordings. At the end of the year all equipment was dismantled and returned to Australia, it having been decided to cease operations in the two disciplines.

## 1. INTRODUCTION

This report describes geomagnetic and seismological operations during 1966 at Wilkes Base in Antarctica. Previous work has been described by Underwood (1960, 1963), Jones (1961), Burch (1962), Whitworth (in preparation), Small (1968), and Browne-Cooper (1968). The author assumed duties on 3rd February 1966; all equipment was dismantled in January 1967 for return to Australia following a decision to cease recording at the station. The equipment has since been returned to its owners in the United States of America.

Geomagnetic results will be published by the Bureau of Mineral Resources and seismological results have been sent to the International Seismological Centre. It is intended that a separate Record on drifting and other faults of seismic recordings at Wilkes will be published at a later date.

## 2. TIMING AND POWER DISTRIBUTION

The timing and power distribution unit consisted of:

1. Times Facsimile Chronometer (tuning-fork control)

2. Timemark Programme Unit (TMU)

3. Power distribution unit

4. National receiver

5. Time-signal unit

6. Battery charger and two six-volt lead-acid accumulators

The chronometer was used to supply one-minute contact closures for the TMU. To ensure accurate timing the one-minute and one-second contacts of the chronometer were wired in series. The chronometer remained extremely accurate throughout the entire twelve months and on only eight occasions did the correction exceed one-tenth of a second. On these occasions it was found that the temperature of the building had fallen twenty or thirty degrees below normal. During June and July the one-second contacts failed at random owing to excessive wear and accumulation of dirt. Several types of contact cleaning solutions were tried before a reliable one was found. This was 'Electrolube No. 1' - a cleaner for non-arcing contacts. Radio interference originating from the one-second contact (owing to static charge build-up) was eliminated by placing a 2-megohm resistor across the contacts (earthing systems in Antarctica are not very effective).

The TMU provides appropriate contact closures to give 12-volt pulses to the recording instruments on receiving one-minute contact closures from the chronometer. This extremely reliable unit operated without failure throughout the twelve months.

The power distribution unit was prone to failure caused by dry solder joints. A completely new unit was built and installed in late September and no further trouble occurred. All previous features were incorporated in this new unit and these include:

Coloured indicator lights for the 1-min, 5-min, and 10-min pulses

D.c. ammeter for monitoring pulse currents

Automatic changeover of a.c. power supplies

Power indicator lights

Separate fuses for the magnetic and seismic huts with 'faulty-fuse' indicator lamps in each circuit.

Press button switch to alter the contact rate from one per minute to one per second allowing rapid triggering of the TMU

Battery-charger current control and monitoring meter

The ionosonde was responsible for quite a few additional timemarks, particularly just after the new distribution unit was installed. It should be pointed out here that the ionosonde was not triggering the TMU but was inducing r.f. into the output cables. This was proved beyond doubt by switching off the TMU. The trouble was eliminated by placing a diode and condenser in parallel across the output of the 1-min circuit. However, if any fault developed in the aerial circuit of the ionosonde then the interference could not be eliminated. If the transmitter of the ionosonde does not have an optimum load then a large amount of r.f. power is made available for induction into any cables in the vicinity, e.g. mains, aerials, and timing cables.

The National receiver was overhauled and tuned using equipment on loan from the radio communication section. This receiver and its aerial were not very effective during winter. Radio reception deteriorates sharply during winter in the Antarctic. This is due to low ionization density in the ionosphere. The time signal unit, used for amplifying 1-kHz time pulses from WWV or VNG, operated satisfactorily all year. However, a very clean signal is required for its operation and thus it received very little use during the winter months.

## 3. GEOMAGNETISM

### Normal magnetograph

This instrument required little attention throughout the year. The Ruska drive was replaced twice but it is doubtful if either mechanism was faulty. It was discovered in January 1967 that excessive pressure between the final drive gears, produced by incorrect installation, was responsible for two failures during that month. The La Cour Z variometer required levelling from time to time. On other occasions the lamp was adjusted to produce finer and more distinct recording traces. The variation of both H and D baseline values, which has been evident in past years, was definitely confirmed by the larger number of absolute observations taken during 1966. Further, comparison of rapid-run records and normal records confirm the smooth though large changes which have occurred every December and January.

The normal D variometer magnet was reorientated on 12th October 1966. In 1962 it had been set in the meridian 84°10'W. The magnetic meridian at Wilkes in October 1966 was in the vicinity of 86°50'W. To reorientate the magnet the torsion head was turned anticlockwise until the northerly reserve spot was in exactly the same position as the original trace. This change represented a rotation of 3°24' westwards and thus the magnet was aligned in the meridian 87.6°W. This gave an ex-orientation angle of about 0.8°. No tests were carried out on the other components.

The La Cour Z thermograph scale value and temperature coefficient were the same as in 1964, viz. 1.14°C/mm and -1.3 gammas /°C respectively.

Scale values and standard deviations are listed in Appendix 2. In early May the scale-value currents were increased so that the total deflection in each case exceeded 40 mm. The normal magnetograph baseline values remained reasonably steady throughout the year; H values showed one shift following adjustments, and D values showed four changes. In all cases the rapid-run and normal records were compared to determine the extent of these changes.

Rapid-run magnetograph

The H and D recordings continued being very reliable as in past years. Minor adjustments were necessary to keep the trace brightness at the required level. Although the Z variometer gave little trouble mechanically, the scale values show erratic changes. The scale value appears to favour a value of 7 gammas/mm, particularly just after the instrument is clamped. However, in general it tends to vary at random between 5 gammas/mm and 7 gammas/mm. This may be due to the knife edges not being sufficiently sharp, or the existence of irregularities in the supporting surface. Further, the use of a plywood bench for supporting the instrument certainly does not help the situation.

The recording mechanism worked well until the author decided it needed lubricating. After that date and for the next three weeks the drum was prone to slipping while the lateral travel mechanism tended to move the drum forward two hours instead of one. These faults were corrected by tightening the slip-clutch and adjusting a few microswitches.

Absolute instruments and corrections

Horizontal intensity and declination. Instruments used were QHMs 492 and 493 and declinometer ASK 506; they gave good results throughout the year. However, the clamps on all three require cleaning. The magnet for the declinometer was damaged when it was dropped and the resultant geometrical distortion produced a large difference (1.5°) between erect and inverted readings. This of course did not affect the accuracy of observations.

Preliminary corrections determined at Toolangi in July 1967 were:

| | |
|---|---|
| QHM 492 | +11 gammas/gauss |
| QHM 493 | -11 gammas/gauss |
| ASK 506 | -0.5 minutes of arc |

Vertical intensity. BMZ 236 was used during 1966. No intercomparisons were made at the 1967 changeover because heavy fast ice prevented the relief vessel from getting into Wilkes. Therefore in March 1967, BMZ 236 was sent to Macquarie Island, where Z is about the same as at Wilkes, for intercomparison with a proton precession magnetometer (PPM).

Intercomparisons made at the 1966 changeover between BMZ 236, a PPM, and long-range BMZ 221 were of doubtful reliability. Because of PPM failures an accurate station difference was not determined and that measured in 1965 has had to be used. For these reasons BMZ 236 corrections have been derived from analysis of all available comparisons and of baseline value changes during 1965 and 1966. The results are shown in Plate 1.

Corrections prior to 1965 show a steady drift. The abrupt changes occurring in 1965 and 1966 are based on the following evidence:

(a) 1966 and 1967 comparisons show a change of correction of about 71 gammas.

(b) Eight observations on 14 August 1966 revealed an apparent baseline value change of 74 gammas. Detailed analysis of magnetograms proved that this was a BMZ effect; possibly the instrument was moved unclamped on 3rd or 13th August.

(c) May-June 1965 baseline values changed about 25 gammas during a period when the BMZ neutral division changed a corresponding amount (Browne-Cooper, 1968). Confirmation that this change took place in the BMZ was obtained by comparing selected quiet day ordinates, observed baseline values, and the amount of secular change.

## 4. SEISMOLOGY

### Grenet short-period seismograph

The seismometer and galvanometer functioned exceptionally well and required very little attention throughout the year. The recorder motor was replaced in June. The mechanism connecting the gears with the motor was of poor design and a new clutch was built and installed by the mechanics. This clutch was a ratchet type and allowed free movement of the gears whilst the record was being changed.

### Lehner and Griffith long-period seismograph

The seismometers and their corresponding galvanometers required considerable attention throughout the year. By far the greatest problem was the drifting of the recording trace. The following is a brief summary of some of the faults occurring in the long-period recording (Z, vertical seismometer; N, north-south; E, east-west):

(1) extensive drifting following rapid temperature variations (Z, N, E);

(2) bays occurring whenever the temperature changes slowly (Z, N, E); cooling tends to produce upward bays while warming produces downward bays (Z only);

(3) long-period oscillation produced by wind, and in some cases random wandering and finally jamming of the Z seismometer;

(4) D.c. currents flowing through the circuits (Z, N, E).

From evidence available at the present moment it appears that temperature variation is the originator of about 90 percent of the above faults. However, the author wishes to point out that thermo-electricity does not account for all of these effects.

Plate 5 shows a plot of minimum and maximum air temperatures recorded at Wilkes in 1966. Below this plot are shown the days on which the Z seismometer jammed and the distance moved (cm) by the Z recording trace immediately after jamming. Sudden temperature changes, e.g. those associated with high winds cause the mass of the Z seismometer to move up or down. If the temperature change is continuous then the mass of the seismometer will continue to move until it hits either the upper or lower stop. Thus, the d.c. current produced by continuous movement in the same direction will suddenly cease and hence the recording trace will show some sharp movement immediately after jamming. In general there is some correlation between the direction of movement of the recording trace and the sign of the temperature change. However, the picture is complicated by other factors such as humidity and static charges.

Modifications to equipment and building

Extensive work was carried out on the building as well as the instruments in an effort to eliminate the faults listed above. The following is a list of changes effected during 1966:

(1) Three new heaters were installed in the recording room (Plate 4). These heaters were made from 500 and 240-watt, 240-volt stove elements; two elements were wired in parallel and clamped on a long strip of No. 8 gauge steel. Three sets were made and, when installed, were operated on two 110-volt phases. Initially attempts were made to control the temperature of the recording room with the aid of a thermostat. However, this created more drifting and hence one of the heaters was allowed to remain on continuously.

(2) The concrete base of the vault was lined with sisalcraft on the inside (the term 'vault' is used for the inner hut which houses the seismometers). This prevented drifting snow from entering the vault and also helped to maintain a steady temperature.

(3) The three perspex lids of the seismometer covers were removed and hinged at the upper end. This provided ready access to the seismometers.

(4) All switches and attenuators were placed in a metal box, which was then installed on the galvanometer pier. Calibrating circuits for the galvanometers were also included in this box.

(5) A zincanneal cover, painted flat white, was installed over all three galvanometers and the control panel. This was part of an effort to control the temperature in the vicinity of the galvanometers.

(6) Polyurethane insulation was placed over the concrete well which surrounds the galvanometer piers (Plate 3) and also around the concrete base of the vault.

(7) All outside surfacesof the building were painted gloss white in an attempt to control solar heating.

(8) The galvanometer tube in the vertical recording unit was replaced twice and the east-west unit was replaced once.

(9) A new time-mark solenoid was installed in the east-west recording unit.

The synchronous motor began operating intermittently in late February because of overheating, possibly due to a short circuit in the motor windings. Since no identical spare was available another motor was dismantled and between the two a workable motor was obtained. This motor operated satisfactorily for the remainder of the year.

At temperatures below 5°C the recording spot, particularly in the vertical unit, split into two distinct spots. The separation of these two spots depended on the temperature and was greater at lower temperatures. This splitting could be compensated for by directing the light beam on to one side of the galvanometer mirror. When this was done one of the spots disappeared.

During May three luminous numbers extracted from a clock dial, were glued to the long-period recording drum. These numbers imprinted 1, 2,and 3 and on the east, north, and vertical records respectively. This is a quite simple and readily available means for the positive identification of records.

## 5. RECOMMENDATIONS

Because of the poor radio conditions during the winter months in the Antarctic it is suggested that a separate aerial beamed on time-signal transmitters be made available for use by the scientific personnel.

It is well known that long-period seismometers and galvanometers are extremely sensitive to temperature changes, and probably sensitive to other weather changes. In the Antarctic it is not uncommon to have temperature changes of 15°C over a period of a few hours. If the instruments are housed in two separate buildings then the problem of temperature control is doubled since it would be extremely difficult to control two separate buildings thermostatically such that the temperature difference between them remained constant. In 1966 the author found that it was necessary to maintain constant temperatures in both the vault and the recording room for the following reasons:

(a) If the temperature of the vault varies then the constant of the suspension spring in the vertical seismometer changes and the mass of Z seismometer moves towards either the upper or lower stop. In the case of rapid warming the mass hits the upper stop and on rapid cooling it hits the lower stop.

(b) If the temperature difference between the recording room and the valut is allowed to vary then a small d.c. current, attributed to the thermo-electric effect, will give rise to thermal drifting in galvanometers. However, at Wilkes in 1965 and 1966 the d.c. current was not small and consisted of two components. One component can be attributed to the thermo-electric effect while a second component is definitely due to static charges. The current due to static charges was definitely related to temperature and though not confirmed as yet, appears to be related to other weather conditions such as humidity.

(c) Slow temperature changes in the recording room, e.g. 3°C in 8 hours, tend to produce sudden excursions or bays which can become so numerous as to destroy completely the usefulness of the record. Whenever either the vault or the recording room was heated thermostatically there was a marked absence of such bays.

Thus the situation can be summed up as follows. In the case of two separate buildings being used to accommodate seismometers and galvanometers one may:

(a) Thermostatically control the temperature of both buildings (not satisfactory because the corresponding temperature variations could not be kept in phase).

(b) Thermostatically control the temperature of one building only (not satisfactory).

(c) Apply constant heating to one or both buildings and hence allow the temperature inside the buildings to follow the outside temperature. In this case the temperature would vary very slowly and hence drifting would not be so erratic. This is what was done at Wilkes in 1966.

(d) Place the seismometers in an underground vault where the temperature would vary only a few degrees over the whole year and at the same time thermostatically control the temperature of the recording room. The amount of drifting in this case will depend entirely on the temperature range of the thermostat involved. A variation of ± 0.5°C is quite tolerable. These were the conditions at Dumont D'Urville when the author visited there in 1966.

All the suggestions above have their disadvantages but out of the four (c) and (d) produce better records than (a) and (b). In fact (a) and (b) produce records which are quite unreadable at times.

Because it is desirable to have the seismometers in a room separate from the galvanometers and recorders, and because it is impossible to prevent drifting by thermostatic control, then both the recording room and the seismometer vault must be placed underground. This suggestion was advanced by G. Dewart as far back as 1957, when drifting proved to be a serious problem during the first year at Wilkes. This task is not as difficult as it may appear. The problem would be to blast a shaft in the side of a steep slope and then seal the entrance with a concrete wall. The usable space inside the shaft would need to have the dimenstions 8 ft high, 12 ft wide, and 24 ft long. Temperature changes inside such a shaft would be very small and the establishment of two rooms inside the shaft would not set up serious temperature gradients. This idea of course is simply a replica of such seismological stations as Mundaring and Toolangi.

## 6. ACKNOWLEDGMENTS

The programme was carried out with the cooperation of the Australian National Antarctic Research Expedition, which was responsible for the accommodation and logistical operations at the Station. The author wishes to acknowledge the assistance given by all members of the 1966 Wilkes Expedition. The author is particularly indebted to S. Taylor, R. Williams, R. Roff, J. Elliot, and C. Huddy for their willing cooperation during the entire year. Meteorological records were supplied by H. Brinkies of the Bureau of Meteorology.

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## APPENDIX 1

## EXTRACTS FROM INSTRUMENT LOGS

### Summary of extracts from seismometer log

| | |
|---|---|
| 24.2.66 | LP seismic motor stopped for some time. |
| 27.2.66 | LP seismic motor replaced. |
| 20.3.66 | New heaters installed in seismic hut. |
| 21.3.66 | Seismic hut rewired. |
| 23.3.66 | New control panel for LP recorder installed. |
| 20.4.66 | Installed metal cover over galvanometers and control chassis. |
| 19.5.66 | LP seismic recorder showing temporary stoppages. |
| 22.5.66 | Grenet seismic motor sheared drive. |
| 24.5.66 | Modified drive installed in Grenet recorder. |
| 10.6.66 | New clutch installed in Grenet drive. |
| 19.6.66 | Timemark mirror suspension spring for east-west LP recorder found broken. Replaced with new one. |
| 4.7.66 | LP records lost because drums not lowered on to drive. |
| 19.7.66 | Replaced 'vertical' galvanometer tube and installed vertical seismometer (LP) on galvanometer pier. |
| 26.7.66 | Reinstalled vertical LP seismometer in vault. |
| 22.10.66 | Painted exterior of seismic hut. |
| 23.12.66 | All seismometers dismantled. |

### Summary of extracts from magnetic log

| | |
|---|---|
| 3.5.66 | Increased scale-value currents. |
| 4.5.66 | Rapid-run Z variometer jammed. |
| 30.6.66 | Replaced Ruska drive. |
| 2-5,8.6.66 | Adjustment of rapid-run Z recording. |
| 22.7.66 | Removed lid of standard vertical variometer. |
| 18.9.66 | Fire in carpenter shop burnt out cable supplying power to all magnetic instruments. |
| 12.10.66 | Reorientated standard D variometer. |
| 15.10.66 | Rapid-run recording drum showing intermittent operation. |
| 14.11.66 | Replaced Ruska drive. |
| 28.1.66 | Rapid-run system dismantled. |
| 3.10.66 | Ruska drive failed. |
| 12.10.66 | Ruska drive failed. |
| 7.2.66 | Ruska instruments dismantled. |

Summary of extracts from timing unit log

| | |
|---|---|
| 19.6.66 | Chronometer timing contacts failing because of excessive wear and accumulation of dirt. |
| 22.6.66 | Cleaned contacts of chronometer. |
| 24.6.66 | Cleaned contacts of chronometer. |
| 6.7.66 | Aligned and cleaned contacts of chronometer. |
| 16.7.66 | Ionosonde inserting additional timemarks. |
| 19.9.66 | Installed new distribution unit. |
| 5.10.66 | Noise from one-second contact of chronometer eliminated. |
| 1.10.67 | Timemark programme unit gaining minutes owing to false triggering by the ionosonde. |
| 7.2.67 | All equipment dismantled. |

Records lost over twelve months

| Record | Full days lost | Half days lost |
|---|---|---|
| Standard magnetograph | 2 | 10 |
| Rapid-run magnetograph | 4 | 3 |
| Grenet seismometer | 6 | 3 |
| LP seismometer | 6 | 3 |

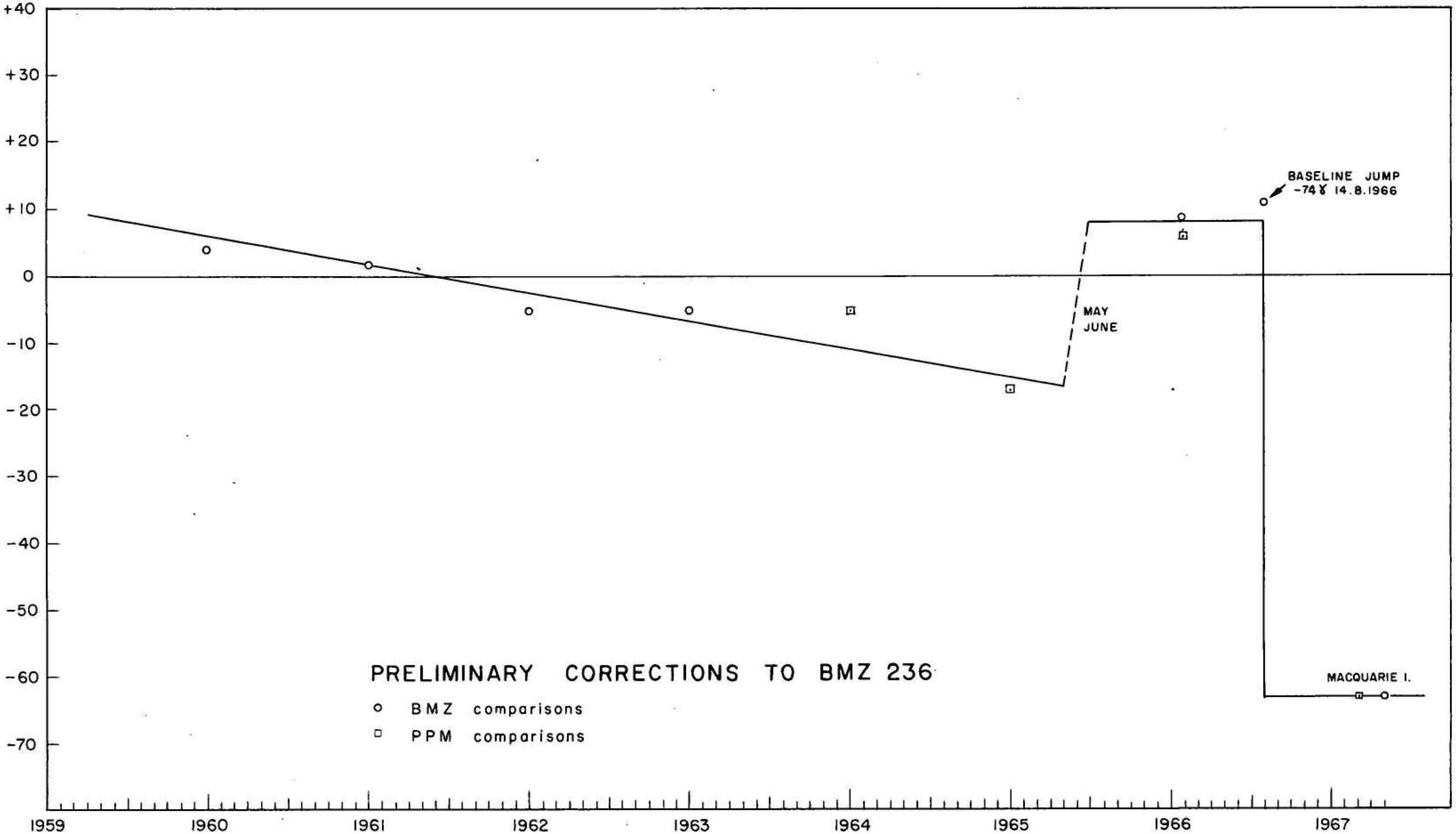
This represents a loss of 2%, the majority of which was due to instrument failure.

# APPENDIX 2

## MAGNETOGRAPH DATA

| Magnetograph | Element | Scale value | Standard deviation | |
|---|---|---|---|---|
| | | | Scale value | Baseline value |
| Normal | D | 10.05 | .08 | 0.9 |
| | H | 25.05 | .12 | 3.0 |
| | Z | 20.80 | .18 | 2.5 |
| Rapid-run | D | 1.12 | .03 | - |
| | H | 5.09 | .04 | - |
| | Z | 6 | - | - |

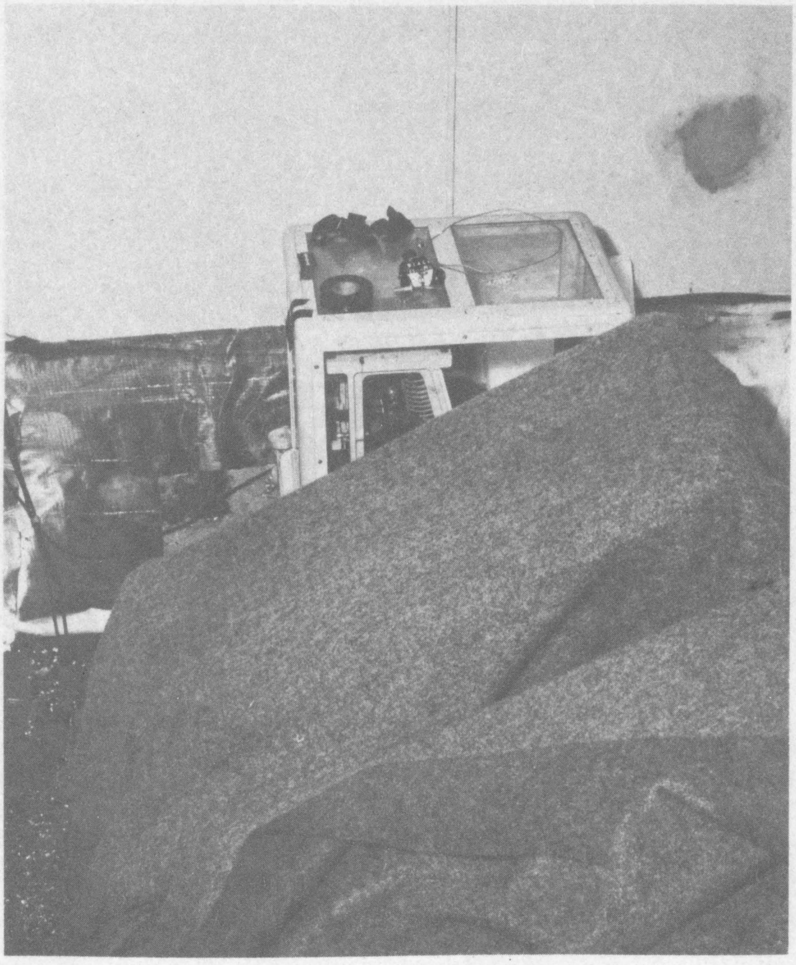
H and Z values are expressed in gammas and D values in minutes.



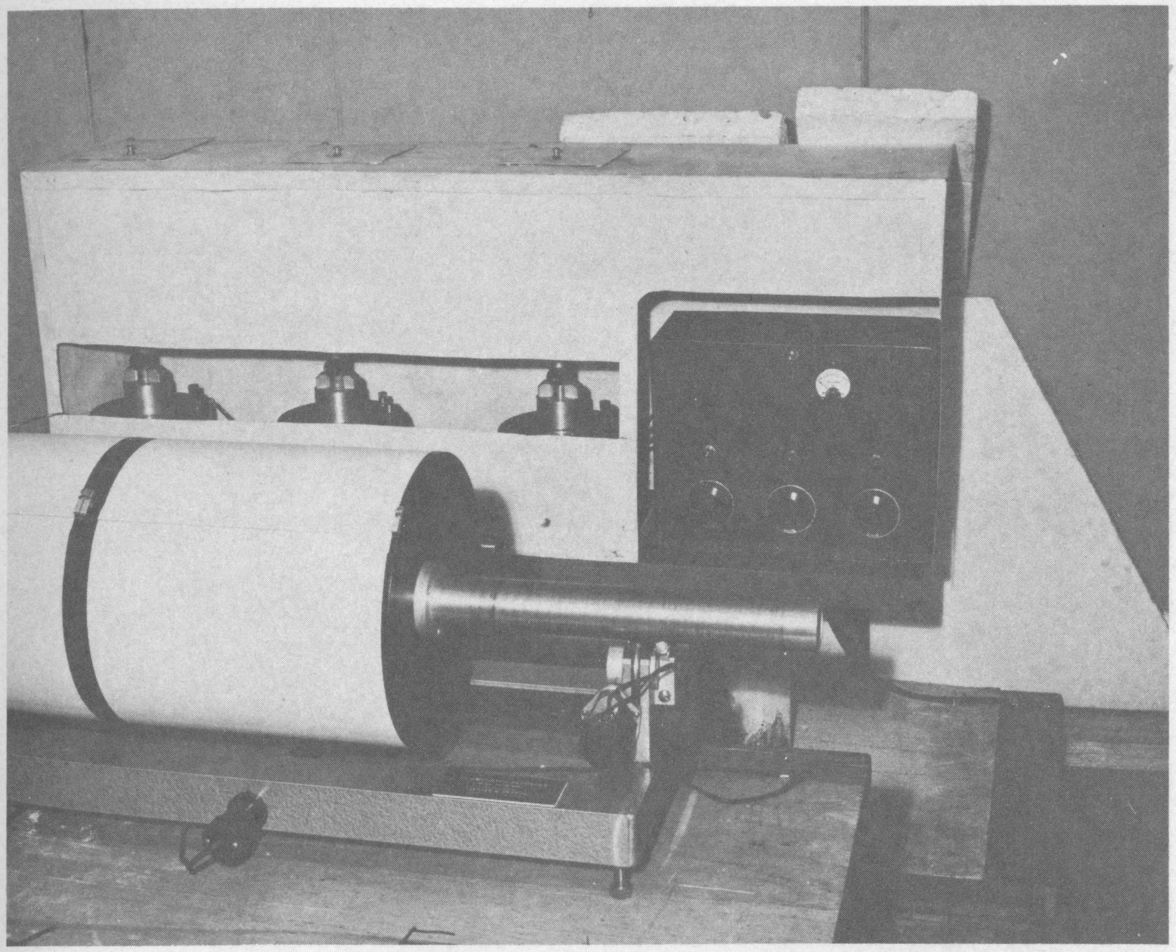

TO ACCOMPANY RECORD No 1968/90

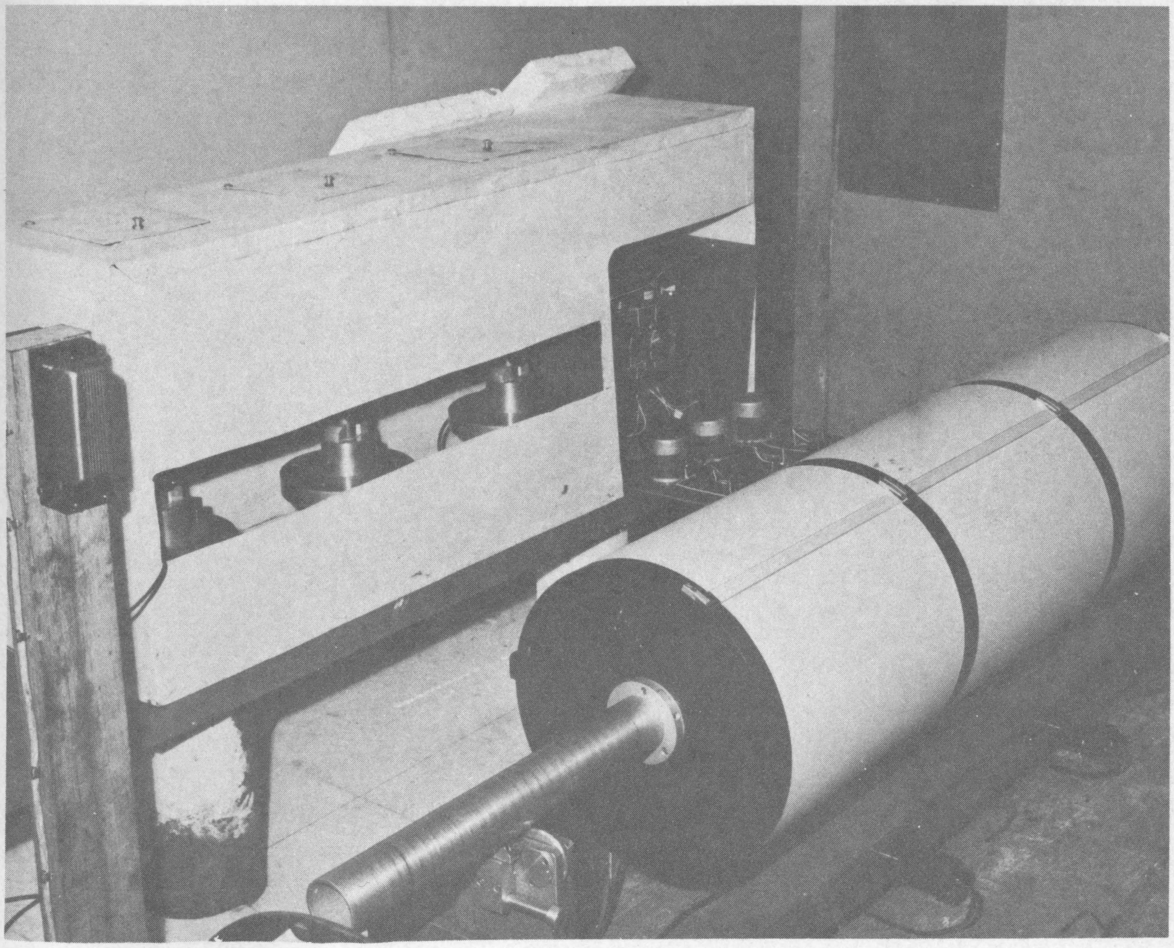
PLATE 1

(a) ENTRANCE TO VAULT



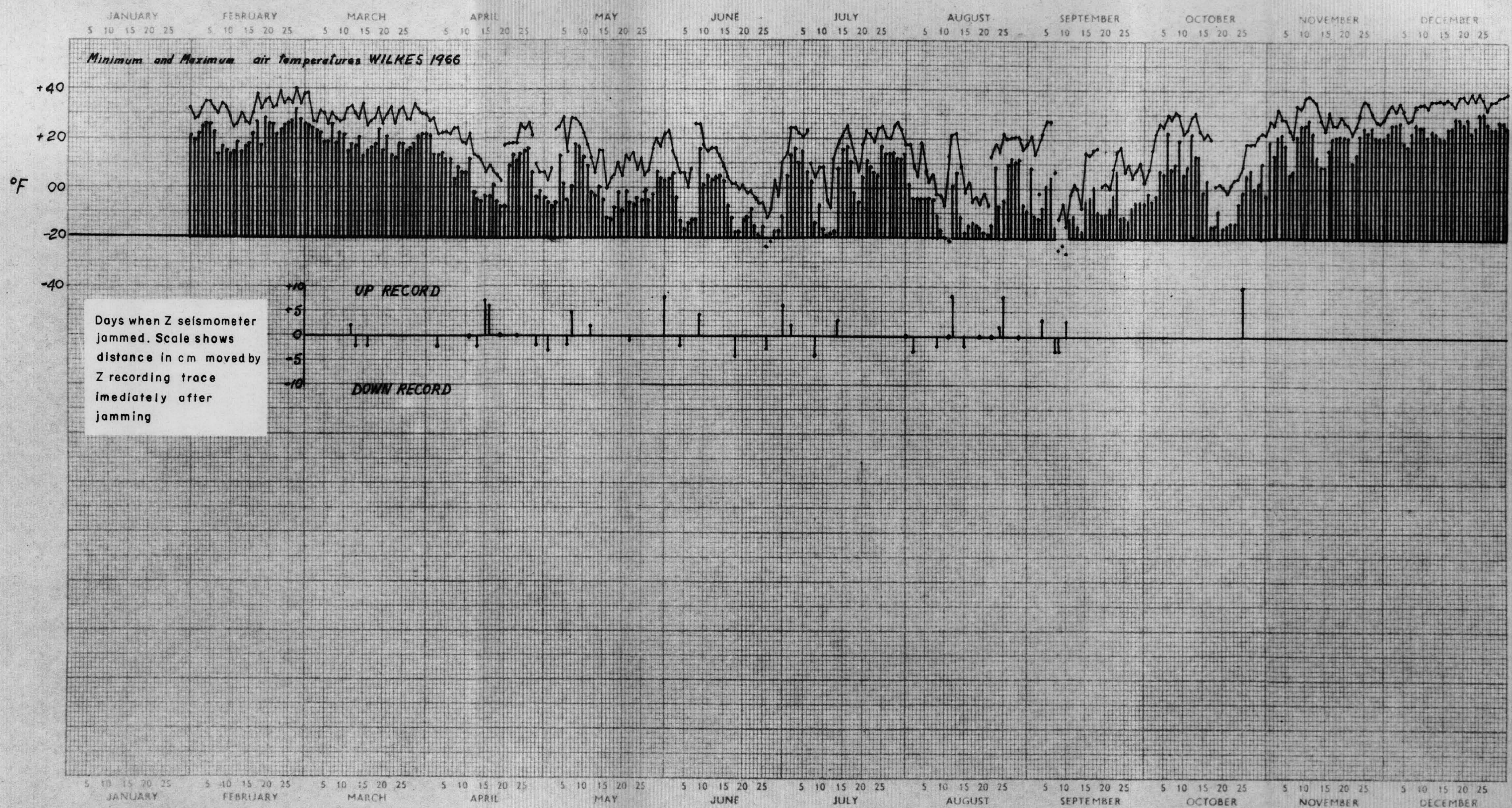
(b) INTERIOR OF VAULT





GALVANOMETERS AND RECORDING DRUM

GALVANOMETER COVER AND ELECTRIC HEATER




DAILY EXTREMES OF AIR TEMPERATURE
AND JOINING OF LONG PERIOD Z SEISMOMETER



WILKES, 1966