DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/115

MACQUARIE ISLAND GEOPHYSICAL OBSERVATORY ANNUAL REPORT 1972

by

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SUMMARY

Geophysical observatory work (comprising the operation of magnetic and seismological observatories) was continued on Macquarie Island during 1972. Normal-run and rapid-run La Cour magnetographs were operated during the year. Results were sent to Melbourne at regular intervals.

A new short-period seismograph station was established on the plateau, and replaced the existing seismograph late in the year. The seismic output from a Willmore Mk II was telemetered by a land line to a recorder situated in the Geophysical Office. A new darkroom was constructed in the office to hold the seismic recorder. The seismic and magnetic timing and power units were integrated in a console in the Geophysics Office.

1. INTRODUCTION

Programs of seismological and geomagnetic recording have been carried out at Macquarie Island since 1950 and 1951 respectively, by the Bureau of Mineral Resources (BMR). The programs are part of the work of the Australian National Antarctic Research Expeditions (ANARE), for which the Antarctic Division, Department of Science, provides accommodation and logistic support.

The geophysical observatory work was done by the author during the interval 27 November 1971 (when he succeeded M. McDowell) to 14 November 1972, (when he was replaced by P. Hill). This Record outlines activities during that period; the main scientific results from the observatory will be published separately, but some preliminary data are included here. Table 1 gives details of the sites used.

2. GEOMAGNETISM

The geomagnetic recording instruments in operation during the period under review were La Cour normal-run (15 mm/hr) and rapid run (180 mm/hr), three-component magnetographs. Regular scale-value and baseline-value determinations were made as appropriate to calibrate the magnetograms (see Tables 2, 3, and 4). Thermometers in the H and Z variometers were read and records changed daily between 2350 and 2400 U.T. The readings were used to calibrate the temperature traces on the normal magnetograms (Table 5). At the end of each month magnetic K-indices, preliminary monthly mean values of the elements, baseline values, and scale values were forwarded by telegram to BMR office in Melbourne. Table 6 is a summary of the preliminary data obtained in 1972 and Table 7 is a summary of the annual mean data 1962-1972.

The orientations of all variometer magnets were determined during June, July, and August (Tables 2 and 3).

Normal-run magnetograph

D variometer. The D baseline values showed excessive scatter until about 15 July; no definite cause could be found for the scatter. Until February there were no D time marks. These were restored by adjusting the time-mark prism of the recorder.

H variometer. The H temperature trace was lost in December 1971 and several variometer adjustments were required to restore it. The ordinate temperature coefficient (3.0 nT/°C) was redetermined by plotting the observed values against temperature.

Z variometer. The Z variometer functioned normally throughout the year and no adjustments were necessary. The temperature coefficient was redetermined (as above) and shown to be 0.0 nT/°C.

Parallax corrections. Parallax tests were made monthly; the corrections to the time-marks were less than 1 minute.

Scale values. At the 1971/72 changeover the MC01 magnetograph calibrator was returned to Canberra, and until February, scale values were done using the MC03 control panel. A replacement MC01 received in February apparently functioned normally until May, when it ceased to work. From May until the 1972/73 changeover, scale values were obtained using the MC03 and substandard meter VML 21164.

The results obtained from the MC03/VML 21164 arrangement were adjusted by applying a meter correction found by Major (1971). They were then compatible with the results obtained in 1971 and 1973, whereas the results given by the MC01 (February-May) were uniformly low. Therefore the MC01 results were not used in the adoption of final values.

Rapid-run magnetograph

This functioned reasonably well during the year. Some of the time-mark mirrors were replaced to improve the time-marks; parallax corrections for the time-marks are included in Table 3. The lamp current was variable and produced a trace of variable intensity. The lamp supply voltage regulation was improved by lowering the output to 8 V and replacing the output transistor.

Absolute instruments

Absolute instruments used during the year were:

H: QHMs 177, 178, and 172 or 179 (which had been restandardized at Rude Skov in October 1971)

D: Askania declinometer 640505

Z: BMZ 236

F: protonprecession magnetometer (PPM) Elsec 592/421.

The PPM was used to derive Z values (called Zp) from measured F, and H derived from the magnetogram. Baseline values computed from Zp were stable during the year.

Until the end of 1971, F was measured at Pier A, which is an external concrete pier about 10 m SSE of Pier W. The top of Pier A is 55 cm above ground level. The PPM sensor is contained in a wooden box which placed the sensor about 25 cm above the pier.

Previous results (McCue, 1971) indicated a field difference of 11 nT between Pier A and Pier W. However, the difference measured in 1971 was 70 nT. Measurements made at different heights alongside Pier A showed that the concrete of the pier has a considerable magnetic effect, and constant readings could only be found with the sensor 45 cm or more above the Pier.

With the PPM sensor 55 cm above the top of the pier, the pier difference was 8 nT.

There was no significant field gradient along the vertical axis of Pier W. During 1972 the total intensity was measured on Pier W.

Intercomparisons and instrument differences. Intercomparisons were made in February 1972 between QHMs 173 and 179 (from Toolangi) and QHMs 172, 177, and 178. In November 1972, intercomparisons were made between: QHM 174 and HTM 704 (Toolangi), and QHM 177; declinometer 640333 (Toolangi) and 640505; and PPMs 339 and 421.

The annual mean differences between the Macquarie Island QHMs were:

QHM 177 - QHM 178 = 7nT
QHM 177 - QHM 179 = 6nT

The Z baseline values derived by the two methods gave the following mean difference:

Zp - BMZ 236 = 148 nT

H baseline values were corrected to QHM 177 and no correction has been applied to this instrument.

Station differences

In order to reduce all observations to the same reference point, viz. pier E, the difference in F between pier W (the F and Z pier) and E was measured at least once a month. It was less than 1 nT.

3. SEISMOLOGY

During the period from November 1971 to September 1972 the seismograph station (MCQ) on the isthmus consisted of a Willmore Mk II seismometer (free period 1.0 s) coupled to a Benioff short-period galvanometer (free period 0.25 s) and a UED single-drum recorder (drum speed 60 mm/min).

During this period a new seismograph station (MQI) was installed on the plateau about 2 km from Geophysics Office. This consisted of a Willmore Mark II seismometer, a Geotech telemetric link to the Geophysics Office, a Benioff short-period galvanometer, and a UED single-drum recorder. From October 1972 this station (MQI) was in regular operation, but both stations (MQI and MCQ) operated more or less concurrently from May to September. A description of the plateau seismograph and its installation are given in the next chapter.

The power and timing for the seismic station and magnetic station were integrated into a single console thus eliminating duplication and considerably improving the timing control for the seismograph station.

Seismograms were processed each day and the data were cabled to Melbourne. About 330 earthquakes were recorded, of which 53 were identified from the National Oceanic and Atmospheric Administration (NOAA) "Preliminary Determination of Epicentre" sheets (Table 8). Seven local earthquakes were felt at the ANARE station (Table 9).

Seismograph system tests to determine the free period and damping of the seismometer and galvanometer, and system magnifications, were done several times. The results are given in Table 10.

Power and timing systems

At the beginning of 1972 there were separate systems for the seismic and magnetic recorders. The seismic power and timing units were housed in the vault on Wireless Hill. Minute marks were put on the record from a Mercer chronometer, which provided a closure (between 00 and 02s), which in turn switched on a transistor with a relay as the collector load. When this relay operated it switched power to the time-mark relay. Chronometer corrections were measured by listening to one of the radio stations which broadcast time signals (VNG or WWV). There was no hour identification on the time marks.

Power for the lamp and time-marks was supplied from a 12-V battery under continuous trickle charge. The recorder was operated from a 50-Hz stablized power supply, which was powered by a 12-V inverter if there was a mains failure.

At the beginning of 1972 the equipment in the Geophysics Office was:

1. A digital clock (EMI) which provided timing pulses and primary power for the magnetograph recorders.

2. An observatory program unit (TMU2) which took a one-minute timing pulse from the EMI clock and gave the following outputs:

    (a) Seismic timing - one-minute closures of 2 seconds duration except for the 00 minute closure, which is of 4 seconds duration.

    (b) Magnetic timing - a closure every 5 minutes plus one at 59 minutes and one at 01 minutes, all of 4 seconds duration.

    (c) Alternative magnetic timing - a closure every 10 minutes of 2 seconds duration except the 00 minute closure, which is of 4 seconds duration.

    (d) A closure every hour of 4 seconds duration.

    (e) A closure every 15 minutes of 2 seconds duration.

The operation of this unit is fully described in the manual (Observatory Timer TMU2).

3. A Power and Timing control panel (PPT-1), which is fully described in the appropriate manual (Power and Timing, Antarctic Observatory).

The 3 units provide for

(a) Primary (EMI) and secondary (Mercer) time-mark distribution to seismic and magnetic recorders.

(b) Primary (EMI) and secondary frequency-controlled power (240 V, 50 Hz) for seismic and magnetic recorders.

(c) 12V DC power distribution to recording lamps.

(d) Controls for recording parallax texts on magnetograms.

(e) An MCO3 magnetograph calibrator.

(f) Input connexions for determinations of variometer magnet ex-orientations and scale values.

This equipment was not being used fully. The sole function was to supply the power and timing to the magnetic observatory, where the precise timing provided by the digital clock was not essential. Facilities were available for the connexion of a secondary timing unit and to extract the necessary timing closure for the seismic observatory.

When the plateau seismograph system (see Chapter 4) was first made operational early in May 1972 the additional equipment required for timing was moved from the old vault to the Geophysics Office. This included the Labtronics radio and the Mercer chronometer, which was to be used as a standby timing unit. A new console was constructed to house all the equipment (Plate 1).

Plate 2 shows a block diagram of the timing system.

The one-minute time marks for the seismic recorder were taken from output (a) of the TMU via a transistor relay to the time-mark mirror of the recorder. The Mercer chronometer provided one-minute and five-minute time marks. The five-minute marks required an additional NTO1 relay, which was built into the clock case. The NTO1 was modified to include an on/off switch and two indicator lamps to monitor the one-minute and five-minute marks. The on/off switch should always be off when the chronometer is not in use; otherwise the TMU receives a one-minute secondary pulse as well as the primary timing pulse from the EMI clock.

The clock was compared with one of the radio time signals (usually VNG) and corrected every day. The one-second pulses from the radio can be switched to the seismic time lines so that the clock error can be recorded on the seismogram.

Power for the discriminators and sending station (plateau seismograph) was obtained from a 30-W 50-Hz stabilized power supply, which also served as a secondary power source for the magnetograph recorder.

When the darkroom was constructed (see below) and the console built, room space was at a premium. To reduce the over-crowding the power supplies were placed in the cold porch with the batteries. Power was taken round the building to various exit points; e.g. 50 Hz to the recorder room, 50 Hz and regulated mains to the console. Plates 3 and 4 show the power arrangements.

Standby recording

At the end of May a failure in the seismograph landline rendered the plateau seismograph inoperative. The isthmus station MCQ was modified to act as a standby when the plateau system was out of action. This system was the same as previously used except that the time marks were taken from the TMU via a landline to the old vault, thus maintaining the centralized timing and power arrangement. The landline comprises a 6-core and a 4-core cable.

Darkroom

When the plateau seismograph station became operational it was necessary to install a photographic recorder in the Geophysics Office, so part of the office was converted into a darkroom; this had been envisaged in the design of the building. A wall was constructed to block off an alcove, and a light trap was made from heavy black cloth (see Plate 4).

The construction work was done by the station carpenter, and the electrical wiring by the electrician. A concrete pier which was level with the floor had already been constructed; on it a concrete pillar 25 cm square and one metre high was constructed to hold the galvanometer. The recorder was placed on a stout wooden table about 35 cm from the pillar.

Comparison of isthmus and plateau seismographs

During September 1972 the relative sensitivities of the MQI and the MCQ systems were investigated. Plates 5 and 6 show the relative differences between MQI and MCQ. Ten earthquakes were recorded at both stations. Table 11 gives the relevant details. As far as possible, amplitude measurements were taken for the same seismic pulse. If this was not possible, the measurements were taken for the same time interval and averaged over several pulses. The noise measurements were obtained in a similar manner.

Events 1 to 5 were recorded with the period of the MQI seismometer set at 1.0 s. There was a slight increase in the sensitivity for the short-period events 3, 4, and 5. The response of the MQI system for the longer-period events 1 and 2 was considerably reduced. Event 1, which was the longest-period event in the group, was not discernible on the MQI records.

Events 6 to 10 were recorded when the period of the MQI seismometer was reduced to 0.7 s. The sensitivity for the short-period events 6, 7, 8, and 10 was increased by a factor of about three. However, the response to the long-period event 9 (period 1.0 sec) was reduced by a factor of three.

A plot of magnitude (Mb) versus distance was produced (Plate 7) for stations MCQ and MQI. If the sensitivity of MQI was greater than MCQ then the threshold magnitude should have been lower; e.g. events of Mb 4 to 5 at $50^{\circ}-60^{\circ}$ should have been recorded. The MQI system was fully operational only during the last three months in 1972, but there were several events with Mb 4 to 5 at $50^{\circ}-60^{\circ}$ during that period, none of which was recorded. Also, during the interval in which the two systems were operating simultaneously, no event was recorded by station MQI which was not recorded by station MCQ.

Considerable effort will be required to keep MQI working, a major part of this effort being devoted to maintaining continuity of the cable. From the results so far obtained, there appears to be no justification in retaining the system, as equally good results can be obtained from the station MCQ.

Sites have been tested on the isthmus (Connelly, 1971) and a site N9 (Plate 8) produced a microseismic noise level of 0.6 times that at the old vault. However, the proximity of the new radio aerials will probably produce too much radio frequency noise in the seismometer. The site N3 about 10 m north of the office, with a noise level of 0.5 times that of the Wireless Hill vault, would probably be an improvement.

4. THE PLATEAU SEISMOGRAPH (MQI)

A seismological observatory (MCQ) has been in operation on Macquarie Island since 1950. The vault used is 14 m above sea level on the slopes of Wireless Hill, which lies to the north of the ANARE station. Owing to its proximity to the sea, ground noise from the waves and the buffeting which the hill receives from the wind are considerable. These factors limit the sensitivity of the instruments used, and many seismic events are obscured. In 1969 a search for a new site with a lower noise level was initiated. Sites were investigated on the Isthmus and Wireless Hill without success. In 1970 the search was extended to the main plateau, which lies to the south of the station. A site which met the specified requirements was found about 3 km from the station in the vicinity of Boot Hill. Results from tests at this site showed that the noise level was 30% of that at the vault on Wireless Hill (Meath, 1971). Consequently a decision was made to replace the isthmus station by one on the plateau, and work towards this objective began in 1971 and was completed in 1972.

During 1971 a hole was excavated and a fibreglass vaultlet to house seismometers and other equipment was sunk in it (Plate 9). A cable was laid from the vaultlet to the Geophysics Office on the Isthmus. The six-core cable was unshielded except for the last 300 m to the vaultlet, which was four-core unshielded cable. On the Isthmus the cable was buried to protect it from seals and other hazards, e.g. tractors. On the plateau the cable was laid on the ground but during the year it was found that rabbits, which are prolific on the plateau, were eating it. Various reputed repellents failed to deter the rabbits.

It was proposed that during 1972 a new six-core screened cable be installed from the Geophysical Office to the vaultlet. A frequency modulation (FM) telemetric system would relay the seismic signal from the vaultlet to the office where the signal would be recovered and recorded on a standard photographic recorder. Plate 10 shows a block diagram of the telemetric system. If the new site proved satisfactory it was intended to have ultimately a three-component seismograph system, but only the vertical component (SP-Z) was to be installed in 1972.

The SP-Z system was to be made operational as soon as possible but because of unforeseen problems with the landline and radio interference (described later), the new station did not become fully operational until September 1972.

Plateau seismograph equipment

Seismometer. The seismometer used was a Willmore Mk II with a 4000-ohm centre-tapped coil. The resistance and configuration of the coil matched the input of the amplifier.

Telemetric amplifier. The TM 251 telemetric amplifier is a single-channel portable amplification and transmission system for use with a seismometer. The TM 251 may be used either with radio frequency (rf) or landline transmission. A constant-bandwith FM transmission is used which maintains constant time delay between channels. Filters with cutoff frequencies of 12.5 and 0.1 Hz are included in the amplifier.

There are three basic components: a seismic amplifier (EA 310), a voltage-controlled oscillator (VCO),

The analog output from the amplifier is converted to a frequency-modulated signal by the VCO. The FM signal is fed to a landline through a bridging transformer. At the receiving station the original signal is recovered by a discriminator.

Six TM-251 units may be multiplexed on the same landline.

Discriminator. To recover the original signal a FM discriminator Model XD410 made by Teledyne Geotech is used. This is a solid-state FM discriminator which has three basic components: (1) a discriminator which can be used over a wide range of frequencies (300 Hz to 10kHz) and which will respond to deviations from ± 3.75% to ± 45%; the frequency used for the Z component was 1700 Hz; (2) a tuning unit which contains the input filter and timing capacitors; and (3) an output assembly. The discriminator is plugged into a housing which also contains the power supplies for both the sending and receiving stations.

Recorder. The UED model DR-270 single-drum recorder has a chart speed of 60 mm/min and a traverse rate of 2.5 mm per revolution. The synchronous motor is driven by the 50-Hz frequency-regulated power supply to ensure that the rotation speed of the drum is constant. The lamp is powered by a 12-V battery. The time-mark mirror is deflected by pulses from the TMU2 (seismic program). Individual controls are available for varying the intensity of the trace and the amplitude of the time-marks.

Calibrator control. This is basically a constant-current generator. It supplies a known current via the landline to the calibration coils of the seismometer. The resultant trace deflection is compared with the deflection produced by known forces on the seismometer mass (see next chapter).

Galvanometer control box. The output from the discriminator is a few volts while the sensitivity of the galvanometer is about 10 μV/degree, so attenuation of 70dB to 100dB is required between the discriminator and the galvanometer. The normal galvanometer control box has a maximum attenuation of 42dB, which is insufficient.

To increase the attenuation the galvanometer and control box attenuator were connected across a Wheatstone Bridge (Plate 11A), and a variable resistance was connected in one of the arms to enable the attenuation to be varied.

Power supplies. There is one power supply for the discriminators and one for the sending station. The power requirements are:

> Discriminators ± 9 V, 62 mA positive and 33.5 mA negative (the clamp to zero requires an additional 45 mA).
>
> Sending station ± 12 V, 18 mA (± 9 V internal regulation).

The power for the sending station is supplied via the landline, and the voltage must be large enough to overcome line losses. The resistance of the line is 13 ohm/300 m and the shield resistance is 1 ohm/300 m so the calculated total resistance of the cable is about 130 ohms; the measured values between vault and the office was 125 ohms. Therefore the voltage drop on the line is about 2.5 V, so the input voltage must be greater than 14.5 V.

The voltage measured at the office was +15.7 and -16.4. A three-component seismograph would increase the voltage drop on the line by a factor of three.

Plateau-to-isthmus landline

Cable. A screened six-core cable made by Nylex Corp. (ref. ZYAA BLACK 6 x 14 .0076 PVC/TCWB/PVC) is used. The cable connections are given in Table 12. The cable was suspended about a metre above the ground on steel and wooden posts, to remove the cable from the reach of rabbits (Plate 12). The cable was supplied in 300-m lengths and weighed about 50 kg per 300 metres. It required two people to carry each reel of cable to the plateau. The total length of cable is about 3000 m.

During November and December 1971 and the early part of 1972 the existing four-core cable was replaced by the new cable.

The cable was tested for continuity and insulation. The continuity was satisfactory. The insulation was low (in the order of hundreds of ohms), several orders of magnitude down on the inter-pin resistance of new plugs. However, it was considered that the insulation was sufficient for the system to work.

Posts. During the early part of 1972 a program of posting was carried out aimed at suspending the cable from posts all the way from the vaultlet to the isthmus. The steel posts were 1.4 m and 1.8 m long and weighed about 2 kg each. They were carried to the plateau five at a time and were spaced about 8 m apart. The cable was tied to the posts with copper wire. After a few months it was observed that friction between the cable and the posts threatened to sever the cable. To overcome this, rubber cushions were put between the cable and the posts.

Wooden posts were used for part of the job because they were lighter and more could be carried to the plateau in one journey. These posts have proved successful: they have withstood the high winds on the plateau without damage and they do not tend to cut the cable.

To protect the instruments from lightning, gas discharge "fuses" were placed in parallel with the landline at the sending station and at the office. These gas-filled cells break down within nanoseconds when the inter-electrode voltage exceeds 90V and provide an effective short across the instrument inputs.

Cable connexions. The rabbit-damaged sections were either repaired or replaced by new cable. The cable sections were joined with eight-pin Cannon connectors. These plugs were waterproofed by liberal quantities of silicone grease and by covering the complete plug with rubber tubing which was securely clamped to the body of the plug. Silastic 732 TTV was used as a final sealant around the rubber tubing.

Insufficient new Cannon connectors were brought from Australia to join all the new cable together. Cannon connectors taken off the old cable were very heavily corroded, and in some the inter-pin resistance was as low as 500 ohms. This was two or three orders of magnitude down on the resistance for new connectors.

Further, a subsequent discontinuity in the line was traced to a new connector which was corroded. Other connectors showed similar tendencies, and it was apparent that these connectors would be a continual source of trouble. Therefore, it was decided to remove all the connectors and replace them by solder joints.

Any method of jointing had to be: waterproof and not subject to corrosion; and strong enough to withstand the strains imposed by the wind.

Corrosion is caused mainly by: normal atmospheric corrosion and moisture; and electrolysis between the power leads.

Several methods of jointing were tried, as follows:

(a) The leads were soldered together and then covered with a layer of silastic. This was waterproof but not very strong. Electrolysis also occurred with the acetic acid acting as an electrolyte. The resulting joint was not very strong.

(b) The joint was coated with epoxy resin. This was waterproof, fairly strong in tension, but weak in bending.

(c) The joint was put in a plastic mould and the mould filled with epoxy resin. This proved very satisfactory, being both waterproof and producing a very strong joint. However, the resin was obtained from the radio department and the limited supplies available were not enough for all the joints.

One disadvantage of these methods was that if a discontinuity occurred in the line it was impossible to find it without taking several joints apart and redoing them.

This involved considerable time (3 to 4 days if it occurred in winter) and consequent record loss.

The final method adopted was to use small wooden boxes within which the joint was housed. The cable was held firmly to the bottom of the box by brass collars so that the solder joint was not subjected to stresses. The joint was coated with silicone grease and covered with plastic sleeving to prevent electrolysis. The inter-lead resistance was measured and found to be about 500k ohms. One advantage of this method is that the joint can be examined with minimum effort and time, and any discontinuity can be isolated quickly. A disadvantage is that the boxes are wooden and therefore subject to corrosion in the west climate on Macquarie Island. To prevent corrosion the boxes should be repainted from time to time.

To keep a check on the landline values of the circuit, resistances are given as measured in the office, with the sending station connected and the discriminators and power supplies disconnected.

Blue - Green	900 ohm (signal)
Black - white	20k ohm (+ 12V power)
Black - Screen	10k ohm (12V/com)
Red - Yellow	260 ohm (calibrator)

A marked departure from these values will usually indicate a landline fault.

Telephone. Considerable time can be saved when setting up and adjusting the instruments if two people are available (one person at the vaultlet and the other in the office), and if there is some means of communication between the two. Therefore, one field telephone was installed in the vaultlet and one in the office and connected via the landline; there is one spare telephone.

Problems encountered, telemetry system

Interference. When the new system was first operated there was considerable radio frequency (rf) pickup when the radio station was transmitting. The pickup was severe, the rf noise being several orders of magnitude greater than the microseismic noise. The office is almost directly under the aerial system for communication with Sydney, and the cable was apparently acting as a rather efficient aerial.

The following entry points for the rf were considered:

(1) Direct pickup by the landline entering the discriminator.

(2) Along the mains (the mains voltage itself is rather rich in harmonics), producing a ripple on the DC power supplies.

(3) Direct pickup by the leads within the housing from the power leads.

Pickup by the landline was reduced by having screened cable all the way from the vault to the office. The housing was rewired using earthed screened cable for all power leads, to reduce pickup from these sources. The mains were further decoupled by 0.01 μF capacitors. The DC inputs to the discriminators were decoupled with two 68-μF capacitors and likewise the power inputs to the sending station with two 100-μF capacitors.

Because the radio transmitter frequencies are between 2.7 MHz and 15 MHz, low-pass filters with a cutoff frequency of about 2 MHz were constructed. The filters were of the pi type and were placed in the line immediately before the discriminator and immediately after the sending station. A similar filter was put between the seismometer and the sending station.

A single earth point was used within the housing and this in turn was connected to the water mains. These measures reduced the rf pickup but did not eliminate it.

Two methods of operating the system were tried:

1. Increasing the output of the sending station until the seismic background noise was comparable to the rf noise. This was partly successful but had the following disadvantages:

(a) The signal was highly distorted during seismic events owing to overloading of the amplifier.

(b) Massive attenuation was required at the recorder

2. Connecting the direct output of the seismic amplifier to the landline and bypassing the modulator and discriminator. Noise pickup from radio transmission and other unidentifiable sources was massive.

At this stage the measures introduced had reduced the rf noise to about 2 V with a DC shift of 2 V. The seismic noise was of the order 0.2 V with the attenuator at the sending station set at 42 dB.

Another entry point for the rf noise was found. This was via the recorder and the galvanometer control box. By making a common earth from the recorder via the control box to the earth point in the housing the rf noise was reduced to approximately 0.6 V. Subsequent investigation showed that the 'earth' point was about 0.6 V above earth. In order to find a 'proper earth', metal posts were driven into the ground at 2-m intervals south of the aerial system. The pickup was measured at each of the posts until a minimum value of rf voltage (0.2 V) was found. This was taken as the common 'earth' point for the system.

This implies that the seismic noise must be 0.2 V or greater in order that the rf noise does not swamp it. The maximum signal out of the discriminator is 10 V, only 50 times higher than the noise level. The maximum deflection of the galvanometer spot will be only 50 times the deflection produced by the noise. Because the frequent small local events produce signals of one to two volts the larger events will overload the amplifier and reduce the useful information obtainable.

When the transmitter aerials are moved about 400 m south in 1973 some attenuation of the signal from the seismometer will be required before it is fed into the amplifier. An attenuation of the background signal level by a factor of 10 would probably be sufficient. Important - while the transmitter aerial remains near the Geophysics Office the calibrator leads must not be left plugged in, nor should the telephone be left connected; otherwise pickup will be recorded.

It was decided to find out if all the filters which had been inserted were necessary. The filters at the sending station and the decoupling capacitors at the power input to the sending station were removed without any adverse effects. The filter at the input to the discriminator was retained. An additional filter consisting of a series 2.5 mH choke and a parallel resistor was inserted between the control box and the discriminator. The galvanometer and the discriminator outputs were decoupled by 0.001 μF capacitors (see Plate 1).

Seismometer output/free-period dependence. During June when the seismograph was inoperative, the sending station and the seismometer were tested in the office; the free period of the seismometer was about 0.7 s, and it was adjusted to 1.0 s.

After the cable had been repaired (at the end of June) and the equipment replaced in the vaultlet with the attenuator settings as before, there was no output. Eventually it was found that the output could be restored by altering the free period to 0.7 s.

Measurements at the 'high output' terminals of the sending station showed that the output at 1.0 s was approximately 20 dB less than at 0.7 s. The wind noise was used as a signal. Therefore the attenuation of the sending station was reduced until an acceptable output was obtained. No satisfactory explanation was available for the loss of sensitivity, but one possibility was that the mass of the seismometer may not have been properly aligned when the period was 1.0 s.

System tests

The galvanometer free period and damping ratio are determined in the office; the seismometer free period and damping tests are made at the vault (Plate 11B). The settings of the control switches during the tests are:

Galvo Free Period Top switch to 'free period' and press test button. The free period is 0.2 s.

Galvo Damp Top switch to 'damp' and press test button. The damping ratio is 10:1.

Seismometer free period Switch the function switch to 'F.P.' and the amplifier attenuator settings to 0 dB. Deflect the mass by applying a current to the calibration coils.

Seismometer damping ratio Switch 'function switch' to 'record/damp'. Observe the seismometer output on an oscilloscope when the mass is deflected.

The damping ratio was about 20:1; however, this was measured with the amplifier disconnected so the seismometer was overdamped in normal operation.

Calibration Before leaving Australia the calibrator motor constant (G) was measured by comparing the deflections produced by lifting a known mass from the seismometer mass, with those produced by known currents through the calibration coil. These tests produced a value of 0.28 N/A. Attempts were made on Macquarie Island to redetermine the constant but these were unsuccessful. The exposed position of the vault, the lack of calm weather, drafts in the vaultlet, and unavoidable movements of the observer prevented any conclusion being reached. However, the value of 0.28 nNA can probably be used in the calculation of magnification.

5. OTHER ACTIVITIES

Tide gauge

A tide gauge was maintained for the Horace Lamb Centre for Oceanographic Research, Flinders University. The records were changed once a week. Time corrections were noted on the charts every day.

Mess duties

Two and half weeks "slushy" duty was done. Assistance was given with the painting of buildings during the latter half of the year.

6. ACKNOWLEDGMENTS

Without the active participation of many of the expeditioners, great difficulty would have been experienced in transporting the cable and posts up to the plateau. Thanks are also due to those who helped in the various tests performed on the MQI seismic system.

7. REFERENCES

CONNELLY, J.B., 1971 - Macquarie Island Geophysical Observatory Annual Report 1968. Bur. Miner. Resour. Aust. Rec. 1971/87.

McCUE, K.F., 1971 - Macquarie Island Geophysical Observatory Annual Report 1969. Bur. Miner. Resour. Aust. Rec. 1971/87.

MAJOR, J.A., 1971 - Macquarie Island Geophysical Observatory Annual Report 1967. Bur. Miner. Resour. Aust. Rec. 1971/86.

MEATH, J., 1971 - Selection of a seismometer site Macquarie Island. Bur. Miner. Resour. Aust. Rec. 1971/79.

Table 1

Macquarie Island site data

	Magnetic Observatory	Isthmus seismo (MCQ)	Plateau Seismo (MQI)
Latitude			
geographic	$54^{\circ}30.0'$S	$54^{\circ}29.9'$S	$54^{\circ}31.2'$S
geomagnetic	-61.1		
Longitude			
geographic	$158^{\circ}57.0'$E	$158^{\circ}57.4'$E	$158^{\circ}55.8'$E
geomagnetic	243.1		
Elevation (metres)	8	14	250

Table 2

Normal-run magnetograph data 1972

Component	Scale value nT/mm	RMS Devn	Orientation (N pole)	Date
D	8.84 (a)	0.19	1.3°E	Jun 24
H	19.40	0.10	0.6°S	Aug 24
Z	20.70	0.10	0.4° Down	Jul 3

(a) 8.84 nT   2.35 minutes of arc

Table 3

Rapid-run magnetograph data 1972

Component	Scale value nT/mm	Parallax (b) seconds	Date changed	Orientation (N pole)	Date
D	3.76 (a)	-4	June 24	1.3°E	June 24
		16	Sep 11		
		-4	Sep 21		
		0			
H	5.55	-23		1.3°N	June 24
Z	6.34	-34		0.5° Down	July 3

(a) 3.76 nT   1.00 minutes of arc

(b) Parallax = True time - Apparent time

Table 4

Magnetograph Baseline value changes 1972

Component	Value nT (a)	Changed	Remarks
Z	63768	Jun 01 00	Unknown
	63765	Nov 01 00	"
	63776		
H	12627	Jan 03 00	Variometer Adj
	12608	Jan 05 00	"
	12587	Jan 09 00	"
	12428	Jan 22 00	"
	12629	Mar 03 00	"
	12571	Mar 13 00	"
	12658	Mar 28 00	"
	12286	Mar 30 00	"
	12588	Apr 17 00	Unknown
	12710	Aug 01 00	"
	12698	Sep 30 00	"
	12692	Dec 06 00	"
	12696		
D	$26^{\circ}50.5'$	Jul 15 00	Unknown
	$26^{\circ}48.0$		

(a) All values are preliminary

Table 5

NORMAL RUN THERMOGRAPH PARAMETERS 1972

From	To	Scale value St °C/mm		Baseline value Bt °C
Z Thermograph				
JAN 01	MAR 22	1.4		-62.8
MAR 22	APR 03	1.4		-63.2
APR 03	MAY 05	1.4		-64.6
MAY 05	MAY 25	1.4		-63.4
MAY 25	SEP 06	1.4		-64.0
SEP 06	OCT 17	1.4		-64.5
OCT 17	NOV 21	1.4		-64.2
NOV 21	DEC 29	1.4		-63.6
DEC 29	DEC 31	1.4		-64.0
H Thermograph				
JAN 01	JAN 31		No H trace	
FEB 01	FEB 29	6.0		-240
MAR 01	MAY 11		No H trace	
MAY 12	MAY 23	6.0		-252
MAY 24	JUN 25	6.0		-240
JUN 26	JUL 20	6.0		-263
JUL 21	AUG 03	6.0		-247
AUG 04	AUG 24	6.0		-256
AUG 25	DEC 31	6.0		-220

Table 6

Preliminary monthly mean geomagnetic values 1972

Month 1972	D (East) °	'	H nT	Z nT	F nT	K
Jan	27°	21.3	12 945	64 006	65 302	2.59
Feb		19.8944	007	303	(2.03)	
Mar		22.6	937	002	296	2.06
Apr		19.0	940	021	316	(1.82)
May		23.4	940	014	309	(1.38)
Jun		21.5	953	016	313	1.73
Jul		24.1	943	023	318	1.15
Aug		22.5	927	022	314	2.52
Sep		23.5	932	012	305	2.03
Oct		22.6	925	001	293	2.19
Nov		21.8	927	63 994	287	2.06
Dec		23.1	935	980	274	1.61
Mean	27	22.1	12 937	64 008	65 302	1.93

Table 7

Geomagnetic Annual mean values 1962-1972

YEAR	D (East) °	'	I °	'	H nT	X nT	Y nT	Z nT	F nT
1962	26	5.8	-78	23.3	13216	11869	5814	-64321	65665
1963	26	8.5	-78	24.2	13193	11843	5813	-64294	65634
1964	26	17.0	-78	24.7	13174	11812	5834	-64249	65586
1965	26	28.6	-78	25.5	13152	11773	5864	-64214	65547
1966	26	37.6	-78	26.7	13121	11729	5881	-64175	65503
1967	26	46.5	-78	28.5	13084	11681	5894	-64166	65486
1968	26	54.7	-78	29.7	13053	11639	5908	-64132	65447
1969	27	2.3	-78	30.8	13026	11602	5921	-64099	65409
1970	27	9.6	-78	32.1	12996	11563	5932	-64078	65383
1971	27	13.3	-78	33.3	12963	11527	5930	-64032	65331
1972	27	22.1	-78	34.4	12937	11489	5947	-64008	65302
Mean Annual change		+7.63		-1.11	-27.9	-38.0	+13.3	+31.3	-36.3

TABLE 8

EARTHQUAKES RECORDED AT MACQUARIE ISLAND 1972 AND LOCATED BY NOAA

DATE	STATION	ARRIVAL TIME hr min s	LOCATION
Jan 18	MCQ	22 04 15.0	New Guinea
Jan 18	MCQ	22 17 15.0	New Guinea
Jan 19	MCQ	20 23 38.0	West MCQ
Jan 23	MCQ	21 25 39.0	New Hebrides
Jan 25	MCQ	02 18 48.0	Taiwan
Feb 12	MCQ	19 00 13.0	Tonga Island
Feb 14	MCQ	23 37 45.0	Santa Cruz
Feb 29	MCQ	09 35 53.0	South Honshu
Mar 23	MCQ	05 26 58.6	MCQ Region
Mar 30	MCQ	05 40 10.0	Fiji
Apr 01	MCQ	23 52 44.0	Auckland Is
Apr 02	MCQ	00 19 07.0	Auckland Is
Apr 02	MCQ	00 40 23.0	Auckland Is
Apr 02	MCQ	03 11 28.0	Auckland Is
Apr 04	MCQ	22 51 51.0	Banda Sea
Apr 25	MCQ	10 45 45.0	Minduro Phil
Apr 26	MCQ	01 39 47.0	Fiji
Apr 28	MCQ	23 41 21.0	Solomon
May 04	MCQ	07 55 43.0	New Hebrides
May 08	MCQ	23 25 25.0	New Britain
May 09	MCQ	12 27 15.0	Fiji
Jun 11	MCQ	16 51 09.2	Celebes Sea
Jun 19	MCQ	15 28 25.0	Aleuttian Is
Jun 20	MCQ	01 44 26.0	Macquarie Reg
Jul 04	MCQ	10 27 26.0	Philippine
Jul 16	MCQ	00 35 45.0	Solomon Is
Aug 06	MCQ	07 24 46.0	Solomon Is
Aug 07	MCQ	09 32 42.0	Somoa

TABLE 8 (cont.)

Aug 17	MCQ	23	52	53.0	New Britain
Aug 28	MCQ	06	19	35.0	Novaya Zemyla
Sep 04	MCQ	18	19	07.0	Santa Cruz
Sep 11	MCQ	13	45	28.0	Ceram
Sep 24	MCQ	20	18	54.0	Tanimbar Sea
Oct 12	MQI	18	00	02.0	Halmahera
Oct 28	MQI	03	24	14.0	New Hebrides
Oct 30	MQI	16	56	46.0	Solomon Is
Nov 02	MQI	20	02	18.5	Loyalty Is
Nov 04	MQI	09	56	16.0	New Guinea
Nov 04	MQI	21	45	53.0	Taua
Nov 05	MQI	00	15	08.0	New Guinea
Nov 09	MQI	08	16	10.0	Fiji
Nov 10	MQI	05	33	40.0	Balleny
Nov 26	MQI	04	24	07.2	Fiji
Nov 27	MQI	15	26	36.0	Banda Sea
Dec 02	MQI	00	30	36.0	Philippine
Dec 02	MQI	01	51	13.4	Philippine
Dec 04	MQI	10	29	01.8	Honshu
Dec 04	MQI	18	01	00.0	New Guinea
Dec 05	MQI	22	09	32.2	New Guinea
Dec 06	MQI	01	52	47.0	New Guinea
Dec 08	MQI	18	08	44.8	Honshu
Dec 11	MQI	08	44	21.0	Balleny
Dec 18	MQI	06	59	53.4	Fiji

TABLE 9

EARTHQUAKES FELT ON MACQUARIE ISLAND 1972

DATE	ARRIVAL TIME hr min sec	MM INTENSITY AT ANARE STATION
Mar 30	21 07 13.0	II
Mar 31	01 19 09.1	III
Apr 07	00 03 05.0	III
Nov 08	07 11 35.0	II
Nov 08	07 13 19.0	II
Dec 24	03 13 14.0	II
Dec 26	15 09 28.7	II

TABLE 10

SEISMOGRAPH CONSTANTS

Date	galvo f.p.	Seismometer f.p.	galvo damp	syst. damp
Isthmus seismograph MCQ				
JAN 31	NO DATA	1.0 sec	NO DATA	CRITICAL
FEB 01	0.2 sec	1.0 sec	NO DATA	CRITICAL
FEB 09	0.2 sec	1.0 sec	NO DATA	CRITICAL
FEB 10	0.2 sec	NO DATA	6:1	CRITICAL
FEB 19	0.2 sec	1.0 sec	8:1	CRITICAL
FEB 27	0.2 sec	NO DATA	6:1	CRITICAL
MAR 27	0.2 sec	1.0 sec	11:1	CRITICAL
APR 28	0.2 sec	1.0 sec	11:1	CRITICAL
MAY 26	0.2 sec	1.0 sec	6:1	CRITICAL
JUN 11	0.2 sec	1.0 sec	6:1	CRITICAL
SEP 07	0.2 sec	0.9 sec	6:1	CRITICAL
Plateau seismograph (MQI)				
	0.2	0.7	10:1	20:1

Table 11

Comparison of seismograph recordings

Date 1972	Time UT	MCQ (Isthmus) Noise Amp mm	MCQ Signal Amp mm	MCQ Signal Period s	MCQ Seismo FP s	MQI (Plateau) Noise Amp mm	MQI Signal Amp mm	MQI Signal Period s	MQI Seismo FP s	Ratio MQI/MCQ
4/9	18 19 04	0.5	3.0	1.5	1.0	Not identifiable				
6/9	19 10 29	1.0	15.0	0.5	1.0	1.0	1.2	0.5	1.0	0.08
8/9	23 23 40	1.0	7.5	0.2	1.0	1.5	4.5	0.2	1.0	0.6
8/9	23 39 15	1.0	3.0	0.2	1.0	0.8	5.5	0.2	1.0	1.8
14/9	21 02 27	1.0	3.2	0.2	1.0	1.0	5.0	0.2	1.0	1.6
20/9	22 58 25	0.5	4.0	0.1	1.0	0.6	18.0	0.1	0.7	4.5
24/9	16 18 34	1.5	15.0	0.2	1.0	1.0	31.0	0.2	0.7	2.1
24/9	19 51 53	1.5	6.0	0.2	1.0	1.0	26.0	0.2	0.7	4.3
24/9	20 18 55	1.0	5.0	1.0	1.0	1.0	1.5	1.0	0.7	0.3
25/9	11 30 44	1.0	3.2	0.2	1.0	0.5	8.0	0.2	0.7	2.5

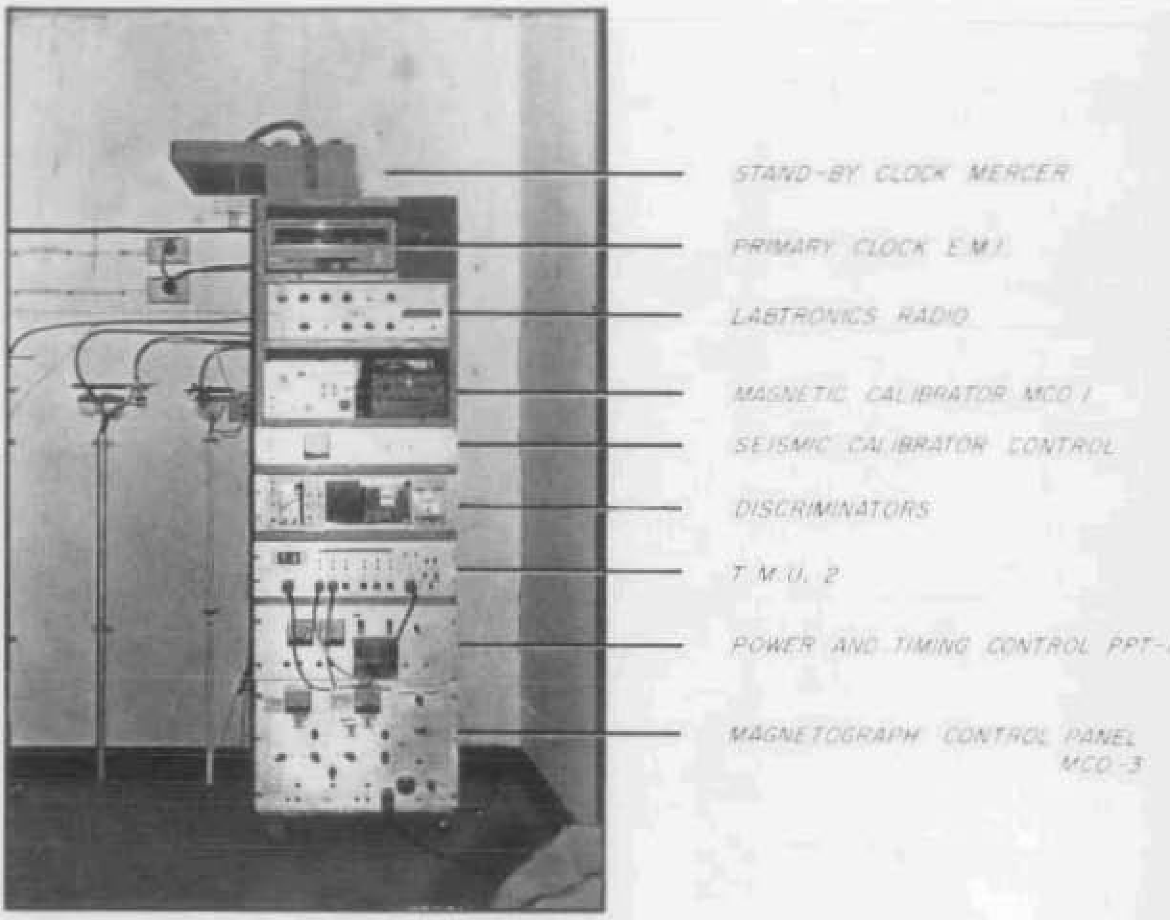
Table 12

Cable connections and inter-lead resistances

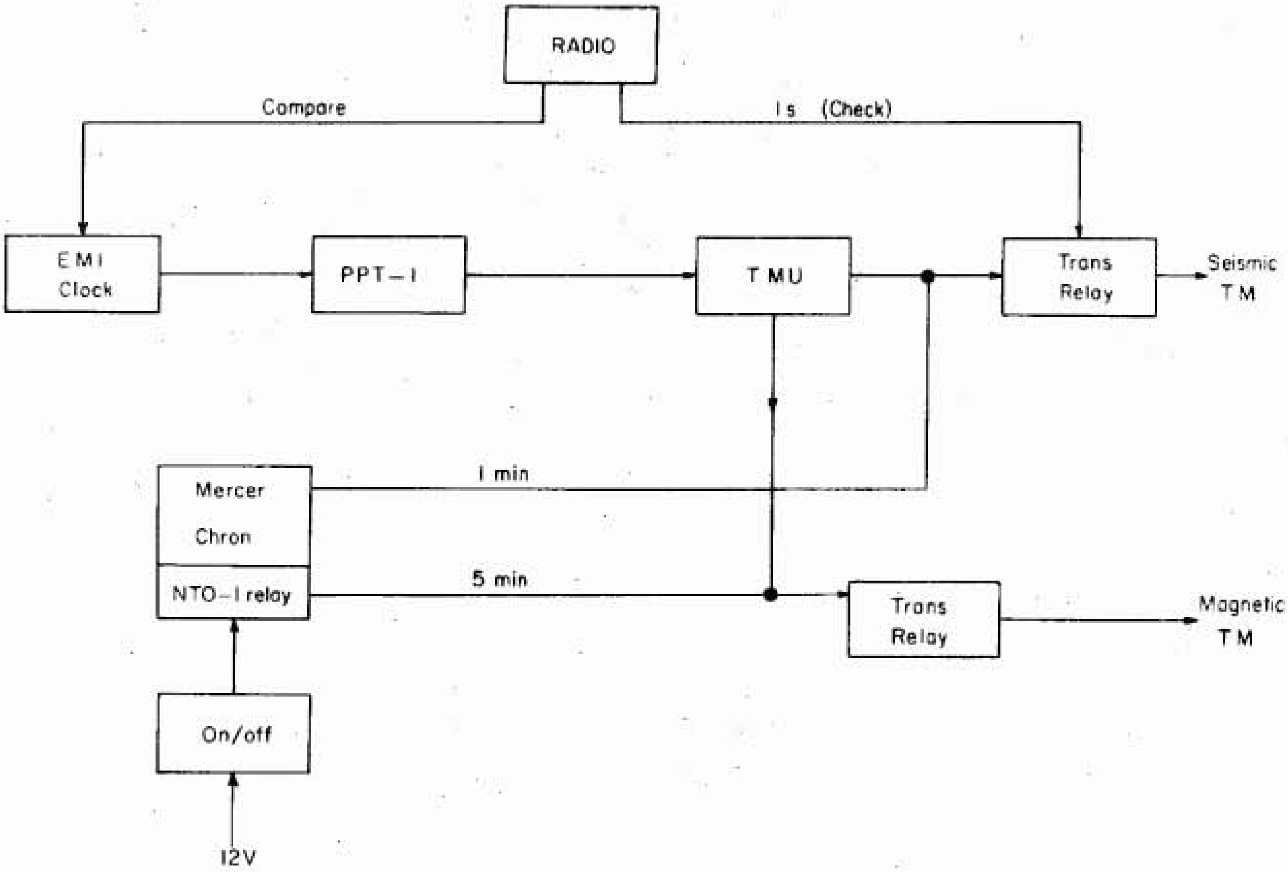
MQI Landline

Cable	Use	Screen	White	Yellow	Black	Green	Blue
Red	Cal/phone	50K	100K	100K	200K	75K	150K
Blue	Signal	25K	150K	100K	150K	150K	
Green	Signal	50K	30K	50K	100K		
Black	-12V	50K	150K	150K			
Yellow	Cal/phone	60K	100K				
White	+12V	50K					
Screen	Com/Earth						

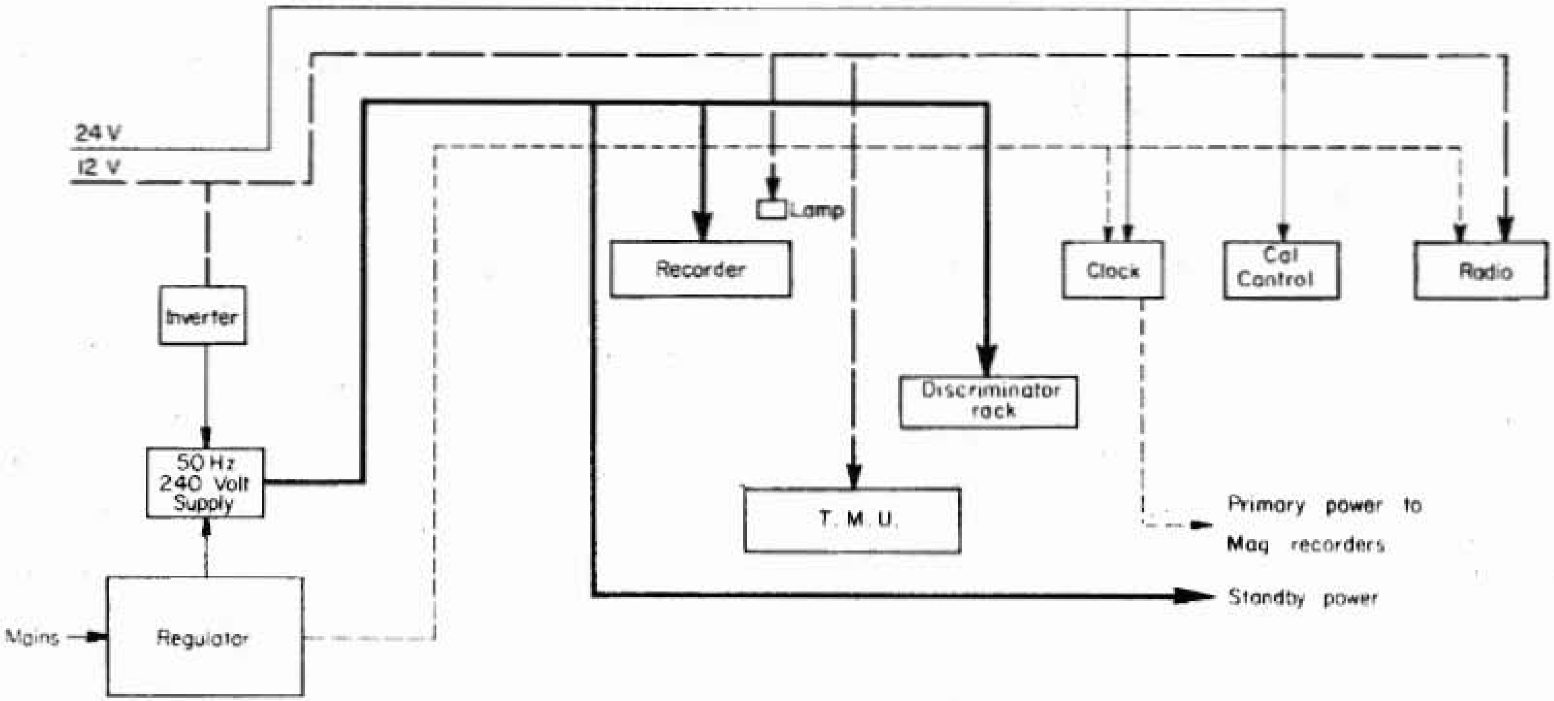
Resistances (ohms) measured with an AVO 8 multimeter



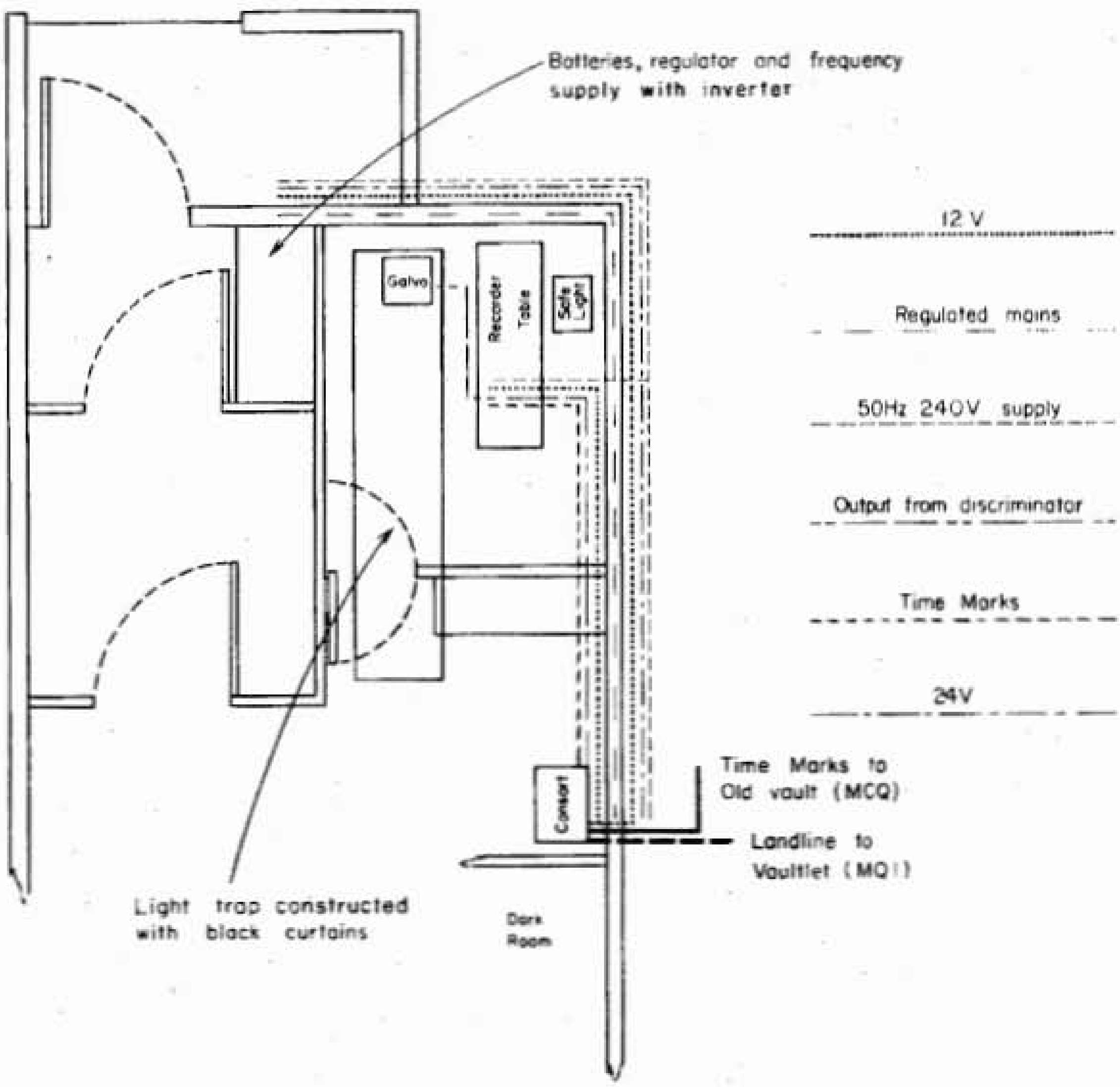
EQUIPMENT CONSOLE IN OFFICE



BLOCK DIAGRAM OF TIMING SYSTEM

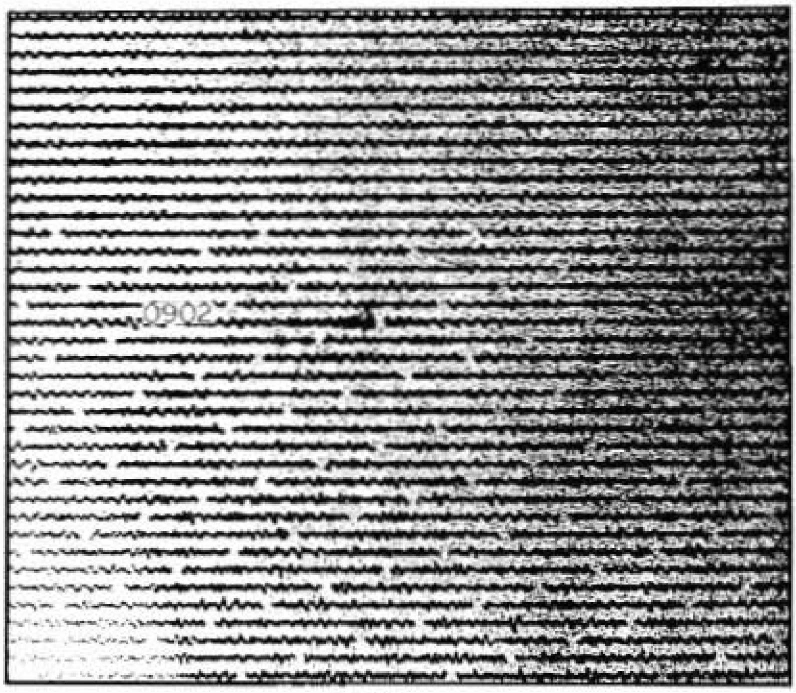


BLOCK DIAGRAM OF POWER DISTRIBUTION SYSTEM



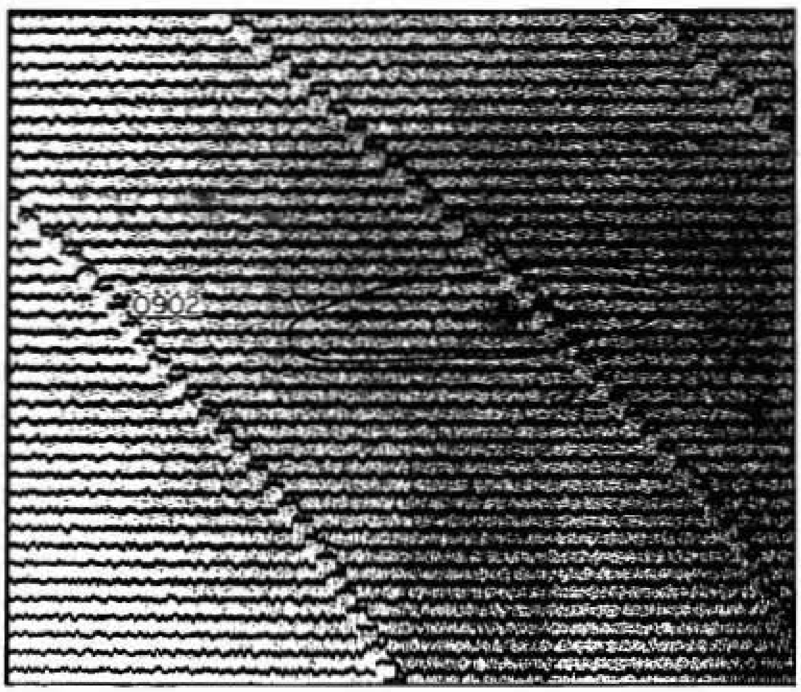
LAYOUT OF THE RECORDER ROOM IN THE OFFICE

04 NOV 1972



MCQ

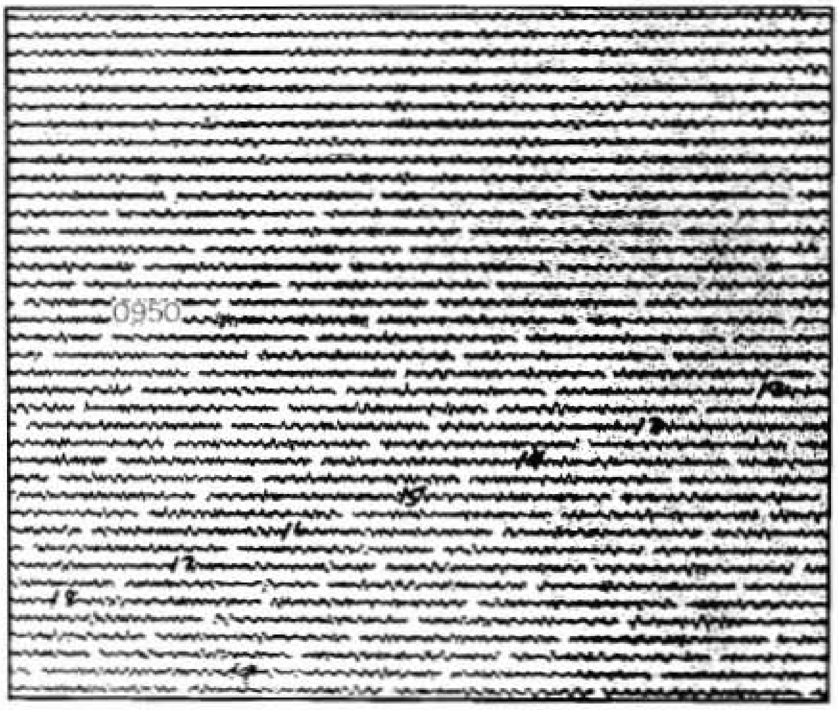
04 NOV 1972



MQI

COMPARISON OF SEISMOGRAMS MCQ AND MQI

04 NOV 1972



MCQ

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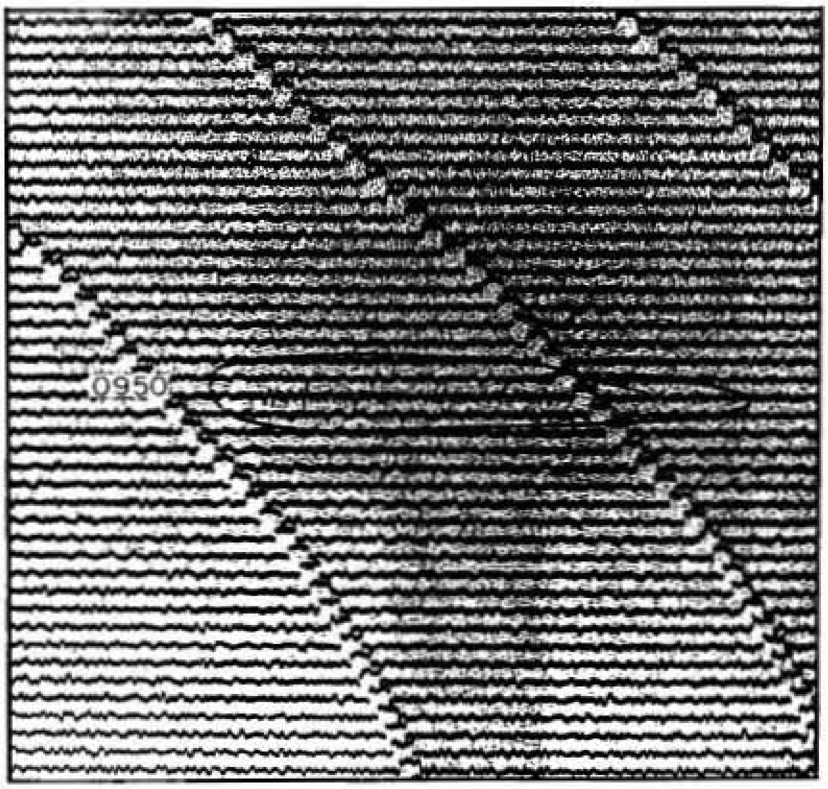
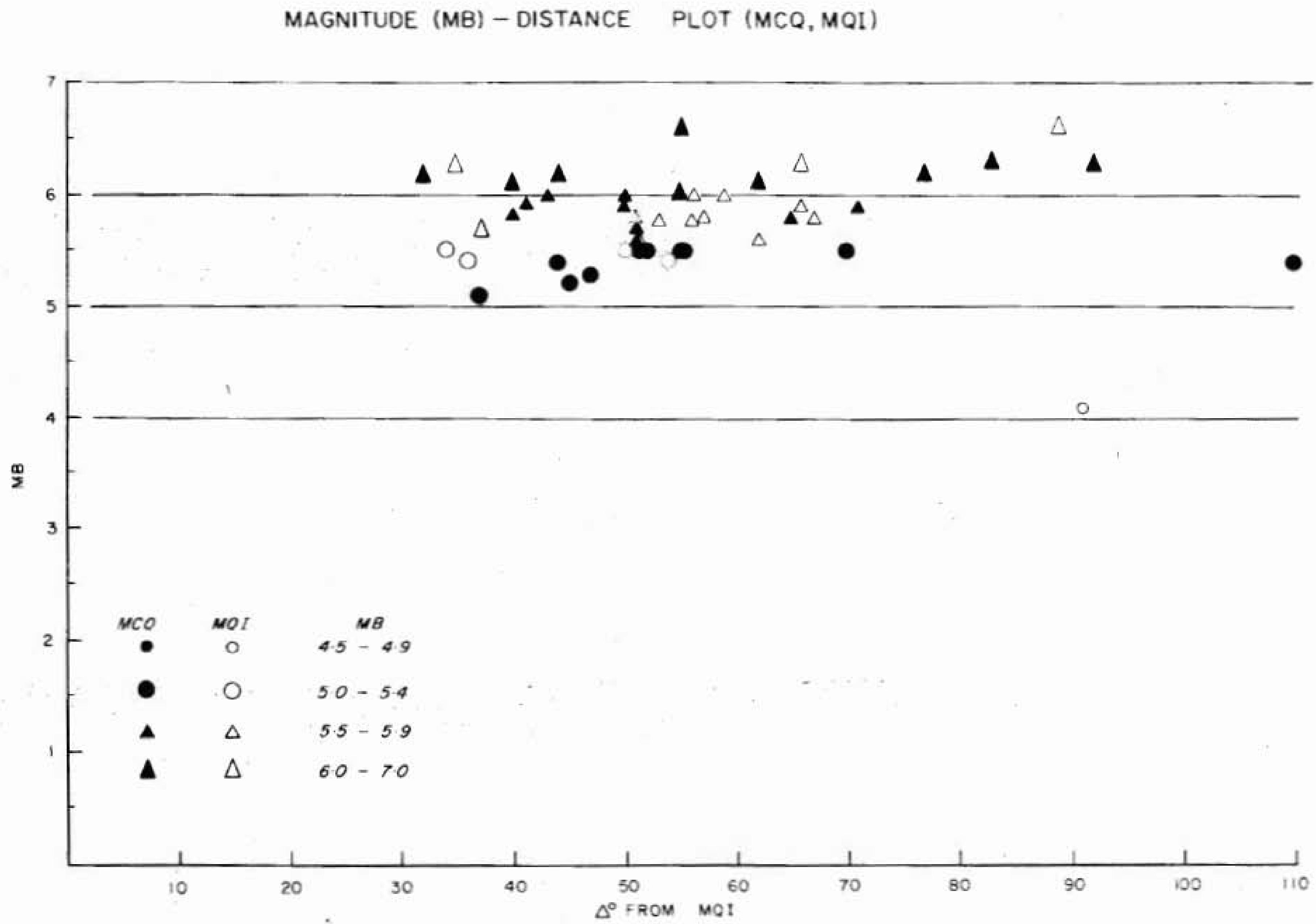


MQI

COMPARISON OF EVENTS ON MCQ AND MQI

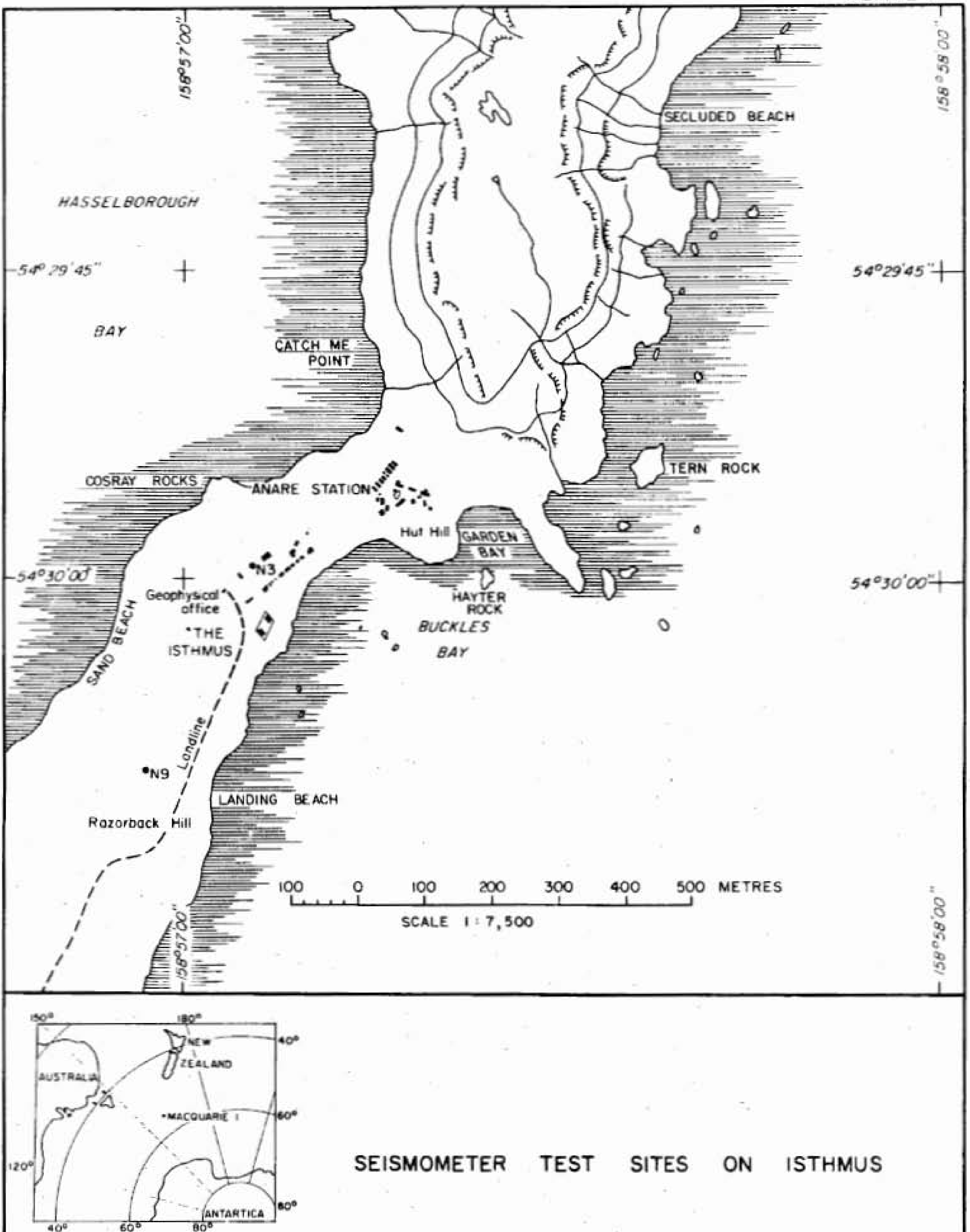
Record No. 1974/15



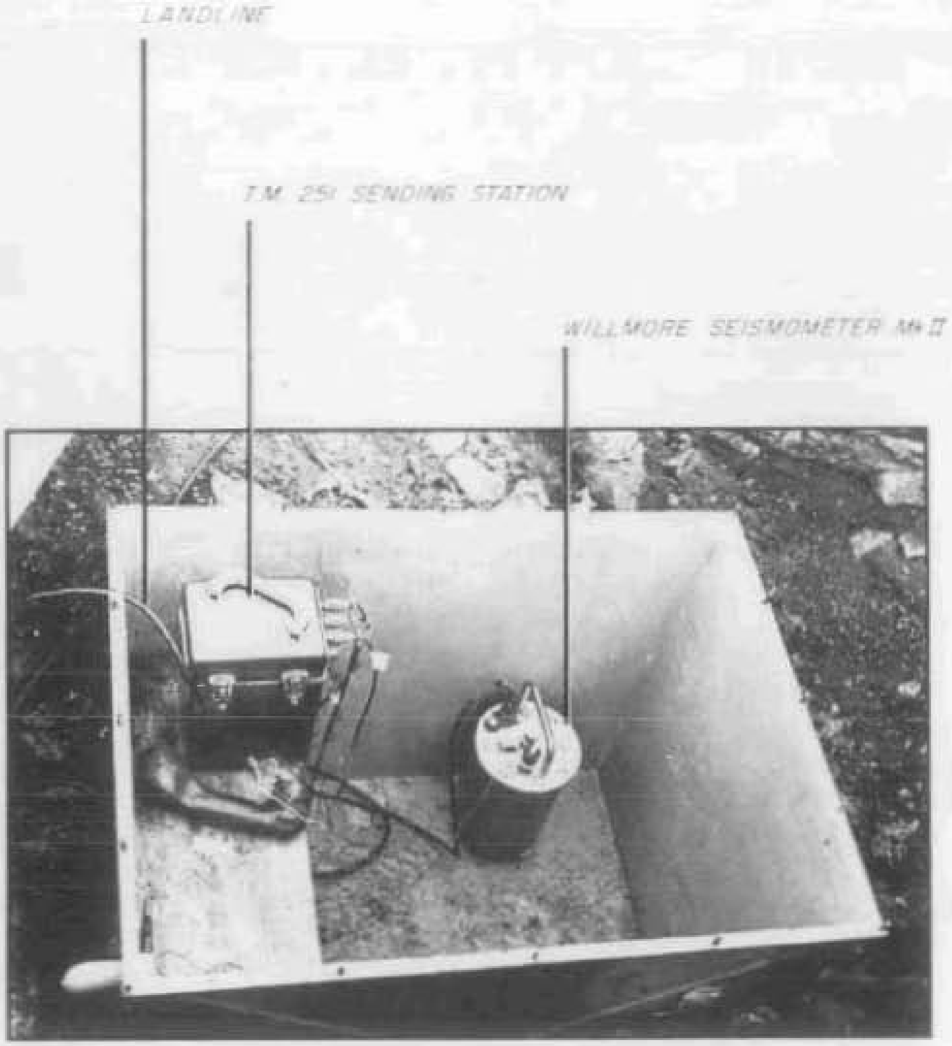
MB 1972

ANT/B9-39A

PLATE 7

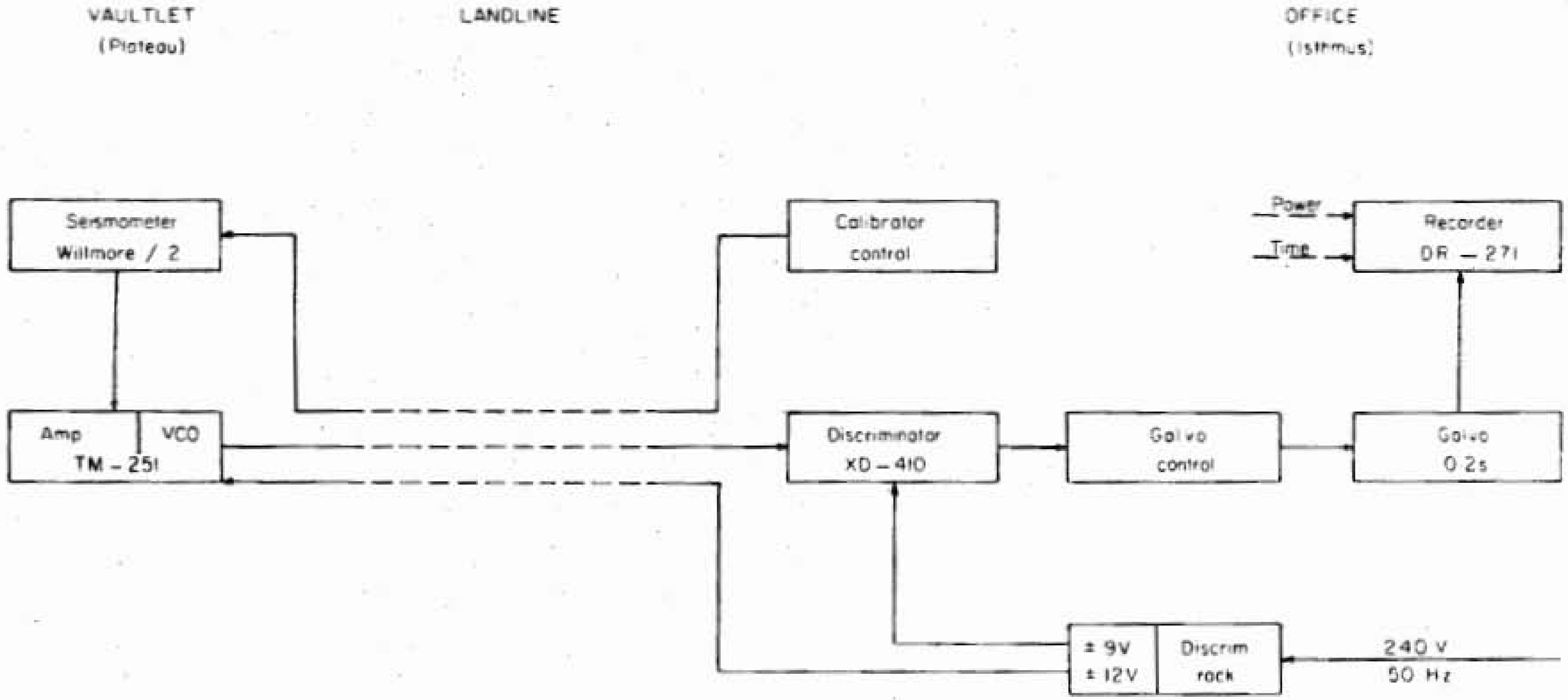


SEISMOMETER TEST SITES ON ISTHMUS



MQI VAULTET ON PLATEAU

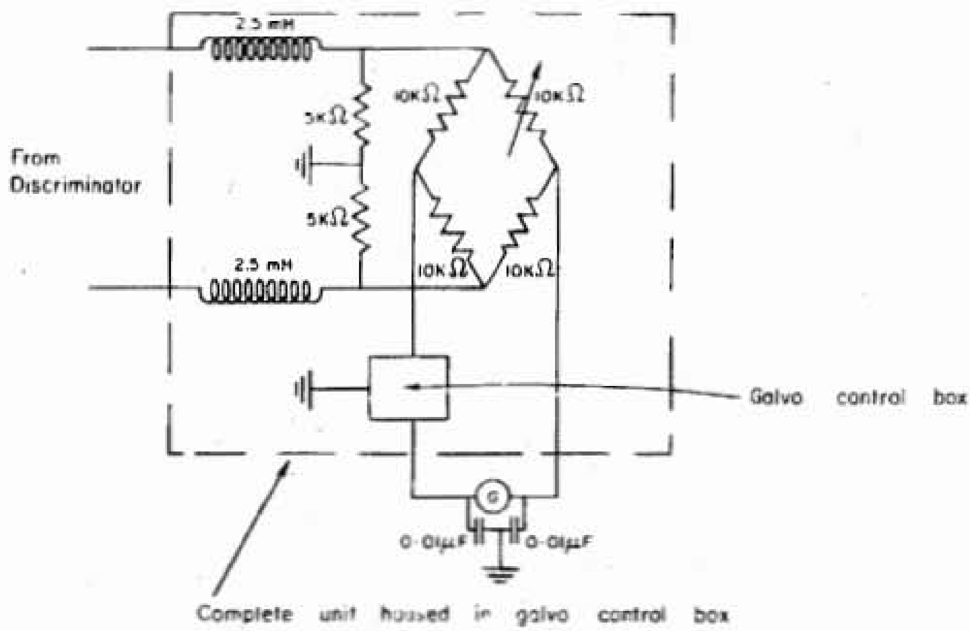
Record No 1974/115



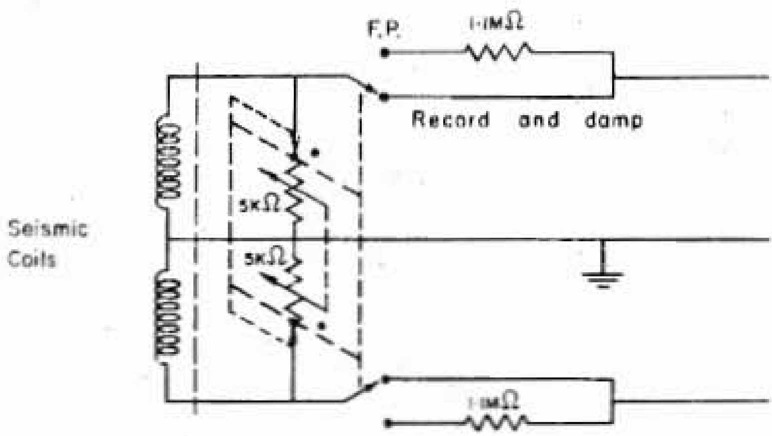
BLOCK DIAGRAM MQI SEISMOGRAPH SYSTEM

ANT/B9-38A

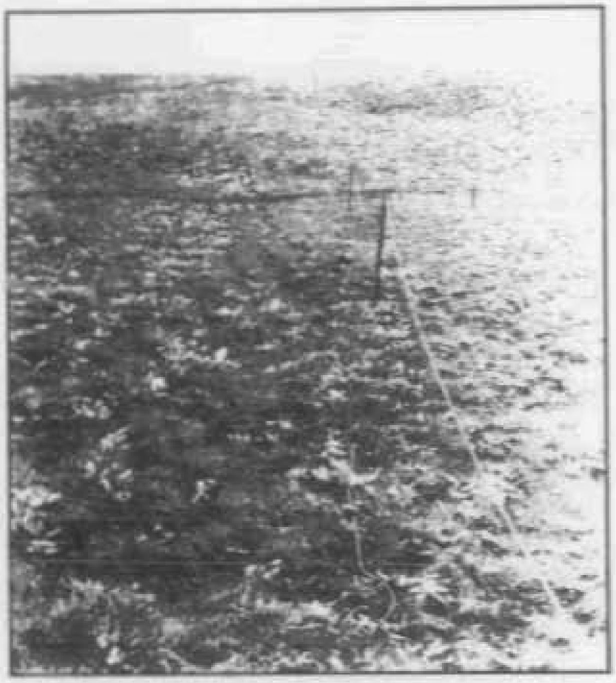
PLATE 10



A. ATTENUATOR CIRCUIT FOR GALVANOMETER



B. DAMPING AND F.P. CONTROL FOR MQI SITUATED IN VAULTLET



MQI LAND LINE