BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

Record 1981/73

INTERIM ENGINEERING SERVICES
SUMMARY OF ACTIVITIES 1981

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ILLUSTRATIONS

1. SUMMARY

Preparation for surveys and provision of engineering support staff in the field absorbed most of IES capacity during the year. The heaviest staff commitments were in airborne and marine geophysics with major inputs also to observatories, regional crustal surveys, seismic survey, magnetotellurics, marine geology and metalliferous geophysics. Few completely new engineering tasks were undertaken, most construction and development tasks being extensions of earlier work.

Full technical support for the operation of both the Twin Otter and Aero-Commander survey aircraft was provided throughout the year and very little time was lost through equipment failure.

A doppler navigation system, an improved gamma ray spectrometer system and other equipment for upgrading the Aero-Commander geophysical survey aircraft have been received, and IES support work is complete or well advanced. Re-equipping will be complete before the commencement of the 1982 field season.

Technical and field support were provided for Metalliferous Group's carborne magnetometry surveys and for field tests of a 3-component SQUID magnetometer. The advantages of a 3D electromagnetic down-hole probe over the conventional 1D probe were demonstrated by field tests of BMR's 3D probe in a diamond-drill hole at Peelwood Prospect near Goulburn.

A new hydraulic operated seismic streamer cable winch was built for Marine Geophysics Subsection and much time spent on preparation of seismic profiling, magnetic and navigation and data acquisition systems for surveys on the Great Barrier Reef, and to Macquarie Island and Antarctica.

A prototype of a repackaged low power unattended Akai seismograph for regional crustal seismic surveys was completed, and work on conversion of 15 units can now go ahead.

Most of the components of a new mini computer data acquisition system for the magneto-telluric equipment have arrived. Further hardware development proposals to make use of remote reference techniques to improve data quality are dependent on provision of funds.

An Exorciser II microprocessor development system was received mid-year and will provide a powerful tool for software development and hardware emulation. Microprocessors are used in two Marine Geology underwater data acquisition systems and are under development in another two. A fifth system is under development for metalliferous carborne surveys and there are firm proposals for at least another two.

2. GENERAL ADMINISTRATION

Formalisation of the organisational structure of IES is expected by early 1982 following a recently completed review of the science technical grades in Geophysical Branch. IES's position in the reorganised BMR remains uncertain.

3. SUB-SECTION ADMINISTRATIVE REPORTS

3.1 Mechanical Sub-section

Mr G. Thom continued to act as STO-2, Group & Program Manager during the year. Contract construction was used to take up a shortfall in workshop capacity, particularly in the machine shop. An analysis was made of unprogrammed tasks which make up such an appreciable proportion of the work load, and this will assist in forward planning.

J. McIntyre was outposted for the full year as Maintenance Mechanic to the Seismic Group and the field work of the TA2 position attached to Marine Geology was shared between D. Foulstone and S. D'Arcy.

3.2 Electronic Technical Sub-section

Mr A. Zeitlhofer continued to carry out both Group and Program Manager functions until Mr D. Cook commenced as Group Manager in October 1981. The review of the Sub-section is still incomplete being dependent on the outcome of the review of the science technical grades and some engineering positions in Geophysical Branch. This is almost complete. With the return to operation of the Aero-Commander the need for another TO-2 position was recognised and obtained from the departmental pool.

A. Zeitlhofer continued to act on the TAFE College Advisory Committee concerned with the Electronics & Communications Certificate course.

The following staff were outposted to other sections:-

J. Grace	A/g. ST02	Full year	)
L. Miller	A/g. T01	" "	)
P. Fowler	TA2	" "	) Seismic/Marine Geophysics
S. Parker	T02	Commenced 15.9.81	) & Well Logging
D. Gardner	T02	Part-time	)
K. Butterfield	T02	Commenced 1.6.81	)
S. Scherl	A/g. Sc.1	Part-time	)
G. Jennings		Full year	)
C. Rochford	T02	Part year	) Regional Geophysics
J. Whatman	T02	Full year	) (crustal, seismic and magneto-tellurics)
W. Greenwood	ST01	Full year	)
G. Woad	T02	" "	) Observatory Section
B. Page	T01	Mundaring	)
G. Green	ST01	Full year	)
J. Eurell	T02	" "	) Airborne Geophysics
J. Mangion	A/g. T02	" "	)
M. Schmizzi	T02	Part year	)
R. Curtis	T02	Full year	Metalliferous Geophysics
T. Dalziell	A/g. T02	Full year	Marine Geology

3.3 Electronic Professional Sub-section

Program Management (K. Seers). The throughput of work in the sub-section was again reduced by the continuing scarcity of technical grades staff who are assigned on a priority basis to field operations in preference to development work.

A notable acquisition was the first stage of a microprocessor development system which simplifies software development and emulates hardware performance in the development of instruments or systems containing microprocessors. The specific microprocessor supported is the general purpose 8-bit 6809, which will be used in the carborne acquisition system for Metalliferous Geophysics. Stage 2 of the system, scheduled for purchase in the current year, will support the low power 8-bit 1802 which has been used in the design of underwater data acquisition systems for Great Barrier Reef studies and which will be used in future systems demanding low power consumption.

Group Management (B. Liu). The number of professional staff was reduced to six following the death of Peter Mann (Procurement Group) and this has thrown additional work on other members of the group. One Class 3 position has been redesignated engineer (B. Liu) and a Class 2 position is also expected to be redesignated engineer following the admittance of B. Devenish to corporate membership of IE Aust. These redesignations following the recommendations of the PSB review of this group in 1980 and eventually all positions are expected to become engineers.

3.4 Procurement Group (P. Mann, R. Dulski, W. Gunner). The Class 3 position in charge of this group has not been filled since the death of P. Mann in March 1981 and much of the work of this group has been taken up by other members of the Professional Electronics Sub-section and professionals in the user areas. Items which required considerable manpower in specifications and other investigations were seismic airgun and compressor, and hydrophone streamer cable for Marine Geophysics, many items for Observatory Group's digital magnetograph stations, a doppler system for VH-BMR, magnetometer base stations for marine and airborne surveys, a density logging tool for BMR's deep logger and a mobile generator for Seismic Group. A microprocessor development system was obtained for use in IES, and purchase of components for development construction and maintenance tasks in IES was also major activity.

4. TECHNICAL REPORTS - EQUIPMENT DEVELOPMENT AND SURVEY PREPARATION

Most of the Branch's activities are for customer groups in other branches. The technical reports are therefore presented under headings which indicate the group for which the work was done.

4.1 Airborne Geophysics (G. Green, J. Eurell, J. Mangion, M. Schimizzi)

Full technical support for the operation of both the Twin Otter (VH-BMG) and Aero-Commander (VH-BMR) survey aircraft was provided throughout the year.

4.1.1 Airborne Surveys. At least one TO was assigned to each aircraft during the following surveys.

Darling Basin Survey: Flown from Broken Hill by VH-BMG from Sept-Nov. 1980 and August-November 1981.

Albany/Fraser Survey: Flown from Esperance and Kalgoorlie by VH-BMG from January to May 1981.

Davenport Range Survey: Flown by VH-BMG from June to August 1981.

Murray Basin Survey: Flown by VH-BMR from between April and September 1981.

4.1.2 Re-equipping of Aero-Commander. All of the original equipment was re-installed in the aircraft for the Murray Basin survey and in general it functioned well. An MNS-2 proton magnetometer was set up and used as a base station during this survey. Preparations for upgrading this aircraft's equipment are well advanced and listed below.

4.1.2.1 Decca doppler system. A Decca doppler navigation system is to be installed in VH-BMR. The equipment and manuals have arrived and the antenna will be installed during the next service in Melbourne in November 1981. A digitiser being made to interface the Decca system to the data acquisition should be completed in November 1981 and the system will be ready for use in 1982.

4.1.2.2 Gamma-ray spectrometer. The new spectrometer system for VH-BMR has been checked out on the bench and the 1,000 cubic-inch NaI(Tl) crystal pack will be installed at the same time as the Decca antenna during the November aircraft service in Melbourne. The system should be operational in 1982.

4.1.2.3 Barometric altimeter and digital thermometer. The electronics have been mounted in a chassis, interface circuits completed and final chassis wiring is well advanced. They should be ready for use in 1982. Circuit layouts and wiring information are being documented for the production of a manual. The sensors have yet to be installed in the aircraft and there is a possibility they may go into the Twin Otter initially.

4.1.2.4 Timer NZA-3. The timer was constructed and installed. A new 5V power supply module was substituted for the original 5V switching regulator which produced interference spikes that affected other equipment. This modification will be made to the other NZA timers. A spare timer for the system is also being built.

4.1.3 Fluxgate magnetometer MFS-7 Ser. No. 4. All of the electronics have arrived and the chassis and mechanical work will be completed in November. Chassis wiring and check out can then go ahead.

4.1.4 Support Equipment

4.1.4.1 28V ground power unit (J. Rutledge, D. Foulstone, R. Dulski). A lightweight 28V ground power unit was designed and constructed and performed well in the field. It uses an aluminium frame, Honda petrol engine and 70 amp Niehoff alternator.

4.1.4.2 Honda fuel pumps. The fuel pump systems were completed and tested with VH-BMG at Broken Hill during the Darling Basin survey.

4.1.5 General Maintenance

Two new 28V power supplies for heating the spectrometer crystal packs performed well. A fault causing loss of resolution in one crystal photo multiplier assembly is proving difficult to find. The Inotech analog to digital convertors for both spectrometer systems are being reinstalled in more space efficient chasses.

Two Collins radio-altimeters developed faults in the 4.3 GHz stages. BMR has no test equipment for these frequencies and the equipment was repaired by Collins in Melbourne.

Other equipment requiring appreciable time for maintenance throughout the year were MFS-7 magnetometers, Fait Tape recorders, Gianinni frame cameras, McColl ground power unit, and Geometrics 826 base station magnetometer and recorder. Noise in the Geometrics 803 airborne magnetometer around 56,500 nT was traced to a beat effect caused by 50 Hz mains supply interference.

4.2 Metalliferous Geophysics (R. Curtis)

Equipment maintenance continued throughout the year in support of a number of short surveys using either SQUID or vehicle-borne magnetometers. Considerable work was involved in preparation of the cryogenic system for the SQUID magnetometer.

4.2.1 Development of a down-hole omni-directional EM probe (R. Cobcroft, J. Major, R. Curtis, A. Warnes)

Following the encouraging results of the survey to Single Tree Hill, Peelwood, NSW, October 1980, a number of improvements to the probe system were made. An output transformer was designed to be fitted to the power amplifier so that the transmit loop could be fed with a balanced, floating signal. Two current transformers were designed, one to derive the reference signal for the PAR analyser directly from the current in the loop. The other to measure the current in the loop with the PAR analyser for greater accuracy in the normalisation of the data. The probe itself was electrostatically shielded.

After these modifications, a variety of tests at the Kowen Forest test site showed that the repeatability of the data had greatly improved. In one test an elliptically polarized field was modelled with phase shifted current in two coils. When the probe was placed in this field and allowed to rotate about its Z axis the standard error in the measured ellipse axes was 2%. See Fig. 4.2.1A.

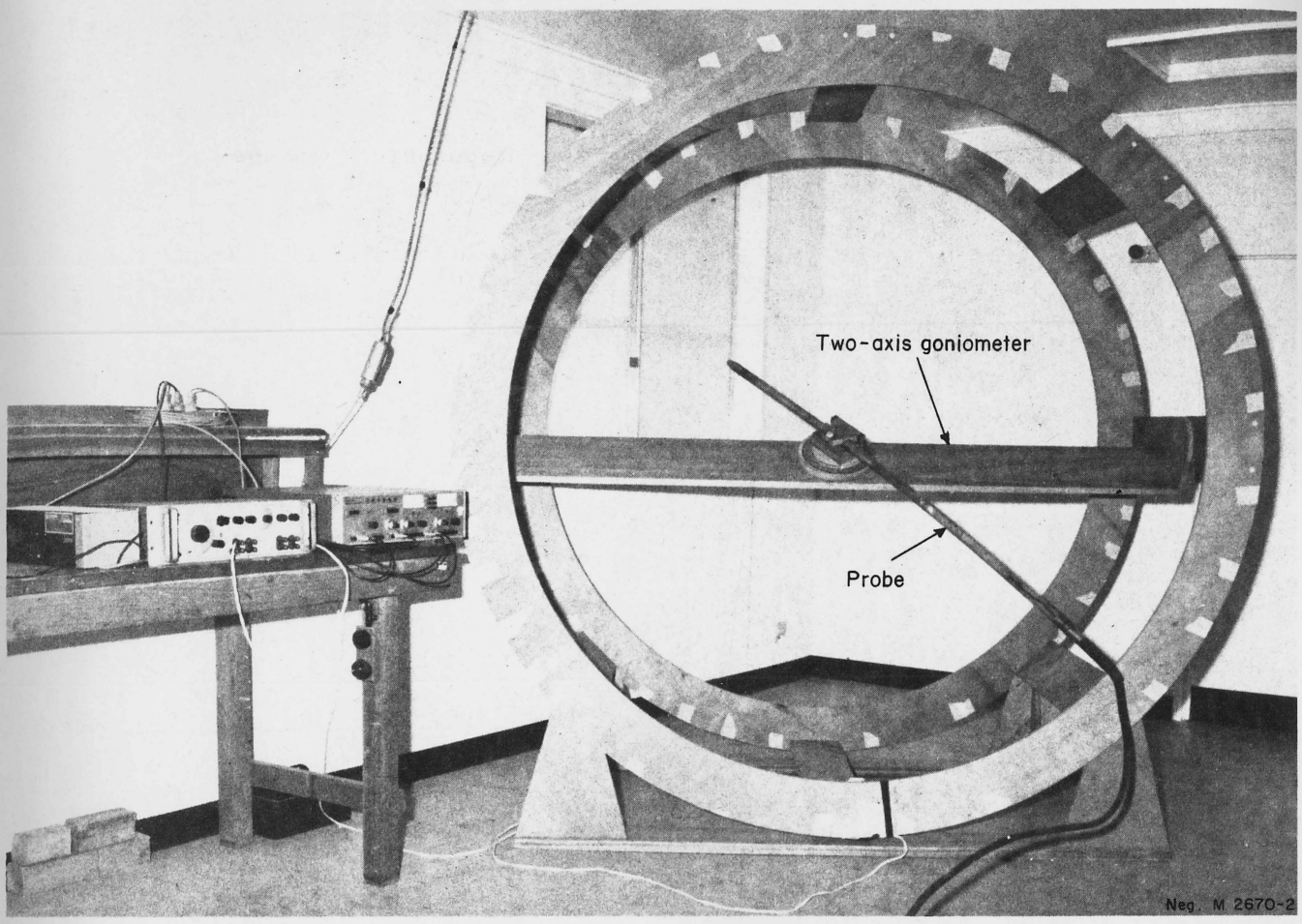


Fig.4.2.1A. Helmholtz coil test facility at Kowen Forest used to measure 3D probe response

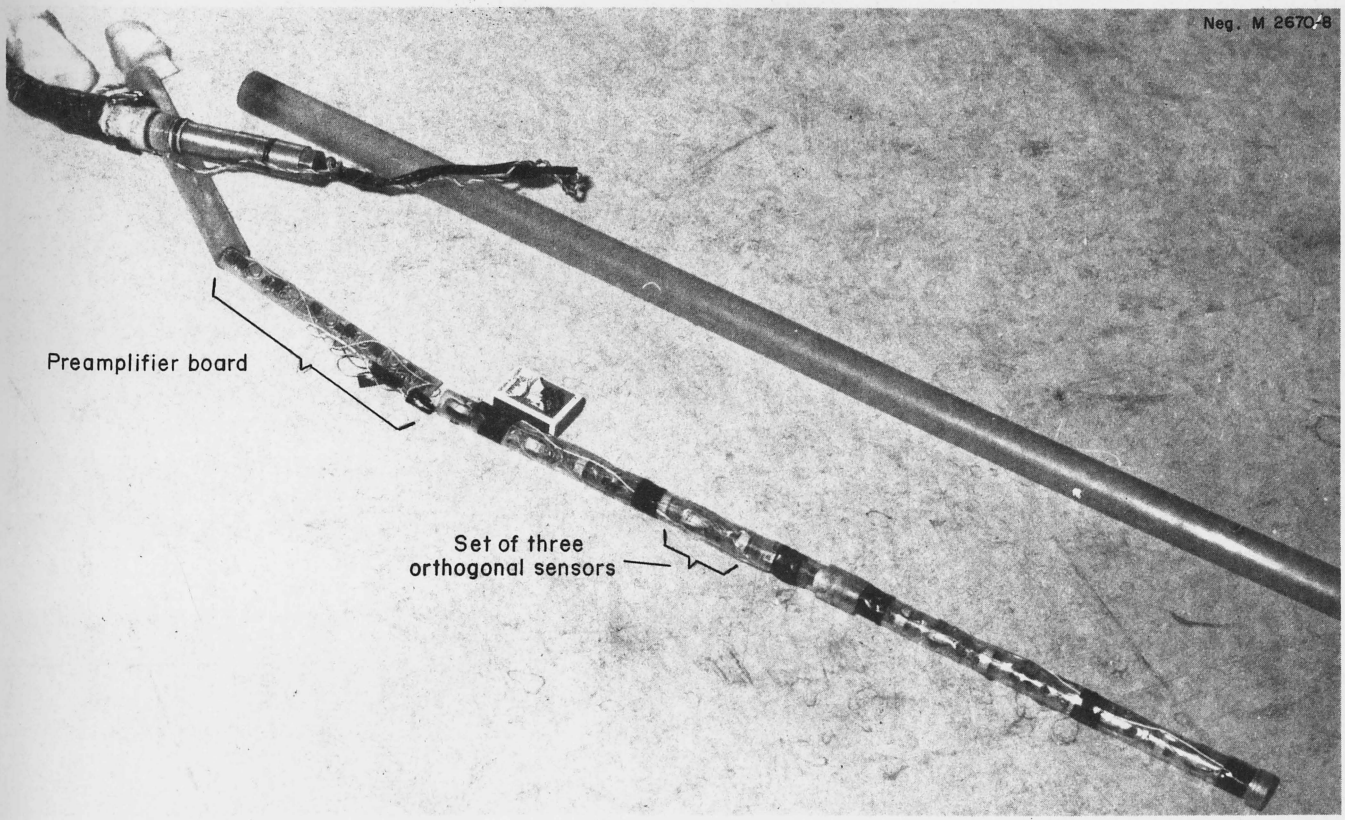


Fig.4.2.1B. Dismantled probe (shielding removed) showing preamplifier board and 10 sets of 3 orthogonal sensor coils

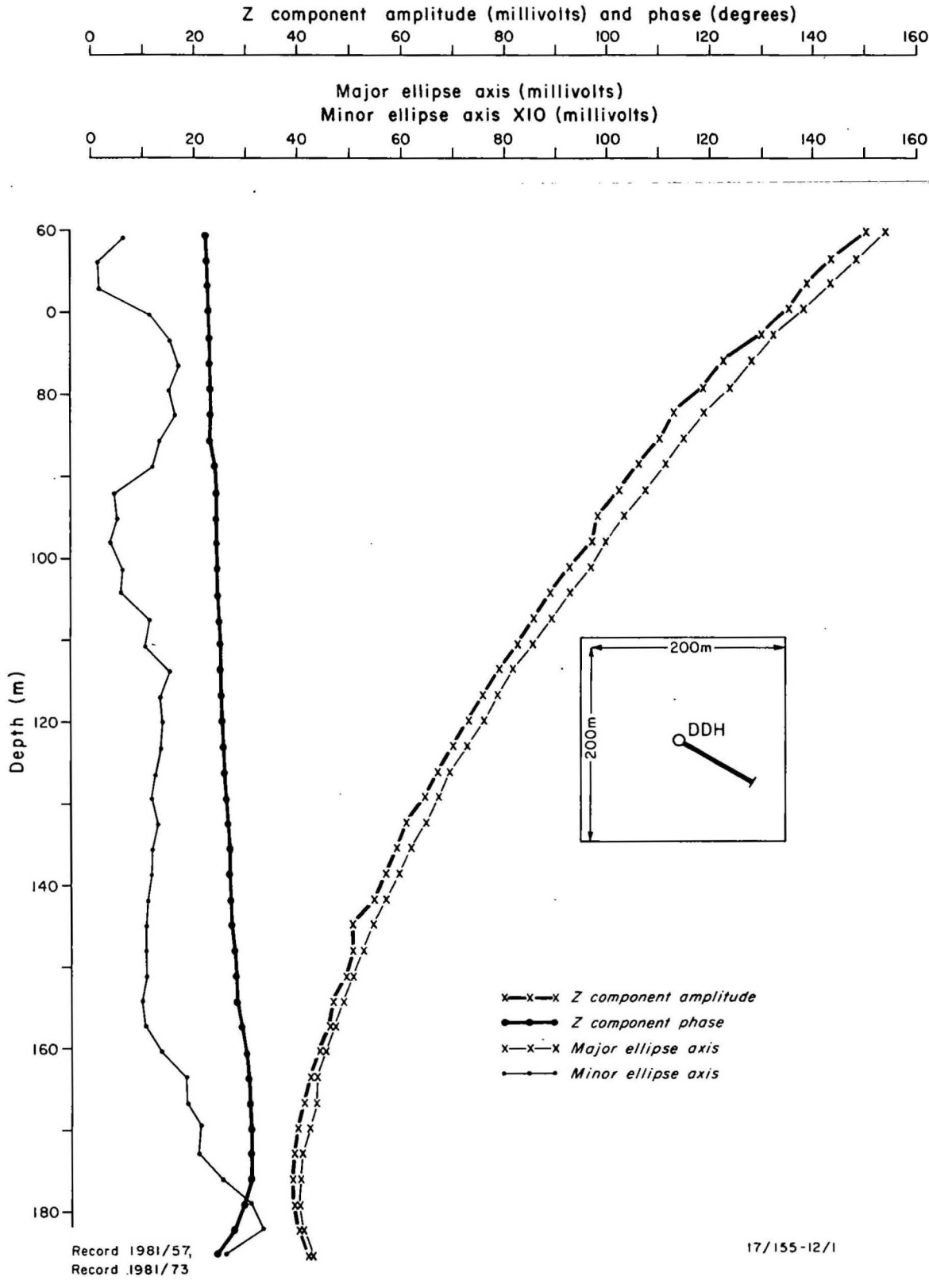
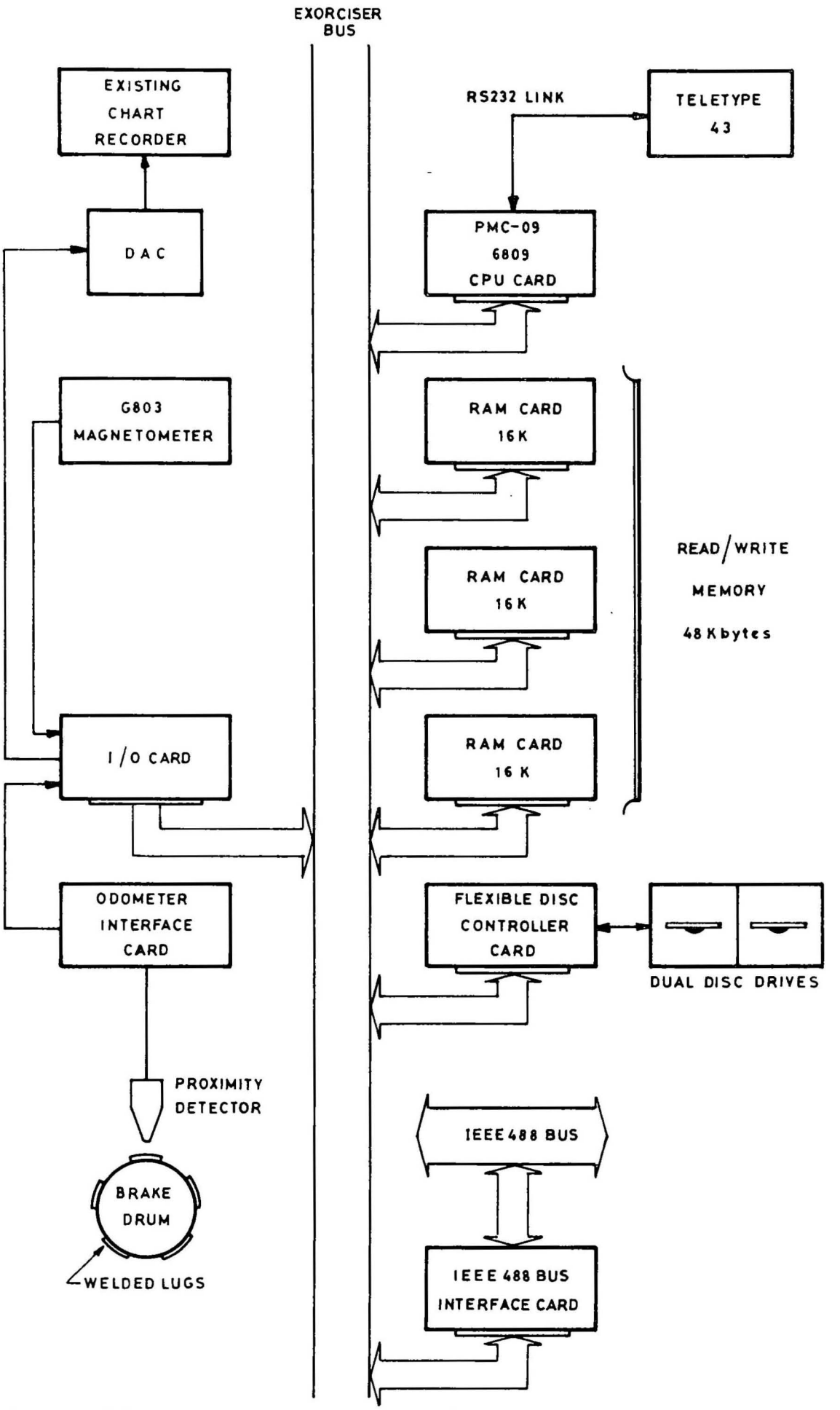


Fig 4·2·1C Results of 3 component downhole electromagnetic survey at 800 Hz at Peelwood Prospect. The additional data provided by the 3 component probe is represented by the major ellipse axis and minor ellipse axis plots. The conventional 1D probe would provide only Z amplitude and phase



Microprocessor based car-borne data aquisition for metalliferous surveys. A compass is being purchased for addition to the system.

Figure 4.2.3.

The guiding principle in modifying the probe system was to give careful attention to shielding, particularly the high impedance sensing coils, and to ensure that the system was balanced from the sensing coils right through to the phaselock analyser. Attention was also given to the transmit loop so that it was fed with an accurately balanced signal which was floating with respect to the system earth. A second survey at Single Tree Hill, Peelwood in mid-September '81 in which two holes were logged vindicated this principle. (See Fig. 4.2.1C). Details of the results of the survey are given in the Geophysical Branch annual summary.

4.2.2 Vehicle-borne magnetometer system (R. Curtis)

Up to 20 nano-Teslas of noise were experienced during field operations in 1981. Most of it is thought to be due to "fluid slosh" in the magnetometer head and ways of reducing this are being investigated.

4.2.3 Development of carborne data acquisition system (R. Cobcroft, R. Curtis)

Metalliferous Sub-section is awaiting delivery of a new vehicle for their carborne system. All accessory modifications (24V alternator, fitting of air conditioner, etc) are to be carried out by the distributor prior to delivery.

A new recommendation for a carborne data acquisition system for the metals group was made based on a 6809 microprocessor (See Fig. 4.2.3). The system recommended uses off-the-shelf ready-manufactured printed circuit cards from a number of suppliers. The total system comprises, 1 central processor card, 3 16K byte memory cards, 1 I/O card, 1 IEEE 488 bus interface card and 1 disc controller card. A card cage with power supplies and 2 5¼ inch flexible disc drives were also part of the system.

Most of the system items have been delivered or are on order. The work of writing the data acquisition software is continuing.

4.3 Engineering Geology Projects

4.3.1 Eh-pH Probe (K. Seers)

This project was deferred in 1980 owing to the unsuitability of commercial high-impedance amplifier used for measuring the potential between the pH and reference electrodes in the down-hole probe configuration. The probe is required for groundwater monitoring down to 100 m, especially for assessing effects of waste disposal and other environmental applications. The purpose is to measure pH, Eh (redox potential), and self-potential.

A comprehensive evaluation of the system originally proposed showed that, as well as the need to design our own amplifier to fit in the available space in the probe, a number of additional features are necessary:

- temperature measurement
- provision for restoring and adjusting pH baseline
- provision for pH probe standardization
- slope correction to allow for pH probe aging
- a method of avoiding interaction between measurements where using a common reference electrode
- isolation from effects of leakage currents from the recording system

An analogue system was designed which should meet these requirements. Prototype construction will start when components are delivered.

The possibility of digitising and telemetering the data up the hole is also under consideration.

4.4 Well Logging

4.4.1 Equipment and survey preparation (G. Jennings, E. McIntosh)

Extensive mechanical maintenance on the 3000 metre logging truck included a major overhaul of the Ford motor alternator engine, maintenance of the winch hydraulic system and many minor mechanical tasks. A contract for the development and supply of a two-receiver density logging tool was renegotiated with the Australian manufacturers.

Five holes drilled near Charleville in early 1981 under a NERDDC oil shale study grant, were logged. Further holes being drilled around Boulia and Charleville in October and November are also being logged.

4.4.2 Digitising of BMR well-logging system (R. Cobcroft, G. Jennings)

The minicomputer based system which had been recommended became unattainable because the minicomputer was used in another system. A system based on the Motorola 6809 microprocessor and using similar boards to the Geophysical Metalliferous Group's vehicle borne data acquisition system was therefore recommended. Various ways of funding the system were looked at but none were possible in 1981. However development can be undertaken using BMR's Exorcisor II microprocessor development system and this is proposed.

4.4.3 Down-hole geophone assemblies (G. Jennings, G. Carr)

The cases were completed for two down-hole geophone assemblies for use with twin channel velocity shoots. The geophone assemblies will be completed in 1981 following G. Jennings' return from field work.

4.5 Observatories

4.5.1 General maintenance (W. Greenwood, G. Thomas)

Field trips for repairs, maintenance and calibration were made with R. Smith (geophysicist) to Stephens Creek station near Broken Hill, Toolangi near Melbourne, Manton, south of Darwin and Bellfield in NSW. The telemetry receiving station in Darwin for the Manton seismic station was moved from the main BMR office in Wood Street to the BMR store near the airport.

The Adkin three-component fluxgate magnetometer did not receive much use during the year. Minor electronic faults were repaired and the electronic drafting section drew up new circuit diagrams working from the printed circuit boards.

The packaging of the 5-component digital magnetograph into Halliburton cases was improved for regional surveys in New Guinea, Irian Jaya and the Antarctic.

Other equipment repaired during the year included EMI clocks, recorders, proton and fluxgate magnetometers, Kennedy tape recorders, telemetry equipment and power supplies. New equipment received and checked out included EDA fluxgate magnetometer, 12 channel Linseis recorders, Helicorders, Doric temperature indicators. Equipment for the Antarctic observatories including minicomputer digital acquisition systems is still being received.

4.5.2 Canberra Magnetic Observatory (CMO) (W. Greenwood)

The CMO at Kowen Forest operated well during the year involving only trips for maintenance and calibration and repair of minor faults.

A telemetry line bringing the I recording to BMR building was installed but caused interference problems. It has been disconnected until the problems can be investigated.

4.5.3 Proton vector magnetometer (K. Seers, W. Greenwood).

New crystals were purchased for the BMR MNS-2 proton magnetometer used with the proton vector magnetometer at Canberra Magnetic Observatory. These were required to reduce apparent baseline shifts but have yet to be installed.

4.5.4 Gnangara magnetic observatory system (W. Greenwood)

A new and longer cable lead for the Gnangara installation was obtained but little work was done on this system during the year.

4.5.5 Photoelectronic magnetograph (B. Liu, K. Seers, K. Jurello, D. Gardner)

The prototype used a QHM as a D variometer which is maintained in a null position by feedback current through helmholtz coils. The feedback current is a record of D variations. The project suffered a major setback due to resignation of K. Jurello (TO-2) early in the year. D. Gardner's involvement in this project was frequently interrupted due to maintenance tasks on marine/seismic systems and seismic field duties for about 3 months. K. Seers carried out a detailed design study to improve the loop response and resolution. Measurements were carried out intermittently on the system drift and noise, and these should be completed in November 81.

4.5.6 Mundaring Geophysical Observatory (G. Woad, B. Page)

Activities are reported in the Geophysical Branch annual summary. Support was given by IES in the form of maintenance, spares and administrative matters.

4.6 Regional Geophysics

4.6.1 Crustal playback system (B. Liu, F. Clements)

Four weeks were spent on system wiring diagrams and circuit schematic upgrading. A paper was submitted by Liu and Seers for external publication.

4.6.2 Development of lightweight seismographs (K. Seers, C. Rochford, J. Whatman)

4.6.2.1 Tape Drives. The prototype tape drive design for low power operation of the Akai tape recorders was successful, reducing the operating current by an order of magnitude to 35 ma. Electronic hardware and the mechanical components for all 15 Akai tape recorders were manufactured. Initial tests run on the Tandberg tape decks indicate that it may be possible to use an identical drive system for these units. Further tests are necessary to confirm this.

4.6.2.2 F.M. modulators (B. Liu, F. Clements, C. Rochford, J. Whatman). The prototype low power F.M. modulator was successfully tested with the Geotech seismometer and amplifier and tape decks. Production of 15 units commenced in April was interrupted by the resignation of C. Rochford. All printed circuit board assemblies have been completed. Wiring to the Geotech amplifiers and production testing have yet to be carried out.

4.6.2.3 NCE-3 low power clock production (C. Rochford, J. Whatman). Production of 36 NCE-3 clocks was completed and they have replaced the old NCE-1 clocks in the seismograph systems.

4.6.2.4 Prototype low power Akai seismograph. A prototype incorporating the above improvements was repackaged and is currently undergoing field tests.

4.6.3 Field work and general maintenance (C. Rochford, J. Whatman)

A lot of work was involved in the maintenance and upgrading of the remote recording seismographs for the crustal investigation program in the Eromanga Basin. J. Whatman took part in the survey, which extended into late November 1981.

4.7 Magneto-tellurics

4.7.1 Maintenance (J. Whatman)

Maintenance, repairs and calibration tests were carried out on the equipment. A frequency and voltage monitor and alarm circuit was designed and built to monitor fluctuations in the supply from the portable generating set.

4.7.2 M.T. system developments (B. Liu)

A new minicomputer based data acquisition system has been ordered for the M.T. system. The new disc and 3M tape cartridge have yet to be delivered.

The development of new H and E-amplifiers was not commenced as planned due to transfer of J. Whatman to other duties. A market survey was carried out on telemetry equipment required for the remote reference system. Noise investigation on the M.T. system in laboratory and Tuggeranong M.T. site are due to be carried out in November. The handbook for the M.T. postamplifiers was almost completed.

4.8 Seismic

4.8.1 Equipment overhaul & survey preparation (J. Grace, D. Gardner, part-time; P. Fowler, K. Butterfield)

All the survey equipment was overhauled and tested between the end of the 1980 field season and the commencement of the Eromanga seismic survey in July 1981. Equipment overhauled and tested included the DFS IV digital recording system, geophone groups, spread cables, Philips radio transceivers, shot-firing equipment and all associated test equipment. The conversion of geophone strings from 8 to 16 per group increased field reliability and efficiency.

4.8.2 Eromanga Basin Seismic Survey July 81 - Nov. 81
(J. Grace, D. Gardner, G. Jennings, K. Butterfield)

K. Butterfield returned from the survey before completion due to illness and was replaced by D. Gardner. The only serious breakdown of the DFS IV system was due to failure of two power supply cards which were repaired. Most of the work was on maintenance of geophones and cables.

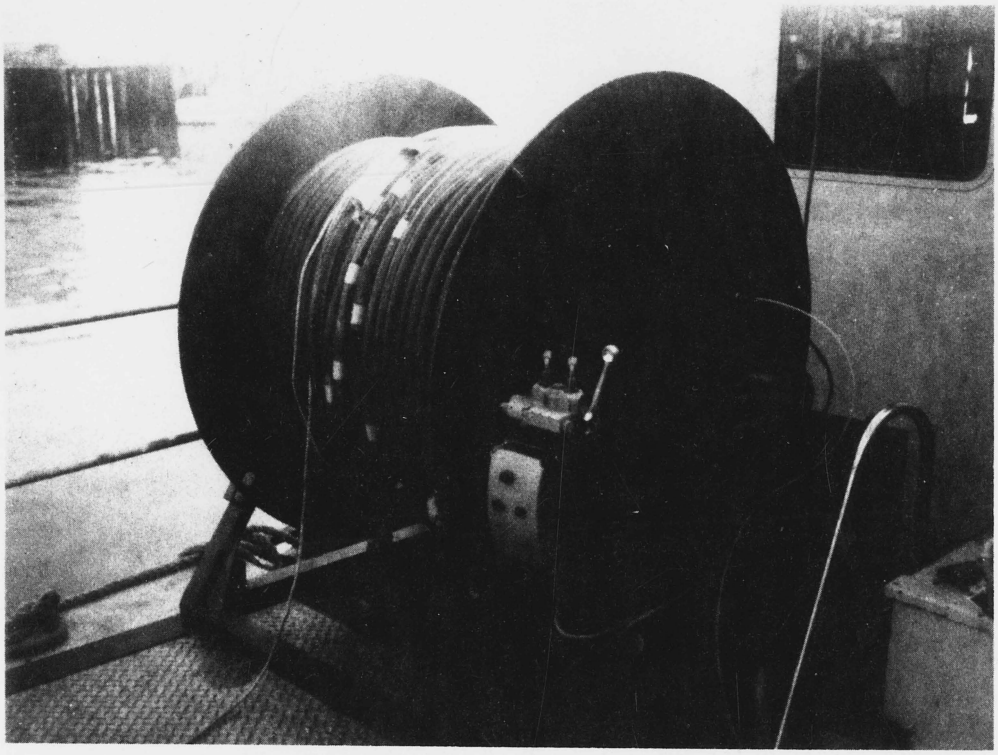
4.9 Marine Geophysics

4.9.1 Survey preparation (J. Grace, P. Fowler, S. Parker, D. Pownall)

S. Parker commenced duty in the section during the year. Equipment maintenance and preparation continued throughout the year in support of GBR and Antarctic surveys. These included work on the sparker systems, a complete overhaul of the Raytheon bathymetric equipment, EPC recorders, Geometrics magnetometers and winches. Shipboard installations of geophysical equipment and the minicomputer based data acquisition systems were major activities. Work commenced on the construction of an active section of a marine seismic streamer cable to replace the active section of the Geotech streamer cable which was lost from the Nella Dan on the Macquarie Island cruise in October.

4.9.2 Seismic streamer winch (J. Rutledge, G. Thom, E. McIntosh, D. Foulstone)

A new seismic streamer cable winch was designed and built for Marine Geophysics. The winch is hydraulically powered and has a total capacity of 650 metres of cable of 19 mm diameter including 350 metres of active section. J. Rutledge joined the GBR survey to install and commission the winch. Modifications were carried out following the GBR survey to provide speed control and to increase the flange diameter to accommodate a wider diameter cable (48 mm) than originally specified. The winch is to be installed on the Nella Dan in December for a 3 month geophysical survey in Antarctic waters. See Fig. 4.9.2.



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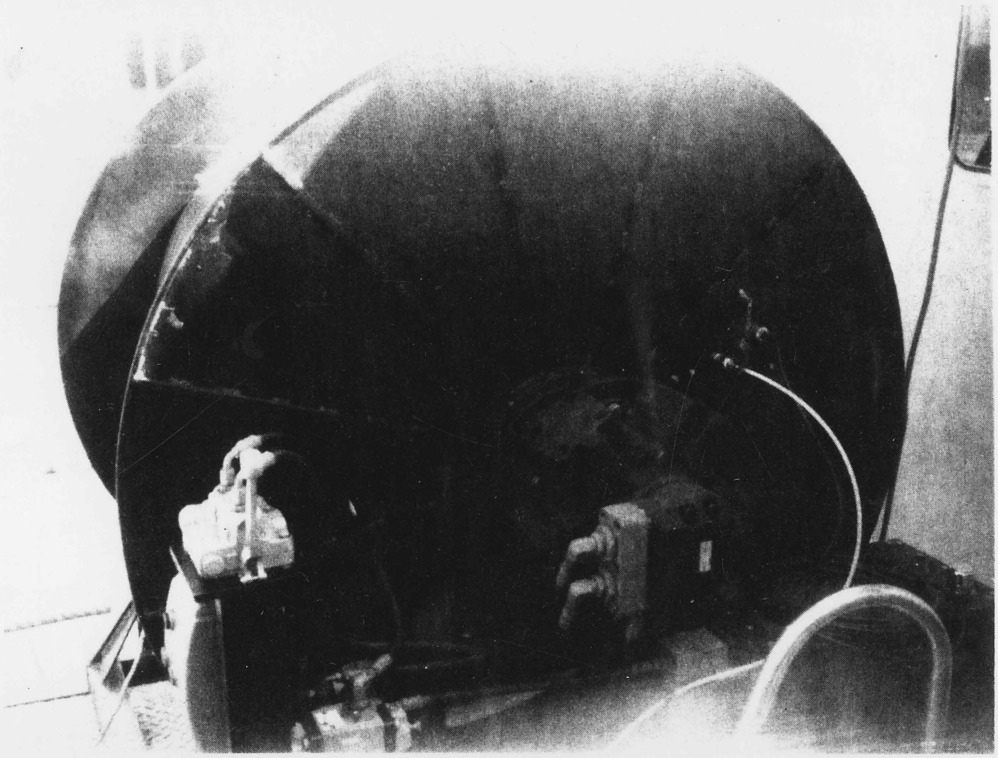

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Fig. 4.9.2. Marine seismic streamer winch showing hydraulic control system and direct drive high torque motor.

4.9.3 Marine magnetometer winch (J. Rutledge)

The design of a replacement magnetometer winch based on a commercially available motorised conveyor belt pulley is well advanced. This will result in a much lighter and more manoeuvreable winch than existing designs making for easier installation and greater service reliability. Construction awaits availability of funds.

4.9.4 Tracor satellite navigator computer interface (B. Devenish)

The Nella Dan supply ship to the Antarctic bases has recently been used for bathymetric and geophysical surveying in Antarctic waters. For this purpose, a satellite navigation system had to be interfaced to BMR's HP computer so that the longitude, latitude and GMT could be read into the computer at any time. A second stage in the project was to enable the computer to command information from the unit such as speed, heading, time of last fix etc. The first stage was completed for the 1979/80 Antarctic season. The second stage has been completed and is to be used in the 1980/81 Antarctic season.

4.9.5 Modification to RA49 seismic amplifiers (B. Devenish, J. Grace)

The marine section required that the upper frequency of the Butterworth filters in their RA49 seismic amplifiers be doubled. A model of the filter using the SPICE package was employed to solve the problem and the amplifier filters were modified accordingly.

4.9.6 Marine data acquisition system (non-seismic) (K. Seers, P. Russell-Smith, F. Clements, K. Mort)

As time and labour became available the following BMR-designed items were attend to:

4.9.6.1 Digital senders XDS-1. The remaining 5 bins were wired under contract giving a total of 8 units now completed.

4.9.6.2 Digital receivers XDR-1. Lack of funds again prevented completion of these. An evaluation of the only unit completed is still necessary, and changed circumstances with regard to installation configuration may remove the need for any further units.

4.9.6.3 Marine timers NTM-1. All four bins (containing a total of eight dual modules) have now been wired.

4.9.6.4 Stand-alone D.A. converter DAC-1. This unit comprising 16 12-bit channels for system monitoring was completed.

4.9.6.5 Recorder patch-panel. The need for this unit lapsed owing to changes in monitoring requirements.

4.10 Marine Geology Projects

4.10.1 Underwater data acquisition system (B. Liu, J. Rutledge, T. Dalziell, R. Gan, D. Stevens)

The two microprocessor based data acquisition systems have been further developed to meet the requirements of faster sampling rate and field programmable capability. The systems are based on an RCA low power CMOS 1802 microprocessor. Software development was carried out with a cross-assembler residing in the in-house HP computer. Three prototype cards were added to each of the two data acquisition systems to meet the April survey commitment. Both of these systems functioned satisfactorily during the surveys in April and September. Due to field commitments of T. Dalziell, construction of the production model was only carried out intermittently during the year.

A large number of impeller water velocity sensors performed very unreliably during the April survey due to intermittent faulty magnetic relays in the sensors. Current measurements had to be suspended for one week to enable replacement of the faulty relays by the manufacturer. A longer term solution to substitute non-mechanical switches for the magnetic reel relays will have to be found.

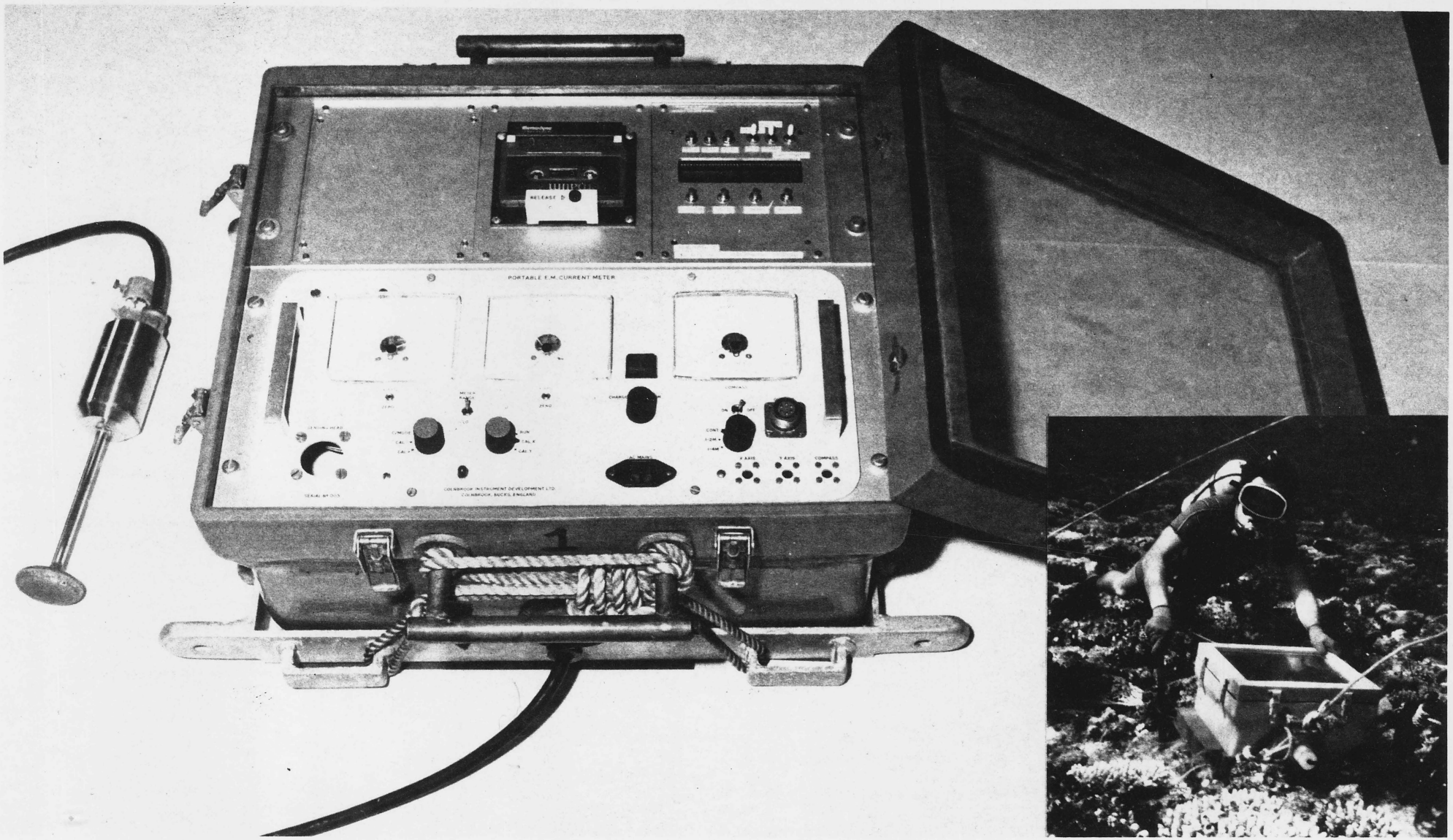

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Fig 4.10.2 Borehole electromagnetic current flow meter for Great Barrier Reef survey. The equipment is housed in a pre-fabricated fibreglass container to withstand water depths of 10 meter. The microprocessor data acquisition system is in the upper part and the E.M. current sensor is on the left of the box.

The two underwater vessels housing the electronics were fitted with clear polycarbonate end plates to allow underwater observation of instrument operation.

T. Dalziell participated in two field surveys, one in April and the other in September, both of six weeks duration.

4.10.2 Borehole EM data acquisition system (B. Liu, T. Dalziell, J. Rutledge, F. Clement, D. Stevens, S. Prokin)

A waterproof container to operate to a water depth of 15 metres was designed and constructed to house the Colnbrook EM current meter. It is constructed of fibre reinforced plastic (moulded) and has a removable glass lid which allows easy access to the instruments and observations of their operation. See Figure 4.10.2.

The salt-water damaged EM current meter was extensively overhauled, including replacement of most of the electronic components on the circuit cards. Some teething problems were encountered with the instrument during the April survey, first water leakage in the container which was rectified with more effective O ring seal, then the electronic stability problem which had plagued the operation intermittently. The problems with the electronics were attributed to corrosion in the circuit cards. On return to BMR, six new circuit cards were fabricated and assembled to replace the damaged ones.

A second Colnbrook current meter was delivered in July. Comprehensive acceptance tests were carried out in laboratory and Kowen Forest hut. Calibration was carried out in the hydraulic laboratory of Duntroon Military College. This unit performed well in the September survey.

Work began on a digital data acquisition system for use with the EM current meter. The central processing unit is an RCA 1802 CMOS microprocessor. Other components of the DAS include a BMR designed clock and a Memodyne digital incremental recorder. Good progress was made on the construction of the DAS after T. Dalziell returned from the September survey.

A set of eight rods each 2-3 metres long was made for the second Colnbrook EM current meter. These are linked together to control the placement of the EM current sensor in the bore hole and are graduated to enable depth to be easily noted.

4.10.3 Modifications to underwater camera (B. Devenish, D. Pownall)

Circuits to extend the life of the 500V battery used in the camera flash charge circuit or replace it with a different system are being investigated. Several circuits have been tried but to date none have been satisfactory.

4.10.4 Vibrocorer developments (J. Rutledge, G. Thom, B. Devenish)

The lightweight vibrocorers tried to date have been based on reported successes of other users. Their approaches have been empirical and the devices have not been satisfactory in the lagoonal reef environment.

A literature search in 1981 revealed several recent papers describing experimental and theoretical investigations into the physics of vibrodriving as used in civil engineering. These have given a reasonable understanding of the process and the critical parameters to be controlled. They also permit some computation of power requirements for varying sediment states. The design options for vibrocoring devices to meet BMR's specific needs are now being investigated.

4.10.5 Hydraulic powered drilling rig (S. D'Arcy)

Extensive maintenance and modifications were carried out on the support equipment for this drill. The work included (1) a complete overhaul of the 25 HP Onan engine that powers the hydraulics and modifications to hydraulic hoses and fittings; (2) repairs to the Briggs & Stratton motor that drives the water pump; (3) new decking with antislip paint for the drilling pontoon; (4) repair of the hydraulic pump under contract to the suppliers in Newcastle. The equipment was used on GBR surveys in April and September and operated well.

4.10.6 Alpha particle spectrometer for uranium series dating

(G. Russell-Smith, M. Gamlen)

The alpha particle spectrometer was completed soon after the components arrived. Modifications were made to both analogue and digital circuitry to overcome minor incompatibilities between system components. System tests are complete and the spectrometer awaits final checks by Marine Geology.

4.11 ADP Projects

4.11.1 X-Ray diffraction system interface to HP computer

(B. Devenish, D. Pownall)

The requirement was to interface the X-ray diffraction system on the third floor to the HP computer system on the ground floor. Since 32 bits of data have to be transmitted some form of digital switching was necessary. A flag signal is transmitted to the computer at the start of a run and at two second intervals to indicate a new reading is required. An encode signal is transmitted to the interface box to switch between the first and second word for transmission to the computer.

The interface box has been constructed and tested with a computer in the laboratory. It has been placed with the X-ray diffraction system and checks out on test programs. Final tests await completion of the control software.

4.12 Engineering Services Branch Projects

4.12.1 Domestic satellite application (K. Seers)

No further progress was made on the possibility of using the satellite for telemetering data from remote seismological stations. Further action awaits the announcement of costs both for satellite usage and for terrestrial links via Telecom's proposed Digital Data Service and/or Austpak Packet Switching Network.

4.12.2 Proton magnetometer development (S. Scherl, G. Russell-Smith, M. Gamlen)

Work continued on the prototype magnetometer which uses a microprocessor algorithm rather than the usual phase-locked loop (PLL) to measure precession frequency. Some time was spent correlating the actual with the calculated performance. As the calculations were for a precession with random noise, analogue pre-filtering had to be removed to achieve the calculated result. This showed, in a practical way, how little the analogue filter reduced scatter; and therefore how good a practical magnetometer could be without the slew-rate limiting of that filter. When doing vehicle-borne surveys, magnetic gradients can be great enough to give filter-induced errors; and worse, the PLL can lose lock. The new magnetometer should therefore be well suited to vehicle-borne surveying. In such work, noise induced by fluid slosh is a problem which worsens as the traverse speed is increased. Ways of reducing this noise by stabilising the fluid and shock mounting the head are being examined.

All of the above work had been done with a simulated precession signal, so the prototype was taken to the Kowen Forest test hut to prove that it could measure real magnetic fields. It did, and the test led to a brief study of the sporadic noise present with the precession signal. As a result, changes will be made to the microprocessor program to enable it to better reject this type of noise.

A new sensor coil was designed and built with the aim of improving the signal-to-noise ratio of the precession signal prior to digital processing. It has not been tested as it would have needed different analogue circuitry from that in the BMR-made MNS-2 magnetometer which was used in all tests. Some design work has been done, but construction and testing was curtailed when S. Scherl was transferred from the IES Branch.

The new 'front end' will enable all of the analogue processing to be done near the sensor so that the sensor cable will carry a pulse train rather than the raw precession signal. This will remove cable-length limitations, and would thus make the instrument more suitable for marine work.

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Fig. 4.12.3 The Exorciser II microprocessor development system provides a powerful tool for software development and hardward emulation, resulting in savings in development costs and time.

4.12.3 Microprocessor systems (T. Dalziell, R. Cobcroft, G. Russell-Smith, B. Liu, M. Gamlen)

A Motorola 'Exorciser' system has been installed. See Fig. 4.12.3. It now provides complete software support and hardware-software integration features for Motorola's 6809 microprocessor. Furthermore, as a powerful desk-top calculator, it is a very useful engineering tool. Quotations have been obtained for additional hardware and software to both increase its versatility, and that of an RCA 1802 CMOS development system which should arrive in early 1982.

A printer for laboratory use and a terminal with non-volatile program storage for field development are the major peripherals being purchased: they will be used with both 6809 and 1802 equipment.

4.12.4 Computer-aided design (R. Cobcroft)

The interactive linear circuit analysis program LINCAD was further corrected to adapt it to the in-house HP computing system. All of its circuit simulation features are now operational. The non-linear interactive circuit analysis program OSUCAD will need to be corrected in the same way. Work has begun on this but must proceed on a low priority basis only.

4.12.5 Ion current meter (G. Russell-Smith, M. Gamlen)

The mass spectrometers, used in geochronology, require accurate current meters to measure isotope ratios, and thereby determine the age of the sample. A resolution of at least one femtoampere (fA) is required, and the presently used instruments cost between five and ten thousand dollars each. Even those with digital outputs must have integrating-type analogue-to-digital converters (ADC) added. Such an ADC would consist of a voltage-to-frequency converter (VFC) connected to a counter with selectable delay and gate times: it would use the on-line data-acquisition computer to correct zero-drift and linearity errors.

A prototype electrometer amplifier was built and when tested with an ADC, gave a standard deviation of 0.5 fA for single two-second measurements on the 100 pA full-scale range. The amplifier is of the varactor-bridge or diode-modulator type, and gallium phosphide diodes were used to reduce the leakage current below one fA. More careful construction and detail changes should improve this performance. Total component cost is a few hundred dollars.

This amplifier will be used as the basis of a more sophisticated ion current meter. To obtain sufficient resolution in digitisation a 0-100 kHz or 0-1 MHz VFC is normally used, but lower frequency, say 0-10 kHz converters are inherently more linear. A new system will use microprocessor signal processing to obtain the necessary resolution from a low frequency VFC. The processor will be a digital filter with the advantages of an analogue filter but without the disadvantages: scatter will be reduced and rise-time and settling time will not be lengthened. Calculations have shown that, for an ion current with random noise, the scatter of readings would be reduced by one to two orders of magnitude. Because of the unpredictable rising or falling nature of ion beams in mass spectrometers, the precise improvement cannot be calculated: it will just be greater for the more stable beams.

A further advantage of the microprocessor filter is that it could be fitted to any existing spectrometer in the BMR/RSES Geochronology Laboratory: it is just an improved digitiser, and therefore can be as readily fitted to older current meters as to new designs.

4.12.6 Sparker seismic source investigations

Sparker and current monitoring equipment are on loan to Duntroon School of Mechanical Engineering where Dr D.B. Stewart is investigating the theory of sparker seismic energy sources. He has a post-graduate student developing mathematical and computer models of bubble formation and is using a laser interferometer technique to investigate spatial and temporal density and pressure changes within the bubble.

4.13 General Services

4.13.1 Miscellaneous Activities - Mechanical Sub-section

Two hundred and nine unprogrammed tasks were carried out during the year.

4.13.1.1 Carpenters shop (G. Lockwood). Tasks included design and construction of a wide range of equipment transit cases, special refrigerator cases, sample storage and display units, manufacture and installation of storage facilities in specialist areas and vehicles, and many other ad hoc tasks.

4.3.1.2 Heavy workshop (R. Westmore et al.). Tasks included design and construction of a steerable trolley for moving heavy equipment in seismic camps, six special cable reels, maintenance to rock crushing machinery and general repairs and maintenance. A Geotech seismic streamer cable winch was modified to provide greater protection from sea water to the DC motor and gearbox which had to be replaced. The winch is being installed on M.V. Nella Dan

4.13.1.3 Instrument and machine shop (R. Grigg et al.). Maintenance, repair and modifications were carried out on a wide range of precision instruments including microscopes, gravimeters, recorders, declinometer, photographic equipment and other instruments. Advice was frequently provided on mechanical instruments and equipment. Other work included construction (mostly by contract to an existing BMR design) of a portable rock coring drill for Metalliferous Geology, construction of a rock clamping arrangement for a diamond saw belonging to the Rock Measurements and Palaeomagnetic Group, and modifications to an observatory drum recorder.

4.13.2 Miscellaneous Activities - Electronic Technical Sub-section

(A. Zietlhofer, D. Pownall, W. Harkness)

4.13.2.1 For Geophysical Branch. Work is well advanced on the thermistor bridge intended for heat flow studies. Accpetance testing of recently purchased equipment included Geotech seismic amplifiers for

crustal and observatory sections, a seismic analyser for Rock Measurements Group and a Hewlett Packard spectrum analyser for Metalliferous Sub-section.

4.13.2.2 For Geological Branch. Maintenance was carried out on the engineering geology down-hole bore flow pump unit and a new distribution box constructed incorporating an earth leakage detector for protection of the operator. A new and more flexible pump supply cable is being manufactured. A salinity down-hole probe was repaired, interfaced with a portable conductivity meter bridge and calibrated against known solutions. A number of other miscellaneous tasks such as rewiring of ore separation apparatus and repairs to 3-phase motor, X-Y plotter and a portable alternator were carried out. The X-Y plotter for the Marine Geology settling apparatus was repaired.

4.13.2.3 For Petroleum Exploration Branch. Work included repairs to Varian gas chromatograph, centrifuge and the relocation of a distillation apparatus with associated rewiring of the mains supply. Minor faults in a spectrophotometer were repaired.

4.13.2.4 For ADP Section. A number of VDU installations were carried out in the BMR building and repairs were made to terminals, cassette recorders and other pieces of equipment including the Gould plotter.

4.13.2.5 Communication Equipment (W. Harkness). Repairs and checkout of Codan transceivers and other communications equipment continued throughout the year to meet field party needs.

4.13.2.6 For Operations Branch. The Gradicon digitiser required frequent attention. Repairs or modifications were made to dyeline and printing machines, arc lamps, ultrasonic cleaners etc.

4.13.2.7 Electronic drafting (W. Gan, F. Clements, K. Mort). Projects requiring major electronic drafting input for printed circuit board design, panels, handbook illustrations, etc. included airborne doppler digitiser, redrafting of circuits and art-work to produce spare pcbs for Observatory Group's Adkin fluxgate magnetometer, further development of Marine Geology's underwater data acquisition systems, and computer interface for X-ray diffraction equipment. Master equipment handbooks were updated as necessary and the components catalogue system maintained.

4.13.2.8 Electronic instrument laboratory (W. Burhop). Maintenance of instrumental accuracy, calibration of equipment and assistance in the use of pool test and measurement equipment continued throughout the year. Instrument repairs, particularly of older virtually obsolete equipment was the most time-consuming activity.

Work commenced on a low noise thermo couple amplifier for use in a needle probe transient method for measuring the thermal conductivity of rock cores.

Modifications were made to the thermal lagging of a Schonstedt thermal demagnetiser for Irian Jaya palaeomagnetic laboratory. The temperature control is being recalibrated and the thermal gradient within the demagnetiser are being redetermined.

5. TRAINING, COURSES, CONFERENCES, REPORTS

5.1 Local Conferences

M. Allen (Private attendance) R. Cobcroft (Private attendance)	ASEG Second Biennial Conference and Exhibition, Adelaide, 18-20 August, 1981.
R. Cobcroft	Conference on Microprocessor Systems, Institute of Engineers, Aust., Brisbane, 17-20 November, 1981.

B. Devenish	Computer in Engineering, Institute of Engineers, Aust., Melbourne, 2-3 September, 1981.
B. Liu	IREE Conference 81, Institute of Radio and Electronic Engineers, Melbourne, 25-29 August, 1981.
J. Rutledge	Metals Structure Conference, IE Aust., Newcastle, 11-14 May 1981.

5.2 Training Courses

External

K. Seers	An Introduction to Packet Switching, RMIT, Melbourne, 18-20 February, 1981.
M. Gamlen R. Cobcroft G. Russell-Smith	Microprocessor Seminar, Motorola, Sydney, 1-2 April, 1981.
R. Curtis	6809 Microprocessor Course, RMIT, Melbourne. 1-5 December, 1980.
G. Woad	Introduction to Computers and Introduction to Microprocessors, Telecom, Perth 17-21 August, 1981.
J. Rutledge	Industrial Hydraulics, Sperry Vickers, Sydney, 14-18 September, 1981.

Internal

IES staff - attendance for all sessions about 15-20.	Airborne Geophysical Instrumentation Training Sessions, BMR Building. 2-3 November, 1981 (Organised by D. Cook).