DEPARTMENT OF
~~NATIONAL RESOURCES~~
NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1979/90

INTERIM ENGINEERING SERVICES BRANCH

SUMMARY OF ACTIVITIES - 1979

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ILLUSTRATIONS

1. SUMMARY

Full implementation of the management changes outlined in the first annual summary (1978) has not been possible mainly because the formal structure of the branch is still not finalised. However, the matrix structure and the task team approach to work programming is better understood and accepted.

In 1979 most work involved completion and continuance of 1978 projects or developments from these projects; new projects were undertaken but none were major engineering tasks. Survey preparation and field support for survey parties absorbed a high proportion of Electronic Technical Group's capacity.

A new 1024 cubic inch crystal package was integrated with the gamma-ray spectrometer system in the Twin Otter survey aircraft. For metalliferous geophysics, work continued on down-hole probes, a digital carborne magnetometer system was assembled, and considerable time was spent on complex resistivity systems and survey preparation. Little work arose from engineering geology and geophysics although a system for automatic monitoring of water bores is under investigation. Wire-line logging was carried out on oil shale bores in Queensland, a source-rock study bore in the Darling Basin, and metalliferous drillholes near Cobar.

An automatic digital magnetic observatory system for Gnangara, WA, and a 5-component digital magnetograph for regional surveys are undergoing de-bugging trials at Kowen Forest observatory. A single-component seismograph was installed at Mount Isa, and the Manton-Darwin telemetry system restored to full operation. For crustal surveys the repackaging of 6 P.I. automatic seismographs from two to one case was completed and a prototype low-power clock for the new light-weight seismographs passed bench-test stage. A second divided-bar thermal conductivity system was constructed for heat flow studies, and a second portable diamond coring drill and computer interface completed for palaeomagnetic work. A. Spence was seconded full-time to magneto-tellurics and the M.T. party obtained data sets from 17 sites in the McArthur Basin, NT.

A control unit for the seismic and marine groups' analogue-to-digital conversion system was modified to interface to the MS 42 analogue seismic playback system, and support was provided for a major new seismic processing system being funded by a NERDDC grant. Two 16-channel multiplexers were built for the marine DAS but completion of major system components, timers, digital senders, and receivers was deferred. Technical support was provided for installation and operation of digital geophysical systems on the <u>Cape Pillar</u> and <u>Nella Dan</u>.

A prototype digital current flow logging system for Great Barrier Reef studies was designed and built, and operated satisfactorily. Some redesign, particularly of the package housing the electronics, has been completed and two systems are being prepared for field work in 1980. A tidal sediment sampling tower constructed in 1978 operated satisfactorily and two towers of improved design are being built for 1980. A new type of vibro-corer is also being assembled for use in 1980.

Numerous ad-hoc tasks were completed for most sections in BMR.

2. GENERAL ADMINISTRATION

The IES Branch's first annual summary in 1978 outlined the organisational structure and mode of operation of this new service branch. During 1979 much time was spent on organisational and staffing proposals, and at time of writing the Branch's formal structure is still incomplete. In late 1978 the Mechanical Subsection structure was finalised, and in mid 1979 the structure of the Electronics Technical Group was investigated by the PSB and should be finalised this calendar year. The Electronics Professional Group remains to be investigated. The loss of two professionals through retirement and the transfer of a third to other duties have seriously affected the Branch's capacity in 1979. For these reasons full implementation of the management changes outline in the 1978 annual summary has not been possible.

3. GROUP ADMINISTRATION REPORTS

3.1 Mechanical Section

Mr D. Hartas, the STO-2 in charge of the mechanical group, transferred to another department in April, and for the remainder of the year Mr G. Thom acted in this position. Mr J. Rutledge commenced duty as STO-1 in design in July. The following staff were outposted for the full year:

M. Tratt	TO-1 Marine Geology
D. Foulstone	TA-2 " "
J. McIntyre	Maintenance Mechanic, Seismic Group, Geophysical Branch.

3.2 Electronics Technical Group

Mr A. Zeitlhofer carried out the duties of pool and program manager throughout 1979. Although the group's structure has not been finalised a second STO-2 position (Pool Manager) has been approved, and the filling of this key position should alleviate many of the difficulties experienced in 1979.

Mr Zeitlhofer attended Bruce TAFE College course advisory committee working meetings on the Electronics and communications Certificate Course during the year, and was appointed observer on the PSB's TO (Engineering) Standards Committee.

One person from the Sesmic Group passed through the group's "Quality Assurance Training Program" which is aimed at retraining in the manual skills required to handle modern electronic technology. H. Kirk, an aboriginal trainee under the NEAT scheme, progressed rapidly to become a very productive member of the group. Permission has been granted to continue his employment for a further 12 months.

Three Trainee Technical Officers (T. Dalziell, D. Pownall, and J. Whatman) graduated during the year to TO-1 leaving only one trainee who is expected to graduate in January. This will mark the end of the TTO (engineering) scheme in BMR.

The following staff were outposted for the full year.

J. Grace	A/STO 2	Seismic and Marine Geophysics
R. Dulski	A/STO 1	
P. Fowler	TA-2	
G. Green	A/STO-1	Airborne Geophysics
J. Eurell	TO-2	
G. Woad	TO-2	Permanent Mundaring Observatory Staff
B. Page	TO-1	
J. Williams	TO-2	Crustal Seismic Geophysics
R. Curtis	TO-2	Metalliferous Geophysics
D. Francis	TA-2	Engineering Geophysics

In addition the following staff were outposted for a significant part of the year: D. Gardner TO-2, Seismic Party; D. Pownall TO-1, Crustal Seismic Party: J. Whatman TO-1, Magneto-telluric Survey Party.

L. Winters STO-1, (Airborne) resigned during the year, S. Ioannou, TO-1 was on leave for most of the year due to ill health.

3.3 Electronics Professional Group (K. Seers, B. Liu, A. Spence, P. Hillman, M. Gamlen, B. Devenish, R. Cobcroft).

Program Management (K. Seers, B. Liu)

During this the second year of the IES Branch and matrix management, the formulation and implementation of the year's program proceeded more smoothly. Nevertheless the monitoring of tasks and the modification of program goals to meet the constraints of staffing and budget took a lot of time, and continuous consultation with customer branches. B. Liu carried out these duties for the first part of the year while K. Seers was seconded on special duties.

Group Management (P. Hillman, K. Seers)

K. Seers continued this role at minimum level following the retirement of P. Hillman at the end of May. Prior to retirement, P. Hillman assessed a selection of audio-visual post-graduate training courses in electronics obtained from University of NSW and presented abridged lectures to the group.

A. Spence was seconded for the full year to Regional Geophysical Surveys where he continued to work full time on magneto-tellurics, both on the equipment and on reduction and interpretation of results.

3.4 Procurement Group (P. Mann, S. Waterlander, W. Gunner).

The group handled technical investigations, wrote tender specifications and made purchase recommendations on a wide range of equipment and components approved in the plant and equipment buying program for the Geophysical and Interim Engineering Services Branches.

For the Geophysical Branch the principal items for the Airborne/ /Metalliferous section purchased after tendering were large-volume crystal detectors for radiometric surveys, a gyrocompass system, and a radiometric logging system. There were insufficient funds to commit for a SQUID magnetometer originally set down for purchase although tender specifications had been prepared. For the Observatory and Regional Seaction a thermal demagnetiser to treat rock specimens for palaeomagnetic measurements was finally delivered after being incorrectly despatched by sea instead of airfreight.

For the Seismic, Gravity and Marine Section tenders were assessed for strings of geophones, geophone cables, test equipment and an electrostatic oscillograph for seismic surveys. Computing equipment including peripheral units and a printer/plotter for a land/marine seismic data processing system were purchased for the Marine Subsection. The implementation of this land/marine seismic data processing system was accelerated by the receipt of a NERDDC grant for this system. Specifications covering a rastering controller and an array transform processor, integral but expensive components of the processing system, were prepared for tendering after the inter-departmental Committee on ADP supported their acquisition.

Although tenders were received for a slim density logging tool for metalliferous surveying no suitable tool was offered. Negotiations with Department of Administrative Services to buy a more general-purpose density tool against these tenders were complicated by guidelines regarding preference for Australian manufactured goods, and were unsuccessful. Specifications have been rewritten and tenders are being recalled.

The main work load for the IES Branch was purchasing electronic, electrical, and mechanical components required to construct specialised equipment unavailable commercially, for programmed surveys. In addition the group handled loans of equipment to institutions and other Government departments and radiocommunication facilities for survey parties.

4. TECHNICAL REPORTS - EQUIPMENT DEVELOPMENT AND SURVEY PREPARATION

Most of the branch's activities are for customer groups outside the branch. The technical reports are therefore presented under headings which indicate the groups for which the work was done.

4.1 Airborne Geophysics

4.1.1 Airborne Surveys (L. Winters, G. Green, J. Eurell, E. Chudyk, S. Wilcox).

Airborne surveys were conducted at a number of places during 1979 using the Twin Otter, VH-BMG.

4.1 Airborne Geophysics

4.1.1 Airborne Surveys (L. Winters, G. Green, J. Eurell, E. Chudyk, S. Wilcox). Airborne surveys were conducted at a number of places during 1979 using the Twin Otter, VH-BMG.

Cobar (J. Eurell, S. Wilcox). A week in mid February was spent in flying experimental work for the Metalliferous Geophysics Group. This involved low-level traverses across selected area. Only minor equipment problems were experienced.

Lithgow (G. Green, S. Wilcox). Two weeks in March were spent surveying an area adjacent to Lithgow from Bathurst airport. The equipment performed satisfactorily except for an occasional burst of noise on the MFS-7 magnetometer.

Bairnsdale (G. Green, S. Wilcox, E. Chudyk). The Bairnsdale 1:250 000 Sheet area was flown from Sale airport between late March and mid April. Minor troubles were experienced with a Facit tape recorder and the MFS-7 magnetometer.

Mallacoota, Warburton, and the Lachlan Fold Belt (G. Green, J. Eurell, Wilcox). From mid April to early May the Mallacoota and Warburton 1:250 000 Sheet areas were completed and several traverses were flown across the Lachlan Fold Belt. The work was flown from Canberra airport. Equipment performance was satisfactory.

Dubbo, Nyngan, Gilgandra (J. Eurell, G. Green, S. Wilcox). These three 1:250 000 Sheet areas were flow from Dubbo airport from May through to mid August. During this time the new 1024 cubic inch gamma-ray crystal pack was installed. Installation was straightforward except for some impedance matching. Power has to be connected 24 hours per day to maintain the crystals at constant temperature. The system performed well, with the expected increase in count rate. Minor troubles with the MFS-7 magnetometers resulted from the poor state of the printed circuit boards, and new boards having been ordered. Troubles indicated by blown fuses appeared in the Doppler system, and other equipment required minor repairs.

Horsham-Naracoorte (G. Green, E. Chudyk) This area was flown from Horsham from September through to November. The Doppler power supply failed and was repaired in the field. The MFS-7 magnetometers and ASQ10 heads required repair as did the Facit tape recorder and gamma-ray E.H.T. unit.

4.1.2 Twin-Otter VH-BMG Installation (B. Devenish, G. Green, J. Eurell).

Gamma-Ray Spectrometer The new 1024 cubic inch crystal assembly was replaced by the manufacturer after acceptance tests showed it to be unsatisfactory. The replacement assembly was installed and interfaced to the Hamner pulse height analyser and BMR Type RAS-1 scalers to give four-channel operation. An Ino-Tech analogue-to-digital converter unit was purchased to enable pulse height analysis to be performed in the HP 2100 series computer used in the airborne data acquisition system. The A-to-D converter was tested, and operation as a multi-channel analyser now awaits software completion by the A.D.P. Section.

4.1.3 Airborne Instrument Development

Airborne Timer (G. Green, H. Kirk, K. Mort, M. Gamlen)

The third NZA-3 timer was substantially completed: its printed circuit board is ready for mounting in an instrument case which has not yet arrived. Progress was slow due to the lack of personnel, and reduced priority while only one aircraft is operational.

MFS-7 Serial No. 4 Fluxgate Magnetometer (G. Green).

Little work was done on the construction of this unit because of the shortage of airborne technical staff. The unit is expected to be completed in the final half of 1980.

MFS-7 Fluxgate Magnetometer: Documentation (K. Seers).

Considerable effort was expended on the production of a handbook and BMR Record (jointly with D. Kerr). The documentation process highlighted the need for a number of design revisions with consequent changes to drawings, parts lists, and layout. A new alignment procedure was detailed. Some of the mathematical analyses of circuit and system operation required correction and revision. This work has to be suspended while the 1980 program was formulated; the handbook should be ready by March 1980.

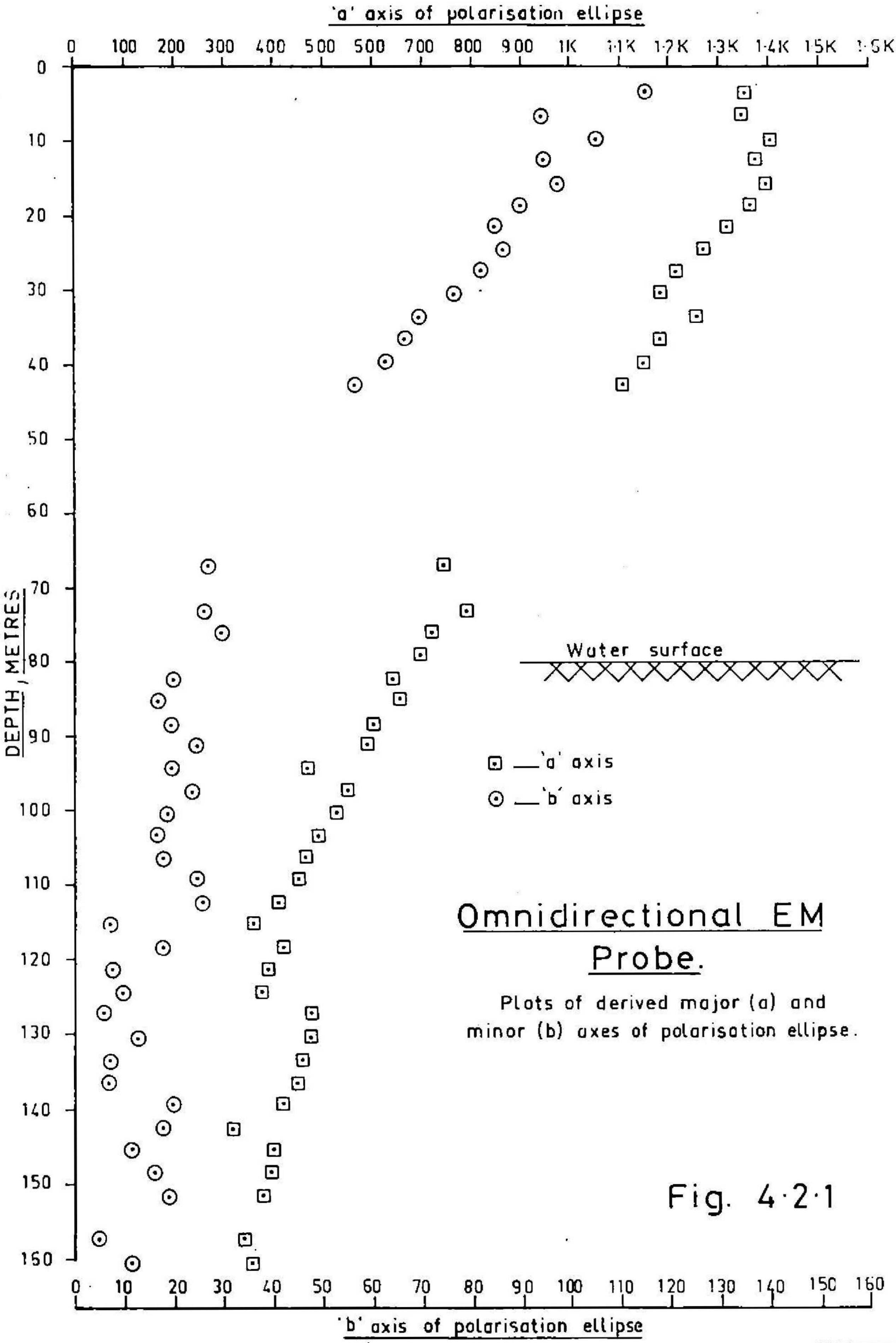
16-Channel Multiplexer (B. Devenish). A BMR Record describing this previously developed instrument was written.

4.2 Metalliferous Geophysics

4.2.1 Development of a Down-hole Omnidirectional EM Probe

(R. Cobcroft, R. Curtis, G. Lockwood, D. Pownall, R. Westmore, J. Rutledge). Work continued on the development of this three-component electromagnetic probe. Marginal instability in the down-hole amplifiers was corrected, and interference from Belconnen naval station transmitter on about 44 kHz was suppressed with low-pass filters in the signal and reference channels of the system. Water leaks in the probe housing were eliminated by reterminating the head unit and changing from PVC to cyano-acrylate adhesive to bond certain sub-assemblies.

A borehole on the edge of the BMR car-park was logged at discrete 6-m intervals using a surface loop approximately 100 m x 100 m with one side about 50 m from the bore as the energy source. About 3.5 amps was passed through the coil and the hole was logged at 440 Hz and 880 Hz. The results obtained looked encouraging. However, when the hole was logged continuously the effect of probe rotation became apparent. The Z component gave a smooth log as expected, but the X and Y components gave serrated logs in which the distance between amplitude peaks corresponded to one half revolution of the probe in the polarisation ellipse. Any logging cable will rotate to some extent, but this cable was chosen for its electrical properties, not its mechanical, and was particularly prone to rotate.



Omnidirectional EM Probe.

Plots of derived major (a) and minor (b) axes of polarisation ellipse.

Fig. 4·2·1

To obtain better data the equipment was taken to the Elura deposit at Cobar and the mine shaft was logged to a depth of 160 metres (the water-table was at a depth of about 85 metres). A loop 200 m x 200 m centred about the shaft was used and 3.5 amps at 440 Hz passed through the loop. The northern gossan hole was also logged to a depth of 60 metres. These and other experiments at Cobar provided data for testing a data-reduction theory in which the major-minor axes of the polarisation ellipse are derived, i.e. parameters which are invariant with probe rotation. The procedure is to obtain semi-major and semi-minor axes of three apparent polarisation ellipses by taking the X, Y, and Z component voltages in pairs and their respective phase differences; these derived axes are not invariant with probe rotation but from them can be derived the semi-major and semi-minor axis of the ellipse of which they are the projections - the lengths of the axes of this ellipse are invariant with probe rotation.

Fig. 4.2.1 shows the Elura logging results. Plot (a) is the major axis amplitude (proportional to volts) and plot (b) the minor axis amplitude. Note the x10 difference in scale, the major axis being of very much greater amplitude as would be expected with the shaft. Anomalies are evident in both the major and minor axes but as yet no geophysical interpretation has been attempted. Much of the scatter is believe to be due to limitations in the up-hole electronics, which can be improved. However, this analysis is not yet complete.

A 2.5-m diameter Helmholtz coil has been designed and built for calibrating the probe and measuring its directional sensitivity. At time of writing, calibration tests were about to commence.

The probe in the present form is not robust enough for regular field use, so it has been mechanically redesigned. The design has also been modified so as to allow the probe to be used with BMR's 3000-metre logging truck and winch.

4.2.2 Slim-hole Induction Logger (R. Cobcroft, R. Curtis)

The metalliferous geophysics group had an immediate need to measure formation resistivity in dry holes, which suggested the use of an induction logging probe. An attempt was made to improvise a slim-hole induction tool since, so far as could be determined, no commercial tools were available with a diameter small enough to be used in NQ and BQ holes. This was also regarded as useful experience towards the development of a slim down-hole SLINGRAM type probe, which is also required.

The first attempt failed due to an underestimation of the effect of mutual inductance between the transmitting and receiving coils. Also the up-hole instrument used to measure the received signal (a Hewlett-Packard gain/phase meter) had insufficient accuracy in the measurement of phase, particularly when measuring a very small real-component voltage in the presence of a large imaginary-component voltage.

A literature review has since been undertaken and a more thorough look at the design problems is being made.

4.2.3 Adaptation of Scintrex EM Probe to Deep Logger (R. Cobcroft, J. Rutledge, D. Stevens). The results of tests made last year at Broken Hill with the Scintrex DHP-4 EM probe attached to the 3000-m logger demonstrated the need to manufacture a new probe adaptor made from a non-conducting material which would insulate the probe from galvanic contact with the bore-fluid. A further need was to bring the signal from the probe to the surface via a balanced pair of conductors within the logging cable and to avoid the use of the outer sheath in the signal path. The design of such an adaptor was completed, and construction commenced in the mechanical workshop.

4.2.4 Down-hole Magnetometer (R. Curtis). The BMR-designed MFS-7 airborne fluxgate magnetometer was adapted for trials of down-hole magnetic measurements (axial field only).

A probe housing was manufactured from rigid PVC tube. The MFS-7 detector element was mounted within the probe which was then filled with oil and sealed against the ingress of moisture. A 150-m length of non-magnetic cable was connected between the magnetometer and the probe and wound on a small hand winch. Laboratory tests of the magnetometer gave reliable results.

On survey at Cobar a number of minor problems caused by dry joints in circuit cards of the MFS-7 were repaired as they arose. A more serious problem, however, was the variation in reading caused by rotation of the probe in the hole. This was due to a slight axial misalignment between detector and probe. A long-term solution to this problem and also to the problem of hole verticality variations would be to manufacture a three component down-hole sensor. A shorter-term expedient was tried at the hole logged at Buri: the probe was attached to a long length of rigid PVC pipe so that rotation of the probe could be prevented. This method worked well but could not be considered other than for very shallow holes. As a borehole magnetic sensor the probe had a noise envelope of about 0.2 gammas (bandwidth 10 Hz) and was used successfully as a detector in experimental magneto-resistivity measurements.

4.2.5 Down-hole Magnetometer Study (M. Gamlen). A preliminary study was conducted on a fluxgate magnetometer which would be suitable for three-component borehole use. The published results of Heinecke (IEEE Instrumentation & Measurement) showed more than adequate performance from a sensor 30 mm long. Heinecke used triangle-current drive to the sensor element and zero-crossing time shift of the output waveform instead of the more common sine-wave drive with second-harmonic detection. A simple implementation has been suggested and a more comprehensive feasibility study is programmed for 1980.

4.2.6 Measurement of Complex Resistivity (B. Liu, R. Cobcroft). Several instrumentation system options were examined with representatives of the metalliferous subsection and A.D.P. section. The measurement of complex resistivity entails passing an alternating reference current into the sample (or the ground) and comparing the amplitude and phase spectra of the reference with those of the voltage produced across the sample; i.e. the transfer function of the sample is determined.

The initial approach will be to use a commercial lock-in analyser to obtain the necessary spectra to evaluate the method. A future possibility is to use a digital spectrum analyser in a data logging system. Minor instrumental modifications will be necessary to commercial units of either type to obtain the resolution required, particularly phase resolution.

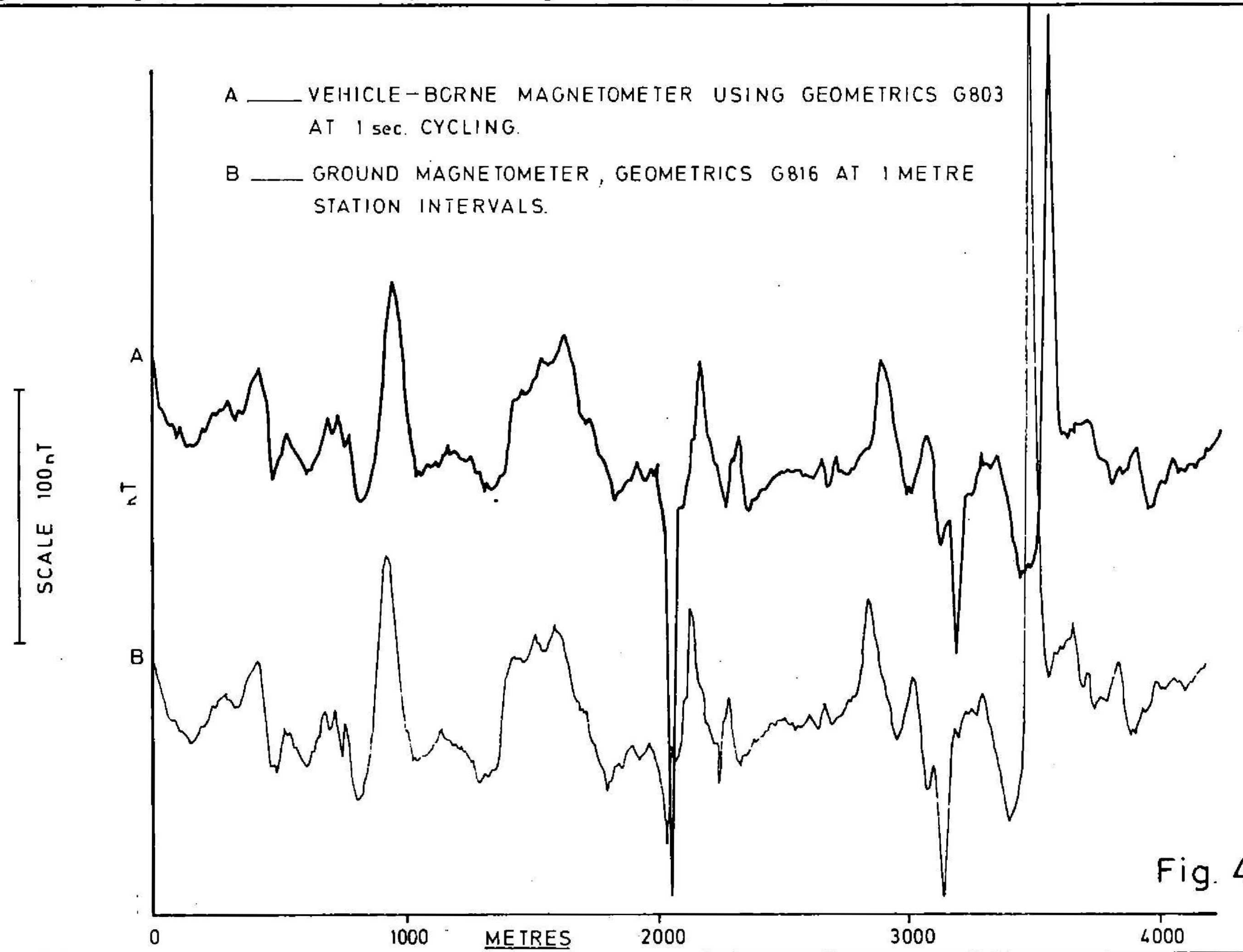
The first analogue measurements are expected to be made early in 1980 and a comparison with the digital system should be possible before then of the year.

4.2.7 Carborne Magnetometer System (R. Curtis, H. Reith, P. Hillman). Early in the year a improvised continuous recording carborne magnetometer comprising a Geometrics G803 proton-precession magnetometer, and a Hewlett-Packard 7100B chart recorder was installed in a Landrover. To avoid magnetic interference from the vehicle the head of the magnetometer was carried by one man at the end of a 15-m cable behind the Landrover. This was also the simplest means of maintaining the head at constant height above ground.

Trial results were very encouraging, so the system was converted to digital recording. A Datamatic parallel-to-serial converter was used to format the digital output of the G803 magnetometer and the data was recorded on a Kennedy 1600 incremental tape recorder. A monitoring output channel from the Datamatic gave an analogue signal with 100 nT full-scale deflection which was recorded by one pen of the chart recorder; the second pen was connected directly to the analogue output of the G803 with a full-scale deflection of 1000 nT. Distance was measured with a resolution of 0.1 metre by pulses from a proximity switch which sensed metallic studs attached to the brake-drum of the vehicle. For every ten pulses the fiducial counter in the Datamatic gave one pulse which operated an event-marking pen on the chart recorder. The contents of the fiducial counter were also recorded by the incremental tape recorder.

About 27 line-km were recorded at Cobar (Buri, Shearlegs, and Elura) with very good results. Ingress of dust into the tape recorder caused concern, and some method of dustproofing the back of the Landrover will probably be necessary.

4.2.8 Development of a Carborne Data Acquisition System (R. Cobcroft, M. Gamlen, B. Liu, R. Curtis). The success of the prototype carborne magnetometer project led to a request for a more sophisticated system in which outputs from a magnetometer, four-channel gamma-ray spectrometer , a digital compass, an odometer, a digital clock, and an operator-controlled event marker would be recorded.



A ——— VEHICLE-BORNE MAGNETOMETER USING GEOMETRICS G803 AT 1 sec. CYCLING.
B ——— GROUND MAGNETOMETER, GEOMETRICS G816 AT 1 METRE STATION INTERVALS.
A
B
nT
SCALE 100 nT
0
1000
METRES
2000
3000
4000

Fig. 4·2·7

A number of alternatives were investigated. The one selected would still use a proximity switch which senses studs on the brake-drum to give a distance resolution of 0.1 metre. The heart of the system would be two Motorola 6800 microprocessors together with sufficient memory and a number of peripheral-interface-adaptor units. One microprocessor would be dedicated to generating the necessary timing signals; the other would handle housekeeping and interfacing the measuring instruments to a cassette tape recorder. A Texas Instruments 'Silent 700' terminal would provide input, and cassette recording facilities. Further work is continuing on the detail of the design proposal.

4.2.9 Recording Microbarometer (R. Cobcroft). A BMR Record describing this previously-completed project was written.

4.2.10 Survey Preparation and Support (R. Curtis). Magnetometers, IP equipment, portable generators, chart recorders, etc. were checked out for the Cobar surveys, and the MPPO-1 TEM system was repaired for a survey in Tasmania.

4.3 Engineering Geophysics

4.3.1 Digital Seismic Acquisition System (W. Greenwood). The equipment was prepared for an experimental high-resolution reflection seismic survey which Engineering Geophysics Group carried out over coal seams near Gloucester, NSW. Two improvised weight-drop systems were provided by the cooperating company as energy sources. The equipment worked satisfactorily. No further work was done on the electronics or alternative energy sources in 1979.

4.3.2 Survey Preparation and Support (W. Greenwood, D. Francis, L. Miller). Equipment was prepared for ACT engineering surveys, one groundwater survey on Niue Island, and a cooperative survey with CSIRO near Blackwater on slope stability investigations.

4.3.3 Eh-pH Probe (G. Thom, A. Kores, C. Rochford). The probe is required for groundwater pollution and mineralisation studies. The body of the probe was built of polycarbonate material to resist corrosion and heat, and was designed to operate to 100 metres. It was tested to 60 metres against pressure compensation and leakage. The probe and electronics gave satisfactory readings on the bench of Eh, pH, and temperature, but have not been tested in a borehole. A small amount of mechanical work has to be completed before this can be done.

4.3.4 Detection of Unexploded Shells (R. Cobcroft, P. Hillman). A study of magnetometers available showed that the most sensitive and practical magnetic technique for the detection of unexploded shells on old artillery ranges would be to use a SQUID 3-component gradiometer. However, because of the high instrumental cost, a fluxgate gradiometer (Elsec) was tried as a compromise. Tests carried out by the Engineering Geophysics Group showed this was not as sensitive as the proton-precession magnetometer previously used for this purpose.

4.4 Well Logging

4.4.1 Miscellaneous tasks - 3000 metre logger. (G. Jennings, C. Rochford, E. McIntosh). Maintenance was carried out on the winch hydraulics and braking system, a redesigned cable head was made, and the electricals and electronics were over-hauled. An overspeed and oil pressure alarm system was added to the engine alternator. The caliper tool was modified to improve resolution and a temperature and differential temperature tool upgraded to the current model. A brief survey of density and sonic tools available was made and some time was spent on the possibility of converting to digital recording. Tenders are being called for a density tool.

4.4.2 Bore logging (G. Jennings, C. Rochford). Two deep oil shale exploration bores near Duaringa, Queensland, one to 1200 metres, were logged with electric, S.P., gamma, neutron-gamma, temperature, caliper, and density tools. Another eight holes of about 100-metre depth near Rundle were also logged.

A number of shallow holes near Hoskinstown and Lake George were logged for Geological Branch, and one source-rock study bore to 305 metres in the Darling Basin near Ivanhoe was logged for PEB Branch. Electric logs, temperature and differential temperature, caliper, gamma and neutron-gamma logs were obtained. Assistance was given to a metalliferous geophysics party in running induced polarisation logs of two bores at Cobar.

4.4.3 Portable loggers (W. Greenwood, C. Rochford). The Widco 450SHL logger was prepared for the Alligator Rivers hydrological survey and operators were instructed in the use of the logger. A Porta logger, and a salinity and temperature logger were prepared for Niue Island hydrological survey, and a Suitcase logger was overhauled for general use.

4.5 Engineering Geology

4.5.1 Bore Flow Pump Test Unit (D. Hartas, E. McIntosh). The troubles with the accumulator-operated winch brake system were overcome, but the solution involved additional controls valves and a major rebuilding of the hydraulic circuitry. The crane jib pedestal was reconstructed and the cover for the engine, hydraulic pump, and electrical equipment was modified to provide better cooling. The unit was tested by an inspector of lifts and cranes, Department of Capital Territory, and approved. It was used in the Northern Territory on the Alligator Rivers hydrogeological survey. Some minor modifications, particularly to the trailer, will be made after field experience gained this year.

4.5.2 Data Acquisition for Groundwater Monitoring (K. Seers). A Sinco electrical piezometer system was purchased for use in the Alligator Rivers hydrogeological survey, for monitoring groundwater levels in boreholes. A proposal to attach a cassette tape recorder or other automatic data logging device to the system is under investigation.

4.6 Observatories

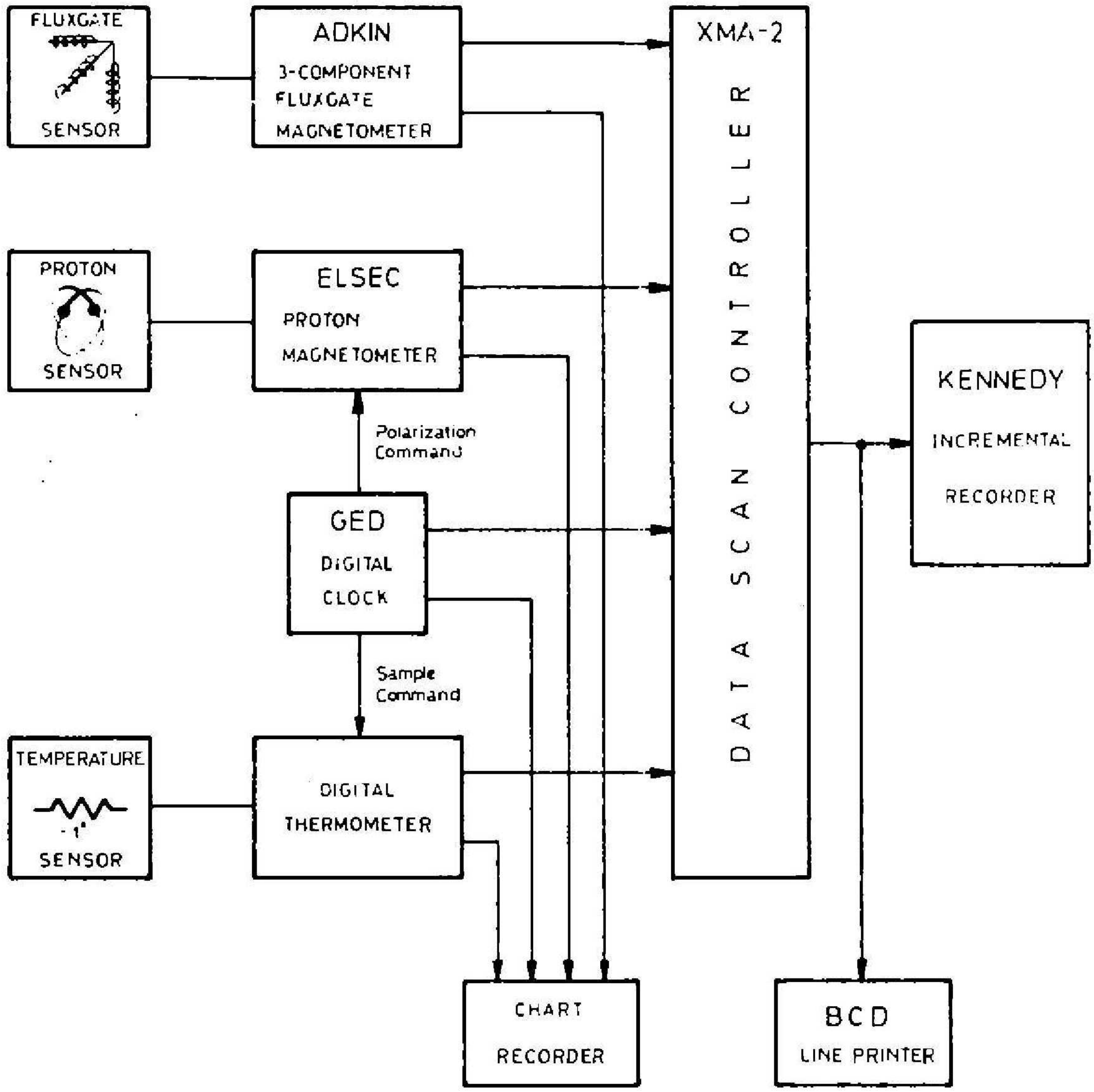
4.6.1 Four- and Five-Component Digital Magnetographs (B. Liu, K. Jurello). The old "Digital-F" system has been incorporated into three systems. The five-component system comprises Elsec 595 proton magnetometer (F), Adkin 3-component fluxgate (X, Y, Z) and temperature recording, GED electronic clock, BMR Type XMA-2 controller, and Kennedy incremental tape recorder. A new rack was constructed to house the Elsec magnetometer, GED digital clock, Kennedy incremental tape recorder, and XMA-2 controller.

The four-component system will use two horizontal channels from the photo-electronic variographs (see para 4.6.3) instead of the Adkin three-component fluxgate magnetometer. The GED clock, XMA-2 controller, and tape recorder for this system are available.

The two GED clocks were checked and interfaced to the system and two digital-to-analogue converter cards were constructed for the Elsec 595 proton magnetometer. Environmental tests were carried out on the system components, and the 5-component system was assembled and is undergoing trials and debugging at Kowen Forest. It will be despatched next March to Heard Island for use as a first-order station required as part of the MAGSAT project.

4.6.2 Gnangara Magnetic Observatory (B. Liu, G. Russell-Smith). The Elsec automatic magnetic observatory equipment for Gnangara arrived in April. Acceptance tests were carried out on the proton magnetometer, digital clock, Elsec controller, and system power supplies. The BMR-designed XMA-3 controller and Kennedy incremental recorder were integrated into the system. An intermittent writing error was traced to an inherent design fault in the Elsec controller. A BCD printer was also added to the system to give on-line monitoring capability. The proton sensor head was found to leaky and was returned to the factory in U.K. for repair.

The system was transferred to Kowen Forest in October for in situ testing. Operator training will be arranged for the Gnangara observatory staff before installation of the equipment at Gnangara.



Five Components
Digital Acquisition System.

Fig. 4·6·1

DRG X2 Sh.22

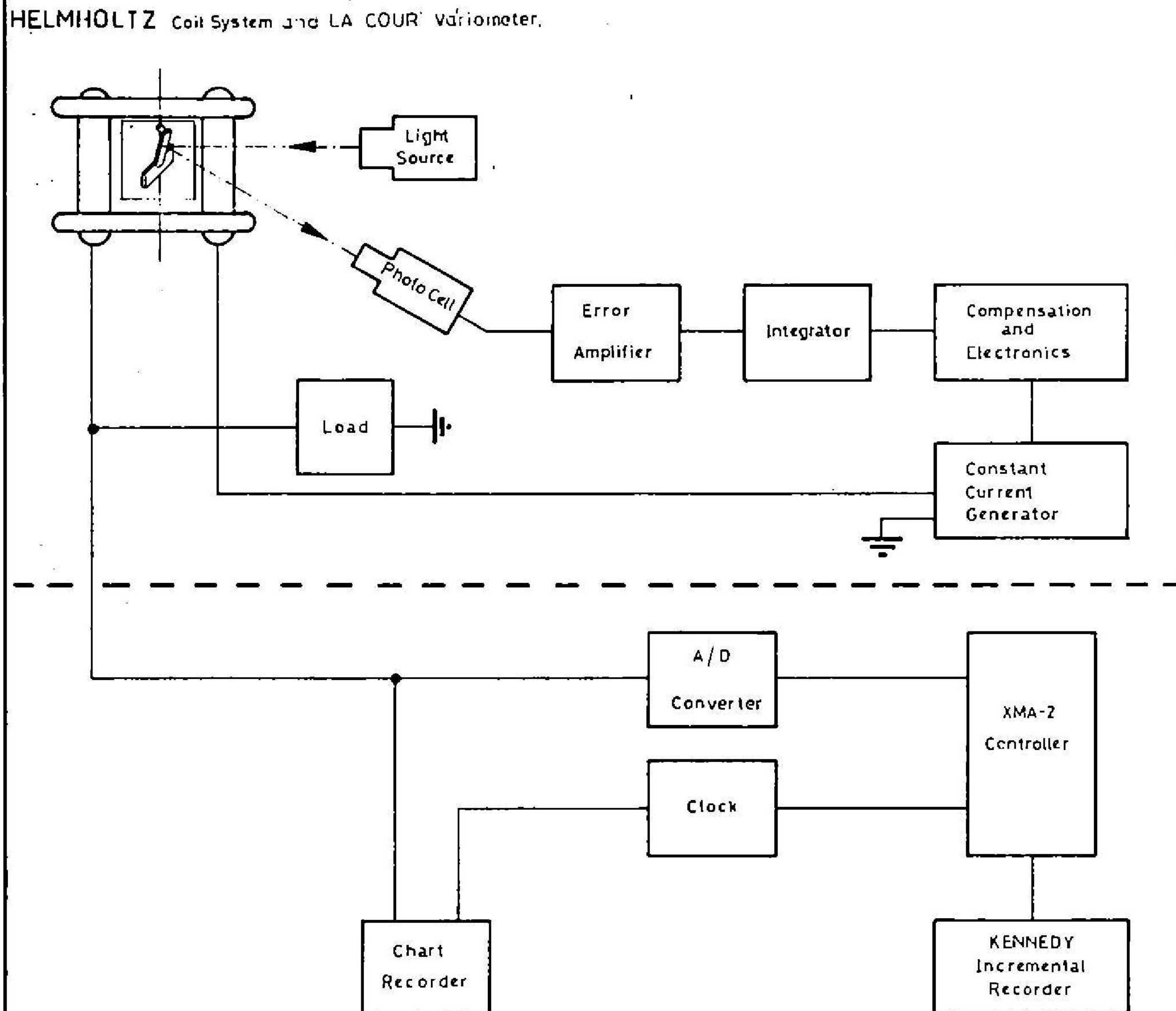


Photo Electronic Variographh System

Fig. 4·6·3

DRG 01 Sh.1

4.6.3 Photo-Electronic Variograph (B. Liu, K. Jurello, F. Clements). This project was commenced in 1978. Progress in 1979 was intermittent due to K. Jurello's engagement on higher-priority tasks. The system makes use of a conventional La Cour H sensor as a null detector in a feedback system in which the H component is backed off with a Helmholtz coil. The feedback current provides an analogue record of H variations, and a digital record is obtained by analogue-to-digital conversion.

Tests were carried out earlier in the year on the detectability and resolution of the photocell sensor to detect the magnet deflection. An order was placed for three types of photocell for the servo-control loops. The design of the servo-control loop and mechanical layout was completed in June. The prototype unit consists of five modules for the two horizontal magnetic vector components. Tests were carried out to optimise the photocell and variometer arrangement. Drift tests carried out on the photocell showed the chosen type to be satisfactory.

4.6.4 Power Supply for Elsec Magnetometer (K. Seers). Early in the year there was a need for a specialised power supply to enable Elsec 595 proton magnetometers to be operated from the 240V 50Hz mains. Detailed design and costing were completed for a supply which would provide regulated 18V at 3A plus a constant-current source, for charging internal Ni-Cd batteries, adjustable from 0.1 to 1A. Monitoring and protection circuits were included. However, changes in survey plans reduced the need, and construction was postponed indefinitely.

4.6.5 Canberra Magnetic Observatory (CMO) (W. Greenwood, C. Rochford, W. Harkness). Difficulties were again experienced with overheating of the proton magnetometer sensor coils. Various methods of cooling the head were tried and the problem is still being investigated. The supplier of the system 'Littlemore' have now available a sensor with increased dimensions which should reduce the overheating problem. The purchase of one of these new heads may be the answer to the problem.

4.6.6 First-Order Magnetic System (A. Zeithlhofer, C. Rochford). The analogue first order magnetic station which comprises Adkin 3 component fluxgate plus temperature, Elsec 595 proton magnetometer, EMI clock and 6 channel Rikadenki recorder performed well throughout the year. Minor problems with power supplies, recorders etc. were rectified.

4.6.7 Mount Isa Seismograph (A. Zeitlhofer, C. Rochford). A standard short-period analogue system using a Geotech seismometer was built and tested, and taken to Mount Isa where it was installed and made operational in August 1979. Problems encountered during the installation were:

a) the local d.c. supply proved to be a positive earth system against the standard BMR negative earth system.

b) The BMR type TAM-5 seismometer amplifier required modifications to the filter to obtain an acceptable frequency response and systems magnification at this site.

4.6.8 Manton Seismograph Station (A. Zeitlhofer). A trip to Manton station in August for major maintenance, resulted in the restoration of all three components of the station and the telemetry link to Darwin; a general improvement in data quality and systems reliability was achieved.

4.6.9 Mundaring Magnetic Observatory (G. Woad, B. Page). Activities are reported in the Geophysical Branch Annual Summary. Some support was provided in equipment repairs, special spares, etc.

4.6.10 General Observatory Equipment Maintenance (A. Zeitlhofer, W. Greenwood, C. Rochford, W. Harkness). General maintenance in support of the existing seismic and magnetic observatory network was carried out throughout the year. This included repairs of digital clocks, seismic amplifiers, three Elsec magnetometers for the Antarctic, Sprengnether seismograph, Facit cassett recorders, Moxon power supplies, and other equipment. A number of low-priced Statronics dual power supplies were purchased to replace the less reliable Moxon power supplies in non-telemetry seismograph systems.

4.7 Regional Geophysical Surveys

4.7.1 Crustal Playback System (B. Liu). This system was completed in 1978 but because of other urgent tasks, little progress has been made on documentation of the system.

4.7.2 Repackaging of 6 P.I. Seismographs (J. Williams, S. Prokin, G. Lockwood). Repackaging of the six seismographs was completed in June prior to the NT field program. It involved:

1) Repackaging of the ½-inch tape recorder and the complete seismograph electronics into one especially built marine-ply case instead of two separate aluminium cases.

2) Rebuilding of the radio time-signal reciever so as to fit under the panel of the tape deck.

4.7.3 Development of Light-weight Seismographs (J. Williams, G. Thom, S. Prokin, B. Liu). The major contribution to this system in 1979 was the development of the prototype NCE-3 low-power digital clock. (See para 4.7.4). Some experimental work using new D.C. motors and gearboxes was done in the development of a low-power tape drive and speed control system for the Akai and Tandberg tape decks; this will continue in 1980. Investigations into the use of the compact Geotech S500 active seismometer, and Geotech amplifiers and modulators and demodulators, were also commenced.

4.7.4 NCE-3 Digital Clock (D. Gardner, B. Liu). A new low-power digital clock (NCE-3) is to replace the NCE-1 clock as part of the overall upgrading of the portable automatic seismograph stations. The specifications call for a 6 mA power consumption against the 1A consumption of the old clock. The power consumption for the portable seismograph station is one of the most important factors effecting the planning of logistic support in the field.

D. Gardner spent considerable time in the artwork design of the printed-circuit boards. Due to the overall size limitation and the high packing density, it was a time-consuming task. Construction of the prototype unit was delayed by late delivery of components. However, construction and most off the tests were completed by August prior D. Gardner's departure to join the seismic party in Queensland. Since his return the prototype has passed all bench tests.

A number of production units are scheduled for construction in the first half of 1980.

4.7.5 Modifications to Survey Vehicles (J. Williams, D. Hartas, E. McIntosh). Design drawings and specifications for auxiliary water and fuel tanks and fuel lines for 3 crustal seismic vehicles were made, and the work was completed by contract. Extra spare-wheel carriers and security wire mesh under the canvas canopies were also fitted.

4.7.6 Timing unit for Gravity Surveys (K. Jurello, B. Devenish). A unit driven from a G.E.D. clock was constructed for the Irian Jaya gravity survey. Its function is to give contact closures at various time intervals.

4.7.7 Additional Divided Bar Thermal Conductivity System (D. Stevens). An additional system was designed and manufactured for use with a Blackhawk Porto-Power hydraulic press which was suitably modified to give the required spacing of the upper and lower components of the thermal conductivity system. The system will enable the use samples of both 25 mm and 35 mm diameter. The upper and lower water-cooled heat-sink capsules and their associated hose fittings were all made of stainless steel to overcome the minor corrosion problems that occurred with the original system. A set of sketches of those components which differ from the original system was made.

At time of writing the system is awaiting testing by Dr J. Cull.

4.7.8 Antarctic Aeromagnetic Survey (S. Scherl). Developments in the MNS-2 magnetometers to be used in this survey are discussed in paragraph 4.16.4. The magnetometer and the ice radar and Collins radio altimeter were installed in the Pilatus Porter aircraft to be used in the Antarctic and were test-flown prior to preparation fo shipment. Good quality magnetic records were obtained with all systems operating. S. Scherl will carry out the 1979/80 Antarctic aeromagnetic survey program; he will also collect cored and oriented rock samples in selected localities for palaeomagnetic examination.

4.8 Rock Measurements and Palaeomagnetism

4.8.1 A.F. Demagnetisers (S. Scherl, M. Gamlen). The two units required were completed in 1978, and the draft of the handbooks was written in 1979.

4.8.2 Palaeomagnetic Data Interface (P. Hillman, G. Russell-Smith). The interface was successfully completed early in the year. It enables data to be acquired by an HP 2100 series minicomputer from the SQUID magnetometer used jointly by the Australian National University and BMR.

4.8.3 Portable Palaeomagnetic Coring Drill (A. Kores, G. Thom). The drill comprises a Stihl chain-saw motor to which has been added a gearbox with output shaft adapted to receive existing diamond coring-drill barrels. Some modifications to gearbox design and gear ratios were made over the design used on the first drill constructed.

4.8.4 Miscellaneous Tasks. Maintenance tasks on X-Y plotter, diamond saw, pump motor, etc. were carried out.

4.9 Magneto-tellurics

4.9.1 McArthur Basin 1978 Survey (A. Spence, D. Kerr, J. Major, R. Moore). Processing of the data continued into the first half of 1979 and included some 2-dimensional inversion modelling of the area in the vicinity of the Emu Fault, a feature which is clearly indicated in the modelling. The results are discussed in the Geophysical and Geological Branch annual summaries.

4.9.2 System Development and 1979 Survey Preparation (A. Spence, B. Liu, W. Greenwood, J. Whatman, S. Darcy). The 1979 McArthur Basin magneto-telluric survey did not receive approval till the end of May, and as a result, survey preparation both technical and administrative was more than usually rushed. During June the problem of drift in the post-amplifiers was examined by B. Liu. Arrangements for servicing of vehicles were made but work proceeded slowly during May/June on the M.T. vehicle installation owing to constant interruptions by higher priority tasks.

Various troubles with the electrical equipment were encountered during July. The disc was repaired three times by Hewlett-Packard. One of the microcircuit interface cards in the HP 21 MX computer gave intermittent faults. A commercial voltage stabiliser was burnt out and had to be replaced with one of a lower rating. A larger-capacity generator replaced the smaller one which tended to cut off during cold nights. Problems with the pre-amplifiers and post-amplifiers were rectified. Three weeks were spent at a site near Tharwa to test the system. Difficulties experienced were mainly due to problems with the data acquisition program. The field party left Canberra on the 13 August.

4.9.3 1979 McArthur Basin Magnetotelluric Survey (A. Spence, J. Whatman, B. Liu). The party arrived at the McArthur geological party's camp on 30 August. A base for operations was established at the Tanumbirini waterhole on 3 September. Data acquisition over six sites was completed by the first week in October and the full 17 sites programmed were completed by mid November. The quality of the data was reasonable though the Ey/Hx apparent resistivity vs period plots generally exhibit more scatter than the corresponding Ex/Hy plots.

Also, signal levels in various bands were very erratic and it was difficult to settle on a fixed schedule of recording. Towards the end of the survey, nearby thunderstorm activity increased noise problems. Due to the pressing time schedule, no one-dimensional inversion of the data was attempted in the field. The data was transferred from disc to tape which was then forwarded to head office for processing.

The major equipment troubles were due to the motor alternator and the disc drive unit. The output of the alternator was ill-regulated; hunting could result from the heat of midday. On a few occasions, it caused a 21MX computer power failure and drop-out of the disc drive.

An intermittent fault in the disc hampered initial field operations until a replacement disc was sent from Canberra. The analogue part of the system and the sensors, pre-amplifiers, and post-amplifiers had only minor faults, and in general performed satisfactorily.

4.10 Seismic

4.10.1 Survey Preparation and Maintenance (J. Grace & others). These activities are reported in the Geophysical Branch annual summary under "Seismic technical services".

4.10.2 Analogue-to-Digital Tape Transcription (B. Devenish, F. Clements). A control unit, previously developed for marine seismic tape transcription, was modified for use in the digitising of tapes played back on the MS-42 analogue office playback system and processed by a Hewlett-Packard minicomputer. The modified unit enables the computer to: start or reset the MS-42; initiate the sequencing of playback channels; and receive a SET FLAG command from the time break on each MS-42 channel.

An oscillator, added to the unit, gives selectable digitising intervals of 1, 2, 4, or 8 ms.

4.10.3 Seismic Processing System (B. Devenish). The Seismic and Marine Group under a National Energy Research Development and Demonstration Council (NERDDC) grant are assembling an in-house seismic processing system for high-speed low-cost processing of seismic data. It utilises some special hardware for which technical advice was provided viz (1) an array processor which under minicomputer control executes most seismic data computations at very high speed, permitting much larger quantities of data to be processed and more sophisticated processes to be applied than would otherwise be possible; (2) a seismic rasterer which is specially designed to handle the seismic reflection data output from the computer and interfaces between the computer and an electrostatic dot plotter on which the reflection section is displayed. It greatly simplifies and speeds up processing. Tenders were called for both items.

4.11 Marine Geophysics

4.11.1 Marine Data Acquisition System (P. Hillman, K. Seers, M. Gamlen, B. Devenish, D. Gardner, D. Pownall, R. Gan, F. Clements, K. Mort, H. Kirk). The retirement of P. Hillman in June brought work on this project almost to a standstill. The following is a status summary for each of the BMR-built units in the system:

(1) Modifications to G.E.D. Clock Type 105. Interface modifications were added to two units to allow them to be used with Hewlett-Packard Data Source Interface cards.

(2) TAM-7 Amplifiers/Filters. The six units built in 1978 were checked for correct filter responses with a specially-built test set.

(3) Digital Senders and Receivers. Thirty-two of each of these circuit boards were assembled by contract and individually tested in BMR using the recently purchased Logic State Analyser. The eight sender bins and four receiver bins still await labour for wiring.

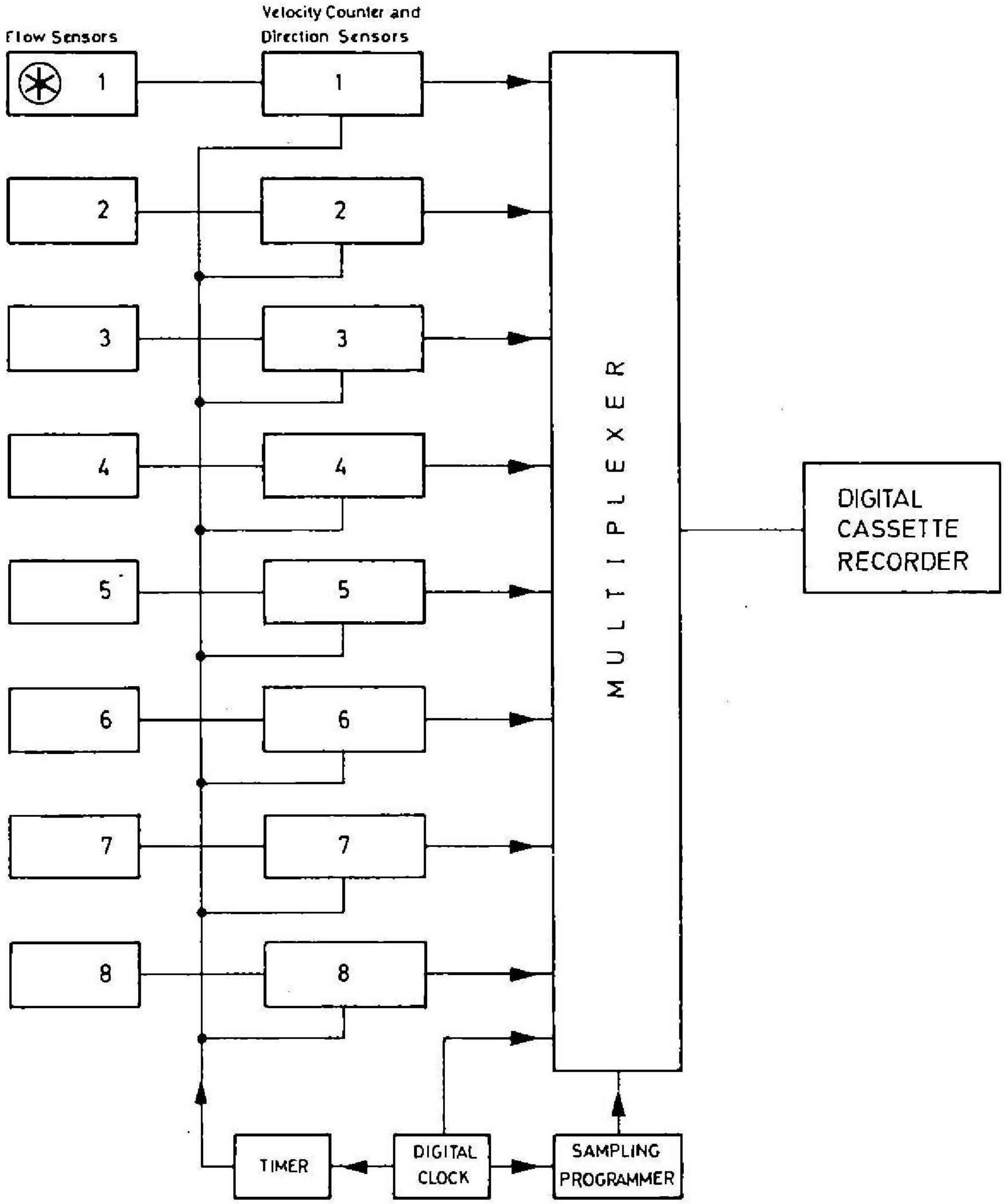
(4) Timers. Eight circuit boards were assembled. Bin wiring and power-supply construction are not yet complete.

(5) Stand-Alone Monitoring Digital-to-Analogue Converter. Most of the components for this 16-channel D-to-A converters were received but assembly was delayed by lack of labour.

(6) Patch Panel. The design of the mounting assembly was completed but lack of labour (and special tools on order) has postponed final construction.

(7) Multiplexers. The 16-channel, 12-bit multiplexers, previously designed by B. Devenish for the airborne data-acquisition system, were tested during the year and found more suitable for the marine system than was the Hewlett Packard multi-programmer originally specified. Two more multiplexers,operating from 240V mains rather than 28 V d.c., were therefore constructed for the marine system.

4.11.2 Technical Support to Marine Surveys (J. Grace, R. Dulski, P. Fowler). Support was provided in maintenance of equipment, in shipboard installation of systems, and in running the equipment during cruises. Maintenance included EGG sparker trigger units, capacitor banks and power supplies, analogue chart recorders, magnetometer winch, Geometrics marine magnetometers, Edo Digitrak, Raytheon pinger-correlator, etc. A computer-based marine data-acquisition magnetometer system was installed in the M.V. Cape Pillar for two cruises in August - September 1979, and a simpler version of the system was successfully installed in the Nella Dan for trials in a cruise to Macquarie Island in October 1979. The developments in these systems, which in the case of the Cape Pillar includes integration with the ship's navigational and bathymetric systems, have been almost exclusively in software, and are reported in the Geophysical Branch annual summary.



GBR Underwater DAS

Fig. 4·12·1

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FIG 4·12·2 HYDRAULIC ROTARY CORING DRILL

FIG 4·12·3 SEDIMENT SAMPLING TOWER

4.11.3 Marine Seismic Cable Winch (J. Rutledge) BMR's large seismic cable winch stored at Oaklands was inspected with a view to modifying it for use with smaller, modern seismic streamer cables. This appears to be economically practicable, and work commenced on these design modifications.

4.12 Marine Geology

4.12.1 Underwater Data Acquisition System (B. Liu, T. Dalziell, J. Rutledge, R. Gan). A digital data-logging system was designed and packaged for monitoring tidal current flow for use in studies of volume transport of sediment in the Great Barrier Reef. An ANSI-compatible cassette recorder was chosen because it conforms with the format requirements of the in-house Hewlett-Packard computer. A cassette option for the T.I. 'Silent 700' terminal was procured so that it could be used for field playback.

The prototype system, packaged in a spray-proof case with the sensor interface, was dispatched in March to One Tree Island for installation on the sediment sampling tower. After initial problems with the flow sensor the system worked satisfactorily.

The second phase of this project involves the construction of two production underwater systems for the 1980 field season. Mechanical design commenced on a stainless steel underwater capsule to house the data logger and primary cells. Selection of a suitable current sensor proved to be difficult: electromagnetic sensors are more reliable than the impeller type, but involve considerable electronics, consume more current, and are generally more difficult to interface. For the present phase of this project the impeller type sensor was selected since its output is digitally compatible, resulting in the saving of an analogue front end.

4.12.2 Drilling Rig and Vibro-corer for Great Barrier Reef Survey (G. Thom, A. Kores, D. Foulstone, E. McIntosh). The portable hydraulic rotary drill built for the 1978 survey was overhauled, plastic liners and core catchers were made, and the drill was used in March and April 1979. A mechanical problem in sealing the head of the Onan motor which drives the hydraulic pump caused the only serious difficulty. The drill is being prepared for further work in 1980.

Problems were encountered with the hydraulic vibro-corer. A jack-hammer adapter was made, and light steel barrels were used to replace the plastic tube tried in 1978, but failures occurred at the threaded junctions between drill barrels. Modifications were made in the field, and cores were obtained, but this remains a weakness difficult to overcome if the equipment is to be kept light.

An entirely different concept for the vibro-corer has since been examined and is being assembled for use in 1980. This uses a 6-metre length of aluminium tube as the drill barrel (i.e. no junctions) and a lighter vibrator driven by a flexible shaft. The aluminium tube will double as drill stem and plastic liner and will be cut lengthwise to recover the core. i.e. only one core will be obtained with each length of tubing.

4.12.3 Tidal Sediment Sampling Towers for Great Barrier Reef Survey (G. Thom, A. Kores, E. McIntosh, D. Foulstone, D. Stevens, R. Westmore). The towers carry containers and mechanisms which automatically collect water samples for sediment analysis during both rising and falling tides. Two towers were completed and used in reef studies in 1979. Following the 1979 field experience a number of design modifications were proposed. Four new towers are being constructed for use in 1980. They use a 63-mm square-section guyed mast instead of the open frame structure, and a simpler design for the falling tide sampling mechanism.

4.12.4 Alpha Particle Spectrometer for Uranium Series Dating (M. Gamlen). The spectrometer system is required for uranium/thorium dating of corals using alpha-particle emission, and will replace absolete equipment that has broken down and is beyond economic repair. Proposals and cost estimates for five possible alternative systems were documented, and a system utilising a multi-channel analyser, as in the original system, was selected. Specifications for the components of the system were completed and the buying and engineering work to re-establish this facility should be completed in 1980.

4.12.5 Core Impregnating Chamber (D. Hartas). A stainless steel low-pressure chamber for the impregnation of cores of porous sediments was designed, and its construction was let to contract. The equipment was completed in February; after initial tests and minor modifications to the original design it worked satisfactorily.

4.13 Petroleum Technology

4.13.1 Pyrolysis Sampling System (B. Devenish, H. Kirk, F. Clements). A design modification was requested to enable the furnace temperature to go from 200°C to 800°C in a ramp of 20, 30, or 40°C per minute. Model circuits were made and tested. Computer modelling of parts of the circuit was carried out. The unit was then constructed and is undergoing tests.

4.14 A.D.P. Group

4.14.1 X-ray Diffraction Interface (B. Devenish). It was proposed that the X-ray diffraction equipment be interfaced to the Hewlett-Packard computer system. Originally it was thought that the only requirement would be to connect data inputs to the computer, with the possibility of level changing. However, on closer investigation it was found that fairly complex circuitry was required to enable the interface device to carry out certain computer-controlled functions. The project was deferred until 1980.

4.14.2 Eight-Channel Digital-to-Analogue Convertors (B. Devenish). A BMR Record was produced describing these plug-in units for Hewlett-Packard minicomputers. Documentation of the design and the ten production units is now complete.

4.14.3 General Maintenance and Installations (W. Greenwood, C. Rochford). A number of terminals to the Hewlett Packard 21 MX in-house computer system were installed or relocated. Considerable time was spent in maintaining the Gradicon X-Y digitiser used principally by the drafting section. Repairs were carried out on the Gould plotter power supply and a low-power digital clock was modified for A.C. operation with battery standby power supply and float charge facility.

4.14.4 Current & Voltage Monitoring System (W. Burhop). A mains voltage/current monitoring system with a current transformer to give peak current and waveform was designed and constructed for the Hewlett-Packard minicomputer installation in Irian Jaya at the request of the A.D.P. Group.

4.15 Museum

4.15.1 Mineral Display Cabinet (W. Harkness, B. Devenish, G. Lockwood). A cabinet for permanent display has been designed as BMR's contribution to Questacon. The design includes the synchronised switching of two types of ultraviolet light with a spoken description of the minerals from a cassette recorder. The electronics are well advanced and the cabinet will be completed in 1980.

4.16 Engineering Services Branch Projects and General Services

4.16.1 Computer-Aided Design/Electronics Design (K. Seers, R. Cobcroft). The debugging and installation of the interactive circuit analysis programs LINCAD (linear circuits) and OSUCAD (non-linear circuits) on BMR's HP-21MX system was suspended owing to high-priority tasks.

The circuit analysis program SCEPTRE, obtained from the USA, was successfully installed on the CYBER computer by the A.D.P. section, and a bench mark program was written and successfully run. The source language and the compiled version were backed up on tape, and are transferred to disc as required.

Two tapes ordered late last year arrived; these contained the program SUPER-SCEPTRE and the library of transistor, diode, and SCR models for use with SCEPTRE and SUPER-SCEPTRE on the CYBER 76 computer. The library tape was read, but the SUPER-SCEPTRE tape could not be read and help has been sought from the CSIRO Division of Computing Research, which is currently working on the problem. The model library tape was successfully run with SCEPTRE in a test program.

There were no meetings of the ad hoc CSIRO Computer-Aided Design committee this year.

4.16.2 Microprocessor Support (G. Russell-Smith, M. Gamlen). The Motorola 6800 system has been expanded this year to include a programmer and eraser for ultraviolet-erasable programmable read-only memory (EPROM). While this board is not being used as a programmer it provides 16 k bytes of EPROM storage on the 6800 bus. A considerable amount of applications softward, which will run on the old 6800 MPU or the new 6801 MPU, has been collected. This latter processor has an extended 6800 instruction set in which the added instructions provide an 8-bit unsigned multiply and a 16-bit arithmetic capability. Four k bytes of read/write random-access memory (RAM) are available to the 6801. Extra RAM is essential for testing applications programs before 'burning' them into EPROM, and it is proposed to purchase a 16 k or 32 k byte partially filled RAM board.

Current applications are: (1) counting experiments in proton-precession magnetometry (see 4.16.5); (2) a proposal for a dual 6800 processor vehicle-borne data acquisition system for Metalliferous Geophysics (see 4.2.8); (3) the borehole fluxgate magnetometer (see 4.2.5), a three-component instrument, which may use a 6800 family processor to compute vector sums of two and three components if the project goes ahead.

4.16.3 Magnetic Bubble Memory (M. Gamlen). Bubble memory chips have been available commercially since 1977 when Texas Instruments released a 92 000 bit unit. Now several companies produce a chip of about 250 000 bit capacity. BMR is particularly interested in using bubble memory for field-data collection as a alternative to magnetic tape, which is not well suited to dusty or hot humid environments.

Cost is a big factor: one megabit of storage costs $2000 to $3000. This includes the complex drive circuitry and programming to avoid the faulty bubble loops present in every commercially available chip. In many field systems, bubble memory boards would need to be changed hourly or even more frequently, and tape is likely to remain the favoured medium here for some time. However, in other applications one megabit can hold days or weeks of collected data; this is an attractive area for bubble memory application, although low-power circuitry, to 'power-up' and 'power-down' each time data is recorded, may need to be developed as bubble memory is highly dissipative while reading and writing.

4.16.4 MNS-2 Proton Magnetometer (K. Seers, S. Scherl, F. Clements, K. Mort, M. Gamlen). A new input amplifier was designed and two were built and tested. New input transformers were used to improve the amplifier's frequency response and so make the instrument insensitive to changes in cable capacitance and head inductance. Signal-to-noise ratio has been slightly improved. The new amplifier will be used for aeromagnetic work in Antarctica during the 1979-80 summer.

The major source of noise in the input amplifier is still the effective noise resistance of the input transformer: that is, the transformer losses inject thermal agitation noise into the field-effect transistory first stage. A low-loss, low-winding-capacitance input transformer was designed and built using a ferrite core. This improved the electrical signal-to-noise ratio by about 7 dB, but was microphonic and so would require acoustic shielding. We hope to overcome this problem in 1980 and further improve the signal-to-noise ratio by 3 dB.

In addition to its use for Antarctic aeromagnetics the MNS-2 is now being used routinely in the Canberra and Gnangara magnetic observatories for vector measurements.

K. Seers wrote some additional material for the handbook, Vol. 1 of which was issued as BMR Record 1979/59.

4.16.5 Digital Processing of Proton-Precession Signal (M. Gamlen). A new sampling technique requiring very simple processing by an 8-bit microprocessor was formulated to improve the resolution of a proton-precession magnetometer signal. The digital processing replaces the more usual phase-locked loop in the front end of the magnetometer. Preliminary tests of the technique and laboratory experimentation supported the theory and M. Gamlen prepared a paper explaining the performance improvement which would result by changing to this digital processing method from the more usual phase-locked loop system. Much of the microprocessor software has been written and the system will be tested on a new Motorola 6801 processor early in 1980. It could also be applied in other geoscience areas where accurate frequency determination of a noisy signal is required.

4.16.6 Ion-Current Meter for use on Ion Microprobe and Mass Spectrometers (M. Gamlen, S. Scherl). Mass spectrometry requires fast-responding current measurement in the nanoampere to sub-picoampere range. New isotope ratio techniques demand greater accuracy if good geochronology is to result. Wide mass-range scanning on the ion microprobe profits from a fast-settling instrument.

A microprocessor-controlled self-calibrating picoampere meter is being developed to meet these needs. It uses a relatively-high-frequency capacitance-modulator-type amplifier to improve dynamic performance. Good progress has been made on the amplifier, and the next step is to test the self-calibration circuitry.

4.16.7 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 with a view to developing a better means of controlling emission spectrum and energy. During 1979 a test tank and laser facility for monitoring bubble growth was almost completed. Bubble growth is to be monitored by counting interference fringes formed by a split laser beam, one path of which passes through the bubble. Advice was given on alternative electronic systems for making these measurements.

4.16.8 Instrument Laboratory (W. Burhop). Two major instruments were added to the pool in 1979: an HP-1615A logic analyser, which has since been in almost continuous use, and a Fluke 892A true RMS digital voltmeter. However, acquisition of such items is not keeping pace with the growing obsolescence of pool instruments. Basic test equipment such as digital multimeters, multi-channel storage oscilloscopes, and high-precision instruments such as the Fluke voltage standard are being increasingly used in the field for development projects or to maintain modern geophysical instrumentation, so that there are no longer enough modern instruments to meet field and laboratory needs.

Some of the standard resistances and standard cells used in the laboratory are 30 years old and need to be replaced. The rubidium-vapour frequency standard broke down following a short power failure; it was repaired and its frequency verified to 1 in 10^9.

Supervision of the allocation of pool instruments, the maintenance of accuracy (or at least coherence) in electrical measurements, and provision of advice on measuring equipment absorbed most available time. Virtually all of the time was spent in keeping the 400 odd items of equipment functional. No routine calibrations were carried out, calibration being confined to restoration on confirmation of accuracy following maintenance etc. Phase calibration measurements were made on a low-frequency spectrum analyser being considered for complex resistivity measurements by the metalliferous geophysics group.

4.16.9 Communications Equipment (W. Harkness). Repairs and check-out of all transceiver and other communications equipment continued throughout the year. All Codan transceivers were fitted with emergency call facilities, and channel frequencies were changed or added to meet BMR's programmed activities.

4.16.10 Miscellaneous Activities - Electronic Technical Group. Portaloggers, portable generators, printers, light tables, display cabinets, driers, pH meters, ultrasonic cleaner, radiometers, centrifuge, atomic absorption spectrometer, gas chromatograph, environmental shake-table, and other instruments from most groups in BMR were maintained or repaired. Floodlights were installed in the BMR foyer for the Map Week 79 display. Acceptance tests were carried out on the new gamma-ray spectrometer, inverters and power supplies, lock-in analyser, etc.

4.16.11 Miscellaneous Activities - Mechanical Technical Group. Over 200 ad hoc miscellaneous tasks were completed during the year. These included: instrument repairs (R. Grigg, D. Stevens, S. Prokin) e.g. to the Gould plotter, Helmholtz coil, Zeta incremental plotter, observatory seismometer, porosimeter, vacuum pump, gravity meters, modifications to microscope slide attachment, ect.; heavy workshop tasks (R. Westmore, S. Darcy) such as overhaul of motor generators, construction of rock-bin rack, overhaul of rock saws and construction of rock vice, addition of motor to heat-flow logging winch, equipment installation in vehicles, etc.; woodworking tasks (G. Lockwood) which included show cases and many special transit cases etc. Three of the more time-consuming jobs were (1) special packaging of 5 refrigerators

(G. Lockwood) to permit transport by helicopter and use on site in their containers; (2) the construction of 23 display boards (G. Lockwood) for use during Map Week 79; (3) investigation of an oil mist problem associated with a large rock saw (D. Hartas, E. McIntosh). Ducting etc. was constructed to permit the trial use of a "Mistpure" mist eliminator. This eliminated the mist, but not the associated smell, and the system was dismantled.

5. TRAINING, COURSES & CONFERENCES, REPORTS

5.1 Training

The retirement of P. Hillman suspended the implementation of internal audio cassette training courses in electronics purchased from the University of New South Wales; they will be resumed in 1980.

K. Seers and A. Zeitlhofer continued to represent the department on the program advisory committee on certificate level courses in electrical engineering at the Bruce TAFE College. Seven meetings were held during the year, and both officers took part in a working group to devise a course evaluation questionnaire for former graduates. In addition, K. Seers collaborated with the committee's executive officer (Mr J. Greethead) to assemble material relevant to education on electronic component characteristics - a topic which the committee believed should receive more emphasis.

5.2 Local Conferences

M. Allen)	Engineering Management Conference, Institution of Engineers Australia, Melbourne, 21-22 March 1979.
B. Devenish) M. Gamlen) A. Zeitlhofer)	Institute of Radio and Electronic Engineera (Aust): IREECON INTERNATIONAL SYDNEY 1979. 17th International Electronics Convention and Exhibition. 27-31 August 1979.

B. Devenish	)	Microprocessor Systems: Institution of Engineers Australia, Melbourne, 27-28 November 1979.
K. Seers	)	Microporcessors for Engineering Managers, Technisearch Ltd, Canberra. 10 November 1979.
B. Liu	)	Communications Satellite Workshop, P & T Department, Canberra, 22-24 August 1979.
B. Devenish	)	Problem Solving Concepts for Computer Systems, Hewlett-Packard, 5 June 1979.

5.3 Training Courses

External

R. Cobcroft	)	Modern E.M. & I.P. Exploration Techniques AMF, Adelaide, 1-5 October 1979.
M. Allen	)	Building of Management Teams, PSB & The Australian Administrative Staff College, Mount Eliza seminar, Canberra, 19-20 February 1979.
R. Dulski	)	First Aid Course, Canberra, 3 & 6 December 1979.

Internal

S. Scherl R. Dulski	))	Introductory Fortran, 28 May-1 June 1979.
K. Jurello G. Jennings	))	Introductory Fortran 17-19, 24-25 September, 4 October 1979.
K. Seers K. Jurello	))	Staff Counselling Techniques, 5-10 August 1979.

G. Thom	)	Basic Management 21 - 25 May 1979.
R. Gan	)	Supervision Workshop, 9-11 October 1979.
J. Rutledge	)	On-the-job Training, 14-16 February 1979.
A. Zeitlhofer	)	
A. Spence	)	Photo Reading and Introduction to Photo Geological Interpretation, 7 March 1979.

5.4 Reports

BMR Records

1979/48	Devenish, A.B.	Sixteen-channel digital multiplexer, BMR Type XDM-1
1979/76	Devenish, A.B.	Development of 8-channel D/A conversion card for HP-2100 Series computers
1979/59	Seers, K.J.	Proton-precession magnetometer, BMR Type MNS-2

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