Record 1986/4

BROKEN HILL MAGNETOTELLURIC SURVEY 1984: OPERATIONAL REPORT

by

T.Barton

CONTENTS

TABLES

FIGURES

SUMMARY

This record reports the operations of the BMR magnetotelluric (MT) survey carried out in the Willyama complex during 1984.

BMR MT work was first conducted in this area during 1982 as an attempt to clarify the location of the Precambrian boundary for the eastern limit of the Broken Hill block in the Willyama complex. The objective of the 1984 survey was to provide additional assistance in the mapping of the boundaries of this region which are obscured by recent cover in the Murray/Darling basin. The survey consisted of twenty sites along two traverses, one northeast and one south of Broken Hill. Magnetic data were acquired along both the 1982 and 1984 MT traverses using the BMR vehicle-borne data acquisition system (VDAS) as a further aid to interpretation. Resistivity measurements were planned at four MT sites, however these were not carried out because of equipment failure.

In addition, one MT site was occupied at Waukaringa S.A. close to a site where deep resistivity soundings had been made by workers from the Research School of Earth Sciences (RSES) of the Australian National University (ANU). The data obtained from this site will allow a comparison of these two techniques.

Preliminary data analysis carried out in the field consisted of producing plots of period versus apparent resistivity upon completion of data acquisition at a site. A marked change in character of these plots along the northeastern traverse, at Yancowinna Creek, was observed. This suggests the possibility of major subsurface structural change occuring in this area. No similar features were observed along the southern traverse indicating that this boundary may be a complex structure.

Good quality data were obtained at all sites and are stored on magnetic tape for post-survey processing and interpretation.

1 INTRODUCTION

This record documents the field operations of the BMR MT survey carried out in the Broken Hill Block during 1984. Included are relevant pre- and post-survey information required for subsequent documentation and interpretation.

The proposal to do MT work in this area is contained in BMR file 82/938 titled MT Broken Hill Block. The objective of MT work in the Willyama complex was to clarify the location of the Precambrian boundary for the eastern and southern limits of the Broken Hill Block.These limits cannot be determined from the surface geology as they are obscured by sedimentary cover in the Murray/Darling basin. This boundary is considered to be a controlling feature in primary models of evolution in the Lachlan Fold Belt.

In 1982 fourteen MT sites were occupied along a 250 km traverse across the southeastern margin along the Broken Hill - Ivanhoe road. Interpretation of these data is described by Cull (1985) and Cull & Spence (1985). The results from this survey warranted further investigations which were carried out between June and August in 1984. Interpretation of results will be reported in a separate document.

2 PREPARATORY PHASE

Preparations for the 1984 survey commenced with a major upgrade of the MT data acquisition system. This began with the installation of a new computer system comprising an HP A600 CPU, HP7908A disc and tape drive, and an HP2623A graphics terminal with printer. The CPU was interfaced with the other components of the system and software was written for data acquisition and processing under the RTE-A.1 operating system. All the electronics and connecting cables were checked and serviced. A diesel alternator was purchased to avoid power supply problems which had been encountered on previous surveys.

A simplified block diagram of the MT data acquisition system hardware as used in the 1984 survey is shown in Fig. 1. A detailed account of both the equipment and software used is given by Barton & others (in prep.), which is an update of Spence & Kerr (1982) and Cull & others (1981).

Calibration of the electric and magnetic pre-amplifiers was carried out in accordance with the Geotronics handbook before commencing field testing. It has been the practice to conduct a full scale field test of the system close to the BMR office prior to commencing a field trip. The same test site has been used on all occasions. This allows a comparison of results to be made so that the long term stability of the system can be checked. The site is located near the intersection of the Pine Island and Tharwa roads in the Tuggeranong Valley, ACT (lat.149°5',long.35°29'). This site was again occupied prior to the 1984 MT survey. Before data were collected a complete system check was made and the data acquisition software was debugged. Results obtained confirmed the long term stability of the system and they are stored on magnetic tape labelled "Tuggeranong test 1984".

3 FIELD OPERATIONS IN THE BROKEN HILL AREA

3.1 FIELD WORK

The field work was carried out from June 2 to August 8 of 1984. Field staff were :

A.Spence - Geophysicist (Party leader)
T.Barton - Geophysicist
L.Allen - Computer Programmer (2/6/84 - 20/6/84)
R.Curtis - Technical Officer (18/6/84 - 8/8/84)
P.Butler - Field hand
P.Menz - Field hand

Five vehicles were used:

ZSU-350 : Bedford (3 tonne) - Recording vehicle
ZSU-910 : Chevrolet (1.5 tonne) - Site installation vehicle
ZSU-828 : Toyota LWB - General purpose vehicle
ZUE-145 : Leyland (3 tonne) - Transport of ancillary equipment
ZUB-328 : Toyota SWB - Vehicle-borne magnetometer system

Additional equipment included one diesel alternator, one petrol alternator on trailer, three radio transceivers and a Geotronics model FT-10 transmitter.

At each MT site, two pairs of electrodes were laid out 600 m apart symmetrically about an origin along x and y axes chosen to fit the local topography conveniently.The axis whose direction lay in the first or primary quadrant was defined as Ex. At the origin, three mutually perpendicular magnetometers are buried, one along each of the E-field axes and one vertically. A complete description of the field procedure is given by Word & Hopkins (1971).

Twenty sites were occupied in the Broken Hill area. Sites 1 to 10 were along a 100 km north-south line at 141°30' longitude between latitudes 31°55' and 32°48'. Sites 12 to 19 were on a 70 km east-west line at 31°45' latitude between longitudes 141°40' and 142°25' (Fig.2). The planned site 11 was not occupied because of poor access. Sites 14A and 14B were added whilst the survey was in progress and will be discussed in a later section. Tables 1 and 2 list the site names, map sheets, latitudes and longitudes, magnetic azimuth of the Ex axis, dates and duration of occupation. An additional MT site at Waukaringa near Yunta in S.A. was also occupied.

In order to minimise time lost between recordings the mode of operation was to occupy a site and while data acquisition was taking place the next site would be set up. All sites, with the exception of Yunta, were within one hour of driving time from Broken Hill, allowing daily trips to and from sites. At least one party member was present on site at all times, thus allowing continuous data acquisition to proceed.

In addition to the MT sites occupied, three magnetic traverses were observed using the BMR vehicle-borne magnetometer system along roads from Broken Hill adjacent to the 1982 and 1984 MT traverse lines.

Resistivity traverses were planned for four sites but cancelled because of equipment failure.

Weather conditions were good during most of the survey with only minor disruption due to rain.

3.2 DATA ACQUISITON

The BMR system is designed to record data in seven overlapping bands covering the spectrum of frequencies from 0.001 Hz to 40 Hz. The limits of the frequency bands used, together with the number of samples collected and the sampling interval, are given in Table 3. A detailed account of the equipment and software used in the 1984 survey is given by Barton & others (in prep.).

Signal activity within bands generally varies with time of day. It has been the practice to acquire a number of data files in each band which, based on previous experience, give reasonable coverage. These are then processed and plotted, any gaps in the plot being filled in by obtaining further data in the deficient bands. Total recording time per site averaged 50 hours. This included two nights over which long period data were collected.

Satisfactory data sets were obtained on all sites. The data from all sites were archived onto HP magnetic tape cartridges using the PUDATA subroutine and labelled with the survey title, site number and tape creation date. The data were also copied onto 9 track format for use on the BMR in-house HP1000 computer upon return from the survey. The magnetic traverse data are stored on five-inch floppy discs, labelled with survey title and numbered EM2 to EM10.

Table 4 lists the files contained on the MT archived magnetic tapes.

3.3 EQUIPMENT PERFORMANCE

Problems experienced with the Geotronics pre-amplifiers at site 18 and again towards the end of the survey caused minor delays to the survey schedule. The unreliability of this equipment was mainly due to vibration during transit and the age of the equipment, resulting in frequent component failure. The A600 computer operated faultlessly throughout the survey. Some time was required for debugging and programming of the acquisition and processing software as this was the first survey carried out since this system was installed. The 8.5 kVA Lister/Braybon generator operated reliably throughout the survey and no problems with power output occurred. The remainder of the MT The equipment performed satisfactorily throughout the survey.

Rain during the survey caused water damage to the Geotronics FT-10 transmitter. Upon inspection it was found that some power transistors in the equipment had been short circuited and it was not possible to repair this in the field. As a result in no resistivity measurements were carried out.

6

The Chevrolet site installation vehicle required major engine repairs. However, it was possible to use the LWB Toyota instead, which caused only minimal disruption to the survey program.

4 POST SURVEY OPERATIONS

New pre-amplifiers of BMR design and construction were delivered to replace the Geotronics E and H pre-amplifiers and software modifications were made to allow these to be interfaced with the system. The A600 computer was transferred to another section so software was written to allow data processing to be carried out on the BMR HP1000 in-house system.

It was not possible either to perform a field test to check the long term stability of the system or to evaluate the new pre-amplifiers performance at the Tuggeranong test site. This was because of the decommisioning of the recording cab and the loss of the A600 computer prevented any further data acquisition being made.

5 DISCUSSION

Satisfactory data sets of good quality were obtained at all sites. Signal levels for each of the recording bands were consistent for all sites during the course of the survey. During the occupation of site 5, data obtained over one long period recording were of a high signal level causing the pre-amplifiers to saturate. This site was located close to high voltage transmission lines and it was suspected that these were related to the high signal levels observed. Subsequent enquiries at the Broken Hill substation determined that this occurred during a failure at Wentworth substation which caused a voltage drop in the transmission lines. It seems likely that these two events were related, as long period data recorded the following night were of acceptable quality.

In-field examination of resistivity plots from sites 12 to 17 showed a marked change in character between sites 14 and 15. Two further sites were occupied between these in an attempt to locate the position of this change. Site 14A was situated midway between sites 14 and 15 with the resultant resistivity plots having characteristics similar to site 15. Site 14B was between sites 14A and 14, also producing results similar to sites 14B and 15. From the data obtained it appears that the eastern boundary of the Broken Hill Block may be along Yancowinna Creek, between sites 14 and 14B. No similar change was seen in results from the southern traverse indicating the possibility that the block boundary in this region may be a complex structure. At present no further MT work is planned for the Willyama complex. Interpretation of results from the MT recordings and magnetic traverses for the Broken Hill survey will be published in a future document.

The Waukaringa MT site was located near where workers from the Research School of Earth Sciences (RSES) of the Australian National University (ANU) had previously conducted controlled-source expanded spread resistivity soundings in this area. The close proximity of this site to the Broken Hill survey area provided an opportunity for MT recordings to be made so that a comparison of these two techniques can be made.

6 ACKNOWLEDGEMENTS

Acknowledgement is gratefully made to the following property owners and managers who allowed the survey party to carry out measurements on their properties:

P.C.Anderson	-	Ascot Vale
N.J.Clarke	-	Balaclava
E.Crossing	-	Topar
J.A.Edwards	-	Broughton Vale
H.R.Harrison	-	Langwell
P.R.Harvey	-	Metford
C.James	-	Broken Hill butchers
D.McRae	-	Netley
H.I.Roberts	-	White Leeds

7 REFERENCES

BARTON,T.,ALLEN,L.,& GARDNER,P.,1986 - BMR magnetotelluric system: Equipment and software, 1984.
Bureau of Mineral Resources, Geology and Geophysics, Australia, Record (in prep.)

CULL,J.P.,1985 - Magnetotelluric soundings over a Precambrian contact in Australia.
Geophysical Journal Royal Astronomical Society, 80, 661-675

CULL,J.P.,& SPENCE,A.G.,1985 - Magnetotelluric soundings across the boundary of the Precambrian Willyama complex and the Cainozoic Murray Basin, southeastern Australia.
Bureau of Mineral Resources, Geology and Geophysics, Australia, Report 250

CULL,J.P.,SPENCE,A.G.,MAJOR,J.A.,KERR,D.W.,& PLUMB,K.A.,1981 - The 1978 McArthur Basin magnetotelluric survey.
Bureau of Mineral Resources, Geology and Geophysics, Australia, Record 1981/1

SPENCE,A.G.,1982 - Central Eromanga Basin magnetotelluric survey, 1980 : Operational report.
Bureau of Mineral Resources, Geology and Geophysics, Australia, Record 1982/34

SPENCE,A.G.,& KERR,D.W.,1982 - BMR magnetotelluric system software, 1980.
Bureau of Mineral Resources, Geology and Geophysics, Australia, Record 1982/35

WORD,D.,& HOPKINS,G.,1971 - Instruction manual : Magnetotelluric system analog data acquisition system.
Geotronics Corporation, Austin, Texas, U.S.A.

TABLE 1
SITE POSITIONS : LATITUDES & LONGITUDES

SITE NO.	MAP (1)	LONG. (E)	LAT. (S)	ORIENT. (2)
01 South Kudgee	Middle Camp	141.643°	32.790°	75°
02 Kudgee	Middle Camp	141.636°	32.706°	75°
03 Backwell	Middle Camp	141.614°	32.606°	11°
04 Netley	Middle Camp	141.568°	32.522°	11°
05 Langwell	Redan	141.553°	32.429°	36°
06 Pine Point	Thackaringa	141.463°	32.304°	30°
07 Ascot Vale	Thackaringa	141.439°	32.222°	33°
08 Balaclava	Thackaringa	141.408°	32.147°	56°
09 White Leeds	Thackaringa	141.381°	32.045°	20°
10 Stirling Vale	Broken Hill	141.353°	31.937°	12°
11	Not occupied because of poor access			
12 Avondale	Taltangan	141.732°	31.902°	13°
13 BM 189	Taltangan	141.829°	31.880°	22°
14 Yancowinna Ck.	Taltangan	141.935°	31.854°	30°
14B Yancowinna Ck. East	Taltangan	141.959°	31.852°	59°
14A Myalla Tank	Taltangan	141.981°	31.850°	18°
15 Topar	Topar	142.035°	31.841°	08°
16 Metford	Topar	142.145°	31.813°	21°
17 Little Topar	Topar	142.216°	31.799°	27°
18 Bilpa Rd.	Topar	142.309°	31.770°	33°
19 Scopes Range	Topar	142.402°	31.736°	01°
Yunta	Orroroo (1:250 000)	139.450°	32.350°	51°

(1) MAP refers to name of 1:100 000 sheet area.
(2) ORIENT. refers to magnetic azimuth of Ex on the original survey axis (E of N).

LAT. and LONG. are given in decimal degrees.

9

TABLE 2
SITE OCCUPANCY INFORMATION

SITE NO.	DATES OF OCCUPATION	DURATION
01 South Kudgee	23-07-84 to 25-07-84	47:30
02 Kudgee	21-07-84 to 23-07-84	48:30
03 Backwell	27-07-84 to 29-07-84	44:30
04 Netley	25-07-84 to 27-07-84	47:30
05 Langwell	18-07-84 to 20-07-84	51:00
06 Pine Point	30-07-84 to 01-08-84	47:00
07 Ascot Vale	14-07-84 to 16-07-84	41:30
08 Balaclava	12-07-84 to 14-07-84	50:30
09 White Leeds	09-07-84 to 12-07-84	70:00
10 Stirling Vale	06-07-84 to 08-07-84	43:00
11	Not occupied because of poor access	
12 Avondale	05-06-84 to 07-06-84	45:00
13 BM 189	08-06-84 to 11-06-84	50:00
14 Yancowinna Ck.	12-06-84 to 15-06-84	51:30
14B Yancowinna Ck. East	02-07-84 to 05-07-84	71:00
14A Myalla Tank	28-06-84 to 01-07-84	53:00
15 Topar	26-06-84 to 28-06-84	45:00
16 Metford	18-06-84 to 22-06-84	55:00
17 Little Topar	16-06-84 to 18-06-84	52:00
18 Bilpa Rd.	22-06-84 to 25-06-84	60:00
19 Scopes Range	07-08-84 to 09-08-84	43:00
Yunta S.A.	02-08-84 to 04-08-84	42:30

10

TABLE 3
FREQUENCY BANDS AND SAMPLING RATES

FREQUENCY BAND (Hz)	NO. POINTS	DIGITISING INT. (msec)	NO. FILES (average)
0.001 - 0.012	2048	4096	10
0.01 - 0.033	1024	2048	10
0.03 - 0.12	1024	1024	10
0.1 - 0.55	1024	256	25
0.5 - 2.5	1024	64	35
2.5 - 12.5	1024	8	35
10.0 - 40.0	1024	4	35

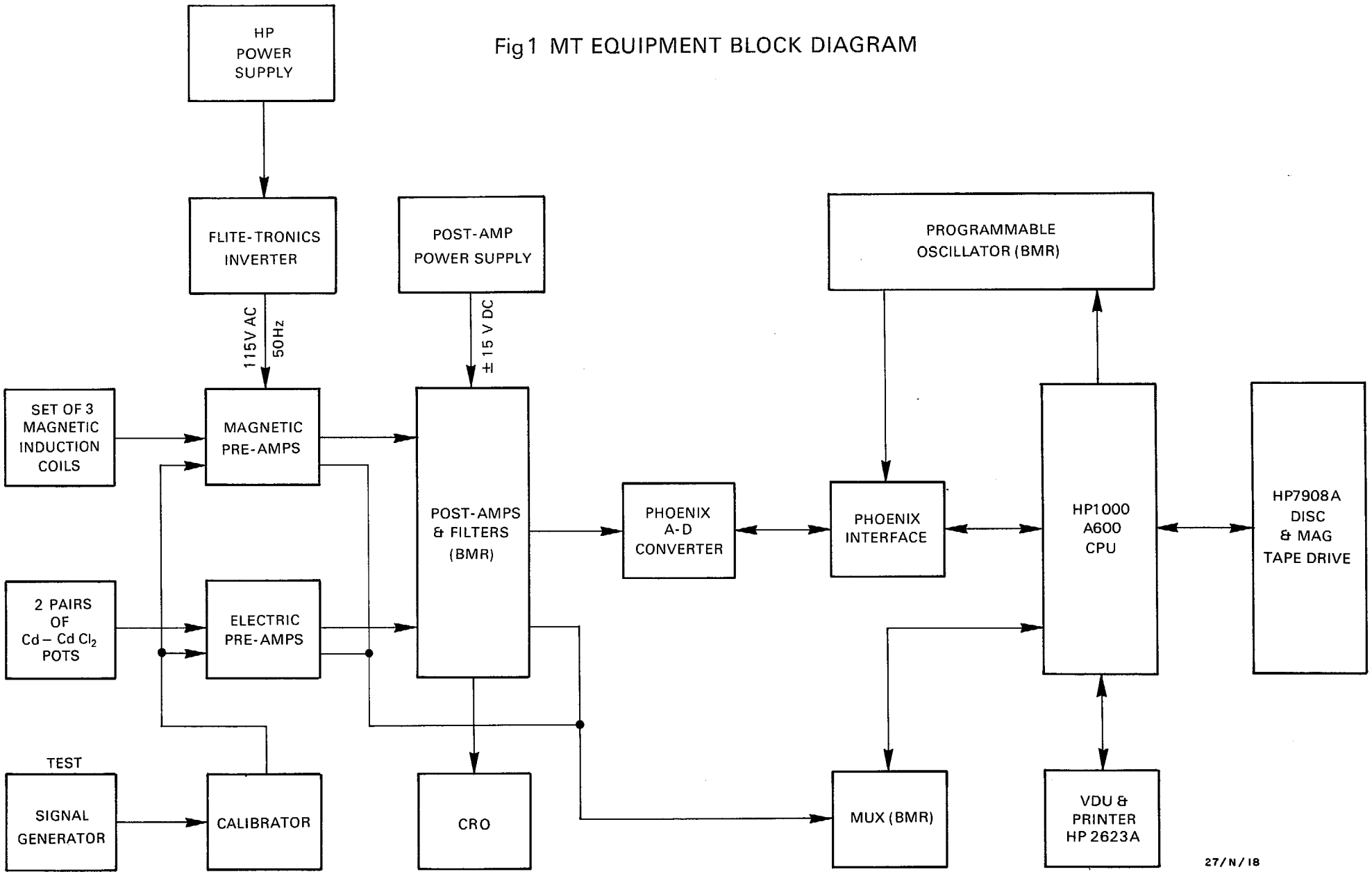
TABLE 4
DATA FILE NAMES

SITE NO.	RAW DATA FILES	FOURIER TRANSFORM FILES
01 South Kudgee	MT3201 to MT3358	FT3201 to FT3358
02 Kudgee	MT3001 to MT3145	FT3001 to FT3145
03 Backwell	MT3601 to MT3765	FT3601 to FT3745
04 Netley	MT3401 to MT3560	FT3401 to FT3560
05 Langwell	MT2801 to MT2947	FT2801 to FT2947
06 Pine Point	MT3801 to MT3959	FT3801 to FT3959
07 Ascot Vale	MT2601 to MT2755	FT2601 to FT2755
08 Balaclava	MT2401 to MT2562	FT2401 to FT2562
09 White Leeds	MT2201 to MT2359	FT2201 to FT2359
10 Stirling Vale	MT2001 to MT2161	FT2001 to FT2160
11	Not occupied because of poor access	
12 Avondale	MT0001 to MT0149	FT0001 to FT0149
13 BM 189	MT0201 to MT0363	FT0201 to FT0355
14 Yancowinna Ck.	MT0401 to MT0556	FT0401 to FT0556
14B Yancowinna Ck. East	MT1601 to MT1746	FT1601 to FT1746
14A Myalla Tank	MT1401 to MT1549	FT1401 to FT1549
15 Topar	MT1201 to MT1371	FT1201 to FT1364
16 Metford	MT0801 to MT0959	FT0801 to FT0957
17 Little Topar	MT0601 to MT0800	FT0601 to FT0800
18 Bilpa Rd.	MT1001 to MT1146	FT1001 to FT1146
19 Scopes Range	MT4201 to MT4362	FT4201 to FT4357
Yunta	MT4001 to MT4161	FT4001 to FT4159

NOTE: All data files are stored in A600 HP cartridge format,and also on HP1000 nine track magnetic tape.

12

Fig 1 MT EQUIPMENT BLOCK DIAGRAM



Record 1986/4

13

KEY

Magnetic induction coils	: Geotronics model MTC-4SS
Cd-CdCl2 pots	: Geotronics model MTE-2
Signal generator	: Hewlett Packard model 3300A
Magnetic Pre-amps	: Geotronics model MTH-4
Electric Pre-amps	: Geotronics model MTE-4
Calibrator	: Geotronics model MTE-4
Post-amp power supply	: BMR construction
Post-amps and filters	: BMR design and construction
CRO	: Tektronix model 5113
Phoenix A-D converter	: Phoenix model 6915-3754
Phoenix interface	: Phoenix model PDI Std. Interface
Programmable oscillator	: BMR design and construction
HP 1000 A600 CPU	: Hewlett Packard model A600
VDU and printer	: Hewlett Packard model 2623A
Disc and mag. tape drive	: Hewlett Packard model 7908A

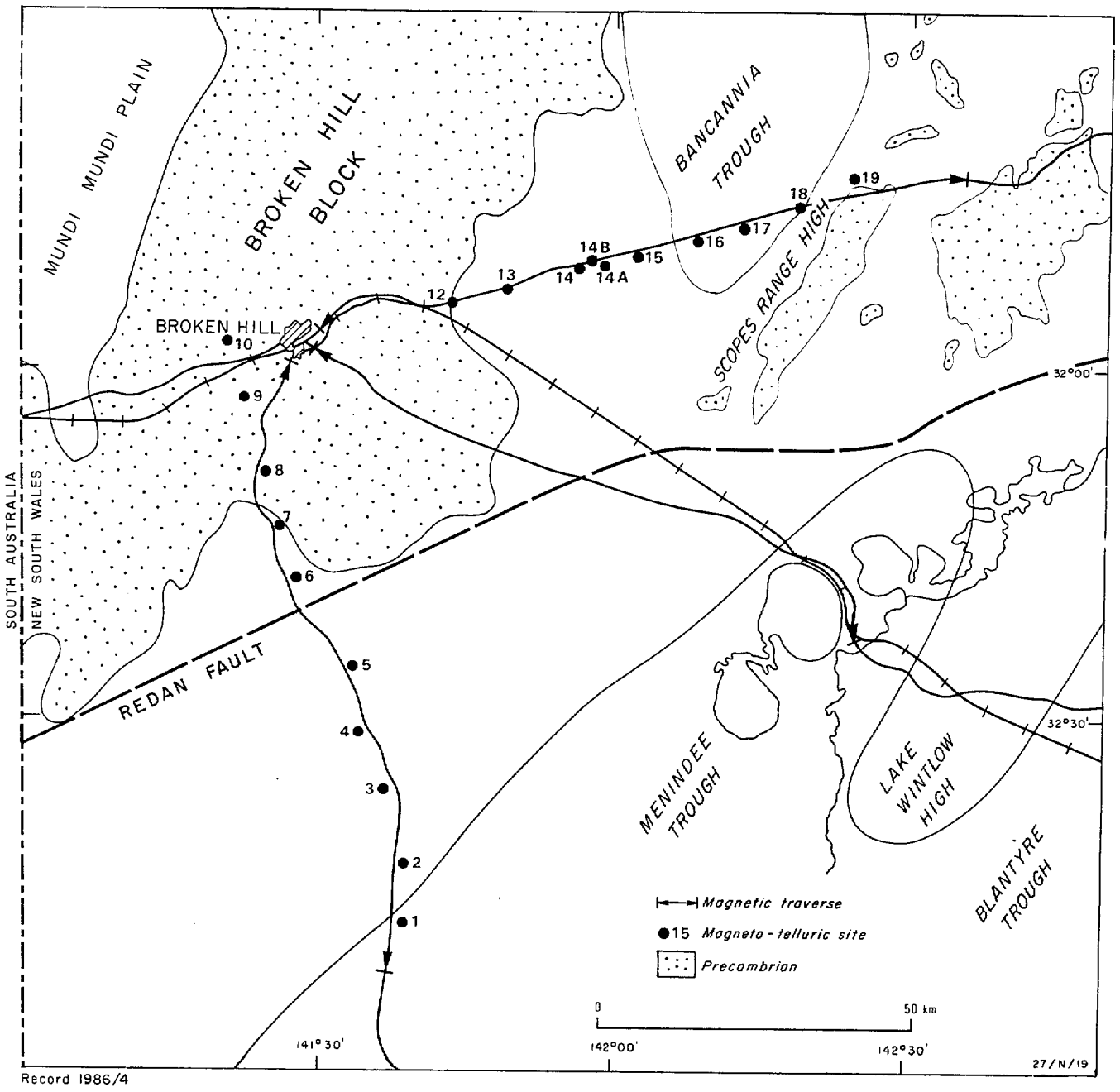


Fig 2 LOCATION OF MT SITES, 1984

15