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GROUND MAGNETIC SURVEY AND DRILLING (BMR AYERS ROCK NOS. 1 AND 2) OF A SHALLOW MAGNETIC-ANOMALY SOURCE IN THE SOUTHERN AMADEUS BASIN, NORTHERN TERRITORY

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ABSTRACT

In 1981, the authors collaborated with staff of BMR's Petroleum Exploration and Geophysical Branches in order to identify the source of magnetic anomalies known since 1965 in the southern Amadeus Basin.

Magnetic readings were made along ground traverses across five of these anomalies in the northern Ayers Rock 1:250 000 Sheet area. Modelling of the data across the most intense anomaly implied that it arises from a tabular dipping body buried at shallow depth.

BMR Ayers Rock No. 1, sited over the peak of this anomaly, penetrated unconsolidated Cainozoic clay, silty clay, and minor calcrete and gravelly sand, 0-87 m; altered porphyritic basalt, 87-126 m; light grey to black, poorly indurated microcrystalline dolostone interbedded with finely crystalline dolomite and minor limestone and chert, 126-150.6 m; and gypsiferous microcrystalline dolostone interbedded, interlaminated, and veined with gypsum, 150.6-158 m (total depth). Because recovery of core from the basalt was poor, a second hole - BMR Ayers Rock No. 2, sited 25 m downdip from the first hole - was drilled in an attempt to recover more of it as core; it intersected the basalt between 87 and 131 m (total depth), and 23 m was cored.

The sequence below the Cainozoic sediments is correlated with part of the Bitter Springs Formation, which is widespread throughout the Amadeus Basin.

Field measurements of the magnetic susceptibility of the basalt from the second hole (average 57 117 x 10^{-6} SI) confirm that it is the source of the anomaly.

The dolomitic rocks have total organic carbon contents mostly of 0.05% or less.

INTRODUCTION

Purpose of investigation, and summary of fieldwork

The scope of BMR's program of work in the Amadeus Basin - where the Petroleum Exploration Branch (PEB) has been investigating the petroleum source rock potential since 1980 - was extended in 1981 to incorporate a project seeking to identify the source of shallow magnetic anomalies in the southern part of the basin. These anomalies were revealed in 1965 by a BMR airborne magnetic survey (Young & Shelley, 1977). They are scattered over a wide area, but are especially prominent in northern AYERS ROCK* and southern LAKE AMADEUS (Fig. 1). PEB enlisted the help of the Metalliferous and Airborne Section of the Geophysical Branch to make a ground magnetic survey of five of the anomalies in AYERS ROCK. Modelling of part of the resulting data suggested that the source of the anomaly with the highest amplitude is buried at a shallow depth, and PEB sited a drillhole (BMR Ayers Rock No. 1) over the peak of the anomaly to intersect its source. A second drillhole (BMR Ayers Rock No. 2) was sited over the same anomaly to further investigate its source.

The magnetic anomalies

The BMR airborne magnetic survey over the Amadeus Basin in 1965 (Young & Shelley, 1977) revealed a contrasting magnetic response in northern and southern AYERS ROCK. In the south, the magnetic profiles are intensely disturbed (Fig. 2), reflecting the near-surface and outcropping crystalline basement rocks at the southern edge of the basin. In the north, the profiles form gentle undulations with wavelengths of 100 km or more, indicating deep magnetic basement, but numerous small, often isolated anomalous peaks with amplitudes ranging from 20 to at least 250 nT occur throughout northern AYERS ROCK and appear to have shallow sources.

The distribution of anomalous peaks with apparently shallow sources extends northward into southern LAKE AMADEUS, and north-northwestward from there across the northern part of BLOODS RANGE, where they are less frequent and less intense, into RAWLINSON and MACDONALD, where their amplitudes range from less than 50 nT to more than 600 nT (Geophysical Associates Pty Ltd, 1965). No such anomalies are evident east of AYERS ROCK.

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*Names of 1:250 000 Sheet areas are printed in capital letters.

Young & Shelley speculated that these anomalous peaks might indicate the presence of volcanic rocks in the sedimentary succession of the Amadeus Basin. They dismissed the possibility that the anomalies are due to dykes after detailed aeromagnetic traversing over Lake Amadeus had failed to confirm this impression.

GEOLOGY

Wells, Forman, Ranford, & Cook (1970) have described the geology of the Amadeus Basin, which comprises over 9000 m of Upper Proterozoic and Palaeozoic sedimentary and minor volcanic rocks overlying a basement composed mainly of Precambrian metamorphic and igneous rocks.

Geology of AYERS ROCK and southern LAKE AMADEUS (Fig. 3)

Exposures of the Amadeus Basin sequence are sparse in AYERS ROCK and southern LAKE AMADEUS. In the northeast and north, Proterozoic dolomite and clastic sedimentary rocks (Bitter Springs Formation, Inindia beds, and Winnall beds) and Palaeozoic clastic sedimentary rocks (Pertaoorrta and Larapinta Groups and Mereenie Sandstone) crop out in mainly northwest-trending strike ridges in a series of subparallel tight folds. In the east, the Winnall beds at Mount Conner are preserved in the core of a small basin whose flanks are formed of the Inindia beds. In the west, the Winnall beds have been very tentatively identified in low ridges and hills, and conglomerate of the Upper Proterozoic or Lower Cambrian Mount Currie Conglomerate and a presumed time-equivalent arkose form the higher terrain - the inselbergs of Mount Currie, Mount Olga, and Ayers Rock. In the south, small scattered exposures of the Proterozoic Dean Quartzite and overlying phyllitic rocks of the Pinyinna beds (the metamorphosed equivalent of the Bitter Springs Formation) overlie a metamorphic and igneous basement.

Most of the area is covered by Quaternary sand, alluvium, and lake deposits, and minor Tertiary conglomerate and travertine.

Local geology over the shallow-source magnetic anomalies in AYERS ROCK and LAKE AMADEUS

Most of the shallow-source anomalies in AYERS ROCK and LAKE AMADEUS occupy an area in which fairly thick Quaternary sediments overlie the Amadeus Basin sequence. Three of them (i, ii, and iii in Figs. 2 and 3), however, are close to exposures of Amadeus Basin sedimentary rocks: (i) is almost 4 km from an outcrop of the Winnall beds and Inindia beds at Winnall Ridge; and (ii) and (iii) are close to outcrops of folded Larapinta Group rocks northwest and west of Milton Dam. An inlier of the Bitter Springs Formation is exposed 2 km northeast of anomaly (ii), and the Inindia beds crop out below the Larapinta Group 4 km southeast of anomaly (iii).

Subsurface geology from bores in northern AYERS ROCK and southern LAKE AMADEUS

Cainozoic sediments have been penetrated in several shallow bores at Curtin Springs and along the Petermann Road, but none of them has intersected the Amadeus Basin sequence. The deepest one (registered No. 12756; Fig. 3) penetrated 99 m of sand and silt with minor clayey and gravelly components.

Farther west, the Water Resources Branch of the former Department of the Northern Territory (drawing no. 1367-19-71) drilled about 50 shallow boreholes between 8 and 19 km northwest of Ayers Rock (Fig. 3); most of them intersected the Bitter Springs Formation, but some of them penetrated the Mount Currie Conglomerate, beneath a Cainozoic sequence 27 to more than 100 m thick.

Farther north, BMR Lake Amadeus No. 3B, sited on an outcrop of gypsum in the Bitter Springs Formation (Fig. 3), penetrated 305 m of evaporite and minor dolomite (Wells & Kennewell, 1972).

THE GROUND MAGNETIC SURVEY

Location

In June 1981, P.M. Davies (geophysicist) and R. Curtis-Nuthall (technical officer) carried out a vehicle-borne magnetic survey along traverses near five of the anomalies (traverses 1 to 5 in Fig. 4). These anomalies had been selected for the survey because they underlie terrain that is accessible along roads and tracks; the Central Land Council, which manages on behalf of the Aboriginals part of the land over which the anomalies are located, had permitted the survey at short notice on Aboriginal land, provided that it was confined to existing roads and tracks. This temporary restriction limited the survey to single-line traverses over each anomaly, and precluded any attempt to determine the strike and continuity of the anomalies during the vehicle-borne survey.

Fieldwork

Before carrying out the traverses, the field party adjusted the compensation coils of the magnetometer, in order to limit the magnetic effect of the vehicle and equipment to less than 2 nT in any direction.

During the survey of the anomalies the magnetic field was measured at roughly 2-m intervals along each traverse. The data were recorded on an analogue chart for immediate examination, and also digitally on magnetic tape for later data processing.

The magnetic anomalies along traverses 2 and 4 are well-defined, having amplitudes of roughly 200 and 300 nT respectively. Anomaly 4 is evident due to one source, but anomaly 2 is complex, reflecting contributions from probably three sources. The anomalies along the other traverses are broad with indistinct peaks, and were not considered suitable for the selection of drill sites.

Modelling of anomalies 2 and 4

For modelling purposes, the source of anomalies 2 and 4 was assumed to be an infinite tabular body - i.e., the width of the body is small compared with its other dimensions. The strikes of the assumed tabular bodies - 125° for anomaly 2, and 150° for anomaly 4 - were estimated from Young & Shelley's (1977) total magnetic intensity contour map. An inverse modelling program based on the non-linear least-squares technique of Jupp & Vozoff (1975) was used.

The resulting model for anomaly 4 (Fig. 5) indicates a body 110 m wide, dipping 62° to the southwest at a depth of 165 m.

A subsequent hand-held magnetometer survey made by Bladon along parallel traverses across anomalies 2 and 4 indicated a revised strike of 70° for anomaly 4 and 35° for anomaly 2. Using this revised strike, the resulting model for anomaly 4 (Fig. 6) indicates a body 100 m wide, dipping 45° to the south-southeast at a depth of 120 m. Modelling of the highest peak of anomaly 2 (Fig. 7) indicates a body 90 m wide, dipping 24° to the south-southeast at a depth of 80 m.

Anomaly 4 was selected as the target for follow-up drilling as the single source made the computed model more reliable.

LITHOLOGIES INTERSECTED IN DRILLHOLES

BMR Ayers Rock No. 1 (Fig. 8), sited over the peak of anomaly 4, intersected the following lithologies:

0-87 m	clay, silt, sand, and calcrete	Cainozoic
87-126 m	altered porphyritic basalt)	
126-150.6 m	poorly indurated microcrystalline) dolostone and interbedded finely) crystalline dolomite)	?Proterozoic
150.6-158 m	gypsiferous microcrystalline) dolostone and gypsum)	

BMR Ayers Rock No. 2 (Fig. 9), sited 25 m south-southeast (i.e., downdip) of No. 1, intersected altered porphyritic basalt between 87 and 131 m (total depth) underlying a similar Cainozoic sequence.

Gypsiferous microcrystalline dolostone and gypsum

Light grey and medium light grey gypsiferous microcrystalline dolostone is interbedded, interlaminated, and veined with gypsum in the bottom 7.4 m penetrated in BMR Ayers Rock No. 1. The gypsiferous microcrystalline dolostone is texturally laminated and possibly stromatolitic locally, and contains vugs in which dolomite rhombs have crystallised. It comprises light greenish grey microcrystalline dolomite enclosed in irregular poikilocrysts of gypsum 1 to more than 7 mm wide; the microcrystalline dolomite appears to have accreted into peloid-like grains less than 0.010-0.025 mm in diameter with diffuse grain boundaries. The gypsum in interbeds and veins has a fibrous habit.

A prominent feature of the rock is its brecciation, of which several stages are apparent: (1) fracturing of the dolostone roughly normal and parallel to interbeds or laminae of gypsum; (2) displacement along the fracture; (3) gypsum filling the fracture, so forming a vein; and (4) persistent movement along the vein until both sides are detached from one another. The dimensions of the fragments so formed range from less than 1 mm to at least 20 cm. The size range of the fragments is well illustrated between 153.39 and 153.64 m; two large fragments of alternately laminated gypsiferous microcrystalline dolostone

TABLE 1. KEY TO ABBREVIATIONS USED IN FIGURES 8 AND 9

Lithologies

Bs	basalt
Cct	calcrete
Cht	chert
Cte	carbonate
Cy	clay
Do	dolomite
Dost	dolostone
Gyp	gypsum
Lst	limestone
Sd	sand
Slt	silt

Lithological and mineralogical modifiers

Amy	amygdales
calc	calcareous
Clt	chlorite
fer	ferruginous
gvl	gravelly
gyp	gypsiferous
Hem	hematite
Piso	pisoliths
Py (py)	pyrite (pyritic)
Q	quartz

Colours

bk	black
bl	blue
br	brown
gn	green
gy	grey
og	orange
ol	olive
pk	pink
pu	purple
y	yellow
wh	white

Other abbreviations

abun	abundant
altn	alternating
ang	angular
anh	anhedral
bd	bedding
bet	between
Bnd	bands
brec	brecciated
c	coarse
$\bar{c}$	with
com	common
cons	considerable/y
Cpnt	component
derv	derived
DH	drillhole
dk	dark
dsk	dusky
dsm	disseminated
eff	efflorescences
evap	evaporite
f	fine/ly
frac	fractured
Frag	fragments
Fss	fissure
h	higher
indt	indurated
Lam	laminae
lam	laminated
lt	light
m	medium
mly	mainly
mnr	minor
mod	moderate/ly
mot	mottled, mottling
o/l	outlined
p	poorly
Pch	patches
Phenc	phenocrysts
Pil	pillow
poss	possibly
prob	probably
Recv	recovery
Rk	rock
s/ang	subangular
s/cnc	subconcentric
s/rd	subrounded
Struc	structure
subh	subhedral
Swl	sidewall
thru	throughout
tr	trace
v	very
Ve	veins
xl	crystalline
Xlam	cross-laminae

and gypsum - one with laminae dipping 45°, the other with laminae dipping 90° - are separated by a finer-grained breccia comprising elongate randomly oriented gypsiferous microcrystalline dolostone fragments less than 1 mm to 1 cm long in a matrix of mixed gypsum, recrystallised carbonate, and finely comminuted dolostone.

Other features of the unit that testify to its deformation are: abrupt changes of dip, which ranges from 24 to 60°; a small isoclinal fold between 150.6 and 150.9 m; and a change of strike of 15° accompanying a change of dip from 48 to 53° between 151.07 and 151.14 m.

Poorly indurated microcrystalline dolostone and interbedded finely crystalline dolomite

Light grey to black, poorly indurated, locally calcareous microcrystalline dolostone, 24 m thick, overlies the gypsiferous microcrystalline dolostone and gypsum in BMR Ayers Rock No. 1. It is interbedded for at least 9 m near the base with grey to greyish black laminated, variably calcareous, finely crystalline dolomite in beds 1 to 10 cm thick; this 9-m section also includes a bed of chert 5 cm thick. Another lithified bed - of light grey crystalline limestone about 50 cm thick - caps the sequence. Pyrite cubes up to 2 mm are abundant at several levels, but especially between 134 and 137.1 m. Platy gypsum is an uncommon constituent in the dolostone (and may be a contaminant from the Cainozoic clay), but evaporite efflorescences are common in the bottom 4 m of the unit.

The poorly indurated microcrystalline dolostone comprises grey and brown microcrystalline dolomite with a similar habit to that in the gypsiferous microcrystalline dolostone below it. Faint laminae are evident in places. Vugs and veins - some filled by crystalline quartz and dolomite or calcite less than 0.1 to 0.3 mm, others by probable chalcedony - are common features, and possible stromatolites are present locally.

The finely crystalline dolomite comprises cloudy grey and pale brown dolomite crystals of a uniform size (0.09 mm), commonly stained orange-brown probably as the result of weathering. The dolomite crystals are tightly packed in places, yet elsewhere the rock has a considerable siliceous component forming a matrix. Opaques, probably pyrite, are common in irregular laminae 0.2 to 0.65 mm thick in which the dolomite crystals are enclosed in a dark grey to black matrix; isolated folds and fractures have deformed the laminae. The finely crystalline dolomite is locally brecciated into elongate fragments up to 2.5 mm long: these are set in a dark grey to black matrix, which also contains clear dolomite/calcite crystals up to 0.3 mm. Veins, filled by possible chalcedony, are less common than in the poorly indurated microcrystalline dolostone.

A comparison of the features observed in thin sections of this unit and the gypsiferous microcrystalline dolostone and gypsum suggests that the one is, at least in part, the weathered upper zone of the other from which gypsum has been removed.

Altered porphyritic basalt

The basalt is a medium bluish grey fine-grained, porphyritic, closely fractured rock in which light grey mottling is a prominent feature. It is severely altered to a chlorite-sericite rock containing (dull black) chlorite as a replacement of probable subhedral to anhedral olivine phenocrysts, and abundant opaques - pyrite, magnetite, chalcopyrite, and possible ilmenite. Chlorite (particularly as fan-shaped aggregates), quartz, calcite, epidote, actinolite, and colloform goethite are common in veins, and quartz also occurs in amygdales.

The light grey-mottled parts of the rock appear to lack devitrified glass in the groundmass, whereas the medium bluish grey colour appears to define the presence of finely scattered devitrified and altered glass.

Possible pillow structures at several levels, and abundant amygdales, suggest that lavas make up much of the basalt sequence. Autoliths are evident in places, suggesting that more than one flow is represented. The presence of possible pillow structures implies that the basalt erupted under water, yet there is no evidence of sediment interbedded with it.

The fractures appear to be randomly oriented throughout the basalt. They probably formed at different times in response to different stresses. The volume and composition of fracture-fill material may be a pointer to their relative ages. If so, then those filled with montmorillonite and disseminated pyrite (J. Fitzsimmons, BMR, personal communication 1981; e.g. at 106.6 m) are probably the oldest; such fractures are up to 7 cm wide, and generally slightly oblique to the length of the core. The surfaces of most other fractures are coated with films of one or more different minerals: a pale blue mineral identified as a swelling chlorite (J. Fitzsimmons, personal communication 1981;

e.g. at 130.5 m); montmorillonite (J. Fitzsimmons, personal communication 1981) pseudomorphing trapezohedra of possible analcime (M. Duggan, BMR, personal communication 1981; e.g. at 130.5 m); pyrite (e.g. at 107.9 m); limonite (e.g. at 105.5 m); and possible epidote (e.g. at 103.5 m). A few fractures have no mineral films on their surfaces; these are probably the youngest.

Although no dips were measured in the basalt, a hypothetical line linking the base of the basalt in BMR Ayers Rock No. 1 and the bottom of the hole (in the basalt) in BMR Ayers Rock No. 2 indicates a dip of at least 12°.

Field measurements of the magnetic susceptibility of the basalt at 11 levels (Table 2) confirm that it is the source of the magnetic anomaly. A typical table of rock susceptibilities (Telford & others, 1976) lists the range of basalts as 20-14 500 x 10^{-6} cgs with an average value of 6000 x 10^{-6} cgs (75 000 x 10^{-6} SI), whereas dolomite has a much lower range (0-75 x 10^{-6}. cgs) with an average value of 10 x 10^{-6} cgs (125 x 10^{-6} SI).

TABLE 2. FIELD MEASUREMENTS OF MAGNETIC SUSCEPTIBILITIES OF BASALT SAMPLES FROM BMR AYERS ROCK NO. 2

Depth interval (m)		Magnetic susceptibility (x 10^{-6} cgs)	Magnetic susceptibility (x 10^{-6} SI)
119.90-119.95		5325	66925
121.85-121.90		4289	53904
123.90-123.95		4091	51416
124.40-124.50		5042	63368
125.15-125.20		3971	49908
125.85-125.90		3828	48110
126.95-127.00		4149	52145
127.95-128.00		4195	52723
128.25-128.30		4685	58881
129.10-129.15		5199	65341
129.85-129.90		5217	65567
	Average	4545	57117

Clay, silt, sand, and calcrete

The sequence overlying the basalt comprises 59 m of multicoloured clay which contains platy gypsum and thin carbonate crusts near the base, and a silty component and gravelly sand interbeds near the top. This is overlain by 28 m of sand - coarse and gravelly at the base, silty and ferruginous in the middle, and mainly fine at the top; calcrete has formed at several levels in the sand.

Correlation

Before the 1981 drilling in the southern Amadeus Basin, the association of basaltic volcanics and an interbedded carbonate-evaporite sequence in the Amadeus Basin was known only in the Upper Proterozoic Bitter Springs Formation in outcrop about 100 km east-southeast of Alice Springs and in Ooraminna No. 1 well (Fig. 1), where spilite forms part of the Loves Creek Member overlying the evaporite-bearing Gillen Member (Wells & others, 1970). Elsewhere in the Amadeus Basin, mafic volcanics are restricted to: (1) the basement beneath the Heavitree and Dean Quartzites in the western part of the Amadeus Basin (Wells & others, 1970), and (2) possibly the Pinyinna beds in north central PETERMANN RANGES (D.J. Forman, BMR, personal communication 1981). The only other formation in the Amadeus Basin that contains interbedded carbonates and evaporites is the Lower Cambrian Chandler Limestone of the Pertaoorrta Group.

An assumption that the other shallow-source anomalies in northern AYERS ROCK and southern LAKE AMADEUS have a basaltic source at roughly the same stratigraphic level as the anomaly investigated prompted us to try to determine this stratigraphic level by examining the position of the anomalies - (i), (ii), and (iii), see pages 2 and 3 and Figures 2 and 3 - with respect to outcrops of sedimentary rocks of the Amadeus Basin sequence. Anomaly (i) is close to outcrops of the Proterozoic Winnall beds and underlying Inindia beds at Winnall Ridge. The shallow-dipping Cambrian to Ordovician Larapinta Group rocks near anomalies (ii) and (iii) are only a few hundred metres thick, and overlie a considerably eroded Proterozoic section; indeed, the Bitter Springs Formation which crops out near anomaly (ii) may host the source of these anomalies. These anomalies, therefore, could all arise from a source within the Bitter Springs Formation. However, an analysis of the shallow-source anomalies coinciding with or close to outcrops in the western part of the Amadeus Basin - for example, in RAWLINSON and MACDONALD - suggests several possible sources, including one within the Bitter Springs Formation.

From the foregoing, we conclude that the volcanics and the carbonate-evaporite rocks in BMR Ayers Rock Nos. 1 and 2 correlate with the Bitter Springs Formation.

CONCLUSIONS

(1) The source of the magnetic anomaly is a dipping tabular body of volcanic rock.

(2) The proven parameters of the volcanics - (a) subcrop width of at least 25 m; (b) dip of at least 12°; (c) depth of overburden of 87 m; and (d) magnetic susceptibility averaging 57 117 x 10^{-6} SI, which represents a high contrast with the sediment and rock above and below the volcanics - are compatible with the postulated source of the anomaly.

(3) The measured strikes of two magnetic anomalies - the one investigated by drilling (070°) and one farther south (035°) - differ considerably from the general trend of outcrops in the southern part of the Amadeus Basin.

ADDITIONAL STUDIES GENERATED BY THE PROJECT

Total organic carbon content

Ten samples of dolostone from BMR Ayers Rock No. 1 were analysed for total organic carbon; the results are tabulated in Table 3.

TABLE 3. TOTAL ORGANIC CARBON (TOC) IN THE WHOLE ROCK OF SAMPLES FROM BMR AYERS ROCK NO. 1

Depth (m)	Sample description	TOC%
137.93	Greyish black and light grey laminated, poorly indurated microcrystalline dolostone	0.30
141.71	Medium grey, poorly indurated microcrystalline dolostone	0.05
143.38	Greyish black and light grey laminated, poorly indurated microcrystalline dolostone	0.10

TABLE 3 (contd)

Depth (m)	Sample description	TOC%
147.10	Greyish black, poorly indurated microcrystalline dolostone with evaporite efflorescence	0.09
150.40	Medium grey and light grey laminated, poorly indurated microcrystalline dolostone	0.04
151.48	Medium grey gypsiferous microcrystalline dolostone and gypsum	0.03
152.84	Medium grey gypsiferous microcrystalline dolostone and gypsum	0.05
155.00	Medium grey gypsiferous microcrystalline dolostone and gypsum	0.05
156.35	Medium grey gypsiferous microcrystalline dolostone and gypsum	0.02
157.50	Medium grey gypsiferous microcrystalline dolostone and gypsum	0.05

Analysts: R. DeNardi & Z. Horvath, BMR Petroleum Technology Laboratory.

Palaeontological interest

E.M. Truswell is keen to search for spores and pollen in grey clay recovered between 50 and 60 m in the Cainozoic sequence of both drillholes. M.R. Walter hopes to find evidence of past life in black chert recovered between 139.86 and 139.91 m in BMR Ayers Rock No. 1. M. Owen proposes to look for acritarchs in the poorly indurated microcrystalline dolostone between 126.5 and 150.6 m in BMR Ayers Rock No.1.

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APPENDIX 1. DRILLHOLE STATISTICS

BMR Ayers Rock No. 1

Location: 70 m from the north side of Petermann Road 18.4 km west-northwest of the junction of the Petermann Road and the Curtin Springs/Ayers Rock road; preliminary co-ordinates: latitude 25°13'46"S, longitude 131°30'23"E.

Derivation of name: first hole that BMR has drilled in AYERS ROCK.

Date spudded: 31 August 1981.

Date completed: 10 September 1981.

Total depth: 158 m.

Drill rig: Mayhew 1000.

Drilling tools and intervals: $4\frac{1}{2}$-inch roller bit and $4\frac{1}{2}$-inch TI Hawthorn blades from 0 to 101.7 m, and from 101.8 to 137.1 m.

Coring tool and intervals: 3 15/16-inch Triefus diamond corehead yielding $2\frac{1}{2}$-inch core from 101.7 to 101.8 m, and from 137.1 to 158 m (Table A).

Casing interval: 5-inch casing from 0 to 58 m.

Drilling/coring medium: air from 0 to 13.7 m; mud from 13.7 to 158 m.

Purposes of drillhole: to identify the source of a magnetic anomaly that a preliminary geophysical model had indicated at a depth of 165 m beneath Cainozoic sediments concealing the Amadeus Basin sequence.

Comments: an attempt to recover continuous core of the basalt from 101.7 m failed: after coring through an interval of 10 cm the diamond corehead intersected clay (either fissure-fill or an ash deposit), which acted as a barrier to further immediate coring. Circulation of the mud was lost at 158 m, where the hole was filled in and abandoned in favour of drilling a second hole for reasons outlined below.

TABLE A: CORE NUMBERS AND DEPTHS, BMR AYERS ROCK NO. 1

Core No.	Depths (m)	Recovered length (m)	% recovery
1	101-70-101.80	0.10	100
2	137.11-137.56	0.33	73.3
3	137.56-138.71	0.47	40.9
4	138.71-139.86	0.65	56.5
5	139.86-141.51	0.50	30.3
6	141.51-142.60	0.56	51.4
7	142.60-145.60	0.95	31.7
8	145.60-146.70	0.55	50.0
9	146.70-149.30	0.60	23.1
10	149.30-150.60	0.52	40.0
11	150.60-152.30	1.70	100
12	152.30-155.00	2.70	100
13	155.00-158.00	3.00	100

BMR Ayers Rock No. 2

Location: 25 m along a bearing of 160° from BMR Ayers Rock No. 1; preliminary co-ordinates: latitude 25°13'46"S, longitude 131°30'23"E.

Derivation of name: second hole that BMR has drilled in AYERS ROCK.

Date spudded: 11 September 1981.

Date completed: 18 September 1981.

Total depth: 131 m.

Drill rig: Mayhew 1000.

Drilling tool and interval: 4½-inch Hawthorn TI blades from 0 to 103.2 m.

Coring tool and interval: 3 15/16-inch Triefus diamond corehead yielding 2½-inch core from 103.2 to 131 m (Table B).

Casing: none.

Drilling/coring medium: mud from 0 to 131 m.

Purpose of drillhole: to identify the source of a magnetic anomaly beneath Cainozoic sediments concealing the Amadeus Basin sequence; in particular to recover core samples of the basalt (recovered as cuttings between 87 and 126 m in BMR Ayers Rock No. 1) after the geophysical model of the anomaly had been revised (based on a measured strike of the anomaly of 070°), indicating a depth of burial of the anomaly source of about 120 m.

Comments: circulation of the drilling mud was lost at 129.5 m; cementing of the hole at this depth aided the recovery of a further 1.5 m of core before circulation was again lost; the hole was filled in and abandoned after field measurements of the magnetic susceptibility of the basalt at 11 levels (average 57 117 x 10^{-6} SI) had confirmed that it is the source of the magnetic anomaly.

TABLE B: CORE NUMBERS AND DEPTHS, BMR AYERS ROCK NO. 2

Core No.	Depths (m)	Length (m)*
1	103.20-104.60	1.40
2	104.60-106.00	1.40
3	106.00-107.25	1.25
4	107.25-109.70	2.45
5	109.70-112.00	2.30
6	112.00-113.75	1.75

TABLE B (contd)

Core No.	Depths (m)	Length (m)*
7	113.75-116.00	2.25
8	116.00-117.80	1.80
9	117.80-120.10	2.30
10	120.10-122.00	1.90
11	122.00-124.50	2.50
12	124.50-126.00	1.50
13	126.00-128.00	2.00
14	128.00-129.75	1.75
15	129.75-131.00	1.25

* Each length of core represents a 100% recovery

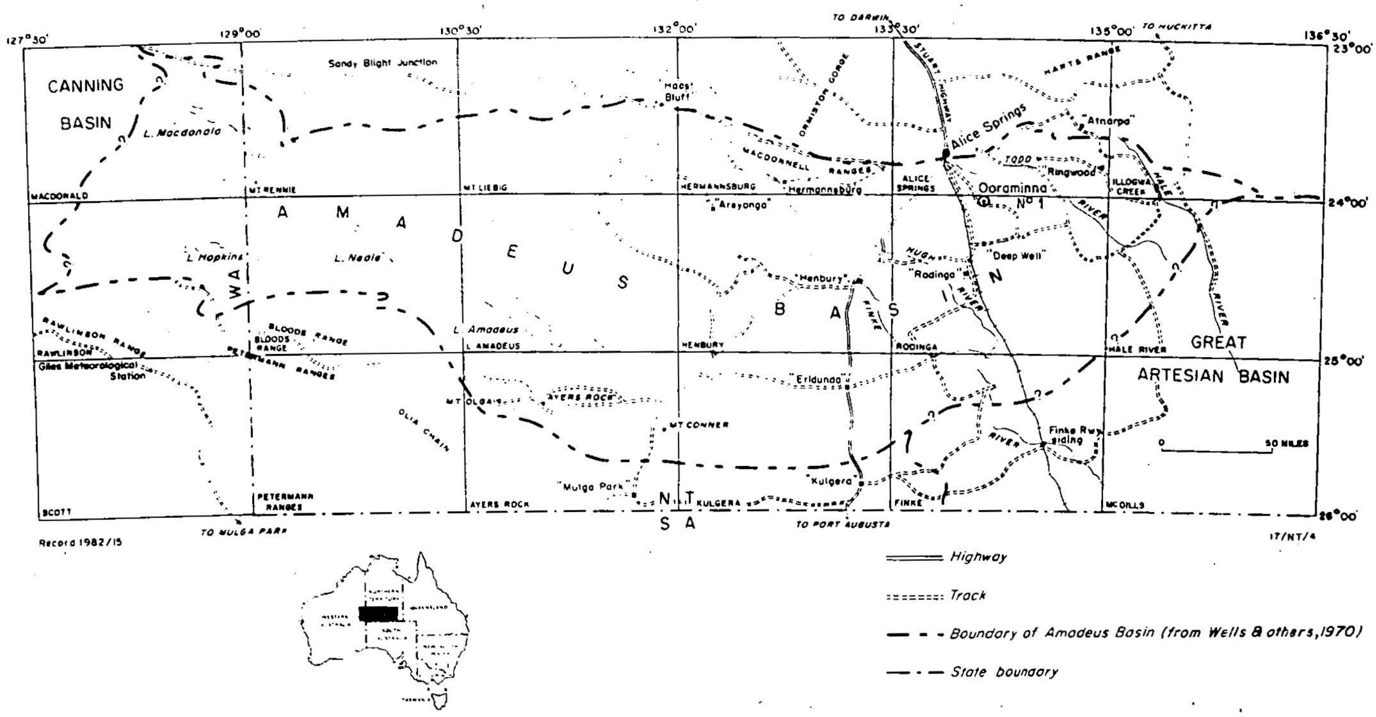


Fig. 1 Location map and index of 1:250 000 Sheet areas in the Amadeus Basin

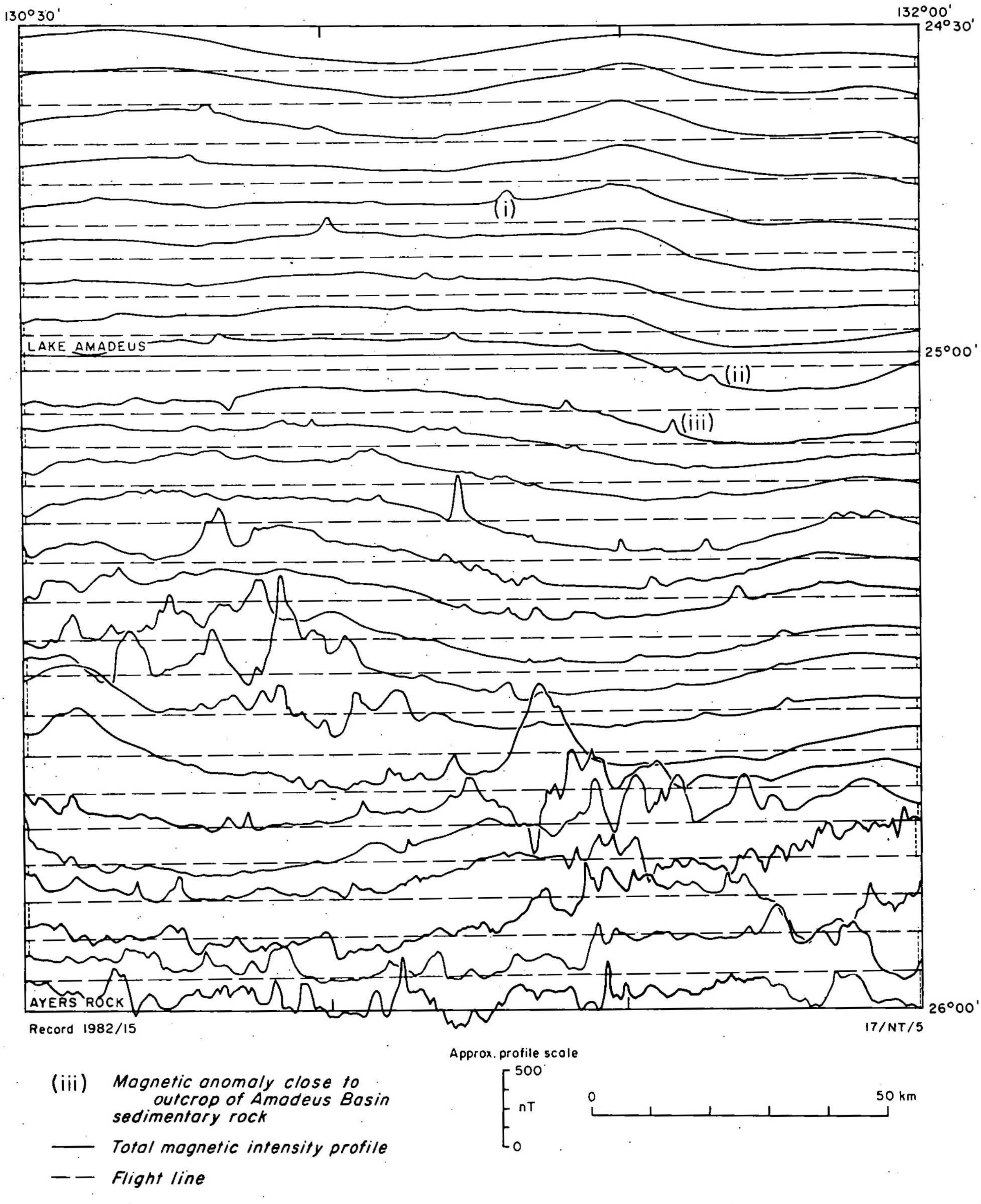
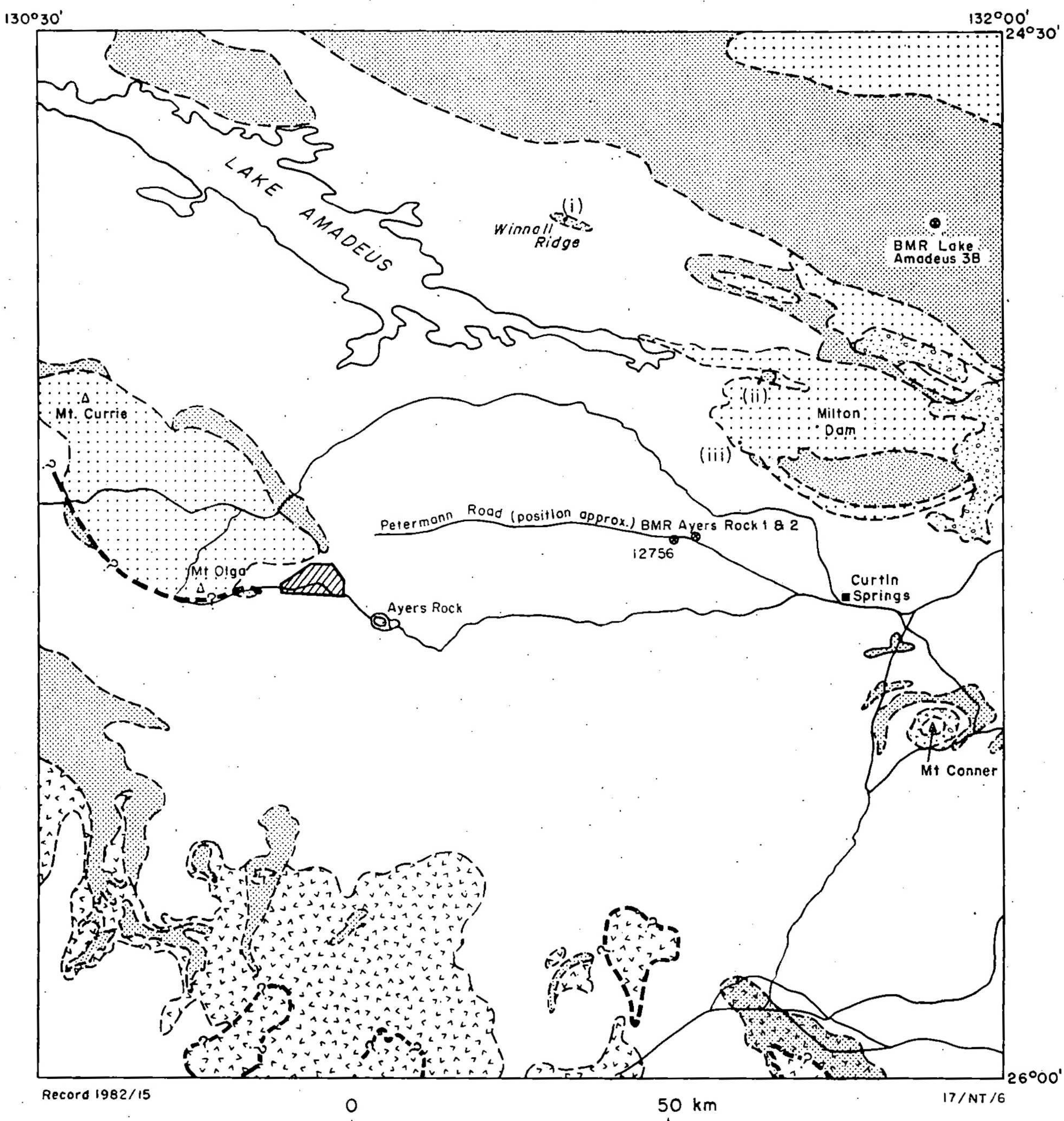


Fig. 2 Total magnetic intensity profiles along east-west lines, AYERS ROCK and south LAKE AMADEUS (from Young & Shelley, 1977)



Quaternary sand, alluvium, and lake deposits

Tertiary conglomerate and travertine

Palaeozoic sedimentary rocks of: Mereenie Sandstone, Larapinta Group, Pertaoorrta Group, Mount Currie Conglomerate and presumed time-equivalent arkose

Proterozoic sedimentary rocks of: Winnall beds, Inindia beds, Bitter Springs Formation, Pinyinna beds, Dean Quartzite

Precambrian metamorphic and igneous rocks

—?— Thrust (position uncertain)

—— Road

• (iii) Outcrop close to site of shallow-source magnetic anomaly

Area of concentrated borehole drilling by Water Resources Branch, former Department of the Northern Territory

Fig.3 Simplified geology, AYERS ROCK and southern LAKE AMADEUS (after Wells & others, 1970)

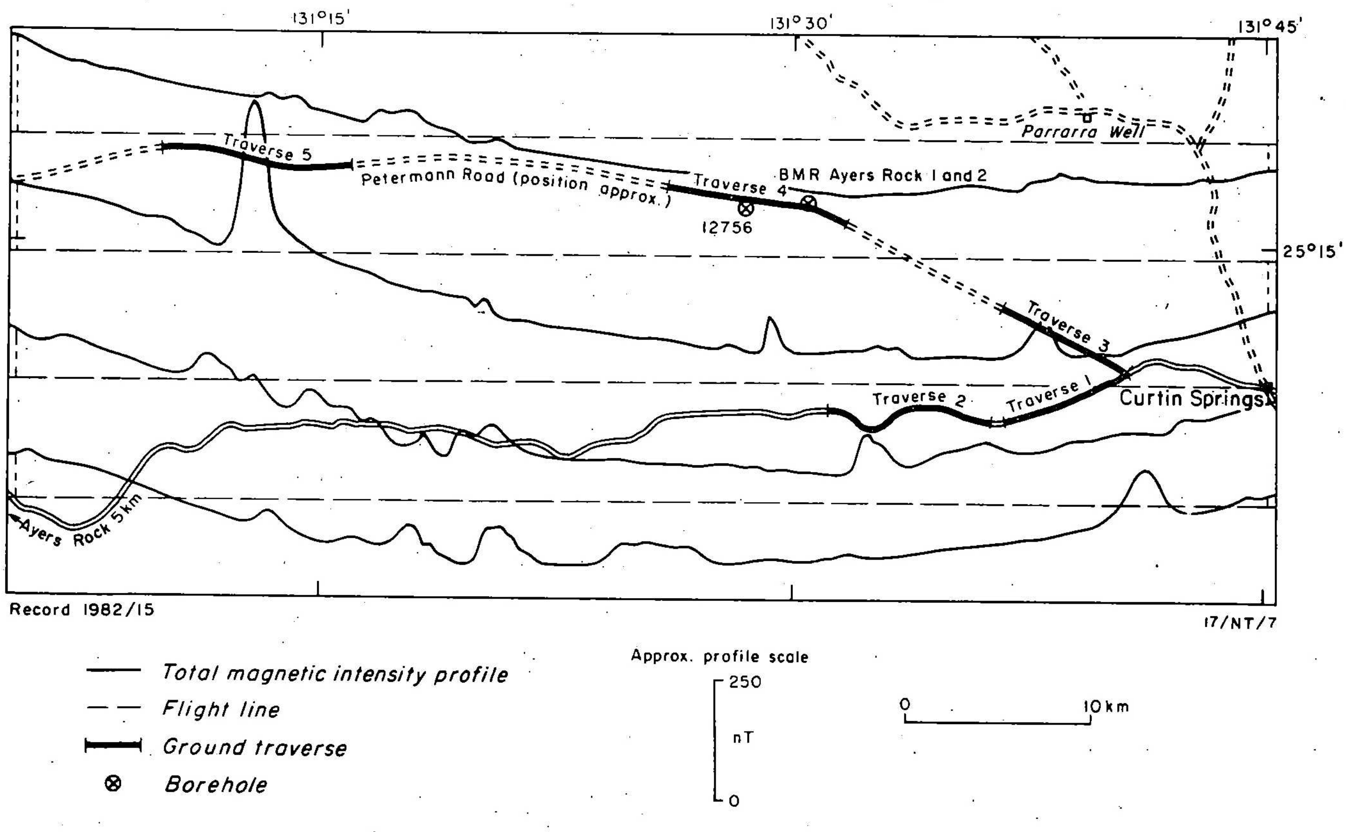


Fig. 4 Locations of ground magnetic traverses, northern AYERS ROCK

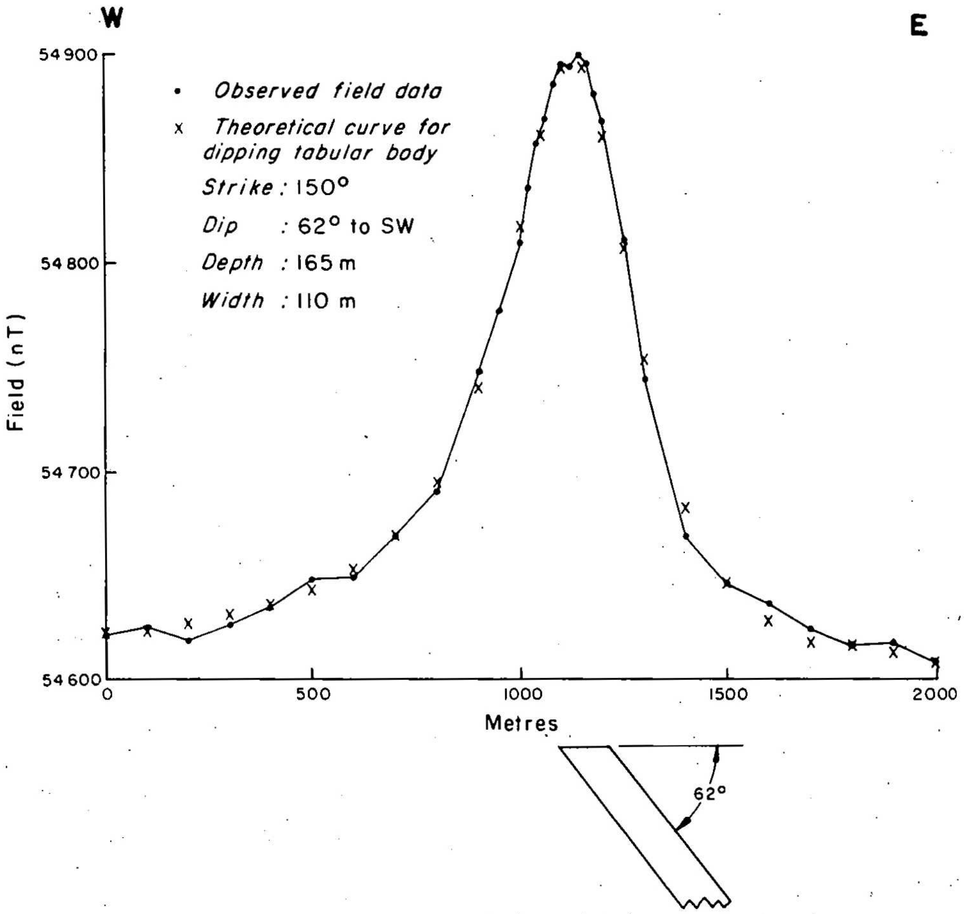
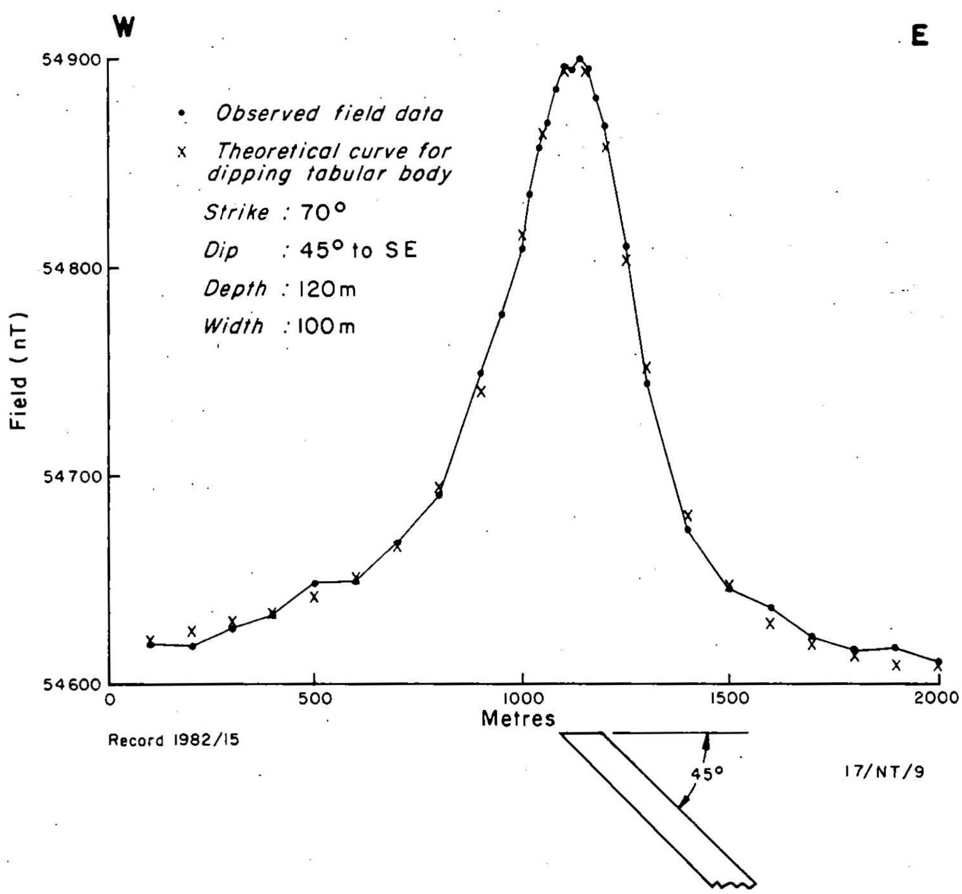


Fig. 5 Preliminary computed model for anomaly 4



Record 1982/15

17/NT/9

Fig. 6 Recomputed model for anomaly 4

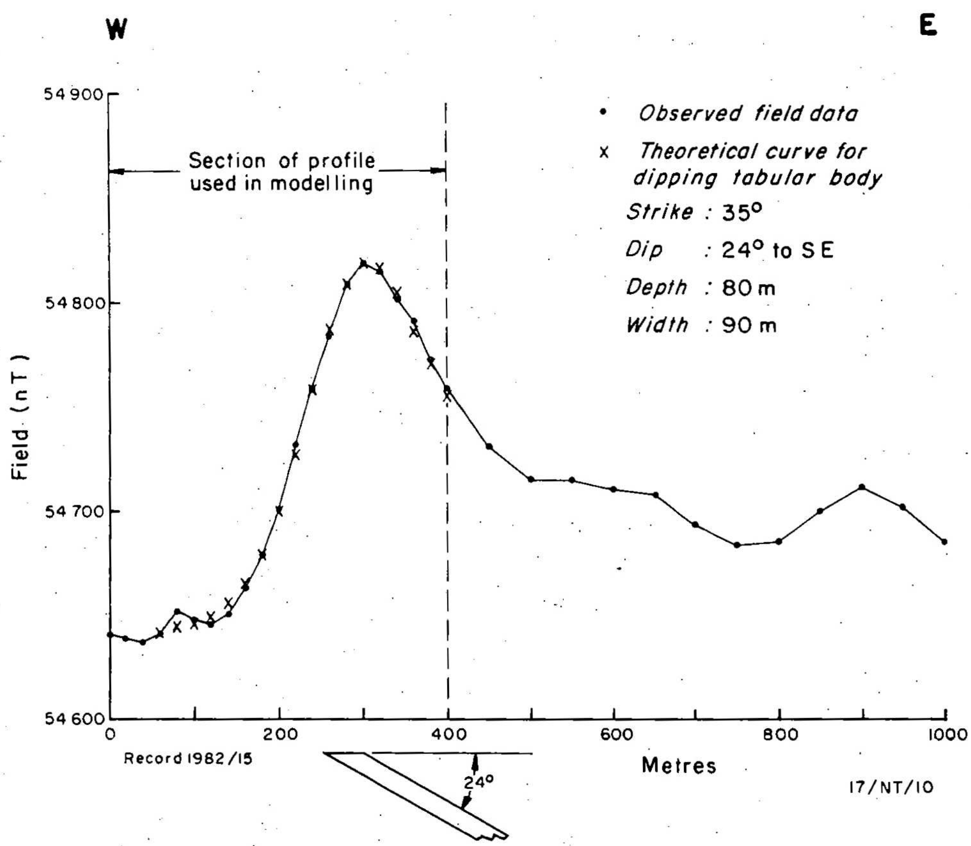
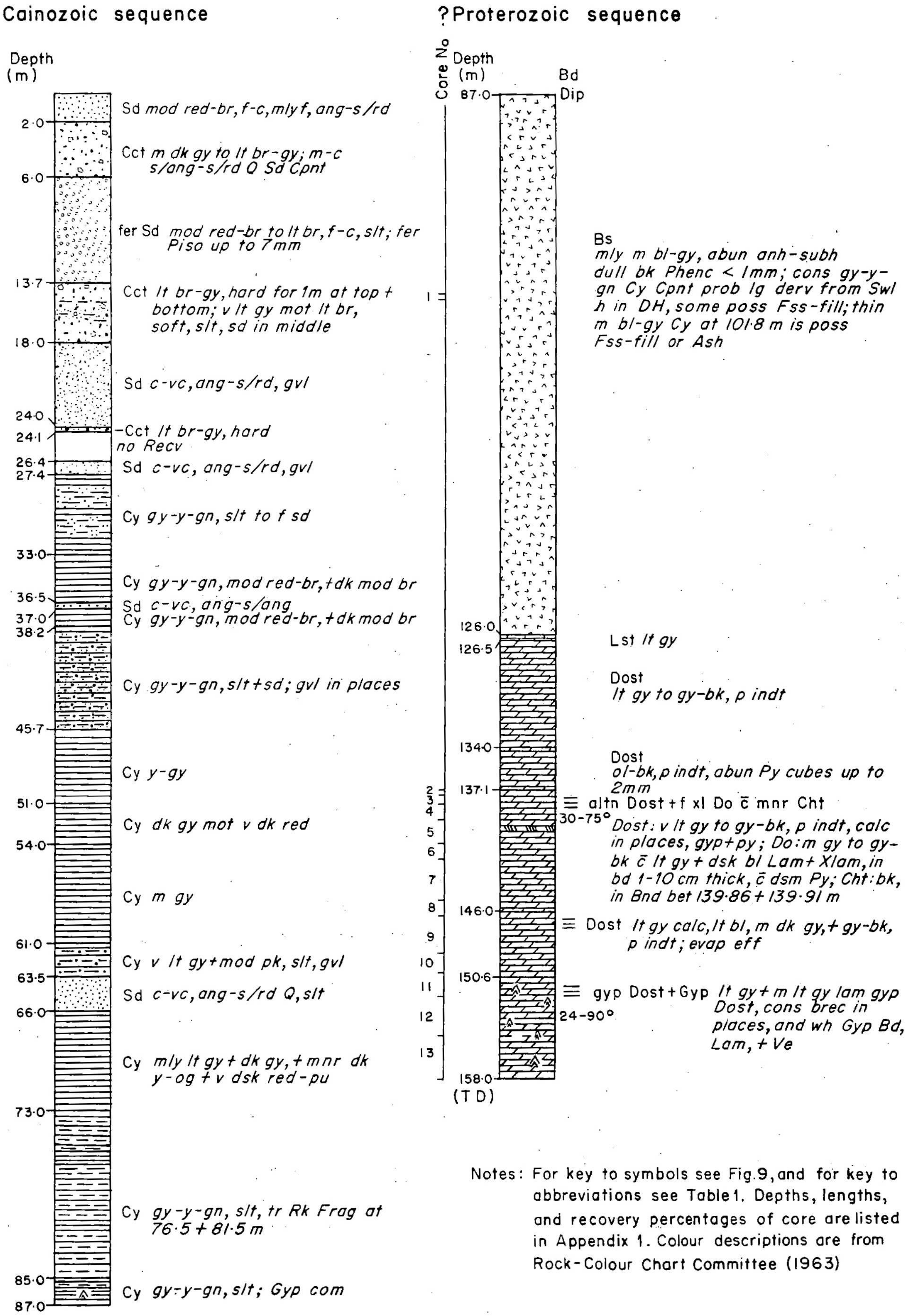


Fig. 7 Computed model for largest source of anomaly 2



Notes: For key to symbols see Fig. 9, and for key to abbreviations see Table 1. Depths, lengths, and recovery percentages of core are listed in Appendix 1. Colour descriptions are from Rock-Colour Chart Committee (1963)

Fig. 8 Graphic log, BMR Ayers Rock No 1

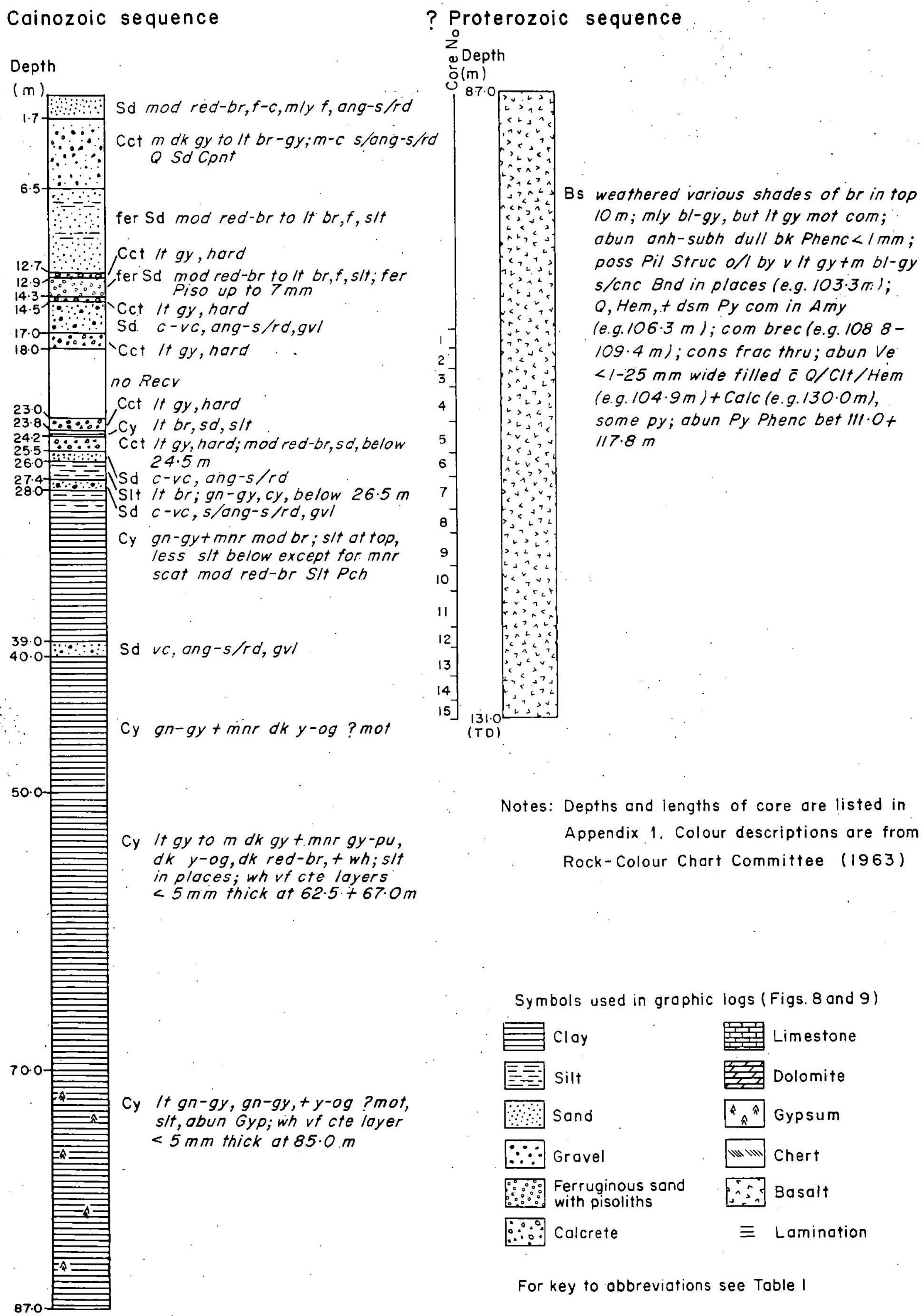


Fig. 9 Graphic log, BMR Ayers Rock No 2