Volume II

Table A1.1

Drill Hole Material Tested

Reference Fig. A2.1	Drill Hole Name	Location Lat.	Location Long.	Length (feet)	Material	Location of Material	Formations+ Penetrated	Test k	Test ρ	Test Mineralogy Sample No.
1	White Lead DDH-DLY5	30°14'	138°35'	540	Core	SADM corestore	TPLY/YUD	x		
2	Paull Consolidated DDH-PC2	30°23'	138°40'	573	Split core	"	"	x		
3	Southern Cross Mine 368E/389N	30°32'	138°33'	470	Cuttings	At drill site	TPLY	x		(CO63)
4	Baratta DDH3	31°56'	139°11'	234	Core	SADM corestore	"	x		
5	Prince Alfred Mine DDH2	32°07'	138°46'	450	"	"	"	x		
6	Waukaringa Hole 8	32°17'	139°26'	160	Cuttings	R.M.C. Minerals	TCIE/TPLY	x		(OR61)
	" Hole 9	"	"	140	"	"	"	x		
7	Ajax Hole 1	32°33'	139°23'	50	"	"	APLA	x		(OR62)
	" Hole 2	"	"	72	"	"	"	x		
	" Hole 3	"	"	50	"	"	"	x		
	" Hole 4	"	"	50	"	"	"	x		
	" Hole 5	"	"	36	"	"	"	x		
	" Hole 6	"	"	26	"	"	"	x		
	" Hole 7	"	"	72	"	"	"	x		(OR60)
8	Walloway Hole 1	32°29'	138°40'	74	"	Mining, Minerals & Metallurgy Ltd. (Adelaide	Quaternary sediments	x		
	" Hole 3	"	"	81	"		"	x		
	" Hole 5	"	"	69	"		"	x		(OR58 & OR59)
	" Hole 6	"	"	110	"		"	x		
9	Spring Creek Mine DDH1/29	32°44'	138°08'		Core	R.M.C. Minerals	TPLY/YUD	x		
10	Anabama Hill DDH-AN1	32°43'	140°13'	469	"	SADM corestore	Granite		x	
	" DDH-AN2	"	"	594	"	"	"		x	
	" DDH-AN3	"	"	514	"	"	"		x	

+ APLA = Appila Tillite

TCIE = Tarcowie Siltstone

TPLY = Tapley Hill Formation (includes Tindelpina Shale Member) - shales & siltstone

YUD = Yudnamutana Subgroup (includes Appila Tillite) - siltstones & quartzites

Appendix A2

MAGNETIC PROPERTIES OF ROCK SAMPLES

A2.1 Volume magnetic susceptibility

Measurements of volume magnetic susceptibility were made on drill cores, drill hole cuttings and crushed surface samples using variously two MS-3 Magnetic Susceptibility Bridges manufactured by Soiltest Inc., Evanston, U.S.A.   The bridge used for the work on all but one of the cores belonged to the SADM, and that used for all other measurements belonged to the Department of Economic Geology, University of Adelaide.

The MS-3 is an A.C. bridge instrument (1,000 cycles per second) which measures the change of inductive coupling between coils when a magnetic substance is placed between them.   The change is registered on a potentiometer graduated in ohms and is determined by obtaining a 'null' with an earphone attachment.   The ohm reading can be converted to suscep- tibility by standard charts provided with the instrument.   Maximum field intensity at the sample position is about two Oersteds.   Test samples should be cylindrical and about 9 cm long.   If they have the maximum diameter possible for the test coils provided (3-6.3 cm), then suscepti- bilities or changes of subsceptibility as low as 5×10^{-6} c.g.s. units can be measured.   With ten or more independent repeat readings lower measurements can be made (e.g. 1×10^{-6} c.g.s. units).   Susceptibilities as low as this are not of interest in magnetic interpretation.

If samples are of smaller diameter than the test coils a simple correction for volume is required to bring the measured 'apparent susceptibility' to a true value.   If samples are crushed, then an additional volume correction, sometimes referred to as a 'porosity correction', is necessary if the susceptibility of solid rock is required.

At the SADM corestore, where the readings on all but one of the cores were made, strong electrical interference (thought to be due to motors in an adjacent factory) prevented measurements of susceptibilities or differences in susceptibilities below 100×10^{-6} c.g.s. units. It is suggested to any further workers that core held by the SADM be examined at some location remote from the corestore, if susceptibilities below 100×10^{-6} c.g.s. units are of interest.

The calibration of the two instruments was checked and adjustments were made accordingly to the measured values.

A2.1.1 Calibration corrections

Two known susceptibilities were used to provide fixed comparisons of MS-3 readings and true values. One came from a ferric chloride solution, the other from a core sample tested with an Astatic magnetometer and the University MS-3 by Mr. J. Wolfensberger (pers. comm.).

The susceptibility of an aqueous ferric chloride solution can be calculated with the following formula (Forsythe, 1959, p.462).

$$k_{mass} = \frac{p}{100} \times k_1 + (1 - \frac{p}{100}) k_2$$

where k_{mass} = mass susceptibility of the solution,

p = percentage by weight of anhydrous $FeCl_3$ in solution,

k_1 = mass magnetic susceptibility of anhydrous $FeCl_3$ -
   = 90×10^{-6} c.g.s. units at room temperature,

k_2 = mass magnetic susceptibility of pure water
   = $-.079 \times 10^{-6}$ c.g.s. units at room temperature.

then k = $k_{mass} \times$ density of the solution

where k = volume magnetic susceptibility.

The solution used by the author had a measured density of 1.435 g/cm^3

and thus contained 41.3% by weight of anhydrous $FeCl_3$ (density converted to percentage from Weast (1964, table D-181). The calculated volume susceptibility was 52.7×10^{-6} c.g.s. units.

Besides the tests with $FeCl_3$ and Wolfensberger's sample (J.W. Sample 2) two of the author's ground rock samples (D.H.T. Samples 1 & 2) were used to compare the two MS-3's. The results are summarised on Table A2.1.

Table A2.1

Calibration Tests on MS-3 Bridges

Sample \ Instrument Coils**	University MS-3 A	University MS-3 B	SADM MS-3 A	SADM MS-3 B	SADM MS-3 C	Astatic Magneto- meter	Calculated
$FeCl_3$	70*	42	67	59	37	-	52.7
D.H.T. Sample 1	1140	850	915	1040	715	-	-
J.W. Sample 2	-	5100	-	-	-	5100	-
D.H.T. Sample 3	7140	6150	5800	7550	6830	-	-

* Susceptibilities from MS-3 bridges were calculated with the calibration curves supplied with the instruments. All values should be multiplied by 10^{-6} to give c.g.s. units.

** Test coils:

      A. Internal diameter 3.02 cm ($1^3/16$ in)

      B.   "   "   4.13 cm ($1^5/8$ in)

      C.   "   "   6.35 cm ($2\frac{1}{2}$ in)

It is believed that a susceptibility measured with either of the instruments is within 30% of the actual susceptibility. Work with

the SADM bridge was too inaccurate to warrant application of calibration corrections.   Calibration corrections applied to measurements made with the University MS-3 are shown on Table A2.2.   Most susceptibility measurements were made with coil A.

Table A2.2

Calibration Corrections for University MS-3

Measured Susceptibility Range (c.g.s. units)	Factor*	
	Coil A	Coil B
0- 500 x 10^{-6}	0.75	1.25
500- 3,000 x 10^{-6}	0.85	1.15
3,000-50,000 x 10^{-6}	0.90	1.00

* Factor by which susceptibility measured using manufacturer's specification should be multiplied to give a true value.

A2.1.2 Porosity correction

Most of the author's susceptibility measurements were for crushed rocks.   All samples were shaken down into a 2.35 cm diameter flat bottomed glass tube until few air spaces were visible.   A comparison of density of 58 solid and crushed rock samples indicated that for samples consisting of unsorted chips ranging from about pea size to fine powder, the ratio

$$\frac{\text{density of solid rock}}{\text{density of cuttings}}$$

fell in the range 1.7-2.5.   The mean of the 58 tests was 1.95.

A porosity correction factor of two was adopted for all crushed drill hole samples, whether they were drill hole cuttings or powder from a seed mill (density of solid samples was unknown). For measurements on crushed samples of surface rocks collected by the author, the appropriate volume factor for each sample was applied because both the solid and crushed rock densities were known.

A2.2 Susceptibilities measured

A2.2.1 Drill core

A2.2.1.1 The base of the Tapley Hill Formation

Five drill cores were tested. In the area of most of the drill holes, mapping by the SADM indicated that the Tindelpina Shale Member occurs at the base of the Tapley Hill Formation. All of the cores contain pyrite and red iron oxides, usually as thin bands less than 0.1 cm thick, and parallel to the sedimentary layering. Often the fine bands are only 0.2-0.5 cm apart.

Spring Creek Mine - DDH 1/29

Core samples were tested with the University MS-3 at the corestore of R.M.C. Minerals, Adelaide. The sampling interval was approximately 4.5 m over sufficient length of core to pass from the Tindelpina Shale into the Yudnamutana Subgroup (Appila Tillite). The results are shown on Figure A2.1. Most values lie in the range $25-100 \times 10^{-6}$ c.g.s. units, and the average is about 75×10^{-6} c.g.s. units. Two values lie close to 300×10^{-6} c.g.s. units. There appears to be no significant difference between values for the Tindelpina Shale and the Yudmanutana Subgroup. Thin bands of pyrite (less than 0.1 cm thick) occur within 15 m of the top of the core.

Paull Consolidated - DDH PC2

Split core samples were tested with the SADM MS-3 at the SADM core-store. The sampling interval was approximately 0.6 m over the entire length of core (573 ft, 175 m). The core extends from the Tindelpina Shale Member into the Yudnamutana Subgroup (Fig. A2.1). Occasional pyrite bands (0.1-0.2 cm thick) occur below 40 m; the core is stained by iron oxides over its entire length.

No measured values were obtained due to the influence of strong electrical noise. The susceptibility of all tested samples was less than 100×10^{-6} c.g.s. units.

White Lead - DDH DLY5

Core samples were tested with the SADM MS-3 at the SADM corestore. The sampling interval was approximately 1.5 m over the entire length of core (358 ft, 109 m). A cross section for the drill hole is shown on Figure A2.1. Pyrite bands occur below 65 m. No measured values were obtained due to the electrical noise. The susceptibility of all but one sample tested was less than 100×10^{-6} c.g.s. units. One sample at 45 m containing a 0.2 cm thick pyrite layer produced a barely detectable response in the earphones probably corresponding to a suscep-tibility of about 100×10^{-6} c.g.s. units. There was no significant difference between different rock units.

Prince Alfred Mine - DDH 2

Core samples were tested with the SADM MS-3 at the SADM corestore. The sampling interval was approximately 1.5 m over the length 12-137 m. The core consists of shale and siltstone similar in appearance to Tindelpina Shale. Fine disseminated pyrite occurs throughout the core.

Electrical noise prevented useful measurements.   The susceptibility of all samples tested was less than 100×10^{-6} c.g.s. units.

Baratta - DDH 3

Core samples were tested with the SADM MS-3 at the SADM corestore. The sampling interval was approximately 0.6 m over the length 43-71 m. The core consists of shales and siltstones similar in appearance to Tindelpina Shale.   It is heavily iron oxide stained above 50 m and contains occasional bands of oxides 2-5 mm thick over its entire length.   Occasional bands of pyrite (up to 0.2 cm thick) occur below 50 m.   Electrical noise prevented useful recordings.   The susceptibility of all samples tested was less than 100×10^{-6} c.g.s. units.

A2.2.1.2 Discussion

Despite equipment problems it appears that the lower part of the Tapley Hill Formation (Tindelpina Shale), at the tested localities is only very weakly magnetic.   All of the cores contain pyrite below about 50 m.   Near the surface the core is stained by layers of iron oxides.   There are no aeromagnetic anomalies recorded at the locality of any of the drill holes and it therefore appears that in these areas the Lower Tapley Hill Formation either contains no strongly magnetic beds or else they are extremely thin.   The latter possibility does not seem very likely, although in the Spring Creek Mine core (DDH 1/29) two susceptibilities were recorded which are approximately four times the general background level of about 75×10^{-6} c.g.s. units.   On the basis that the depth at which fresh pyrite occurs is the depth of oxidation and the depth of magnetic weathering, it appears that in the absence of strongly magnetic beds the susceptibility of both the fresh and weathered rock is about 75×10^{-6} c.g.s. units.   From tests of random samples from

each drill hole, with a magnetometer, it appears that the rock does not possess a strong component of remanent magnetism.

A2.2.2 Percussion drill cuttings

A2.2.2.1 The top of the Yudnamutana Subgroup

Seven shallow percussion holes were drilled by R.M.C. Minerals at a locality suggested by the author 12 km south-west of Waukaringa (2 km south of the Ajax Mine).   At the locality the upper part of the Yudnamutana Subgroup mainly consists of quartzites, dolomites and boulder tillite of the Appila Tillite.   The drill holes were positioned by ground magnetometer work which recorded anomalies attributable to small sources within 5 m of the surface at the locality of Hole 6 and Hole 1 and within 10 m of the surface at the locality of Holes 3, 4 and 5 (Fig. A2.2).   The magnetic interpretation indicated that the sources are strongly remanently magnetized.

Ajax - Holes 1 to 7

Seed mill samples of percussion hole cuttings collected over 0.6 m intervals were tested with the University MS-3.   The results are shown on Figure A2.2.   Most values lie in the range 50-100 x 10^{-6} c.g.s. units. In most holes there is a drop in susceptibility over the first 2-3 m, followed by a rise over the next 2-5 m, followed by a general levelling off beyond 10 m.   Mineragraphic studies (see Appendix A4, Samples OR62 & OR60) showed the presence of about 1.5% pyrrhotite (by weight) in two samples tested (Hole 1 (1.5-2.5 m), and Hole 7 (17-17.5 m)).   This quantity is probably sufficient to cause the observed susceptibility.

A2.2.2.2 The top of the Tapley Hill Formation

Two shallow percussion holes (Waukaringa, Holes 8 & 9) were drilled by R.M.C. Minerals at a locality suggested by the author,

1 km north of Waukaringa.   In this area the ORROROO geological map

shows an unnamed felspathic sandstone bed at the top of the Tapley Hill

Formation.   Gold bearing sulphide ore has been mined from the 15 m thick

sandstone bed.   Aeromagnetic and ground work indicate that a magnetic

bed interpreted to be 50-60 m below the surface, may be associated with

the sandstone.

Waukaringa - Holes 8 & 9

The two holes were drilled by R.M.C. Minerals to test the geochemistry

of the sandstone bed.   The drill did not have the capacity to reach the

predicted magnetic material.   Therefore the work was confined to the

near surface part of the sandstone member.   Seed mill samples of per-

cussion hole cuttings collected over 3.5 m intervals were tested with the

University MS-3; the results are shown on Figure A2.3.   Except for one

value of 400×10^{-6} c.g.s. units near the top of Hole 8, and 170×10^{-6}

c.g.s. units near the top of Hole 9, all susceptibilities lie below

100×10^{-6} c.g.s. units.   Pyrrhotite was identified in the high suscepti-

bility sample (OR61, see Appendix A4).

A2.2.2.3 Quaternary sediments of the Walloway Plain

Six shallow percussion holes were drilled by Minerals,

Mining and Metallurgy Ltd. at a site suggested by the author, 12 km

north-east of Eurelia Railway Station.   The holes were drilled to make

a preliminary test of the source of a linear aeromagnetic anomaly along

the west side of the Walloway Plain.   Geological mapping (Binks, 1968,

1971) indicates that the partly consolidated strata of the Walloway

Plain are of Quaternary age.   Susceptibility measurements on material

from four of the drill holes are discussed below.

Walloway Plain - Holes 1, 3, 5 & 6

Percussion hole cuttings were tested with the University MS-3.
Material from the holes consisted mainly of heavily iron oxide stained
clay and sand, with occasional pebbles of quartzite.

Susceptibility measurements are shown on Figure A2.4.   The
Quaternary sediments at the locality have a surprisingly high suscepti-
bility.   For samples from Hole 6 the average over 30 m of section is
about $1,090 \times 10^{-6}$ c.g.s. units.   Maghemite was identified in two
samples (Appendix A4, Samples OR58 & OR59).   It is considered that the
high susceptibility of the sediments is probably caused by this mineral.
In Hole 6 susceptibilities below 30 m are significantly lower than those
above.   The low susceptibilities recorded for samples near the bottom
of Holes 3 and 6 are close to the background level recorded elsewhere
for Adelaidean strata (75×10^{-6} c.g.s. units).   On this basis it is
probable that magnetically weathered Adelaide System sediments were pene-
trated at 30 m in Hole 6.   Two small chips of shale were found in the
cuttings below 30 m.   This is weak supporting evidence that Adelaidean
strata were penetrated by the drill hole below 30 m.

A2.2.3 Surface samples

Approximately 100 surface rock samples associated with
magnetic bodies were collected and tested for susceptibility.   Most
were from ORROROO.   Each rock sample collected was one to four fists
in size.   A small piece 50-100 cm^3 in volume was cut from each sample
and crushed in a press.   Thus test specimens contained a range of
particle sizes ranging from dust up to pea size.

The 72 samples for which frequency histograms of susceptibility are shown on Figure A2.5 were collected from Adelaide System sedimentary beds, which interpretation of the magnetic anomalies indicates are magnetic below the surface. Results of tests on the other samples are not included here. The samples were from a variety of sedimentary formations, small intrusive bodies and mine dumps. Some of the measurements are mentioned in the text of the thesis.

A2.2.3.1 Ulupa Siltstone

31 samples of Ulupa Siltstone were collected along ground magnetometer traverses 14A, 15 and 18 over total distances less than 300 m, where interpretation of the anomalies indicates that near surface rocks are magnetic. The histogram (Fig. A2.5(a)) shows two weak groupings of values, one less than 100×10^{-6} c.g.s. units, and the other centred near $1,000 \times 10^{-6}$ c.g.s. units (range approximately $500-5,000 \times 10^{-6}$). The most strongly magnetic sample which has a susceptibility of $15,000 \times 10^{-6}$ c.g.s. units, contains about 20% magnetite (Appendix A4, Sample OR17).

A2.2.3.2 Lower Tapley Hill Formation (Tindelpina Shale)

Measurements on 26 samples collected by the author and Mr. J. Sumartojo from different localities, are summarised on Figure A2.5(b). Most of these samples came from outcrops which the magnetometer profile interpretation indicates were the surface outcrop of deep magnetic beds. The values lie in the range $10-80 \times 10^{-6}$ c.g.s. units and are grouped near 30×10^{-6} c.g.s. units.

A2.2.3.3 Appila Tillite and Holowilena Ironstone

Measurements on 11 samples of Appila Tillite from different

localities and four specimens of Holowilena Ironstone from two locali-
ties 10 km north-north-east of Waukaringa are summarised on Figure
A2.5(c).   Values for the Appila Tillite lie below 180×10^{-6} c.g.s.
units and are grouped around 70×10^{-6} c.g.s. units.

Values for the four Holowilena Ironstone samples show a wide range
($150-58,000 \times 10^{-6}$ c.g.s. units).   The most strongly magnetic specimen
contains about 25% magnetite (Appendix A4, Sample AAH1).

A2.2.3.4 Discussion

Susceptibilities of surface samples show a significant
grouping below 100×10^{-6} c.g.s. units.   These values are presumably
those of the magnetically weathered material.   Even in the most strongly
magnetic rocks there is mineragraphic evidence of weathering.   An average
susceptibility of a fresh magnetic bed cannot be derived from the
available surface data.

A2.2.4 Soil samples

The susceptibilities of two residual soil samples over the
Ulupa Siltstone were 40 and 120×10^{-6} c.g.s. units.   Three red drift
sand samples had susceptibilities in the range $80-1,200 \times 10^{-6}$ c.g.s.
units.   Magnetite was identified in a drift sand sample.

A2.3 Susceptibility anisotropy

Approximate estimates of susceptibility anisotropy were made on a
surface sample of Ulupa Siltstone, Tindelpina Shale and Holowilena
Ironstone in the following manner.   A 10 cm long specimen with square
cross section (1.8 cm/side) was cut from the rock such that the bedding
plane was parallel to the long axis of the specimen.   This was cut into
five cubes.   Measurements were then made with the University MS-3 on the

five cubes taped together so that bedding planes were first parallel
to the long axis of the sample (giving Rp) and then normal to it
(giving Rt); the measurements Rp and Rt were scale units of the MS-3,
and were not converted to susceptibilities. With this arrangement
the axial magnetic field of the test coil was first parallel to the
bedding planes and then normal to them. After each pair of measure-
ments the cube at the bottom was placed at the top and the measuring
procedure repeated. Thus a total of five pairs of readings were obtained.
These were averaged. Within each group of five readings the difference
between the highest and lowest values obtained was less than 28% of the
highest value.

The measurements and calculated percentage anisotropy are shown on
Table A2.3.

Table A2.3

Susceptibility Anisotropy

Sample	Lithology	Rp	Rt	% Anisotropy
OR25	Ulupa Siltstone	79	81	2.5
OR50	Tindelpina Shale	3.4	3.4	0
AAH1	Holowilena Ironstone	3664	3463	5.5

Two of the samples appear to be slightly anisotropic with regard
to susceptibility. For the Ulupa Siltstone sample the easy direction
of magnetization is transverse to the sedimentary layering, while for
the Holowilena Ironstone the opposite is the case. For the Holowilena
Ironstone it was noted that magnetite grains are elongated parallel to

the sedimentary layering.   The measurement method was too insensitive to give a meaningful estimate for the Tindelpina Shale sample.

A2.4   Measurements of remanent magnetic properties

The main factors of interest to interpreters of magnetic anomalies, apart from susceptibility, are (1) the direction of the remanent magnetism in a rock and (2) the Koenigsberger ratio Q_n,

$$\text{where } Q_n = \frac{\text{intensity of natural remanent magnetism}}{\text{intensity of magnetization induced by the earth's field}}$$

(cf. Irving, 1964, p.11)

While there are various elaborate methods which can be applied to find these properties (see Collinson, Creer & Runcorn, 1967), the author devised a very simple technique based on approximate methods described by Fromm (1967), and Doell and Cox (1967).   The technique devised to find these factors for small cubic rock samples is rapid to apply and gives useful approximate results for strongly magnetic samples.   Once a sample has been cut, measurements and computations take about 20 minutes.   The method may be of appeal to others working on strongly magnetic rocks (such as the Banded Iron Formations in Western Australia) and is therefore described fully below.

The remote head of the University's fluxgate magnetometer was firmly fixed inside a flat topped glass tube such that the centre of the sensing element was 3.0 cm below the top face of the tube.   On the top face of the glass tube a square of cardboard with a 1.8 cm square hole in it was glued so that samples could be relocated in exactly the same position.   This arrangement was taped to a block of wood such that the sensor was aligned parallel to the earth's field (inclination -65°, intensity 59,000 gammas at Adelaide).   Thus the instrument was set up

as a total field magnetometer. The deflection on the magnetometer (gammas) was noted as each of the six faces of cubes of rock (with side length of 1.8 cm) were located in the cardboard square.

Fromm (op. cit.) stated that the error in assuming the magnetic effect of a cube could be approximated by a point dipole at its centre of gravity, is less than 1.5% if the angle between the centre of the fluxgate sensing element and the nearest edges of the cube is less than 34°. To conform with this, for the author's specimens the distance between the sample and the centre of the sensing head was 3.0 cm. Thus the results of the six measurements on each cube can be treated as being due to a point dipole. Each measurement recorded the combined influence of inductive magnetism and the component of remanent magnetism in the direction parallel to the long axis of the system. Each face of the cubes was marked with a letter corresponding to a right handed orthogonal coordinate system, e.g. Z' for the face normal to OZ' axis, Y normal to OY, Z normal to OZ, Y' normal to OY', X' normal to OX', and X normal to OX. In the table of results (Table A2.4) reading corresponds with the face Z' being nearest to the sensing head and normal to the earth's field; reading Y corresponds with face Y in the above arrangement etc. The formulae used to derive the inclination of remanent magnetism with respect to the bedding planes, and the Koenigsberger ratio are shown below the table. To simplify the mathematics, the faces X' and X were cut parallel to bedding planes and the edge defined by the join of faces X and Z was cut approximately parallel to the horizontal (marked in the field). Thus Y'OY defined the horizontal.

Table A2.4

Remanence tests on Holowilena Ironstone, Sample AAH1

Results / Specimen No.	1	2	3
Reading Z' (gammas)	-130	-55	-65
" Y "	-330	-160	-200
" Z "	-60	-45	-50
" Y' "	170	70	95
" X' "	-60	-30	-35
" X "	-90	-55	-70
Y-Y'	-500	-230	-295
Z-Z'	70	10	15
X-X'	-30	-25	-35
R	506	232	297
Y+Y'	-160	-90	-110
Z+Z'	-190	-100	-115
X+X'	-150	-85	-105
I	-167	-92	-110
θ_r^o	$4^o6'$	$6^o42'$	$5^o12'$
Q_n	3.20	2.52	2.68

All of the above readings have units of gammas, except for Q_n which is unitless, and θ which is a measure in degrees. Gamma readings are accurate to within $\pm$ 5 gammas.

$R = ((B - D)^2 + (C - A)^2 + (E - F)^2)^{\frac{1}{2}}$ is a measure of remanent intensity.

$I = ((B + D) + (C + A) + (E + F))/3$ is a measure of induced intensity.

$$\theta_r^o = \text{arc cos} \left\{ \frac{R^2 + (B - D)^2 + (C - A)^2 - (F - E)^2}{2R ((D - B)^2 + (C + A)^2)^{\frac{1}{2}}} \right\} \text{ is the angle}$$

which the remanent vector makes with the bedding plane.

Q_n = is the Koenigsberger ratio.

The results indicate that the inclination of remanent magnetism in the samples lies at an angle of about 5° to the bedding planes, and that the ratio of remanent to induced intensity is quite high (2.8 for average of the three specimens).   Other elementary calculations indicated that the direction of remanent magnetism is within 10° of the horizontal reference of the sample.

The method was tried unsuccessfully on specimens of Ulupa Siltstone; the reading errors with the magnetometer were too high to warrant a quantitative analysis.

The main problem with the simple apparatus was man-made noise (motor cars).   This caused readings to wander by $\pm$ 30 gammas at times.   However, the readings Z' to X shown on Table A2.4 are accurate to $\pm$ 5 gammas.

Appendix A3

GROUND MAGNETOMETER LINES

Magnetometers used in the field were as follows:

1.   Vertical Field

Ruska Balance - manufactured by Ruska Instrument Corp.

Fluxgate - McPhar M700

2.   Total Field

Elsec Proton Precession Magnetometer

Sander Proton Precession Magnetometer

Most ground magnetometer traversing was with reconnaissance lines, one or two being put in at each favourable location.   The length was normally in the range 1-4 km;   four lines were slightly more than 8 km long.   Usually one or two specific anomalies recorded by the aeromagnetic survey were of interest;   the main traverses were made sufficiently long to record the background, and extend between points easily identified on 1:63,360 stereo air photos.   Traverses were usually normal to geological (and geophysical) strike.

Particular attention was paid to photo location and positioning during the course of ground traversing.   On the main traverses distance along the ground was measured by an offsider with a road measurer (graduated in feet).   Usually this gave a length 1-2% above the distance scaled from maps, probably due to undulations in the ground surface.   This size of error is unimportant in interpretation of anomalies.   Magnetometer stations (usually 25-100 ft apart (7.5-30 m)) were marked on the ground, or with a 15 cm long piece of aluminium wire with short lengths of plastic flagging attached.   The wire markers were placed at regular intervals

along the line (e.g. 500 ft (150 m)) and left until geological work had been carried out. When working across open country it was found an advantage to drive along the proposed traverse and then walk along the vehicle wheel tracks while reading the magnetometer.

Diurnal variation was recorded by a base station reoccupation method. Usually a base station was reoccupied at intervals of no more than 90 minutes. In this time drift was usually less than 40 gammas. With the fluxgate magnetometer it was found an advantage to use a cement brick or block of wood for a base station. They were placed at a position where a small error in repositioning the magnetometer on the block produced no observable change of reading. On long traverses (4 km or more) three or four blocks were laid in advance along the traverse, and readings were made on the blocks on the outward and return trip.

Particular care was taken to ensure that no magnetic material was carried while reading the magnetometers.

It was found that man-made magnetic sources are often associated with roads and tracks. Where possible traversing on roads was avoided. Various traverses were put in parallel to roads 20-30 m into the adjacent paddocks.

It was found that a considerable amount of time could be saved if magnetometer data were recorded directly on IBM coding forms ready for punching rather than on a note pad (40 hours traversing required 23 hours of transcription to IBM forms for one of the early surveys). Therefore nearly all of the original field data were directly recorded on coding forms. Information on the coding forms used for computing and profile plotting included

1. magnetic anomaly values,

2. distance of each station from the first base station (if a traverse extended both sides of the first base station distances in one direction were positive, and in the other were negative),

3. corrections to compensate for diurnal variations, and

4. corrections to compensate for significant deviations of the traverse from normal to geological strike.

Other information recorded on the coding forms included the traverse number, topographic reference points (e.g. creeks, fences, roads, hilltops etc.) and various geological features (e.g. major outcrops and geological dips and formation boundaries where recognizable).

Figure 2.1 shows the locations of magnetometer surveys. The various areas surveyed are given a reference letter for easy reference on Table A3.1. The main magnetometer traverses are listed on the table. Most of the work was carried out on ORROROO; the locations of the main traverses on this sheet are shown on Figure 1.5.

At various localities one or more short traverses or small grids were made close to the main traverses to check the linear continuity of magnetic features. Distances were usually measured by pacing and the end points of the lines were not usually photo located. A summary of these data is not included on Table A3.1.

The most important original ground magnetometer data are lodged with the Department of Economic Geology, University of Adelaide. This includes

1. Aerial photographs and sketch maps showing the locality of ground traverses,

2. A computer listing of original and corrected data,

3. A microfilm copy of anomaly profiles, and

4. IBM card decks of original data for treatment with program
    MAGLINE (see Appendix A5).

Table A3.1

Ground Magnetometer Traverses

Reference Letter on Fig. 2.1	Locality Name	Traverse Number[1]	Photos[2]	Magnetometer[3]	Formations Crossed[4]
A	Mt. Coffin Diapir	123-134	Angepena (sketch map)	ΔZ	UMB, dolerite dykes
B	Eucolo	6,7	Eucolo	ΔZ	Eyre Peninsula dyke swarm
C	Neuroodla	86,87,88	Hawker	ΔZ	Possible buried intrusive
D	Berrimans Well	136	Siccus (sketch map)	ΔT	UMB
E	Hesso	1,4,5	Yudnapinna	ΔZ	Eyre Peninsula dyke swarm (? dolerite)
F	Yudnapinna	100,101	Yudnapinna	ΔZ	Eyre Peninsula dyke swarm (? dolerite)
G	Corunna	98,99	Corunna	ΔZ	Gawler Range Volcanics basic dyke
H	Cooey Dam	97	Corunna	ΔZ	Dolerite dyke
I	Waukaringa	26-38,44-49,60-72, 76,121,124-127	Koonamore Waukaringa	ΔZ	UMB, top of BRA
J	Walloway Plain	77,78,137-140	Carrieton Orroroo	ΔZ	Quaternary sediments, UMB
K	Walloway Diapir	144 (grid)	Orroroo (sketch map)	ΔZ	Carbonatite dykes & plugs
L	Spring Creek Mine	25	Wilmington	ΔZ	UMB
M	Paratoo Diapir	73,74,123	Paratoo	ΔZ	WNA, UMB
N	Peterborough	8,8A,9,14,14A,15,15A,15C 16A,18,79,89-95,115-120	Peterborough, Melrose, Nackara	ΔZ, ΔT	WNA,UMB,BRA; possible intrusive (94,95)
O	Steelton	84	Riverton	ΔZ	UMB
P	Point Pass	85	Eudunda	ΔZ	UMB
Q	Kapunda	83	Kapunda	ΔZ	UMB
R	Sturt Gorge	75,81,82	Echunga	ΔZ, ΔT	UMB
S	Willunga	80	Echunga	ΔZ	UMB

Notes

1. Where traverses cross the same formation twice (e.g. across anticlines), in the text of the thesis they are sometimes referred to in parts, e.g. 65N (north) and 65S (south).

2. Aerial photos are indexed according to the official name of 1:63,360 areas. These areas are 15' of latitude high and 30' of longitude wide, e.g. Eucolo.

3. ΔZ = vertical field magnetometer; ΔT = total field magnetometer: a few lines were read with both types of instrument, viz. 80, 94 & 115.

4. WNA = Wilpena Group; UMB = Umberatana Group; BRA = Burra Group; in most cases any particular traverse crossed only a part of the rock group.

Appendix A4

MAGNETIC MINERAL ANALYSES

The strongly magnetic minerals present in various rock samples were tentatively identified by microscope and/or X-ray analysis. The results of this preliminary work are summarised below. Magnetic susceptibilities indicated in the appendix have been corrected as dis-cussed in Appendix A2.

A4.1 Solid rocks

Polished sections of four surface rock samples collected from localities where detailed ground surveys indicated surface rocks are magnetic, were examined (Table A4.1). The two samples of Ulupa Siltstone came from one locality 17 km north-east of Peterborough. The two samples of Holowilena Ironstone came from one locality 10 km north-north-east of Waukaringa.

Table A4.1

Sample	Source rock	k c.g.s. units	% Iron oxides (by volume)	Composition of average iron oxide grain	
AAH1	Holowilena Ironstone	0.058	45-50	50% magnetite	50% martite
AGC1	"	0.011	50	30% magnetite	70% martite
OR17	Ulupa Siltstone	0.015	5-50*	70% magnetite	30% martite
OR13	"	0.005	7	90% magnetite	10% martite

* Variation across the samples (2 cm wide).

In these samples, magnetite euhedra and aggregates of euhedra were seen to be altering to martite. The diameter of individual grains and aggregates lay in the range 20-80 microns. There was a marked tendency for grains to lie along the sedimentary bedding planes of the sediments. In sample AAH1 grains had an elongation biased parallel to the sedimentary layering.

Sample OR55

Collected from: Waukaringa Mine dump.

Source rock: sulphide ore, probably from within the felspathic sandstone member between the Tapley Hill Formation and the Tarcowie Siltstone.

Test material: polished section of the rock and a polished section of the strongly magnetic fraction (separated from a crushed sample with a hand magnet).

Magnetic susceptibility: $1,000 \times 10^{-6}$ c.g.s. units.

Discussion: the rock mainly consisted of pyrite. It contained approximately 0.5% pyrrhotite and 0.05% magnetite (by volume). These quantities are probably sufficient to produce the observed magnetic susceptibility of the rock.

A4.2 Percussion drill cuttings

Samples OR58 and OR59

Collected from: Hole 6 - Walloway Plain.

Location: 2 km south-east of Oladdie Mine (12 km north-east of Eurelia Railway Station).

Source rock: sediments of Quaternary age.

Test material: polished sections of the strongly magnetic fraction.

Each 100 g sample of cuttings was sieved to the diameter range
0.0099" - 0.0139" (250-350 microns) and washed. The strongly
magnetic fraction was separated from the washed material with a
hand magnet (Table A4.2).

Discussion: iron oxides present in the magnetic fraction of both samples
included earthy clay limonite, colloform limonite and micro-crystalline
goethite. Approximately 10% of the magnetic grains consisted of
maghemite (X-ray and reflectance tests). No magnetite was observed.
The sample contained a trace of pyrrhotite (20-30 micron diameter
grains).

Table A4.2

Magnetic mineral separation of cuttings from Hole 6, Walloway Plain

Sample	Depth Range	k for unwashed material*	Weight of magnetics / Sample weight	Maghemite present in washed sample (by weight)
OR58	2.5-5.5 m	0.0006 (cgs)	1.04%	0.1%
OR59	20-22 m	0.0035 (cgs)	10.47%	1.0%

* Insufficient washed material was available to make susceptibility
measurements.

Maghemite has a saturation magnetization close to that for magnetite.
On this basis it is probable that the observed susceptibility of the
samples is due almost entirely to the presence of maghemite. The
reason why grains of other iron oxides present in the samples are strongly
magnetic is not known. It is probable that they are strongly remanently
magnetized, but contribute little to the susceptibility.

Samples OR60 and OR62

Collected from: Ajax, Hole 7 (OR60), Ajax, Hole 1 (OR62).

Location: 12 km south-west of Waukaringa.

Source rock: dolomite within the Yudnamutana Subgroup (Appila Tillite).

Test materials: polished sections of the magnetic fraction. The strongly magnetic fraction was separated from washed, sieved cuttings with a hand magnet (Table A4.3).

Discussion: the magnetic mineral was identified as pyrrhotite.

Table A4.3

Magnetic mineral separation for samples OR60 & OR62

Sample	Depth Range	k for unwashed material (c.g.s. units)	Weight of magnetics / Sample weight
OR60	17-17.5 m	100×10^{-6}	1.4%
OR62	1.5-2.5 m	110×10^{-6}	1.6%

Sample OR61

Collected from: Waukaringa Hole 8.

Depth range: 1-3 m.

Location: 1 km north of Waukaringa.

Source rock: felspathic sandstone between the Tapley Hill Formation and the Tarcowie Siltstone.

Test material: polished sections of the magnetic fraction (separated from washed cuttings with a hand magnet). The magnetic fraction

was 2.8% by weight of the sample.

Discussion: the only mineral positively identified was pyrrhotite (5-10%). The other 90-95% of the magnetic fraction was tentatively identified as lepidocrocite. Four of these mineral grains had a hardness in the range 295-367 (Vickers Hardness tester). The grains had red internal reflections but did not appear to be aniso-tropic. The quantity of pyrrhotite detected in the sample is probably too small to cause the observed magnetic susceptibility.

Sample C063

Collected from: Southern Cross Mine, Hole 368E/389N.

Depth range: 84-85 m.

Location: Mt. Coffin Diapir (COPLEY).

Source rock: Tindelpina Shale Member.

Magnetic susceptibility: 35×10^{-6} c.g.s. units.

Test material: polished section of the strongly magnetic fraction. The magnetic minerals (2% by weight) were separated with a Frantz magnetic separator from a crushed and washed percussion drill sample.

Discussion: the magnetic material contained the following:

(a) rounded grains of magnetite (300 microns diameter)

(b) flakes of magnetite (350 microns long, 35 microns thick)

(c) quartz-magnetite composite grains (300 microns diameter)

(d) quartz grains in a goethite matrix.

A4.3 Soil samples

Samples OR56 and OR57

Sample OR56 was collected with a hand magnet from a sand drift near

Waukaringa.   Sample OR58 was collected with a hand magnet from a dry
creek bed 10 km south of Waukaringa.   X-ray analysis of the two
samples indicated that magnetite was the main magnetic mineral present.
Hematite was also detected.

Appendix A5

COMPUTER PROGRAMS

To assist with interpretation of the geophysics, various computer programs were written in Fortran for the University's CDC 6400 machine. None of the programs offer any new innovation to geophysics.

Card decks and listings of the programs used for the thesis, together with source data, are held in the Department of Economic Geology, University of Adelaide. The programs and their functions are listed below.

A5.1 PROGRAM MAGLINE

For: Treatment of field data from individual ground magnetometer traverses.

Functions:

(1) Ground magnetometer data are corrected for diurnal variation.

(2) If the traverse is oblique to strike or contains bends along its length (for example, if it follows a road), the station spacings can be adjusted so that the profile is effectively normal to geological strike.

(3) A linear regional can be removed.

(4) The data can be gridded to some chosen interval by linear interpolation.

(5) The data can be linearly filtered using an operator which acts on nine gridded values. Coefficients of the operator can be altered as desired.

(6) The gridded data can be upward or downward continued
up to five times the grid spacing (following the method
of Henderson, 1960).

Output:

At any or all of the six stages, printouts and/or plots can
be obtained. Plot scales can be altered as desired.

A5.2 PROGRAM COMPS2P

For: Computing theoretical magnetic anomalies across dipping tabular
bodies of infinite length and depth extent.

Function:

The program computes the theoretical anomaly on a horizontal
surface above one or more (up to nine) dipping flat topped
tabular bodies of finite thickness.   The equation used for
the anomalies is that of Gay (1963) for the case where demag-
netization is neglected.   The direction of magnetization in
the bodies, and their depth, thickness and magnetization can be
different.   The dip of all bodies must be the same but can be
varied as necessary.

Output:

Printout and/or plot.

A5.3 PROGRAM MAGHIL3

Written by Mr. John Trethewie (Austral Exploration Services, Adelaide,
S.A.).

For: Computing the theoretical magnetic anomaly of an arbitrarily
shaped solid three dimensional body.

Function:

The program computes the theoretical anomaly on a horizontal

square grid above a magnetic body for any chosen direction of

magnetization.   If desired a single north/south or east/west

profile can be computed.   The program is based on the method

of Talwani (1965).

Output:

Printout.

A5.4   PROGRAM GRBOTT2

For: Computing the shape of a basin of infinite length to account

for a Bouguer anomaly.

Function:

The program iteratively computes the depth to the bottom of a

chosen number of infinitely long rectangular blocks until the

resulting theoretical anomaly of the arrangement differs from

the input anomaly by less than some chosen criterion.   The

method follows that of Bott (1960).

Output:

Printout.

A5.5   PROGRAM DENSPR2

For: Computing Bouguer anomalies along a line of gravity stations

for six Bouguer densities (2.0, 2.2, 2.4, 2.6, 2.8 & 3.0 g/cm^3).

Function:

The program was designed to treat Bouguer anomalies originally

computed by the BMR for a Bouguer density of 2.67 g/cm^3.   The

value at each station is reduced to the condition where the
Bouguer density is zero and then the Bouguer anomaly is recom-
puted for the six values shown above.

Output:

Printout and/or plot with the six profiles in juxtaposition.

A5.6 PROGRAM MOMENT3

For: Calculating the excess mass (or mass deficiency) associated
with a Bouguer anomaly.

Function:

The program integrates over a square or rectangular grid of
Bouguer anomalies by the method suggested by Grant and West
(1965, pp.269-271), and from the resulting volume of the anomaly
calculates the excess mass. As suggested by Grant and West
(op. cit.) tail corrections are applied to account for exten-
sion of the anomaly outside the grid.

Output:

Printout.

A5.7 PROGRAM GRAVIL3

Written by Mr. John Trethewie (Austral Exploration Services, Adelaide,
S.A.).

For: Computing the theoretical Bouguer anomaly of an arbitrarily
shaped three dimensional body.

Function:

The program computes the theoretical anomaly on a horizontal
grid above a gravitating body. If desired a single profile

across the body can be computed.   The program is based on the method of Talwani (1965).

Output:

Printout.

Appendix A6

INTERPRETATION OF TABULAR BODY ANOMALIES

The methods for interpreting magnetic anomalies due to dipping tabular bodies of considerable strike length and depth extent are discussed in the literature. Readers of the thesis unfamiliar with interpretation techniques are referred to the following papers (Peters, 1949; Gay, 1963; Bruckshaw & Kunaratnam, 1963; Powell, 1965; Grant & West, 1965; Koulomzine et. al., 1970).

A6.1 Parameters of interest in magnetic interpretation

The parameters usually sought in interpretation of magnetic anomalies over inductively magnetized dipping tabular bodies are

(a) depth to the top surface and apical width,

(b) geological dip,

(c) thickness of the body, and

(d) magnetic susceptibility.

If the body possesses a strong component of remanent magnetism as well as inductive magnetism, the parameters which can be directly found are

(1) depth to the top surface and

(2) apical width.

If the geological dip is known, then the interpretation can find

(3) thickness,

(4) strength of the effective magnetization (the effective magnetization is the component of the total magnetization in the dip plane, i.e. the plane normal to the trace of outcrop of the body), and

(5) the attitude of the effective magnetization in the dip plane.

If the magnetic susceptibility of the beds is also known, then from the anomalies, interpretation can find

(6) the strength and direction of the effective <u>remanent</u> magnetization.

For magnetic beds in the Adelaide Geosyncline it appears that in most cases, remanent magnetism is an important contributor to the anomalies. Thus the parameters 1-6 are of interest. In general, while the geological dip is known, the susceptibility of the beds is unknown; thus, only parameters 1-5 can be found. With an anomaly similar in shape to the theoretical anomaly of a tabular body, estimation of the parameters 1-3 is straightforward and the various available methods give closely similar results (e.g. Peters, 1949; Koulomzine et al., 1970; Gay, 1963). Gay's standard curve method (Gay, op. cit.) was found most useful for estimating the five parameters.

In the following section the methods used by the author to find parameters 1-5 are outlined.

A6.2 Interpretation of magnetic anomalies

The method used to find these parameters is based on the method of Gay (op. cit.) for interpretation of anomalies due to tabular bodies of finite thickness, with demagnetization neglected. The reader is referred to this paper as a preliminary to the following notes.

Gay's paper contains a standard **family** of curves (Charts 7 through 16) each of which has a particular index parameter, θ_F. The curves were computed with the following formula.

$$\Delta F = C_F \left[\left(\frac{\psi_1 - \psi_2}{R} \right) \cos \theta_F + \left(\frac{1}{R} \ln \frac{\cos \psi_2}{\cos \psi_1} \right) \sin \theta_F \right]$$

where ΔF can be either the vertical field anomaly (ΔZ), the horizontal field anomaly (ΔH) in the direction normal to the strike of outcrop, or the total field anomaly (ΔT_{Io}) in the direction of the earth's magnetic field.

C_F is a coefficient term which in the case of vertical field anomalies (of interest in this discussion) is as follows:

$C_F = 2 J' \frac{t}{z}$. Here J' is the intensity of magnetization in the dip plane, t is the thickness of the tabular body and z is the depth of the body below the plane of observation. The geometrical relationships of the body which determine ψ_1, ψ_2, and R are shown below.

Geometry of a Thick Tabular Body

$$R = \frac{w}{z}$$
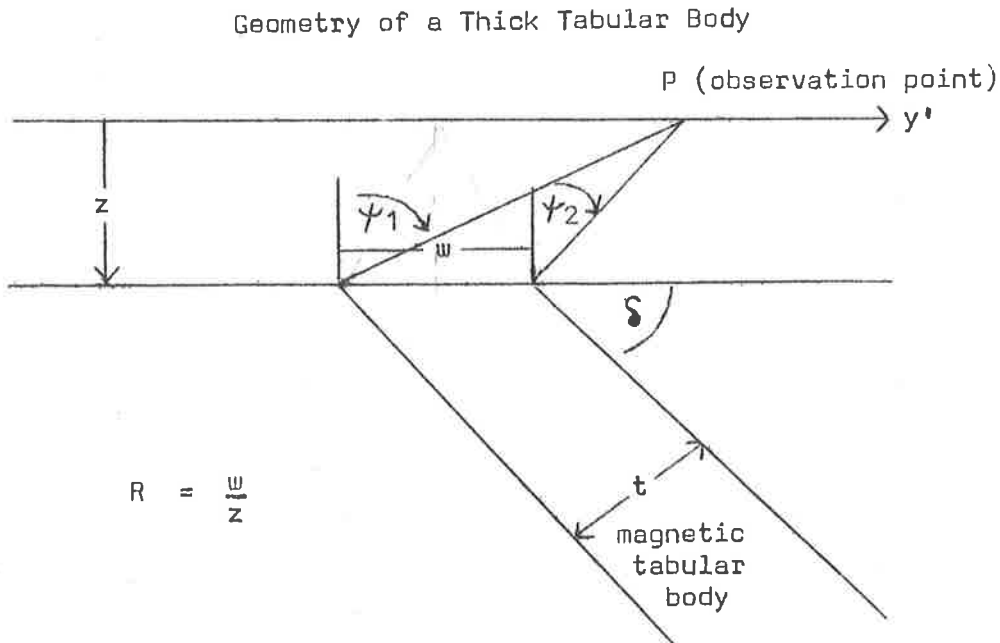
Although Gay's method was designed to treat the case of induced magnetism, it also has application in the case of remanently magnetized bodies. He pointed out that the effect of an element of remanent magnetism

is to change the anomaly shape to a new member of the standard family of curves. If the geological dip is known this property can be used to find the actual inclination I_0''' of the effective magnetization. The author's method for finding I_0''' from <u>vertical field anomalies</u> is outlined below.

The field profile is drawn so that the north side of the dipping body corresponds with the right hand part of the profile.

For interpretation of anomalies the method is to successively adjust the scales (distance and amplitude) of the field profile until it matches one of the standard family of curves (computed for various values of the thickness factor R). Then the depth (z) is derived by comparison of the horizontal scale of the standard curve with the adjusted horizontal side of the field profile. The apical width (w) is computed from the factors R and z. If geological dip is known, then the thickness t can be estimated. Then the magnetization J' in the dip plane is given by

$$J' = \frac{A\,z}{a\,t} \times 10^{-5} \text{ c.g.s. units}$$

where A is the peak-to-peak amplitude of the vertical field anomaly in gammas, a is an amplitude scale factor which depends on the thickness factor (R), and z and t are as defined before.

We let J' have a direction I_0''' which is measured in the dip plane, clockwise from the horizontal on the north side of the body. I_0''' is determined from the standard curves by use of the index parameter θ_F which is in the top right hand corner of the standard anomaly curve selected as most similar to the field profile.

$$I_0''' = -(\theta_F - \delta)$$

where δ = the north component of dip of the body.

Examples illustrating the relationship of the profile shape to the
dip (δ) and I_0''' are shown on Figure A6.1. On the figure, the anomaly
curves are shown for θ_F in the range $-360°-0°$. Two configurations of
tabular bodies and corresponding directions of magnetization are shown
which can produce the theoretical anomalies. The direction of magnetiza-
tion is shown as an arrow: a solid arrow for Body 1 (solid line); a
dashed arrow for Body 2 (dashed line). The corresponding values of I_0'''
are shown alongside each profile; $I_0'''(1)$ corresponds to Body 1, $I_0'''(2)$
corresponds to Body 2. Thus where $I_0'''(1)$ is $420°$, the effective
magnetization of Body 1 is in the direction $60°$ above the horizontal in
the north direction.

Appendix A7

ADDITIONAL MATTERS ARISING FROM COMMENTS

In a thesis of this kind which covers a large area and is the first major attempt to find answers to some of the many complex problems of the area, it is almost inevitable that many questions will remain unanswered and that various points will need clarification. It is the purpose of this appendix to list the main comments made during examination of the thesis and provide answers to some of the questions raised.

A7.1 It was pointed out that the gravity and magnetic sections could have been more closely connected through a more detailed interpretation of the anomalies associated with granites.

This problem was recognised at the time of writing the thesis, but the information for the necessary detailed interpretation was not available and due to local conditions, poor outcrop, deep weathering and only widely spaced gravity data (and no gravity meter in the Department to get more closely spaced data), could not be obtained.

The problem was heightened by this work being the first attempt to draw available information together and extract new answers. Because there was so little known it was difficult to see which directions of work would be the most rewarding and mutually supporting so that in the thesis there are a number of weak links, particularly regarding problems recognised in areas where the geology is poorly exposed or not investigated.

In a similar granite problem at Rum Jungle in the Northern Territory (B.M.R. report in prep.) the problem can be resolved more satisfactorily because fresh samples from drill core are available to define

the density of the different rock groups used in the models which form
the basis for calculating expected response. The problem solved at Rum
Jungle is similar to the ones encountered in South Australia and the
method used to interpret comes as a development of those used in this
thesis.

A7.2 A wider discussion of the discoveries set out in Chapter 5, without
first obtaining fresh rock samples from the lower Tapley Hill magnetic
bed, could only give rise to theories developed from inadequate facts.
It had been hoped that such a development of the research work would form
a considerable part of the thesis but after spending several months
without success, searching for fresh material in the most promising parts
of several thousand square kilometers of the area, it became obvious
that this study could not be completed within the scope of this Ph.D.
thesis. In the course of this search, the Department of Mines and
thirty five active exploration companies were approached. Only two com-
panies were able to provide fresh rock and this was not from the areas of
magnetic rocks. The difficulties in finding fresh rocks for study,
outlined above and on page 4 of the thesis, have been experienced in the
area by others (Mumme, 1964; Briden, 1967). Thus interpretation fell
to the airborne and ground magnetic data. In view of the difficulties
and errors in interpreting anomalies for other than the simplest of mag-
netic problems, it seemed that speculation regarding the significance of
the results should be taken only as far as justified by the data available.

A7.3 Refinements of the gravity model using associated magnetic data,
was limited by the spacing of the gravity observations and by the absence
of the original magnetic records; the available contour maps are of
relatively low information content as the contour intervals are drawn at
100 gammas and are the results of a very early survey flown by the

Bureau of Mineral Resources.   The gravity survey was of a regional nature,
the observations being made on a 7 kilometer grid.   To provide further
details for modelling the Anabama Granite would have required extensive
field work in an area which was inaccessible and has very poor outcrop.
A comparison of this problem with a similar one from an area of Protero-
zoic rocks at Rum Jungle in the Northern Territory, where fresh rock from
drill core provides an adequate number of samples and an indication of
the probable proportion of different rock types, has demonstrated the limi-
tations of gravity interpretation with inadequate geological control.   In
this case, even with the large quantity of drill core available, it is
extremely difficult to establish reliable density contrasts.

To discuss a relationship between the presence of the granite and
development of magnetic anomalies would probably have called for a further
section to the thesis.   This was considered during the research project
but, as the granites lie outside the ORROROO area and there are no
granites known on ORROROO, it was not considered a high priority problem.

The "Burra Granite" cannot be studied because neither the granite
nor adjacent contact rocks are exposed.   Moreover, the airborne magnetic
data, contoured at 50 gammas, was of low quality.

It was suggested that additional magnetic horizons might easily be
analysed in relation to the pattern shown on Figs. 5.1 and 5.2.

Other horizons were analysed (pages 81 and 82) and support was
found for the interpretation made for the character of the Lower Tapley
Hill magnetic bed.   In contrast to the Tapley Hill it was found to be
impractical to fully analyse other magnetic beds.   The amplitude of
anomalies was usually not sufficiently high to give enough well defined
anomalies over a long strike length, and especially around suitable struc-

tures. Lithologic and stratigraphic changes often made it difficult to be sure the same magnetic bed was under study. In some of the more promising beds the problem of establishing the character of remanent magnetization is compounded by the presence of strong induced magnetization (viz. Holowilena Ironstone and Ulupa Siltstone).

A7.4 It was suggested that an investigation should be made of the influence of susceptibility anisotropy and other mechanisms on the production of the observed remanent magnetism.

Susceptibility anisotropy tested on rock samples of Ulupa Siltstone, Holowilena Ironstone and Tindelpina Shale Member was found to be small (Appendix 2, Table A2.3), and appears to be too low to confine J2 to the bedding. While the presence of J2 was deduced, its explanation must remain open to speculation until fresh rock samples are available. Grain sizes will be found to be important (page 83) as has been suggested by Evans (1972).

Support for the derived direction and suggested time of acquisition for J1 has recently appeared in another source. Embleton (1973) has given Palaeolatitudes for Australia in the Phanerozoic; his picture for the Ordovician fits well with J1 being acquired in low latitudes. Perhaps J2 is a soft component acquired recently by a larger grain size than that which gives the harder J1.

A7.5 It was suggested that it might be possible to determine more about the boundary between areas A and B, especially its attitude.

During the study regional magnetic anomalies were examined with this in mind, but nothing at all was found. Further work in other fields has given support for the location of the boundary (McKirdy, Sumartojo, Tucker and Gostin, 1975).

A7.6 A possible horizontal extension of the Anabama Granite was suggested. There is nothing in the magnetics to indicate extension of the body to the northwest.   The depth of 23 kilometers is consistent with the observed gravity anomalies as indicated by the modelling.   It could be reinterpreted to use smaller depths by making various uncheckable geological assumptions, but with the present data there is little to be gained by going further in the analysis.

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Plate 1 (pocket) : Locality map of places referred to in the text

   of the thesis.

Figure 1.1 : Distribution of Adelaidean strata in Australia.

Source of data - tectonic map of Australia and New
Guinea, 1971.

SURFACE

SUBSURFACE

Scale km
200   400   600

Adelaide Geosyncline

DISTRIBUTION OF ADELAIDEAN STRATA IN AUSTRALIA
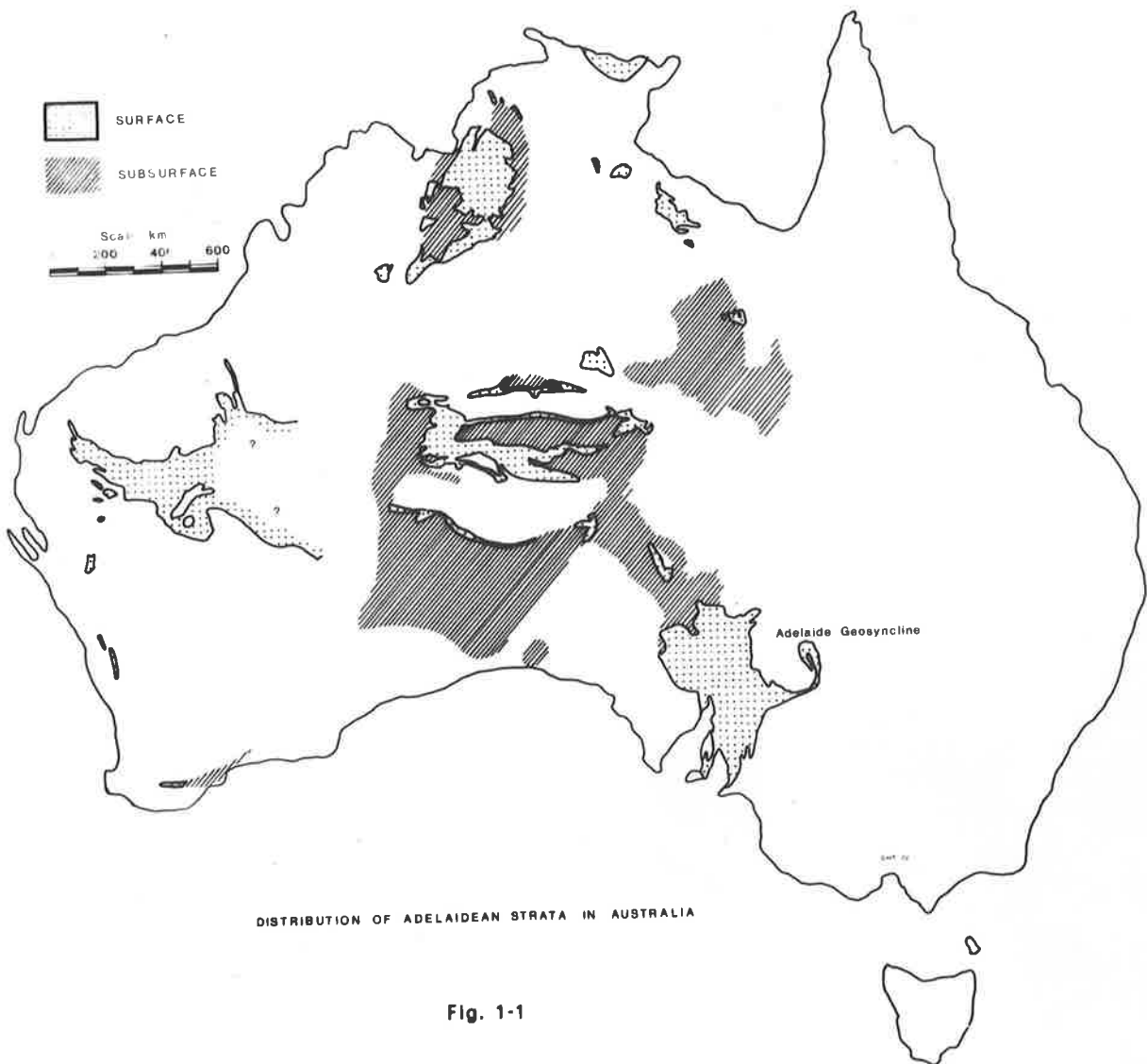
Fig. 1-1

Figure 1.2 : Geology of the Adelaide Geosyncline.

Legend

1. Mainly Cainozoic and Mesozoic sediments
2. Palaeozoic granites
3. Cambrian sediments
4. Adelaidean sediments
5. Lower Proterozoic volcanics (Gawler Range Volcanics)
6. Lower Proterozoic metasediments
7. Lower Proterozoic granites and granitization complexes
8. Fold axis
9. Fault
10. Little deformed Adelaidean and Cambrian rocks essentially unmetamorphosed
11. Mildly folded Adelaidean to Cambrian rocks metamorphosed to chlorite grade
12. Moderately folded Adelaidean to Cambrian rocks metamorphosed to biotite grade
13. Strongly folded Adelaidean to Cambrian rocks metamorphosed to amphibolite facies

Source of data - geology base from Parkin (1969) and SADM geology maps; metamorphic zones from Preiss (1971), Offler and Fleming (1968) and Binks (1971).
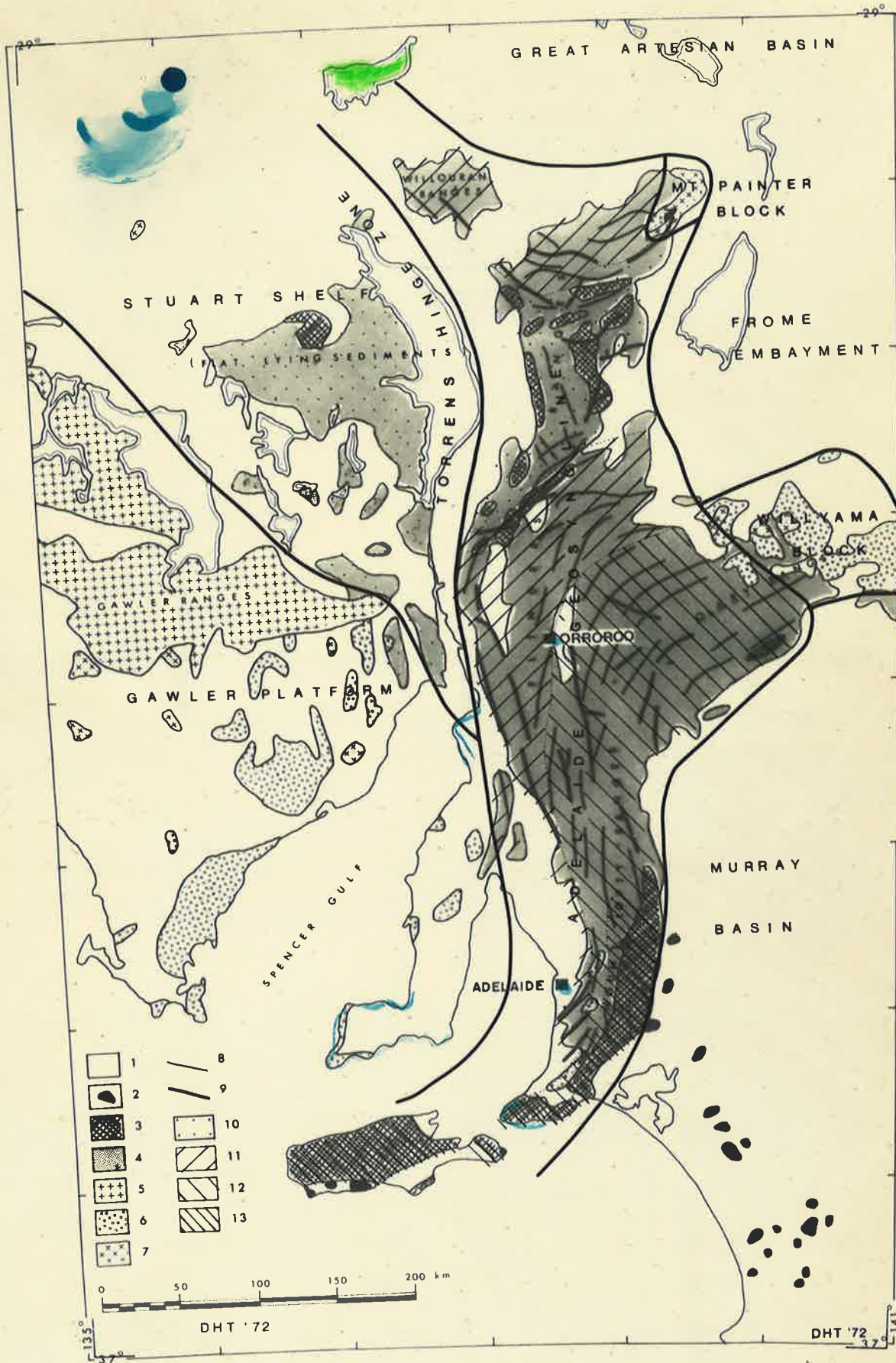
Fig. 1-2

Figure 1.3 : Geology and Bouguer anomalies of the northern part
of the Adelaide Geosyncline.

The contour interval is 5 milligals. Over the area
inside the double lines the Bouguer density for
reduction was 2.67 g/cm^3. North and south-east of
the double lines the reduction density was 1.9 g/cm^3
and 2.2 g/cm^3.

Source of data - geology generalized after Sprigg
(1953); the Bouguer anomaly contours are from
unpublished maps by the BMR.

GEOLOGY AND BOUGUER ANOMALIES

Fig 1-3

(BASED ON SA/BO-6A)

KILOMETRES

DHT '72

GEOLOGY GENERALIZED AFTER SPRIGG, 1953
(GEOLOGICAL MAP OF S.A. 32M = 1")
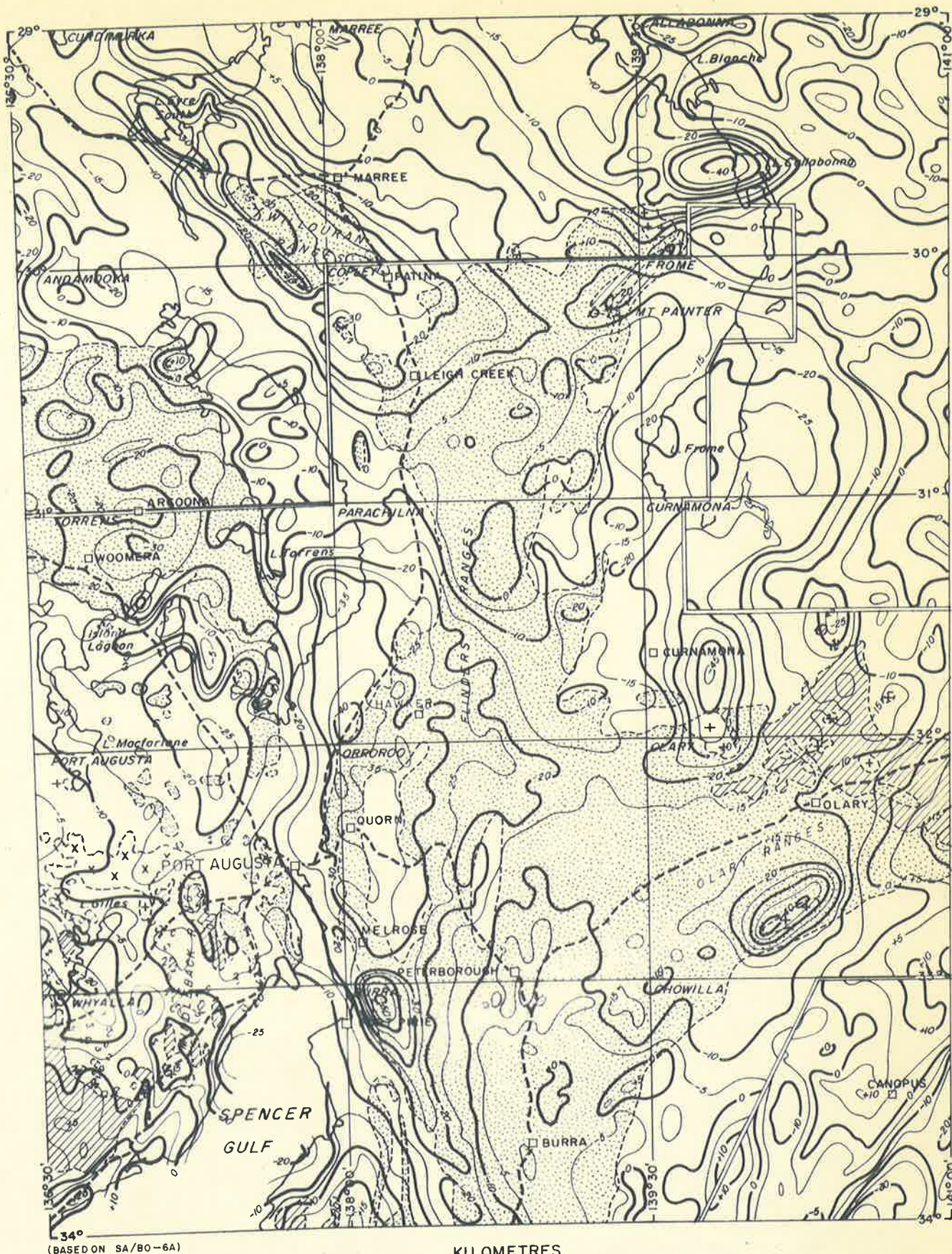
SEDIMENTS

CAMBRIAN AND
ADELAIDEAN SEDIMENTS

METAMORPHIC COMPLEXES OF
THE MT PAINTER AREA, WILLYAMA
BLOCK AND GAWLER CRATON

ACID INTRUSIVE AND
GRANITOID ROCKS

FELDSPAR QUARTZ PORPHYRIES
OF THE GAWLER RANGES

BOUGUER ANOMALY CONTOURS

Figure 1.4 : Aeromagnetic map, geology (overlay 1) and interpre-
tation (overlay 2) of the northern part of the
Adelaide Geosyncline.

Magnetic sources at or near the surface

1. Magnetic Adelaidean strata
2. (?) dolerite dykes on the Eyre Peninsula
3. Iron Formations of the Middleback Ranges
4. Metasediments (schists, phyllites and acid
   intrusives)
5. Metasediments and intrusives

Zones of magnetic anomalies

A   Magnetic Gawler Platform strata at or near the
     surface (depth range 0-1 km)

B   Strong broad anomalies due to unknown sources,
     possibly intrusive bodies (depth range 2-5 km)

C   Very weak, very broad anomalies probably due to
     sources in the depth range 5-15 km. Super-
     imposed linear anomalies are due to magnetic
     Adelaidean strata

D   Magnetic Mt. Painter Block strata at or near
     the surface (depth range 0-1 km)

E   Strong broad anomalies due to unknown sources,
     possibly of the kind on the Willyama Block
     (depth range 1-6 km). The feature circled
     with a dashed line is referred to in Chapter 7

F   Magnetic Willyama Block strata at or near the
     surface (depth range 0-1 km)

G   Strong circular anomalies due to unknown sources
     in the depth range 1-2 km. Anomalies in this
     zone are similar to zone F. The source rocks
     in the two zones are probably similar

Source of data - geology after Sprigg (1953). Aero-
magnetic contour map from SADM 1:1,000,000 map of
S.A. (unpublished). The contour interval is 100
gammas.

CURDIMURKA MARREE CALLABONNA

L. Eyre South L. Blanche

L. Callabonna

MARREE

WILLOURAN RANGES

ANDAMOOKA COPLEY PATINA FROME

MT PAINTER

BASIN LEIGH CREEK

F R O M E

L. Frome

ARCOONA PARACHILNA CURNAMONA

TORRENS FLINDERS RANGES

WOOMERA L. Torrens E M B A Y M E N T

Island Lagoon CURNAMONA

TORRENS

L. Macfarlane HAWKER

PORT AUGUSTA ORROROO OLARY

PIRIE QUORN OLARY RANGES OLARY

QUORN BASIN

x PORT AUGUSTA WILLOCHRA BASIN WALLOWAY BASIN Anabama Granite

L. Gilles MELROSE

MIDDLEBACK RANGE PETERBOROUGH CHOWILLA

WHYALLA BURRA

PORT PIRIE M U R R A Y

SPENCER CANOPUS

GULF B A S I N

BURRA

KILOMETRES

50   0   50   100   150

DHT '72

LEGEND

CAINOZOIC AND MESOZOIC [   ] SEDIMENTS

PALEOZOIC AND PROTEROZOIC CAMBRIAN AND ADELAIDEAN SEDIMENTS

LOWER PROTEROZOIC METAMORPHIC COMPLEXES OF THE MT PAINTER AREA, WILLYAMA BLOCK AND GAWLER CRATON

IGNEOUS AND + + + ACID INTRUSIVE AND GRANITOID ROCKS

RELATED ROCKS x x FELDSPAR QUARTZ PORPHYRIES OF THE GAWLER RANGES

Overlay 1 . Fig. 1-4

GENERALIZED GEOLOGY
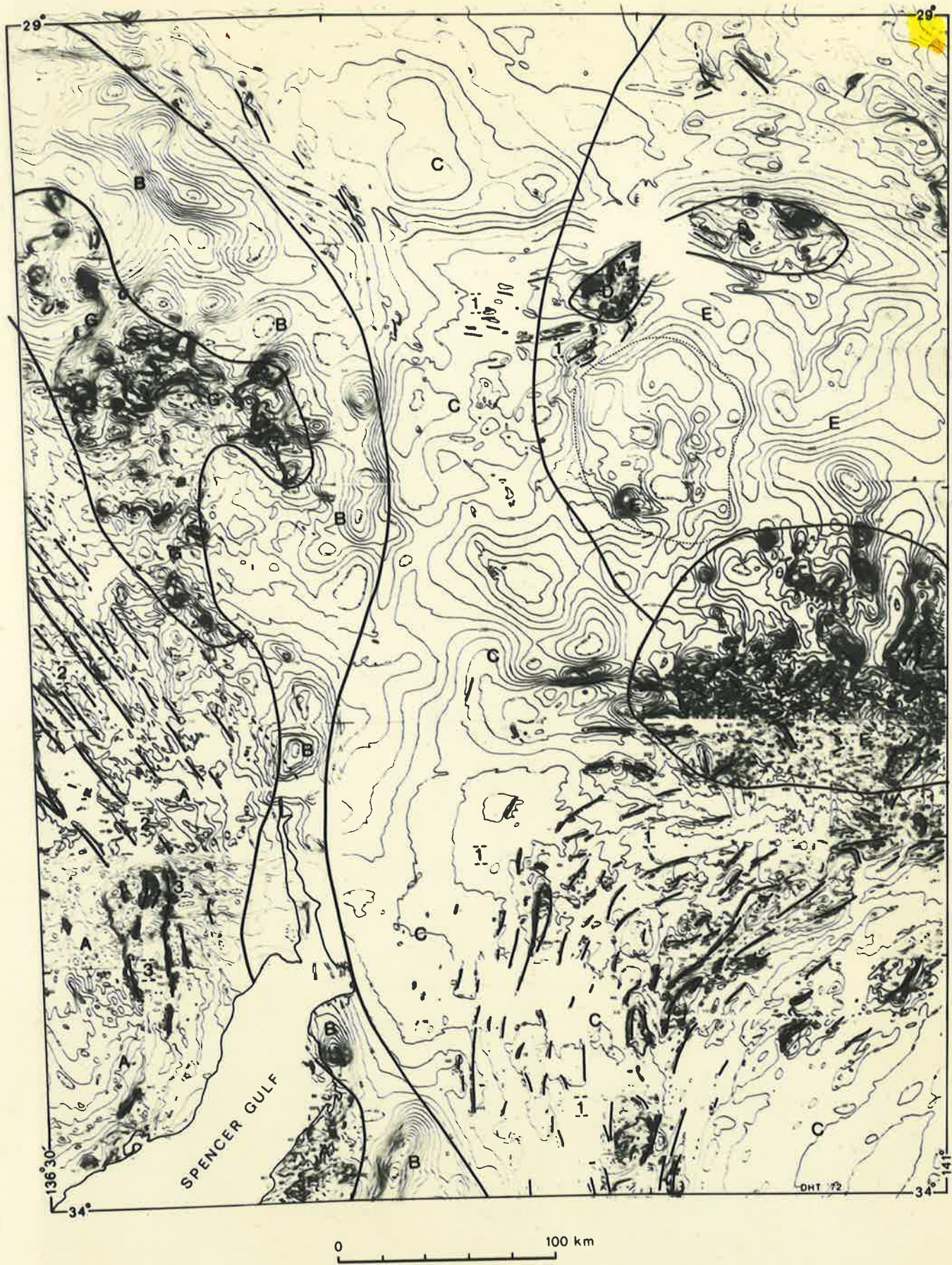
Fig. 1-4

F

Figure 1.5 : ORROROO geological map showing the localities of
 (pocket)
            ground magnetometer lines.

            Magnetometer lines are numbered.

Figure 1.6 : ORROROO aeromagnetic map of total intensity.
  (pocket)

The contour interval is 10 gammas. The data were

recorded with an airborne magnetometer at a con-

tinuous ground clearance of 150 m.

Figure 1.7 : Time and rock terms used in the Adelaide Geosyncline.

In the study of magnetic anomalies most attention
was given to the Wilpena, Umberatana and Burra
Groups.

Source of data - Parkin (1969, p.51).

ROCK SEQUENCES
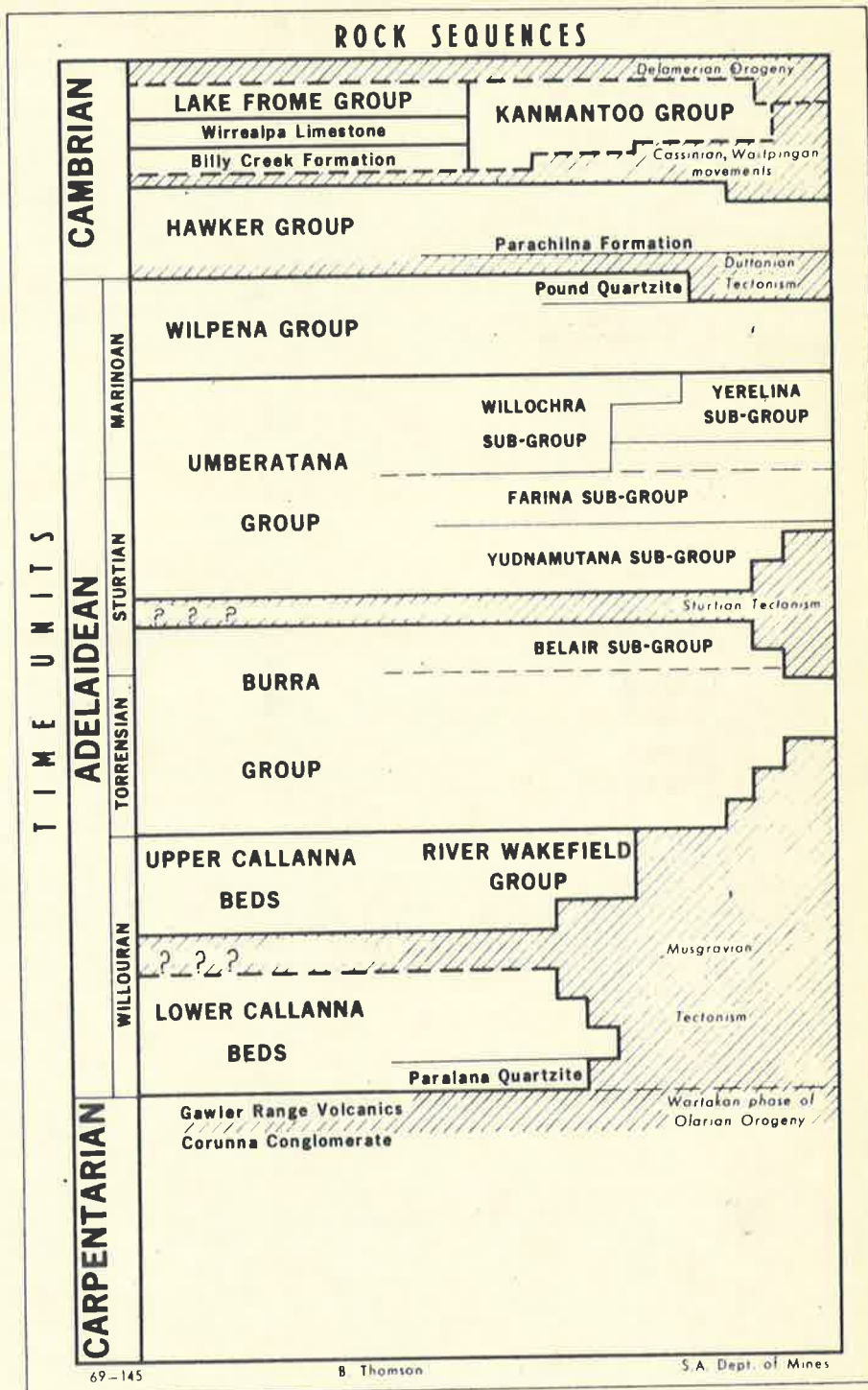
Time and rock terms used in the Adelaide Geosyncline and
adjoining areas.

Fig. 1 - 7

Figure 1.8 : Precambrian basement contours, form lines and

other structural features in South Australia.

Source of map – Thomson (1970).
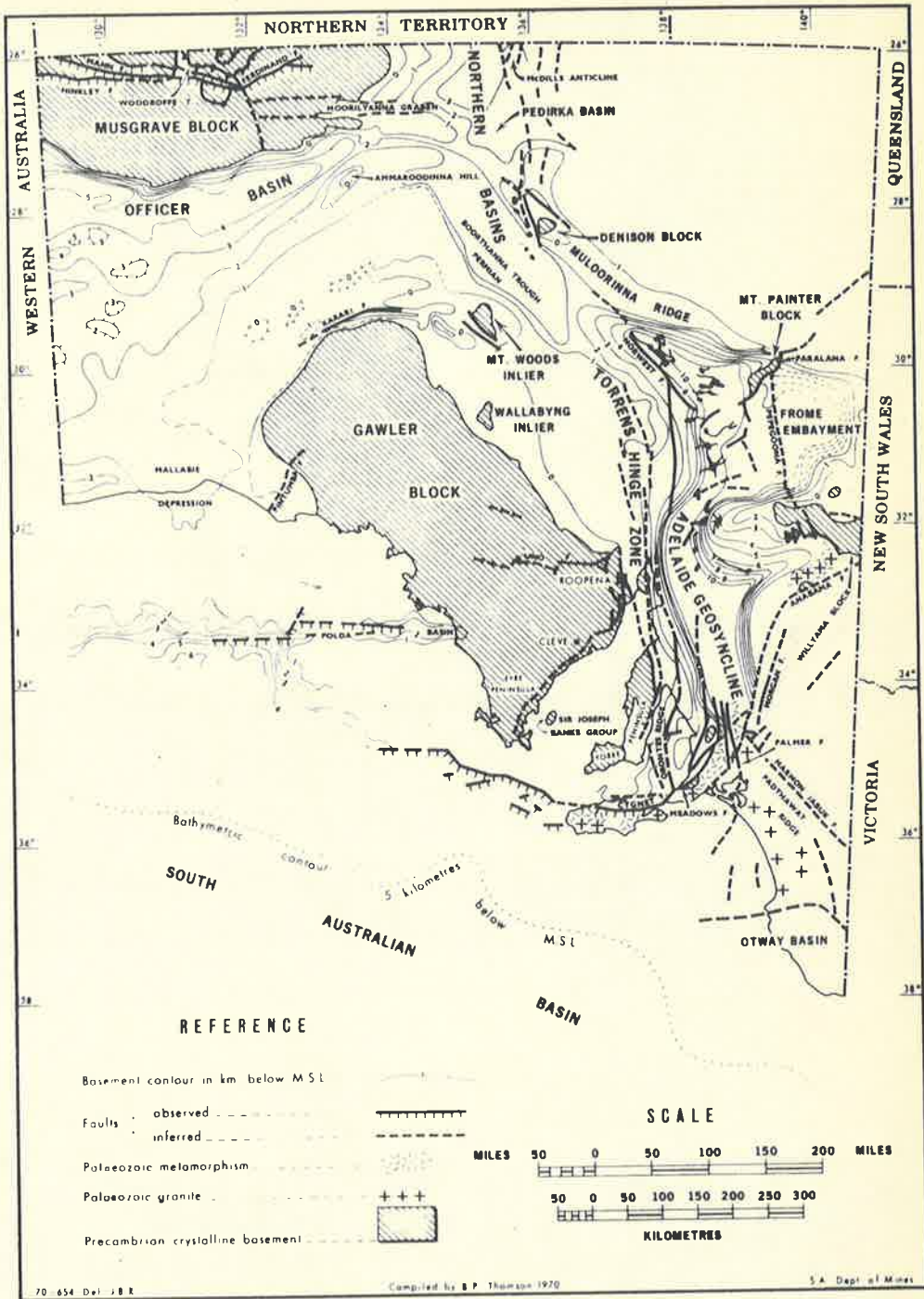
Precambrian basement contours, form lines and other structural features in South Australia.

Fig. 1-8

Figure 2.1 : Index map showing 1:250,000 sheet names; the
localities of drill holes from which material was
tested for magnetic susceptibility, density or
mineralogy; and the localities of ground magneto-
meter surveys.

A table of drill hole names and tests carried out
is included in Appendix A1; a table of magnetometer
surveys is included in Appendix A3.
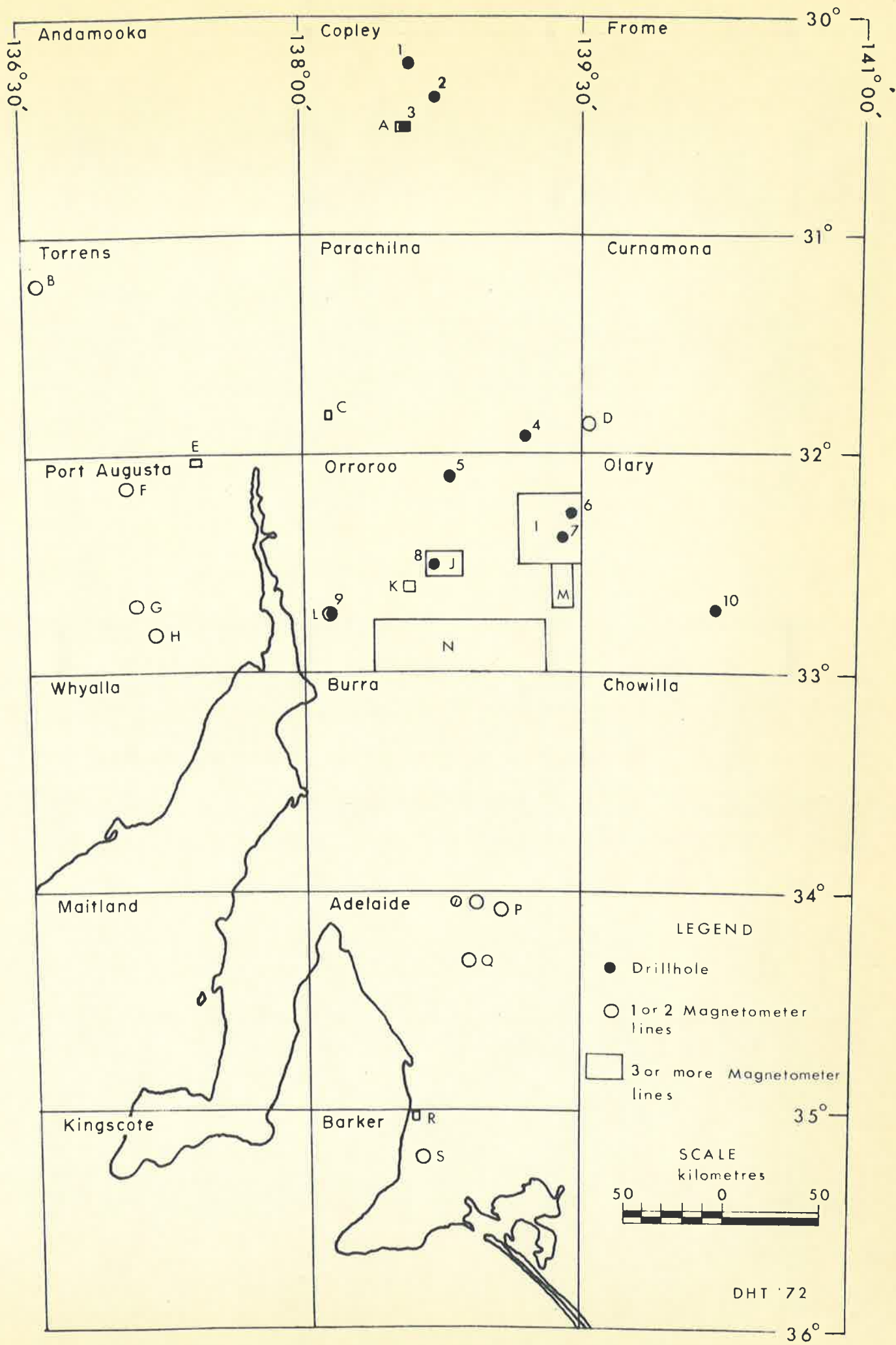
Fig. 2 - 1

Figure 3.1 : (a) and (b) show total field aeromagnetic flight

charts and the interpreted anomalies from near surface

sources. (b) illustrates how ambiguity in selected

anomalies can occur if there are two reasonable base

levels which can be chosen. (c) illustrates the

interpretation given to magnetic anomalies on part

of the Peterborough 1:63,360 map area. Arrows show

the position and sign of peaks of anomalies; dots

show the location of photo centres along flight lines.

The original scale of the geology base maps and

magnetic anomaly compilation sheets was 1:47,520.

The horizontal scales of the three diagramsare shown

below (c).
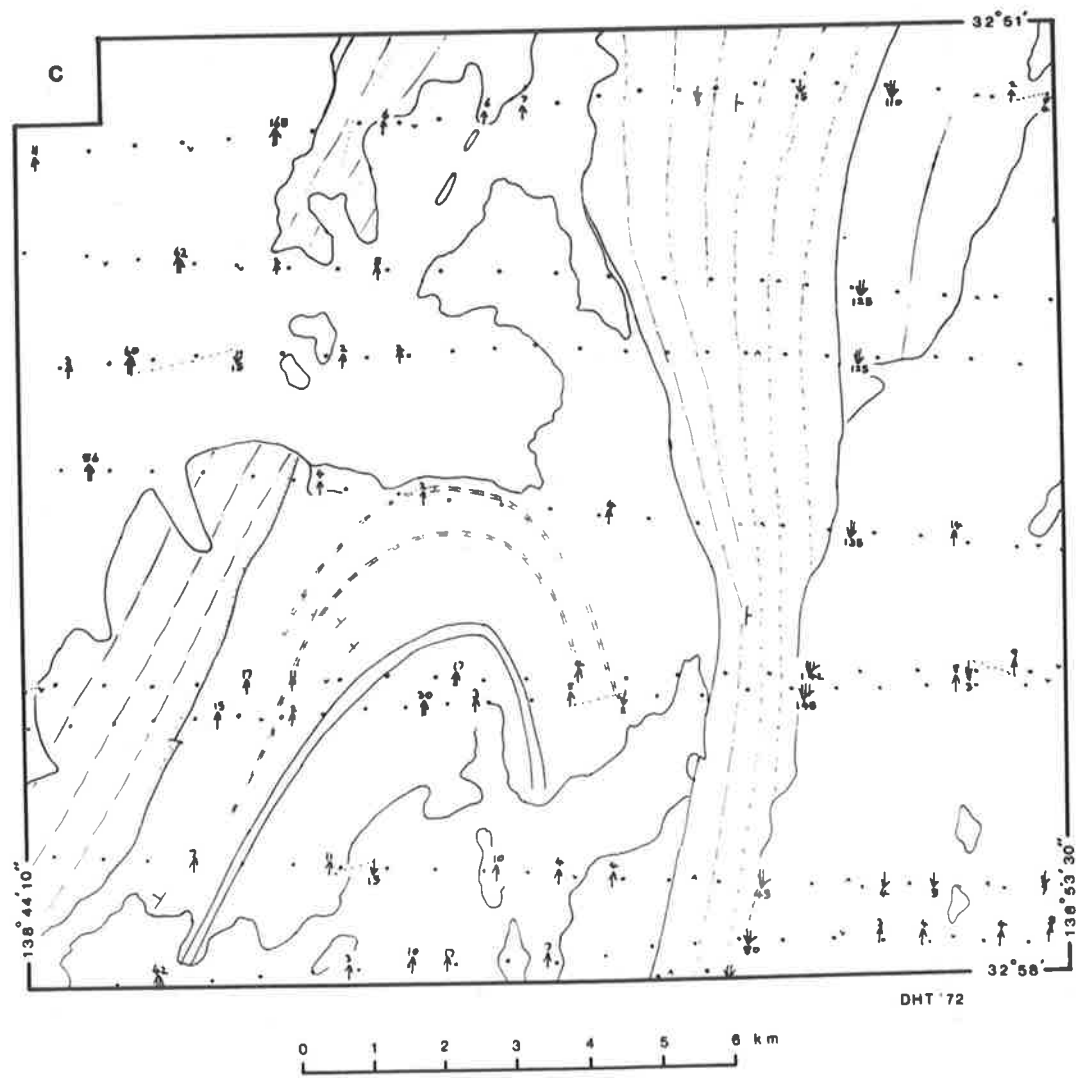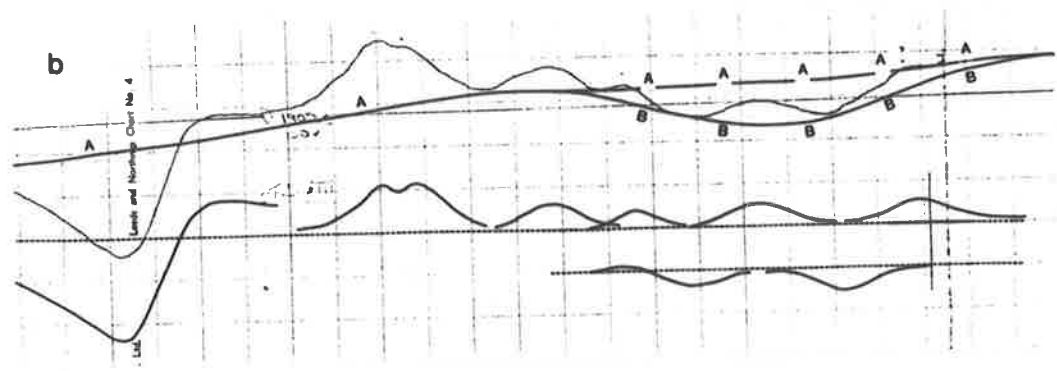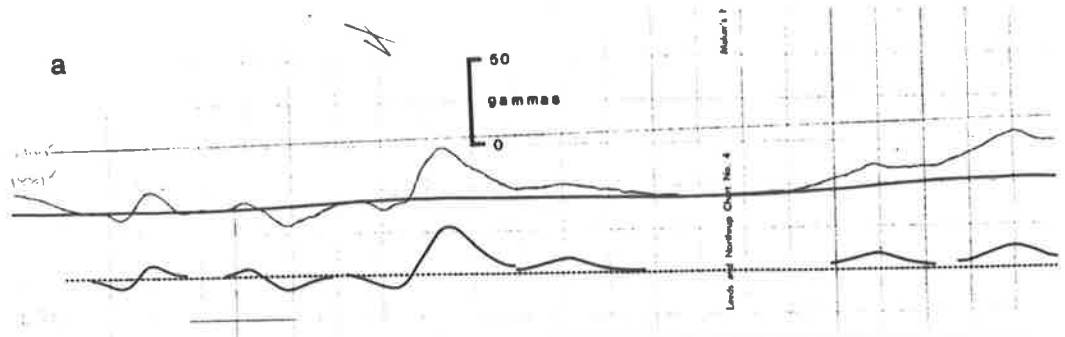
Fig. 3-1

Figure 3.2 : Overlay of interpreted locations of shallow magnetic sources on a simplified

geological map of ORROROO.

Legend - geology

Cainozoic	1	Sediments
Palaeozoic	2	Hawker Group sediments
	3	Wilpena Group sediments
	4	Umberatana Group sediments
Proterozoic (Adelaidean)	5	Burra Group sediments
	6	River Wakefield Group (Callanna Beds)
	7	Diapiric breccia
	8	Geological boundary

Legend - magnetics (overlay)

The amplitude of aeromagnetic anomalies at each source position fall in the following ranges

1.   5-20   gammas
2.   21-100   "
3.   101-400   "
4.   401$^+$ "

In Area B (western part) the amplitudes of anomalies usually lie in Range 1; in Area A, amplitudes often lie in Range 2 or higher.

Source of data - geology simplified after Binks (1968); magnetics compiled from a study of original aeromagnetic flight charts.

Cainozoic

Cambrian

Proterozoic
(Adelaidean)

1
2
3
4
5
6
7
8

0   10   20   30 km

Orroroo _____ ● O
Peterborough _____ ● P
Waukaringa _____ ● W

N

DHT '72

32°

139°30'

33°

138°00'
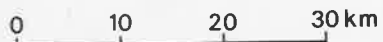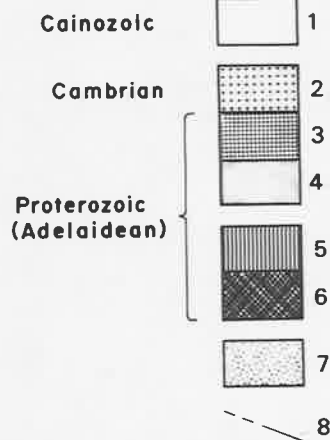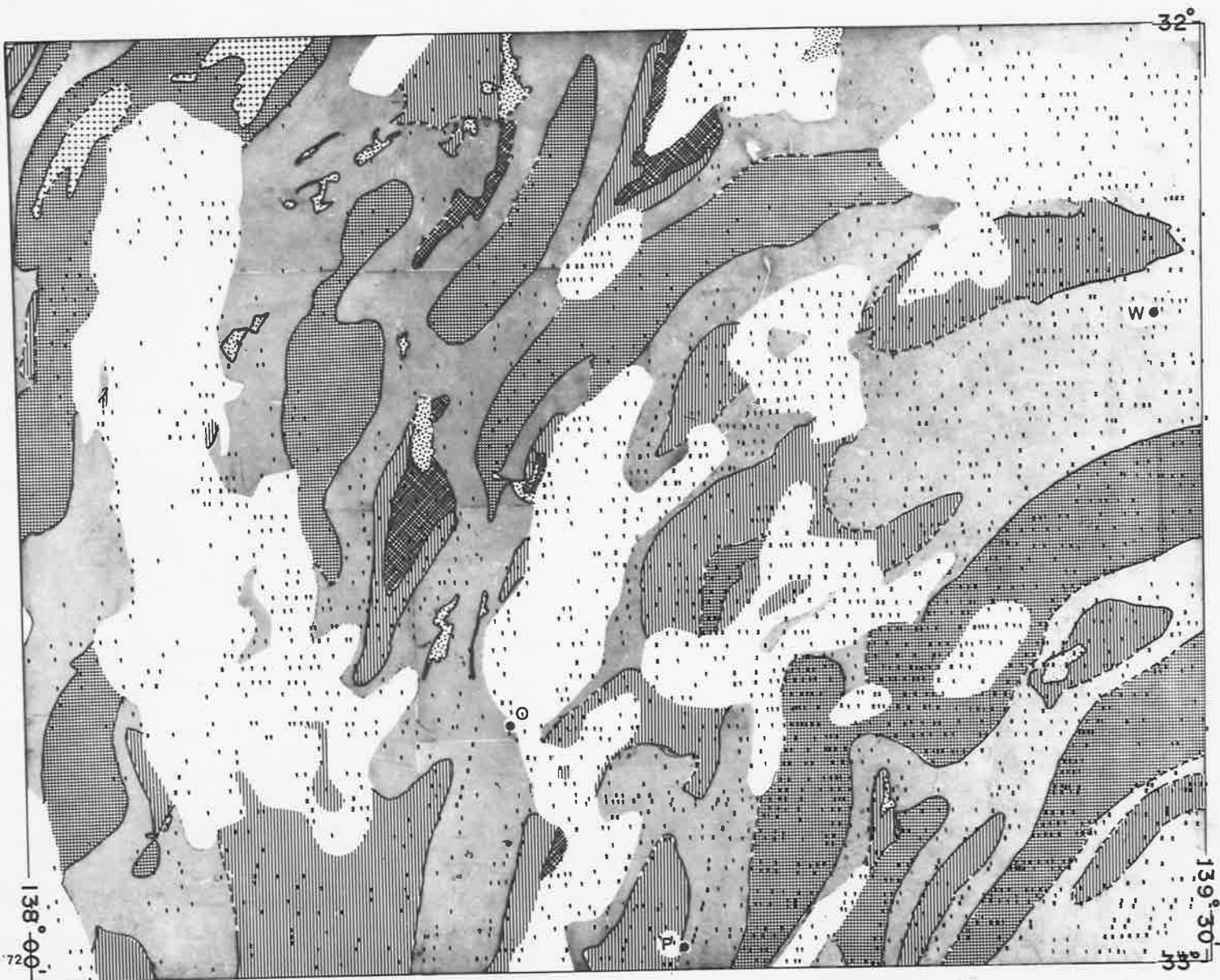
Figure 3.3 : Geophysical interpretation given to two
adjacent flight profiles across a synclinal structure
near Peterborough.

The heavy black lines on the geological section are
interpreted magnetic beds. On the flanks of the high
amplitude anomaly the selection of partly resolved
low amplitude anomalies possibly caused by weakly
magnetic beds is very difficult. The key to whether
a particular low amplitude bump indicates the posi-
tion of a magnetic bed comes from the study of
adjacent profiles or profiles from another locality.
For example, on the upper section, a magnetic bed is
shown just above the contact between units E (Ulupa
Siltstone) and D. The amplitude of the anomaly is
about 5 gammas. On the lower section, the correspon-
ding anomaly is better resolved and has an amplitude
of about 15 gammas.
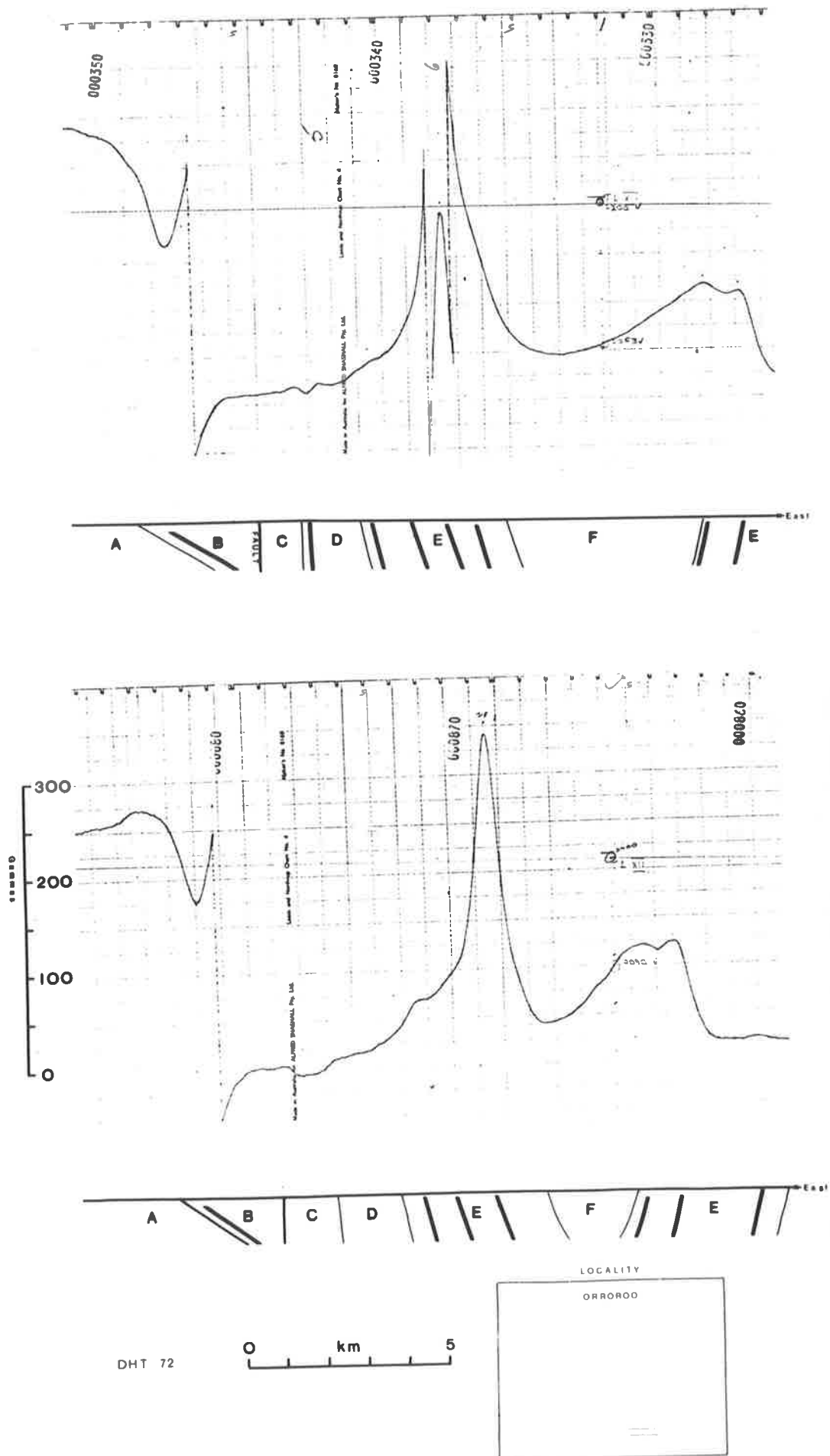
Fig. 3-3

Figure 3.4 : Positions of magnetic beds (black lines) within Adelaide System sediments on ORROROO

Legend - geology

Cainozoic   1 Sediments

Palaeozoic   2 Hawker Group sediments

               3 Wilpena Group sediments

               4 Umberatana Group sediments

Proterozoic   5 Burra Group sediments
(Adelaidean)
               6 River Wakefield Group (Callanna Beds)

               7 Diapiric breccia

               8 Geological boundary

Legend - magnetics

               9 Magnetic bed

Source of data - geology simplified after Binks (1968); magnetics compiled from

          a study of original flight charts and 1:47,520 scale geological

          maps.

Fig. 3-4

Cainozoic   □ 1

Cambrian   ▦ 2

                 ▦ 3

Proterozoic   □ 4
(Adelaidean)
                 ▦ 5

                 ▦ 6

                 ▦ 7

                 ⟋ 8

                 ⟍ 9

0   10   20   30 km

Orroroo _____ ● O
Peterborough ____ ● P
Waukaringa _____ ● W

N

DHT '72
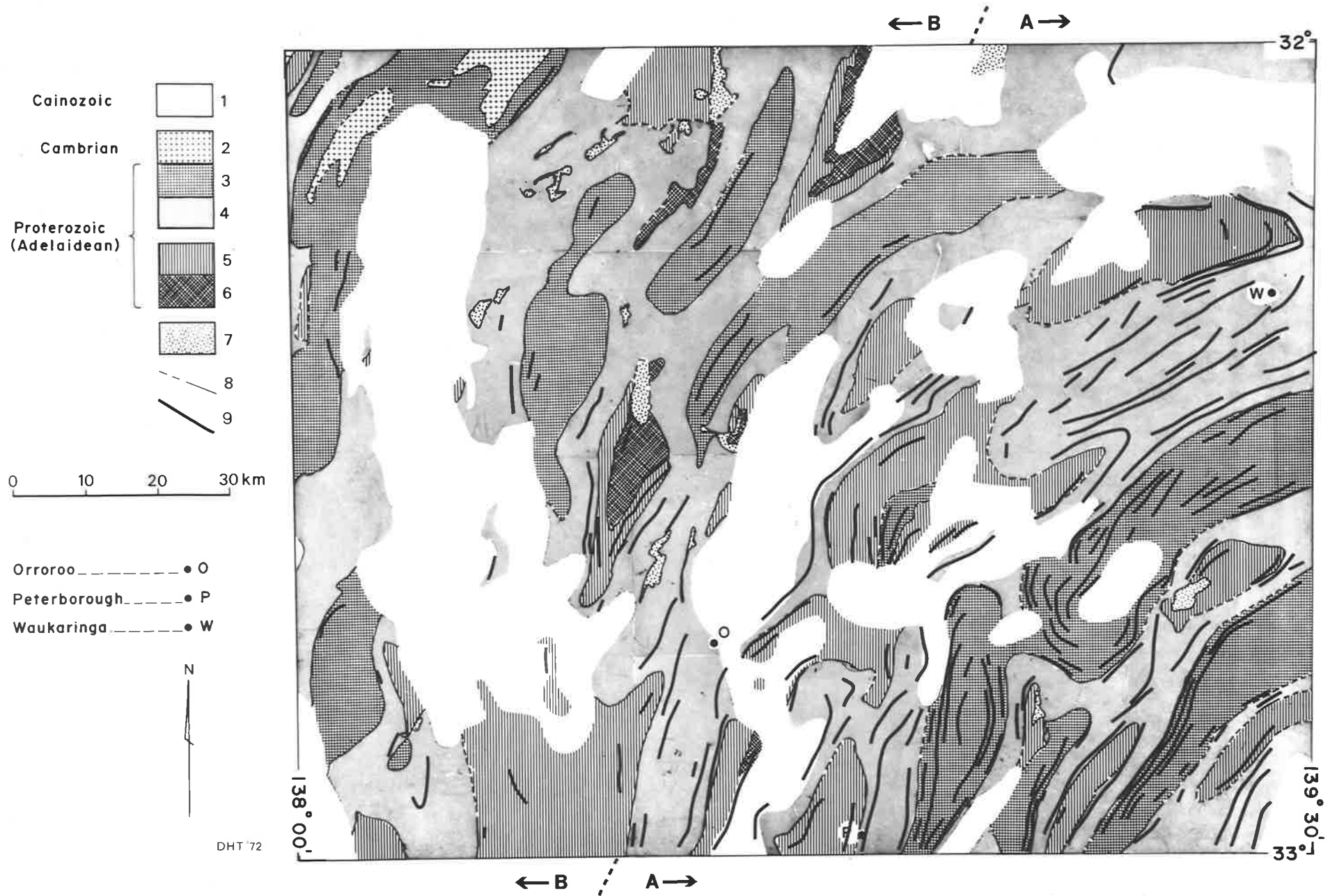
Figure 3.5 : Interpreted position of magnetic beds in the

stratigraphic succession for ORROROO.

The maximum amplitudes of aeromagnetic anomalies

recorded over the various magnetic beds are

indicated in gammas.

Source of data - rock relation diagram from Binks

(1968); magnetics compiled from a study of original

flight charts and 1:47,520 scale geological maps

MAGNETIC BEDS
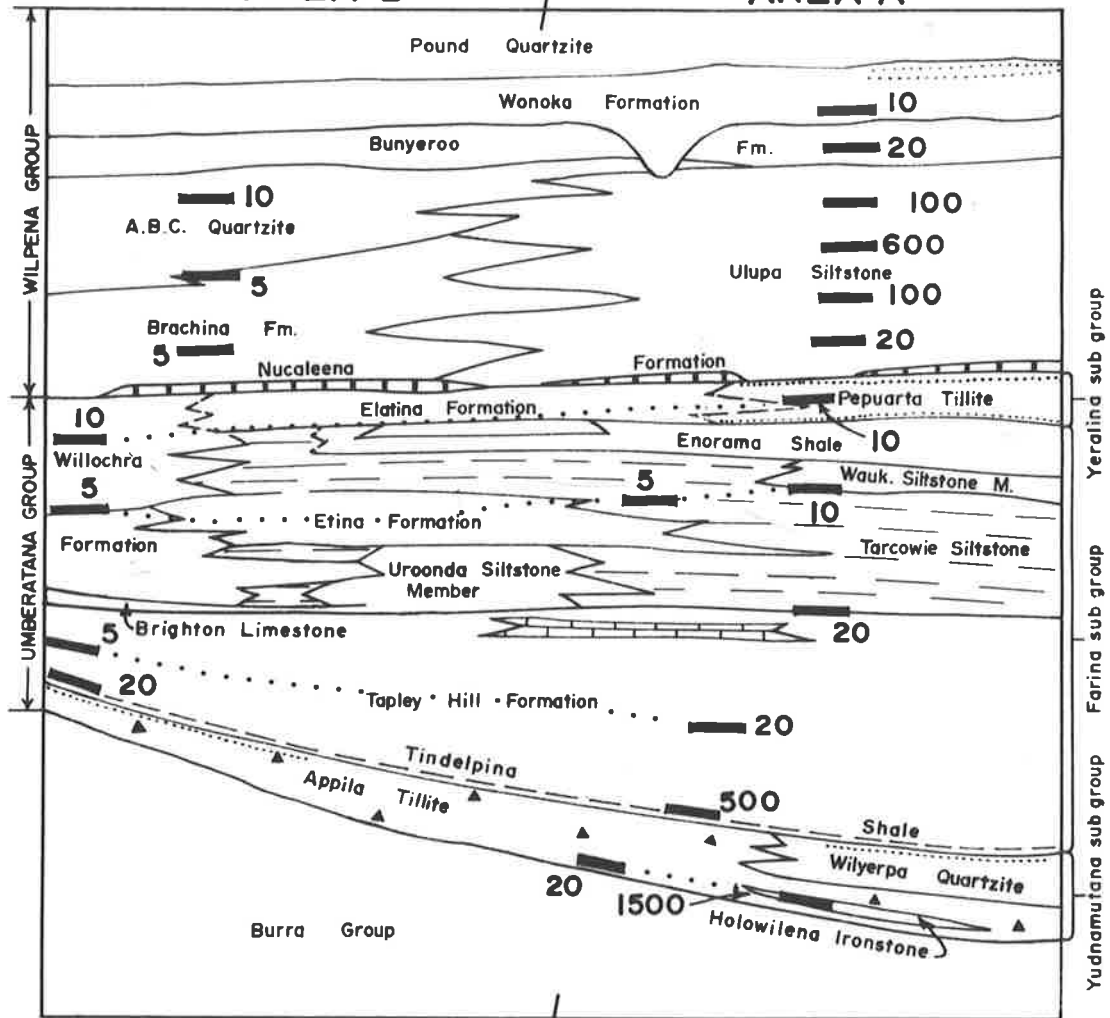
AREA B   AREA A
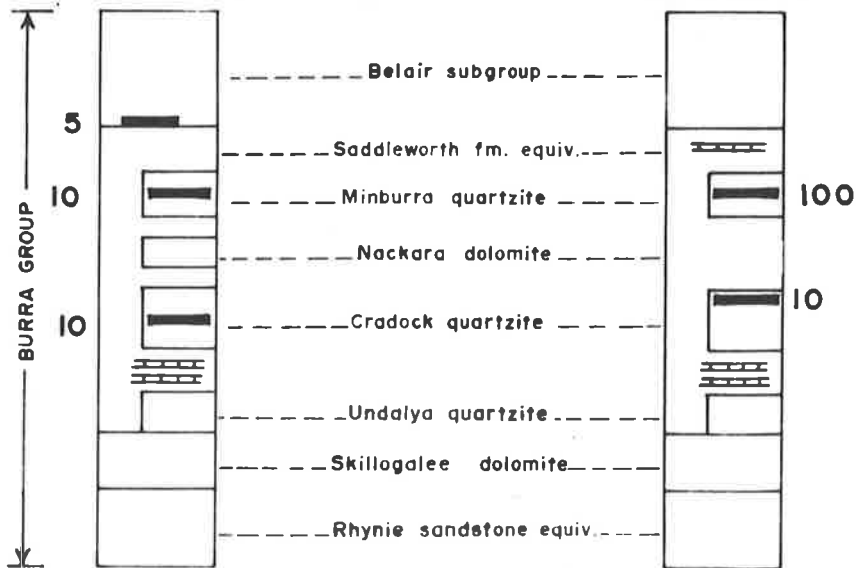
(Stratigraphic Column and Rock Relation Diagram after S.A. Dept. of Mines 1:250,000 Orroroo sheet.)

DHT '72

Figure 4.1 : (a) The upper diagram shows the results of reading

a vertical field fluxgate magnetometer at the

same stations on two different days. The lower

diagram shows the differences between the two

sets of data. The envelope of the differences

is 10-20 gammas wide and is attributed to

reading errors.

(b) Vertical field profile across the Lower Tapley
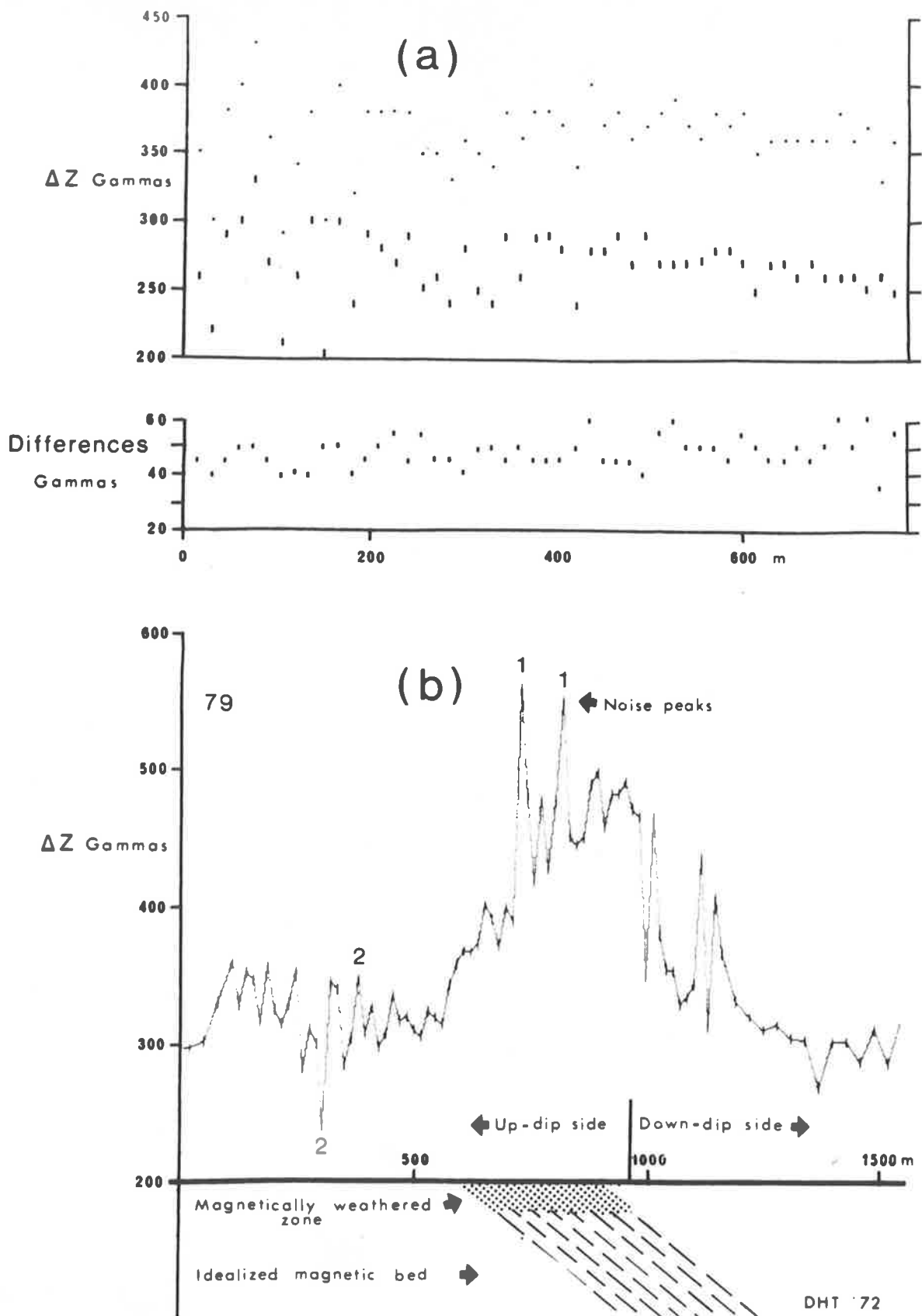
Hill magnetic bed.

Fig. 4-1

Figure 4.2 : Stratigraphic column for the lower part of the
              Tapley Hill Formation in the Waukaringa area.

              The Lower Tapley Hill magnetic bed is interpreted
              to lie between the two arrows.

              Source of data - field work in the Waukaringa area.

Fig. 4-2

Text labels within the figure:

Zone of magnetic strata (vertical axis label)

Vertical scale (METRES): 400, 350, 300, 250, 200, 150, 100, 50, 0, -50

Siltstones

Tapley Hill Formation

Float of limonite pseudomorphs after pyrite.
Crystals up to 1·5 cm. diameter.

Siltstones

Shales with interbedded thin carbonates which
contain approx. 10% limonite pseudomorphs after
pyrite and rarely after magnetite

Tindelpina Shale Member

Heavily Iron oxide stained shales

Interbedded sandstones and siltstones

Yudnamutana Subgroup

Tillite with carbonate matrix   DHT '72

Figure 4.3 : Four interpreted vertical field magnetometer profiles

across the Lower Tapley Hill magnetic bed. (The

locations of the profiles are shown on Figure 4.4(c)).

The field profiles are drawn on an arbitrary base

level. The directions indicated on the right hand

side of the profiles are measured east of geographic

north. Note that the amplitude and distance scales

on the diagrams are different. Data points on the

field profiles are indicated by vertical lines; the

grid intervals for computation of the theoretical

profiles are indicated in metres. The Yudnamutana

Subgroup (Appila Tillite) is shown as the shaded

formation on the geological cross sections. The

inset clocks show the effective direction of the

earth's field (T') at the localities, and the direc-

tion of the effective magnetization (J') in the

models for which the theoretical anomalies were

computed.
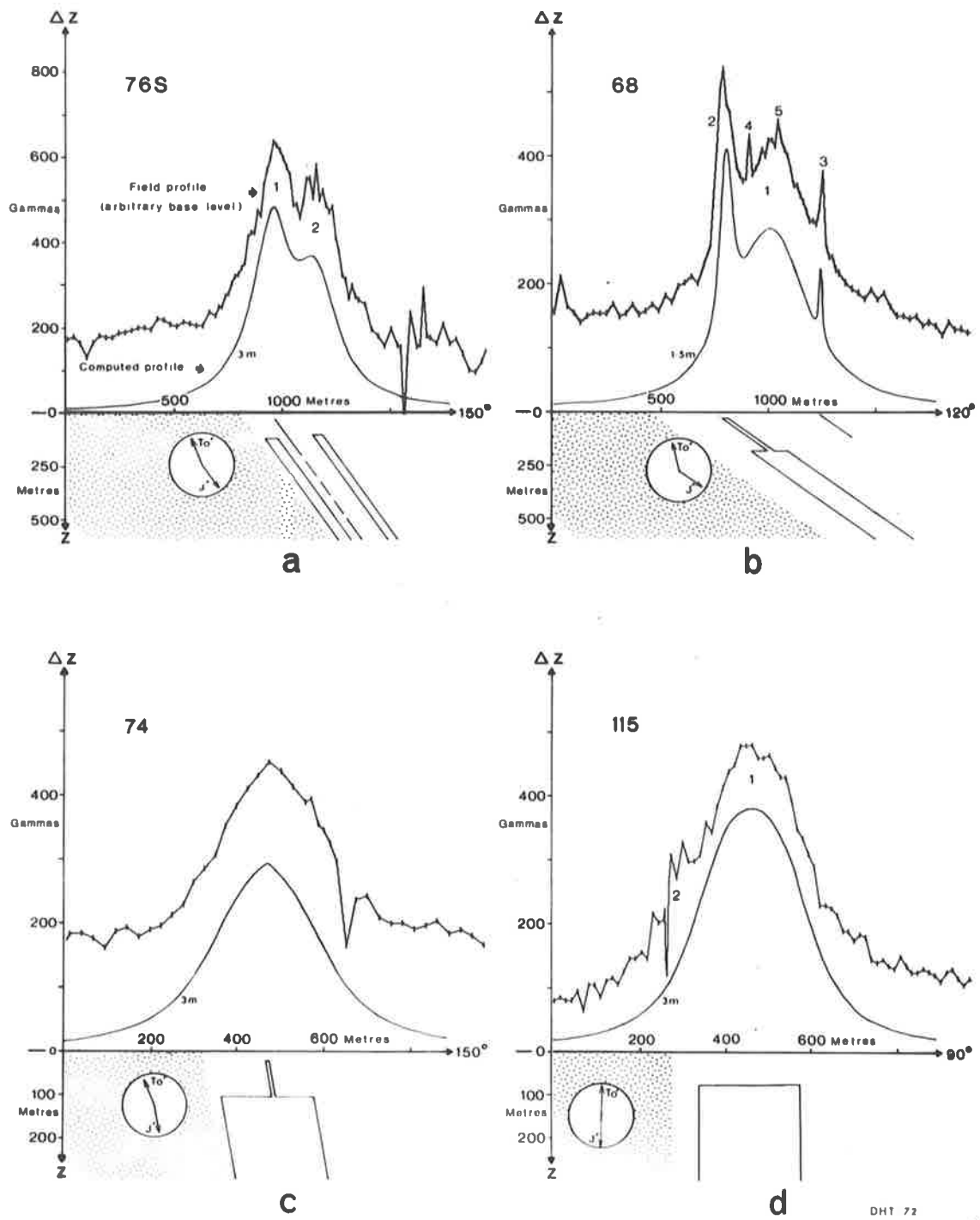
Fig. 4-3

Figure 4.4 : (a) & (b) Two interpreted vertical field magneto-

meter profiles across the Holowilena Ironstone

(Yudnamutana Subgroup).   (c) shows the localities

of the profiles on Figures 4.3 and 4.4 on ORROROO.

The field profiles are drawn on an arbitrary base

level.   The directions indicated on the right hand

side are measured east of geographic north.   Note

that the amplitude and distance scales are different.

Data points on the field profiles are indicated by

vertical lines; the grid intervals for computation

of the theoretical profiles are indicated in metres.

The zones of outcrop of ironstone beds are indicated

on the cross sections by thick black lines;   in these

zones individual ironstone beds are about 1 m thick

and are separated from each other by siltstones.

The inset clocks show the effective direction of the

earth's field (T') at the localities, and the

direction of the effective magnetization (J') in

the models for which the theoretical anomalies were

computed.
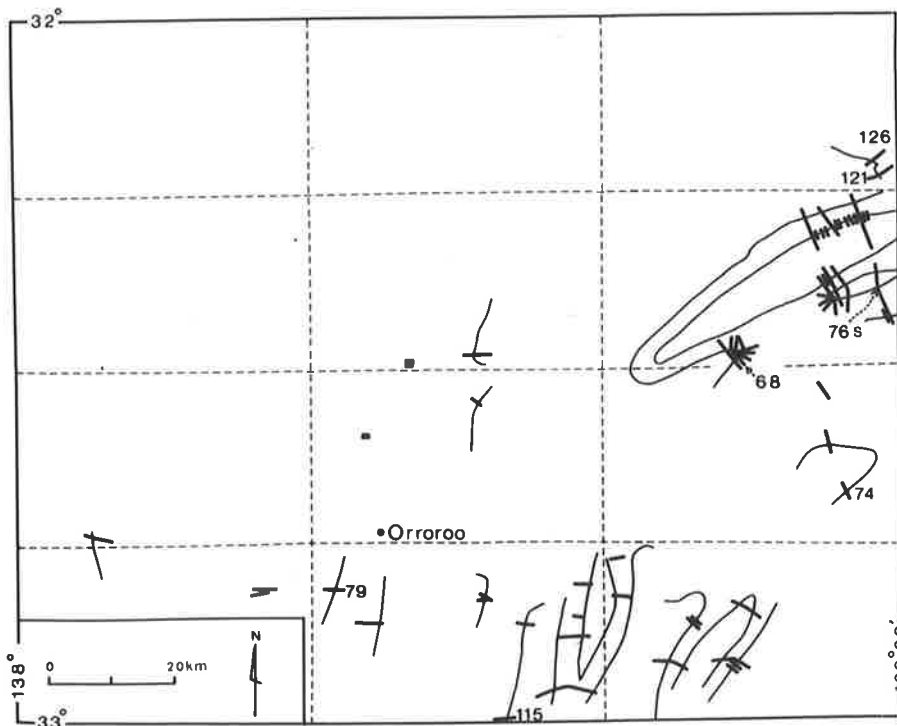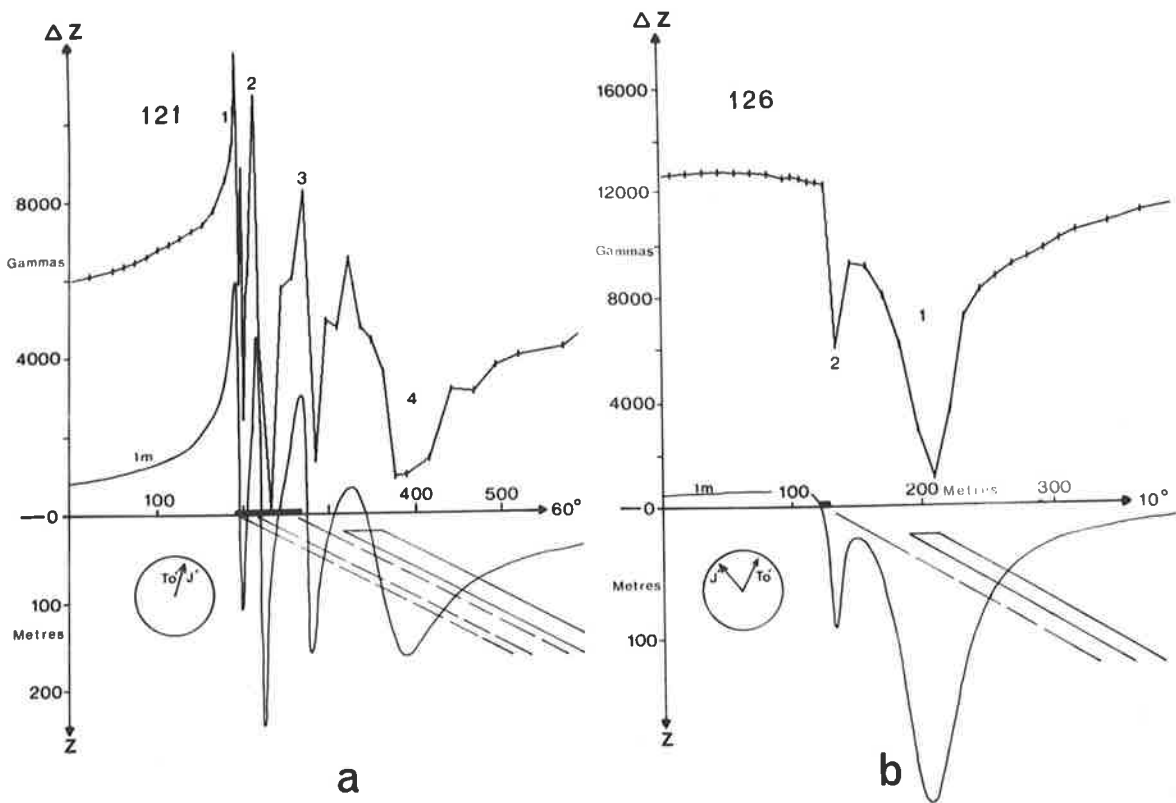
Fig. 4-4

Figure 5.1 : Total field aeromagnetic anomalies over the lower
(pocket)
part of the Tapley Hill Formation (Lower Tapley Hill

magnetic bed) in the Adelaide Geosyncline.

Source of data - geology from SADM geological maps;

magnetic anomalies for ORROROO from a study of aero-

magnetic flight charts, magnetic anomalies for other

areas from SADM contour maps of total magnetic inten-

sity.

Figure 5.2 : Areas of characteristic total field magnetic

anomalies over the Lower Tapley Hill magnetic bed

in the Adelaide Geosyncline.

The characteristics are as follows:

Characteristic 1 - anomalies over S, SE and E dipping

beds are negative; anomalies over N, NW or W dipping

beds are positive; the amplitudes of negative

anomalies exceed those of positive anomalies.

Characteristic 2 - anomalies over S and E dipping

beds and N and W dipping beds are negative; the

amplitudes of anomalies over S and E dipping beds

exceed those over N and W dipping beds.

Characteristic 3 - anomalies over E and W dipping

beds are positive; the amplitude of anomalies over

W dipping beds are higher than over E dipping beds.

The locations of two anticlinal structures near

Waukaringa, where detailed vertical field ground

magnetometer traverses were put in, are arrowed

(C and D).

Source of data - Figure 5.1.

Mt. Painter

Waukaringa

Peterborough

Adelaide

N

0   km   100

DHT 72

29°

36°

136°30'

141°
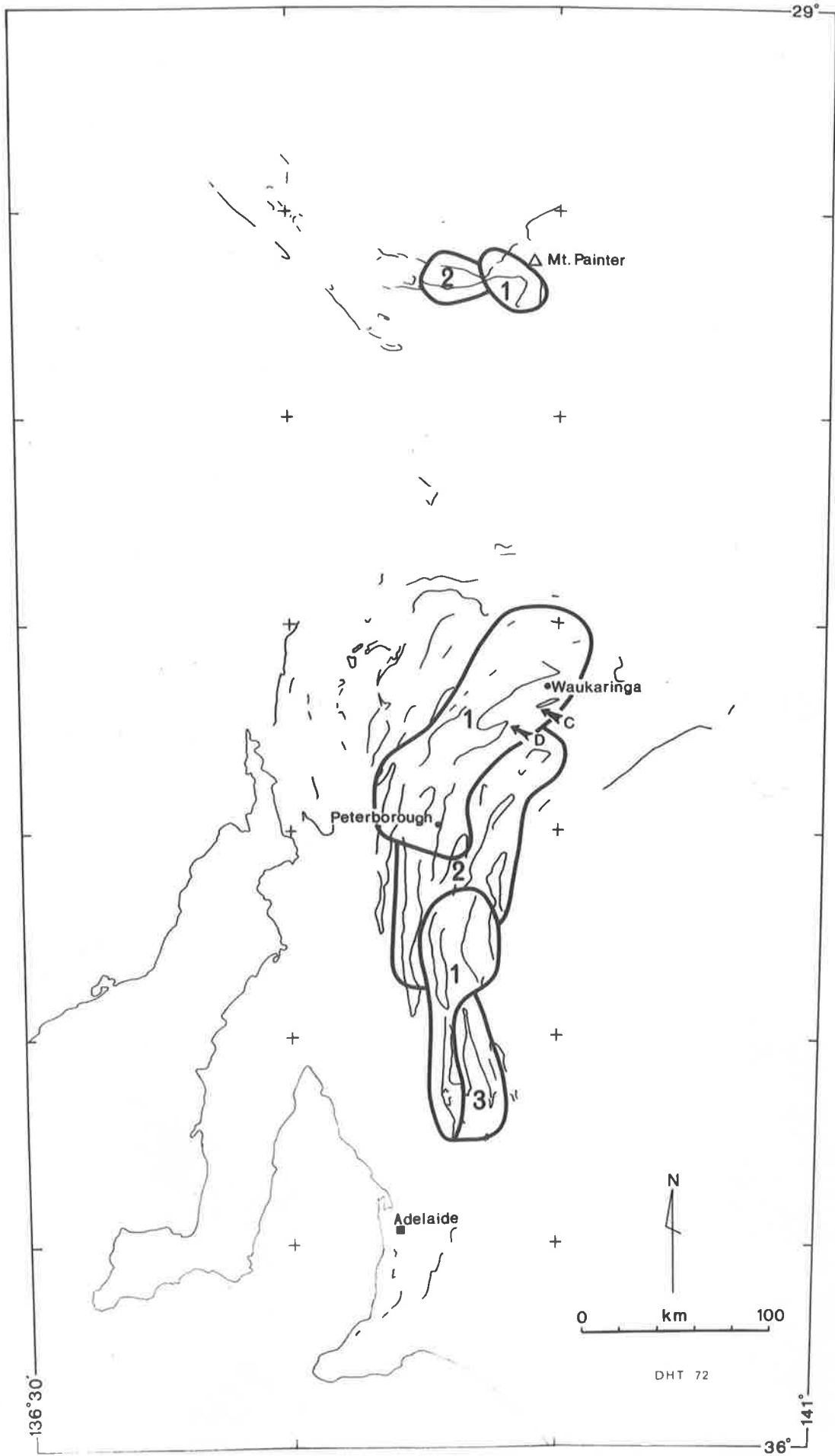
Fig. 5-2

Figure 5.3 : Vertical field ground magnetometer profiles over the anticlinal structures C and D near Waukaringa.

The unit shaded with small circles is the Yudnamutana Subgroup (Appila Tillite). The grey shaded unit corresponds with the Lower Tapley Hill magnetic bed at a depth of 100-200 m below the surface. Note the change of anomaly sign around structures.
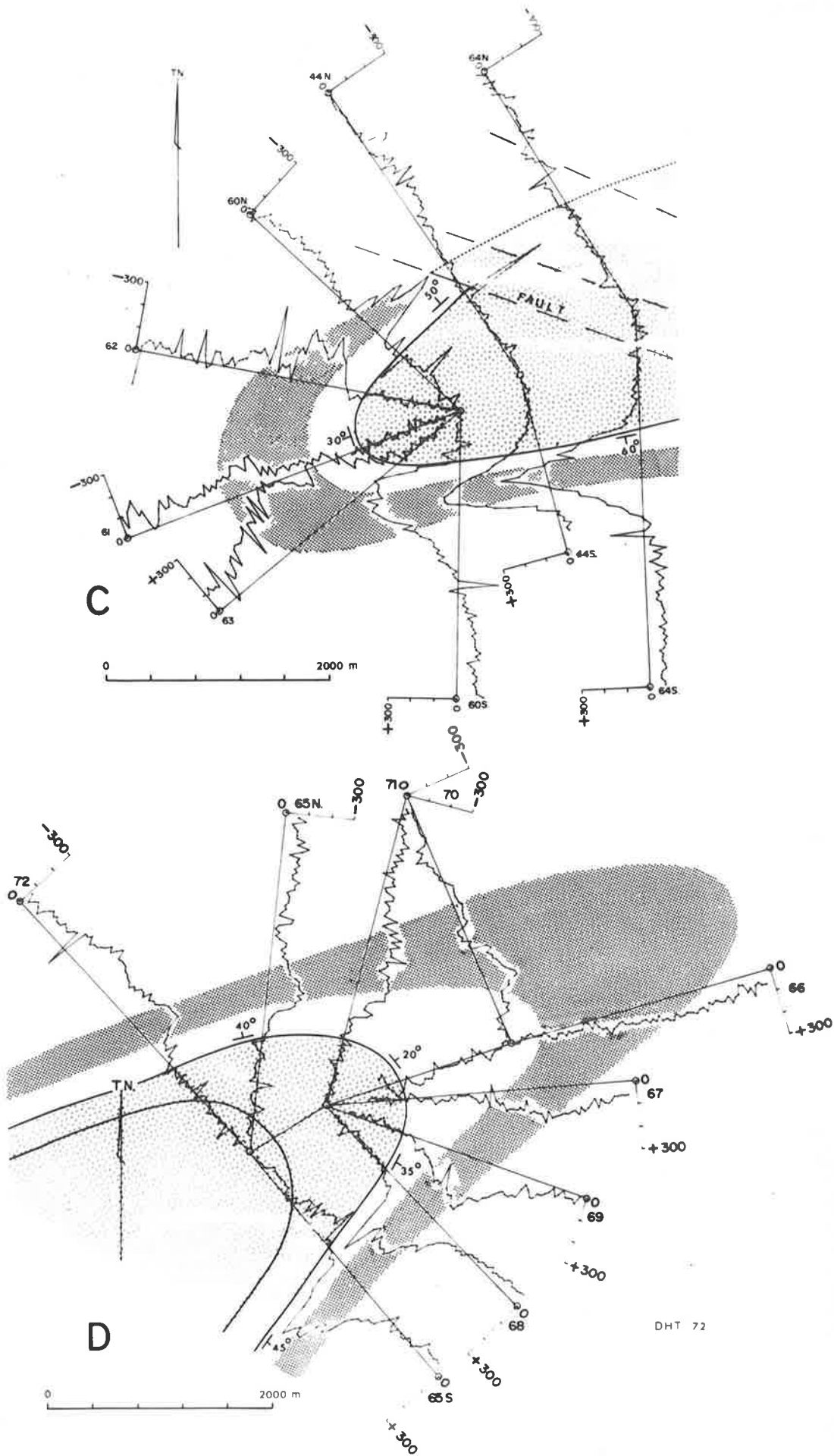
Fig. 5-3

Figure 5.4 : Amplitudes and areas under anomalies attributable
to the Lower Tapley Hill magnetic bed, plotted
against strike direction.

Solid points are for data from Area D, circles are
for data from Area C.

The convention for strike is as follows:

when standing directly over the interpreted position
of the Lower Tapley Hill magnetic bed, facing down
dip, the strike is measured east of north to the
direction of the right hand. On the figure,
strikes have been plotted beyond 360° to group the
data from each area. The dashed line gives the
zero level for the sinusoids fitted to the data.
See text of Chapter 5 for further discussion.

AREA

a

AMPLITUDE

b
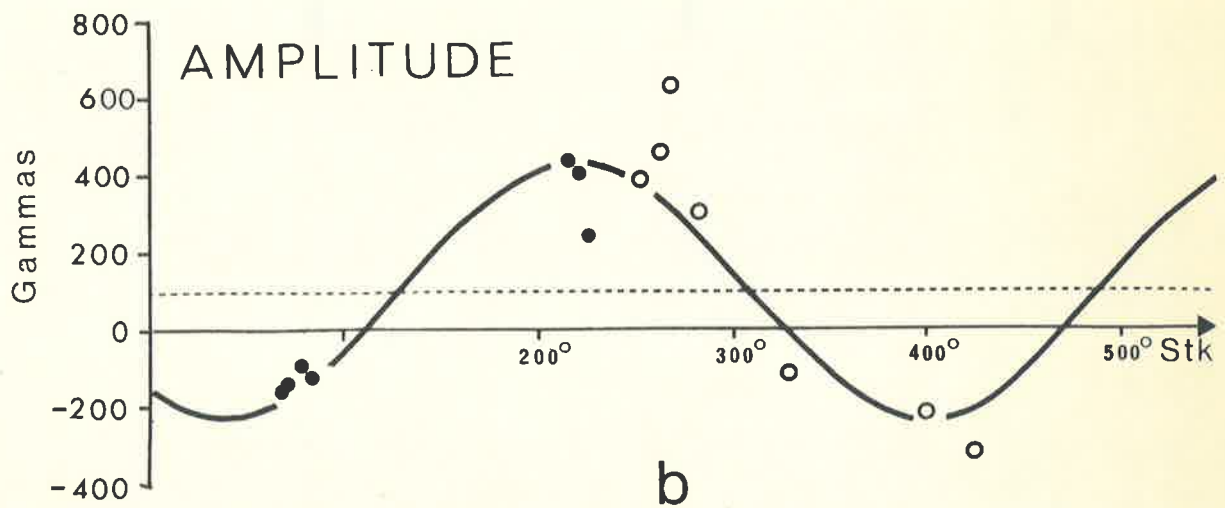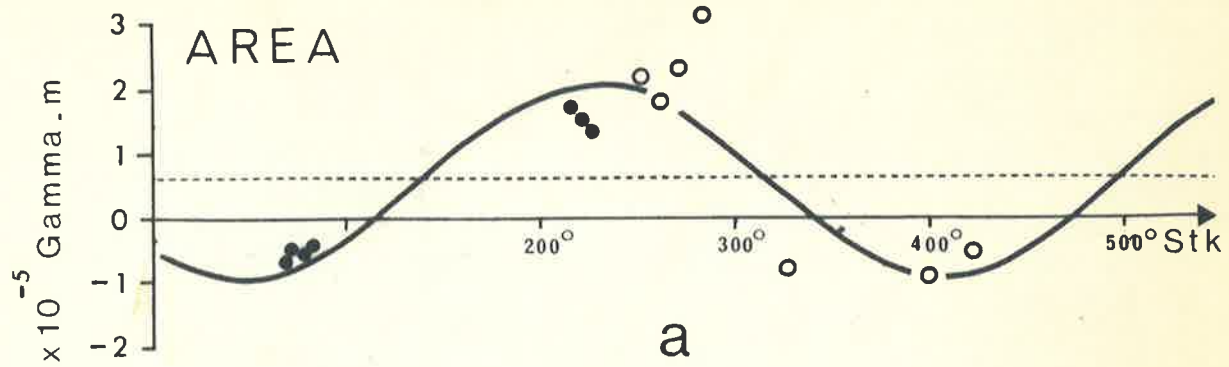
DHT '72

Fig. 5 - 4

Figure 6.1 : Magnetic features on ORROROO which are not caused by magnetic beds within the
Adelaide System sediments.

Legend - geology

A   Cainozoic sediments

B   Adelaidean sediments

C   Diapiric breccia

Legend - magnetics

D   Linear magnetic feature (maximum amplitude shown in gammas)

E   Localized magnetic feature (amplitude in gammas)

F   Group of magnetic anomalies (average amplitude in gammas)

G   Non-magnetic zone

Diapirs with strong associated aeromagnetic anomalies are shown thus: Baratta (100).
Arrowed localities 1 and 2 are discussed in the text of Chapter 6.   Magnetic features
recognized previously by Bennett (1968) are indicated with a B;   features recognized
by Tipper and Finney (1966) are indicated with a T.

Source of data - study of aeromagnetic flight charts and 1:47,520 scale geological
maps of ORROROO.

Fig. 6-1

Legend:
- A
- B
- C
- D — 20
- E — O 150
- F — 20
- G

0 10 20 30 km

N

DHT 72

Map labels:
- 32°
- 138° 00'
- 33°
- 139° 30'
- Baratta (100) T \ 500 20
- O 110
- KOONAMORE PLAIN 10
- 15
- 30
- T 20
- Round Hill 30
- 10
- 15
- 20
- 10
- 20
- 30
- 40
- WILLOCHRA PLAIN
- 20
- Walloway Diapir
- WALLOWAY PLAIN
- 10
- 40
- 20
- 40
- 20
- 50
- 50
- 10 20
- 15
- Orroroo
- 20
- 250 O B
- 2
- 100 B
- 50 B
- 10
- 10
- Paratoo (400)
- Mt. Grainger (90)
- 150
- Oodlawirra (140)
- 15 B
- Peterborough
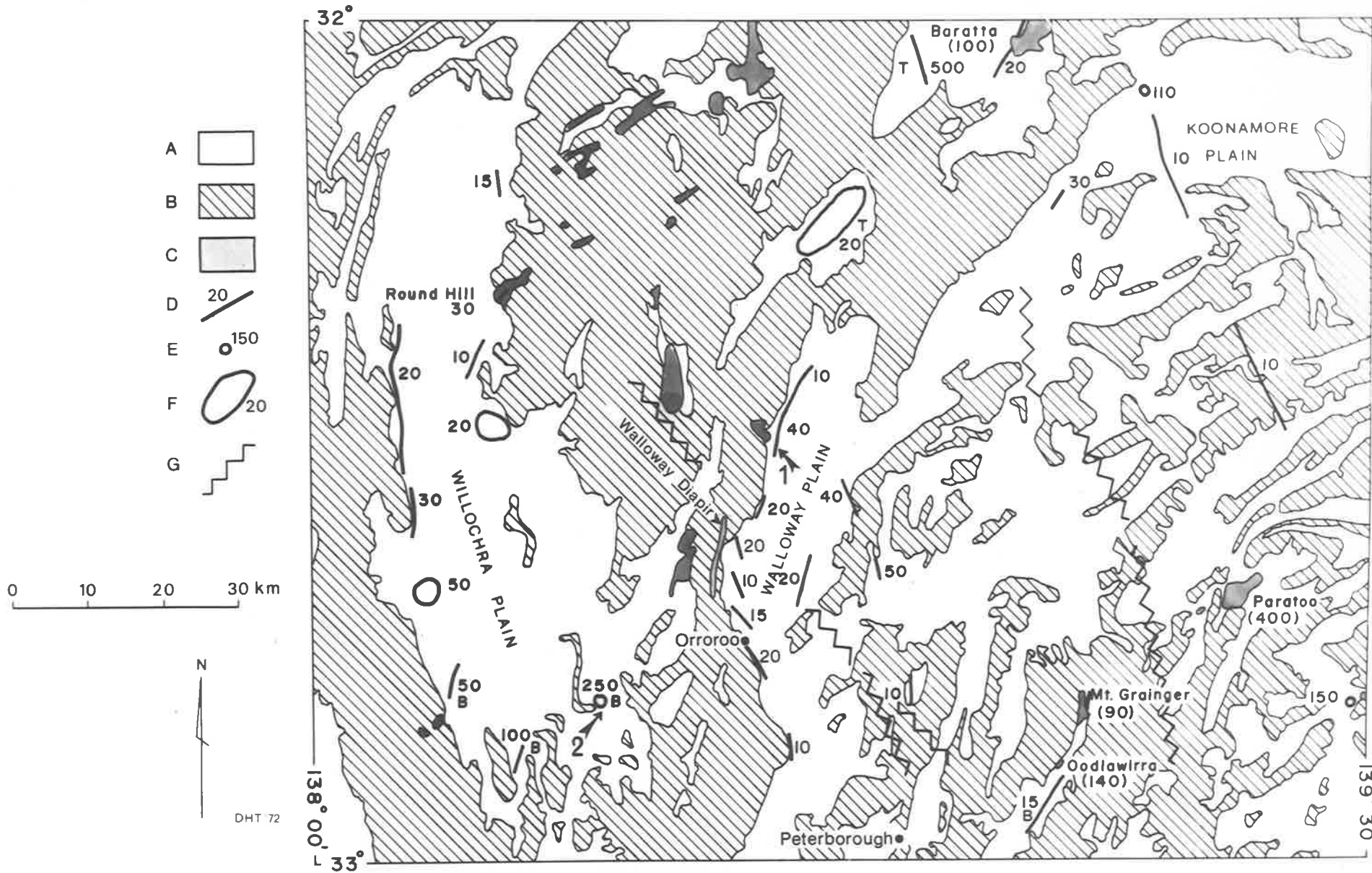
Figure 6.2 : Interpreted linear cross cutting magnetic features

near the town of Orroroo, which are unlikely to be

caused by magnetic beds within Adelaide System

sediments.   Linear features attributable to the

Lower Tapley Hill magnetic bed are also shown.

Legend - geology

Unshaded unit - Quaternary sediments
Grey unit   - Tapley Hill Formation
Circled unit   - Yudnamutana Subgroup (Appila Tillite)

Legend - topography

Narrow dashed lines - roads
Heavy dashed line   - railway line

Legend - magnetics

The peaks of anomalies are indicated by arrows

(amplitudes in gammas).   Linear features are

indicated by heavy lines.

Source of data - aeromagnetic flight charts and

1:47,520 scale geological maps.

Orroroo

0　　　　1　　　　2 km

DHT '72

N
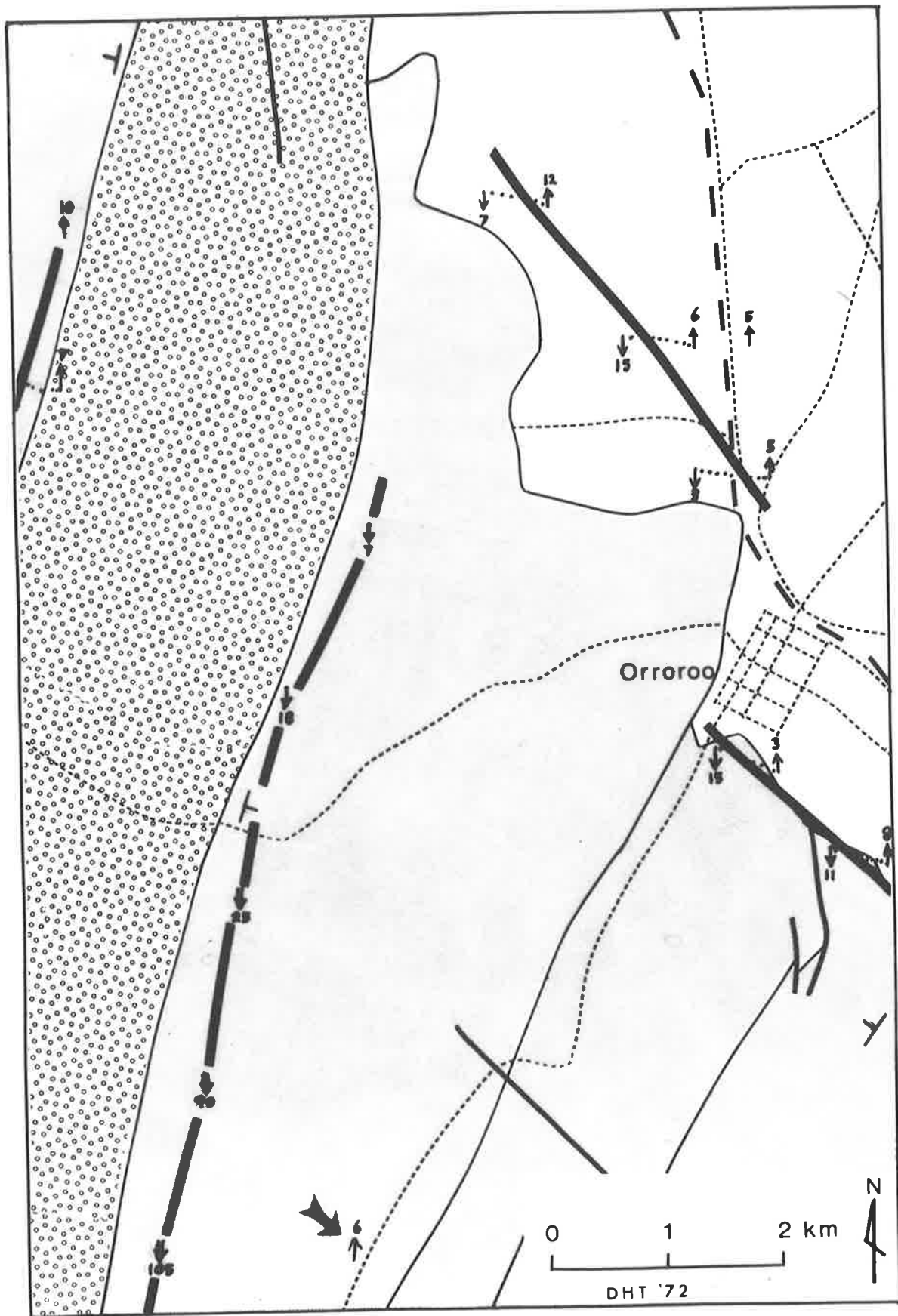
Fig. 6 - 2

Figure 6.3 : Positions and amplitudes (gammas) of aeromagnetic

anomalies over areas of diapiric breccia on ORROROO.

The areas of breccia are numbered for reference in

the text of Chapter 6.

Source of data – aeromagnetic flight charts and 1:47,520 scale

geological maps.

Fig. 6·3
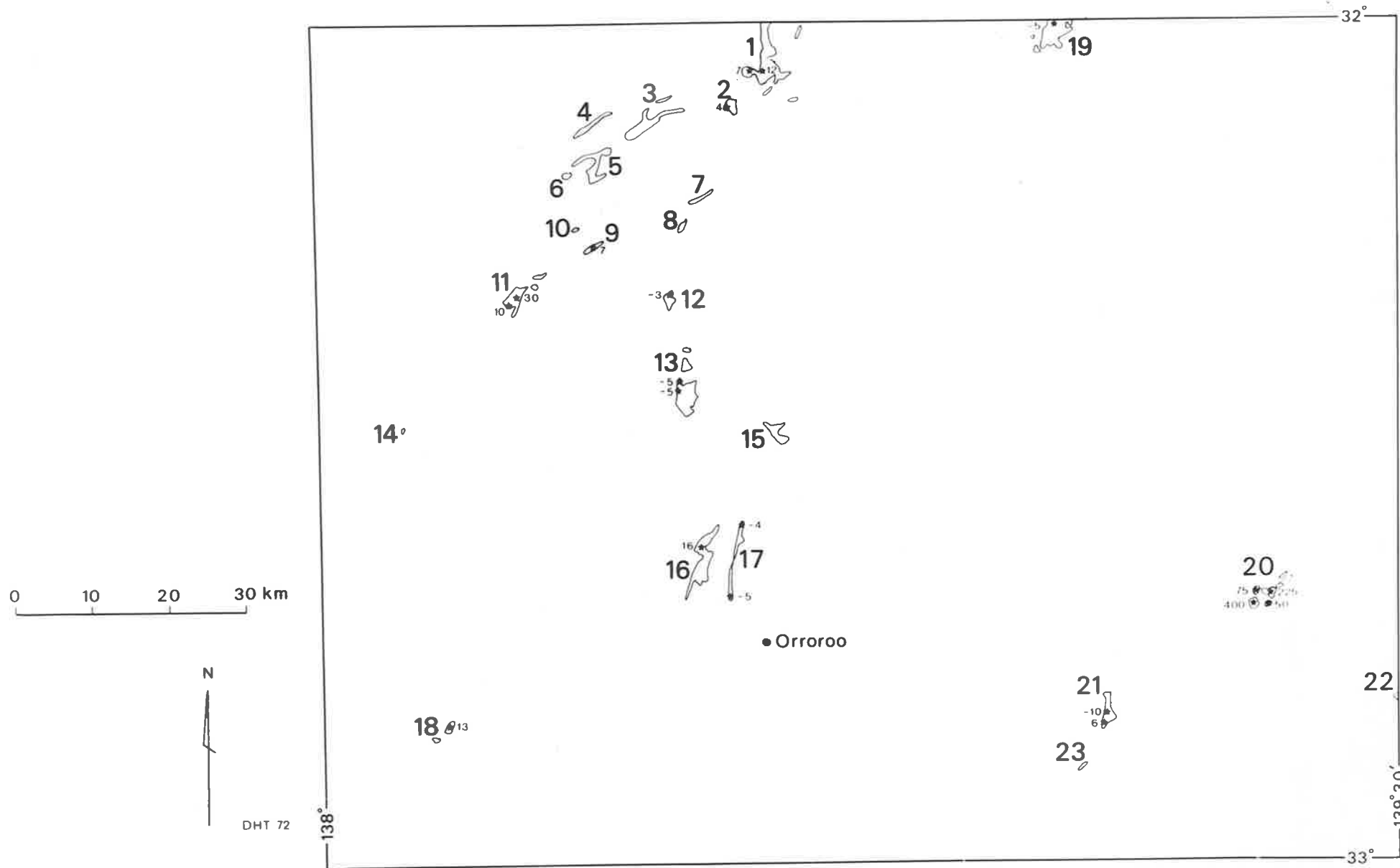
Figure 6.4 : Interpretation of magnetic anomalies near Hesso, attributed to a member of the Eyre Peninsula dyke swarm.

Legend

1. Cainozoic sediments

2. Flat lying Adelaide System sediments

3. Geological boundary

4. Creek

5. Road

6. Railway line

7. Zone of magnetic material indicated by interpretation of aeromagnetics

8. Ground magnetometer traverse

9. Magnetic dyke indicated by interpretation of vertical field ground profiles

Source of data - SADM geological maps and aeromagnetic contour maps; field work in the area.
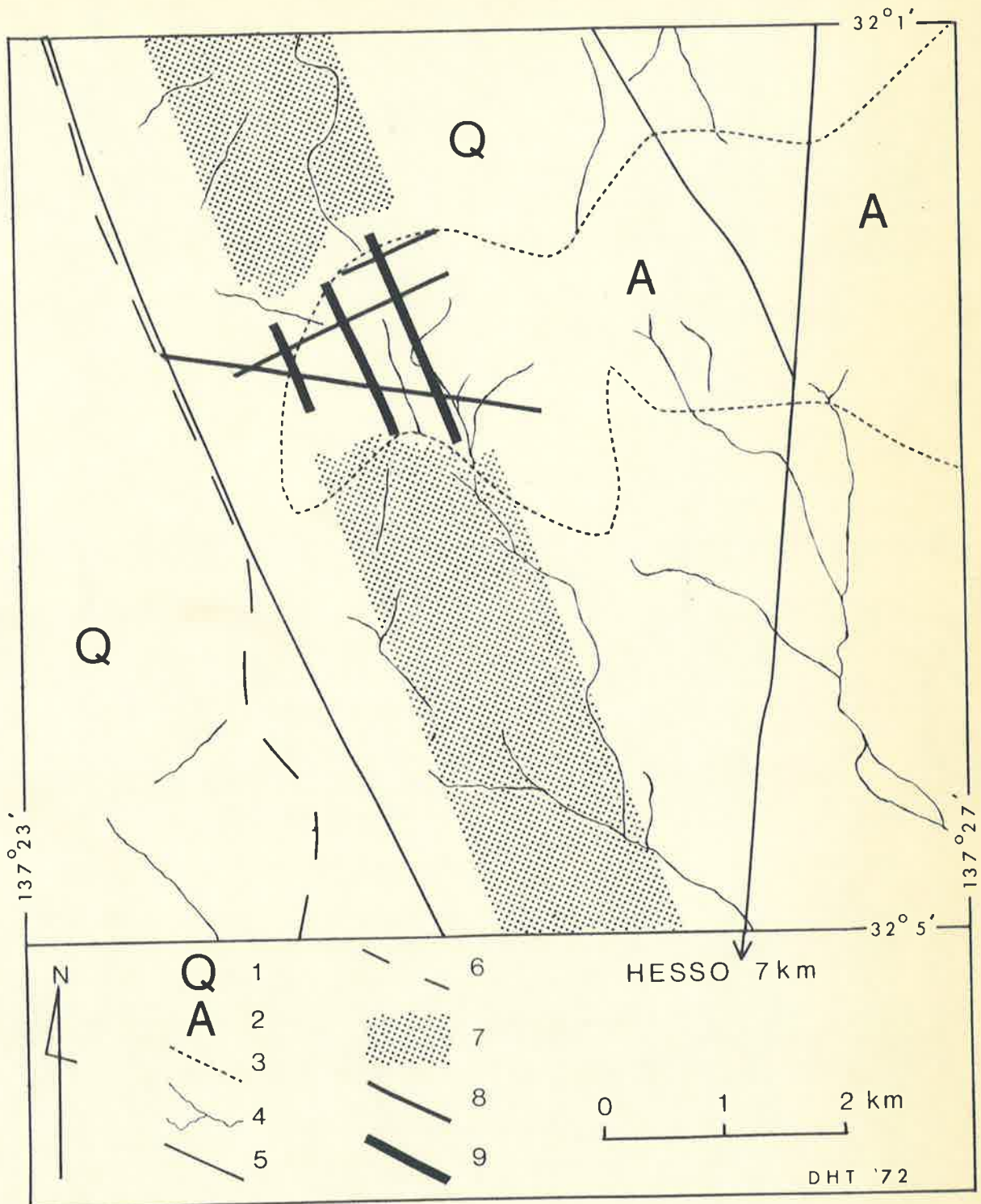
Fig. 6 - 4

Figure 7.1 : Interpreted depths to magnetic sources in the northern
part of the Adelaide Geosyncline.

Depth estimates are shown in hundreds of metres.

Source of data - BMR Records (depths originally scaled
in feet).

INTERPRETED DEPTH TO MAGNETIC SOURCES

Fig. 7-1

Figure 8.1 : Dry specific gravity logs for drill core from the

Lyndhurst Diapir.

Source of data - SADM general drilling program, 1966.

DDH LYD 3

DDH LYD 5

DRY SPECIFIC GRAVITY

DRY SPECIFIC GRAVITY
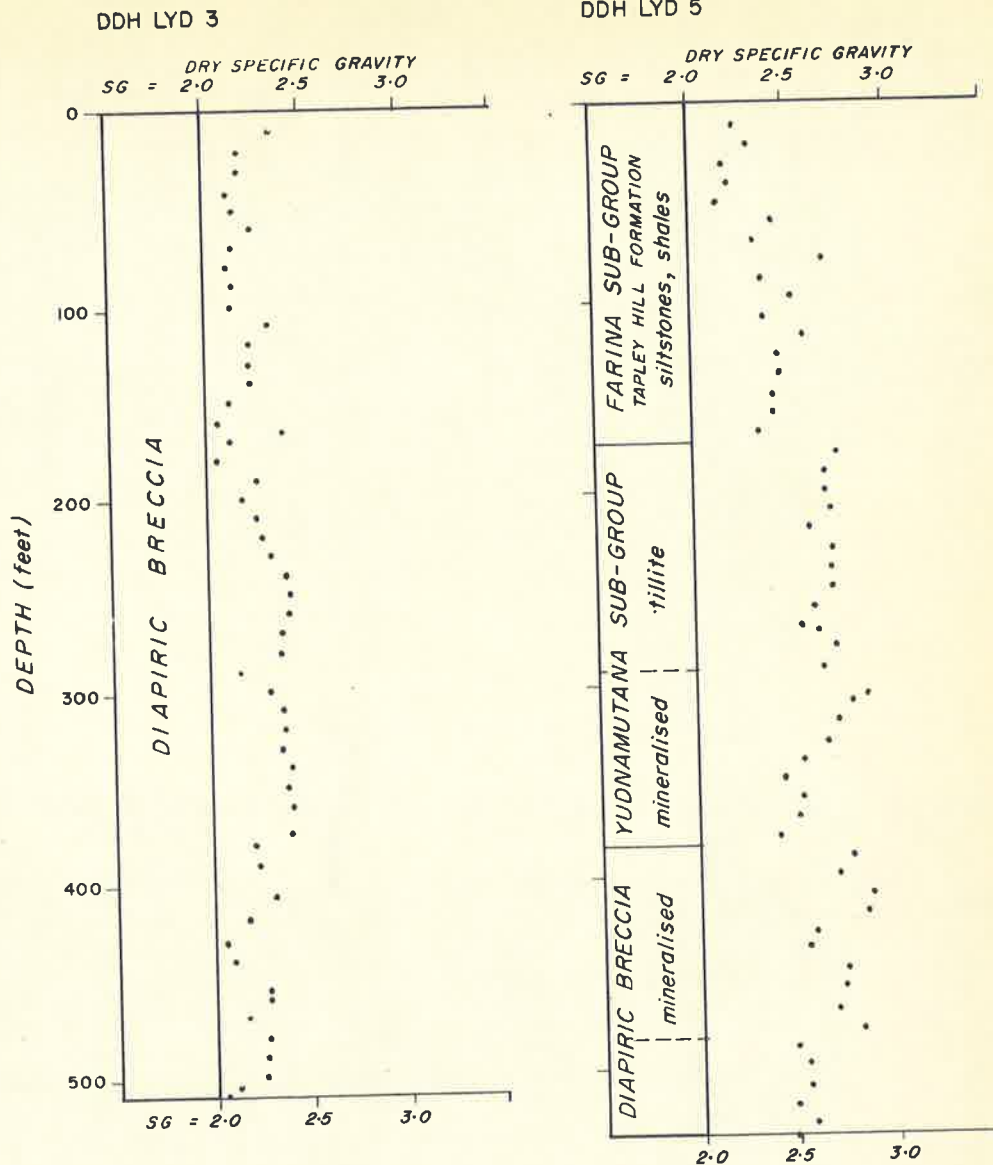
Core sampled at 10ft intervals.   Specimens of approximately 40g.
Specific gravity by Archimedes method.

After South Australian Department of Mines general drilling programme 1966

LYNDHURST DIAPIR

DRY SPECIFIC GRAVITY LOGS

DHT '72

Fig. 8·1

Figure 8.2 : Frequency histograms of dry density measurements
on Adelaide System sediments.
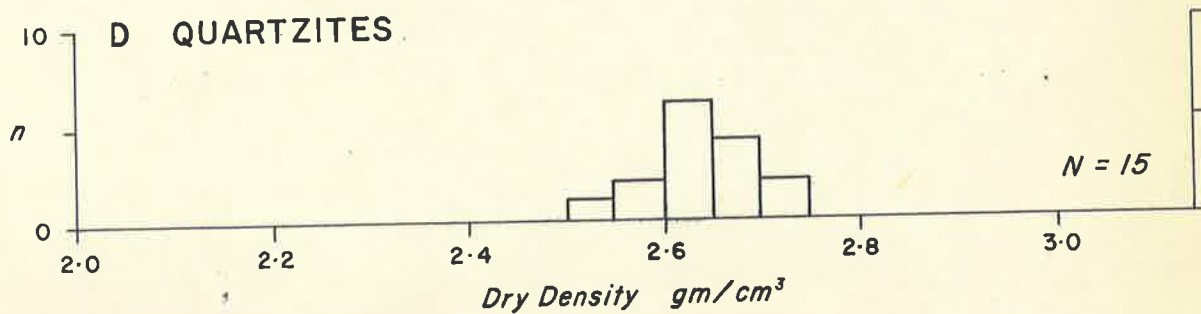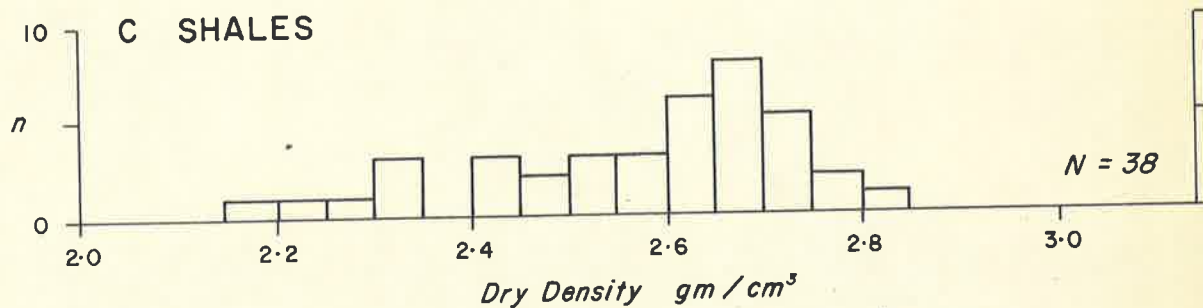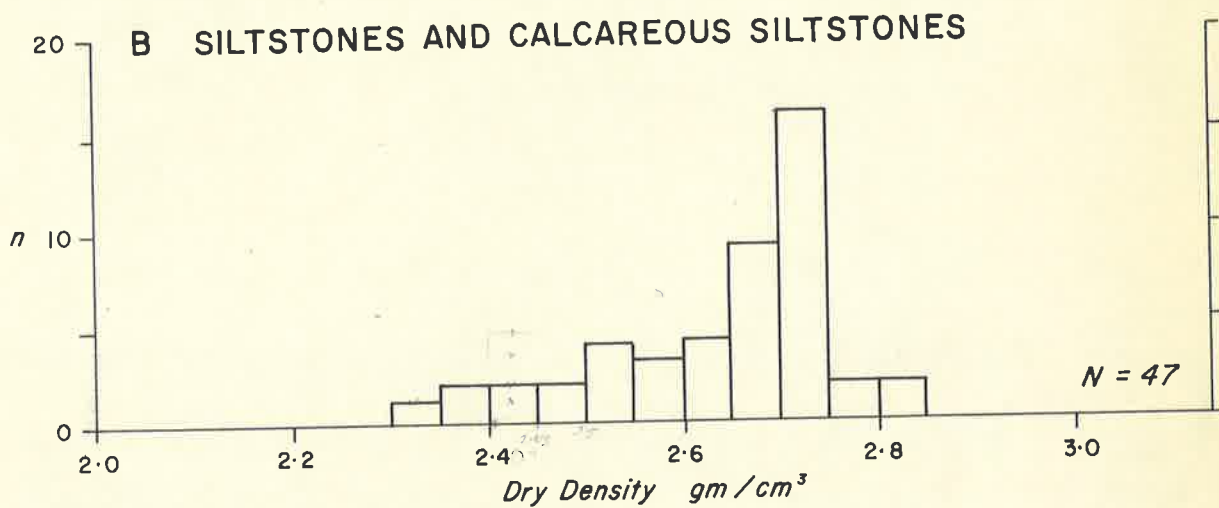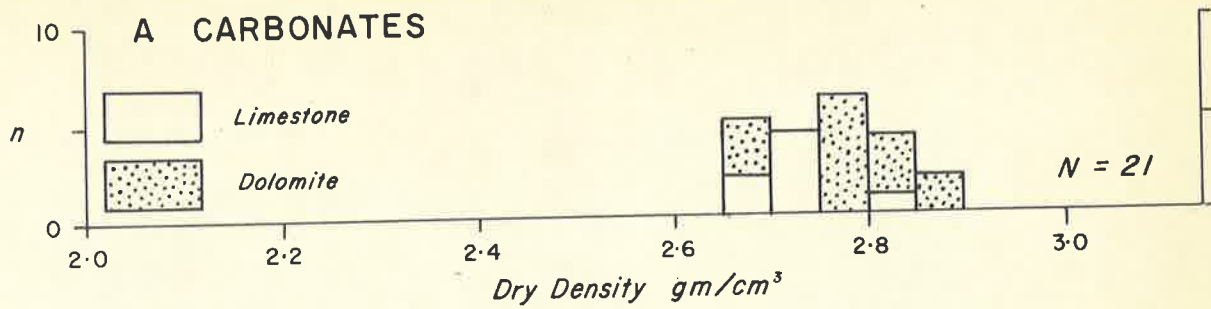
DENSITY OF ADELAIDEAN SEDIMENTS

Fig. 8·2

DHT '72

Figure 8.3 : Density profiles across the Adelaide Geosyncline.
(pocket)

The Bouguer densities used for the calculation of Bouguer anomalies are shown on Profile A. The dashed line below each group of density profiles shows the topography as recorded at the gravity stations.

Source of data - original elevations and Bouguer anomaly values from BMR maps (Bouguer density 2.67 g/cm^3).

Figure 8.4 : Frequency histograms of dry density measurements

on drill core from the Anabama Granite, and

schists in the Broken Hill area.

Source of data - original measurements on schists

provided by Broken Hill South Pty. Ltd.

ANABAMA GRANITE

Samples from 0—30 m.
"   " 30—182 m.

n

50

40

30

20

10

0

2·0   2·4   2·8   3·2

Dry Density Gms./Cm.^{3}

N = 194

SCHISTS FROM BROKEN HILL

biotite and sericite schists

garnetiferous biotite and sericite schists

n

15

10

5

0

2·0   2·4   2·8   3·2

Dry Density Gms./Cm.^{3}

N = 25
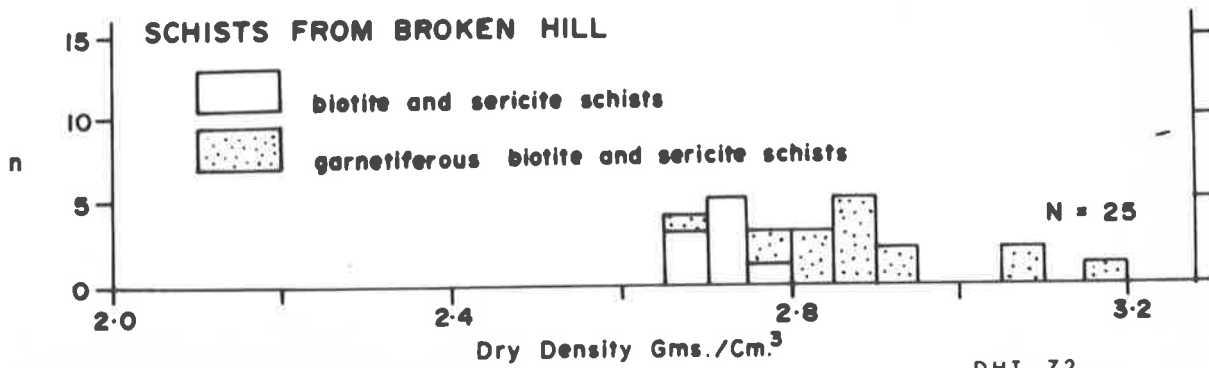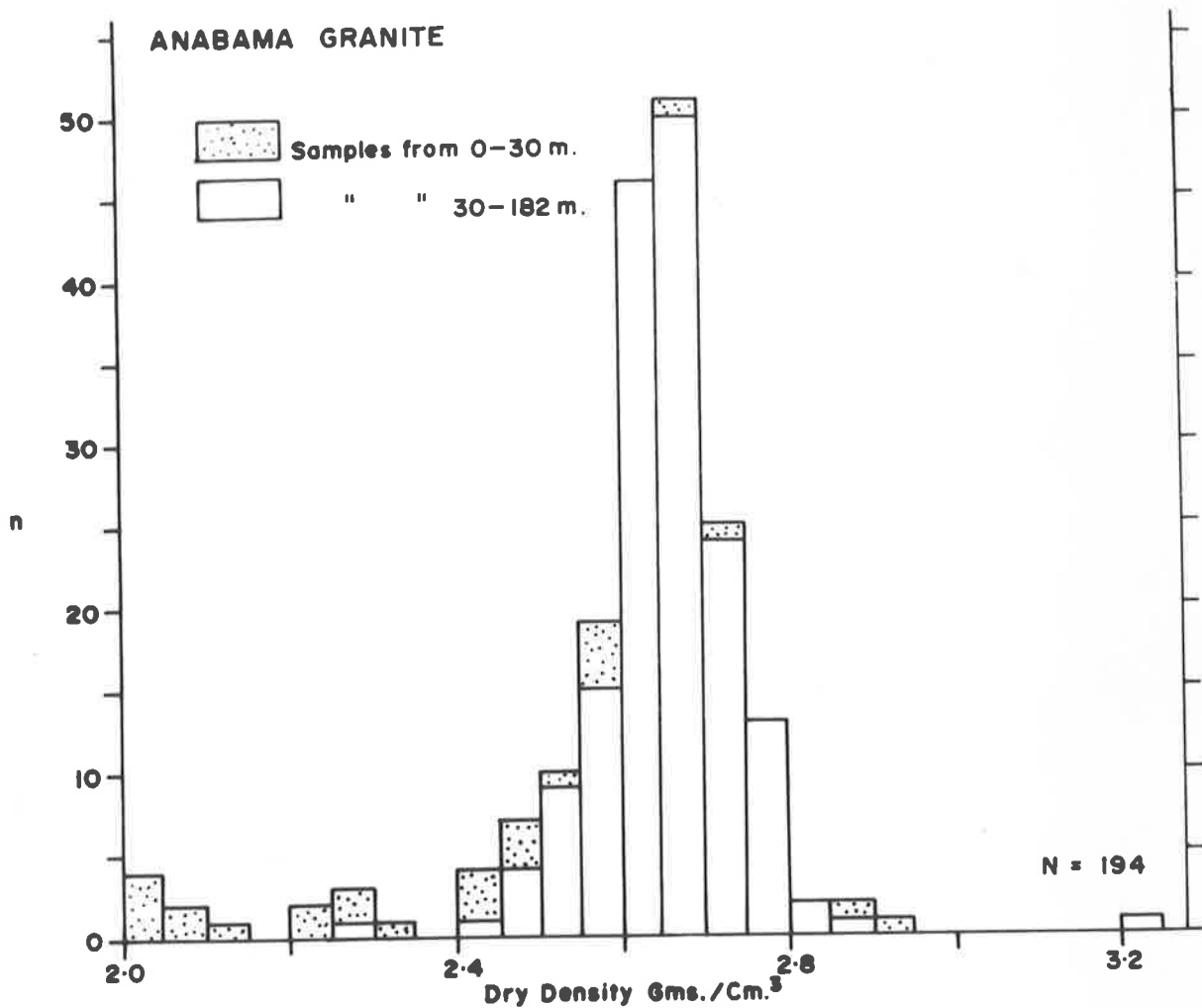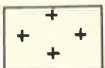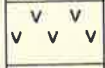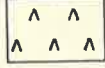
DHT 72

Fig. 8 - 4

Figure 8.5 : Dry specific gravity logs for drill core from the

Anabama Granite

DDH AN3
dip = 45°
strike = 17° mag

DDH AN2
dip = 45°
strike = 275° mag

DDH AN1
dip = 90°

DEPTH (feet)

WATER LEVEL
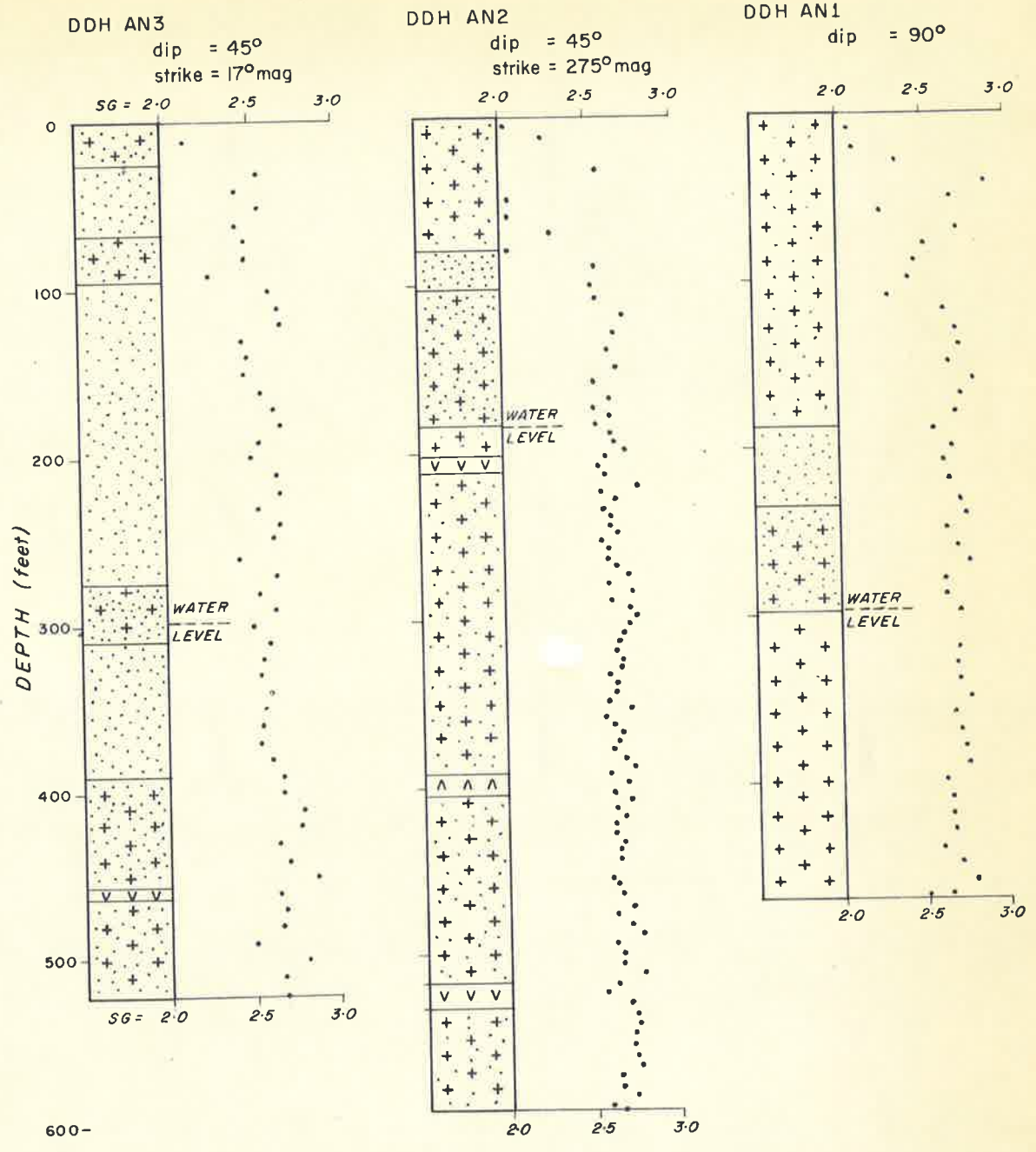
LEGEND

Granite

Greisen

Feldspar porphyry

Quartz biotite porphyry

Lithology generalized after A.J.Hosking (1970)

Specific gravity by Archimedes method. Measurements by
D.H.Tucker using regular samples of split core
(weight approximately 150 grammes)

ANABAMA GRANITE

ANABAMA HILL SA

DHT '72

DRY SPECIFIC GRAVITY LOGS

Fig. 8-5

Figure 9.1 : Bouguer anomalies over the northern part of the
Adelaide Geosyncline.

The contour interval is 5 milligals. Anomalies
arrowed and numbered are discussed in the text of
Chapter 9.

Source of map - BMR.
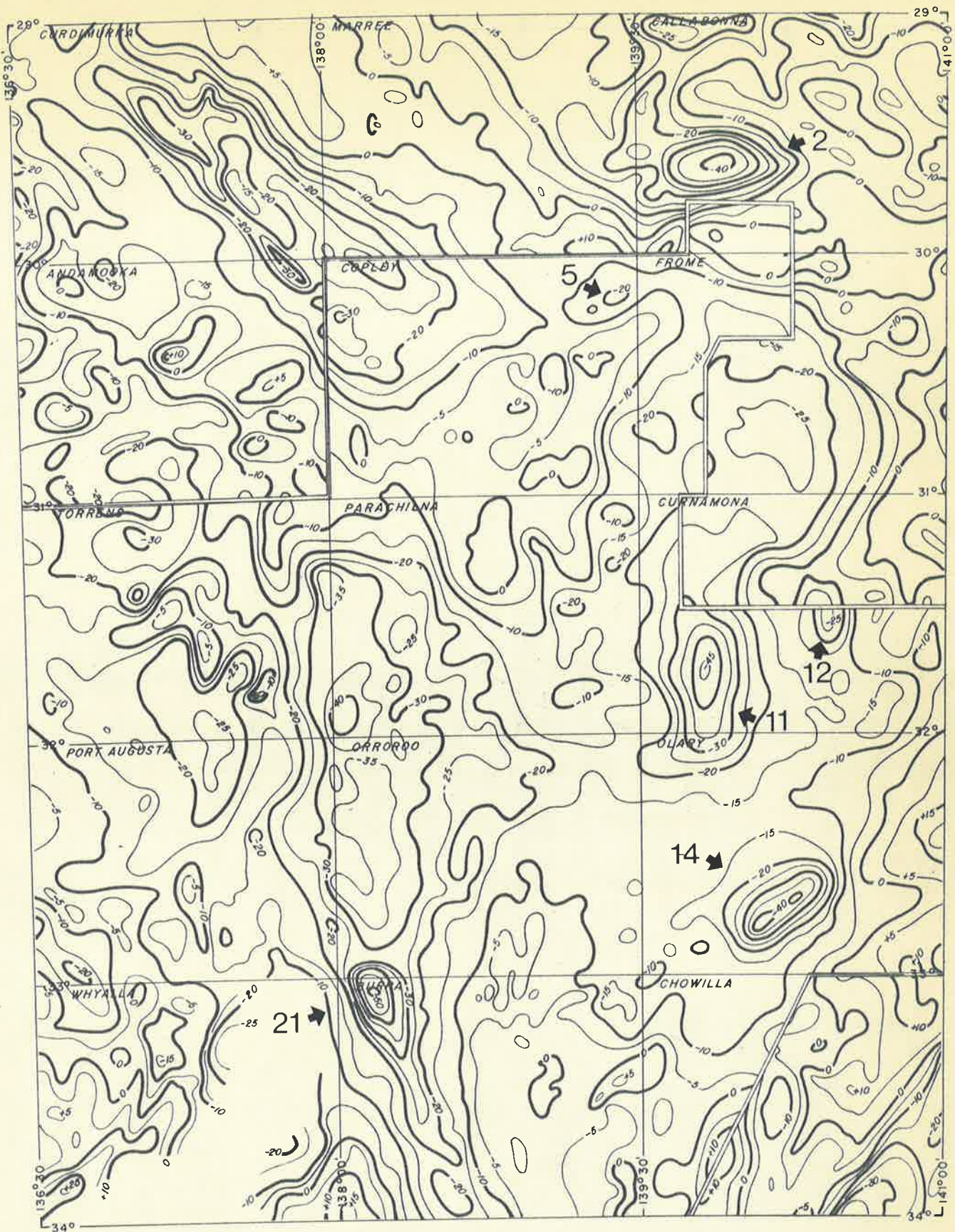
BOUGUER ANOMALIES

KILOMETRES

BOUGUER DENSITY in g/cm³

DHT '72

Fig. 9-1

Figure 9.2 : Bouguer anomaly profiles and generalized geological
cross sections in areas of granitic rocks on the
eastern side of the Adelaide Geosyncline.

The dots are Bouguer anomaly values recorded on
adjacent lines of gravity stations. Models were
determined to account for the dashed Bouguer anomaly
profiles. On diagram B, Profile 2 was used for
model studies. In the area of Profile 2, material
at the surface consists of Cainozoic sediments.
Profile 1 for anomalies on a single line along
latitude 32° corresponds with the generalized
geological cross section.

Source of data - BMR 1:250,000 maps of Bouguer
anomalies. The plotted points on sections A and C
are for data reduced with a Bouguer density of
2.67 g/cm^3; on diagram B the data were reduced with
a Bouguer density of 2.2 g/cm^3.

A   Anomaly 5

MGALS

0

-10

-20

-30

0   20 km

NW   SE

Mt Painter

Cainozoic & Mesozoic

Adelaidean sediments   Mt Painter Granites   Adelaidean

B   Anomaly II

MGALS

0

-10

-20

-30

-40

-50

0   40 km

W   E

Glenorchy

1

2

Adelaidean sediments   Glenorchy Granites   Schists, quartzites and granitic rocks of the Willyama Block

C   Anomaly 14

MGALS

0

-10

-20

-30

-40

0   40 km

NW   SE

Anabama Hill

DHT '72

Cainozoic & Mesozoic

Adelaidean sediments   Anabama Granite   Adelaidean

Fig. 9-2

Figure 9.3 : Geology and geophysics for the area of the Anabama Granite (Bouguer Anomaly 14).

The drill holes shown on the figure were located on Anabama Hill. Anabama Hill is the index point for the geophysical models shown on Figures 9.4 and 9.5. The distance scales on Figures 9.3, 9.4 and 9.5 are the same.

Source of data - geology and magnetics - see figure; Bouguer anomaly contours from the BMR map of OLARY. The Bouguer density used for reduction of the data was 2.67 g/cm^3.
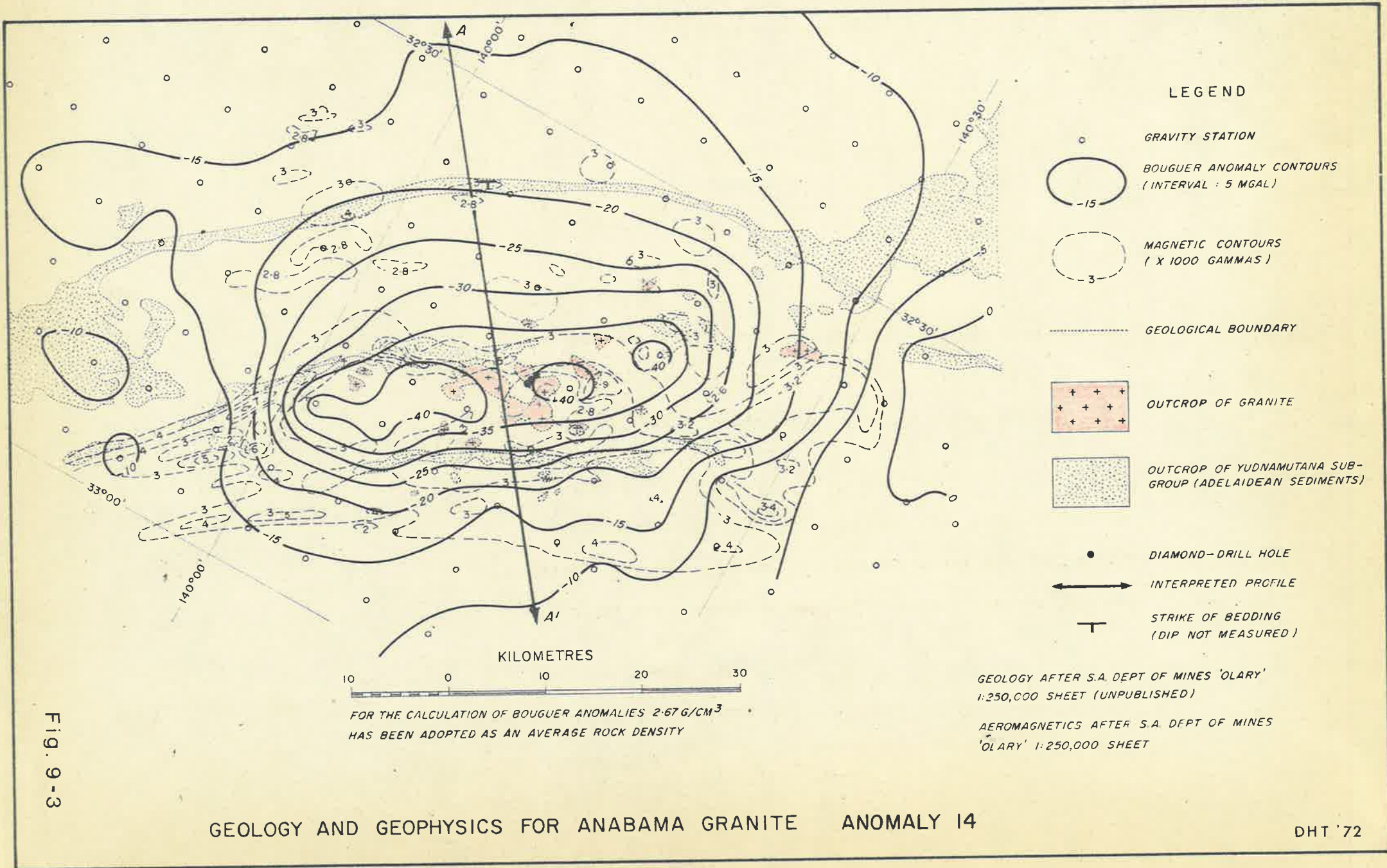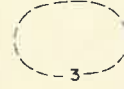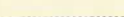
LEGEND

	GRAVITY STATION
	BOUGUER ANOMALY CONTOURS (INTERVAL : 5 MGAL)
	MAGNETIC CONTOURS (x 1000 GAMMAS)
	GEOLOGICAL BOUNDARY
	OUTCROP OF GRANITE
	OUTCROP OF YUDNAMUTANA SUB-GROUP (ADELAIDEAN SEDIMENTS)
	DIAMOND-DRILL HOLE
	INTERPRETED PROFILE
	STRIKE OF BEDDING (DIP NOT MEASURED)

GEOLOGY AFTER S.A. DEPT OF MINES 'OLARY' 1:250,000 SHEET (UNPUBLISHED)

AEROMAGNETICS AFTER S.A DEPT OF MINES 'OLARY' 1:250,000 SHEET

KILOMETRES

FOR THE CALCULATION OF BOUGUER ANOMALIES 2·67 G/CM³ HAS BEEN ADOPTED AS AN AVERAGE ROCK DENSITY

Fig. 9-3

GEOLOGY AND GEOPHYSICS FOR ANABAMA GRANITE   ANOMALY 14
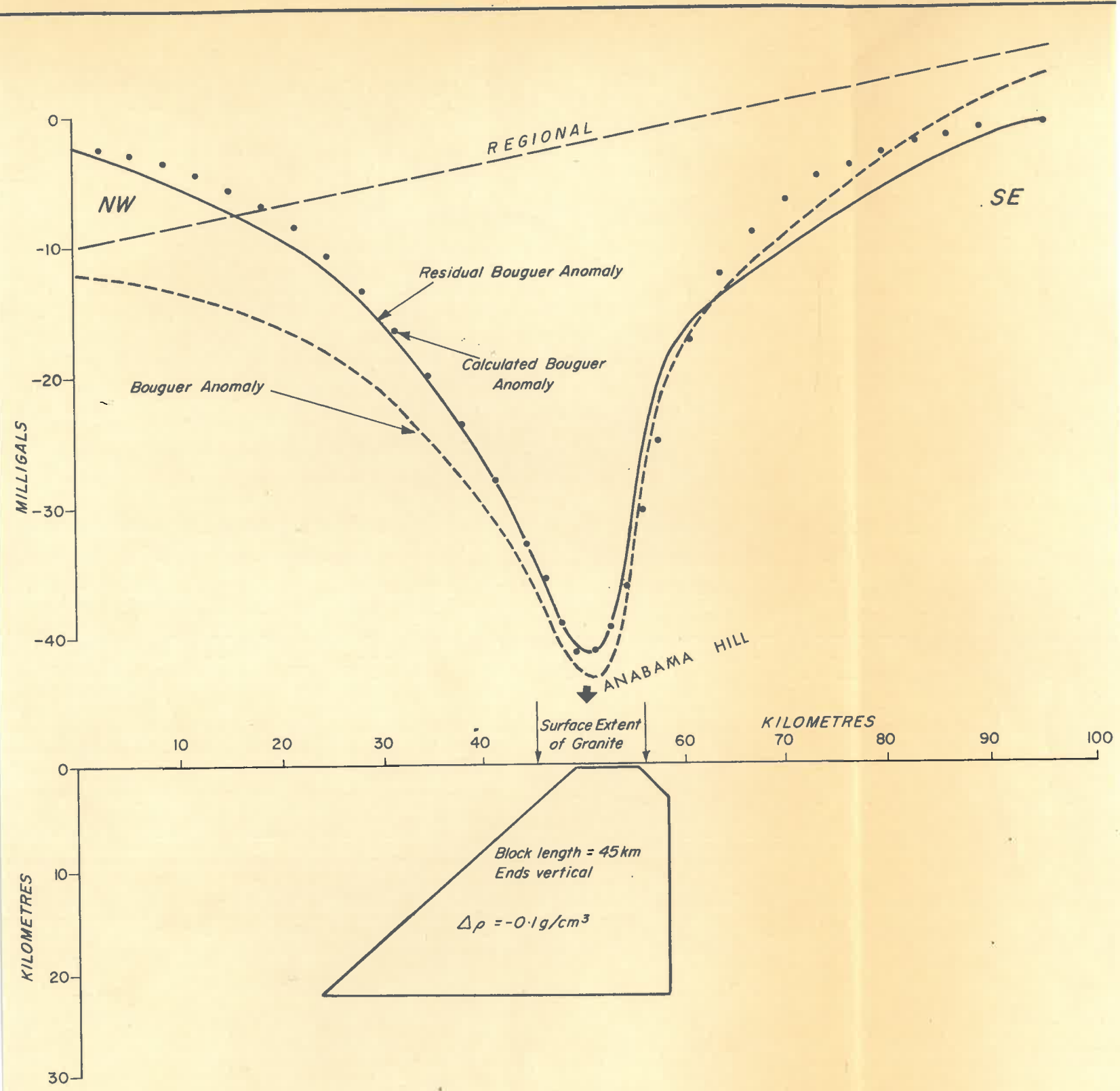
DHT '72

GEOPHYSICAL MODEL 1 FOR ANOMALY 14

DHT '72

Fig. 9-4
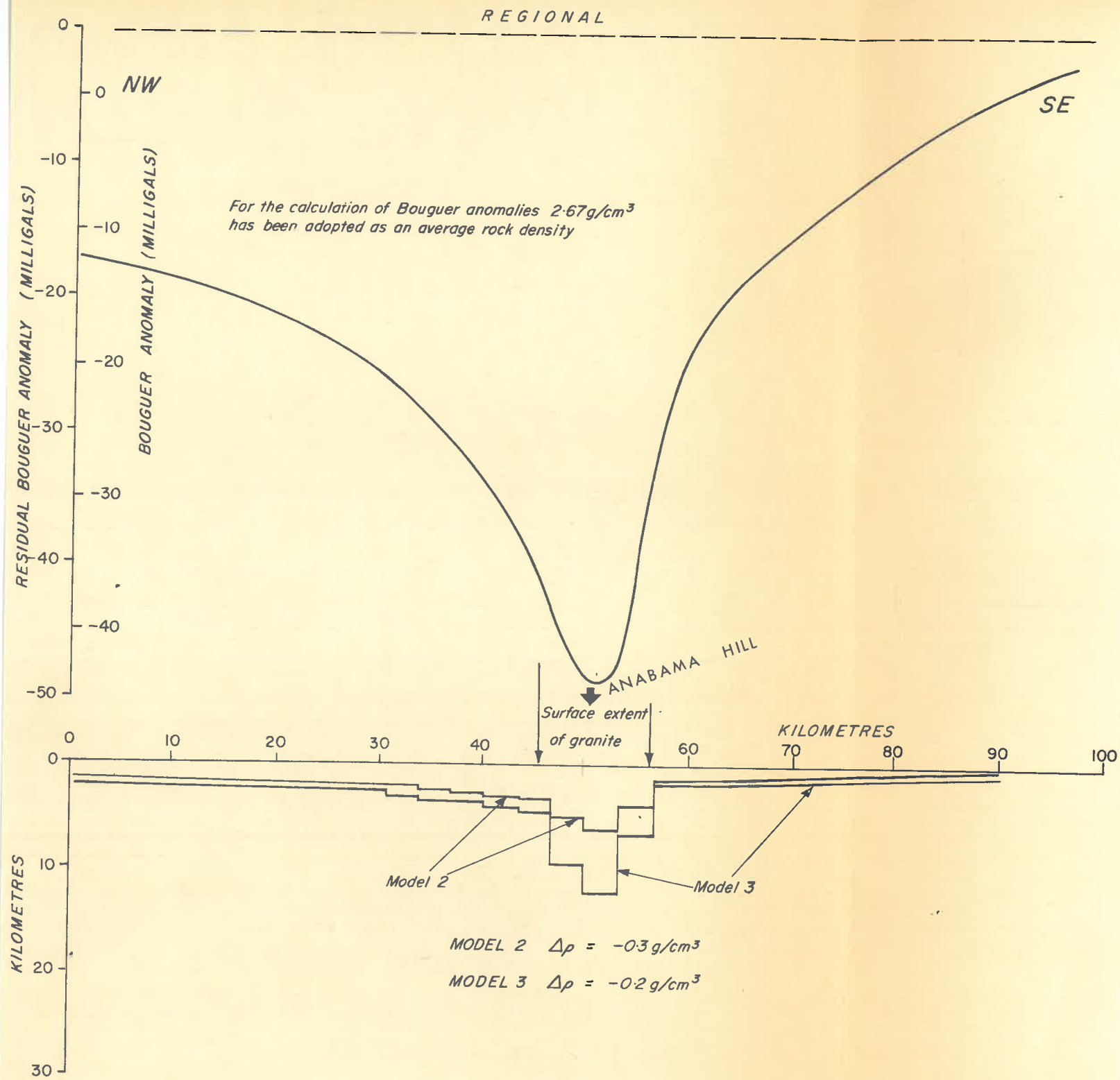
GEOPHYSICAL MODELS 2 & 3 FOR ANOMALY 14

Fig. 9-5
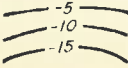
Figure 9.6 : Geology and geophysics for the Glenorchy area
(Bouguer Anomaly 11).

Models determined to account for the gravity anomaly
are shown on Figures 9.7 and 9.8; these are for a
profile along AA'.

Source of data - geology and magnetics - see figure;
Bouguer anomaly contours from BMR maps of CURNAMONA
and FROME.   The Bouguer density used for reduction
of the data for computation of the map was 2.67 g/cm^3.
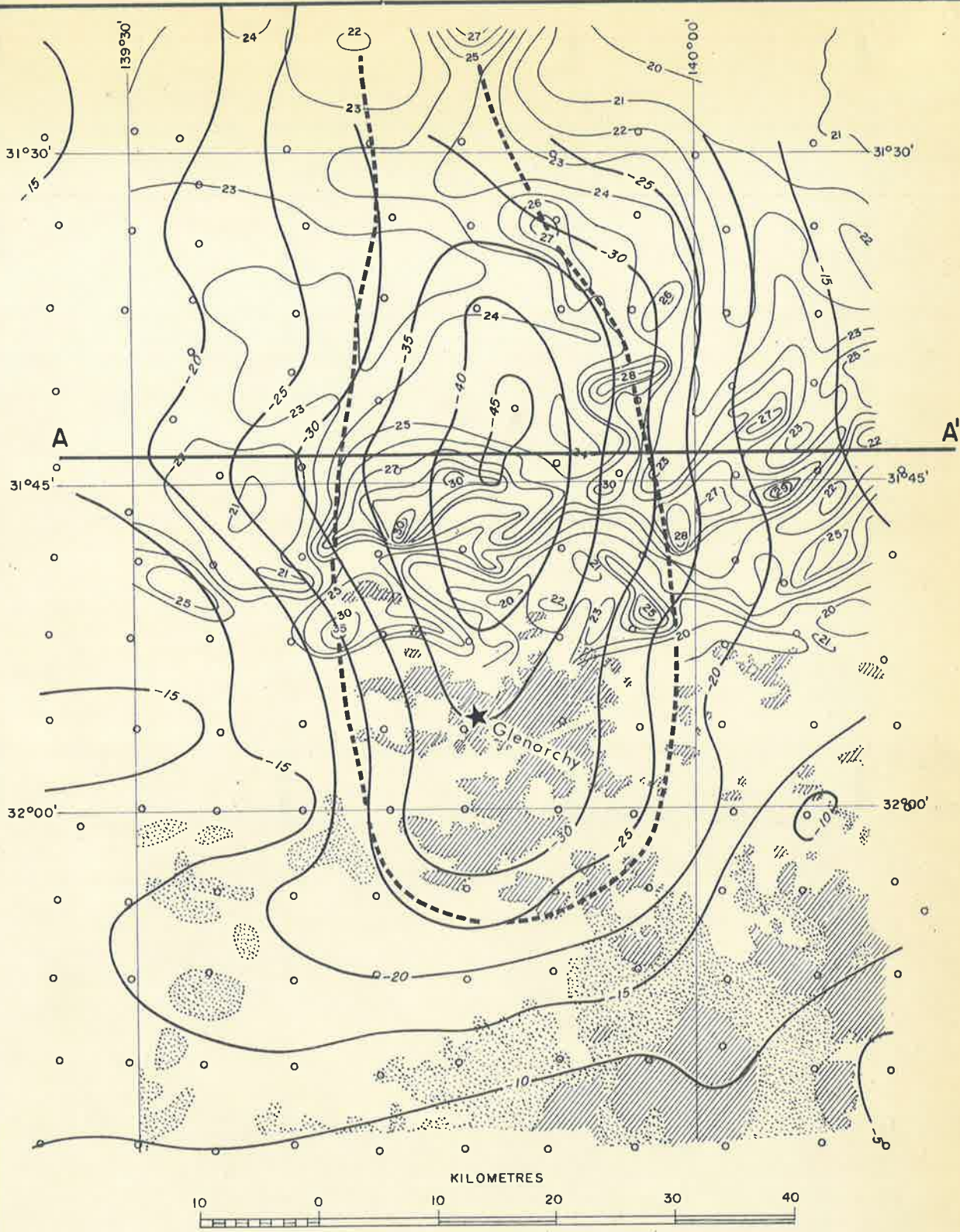
GEOLOGICAL AND GEOPHYSICAL
SKETCH MAP OF AREA COVERING
ANOMALY 11

Fig. 9-6
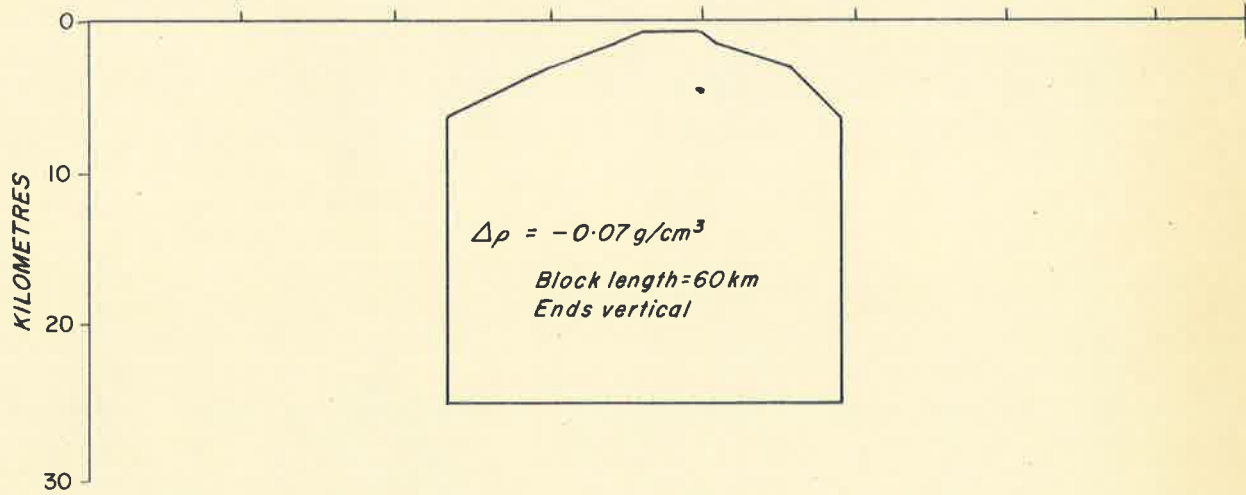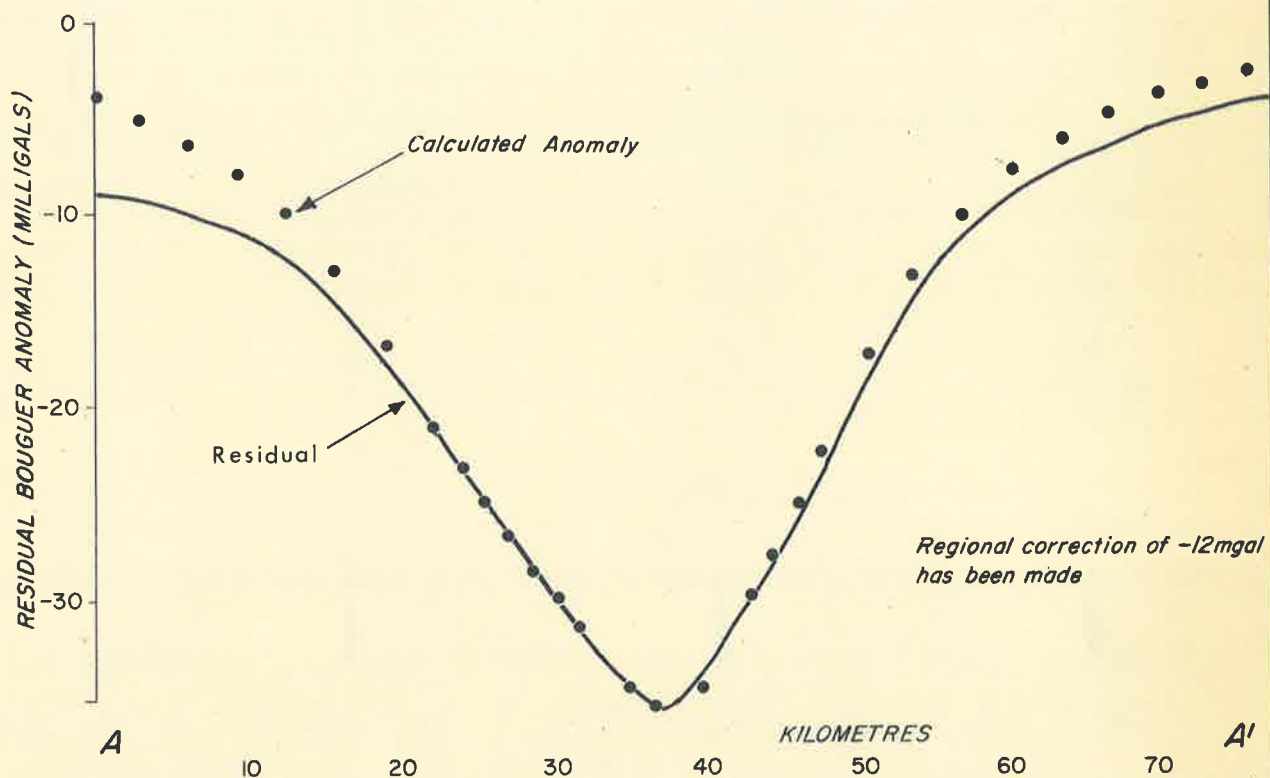
DHT '72

Fig. 9-7
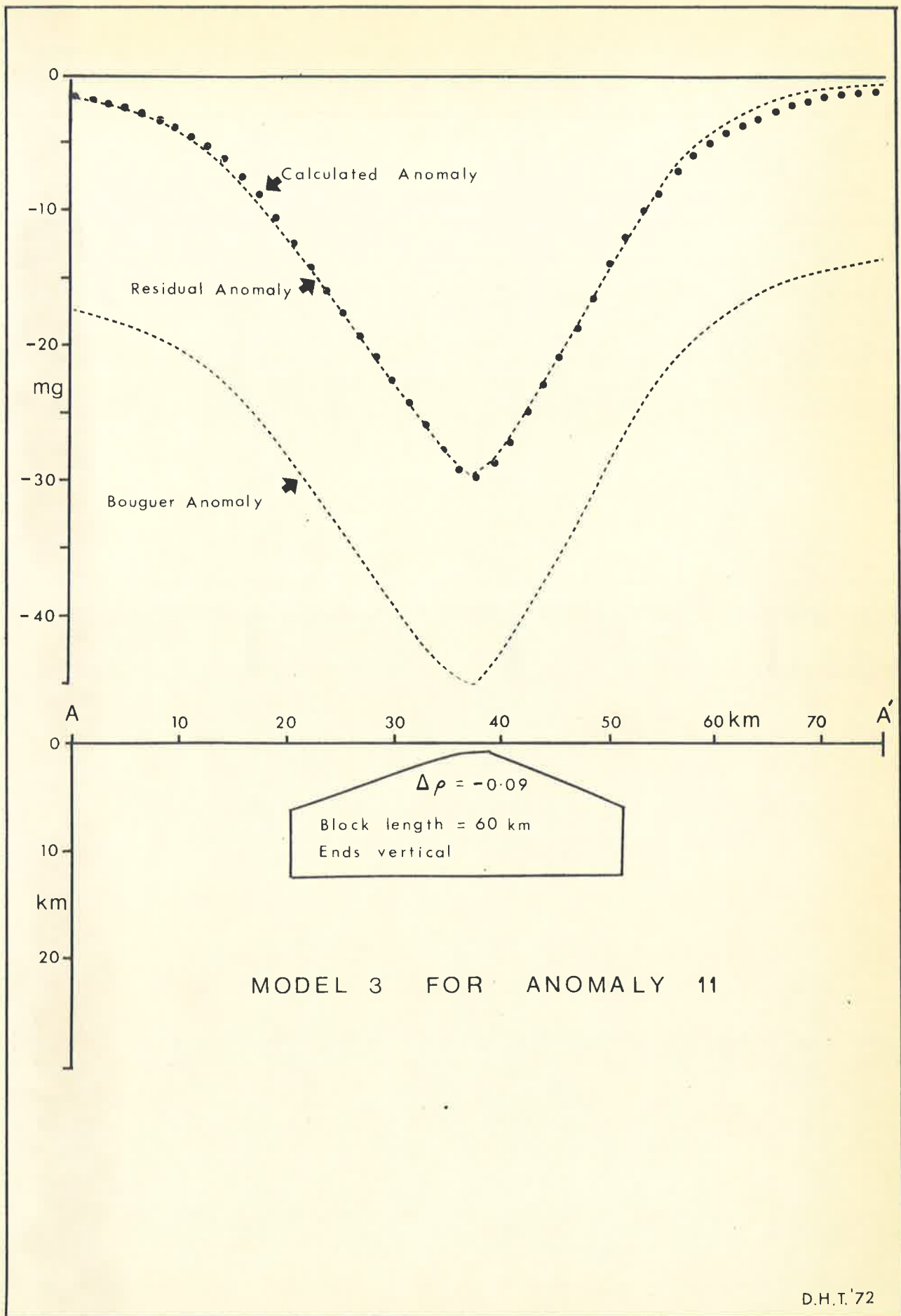
Fig. 9 - 8

Figure 9.9 : Geology and geophysics for the Mt. Painter area

(Bouguer Anomaly 5).

Source of data - geology - see figure; Bouguer

anomaly contours from the BMR maps of COPLEY and

FROME.

KILOMETRES

| 5 | 0 | 5 | 10 | 15 |
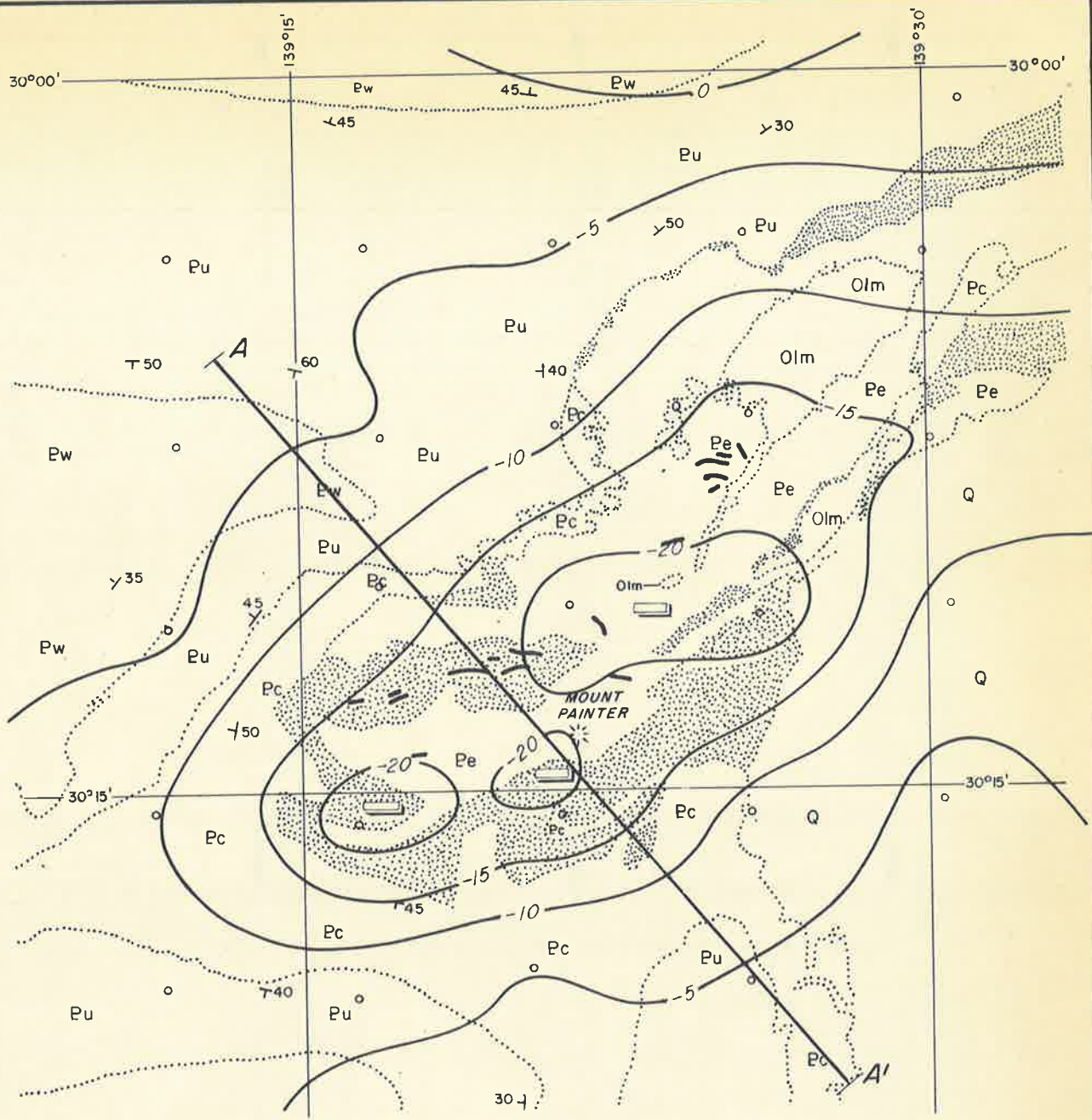
.... Geological boundary
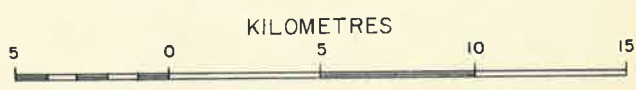
⬭ -20 ⬭ Bouguer anomaly contour (mgal)

⬭ Gravity 'low'

∘ Gravity station

50 Strike & dip of bedding
⊥

| Olm | Mudnawatana granite and pegmatite |

| Pw | Wilpena group |

| Pu | Umberatana group |

| Pc | Burra group and Callanna beds |

| ▒ | Older granite suite |

| Pe | Radium Creek metamorphics |

Geology generalised after SA Department of Mines
Mt Painter provisional 2m = 1" map and Copley
preliminary 1:250,000 sheet

For the calculation of Bouguer anomalies $2·67 g/cm^3$
has been adopted as an average rock density

**GEOLOGICAL AND GEOPHYSICAL SKETCH
MAP OF AREA COVERING ANOMALY 5**

Fig. 9 - 9

DHT '72

GEOPHYSICAL MODEL 1   ANOMALY 5

DHT '72

Fig. 9-10

REGIONAL

Calculated Anomaly

Bouguer Anomaly

Surface extent of Older Granite
Suite and Radium Creek
Metamorphics

MILLIGALS

0
-5
-10
-15
-20
-25

A   A'
KILOMETRES
0   5   10   15   20   25   30   35

KILOMETRES
0
5
10
15

Block length = 24 km
Ends vertical

$\triangle \rho = -0.1 \, g/cm^3$
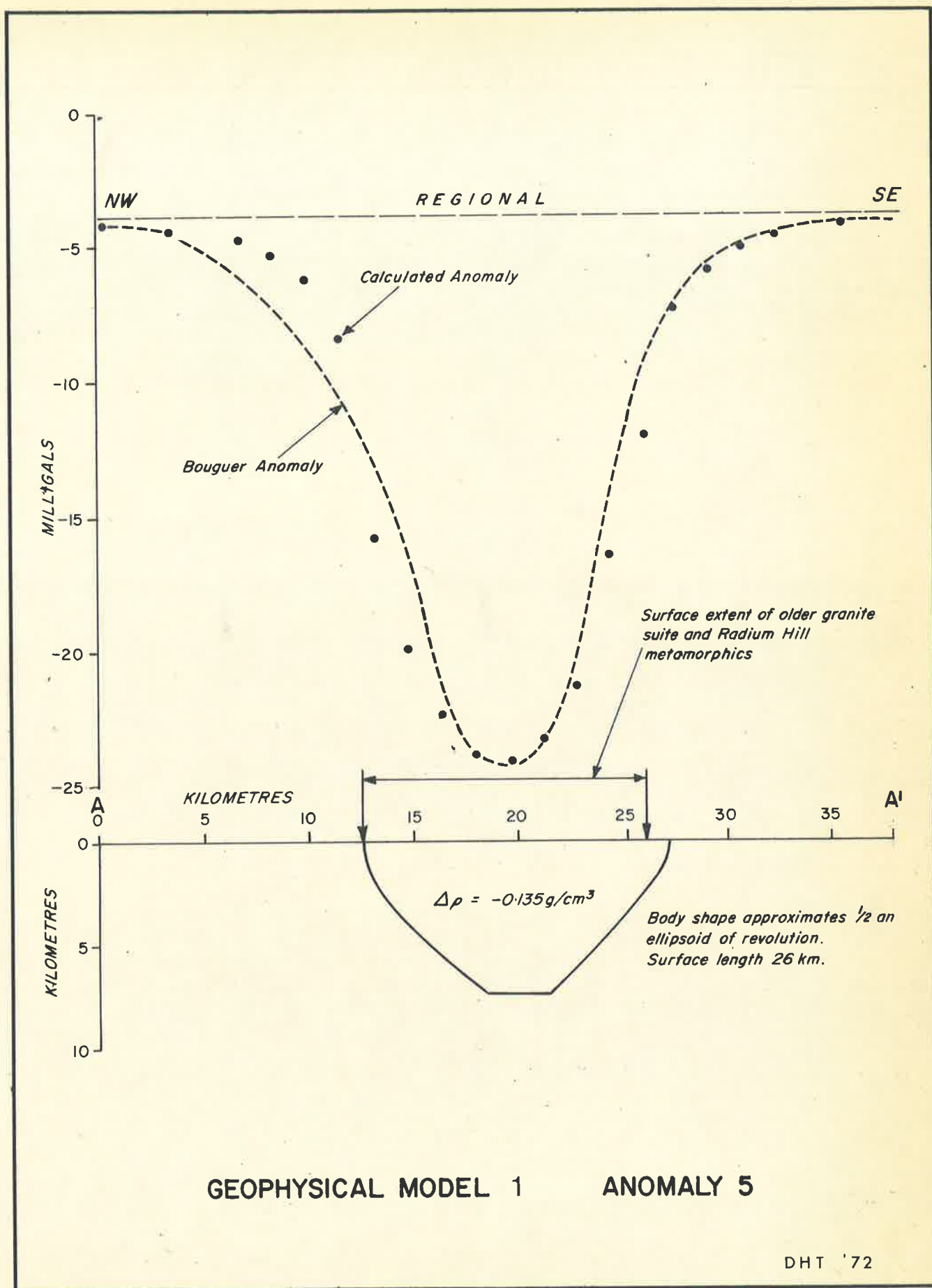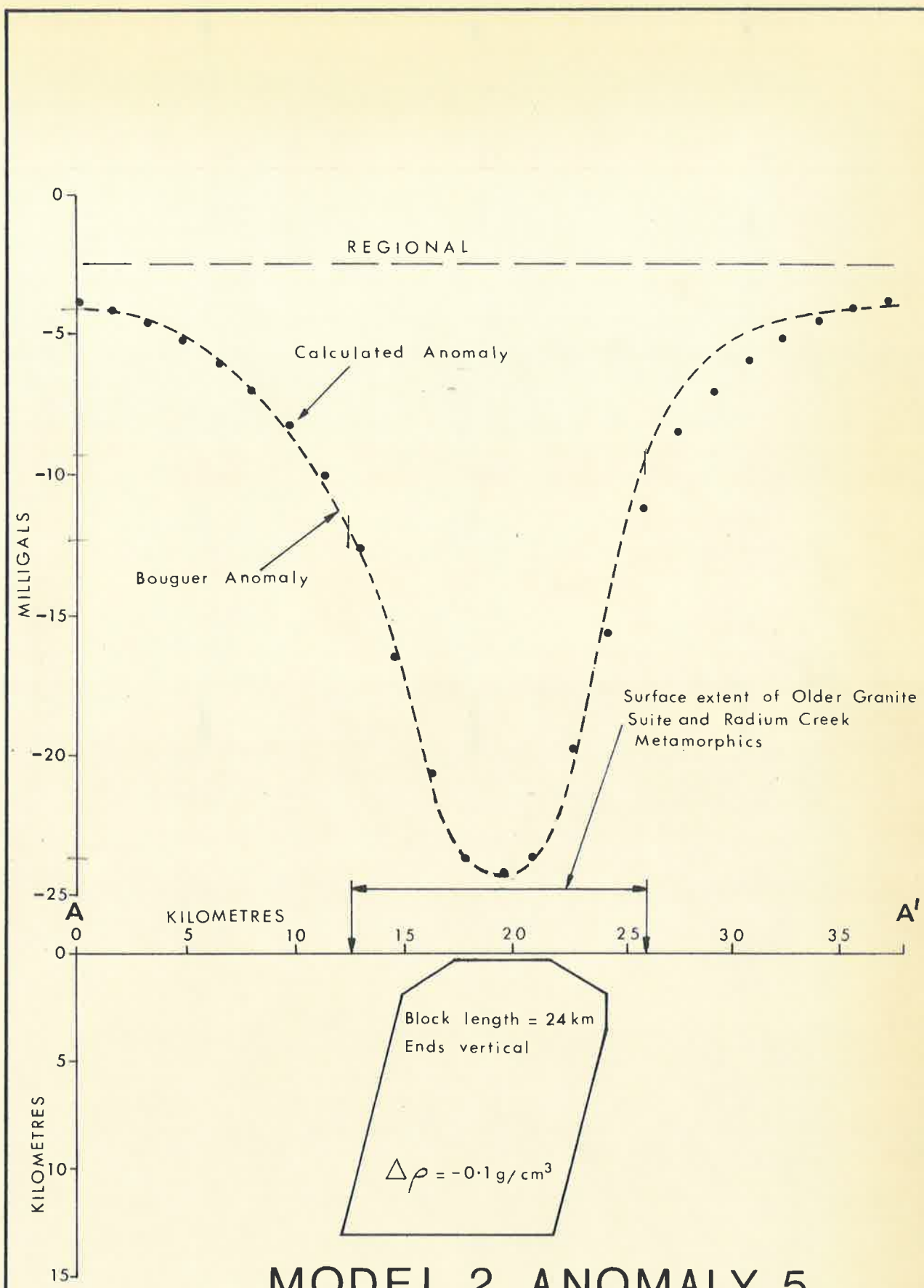
MODEL 2 ANOMALY 5

Fig. 9-11

DHT '72

Figure A2.1 : Volume magnetic susceptibility measurements on

the Tindelpina Shale Member

SPRING CREEK MINE
DDH 1/29
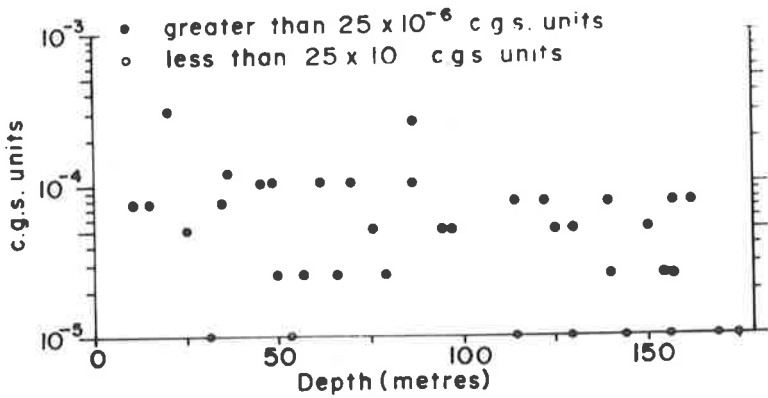
SPRING CREEK MINE
DDH 1/29
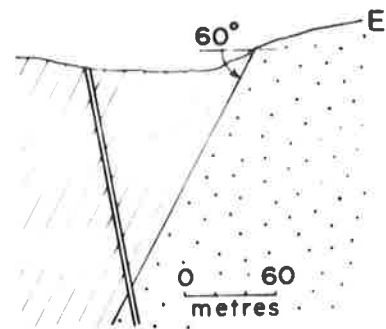
PAULL CONSOLIDATED
DDH PC2
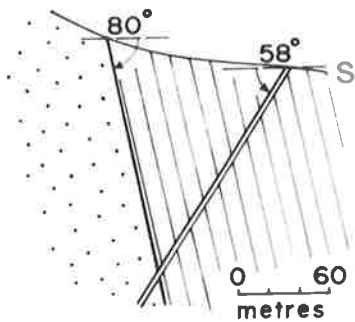
WHITE LEAD
DDH DLY5
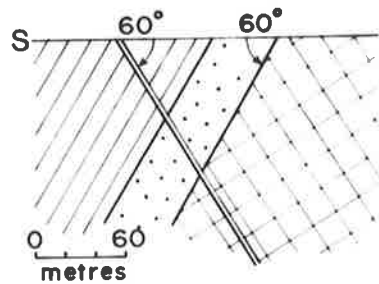
LEGEND
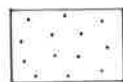
Yudnamutana sub-group
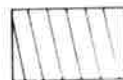
Tindelpina shale member

Diapiric breccia

DHT 72

Fig. A2-1

Figure A2.2 : Volume magnetic susceptibility measurements on the

Appila Tillite - Ajax Mine Area (ORROROO).
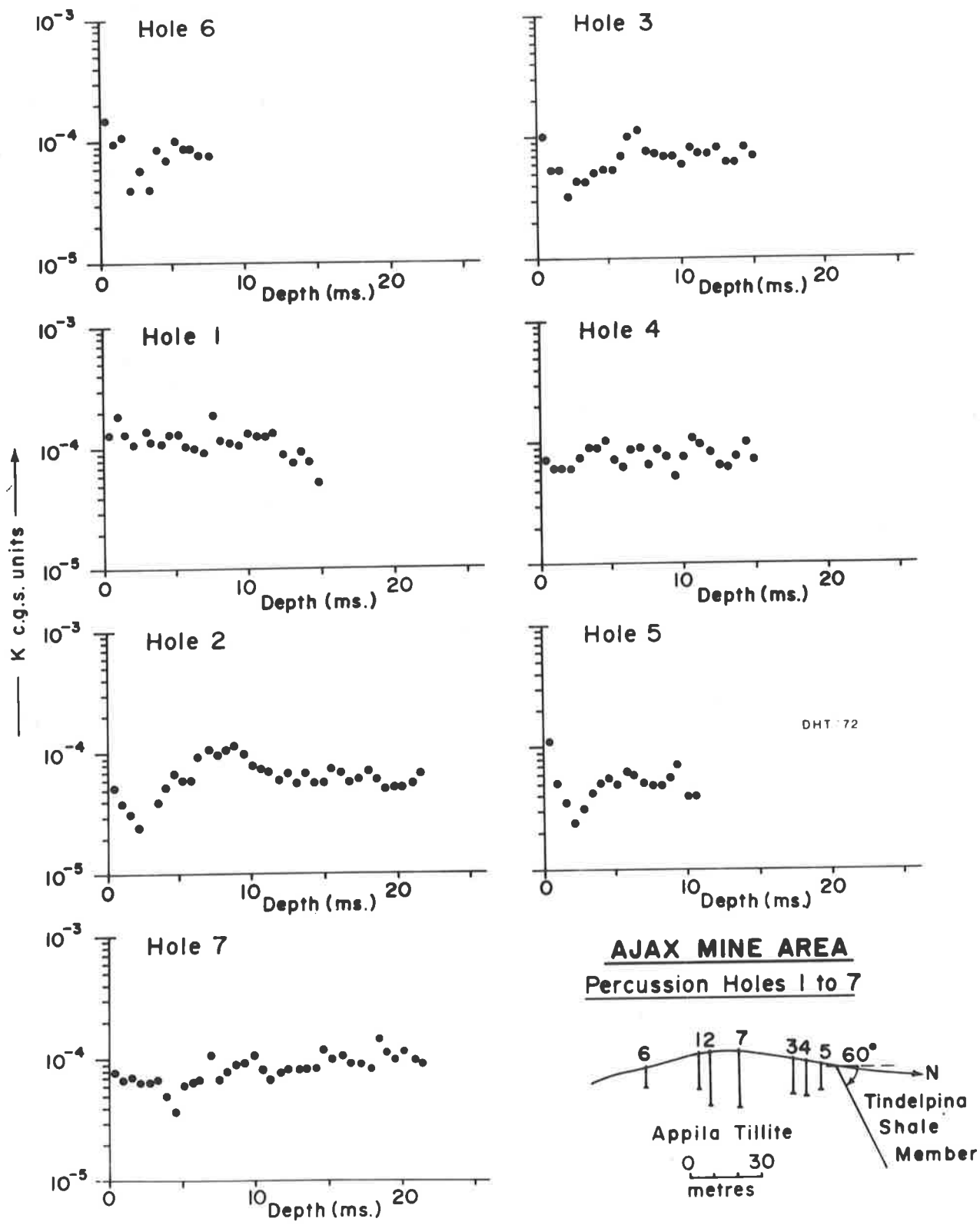
Fig. A 2-2

Figure A2.3 : Volume magnetic susceptibility measurements on the

Tapley Hill Formation and Tarcowie Siltstone -

Waukaringa Area.

Hole 8

Hole 9
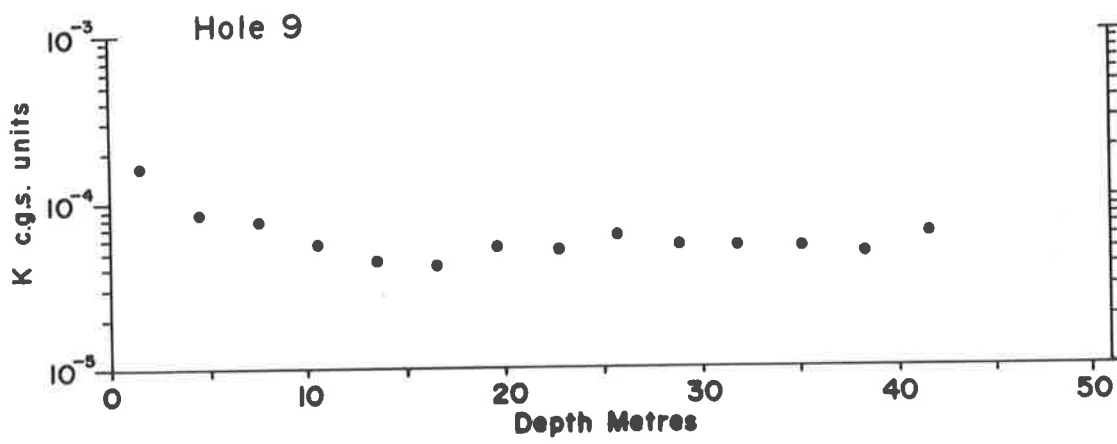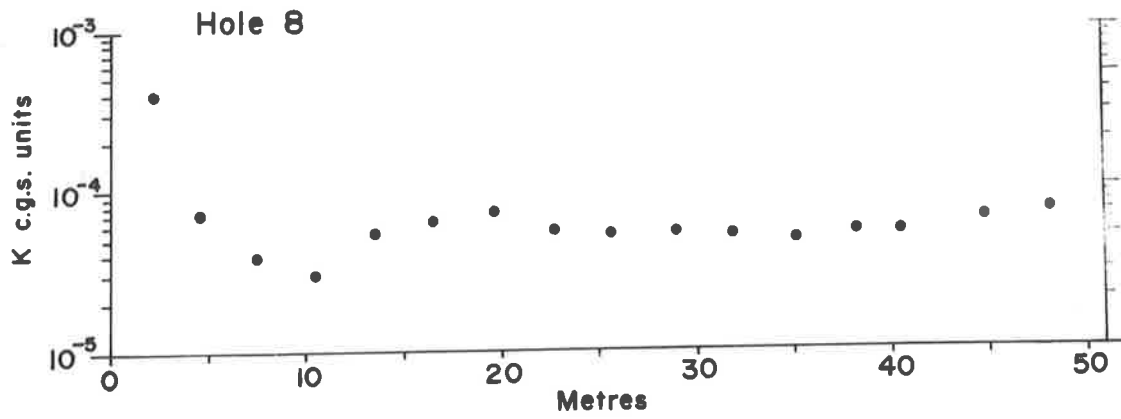
WAUKARINGA AREA
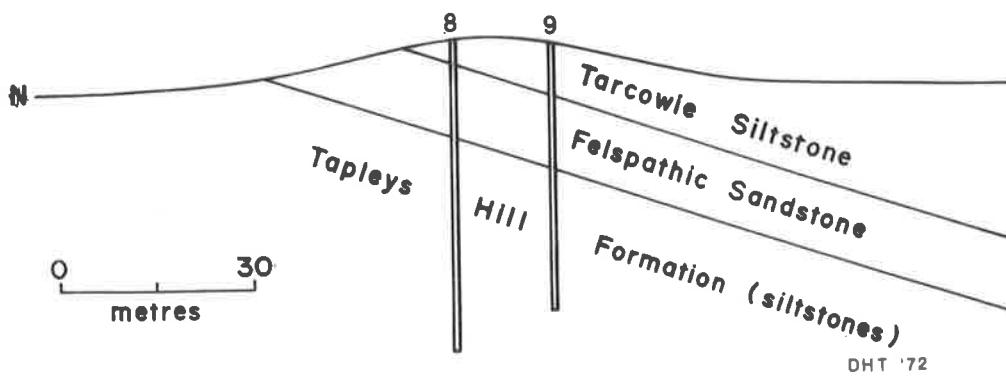
Fig. A 2-3

Figure A2.4 : Volume magnetic susceptibility measurements on

Quaternary sediments of the Walloway Plain.

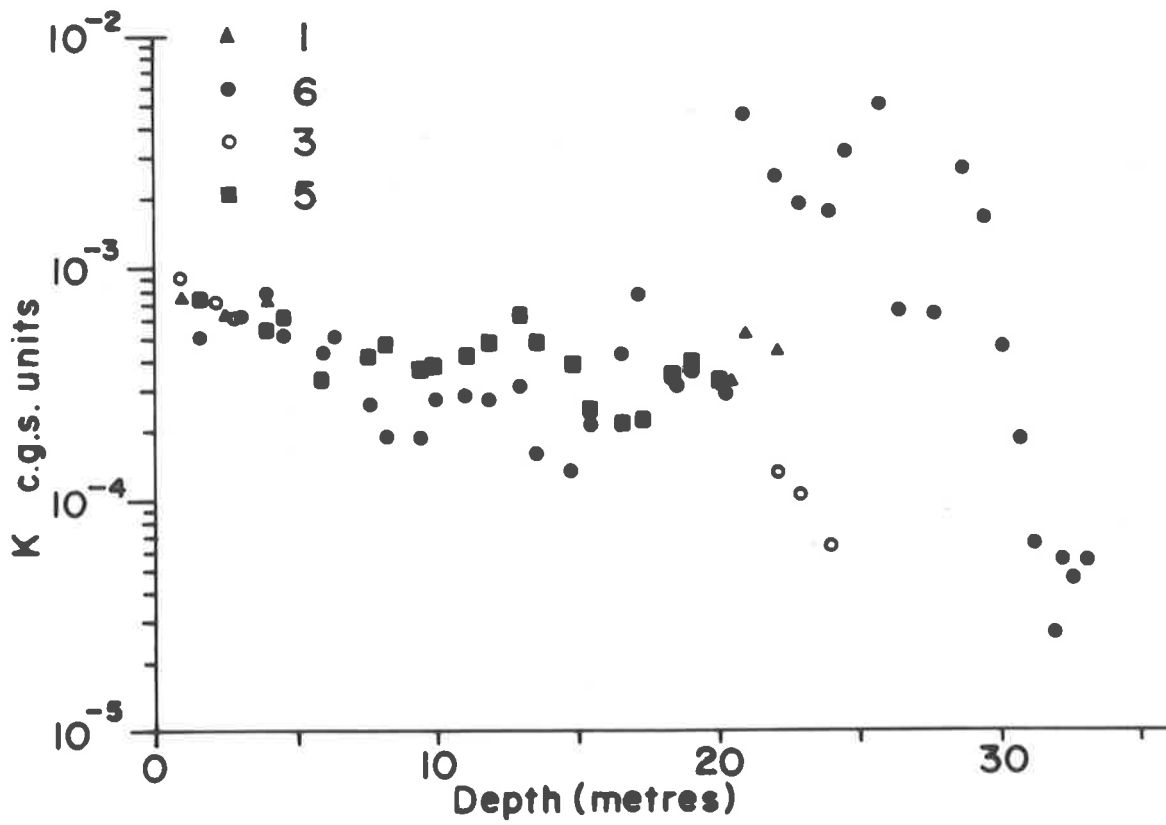The shaded unit on the cross section is interpreted

to be Adelaide System sediments.

HOLE 6 1 3 5
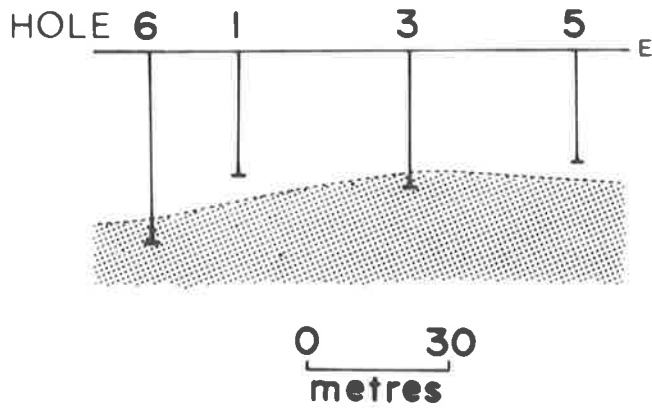
DHT 72

Fig. A2-4

Figure A2.5 : Histograms of volume magnetic susceptibility
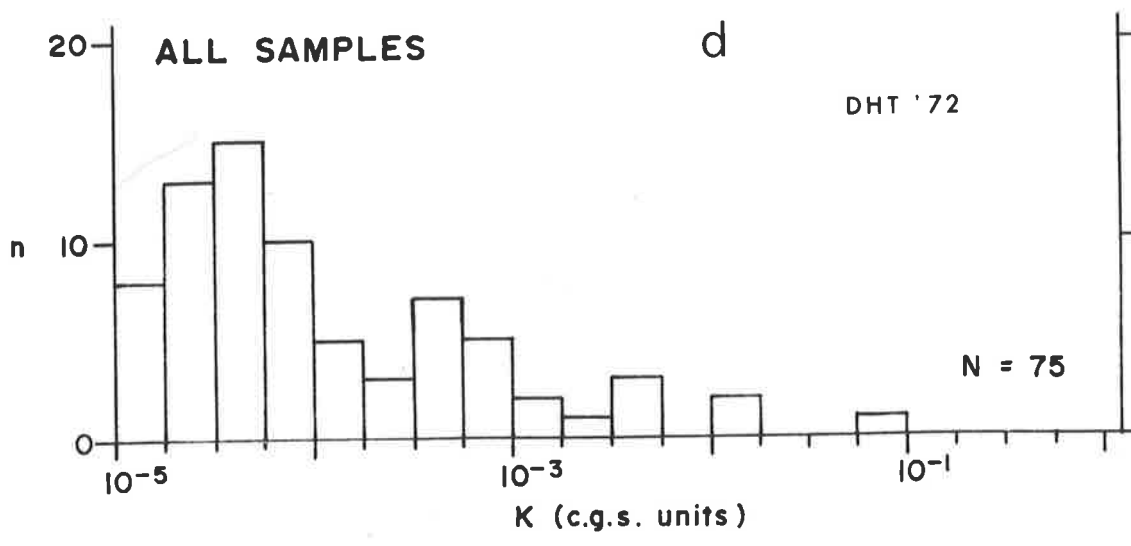measurements on surface samples of Adelaide System
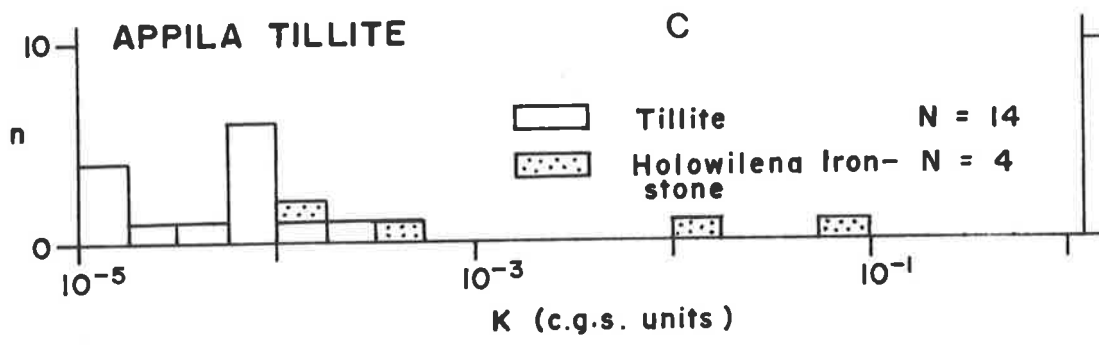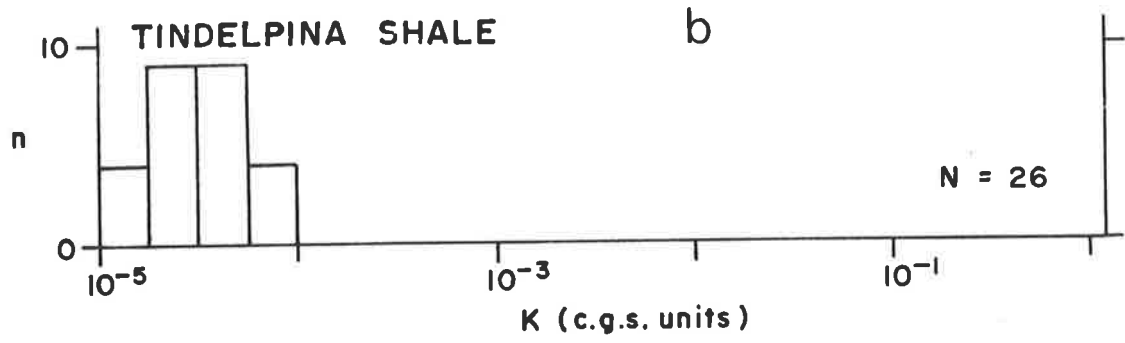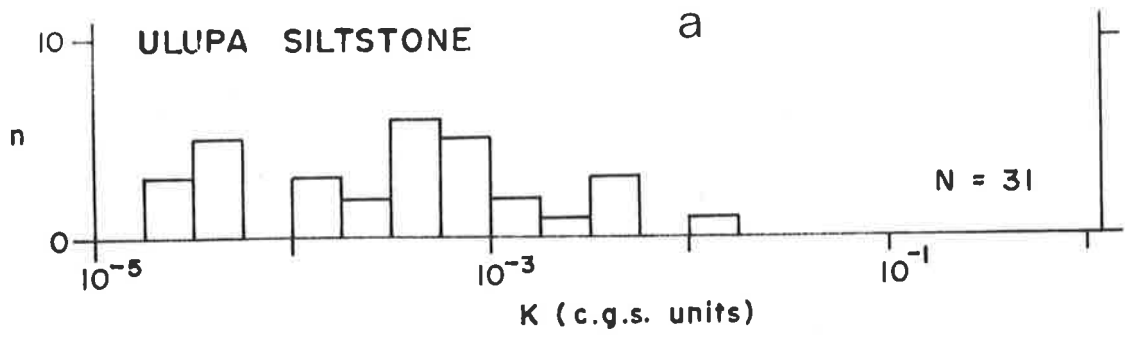sediments.

Fig. A2-5

Figure A6.1 : Theoretical vertical field magnetic anomalies

and an illustration of the method of determining

the effective direction of magnetization in

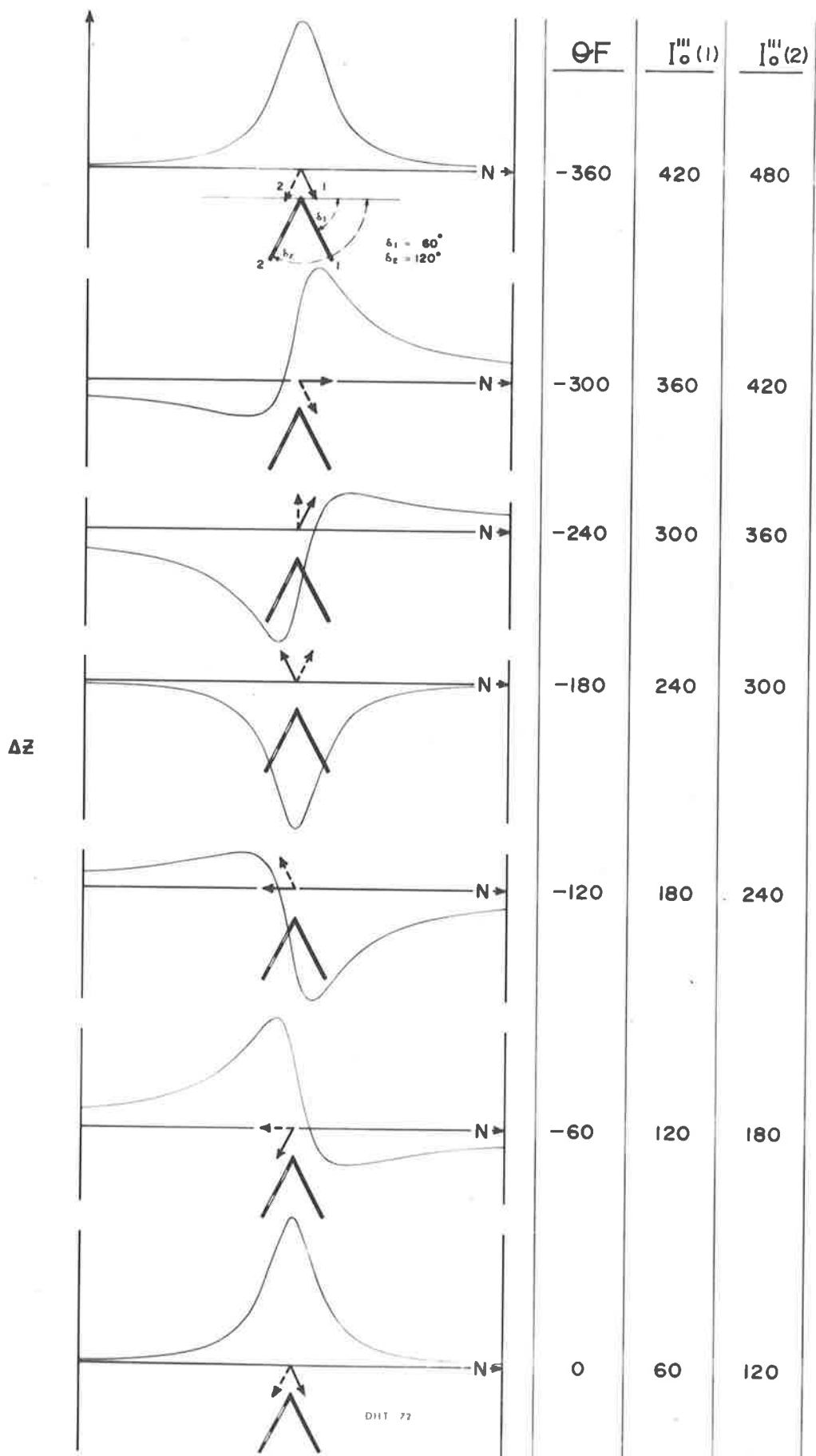magnetic beds.   See text of Appendix A6 for

discussion.

ΘF	$I_o^{'''}(1)$	$I_o^{'''}(2)$
−360	420	480
−300	360	420
−240	300	360
−180	240	300
−120	180	240
−60	120	180
0	60	120

$\delta_1 = 60°$
$\delta_2 = 120°$

ΔZ̄

DHT 72

FIG. A6 - 1