DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
EXPLORATION SERVICES DIVISION

THE BUTE AEROMAGNETIC ANOMALY

BY

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EXPLORATION GEOPHYSICS SECTION

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ABSTRACT

Detailed total magnetic intensity traverses and a gravity traverse were recorded over the Bute Aeromagnetic Anomaly between the 4th March and 10th April, 1970, by the Exploration Geophysics Section. The source of the anomaly was interpreted as being approximately 1200ft. below ground level. The susceptibility contrast of 2.4 x 10^{-3} c.g.s. units was attributed to a basic rock containing a small quantity of disseminated magnetite. Bute stratigraphic drill hole No. 2 intersected an amphibolite at 405 ft. below ground level. The estimated depth of 1200ft. placed the source of the anomaly beneath the amphibolite. The model assumed that the magnetite was confined to a tabular body. However, this model is not really satisfactory for the case of the magnetite being disseminated throughout a large mass. The depth estimate appears to be an overestimate, which could be explained by either a thick section of weathered amphibolite, i.e. unmagnetic, with fresher material below 700 feet or another intrusion below the amphibolite.

INTRODUCTION

This survey was requested by B.P. Thomson, Supervising Geologist, Regional Geological Mapping Section, to help site a number of additional drill holes after the completion of stratigraphic drill holes Bute No. 1 and 2. These drill holes were undertaken to define stratigraphically the Cambrian-PreCambrian boundary, the lithology of the PreCambrian basement and perhaps to verify the source of the aeromagnetic anomaly.

Gravity data using the La Cost Romberg gravimeter, and total magnetic intensity traverses, using a Elsec magnetometer, were recorded by the author and C. Bowden, Field Assistant between the 4th and 6th March, 1970. Traverses were made along roads oriented approximately eastwest and north south. Later, between the 7th and 10th April, 1970, a series of detailed total magnetic intensity readings were recorded along the same and additional roads at a closer station interval by G. Pilkington, Mathematical Geophysicist, and C. Bowden.

PREVIOUS GEOPHYSICAL WORK

The one mile sheet area of Wallaroo was flown by the Bureau of Mineral Resources in 1952 at 500ft. above ground level along lines orientated northsouth, with a flight line interval of 1 mile. Later, in 1960, the B.M.R. whilst flying BURRA 1:250,000 sheet area, reflew Wallaroo along lines oriented east west with the same flight line spacing and altitude as previously flown.

Most previous geophysical prospecting surveys have been in the Kadina - Wallaroo - Moonta area in search of copper and do not extend eastwards into the Bute area. Some of the previous vertical magnetic intensity data over other aeromagnetic anomalies have been reinterpreted to estimate their susceptibility contrasts, which have been used in the interpretation of the Bute anomaly.

GEOLOGY

The Bute anomaly is located near the Western and eastern edges of Blyth and Wallaroo 1:63,360 sheet areas, respectively. The geology of Blyth

is incorporated in Burra 1:250,000 sheet area mapped by Mirams (1964). Wallaroo was mapped by Crawford (1960).

Mirams showed small inliers of Cambrian Limestone, surrounded by Quaternary deposits, and situated approximately one mile east and southeast of Bute (Blyth). Crawford showed remnants of "shield Proterozoic" sediments surrounded by Quaternary deposits.

Thomson (1970) revised Crawford's geology in the area west of Bute, as shown in Fig. 2. From the data of the Bute stratigraphic drill hole No. 2, which was drilled to 707 feet, Thomson established that a Cambrian succession of dolomite and sandstone rests disconformably on Sturtian (?) shales and siltstones, which in turn rests nonconformably on basement at 405 feet. A thick sequence of shelf Proterozoic rocks, Sturtian in age, was established in Bute No. 1 drill hole, but unfortunately this hole was terminated before basement was reached.

The basement rock type from Bute No.2 was a medium to coarse grained dark green amphibolite, with traces of pyrite and hematite. Analyses for copper of samples of this rock, taken at various depth, contained up to 300 p.p.m. Two more stratigraphic drill holes Nos. 3 and 4 have been recommended by Thomson.

RESULTS & INTERPRETATION

The contours for the Bute aeromagnetic anomaly shown in fig. 2, were compiled by the South Australian Department of Mines from the Bureau of Mineral Resources 1960 survey of BURRA. The original estimate of the sources of this aeromagnetic anomaly was placed at 5000 ft. below ground level.

The ground total magnetic intensity profile XY, which passed obliquely through the aeromagnetic anomaly, (plate 2) has a station interval of ½ mile and an amplitude of approximately 1000 gammas, as shown in the profile in Plate 3.

The interpreted depth, using a Peter's Factor of 1.6, was estimated to be 3800 ft. This anomaly was then considered as being produced by two unresolved parallel vertical tabular bodies striking at 050°. The depth of one of these bodies was estimated to be 2670 ft. for a body having a width of 9500 ft. from Gay (1963) curves. The susceptibility contrast for this model was 2.74×10^{-3} c.g.s. units.

The gravity data for the same profile XY together with a geological section after Thomson is shown on plate 3. The gravity profile shows a step feature of magnitude 2.25 milligals. the depth to the top of a thin horizontal half plane (step) is estimated to be 1200ft. below ground level.

The contours of the detailed total magnetic traverses along roads at a station interval of 1/8 mile are shown in plate 4. The overall statistical noise of each station was 10 gammas. Station 68E5.10I3 was given an arbitary value of 1000 gammas and was used as the datum level for the results.

The main anomaly has a strike direction of 060°, strike length 4 miles, and an amplitude of 1140 gammas. The anomaly was not definitely resolved into two sources. The southeastern side of the anomaly shows a gradual gradient, whereas the eastern side is steeper and appears to be truncated by a lineament, striking at 160°. This lineament is probably a fault, which down-throws to the east. The point anomalies on the northern side probably represent either near surface geological sources or electrical power lines.

The interpreted results of profiles AA' and BB' were estimated after the method of Hee (1965) for the depth, width and dip; and the susceptibility contrast was estimated from a formula of Gay. The results and anomaly amplitude are given below.

Amplitude GAMMAS	Width FEET	Depth FEET	Dip	Susceptibility Contrast
1140	5940	1280	92^{o}	2.39×10^{-3} cgs. units

The dip estimate verifies the assumption of a vertical body. The former width estimate for traverse XY was the apparent width for a profile taken obliquely across the body. This would give an overestimate of the actual width and depth of the body.

CONCLUSIONS & RECOMMENDATIONS

The anomaly was not clearly resolved into two or more components by the detailed magnetic results. However, two trends which can be identified from the contours, suggest two sources.

In this report, the model assumed to represent the source of the anomaly, was a vertical tabular body. The initial estimates of the width and depth of the body have been reduced to 5900 and 1300 feet, respectively. The estimated depth from the gravity step model agrees favourably with the depth estimates from the magnetics. The estimated susceptibility contrast of the Bute anomaly is lower than the previously investigated aeromagnetic anomalies in the Wallaroo-Moonta province. The source of the Bute anomaly is probably due to a basic rock type, with disseminated magnetite. This was confirmed by the Bute stratigraphic drill hole No. 2 which intersected amphibolite between 405 to 707 feet.

The magnetic susceptibility and specific gravity measurements based on core samples of amphibolite, see Appendix I, confirms that the source magnetic material producing the Bute anomaly is located beneath the actual geological amphibolite basement, and beneath the terminated depth of the Bute No. 2 drill hole. This can be seen by comparison of the interpreted susceptibility contrast of 2.39×10^{-3} cgs. units being a factor of 10 times the measured susceptibility results of the amphibolite core samples.

It is recommended that more aeromagnetic anomalies to the north be investigated to test this discrepancy. The area should be further investigated for areas of concentrated copper mineralization.

It is also recommended that the proposed Bute No. 4 is drilled deep into the amphibolite to verify the existence of another intrusion.

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RAG:PdA
30.11.70

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APPENDIX I

MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY MEASUREMENTS ON CORE SAMPLES OF THE BUTE NO. 2 DRILLHOLE

The magnetic susceptibility and specific gravity measurements were performed by G. Galbrath and the computer girls of the Exploration Services Section. Both of these results are plotted against depth shown with the geological section on diagram S.8084 fig. 5.

1. MAGNETIC SUSCEPTIBILITY MEASUREMENTS

The magnetic susceptibility measurements were determined using the Susceptibility Bridge, Model MS-3; no correction was applied to correct for irregular ends of the core. All measurements were low, generally less than 0.2×10^{-3} cgs. units. The precision of measurement with the bridge was $\pm$ 5 ohms which corresponds to the variation of susceptibility calculated for different core diameters shown below.

CORE DIAMETER (inches)	READING ERROR IN MAGNETIC SUSCEPTIBILITY UNITS ($\times 10^{-3}$ cgs. units)
Between 2.03 to 2.15	$\pm$ 0.45
Between 1.37 to 1.65	$\pm$ 0.028

Readings of this order should be regarded as zero susceptibility.

The Cambrian dolomite and basal conglomerate located between 40 to 320 feet were taken at 50 foot intervals. The susceptibility measurements showed a range of values from 0 to 0.4×10^{-3} cgs. units. The higher values were considered to be isolated bands of higher magnetic content.

The banded shale and dolomitic siltstone sequence located at a depth between 322 and 410 feet was sampled with a sampling interval of 2 feet.

The results showed that this sequence was non-magnetic. This lithology was originally considered by B.P. Thomson as Sturtian in age, is now considered by him to be Middle Cambrian in age.

The basement amphibolite assumed to be Pre-Cambrian in age, was sampled at 10 foot intervals between 410 to 707 feet, with additional values at a smaller interval between 680 to 707 feet. The susceptibility results of the amphibolite fall into two groups, given as follows:

	Depth of Drill Hole (feet)	Number of Readings	Magnetic Susceptibility ($x10^{-3}$ cgs. units) Range of Values	Mean	Standard Deviation
GROUP I	420 to 685	45	0 to 0.3263	0.0717	0.0610
GROUP II	685 to 707	7	0.1168 to 0.6535	0.3267	0.1689

This grouping of the results of the amphibolite represents either that the amphibolite has been weathered to a depth of 300 feet below top of the amphibolite (pre-Proterozoic erosion surface) and the second group represents fresher material; or the grouping represents a layered mass with the higher magnetic material below 700 feet; or probably another intrusion below the amphibolite.

2. SPECIFIC GRAVITY MEASUREMENTS

The specific gravity results were sampled at 50 ft. intervals with increased sampling interval of 10 ft. between 320 to 370 ft. These results are plotted against depth and are shown in drawing S.8084 fig. 5. There appeared to be a high density band at the top of the banded shale and dolomitic siltstone sequence with a density of 3.36 gm/cc in comparison with 2.76 gm/cc.

A summary of the specific gravity ranges, mean and standard deviation for each lithological unit is given below.

RANGE OF DEPTH IN DRILL HOLE	PROPOSED AGE AND (LITHOLOGY)	SPECIFIC GRAVITY (gm/cc)		
		RANGE	MEAN	STANDARD DEVIATION
50 - 322 feet	CAMBRIAN Dolomite	2.80 to 2.86	2.823	0.026
322 - 408 feet	CAMBRIAN? STURTIAN? Banded shale ' dolomitic Siltstone	2.72 to 3.36	2.818	0.270
408 - 707 feet	ARCHEAN Amphibolite	2.82 to 3.04	2.894	0.077

The difference between mean specific gravities of the sediments and amphibolite is 0.07 gm/cc. This would not be large enough to explain the Bouguer anomaly as shown in drawing 70-675, fig. 5.

SUMMARY

The magnetic susceptibility and specific gravity results indicate that the source of the magnetic anomalies is below the terminate depth of the Bute No. 2 drill hole.

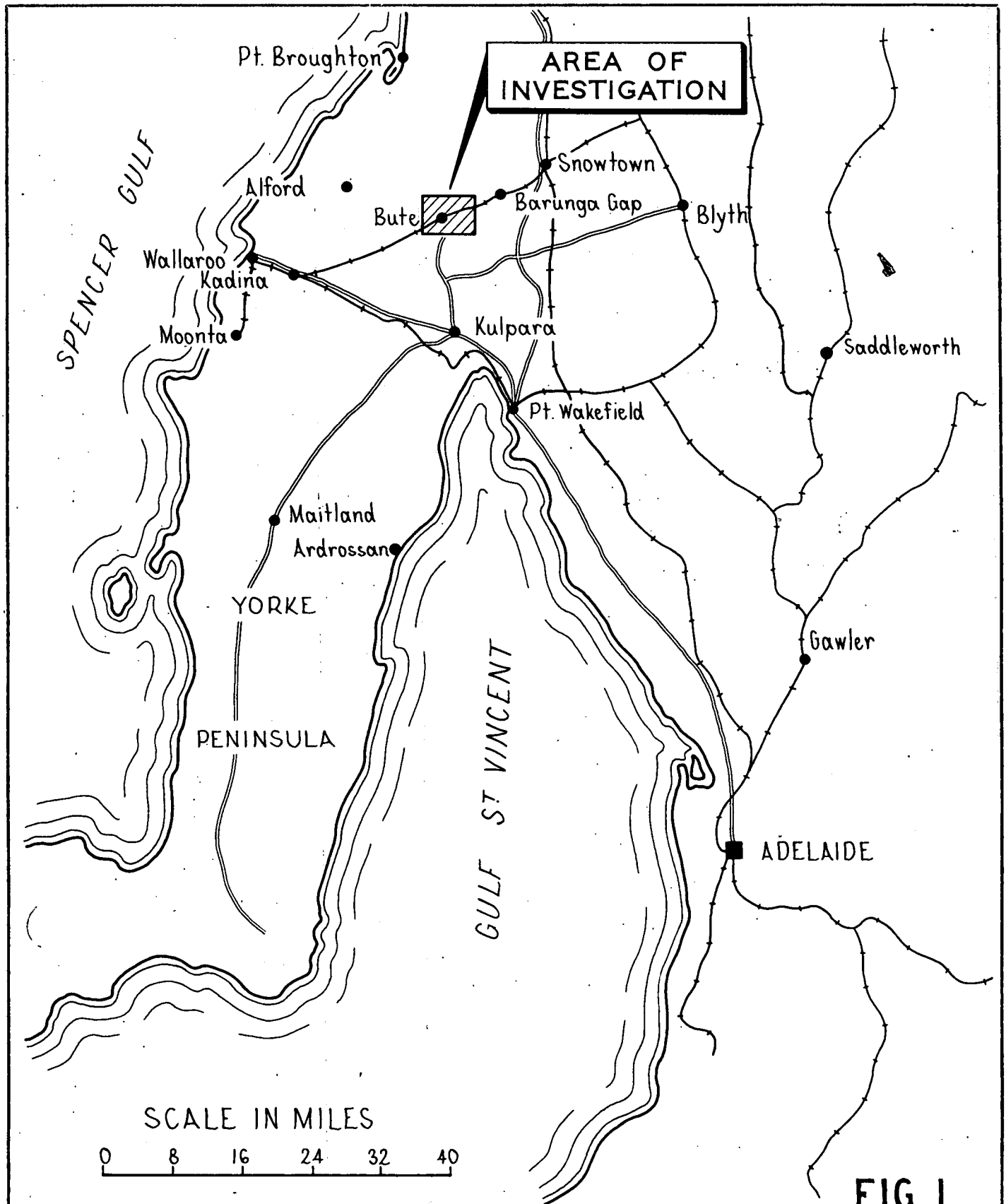
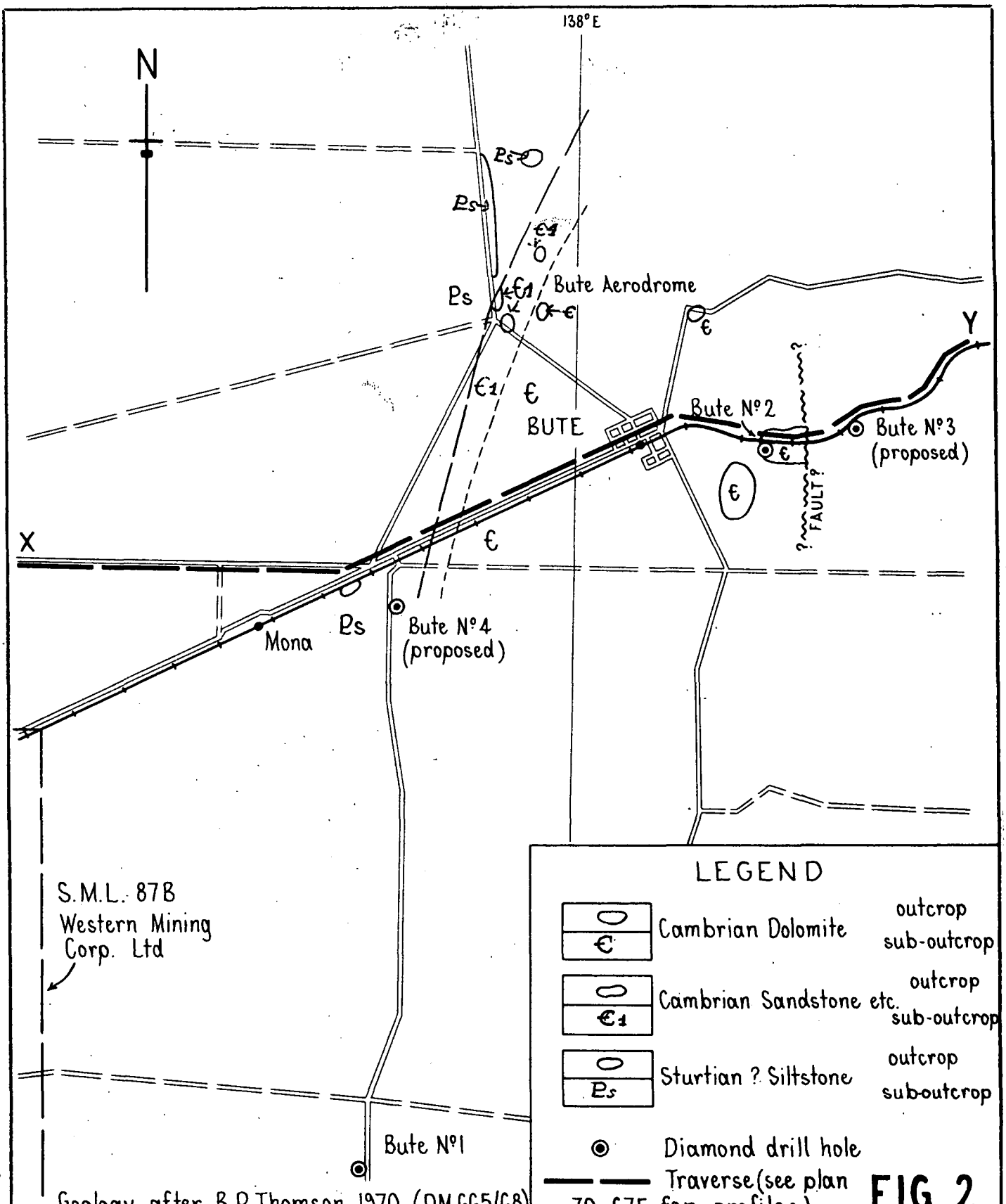


FIG. 1

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:1000 000
Compiled: R. G.	BUTE AEROMAGNETIC ANOMALY LOCALITY PLAN	Date: 29 July 1970
Drn. R. H. | Ckd. L.V.W.		Drg. No. S7889 Gc5+8

1M—2.70 A1810

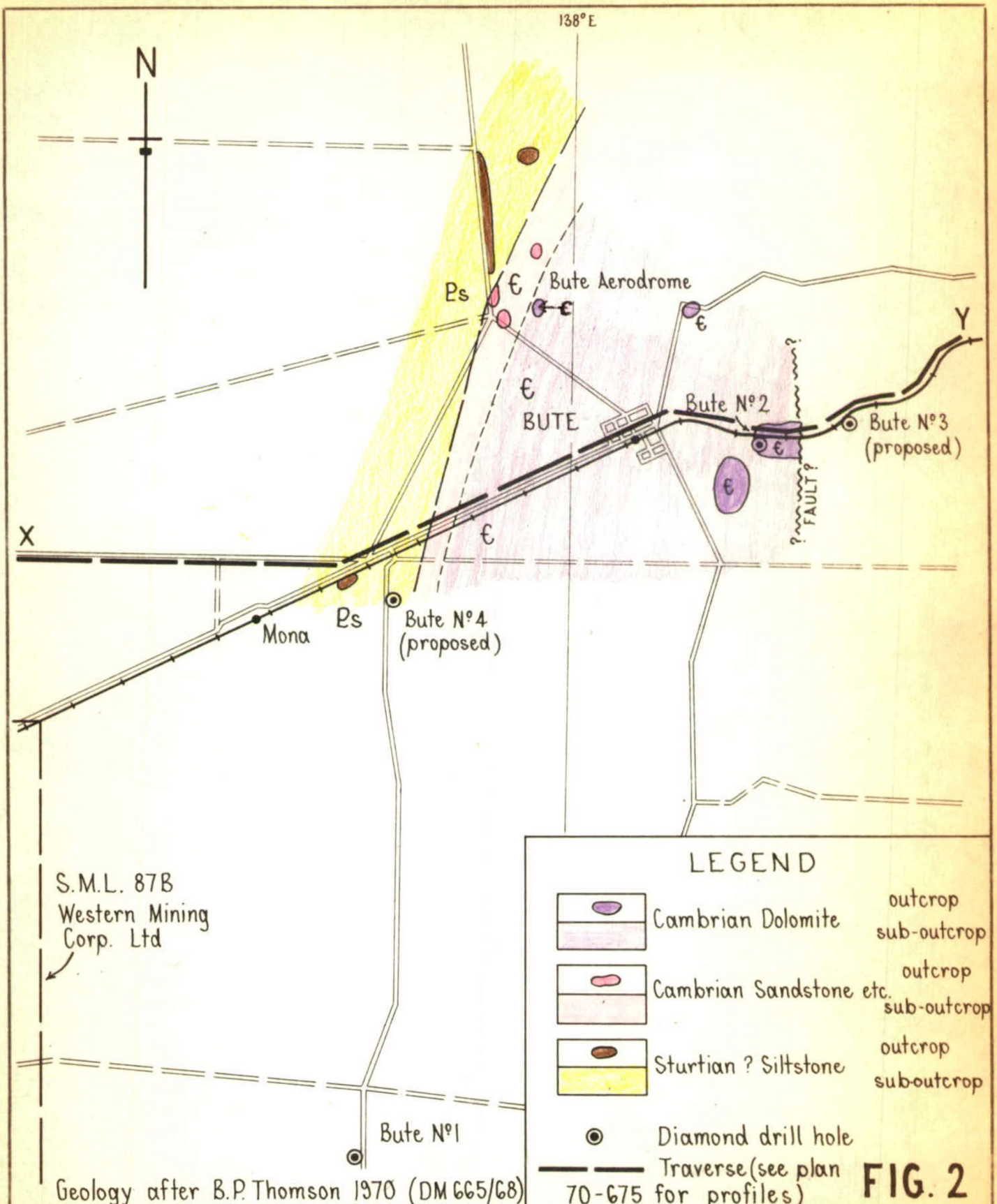


Geology after B.P. Thomson 1970 (DM 665/68)

FIG. 2

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1 inch = 1 mile
Compiled: R. G.	BUTE AEROMAGNETIC ANOMALY	Date: 30 July 1970
Drn. R. H. | Ckd. L.V.W.	GEOLOGICAL PLAN & LOCATION OF TRAVERSE XY	Drg. No. S7890 ··· Gc5+8

1M—2.70 A1810

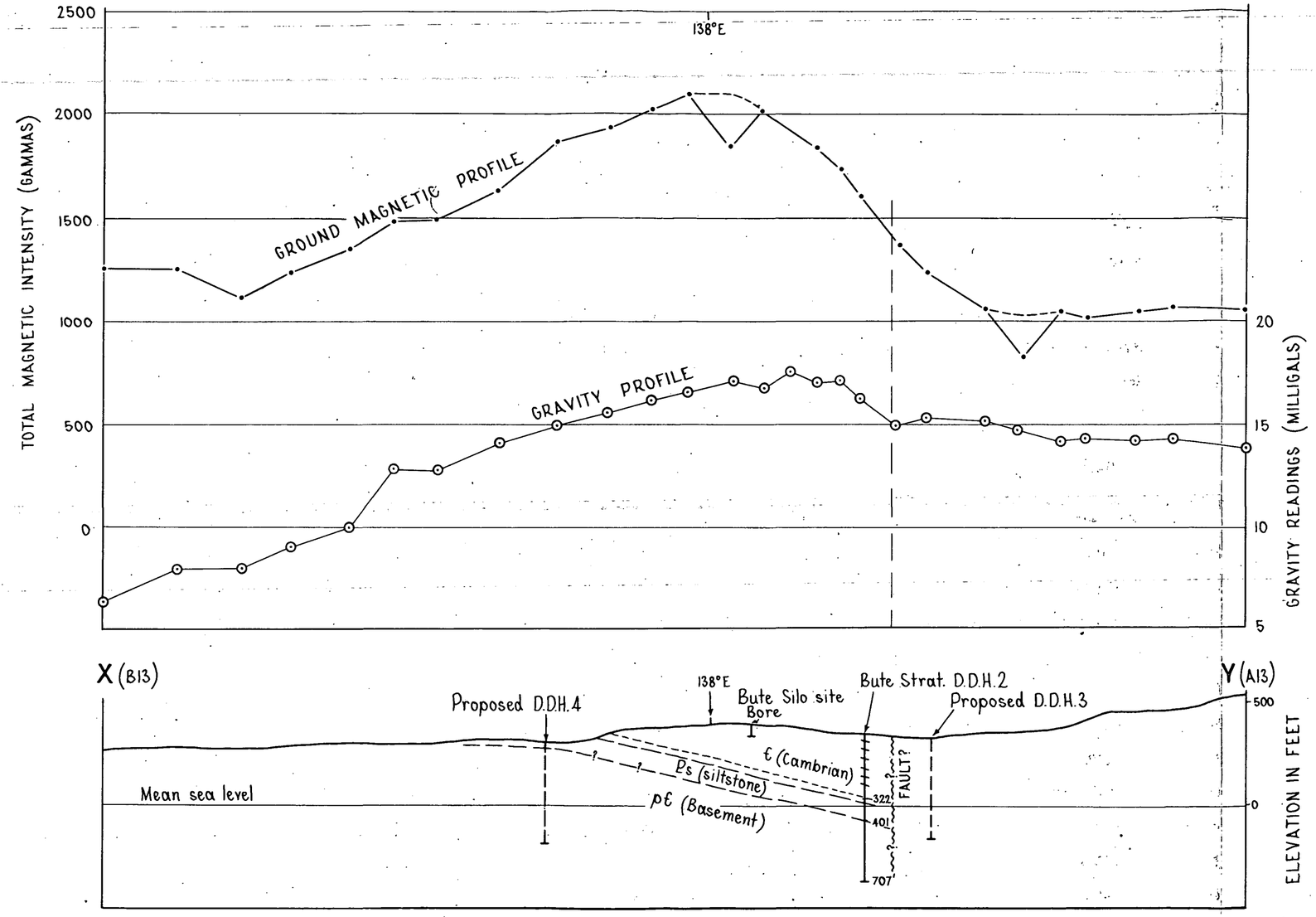


Geology after B.P. Thomson 1970 (DM 665/68)

FIG. 2

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1 inch = 1 mile
Compiled: R. G.	BUTE AEROMAGNETIC ANOMALY	Date: 30 July 1970
Drn. R. H. | Ckd. L.V.W.	GEOLOGICAL PLAN & LOCATION OF TRAVERSE XY	Drg. No. S7890 Gc5+8

1M—2,70 A1810



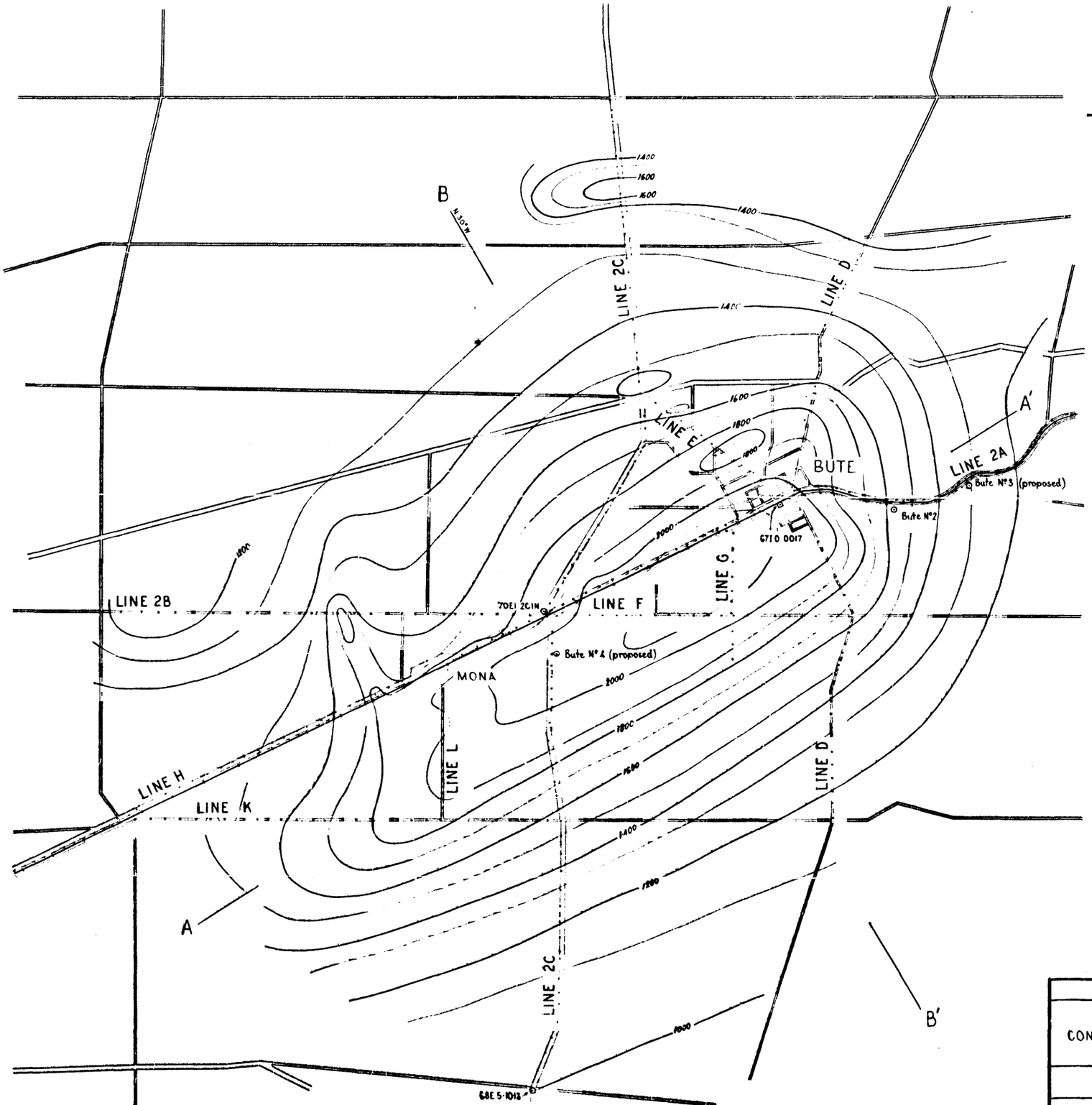
For location of Section XY see drg. Nº S7890

FIG. 3

Geology after B.P. Thomson 1970. (DM 665/68)

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1inch=1mile
Compiled: R.G.	BUTE AEROMAGNETIC ANOMALY	Date: 31 July
Drn. R.H. | Ckd. L.V.W.	PROFILES OF MAGNETIC INTENSITY, GRAVITY AND GEOLOGICAL SECTION XY	Drg. No. 70-675 Gc5/8

1M—2.70 A1811



LEGEND

- Station
- 68E 5·1013 Base station
- 1100 Magnetic Intensity contour (interval · 100 gammas)

Values at stations have noise level at 10 gammas

All values in gammas referred to base station 68E 5·1013

A A' Profile line (used in interpretation only)

FIG. 4

DEPARTMENT OF MINES — SOUTH AUSTRALIA

BUTE AEROMAGNETIC ANOMALY

CONTOURS OF GROUND TOTAL MAGNETIC INTENSITY

		Drn. R G	SCALE: 1 inch = 40 chains
		Tcd. R H	70-676
		Ckd. L V W	GC 5·8
Director of Mines		End.	DATE: 3 Aug 1970