DEPARTMENT OF MINES AND ENERGY

SOUTH AUSTRALIA

GEOLOGICAL SURVEY

A GEOPHYSICAL STUDY OF THE BROUGHTON AREA IN WALLAROO AND BLYTH 1:100 000 SHEET AREAS

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Rept.Bk.No. 78/109
E.L. No. 207
G.S. No. 6076

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ABSTRACT

An interpretation of regional aeromagnetic and gravity data in the area near Port Broughton, supplemented by detailed gravity traverses and stratigraphic information from recent drilling, Tickera DDH's 1 and 2, and Wokurna DDH's 1 to 3 inclusive, indicates that the metamorphic basement is shallow west of the Broughton Hinge Line, and is unconformably overlain by an Adelaidean sedimentary sequence.

A gravity model along the east-west Tickera traverse across the basement-cover contact shows that the Broughton Hinge Line forms part of the eastern tectonic boundary of the Gawler Block, and is probably underlain at depth by a belt of granulite or amphibolite.

1. PURPOSE

The purpose of the geophysical survey in the Port Broughton area (Figure 1), was to assist in siting stratigraphic drill holes for geological investigations across the edge of the Gawler Block close to the Broughton Hinge Line (defined in this report). Regional gravity and aeromagnetic data were used to establish parameters for an interpreted pseudogeological cross-section of the basement structures and overlying shelf Adelaidean sediments.

2. INTRODUCTION

Geophysical investigations for the Department's combined geological and geophysical exploration programme in E.L. 207 originally started in the Bute area in E.L. 75 (Gerdes, 1970 and 1972; Pilkington, 1971; Gerdes and Wightman, 1973).

Subsequent reports on the drilling and geology, which on the whole confirmed the geophysical interpretation, are summarised by McCallum (incomplete), Thomson (1973), and Parker and Thomson (1977).

These studies provided information on the East Bute Hinge which is defined by a magnetic lineament. The depth to magnetic basement increases to the east, suggesting an increase in depth of the metamorphic basement across the hinge. This feature is an en echelon continuation of the Clinton Hinge, another magnetic lineament, which is expressed on the surface by the Yarraroo Fault.

In addition, a thick sequence of relatively flat lying shelf Adelaidean sediments have been recognised resting unconformably on a low grade metamorphic sedimentary and volcanic sequence (Willamulka Volcanics and metasiltstones, Thomson, 1973). Subeconomic copper mineralisation was encountered in the Sturt Tillite, and some chalcopyrite mineralisation replacing pyrite (6 m of 0.25% Cu) occurs in the chloritised (?) andesite of the Willamulka Volcanics (Thomson, op. cit.). This portion (the Bute area) of the original E.L. 75 was re-leased to North Broken Hill Pty. Ltd. and is now held under E.L. 248.

More recently, exploration emphasis within the original E.L. 75 for possible areas of shelf Adelaidean sediments and shallow metamorphic basement, was extended into the Tickera - Port Broughton area, near the Broughton Hinge Line. Similar exploration principles are being applied to provide a cross-section (Tickera traverse) over this hinge zone, so that correlations and extrapolations between this section and the Bute stratigraphic cross section can be undertaken.

3. GEOLOGY

The geology of Broughton is shown in the 1:250 000 preliminary sheet of WHYALLA and that of Mundoora is shown in BURRA. McCallum (report in preparation) remapped the Wallaroo 1:100 000 sheet area at the scale of 1:50 000. This showed the area was mainly covered by Quaternary sediments with isolated areas of Tertiary sediments. The only outcrops of metamorphic basement, situated north of Kadina, occur in the Tickera and Alford areas (Gerdes, 1973, drawing no. 73-709).

The lithologies and stratigraphy of stratigraphic drill holes Tickera Nos. 1 and 2 and Wokurna Nos. 1 to 3 were reported by Parker and Thomson (1977).

4. PREVIOUS GEOPHYSICAL SURVEYS

4.1 REGIONAL DATA

(1) Aeromagnetic data

In 1960, the Bureau of Mineral Resources flew the eastern portion of WHYALLA whilst surveying BURRA (Webb, 1962). These survey data were obtained along flight lines orientated east-west with a flight line spacing of 1.6 km, at an elevation of 150 m a.g.l.

In 1975, the B.M.R. reflew WHYALLA whilst flying Spencer Gulf, using similar survey specifications to the previous survey. The preliminary 1:250 000 sheet edition, I53/BI-27 (B.M.R. standard notation) shows the aeromagnetic contours plotted at a 50 nT interval. The same data for

Wallaroo 1:100 000 sheet area was computer contoured at a 25 nT interval and has been issued as Department of Mines drawing no. 76-166. No detailed low level aeromagnetic data are available over this area.

(2) Regional gravity data

The regional gravity coverage of this area has a station density of approximately 1 station per 25.75 km^2. The Bouguer gravity contours are shown in BURRA (Coppin, et. al., 1973) and WHYALLA (Morony, et al., 1973).

4.2 DETAILED DATA

(1) Detailed gravity data

In 1968, C. Bennet (DM 665/68 unpublished) surveyed six gravity traverses across the Torrens Hinge Zone. Traverse 2, located east of Port Broughton and extending to Collinsfield, has been used in preparing the detailed gravity contours, Figure 2.

(2) Miscellaneous geophysical data

Previous detailed ground geophysical data in the Tickera-Port Broughton area are outlined by Gerdes (1974). Part of the resistivity data in this previous report will be discussed later in connection with Tickera DDH1, together with a gravity study of a two-dimensional model.

5. REDUCTION OF GRAVITY RESULTS

The diurnal and instrumental corrections for the gravity data were undertaken by D. McPharlin. The survey statistics and resultant gravity network are given in Appendix 1. No list of station values for these traverses is given in this report, as all relevant data are available on a computer file.

The locations of the gravity traverses are shown in Figures 2 and A.1.1, and the Bouguer gravity data are presented in both contour (Figure 2) and profile forms (Figure 3) at the scale of 1:100 000. The Tickera traverse (Tck), is shown with interpreted magnetic basement depths and geological logs at an enlarged scale (Figure 5). An interpretation of these results is given in section 7.2.

6. RESULTS OF INTERPRETATION

Figure 1 shows summarised contours of magnetic basement depths of the pre-Adelaidean basement and the expected distribution of the undifferentiated sediments present on the Gawler Block, viz. Adelaidean, Cambrian and some Quaternary and Tertiary sediments. The contoured data are heavily smoothed due to difficulties in resolving individual anomalies within the pre-Adelaidean basement area. The boundary of the shallower portion of the Gawler Block beneath the sedimentary cover is defined by the envelope of the Clinton, East Bute and Broughton Hinge Lines. The Ninnes Hinge, a magnetic lineament, is a deeper basement feature subparallel to the Orontes Structure situated east of Yorke Peninsula. The locations of the Bute stratigraphic drill holes 1 to 7, and the recent Tickera and Wokurna drill holes 1 and 2, which were drilled at selected stations along the Tickera gravity traverse, are shown in Figure 1. The location of Wokurna DDH3 is shown in Figure 4.1.1. These drill holes were sited after consideration of both the Tickera gravity data and all available aeromagnetic data of Wallaroo and Broughton.

6.1 AEROMAGNETIC DATA

The B.M.R. 1975 computer contoured aeromagnetic data of Wallaroo 1:100 000 were used for a qualitative interpretation of the area under investigation. The qualitative magnetic trend and zone type classification and distribution is shown in Figure 4 and the significance of the classification criteria is given in Appendix 2.

The term Major Zone is defined in this report as a magnetic subprovince, which contains any number of magnetic zone types having similar trend characteristics. The Port Broughton aeromagnetic anomaly (Major Zone I), consisting of magnetic zone types 11, 12 and 13, is considered to correlate with banded iron formations, similar to the Middleback Group. The interpreted magnetic susceptibility contrasts of the sources of these anomalies range between 6.6 to 24.0 x 10^{-3} cgs units. The interpreted dips indicate a steeply dipping closed synclinal structure, plunging steeply to the north (Gerdes, thesis in preparation).

The Major Zone II located to the east of Zone I, consists of a series of approximately north-south trending magnetic zones of types 9 to 12. The susceptibility contrasts of these sources range between 1.7 to 8.3 x 10^{-3} cgs units. The interpreted dips (with the magnetic effects assumed to be produced by the induced component only) indicate a closed anticlinal structure plunging south (Gerdes, thesis in preparation). The interpreted dips range between 30^{o} to 80^{o}, based on curve matches of standard thin and thick dyke curves (Parker Gay, 1963). The relationship of Major Zones I and II is similar to the magnetic relationships between the Middleback Ranges, Camel Hill and Ash Range magnetic anomalies. The latter two ranges are known to contain banded iron formations (N. Lemon, pers. com.).

These two Major Zones are separated by an area of little magnetic response which is interpreted to be associated with a granite intrusion. Tickera DDH 2 intersected adamellite which supports this concept. The small isolated zones of types 2 and 3 within this granite are interpreted to arise from basic intrusions.

It should be noted that the Middleback and Camel Hill banded iron formations are separated by gneiss, and the same may be true here.

The Major Zone III defined by the pronounced east-west magnetic trends of zone types 10, 12 and 13 is distinctly different from the trends in Zones I and II. Zone III is separated from Zones I and II by a major discontinuity marked by the fracture PQ (Figure 4) which trends at 130°. This fracture direction is dominant in the Gawler Block and a number of similar features have been resolved in PORT AUGUSTA, MAITLAND and WHYALLA. The fracture RS situated to the north of PQ is a good example.

The feature PQ may represent a dislocation between two major tectonically different geological units, e.g. the boundary between the Middleback Group type metasediments and the metasediments and metavolcanics of the Wallaroo-Moonta province.

The feature AA' defined by a major magnetic gradient in Wallaroo 1:100 000, separates Major Zones I, II and III from the relatively undisturbed magnetic Major Zones IV and V, and represents either a major metamorphic discontinuity or a major dislocation. It is comparable with the magnetic responses associated with a mylonite zone west of Cowell (A.J. Parker, pers. comm.) in Eyre Peninsula.

Major Zone IV is characterised by a series of isolated magnetic responses of zone types 2 and 3, in a relatively non-magnetic environment. The subsurface rocks within this region are dense, as can be seen from the Bouguer gravity contours (Figure 2). Further stratigraphic drilling, geophysical logging and sampling of the core for density and susceptibility values is required to define the subsurface rock types. For further discussion, refer to section 7.2.

Major Zone V is characterised by non-magnetic sediments, probably representing a thick sequence of Adelaidean rocks.

6.2 REGIONAL GRAVITY DATA

The survey statistics and network computations for the detailed gravity data are given in Appendix 1 and Figures A.1.1 and A.1.2 respectively. The Bouguer gravity contours (Figure 2) were compiled from both the detailed traverse data and regional data from BURRA and WHYALLA. The Bouguer elevation correction factor used was for a density of 2.67 gm/cm^3.

The regional gravity contours show a distinctive negative gravity anomaly with a magnitude of 20 milligals below background located west of BM5922. This gravity low is separated by a small positive anomaly situated at Tickera, trending north-south and correlating with the iron-rich metasediments of the Port Broughton synclinal structure.

Granite, which includes the adamellite from Tickera DDH2, and interpreted from aeromagnetic data, is coincident with a gravity low around station Tck110. This negative gravity feature extends southwards over the Tickera granite complex and is interpreted to represent a batholithic mass of granite material. The adamellite present in Tickera DDH2 has a measured density of 2.66 g/cm^3. This value was assumed for the granite, with a contrast of 0.34 g/cm^3 for the source of the regional gravity high to the east. The thickness of a horizontal near surface slab of granite necessary to produce the gravity values of the regional Tickera profile would then be at least between 1.5 and 2 km. The data further south are too sparse for any quantitative estimates of slab thickness.

The regional configuration east and southeast of Port Broughton is broadly a gravity high region outlined by the -4 milligal contour. This broad high is composite and consists of two separate gravity highs, one located around Wokurna DDH2 and the other, smaller in magnitude, located east of Port Broughton. These responses are from basement or intrabasement sources, but their origin is unknown. Further stratigraphic drilling may resolve the problem. Further east the gravity values decrease towards the Adelaide Geosyncline.

6.3 DETAILED GRAVITY DATA

The gravity response shown on the Bouguer gravity contours (Figure 2) consists of a series of low amplitude gravity highs and lows in the central portion of the area, e.g. north of Tck 134. The comparatively shallow sources associated with these anomalies are clearly resolvable and are shown by the residual profile for the Tickera traverse (Figure 3) discussed in section 7.

Figure 3 shows a composite plot of the Bouguer gravity data of the east-west traverses with a common base datum of -6 milligals, for convenience of presentation. The regional profile is shown in traverse Tck (Figure 5).

The residual anomalies, both positive and negative, are shaded in Figure 3, and a tentative correlation between lines is outlined. The two residual anomalies A and B on traverse Tck are produced by banded iron formation.

The correlation of the residual gravity anomalies shows an approximate north-south positive and negative striation, L, M, N, O, P and Q, located east of the line YZ. This striation may represent lithological density variations within the Adelaidean sediments. The density contrast of 0.07 gm/cm^3 for the combined thickness (90 m) of the Woocalla Dolomite Member and the tillite (Sturtian) from Wokurna DDH2, is not sufficient to produce the observed 0.67 milligal response within striation M. However, a lower amplitude anomaly coincident with the local topographic high, situated immediately west of Wokurna DDH2 (Figure 5), can be explained by this thickness and density contrast.

The major anomaly further east may be related to a fault, situated approximately 2 km east of the fault defined by the magnetic depth estimates. The minimum estimated depth of a magnetic feature near this fault is 250 m b.g.l., and therefore the effect originates from within the basement, possibly associated with the feature RS (Figure 4).

The other gravity striations N, O, P and Q are of the correct magnitude to correlate with the shelf Adelaidean sediments based on density data of the recent measurements of core samples and/or with local Tertiary channels containing low density sediments. The striation M on the Port Broughton - Collinsfield and E traverses is broader, and may be produced by a different source from those to the south. An increased number of gravity stations and more drill hole data will be required to verify the continuity of this striation between these two traverses.

Striations J and K probably correlate with basement density changes, and the line YZ is interpreted as delineating the surface extent of the shelf Adelaidean sediments; drilling should test this hypothesis.

7. THE TICKERA GRAVITY TRAVERSE

This section is concerned with providing the necessary parameters for gravity modelling of the Tickera gravity traverse based on the recent stratigraphic drill hole data, and is in two parts.

Part 1 is concerned with outlining the necessary physical properties based on core samples from recent drilling for a model study of the gravity data. The magnetic susceptibility and specific gravity data are divided into two subdivisions, classified on the geological age of the rocks, which are:

(1) Basement rocks, defined as pre-Adelaidean;

(2) Shelf Adelaidean rocks.

Part 2 is a first approximation for the cross section across the Broughton Hinge Line, i.e. a boundary of the Gawler Block with the Adelaide Geosyncline. The interpreted two-dimensional model for the gravity model study was based on the available geological information from stratigraphic drill holes, an interpretation of the aeromagnetic data, and knowledge gained in interpreting information from the Bute region to the south.

7.1 PART 1

SPECIFIC GRAVITY AND MAGNETIC SUSCEPTIBILITY DATA, BASED ON THE STRATIGRAPHIC DRILL HOLES

Specific gravity and susceptibility data were obtained from stratigraphic drill holes Tickera DDH2, and Wokurna DDH's Nos. 1, 2 and 3. The sampling interval used was one metre for the diamond drill core of both basement (pre-Adelaidean) rocks and Adelaidean shelf sediments.

7.1.1 Basement rocks encountered in Broughton area

Two stratigraphic diamond drill holes, Tickera

No. 2 and Wokurna No. 1 penetrated metamorphic basement in this region.

A. TICKERA DDH 2 was sited to obtain basement data associated with the broad gravity low. A granite was intersected at 121.8 m and was still present at the total depth of the hole (150 m b.g.l.). There were 4 m of weathered basement above the fresher material. A petrological study of a specimen (P190/76) sampled at 130.95 m, by A.J. Parker, was reported to be a partly altered adamellite, containing plagioclase (oligoclase) - quartz-microcline and chloritized biotite. "The plagioclase has been sericitized and all of the biotite in this rock has been completely replaced by chlorite associated with minor amounts of leucoxene or recrystallized titanium oxide and iron oxides" (Whitehead, 1976a).

The histograms of magnetic susceptibility and specific gravity data taken at metre intervals on core of this granite are shown in Figure 7.1, and the parameters are given in Table 7-1.

The magnetic susceptibility shows two distinctive populations separated at 117.5 x 10^{-6} cgs units based on a log-linear cumulative frequency plot. These populations may represent variable amounts of magnetite present in the rock, reflecting either original composition variations or different alteration products of the biotite, as noted by Whitehead (1976a).

The specific gravity histogram shows a median value of 2.66 with 95% confidence limit ($\bar{x} \pm 1.96s$) values of 2.58 to 2.78 where $\bar{x}$ and s are the mean and standard deviation respectively. The values greater than 2.75 may reflect a separate population.

B. WOKURNA DDH1 was drilled on a combined low amplitude magnetic and gravity anomaly near the upper inflexion point of the broad gravity gradient. The magnetic basement depths in the area were shallow (between 10 to 30 m).

The drill hole encountered basement at 26 m, composed of a gabbro which extended down to the total depth of the hole, 61.5 m b.g.l., a thickness of 35.5 m. Three samples of this core submitted by A.J. Parker for petrological studies, were taken at 27.3, 43.2 and 56.1 m. respectively. The specimens are medium - moderately coarse grained igneous rocks originally composed largely of prismatic plagioclase (labradorite) now sericitized, intergrown with clinopyroxene, secondary amphibole (actinolite) and biotite and a few interstitial crystals of opaque oxide, probably ilmenite and/or titaniferous magnetite (Whitehead, 1976b). Some sericitization and epidotization has occurred. There is no evidence of metamorphism or tectonic stress except for some local fracturing.

The log of the magnetic susceptibility and specific gravity taken at metre intervals over the available section of the gabbro is shown in Figure 7.2. The weathered and extremely weathered zones within the gabbro, based on the geological log (A.J. Parker, in press), are shown in the same figure. These results show a distinctive correlation of both parameters with the extremely weathered zones, as defined by Parker.

The histograms of magnetic susceptibility and specific gravity data recorded over the whole section of gabbro are shown in Figure 7.3, and the parameters are given in Table 7-1.

The magnetic susceptibility has an overall mean value of 94.6×10^{-6} cgs units, and a median value lies between 90 to

TABLE 7 - 1

MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY DATA

OF BASEMENT IN TICKERA DDH 2 AND WOKURNA DDH 1

(in the Port Broughton Area)

Drillhole and Lithology	Magnetic Susceptibility (in x 10^{-6} cgs.units)				Specific Gravity			
	Number	Range	Mean	S.D.	Number	Range	Mean	S.D.
TICKERA DDH 2								
Granite	29	30 to 318	107.5	62.5	29	2.58 to 2.77	2.66	0.04
WOKURNA DDH 1								
Gabbro (Overall)	28	20 to 150	94.6	30.4	28	2.30 to 3.09	2.86	0.23
Gabbro (population A)	18	70 to 150	110.3	20.6	18	2.96 to 3.09	3.01	0.03
Gabbro (population B)	10	20 to 100	66.3	24.3	10	2.47 to 2.76	2.57	0.14

120×10^{-6} cgs units. These results are low for a gabbro and reflect both a certain degree of oxidation and/or alteration of the total iron content by sericitization and epidotization. The mean value of population A gives the correct magnetic susceptibility value of 110×10^{-6} cgs units for the gabbro, and the mean value for population B gives magnetic susceptibility of the weathered material.

The specific gravity data show two distinctive populations, the lower density group ranging between 2.30 to 2.76 with the other grouped between 2.96 and 3.10. These populations have mean values of 2.57 and 3.01 respectively. There is a corresponding population separation in the magnetic susceptibility results with mean values of 66.3 and 110.3×10^{-6} cgs units respectively. The lower populations B for both parameters correlate with the weathered bands within the gabbro, (Figure 7.2). Petrological sample P193/76 corresponds to one of the lower density and susceptibility bands, where the pyroxene has been partly to extensively replaced by very fine grained amphibole and clay-like material stained by iron oxide (Whitehead, 1976b). In addition, this rock is cut by small calcite veins. This type of alteration explains the physical properties of the lower value population present in both parameters.

The parameters for population A were used for the model study of the Tickera traverse.

7.1.2 Adelaidean rocks encountered in the Wokurna stratigraphic drill holes 2 & 3

A summary of the physical parameters and comparison of the composite geophysical logs of stratigraphic drill holes Wokurna DDH's 2 and 3 are given in Appendix 3 in terms of each stratigraphic unit or major lithological unit. The magnetic susceptibility and specific gravity parameters for the different stratigraphic units for Wokurna DDH's 2 and 3 are given in Tables A.3.1. and A.3.2 respectively.

Table A.3.1 shows the data for the Tapley Hill Formation, Woocalla Dolomite Member, an un-named stratigraphic dolomitic conglomerate unit located beneath the Woocalla Dolomite Member, the Sturt Tillite (Appila Tillite, Coats, pers. com.) and (?) Rhynie Sandstone. This un-named dolomitic conglomerate unit is considered by Parker (pers. comm.) to be the dolomitic facies of the Sturt Tillite.

These results show that a mean density value of between 2.78 and 2.79 gm/cm^3 for the whole sequence can be used for the computer model cross-section. These stratigraphic units can be considered as only weakly magnetic, having mean susceptibility values generally less than 60×10^{-6} cgs units. The maroon-grey to brown slates (Tapley Hill Formation) are the most magnetic unit.

Table A.3.2 shows that the Marinoan sediments have low susceptibilities, generally less than 60×10^{-6} cgs units, except for the magnetic subunit D2 in Unit D, i.e. the interbedded red to maroon shales and grey feldspathic sandstone unit, which has a mean value of 78×10^{-6} cgs units. Its significantly different value may be useful for stratigraphic correlations. The specific gravities of these units fall into two groups. The lower density group consisting of lithological Units A, B and C, has a mean density value less than 2.73 gm/cm^3. Unit D has a high overall mean density between 2.77 to 2.78 gm/cm^3, and subunit D3 has the highest value of 2.78 gm/cm^3.

7.2 PART 2

TWO-DIMENSIONAL MODEL OF THE TICKERA GRAVITY TRAVERSE

The profile for the Tickera (TCK) gravity traverse (Figure 5) shows a broad regional profile, which may be represented by a third order polynomial having an equation as shown in Figure 5. This was used to estimate the possible depth and contrast of the deeper seated source. The residual sources are considered to be produced by relatively near surface sources within the basement west of the hinge zone. The lower profile shows the topographic cross section and available geological control. The geophysical control for this model study is based on the extrapolation of depths to highly resistive basement in Tickera (Gerdes, 1974) and an interpretation of the aeromagnetic data, e.g. B.M.R. 1962 BURRA-WHYALLA data, giving magnetic basement depths and the positions of major lineaments or faults (Gerdes, thesis in preparation).

The depth of the Quarternary and Tertiary cover rocks is defined by vertical electrical soundings (Gerdes, 1974), magnetic basement depths and geological logs of the stratigraphic drill holes. The assumed thickness of the Adelaidean sediments is based on the drilling data; the likely missing stratigraphic units beneath the Marinoan sediments in Wokurna DDH 3 (A.J. Parker, pers. comm.); and the assumption that the sequence penetrated in Wokurna DDH2 is present at depth beneath DDH3. The Adelaidean sediments have been assumed to be horizontal overall, although actual dip in Wokurna DDH 2 is 10 degrees (A.J. Parker, pers. comm.).

The computed profile using a two dimensional model for the pseudogeological cross-section consisting of seventeen polygons is based on a computer programme MODEL, which sums the gravity effects of each polygon, and provides a listing of the gravity profile at a specified sample interval. The background lithology is assumed to be a gneissic sequence having a density of 2.68 gm/cm^3.

The pseudo-cross section shown in Figure 6 is a first order approximation for the geological cross-section. The residual differences between the observed and computed profiles are assumed to represent comparatively shallow sources within the metamorphic basement (Magnetic Zone IV) such as dykes and sills in block 12 (e.g. the basic rock in Wokurna DDH1) and possibly similar volcanics are located within blocks 13 and 14. The latter are assumed to represent the Willamulka metasiltstones and volcanics. Block 12 may be equivalent to either Hutchison Group metasediments, or the Willamulka metasiltstones. The former may be a correct assumption as the block density is 0.02 gm/cm^3 greater than those attributed to the latter sequence. This increase in density may correlate with either dolomites or quartzites (being high density and low susceptibility rocks) within the sequence. Shallow drill holes could check this hypothesis.

The Broughton Hinge is represented by the fault F1 and together with the faults F2 and F3 correspond with the major faults defining the edge of the Gawler Block. Using a model extending these faults to depth with the density distribution due to the deep seated slab blocks 15 and 17 (Figure 6) gives a better correlation with the observed curve than that produced by a single slab source. The density of this rock unit is 2.88 gm/cm^3 and being relatively non-magnetic, may correlate with either granulite or amphibolite metamorphic rocks.

Magnetic Zones II and IV are separated by a major discontinuity assumed from the magnetic response to correlate with a change of metamorphic grade. The overall density contrast between the two is computed to be 0.05 gm/cm^3 (Figure 6). Zone II (Block 10), includes a possible basic plug (magnetic zone type 3) and a thick, dipping block of banded iron formation (Middleback Group) correlating with a zone type 12. The zone type 11 to the east (Figure 4), only slightly resolved on the gravity profile, is situated between the 10 to 11 km marks on the traverse, and appears to have either a limited depth extent or a very slight density contrast with the major block 10.

The synclinal structure of banded iron formation, known as the Port Broughton aeromagnetic anomaly (McPharlin, pers. comm.) is well resolved by the gravity data beneath Tickera DDH1, as a two peaked anomaly correlating with two dipping thick sheets. Block 7 represents this overall synclinal structure and shows a reasonable correlation: however, the depth extent of the eastern limb lies between 350 to 600 m as shown by the two possible models given in Figure 6.

The granite outlined on the magnetics (Figure 4), and intersected in Tickera DDH 2 has been modelled to a depth of 2 km only, assuming a density of 2.66 gm/cm^3. It is assumed that with a gradual increase of density with depth this would be indistinguishable from the undifferentiated gneisses beneath, and may represent a remobilised portion of the Tickera batholith as outlined by the regional gravity contours over the Tickera granitic complex.

8. CONCLUSIONS

The combined study of aeromagnetic and detailed gravity data has outlined five major magnetic sub-provinces (Magnetic Zones I to V) correlating with different basement structural zones and Adelaidean sediments. The gravity modelling of the Tickera gravity traverse, which confirms the position of the major faults as defined from the magnetic data over the edge of the Gawler Block (Broughton Hinge Line), shows the complex nature of these faults, and the existence of possible amphibolite or granulite rocks at depth beneath this zone.

The study of the geophysical logs with the related stratigraphic units should be useful for future correlations of Adelaidean rocks on the Stuart Shelf both in this area and further north.

9. RECOMMENDATIONS

Future stratigraphic drilling programmes on the Tickera Traverse should aim at defining the general metamorphic basement in Magnetic Zones II and IV where the magnetic basement is shallow, and investigate the detailed structure of the Broughton Hinge between stations Tck 138 to 148 for possible mineralisation within the Woocalla Dolomite Member and Sturt Tillite.

A deep stratigraphic drill hole located at Tck 155 and drilled to at least 600 m to intersect the Willimulka metasiltstones would be warranted for stratigraphic correlation between Wokurna DDH 2 and 3, and to test for possible stratiform mineral deposits. It may also resolve the significance of the major northwest-trending magnetic lineament. It would be impractical to investigate east of this lineament for economic mineralisation within the pre-Adelaidean basement. Drilling further north should aim at defining the Broughton Hinge both west and east of this structure and mainly within the area of the positive gravity strip K (figure 3) between WX and YZ.

A lower priority is a drill hole with a target depth of 800 m within the low resistivity basin near Tickera DDH 1, to investigate the Tertiary lignitic clays and resistive basement. The drill hole should be sited west of the possible fault located near Tck 107 resolved by both the resistivity and magnetic data (Gerdes, 1974).

The recent Bureau of Mineral Resources aeromagnetic data flown with a flight line spacing of 1.6 km is inadequate for resolving complex geological structures. It is therefore recommended that the whole area of EL. 207 and the Wallaroo 1:100 000 sheet, except for the EL. 248 and part of EL. 247, should be flown at an elevation of 90 m with a flight line spacing of 200 m along northwest-southeast oriented flight lines.

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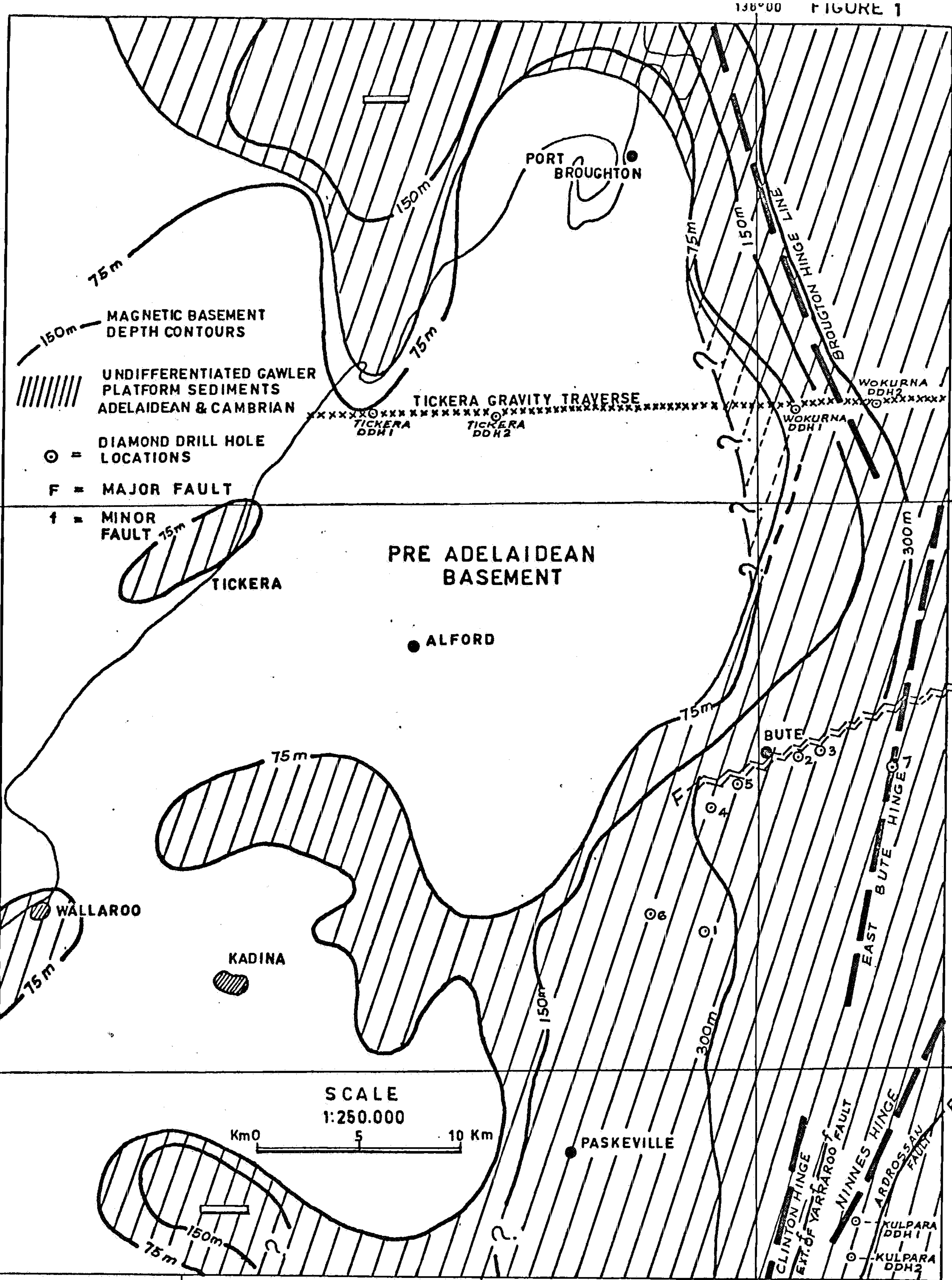
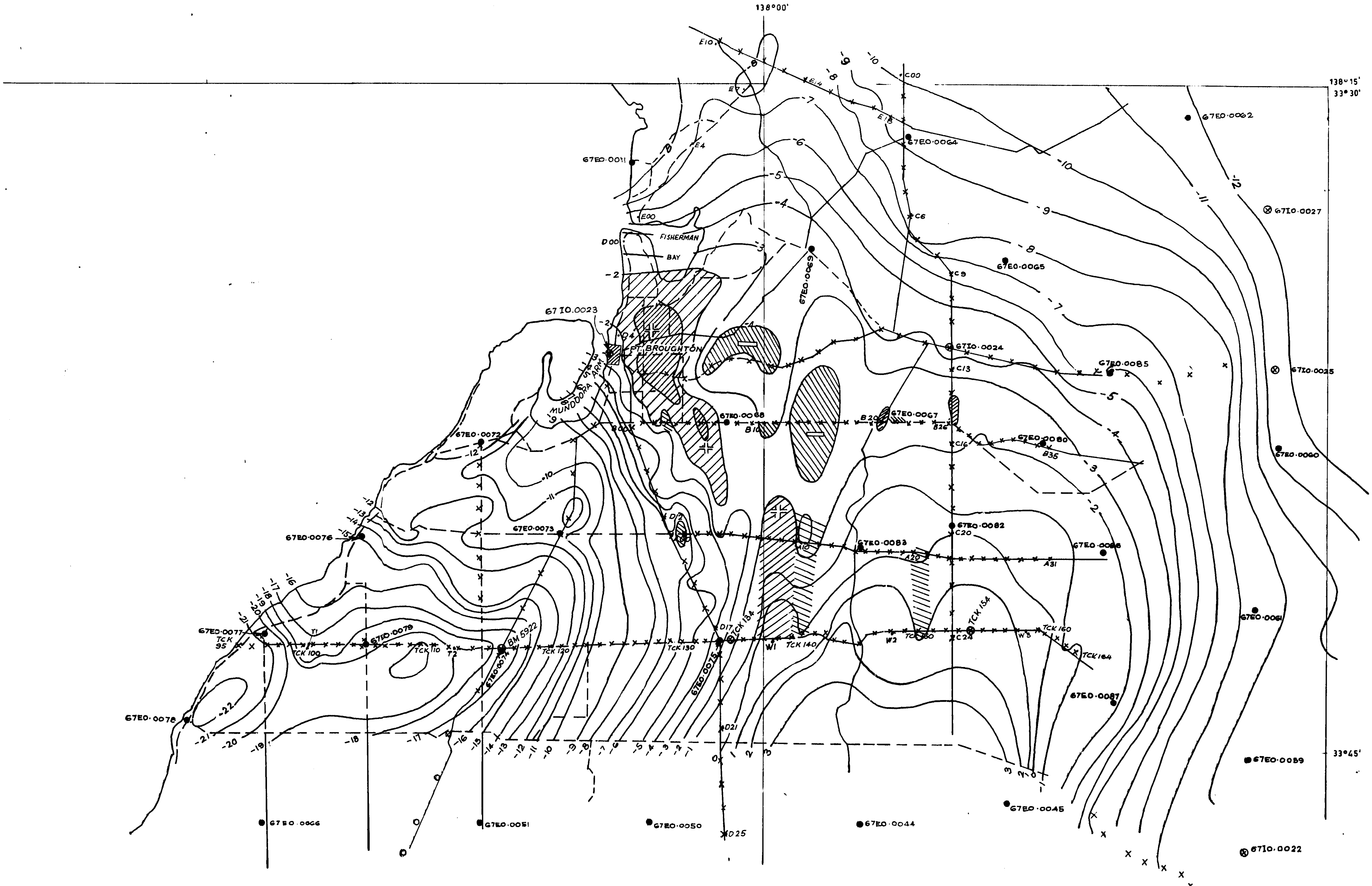


	DEPARTMENT OF MINES–SOUTH AUSTRALIA	Scale: 1:250,000
Compiled: R.A.G.	INTERPRETED DISTRIBUTION OF THE ADELAIDEAN AND CAMBRIAN SEDIMENTS BASED ON MAGNETIC BASEMENT DEPTH DATA	Date: 21.1.77
Drn. / Ckd.		Drg. No. S 12705

500—6.76 G6584 O



SCALE

1:100.000

Km 0 1 2 3 4 5 Km

Density: 2·67 gm/cm^3

Contour Interval: 1 mgl

X Detailed Stations

Regional Stations

●-E

⊗-I Central Points

FIGURE 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
BOUGUER GRAVITY CONTOURS OF BROUGHTON AREA			
		Drn. R.A.G.	SCALE: 1:100,000
		Tcd.	77-542
		Ckd.	
Director of Mines		Exd.	DATE: 26.1.77

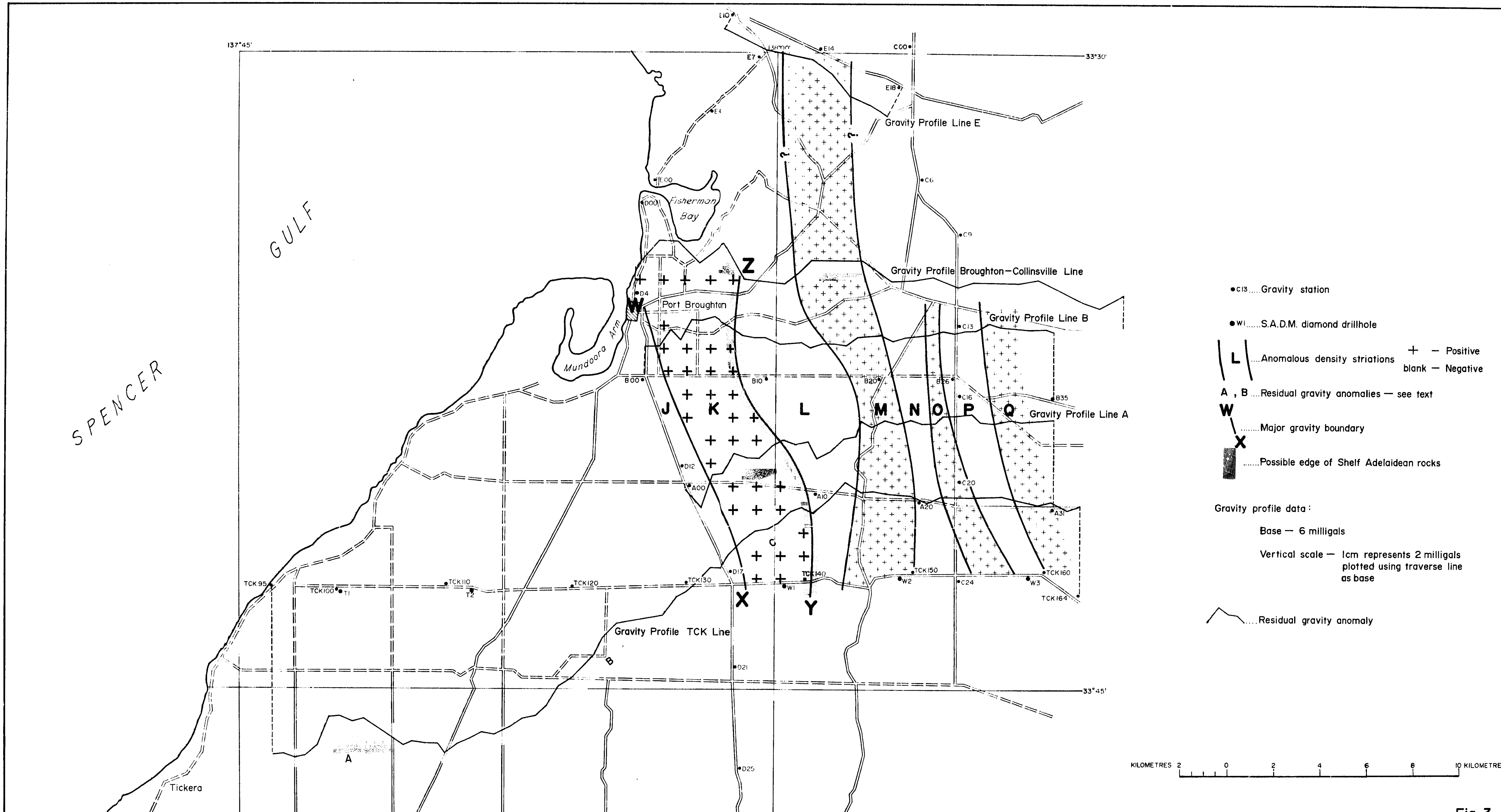


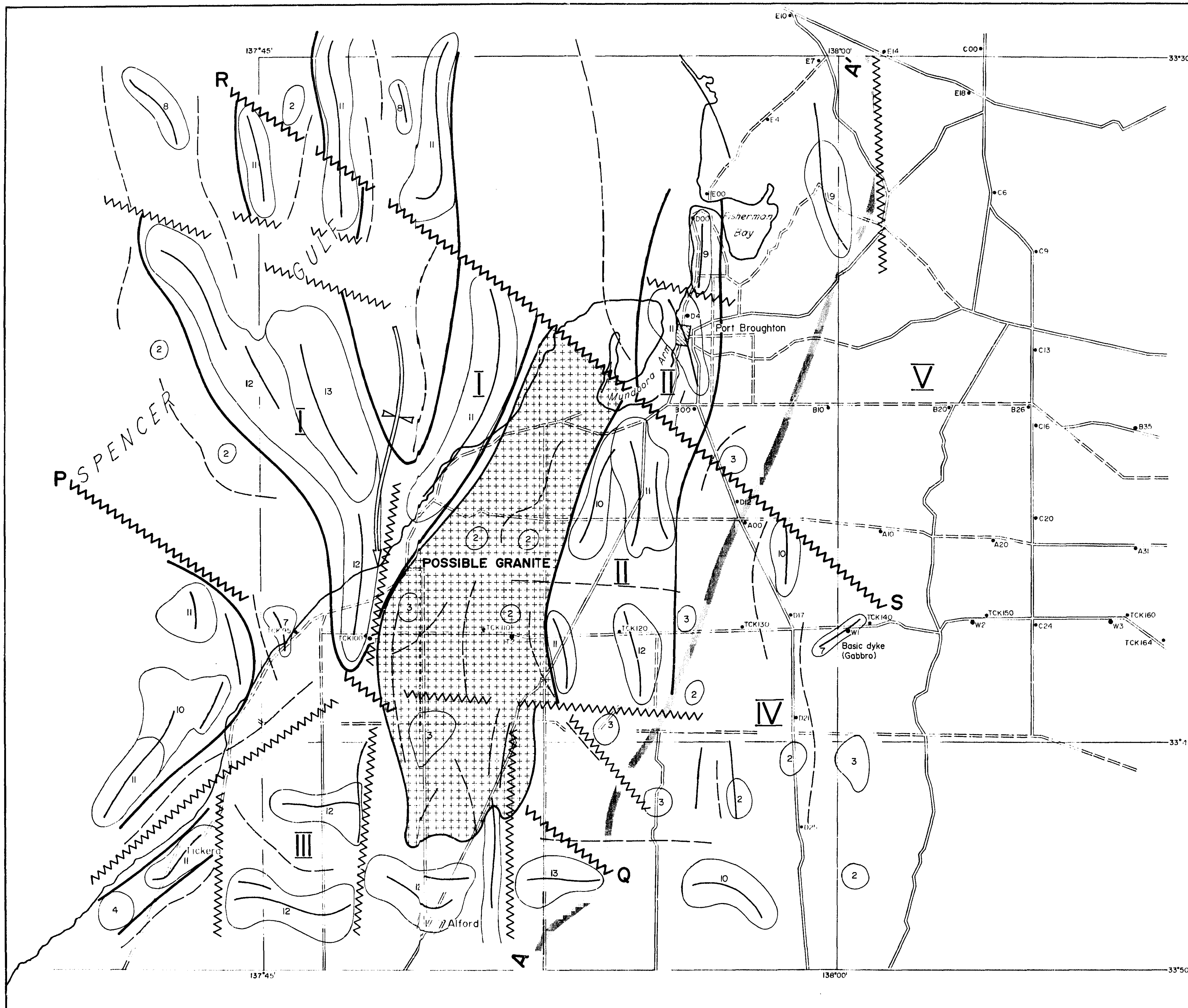
Fig. 3

DEPARTMENT OF MINES–SOUTH AUSTRALIA

BROUGHTON AREA GEOPHYSICAL INVESTIGATION

GRAVITY PROFILES AND RESIDUAL GRAVITY INTERPRETATION

GEOPHYSICAL SERVICES SECTION	COMPILED R.A.G.	DRN A.F.	SCALE 1:100 000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE	77-555



- •E7 Gravity station
- •W2 S.A.D.M. Diamond drillhole
- Major discontinuity (or fracture)
- Positive magnetic trend
- Negative magnetic trend
- (10) Magnetic zone type 10
- (II) Major zone (or lithological unit and/or group of similar units)
- A — A' Major magnetic gradient (possible major metamorphic or structural boundary)
- Interpreted granite intrusion
- Major plunging synclinal structure

Interpretation based on B.M.R. 1975 aeromagnetic contours.

KILOMETRES 2 0 2 4 6 8 10 KILOMETRES

Fig. 4

DEPARTMENT OF MINES – SOUTH AUSTRALIA

BROUGHTON AREA GEOPHYSICAL INVESTIGATION

INTERPRETED MAGNETIC ZONES AND TRENDS

GEOPHYSICAL SERVICES SECTION	COMPILED R.A.G.	DRN A.F.	SCALE 1:100 000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE MAY 1977	77-556

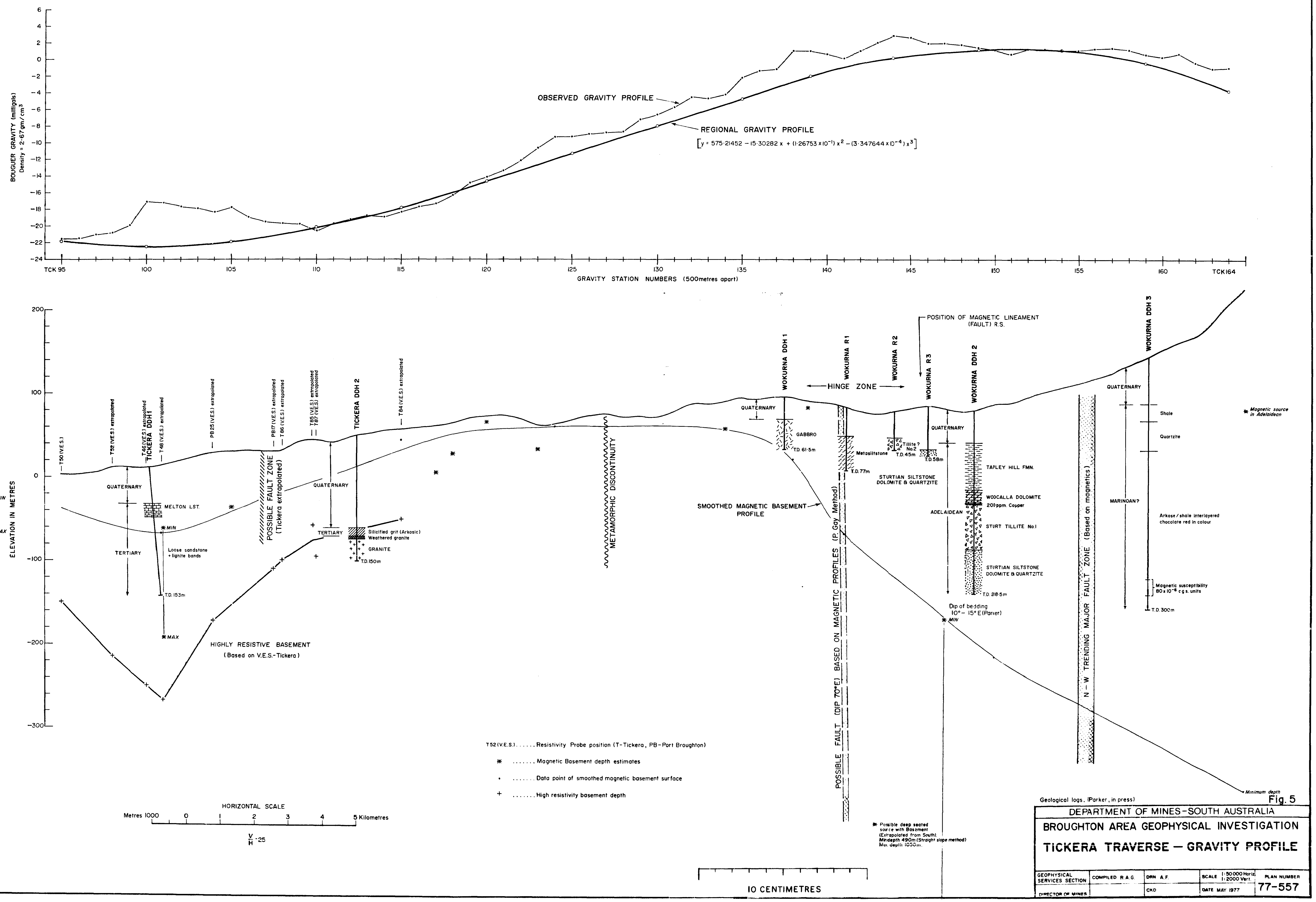


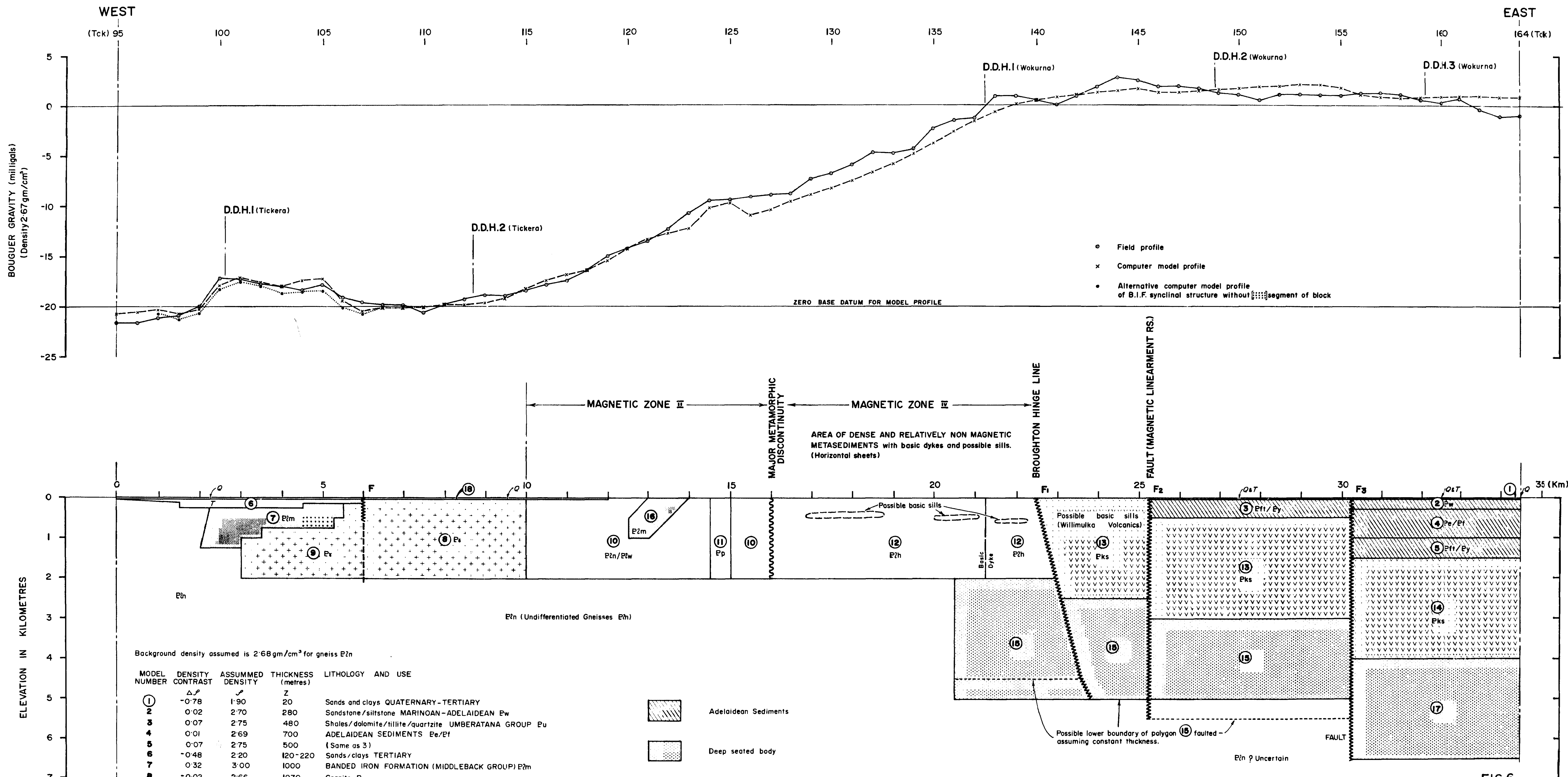
Fig. 5

DEPARTMENT OF MINES–SOUTH AUSTRALIA

BROUGHTON AREA GEOPHYSICAL INVESTIGATION

TICKERA TRAVERSE — GRAVITY PROFILE

GEOPHYSICAL SERVICES SECTION	COMPILED R.A.G.	DRN A.F.	SCALE 1:50000 Horiz. 1:2000 Vert.	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE MAY 1977	77-557



Background density assumed is 2·68 gm/cm³ for gneiss Ꝑ?n

MODEL NUMBER	DENSITY CONTRAST Δρ	ASSUMMED DENSITY ρ	THICKNESS (metres) Z	LITHOLOGY AND USE
(1)	-0·78	1·90	20	Sands and clays QUATERNARY-TERTIARY
2	0·02	2·70	280	Sandstone/siltstone MARINOAN-ADELAIDEAN Ꝑw
3	0·07	2·75	480	Shales/dolomite/tillite/quartzite UMBERATANA GROUP Ꝑu
4	0·01	2·69	700	ADELAIDEAN SEDIMENTS Ꝑe/Ꝑf
5	0·07	2·75	500	(Same as 3)
6	-0·48	2·20	120-220	Sands/clays TERTIARY
7	0·32	3·00	1000	BANDED IRON FORMATION (MIDDLEBACK GROUP) Ꝑ?m
8	-0·02	2·66	1970	Granite Ꝑɪ
9	-0·02	2·66	1250	" (Possible gneiss)
10	0·03	2·71	2000	Metasediments Ꝑ?m/Ꝑ?w ?
11	0·25	2·93	500	Basic plug (Magnetic zone 3) Gabbro. Age ? Ꝑβ
12	0·08	2·76	2000	Metasediments HUTCHINSON GROUP Ꝑ?h
13	0·06	2·74	2500	Slates and phyllites Ꝑks
14	0·06	2·74	2500	East Kadina Phyllites (Metasiltstones)
15	0·20	2·88	2500	Unknown, could be granulites ?
16	0·08	2·76	500	(Same as 7)
17	0·20	2·88	2500	Unknown (Same unit as 15)
(18)	-0·78	1·90	30	Sand QUATERNARY

FIG.6

DEPARTMENT OF MINES-SOUTH AUSTRALIA

TICKERA GRAVITY TRAVERSE

TWO DIMENSIONAL MODEL

GEOPHYSICAL SERVICES SEC.	COMPILED R.A.G.	DRN A.G.R.	SCALE 1:50,000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE 27 May '77	77-558

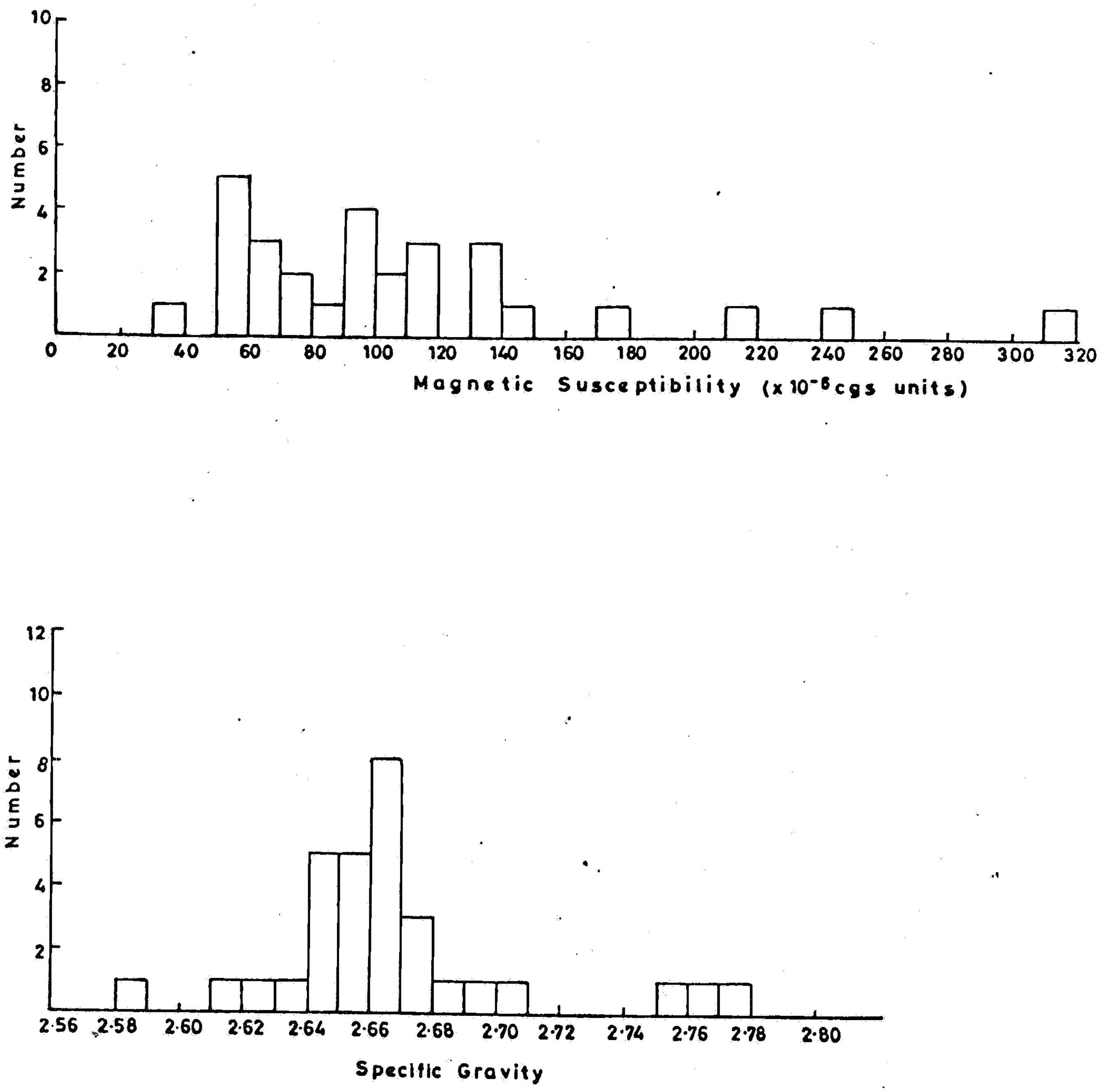
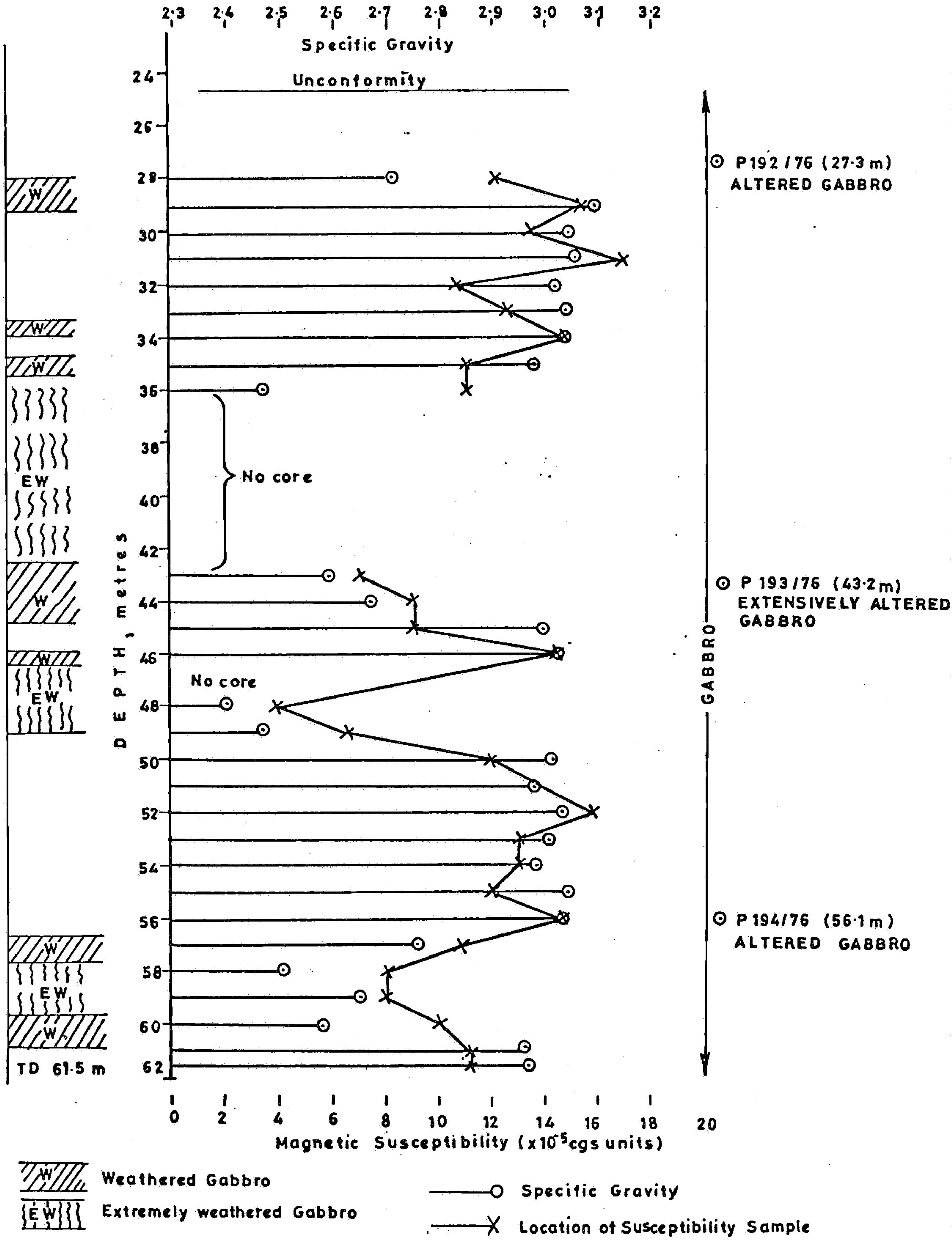


Figure 7.1

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.	HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY OF GRANITE (ADAMELLITE) IN TICKERA DDH 2	Date: 6.1.77
Drn. / Ckd.		Drg. No. S 12706

500 6.76 G6584 O



Geological log after J. Parker 1976

Figure 7·2

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.	GEOPHYSICAL LOG OF THE GABBRO FROM THE STRATIGRAPHIC DDH WOKURNA Nº1 (Specific gravity and magnetic susceptibility)	Date: 21.1.77
Drn. / Ckd.		Drg. No. S 12707

500—6.76 G6584 O

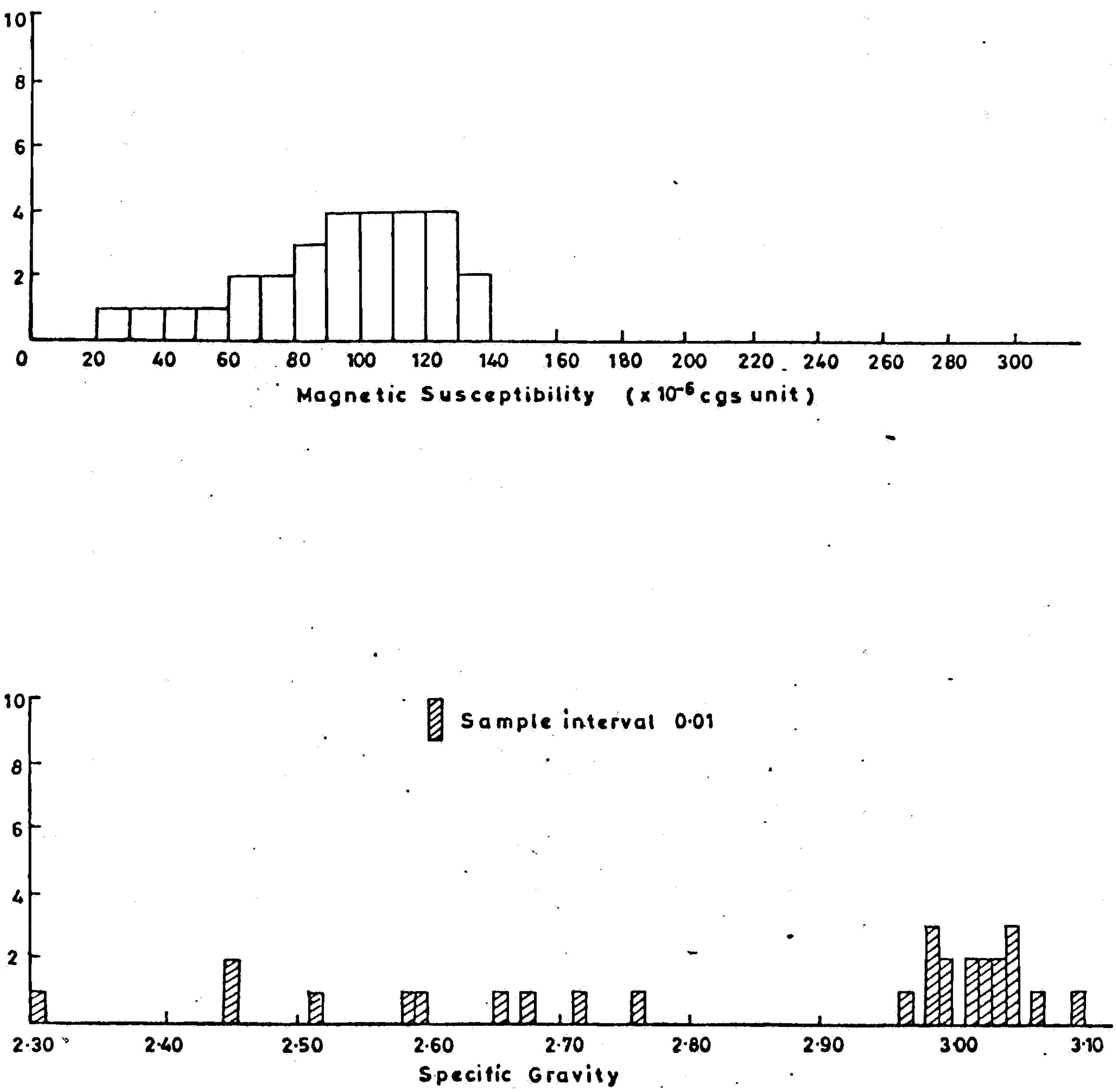


Figure 7·3

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.	HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY OF GABBRO IN WOKURNA DDH 1	Date: 6.1.77
Drn. / Ckd.		Drg. No. S 12708

500–975 F9882 O

APPENDIX I

APPENDIX I

SURVEY DETAILS FOR THE GRAVITY TRAVERSES IN THE BROUGHTON AREA

Survey details for three separate gravity surveys (Figure A.1.1) utilized in this area are outlined below.

a. PORT BROUGHTON - COLLINSFIELD TRAVERSE (Line 2)

This gravity traverse was recorded by C. Bennet in 1968, along approximately west-east roads located from Port Broughton to Collinsfield. The station interval was approximately 0.8 km. The observed gravity data were tied to control stations in BURRA and WHYALLA and the elevation data was barometric and tied to Lands Department Bench Marks.

The gravity control stations were 6710.0023, 0024 and 0025; details are given in Table A.1.

b. TICKERA TRAVERSE (Tck)

The stations for this traverse were optically levelled by the S.A.D.M.E. survey section and were located on the southern side of a west-east road at intervals of 500 m. All stations were marked by stakes and the even numbers marked at the base of a 2" x 2" peg. The westernmost peg is Tck 95 and the easternmost is Tck 164, situated near the Hummock Ranges.

The elevations are tied to S.A.D.M. 3rd order bench marks and referred to MSL (1) via Lands Department Bench mark (BM 5922) and some E.W.S. 4th order control points.

The gravity data were recorded using the Sharpe gravity meter 201, having a calibration constant of 0.09998(2) milligals per division.

Lands Department BM 5922 (now control station 7611.5922) was established as an additional control station, being tied to control stations 67I0.0019 and 67I0.0023.

c. BROUGHTON TRAVERSES

Five gravity traverses along roads were optically levelled. The stations having a sample interval of 500 m were recorded in October 1976 using gravity meter Sharpe 190G. The gravity meter calibration constant was 0.1000(7) milligals per division. These data were tied to control stations located at Port Broughton, Bute and Snowtown.

A section of the traverse E (stations 0 to 7) was not recorded since the road was waterlogged and impassable. However, the network was closed between station DOO (S.A.D.M. BM 0435) and station E8. This tie showed that the misclosure shown below was an accumulated error produced by the loop system used. The error is about 0.003 milligals per station, or a leg error of 0.0138 milligals per leg, where a leg is defined as the interval between major control stations within a closed loop system.

GRAVITY NETWORK SYSTEM

The gravity network shown in Figure A.1.2 is for the combined Tickera and Broughton data and shows the network errors after drift corrections have been applied. The maximum closure error is 0.18 milligals. However, the mean error of the eleven loops is 0.07 milligals with a standard deviation of 0.07 milligals.

The leg adjustments using least squares method (Smith, 1951) given in Figure A.1.2 show that the maximum adjustment for any one leg is 0.06 milligals. The mean and standard deviation leg error of the twenty three units is 0.0317 and 0.0164 milligals respectively, representing that the nodal error (95% Confidence Limit) is between 0.004 and 0.064

milligals. This is within the experimental error or repeatability of the results at particular stations. The maximum leg error distributed between twenty three stations is 0.002 milligals per station. This error is small and no adjustments have been applied to the traverse of contoured data.

Smith, A.E. 1951. Graphic adjustment by least squares. Geophysics, 16(2) April, 1951.

TABLE A.1

GRAVITY CONTROL STATIONS

Location	Station Number	Observed Gravity (in milligals)	Elevation (in metres)
Bute (Railway Station)	67I0.0017	979642.56	113.39
Alford (War Memorial)	67I0.0019	979623.42	64.31
Snowtown (Railway Station)	67I0.0022	979616.59	103.94
Port Broughton (War Memorial)	67I0.0023	979624.43	4.57
Mundoora (Hotel)	67I0.0024	979610.55	64.01
Collinsfield (Railway Station)	67I0.0025	979595.44	112.78
BM 5922	76I1.5922	979607.38	61.746

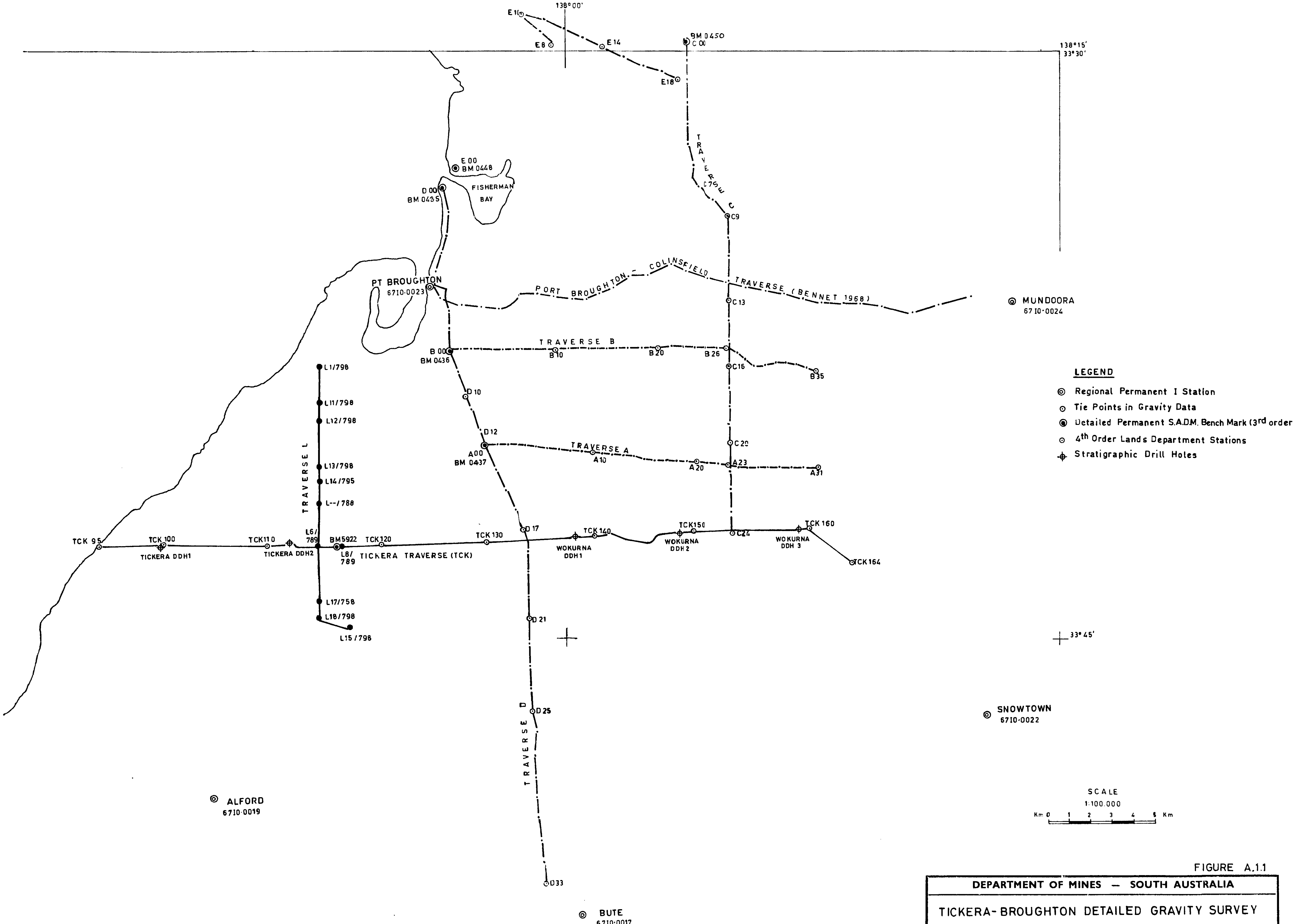


FIGURE A.1.1

DEPARTMENT OF MINES — SOUTH AUSTRALIA

TICKERA-BROUGHTON DETAILED GRAVITY SURVEY

LOCATION OF PRINCIPLE POINTS AND TRAVERSES

		Drn. R.A.G.	SCALE: 1:100,000
		Tcd.	77-543
		Ckd.	
Director of Mines		Exd.	DATE: 16.2.77

77-544

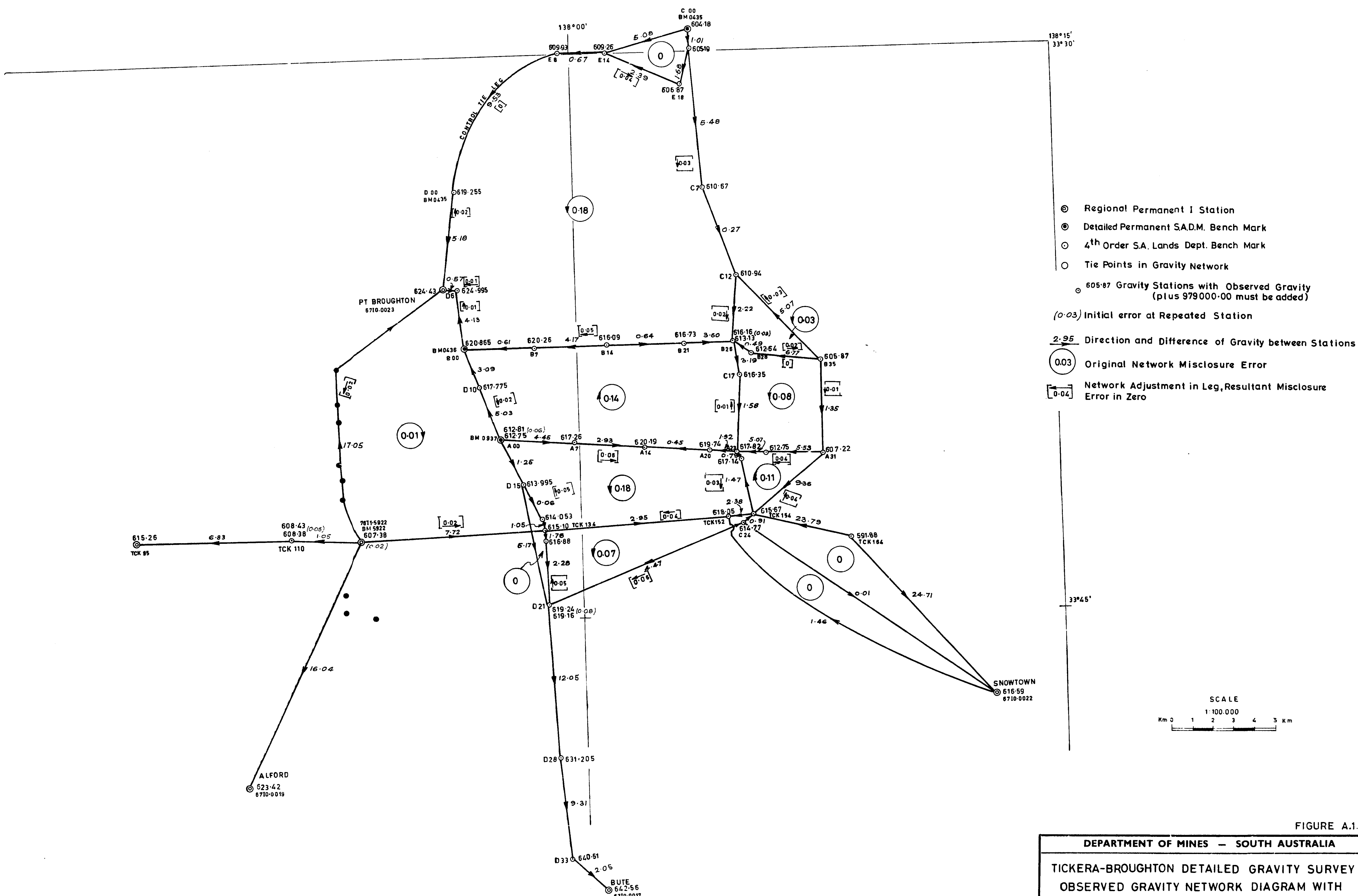


FIGURE A.1.2

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
TICKERA-BROUGHTON DETAILED GRAVITY SURVEY OBSERVED GRAVITY NETWORK DIAGRAM WITH ADJUSTMENTS			
		Drn. R.A.G.	SCALE: 1:100,000
		Tcd.	77-544
		Ckd.	
Director of Mines		Exd.	DATE: 14.2.77

10 CENTIMETRES

APPENDIX II

APPENDIX II

MAGNETIC ZONES AND THEIR SIGNIFICANCE

The magnetic zone boundaries drawn around positive magnetic trends were located at the inflexion point of correlatable anomalies. The anomaly range quoted for each zone type includes most, but not necessarily all, of the anomalies in any zone of that type. The zone type classification and anomaly characteristics are given below:

Zone Type	Anomaly Range	Characteristics
1	less than 100 gammas	Poor linearity
2	100 to 250 gammas	"
3	250 to 500 gammas	"
4	500 to 1 000 gammas	"
5	greater than 1 000 gammas	"
6	less than 50 gammas	Good linearity
7	50 to 100 gammas	"
8	100 to 200 gammas	"
9	200 to 300 gammas	"
10	300 to 500 gammas	"
11	500 to 1 000 gammas	"
12	1 000 to 2 000 gammas	"
13	2 000 to 5 000 gammas	"
14	greater than 5 000 gammas	"

The correlation of magnetic zone types with rock types is mainly based on the study of the Cleve Metamorphics and Carpentarian rocks on Eyre Peninsula and Yorke Peninsula. Their significance is given in the text.

APPENDIX III

APPENDIX III

GEOPHYSICAL CORRELATIONS IN STRATIGRAPHIC DRILL HOLES WOKURNA NOS. 2 & 3

This is a summary of physical parameters and comparison of the composite geophysical logs for the stratigraphic drill holes Wokurna DDH 2 and DDH 3 shown in Figures A.3.1 and A.3.2 together with their lithological logs as reported by A.J. Parker (unpublished). The composite logs shown are gamma, self potential and point resistivity based on in-situ measurements and specific gravity and magnetic susceptibility data recorded on samples of the drillhole core.

The details of each stratigraphic drill hole are given below.

WOKURNA DDH2

The stratigraphic units and their lithologies to be discussed are shown in Figure A.3.1. Unfortunately, the self potential and point resistivity data are unreliable above 108 and 105 m respectively, due to an erroneous response caused by the presence of the bore hole casing.

The histograms for each stratigraphic unit, both specific gravity and magnetic susceptibility, are shown in Figures A.3.3 to A.3.6 and their population parameters are given in Table A.3.1. The physical characteristics of the stratigraphic units for the geophysical logs are given below.

TAPLEY HILL FORMATION (Figure A.3.3)

Depth Range: 26 to 96 m. Apparent Thickness: 70 m.

GAMMA LOG: shows a slightly higher gamma response towards the base of the unit.

SELF POTENTIAL AND POINT RESISTIVITY LOG: No data due to the presence of the casing.

SPECIFIC GRAVITY: This shows an overall increase with depth from 2.55 to 2.75 which is probably related to:

(i) decrease in the weathering effect with depth,

(ii) increase of dolomite content with depth, towards the Woocalla Dolomite Member.

The upper slate unit (maroon to grey brown in colour) has a mean value of 2.57 and is clearly distinctive from the lower dark grey slate which has a value of 2.69.

MAGNETIC SUSCEPTIBILITY: The susceptibility log shows the presence of three magnetic units which are as follows:

(i) Between 47 to 65 m. Magnetic Unit I, having a susceptibility value generally greater than 60×10^{-6} cgs. units and correlating with the maroon-grey to brown coloured slate.

(ii) Between 65 to 80 m. Magnetic Unit II, is a non-magnetic zone, with a slight response, 20×10^{-6} cgs. units at the top, probably reflecting a gradual change in the ferromagnetic minerals component.

(iii) Between 81 to 98 m. Magnetic Unit III, compares in magnitude with Unit I but correlates with the dark grey slate. The ferromagnetic minerals are pyrite or pyrrhotite (Coats, pers. comm.).

Magnetite was found to be responsible for the response in the Tindelpina Shale Member and Tapley Hill magnetic unit in the Geosyncline (Tucker, 1972).

<u>WOOCALLA DOLOMITE MEMBER</u> (Figure A.3.4)

Depth Range: 97 to 105 m. Apparent Thickness: 9 m.

GAMMA LOG: shows a significant decrease in gamma response between 102 to 107 m of magnitude 80 cps.

SELF POTENTIAL LOG: No data.

POINT RESISTIVITY LOG: shows a relatively uniform response with a distinctive low resistive band at the base correlating with a conglomeritic band.

SPECIFIC GRAVITY: shows a significant density response, having a mean value of 2.89.

MAGNETIC SUSCEPTIBILITY: shows a general decrease in response, mean value of 40 x 10^{-6} cgs. units.

<u>STURT TILLITE</u> (sandstone member - based on composition of matrix)

(unnamed dolomitic conglomerate member (Transition Beds)) (Figure A.3.4)

Depth Range: 106 to 117 m. Apparent Thickness: 11 m.

GAMMA LOG: shows a slight increase in radioactive response compared with the Woocalla Dolomite Member.

SELF POTENTIAL LOG: shows a slight positive and negative anomalous fluctuation, with a 40 mV statistical noise envelope.

POINT RESISTIVITY LOG: No significant response.

SPECIFIC GRAVITY: No significant response, mean value 2.76.

MAGNETIC SUSCEPTIBILITY: No significant response, mean value 34 x 10^{-6} cgs units. The histograms of the two dolomite members, Figures A.3.4, shows comparable susceptibility results but the specific gravities are distinctly different.

<u>STURT TILLITE</u> (siltstone member - based on composition matrix).

Depth Range: 117 to 166 m. Apparent Thickness: 49 m.

GAMMA LOG: shows a significant gamma response with a very sharp change at the base of the unit, correlating with a dolomitic siltstone and conglomerate (164 to 166 m).

SELF POTENTIAL LOG: shows a significant response.

POINT RESISTIVITY LOG: shows a general uniform response and a distinctive change with the underlying unit.

SPECIFIC GRAVITY: relating uniform density response, with a slight increase with depth, 2.75 to 2.78. The mean specific gravity is 2.78. The histogram, Figure A.3.5, shows two possible populations having median values of 2.76 and 2.83 respectively.

MAGNETIC SUSCEPTIBILITY: shows a random response, median value of histogram is 50×10^{-6} cgs. units, and the mean value 41×10^{-6} cgs. units (Table A.3.1 and Figure A.3.5).

?RHYNIE SANDSTONE (EMEROO QUARTZITE (?))

The physical responses of this member indicates two distinctive units, namely Unit A and B, defined as follows:

UNIT A Depth Range: 166 to 200 m.

This unit is characterised by a low magnetic response, irregular self potential response and a slightly random resistivity response, e.g. 30 ohm m wide noise statistical envelope.

The specific gravity has a high mean value of 2.80, population 1 in Table A.3.1, with a corresponding low magnetic susceptibility (relatively non-magnetic).

UNIT B Depth Range: 200 to 218 m.

This unit when compared with Unit A, shows a marked increase in gamma response and point resistivity, and a slight decrease in self potential.

The specific gravity values are less, 2.72 overall. The histogram shows a mean value of 2.77 (Population 2) and a relative increase in magnetic susceptibility.

The log-linear cummulative percentage frequency plots of the specific gravity showed two distinctive populations separated at 2.70. A similar relationship is shown by the histogram of susceptibility, Figure A.3.6.

These results show quantitatively that two distinct lithological units are present in this member and it may in actual fact be composed of two stratigraphic units.

WOKURNA DDH3

The exact stratigraphic units of this drill hole are uncertain, but are considered to be of Marinoan age (Thomson, pers. comm.). The lithological log (Figure A.3.2, A.J. Parker, unpublished) shows the main rock types. However, with the use of the geophysical logs, five major geophysical Units A to D are defined in this section, and Unit D may subdivide into 2 or perhaps 3 subunits. It is assumed in this report that subunits D_1 and D_3 are the same, as the only geophysical difference is in the point resistivity log and a possible slight decrease in magnetic susceptibility.

The reliable data on both the self potential and point resistivity logs start at 74 m, as the data above are subject to a casing effect. The population parameters for the magnetic susceptibility and specific gravity for the Units A to D are given in Table A.3.2. The mean results for the specific gravity are all similar, except for a gradual increase in density with depth, which may be a function of compaction. The only significant magnetic subunit is D_2, having a mean susceptibility of 78×10^{-6} cgs. units. The contrast is only approximately 20×10^{-6} cgs. units, and the lack of magnetic response shows that no great thickness of this subunit is present.

The physical parameters of each unit are given below.

These data may be useful for future stratigraphic correlations.

UNIT A

DEPTH RANGE: 46 to 74 m

APPARENT THICKNESS: 28 m

LITHOLOGY - Shale

GAMMA LOG: shows a distinctive peak at the top and bottom of unit. The magnetic susceptibility and specific gravity histogram (Figure A.3.7) have mean values of 56 x 10^{-6} cgs. units and 2.71 respectively.

UNIT B

DEPTH RANGE: 74 to 121 m

APPARENT THICKNESS: 47 m

LITHOLOGY: Calcitic feldspathic sandstone plus some conglomeratic material, contains volcanics and gneiss.

GAMMA LOG: Generally low gamma response, with an increase in level at about 110 m. Probably correlating with the volcanics and gneiss within the conglomeratic section.

SELF POTENTIAL AND POINT RESISTIVITY LOGS: These logs show an irregular S.P. and resistivity variation, both positive and negative, the statistical noise envelope being 16 mV and 100 ohm m respectively, i.e. approximately a standard deviation wide.

MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY: The median and mean specific gravity are 2.73, and the median and mean susceptibility values are 65 and 53 x 10^{-6} cgs. units respectively. The higher median value probably reflects for 'foreign' igneous material in the conglomerate, and one data point has a value of 289 x 10^{-6} cgs. units.

UNIT C

DEPTH RANGE: 121 to 214 m

APPARENT THICKNESS: 93 m

LITHOLOGY: Interbedded banded red to maroon shale and grey feldspathic sandstone.

GAMMA LOG: A marked increase in background gamma response of 20 cps, with a general random statistical noise having an envelope width of 8 cps.

SELF POTENTIAL AND POINT RESISTIVITY LOG: A general low relatively smooth S.P. response. The resistivity response has an overall smooth profile with a gradual decrease from 120 ohm metres over 80 m, e.g. 1.5 ohm m per m. A considerable number of negative spikes are evident, reflecting sudden decreases in resistivity, of magnitudes of 60 ohm m.

There is a marked increase of both S.P. and resistivity at 200 m of 16 mV and 120 ohm m respectively, but the change is not coincident with the gamma response.

The median and mean specific gravity and magnetic susceptibility values of this unit are: 2.75 and 2.73; and 60×10^{-6} cgs. units respectively.

UNIT D

DEPTH RANGE: 214 to 306m

APPARENT THICKNESS: 92 m

LITHOLOGY: Same as Unit C (A.J. Parker). However, from a physical view point it is different as outlined below:

GAMMA LOG: The gamma response for the whole Unit D is relatively uniform with a statistical envelope of 4 cps. There is a slight increase of gamma response with depth.

SELF POTENTIAL AND POINT RESISTIVITY LOGS: Both logs show two distinctive characteristics, representing three possible subunits D_1, D_2 and D_3. Parameters given are referred to an arbitary datum on each log at a selected level taken between 200 to 210 m and are given in table A.3.3.

The specific gravity is relatively uniform, with slight variations. The magnetic susceptibility data show a marked increase for subunit D_2, and correspond with a decrease in both the S.P. and P.R. responses.

Table A.3.3 clearly shows that using the physical characteristics, there are at least three major lithological units within Unit D.

REFERENCE

TUCKER, D.H., 1972: Magnetic and gravity interpretation of an area of Precambrian sediments in Australia. Department of Economic Geology, Adelaide University. Ph.D. Thesis (unpublished).

TABLE A.3.1

MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY DATA OF THE ADELAIDEAN SEDIMENTS IN WOKURNA DDH2

STRATIGRAPHIC NAME	LITHOLOGY	NUMBER OF SAMPLES	MAGNETIC SUSCEPTIBILITY ($x10^{-6}$ cgs. units) RANGE	MEDIAN	MEAN	S.D.	SPECIFIC GRAVITY RANGE	MEDIAN	MEAN	S.I
TAPLEY HILL FORMATION	Maroon-Grey to Brown Slate (Possibly Weathered)	14	40 to 75	-	60	11	2.40 to 2.68	-	2.57	0.(
	Dark Grey Slate	37	0 to 90	0/70	45	31	2.56 to 2.87	-	2.69	0.(
WOOCALLA DOLOMITE MEMBER	Dolomite	8	20 to 65	-	40	16	2.80 to 2.98	-	2.89	0.(
UNNAMED MEMBER	Dolomitic conglomerate (Transition Beds)	9	10 to 45	45	34	13	2.72 to 2.84	2.75	2.76	0.(
STURT TILLITE	Tillite	50	5 to 55	50	41	14	2.67 to 2.90	2.76	2.78	0.(
RHYNIE SST. (EQUIV.) Emeroo Quartzite (?)	Dolomitic and Feldspathic Quartzite	OVERALL (51)	0 to 63	-	28	21	2.69 to 2.96	-	2.79	0.(
	Population 1	25	less than 30	0	9	9	2.71 to 2.96	-	2.81	0.(
	Population 2	27	35 to 63	45	46	8	2.69 to 2.90	-	2.77	0.(

TABLE A.3.2

SPECIFIC GRAVITY AND MAGNETIC SUSCEPTIBILITY DATA
OF LITHOLOGICAL UNITS IN WOKURNA STRATIGRAPHIC DDH3

LITHOLOGICAL UNIT	SPECIFIC GRAVITY					MAGNETIC SUSCEPTIBILITY ($x10^{-6}$ cgs. units)				
	RANGE	NUMBER	MEDIAN	MEAN	S.D.	RANGE	NUMBER	MEDIAN	MEAN	S.D.
UNIT A	2.67 to 2.77	15	2.73(?)	2.71	0.03	0 to 93	15	-	56	24
UNIT B	2.60 to 2.78	46	2.73	2.72(6)	0.04	0 to 80*	45	65	53	20
						*one value of 289 x 10^{-6} cgs units at 112 m not included in mean.				
UNIT C	2.49 to 2.82	93	2.75	2.72(9)	0.06	30 to 82	94	60	60	11
UNIT D (Overall)	2.58 to 2.93	92	2.78	2.77(6)	0.04	30 to 95	92	-	63	15
Subunit D_1	2.58 to 2.85	36	-	2.76(8)	0.04	36 to 80	37	-	59	9
Subunit D_2	2.58 to 2.85	28	2.81	2.77(9)	0.05	54 to 95	28	80	78	10
Subunit D_3	2.71 to 2.84	27	-	2.78(1)	0.03	30 to 63	28	-	52	12
Unit D_1 to D_3 (if same)	2.69 to 2.93	64	2.78	2.77(4)+	0.04	30 to 80	64	60	56	11

+(4) 3rd Decimal Place

TABLE A.3.3

COMPARISON OF PARAMETERS OF UNITS D_1 TO D_3
FROM WOKURNA DDH 3

UNIT	Depth Range (in metres)	Self Potential (millivolts)	Point Resistivity ohm metres	Specific Gravity	Magnetic Susceptibility (x 10^{-6} cgs units)
D_1	214 to 251	12 (Noise ± 2 mV)	Increase with depth from 200 - 380 Noise ± 40 mV Rapid Increase with Depth at top of unit.	2.77	59±9
D_2	251 to 279	Change from 12 to 0 Noise ± 2 mV	Change from 380 to 160 (Noise ± 5 mV)	2.78	78 ± 10
D_3	279 to 306	BASE LEVEL	Uniform at 80 ohm m.	2.78	52 ± 12

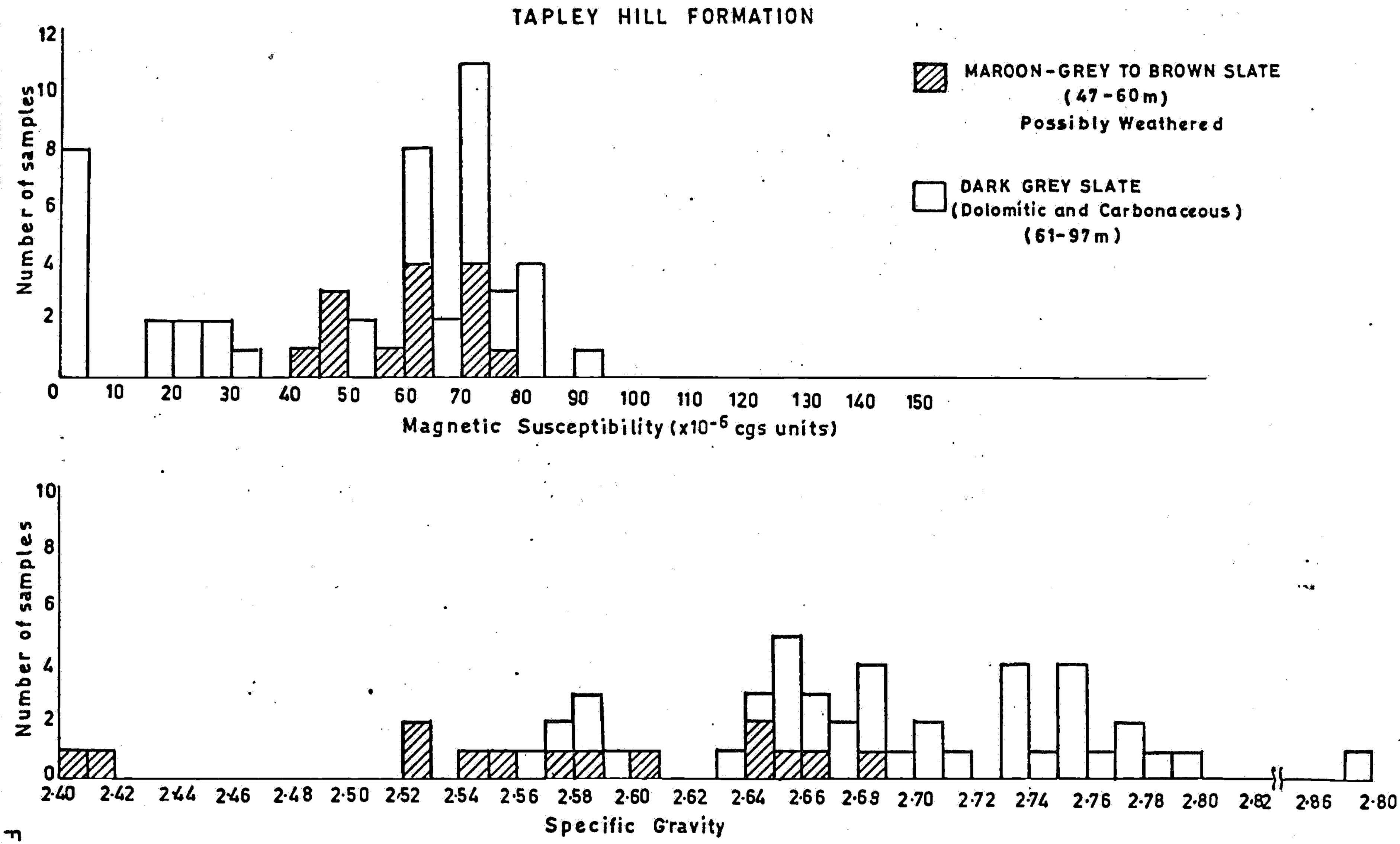


Figure A.3.3

DEPARTMENT OF MINES—SOUTH AUSTRALIA

HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY IN THE WOKURNA STRATIGRAPHIC DRILL HOLE N°2

Compiled: R.A.G.

Drn.

Ckd.

Scale: As shown

Date:

Drg. No.

S 12709

500-6.76 G684 O

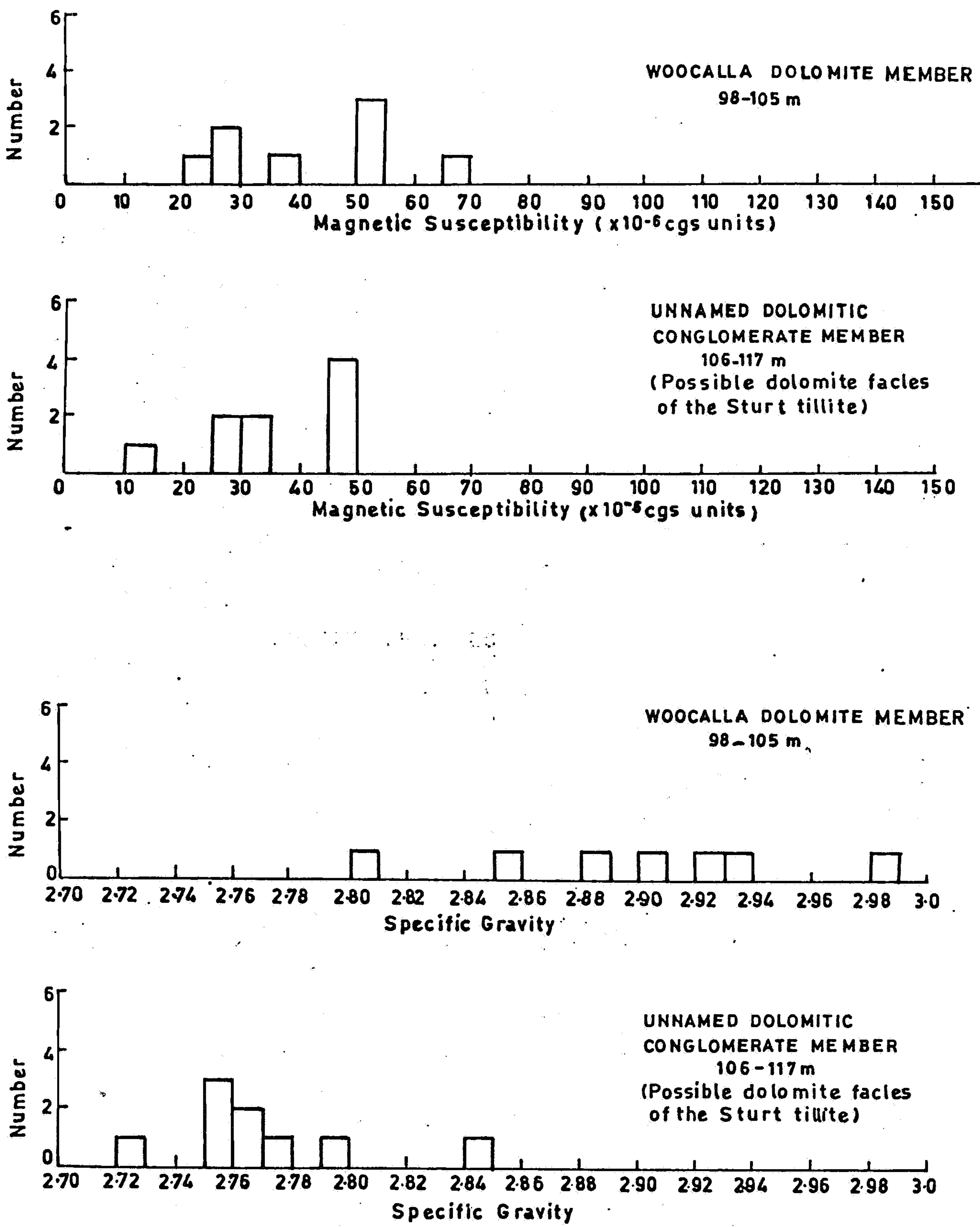
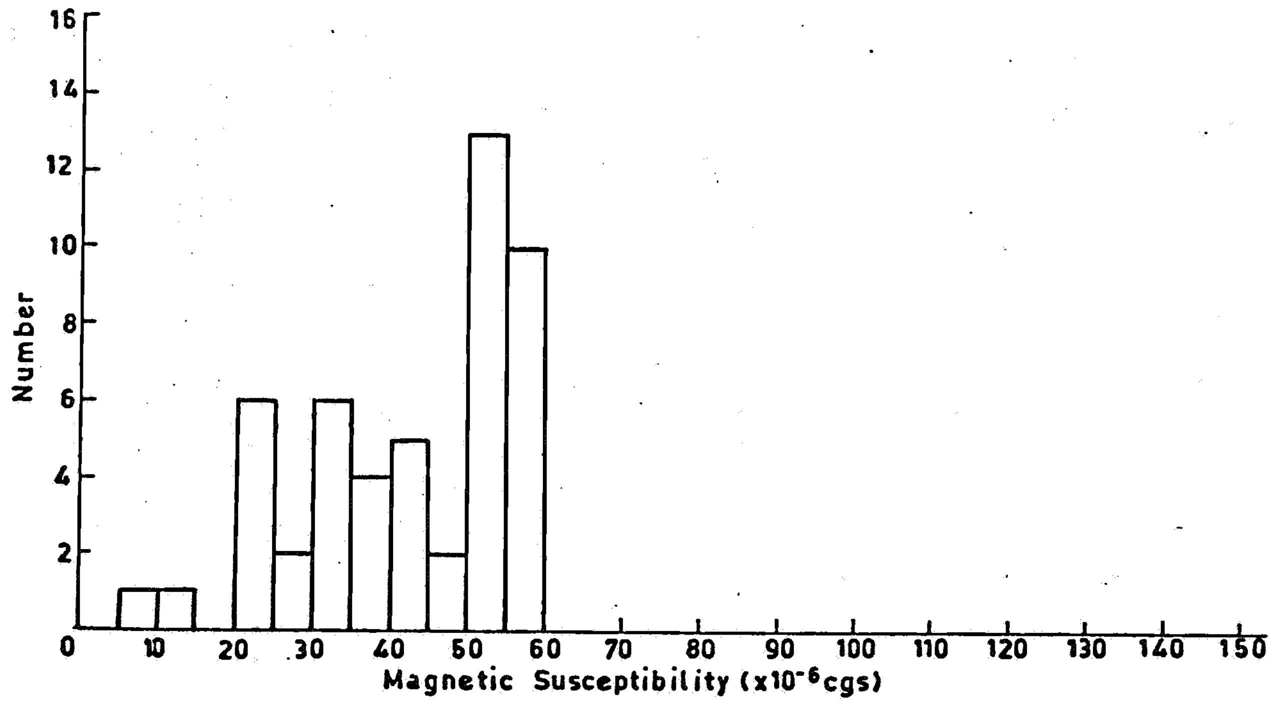


Figure A.3.4

		DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.		HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY, WOOCALLA DOLOMITE MEMBER AND UNNAMED DOLOMITIC CONGLOMERATE IN WOKURNA STRATIGRAPHIC DRILL HOLE N°2	Date: 18.2.77
Drn.	Ckd.		Drg. No. S 12710

500—6.76 G6584 O



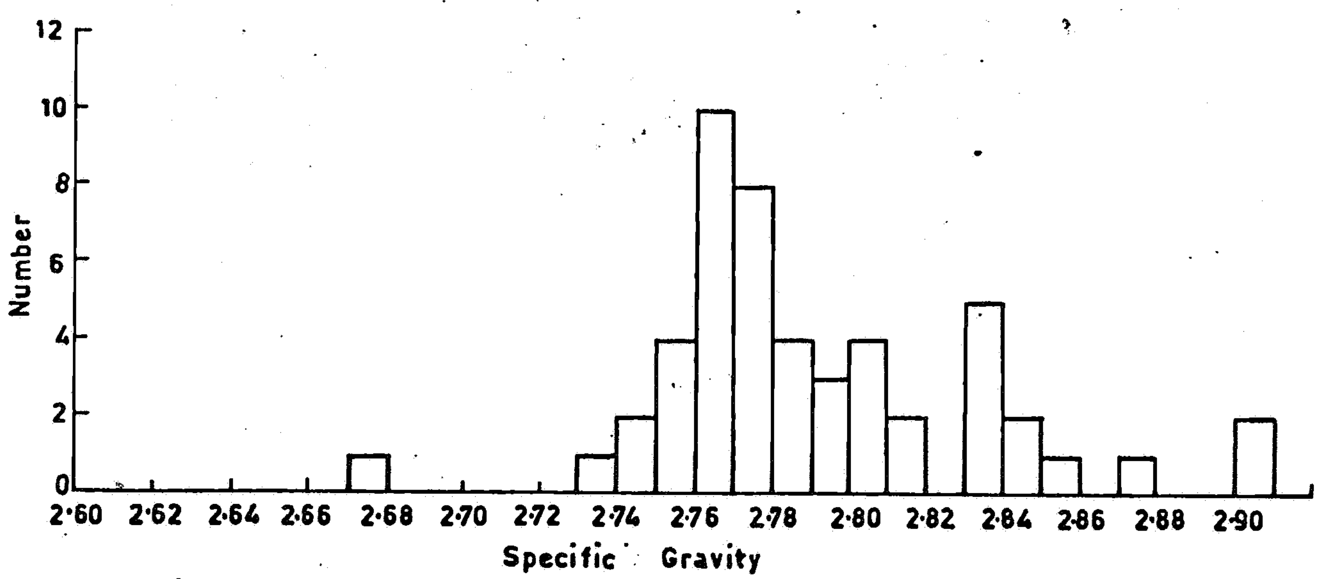


Figure A.3.5

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.	HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY OF THE STURT TILLITE FROM WOKURNA STRATIGRAPHIC DRILL HOLE N° 2	Date: 18.2.77
Drn. / Ckd.		Drg. No. S12711

500—9.75 F9882 O

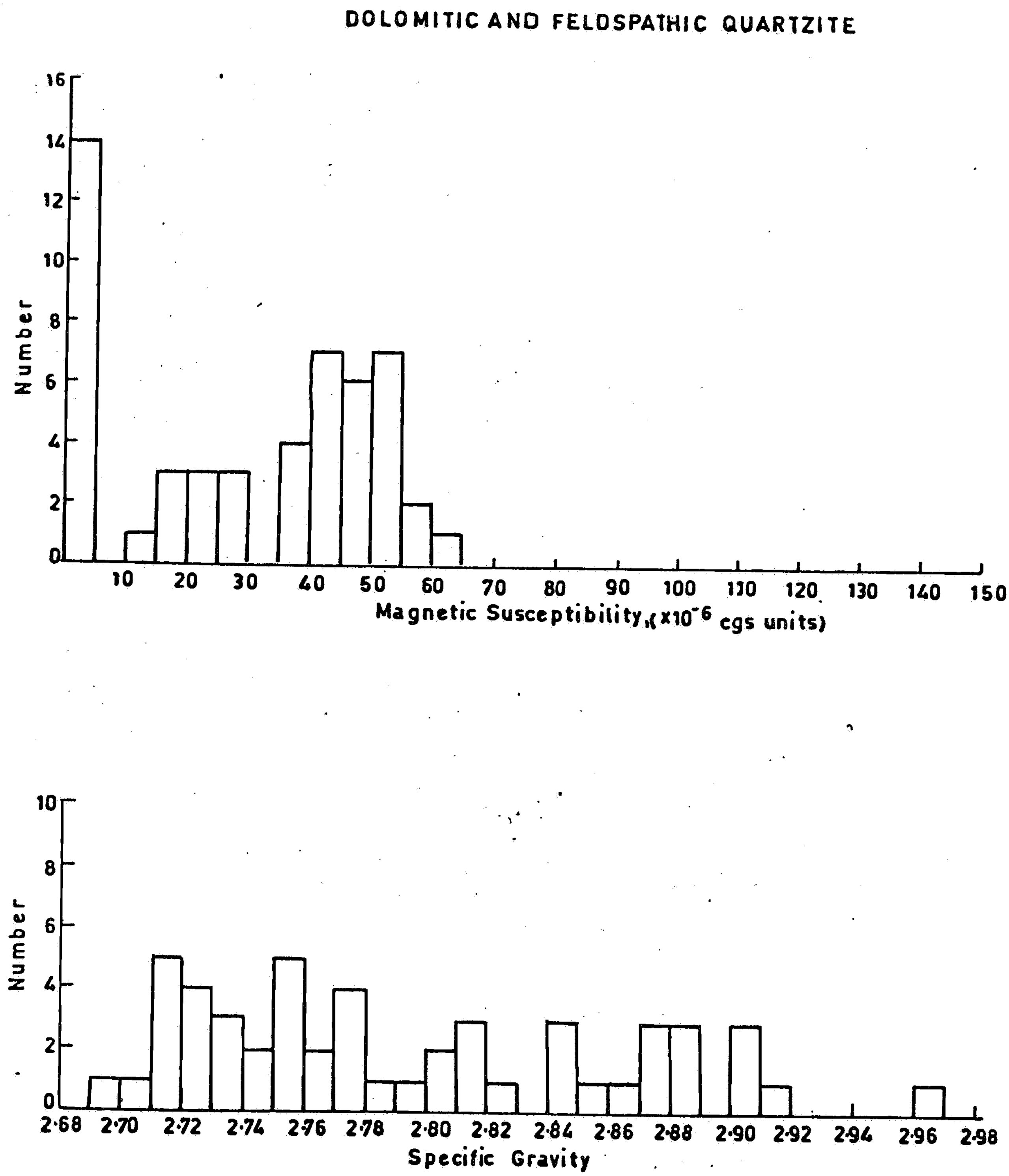


Figure A.3·6

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale: As shown
Compiled: R.A.G.	HISTOGRAMS OF MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY OF THE RHYNIE SST (EMMEROO QUARTZITE (?)) FROM WOKURNA STRATIGRAPHIC DRILL HOLE N°2	Date: 18.2.77
Drn. / Ckd.		Drg. No. S 12712

500—9.75 F9882 O

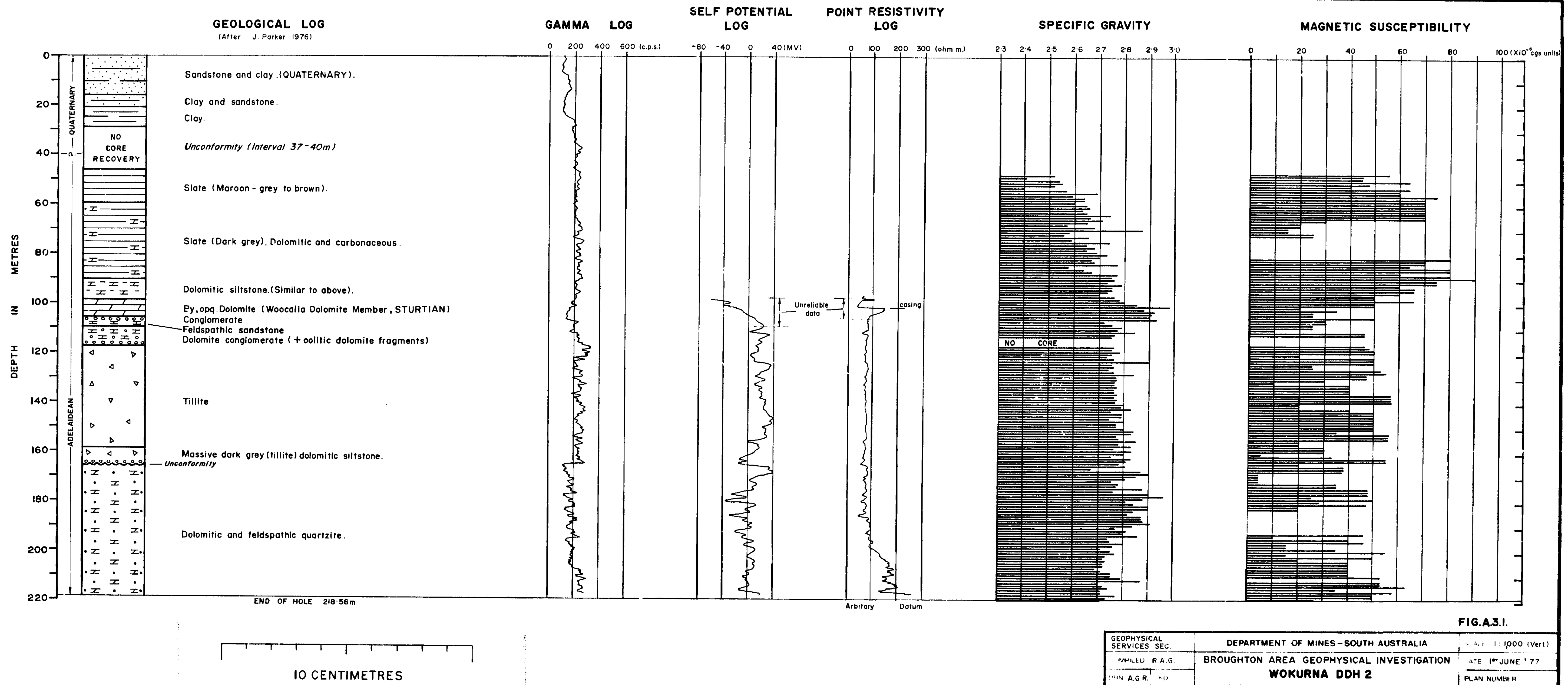


FIG. A3.1.

GEOPHYSICAL SERVICES SEC.	DEPARTMENT OF MINES - SOUTH AUSTRALIA	1:1000 (Vert.)
R.A.G.	BROUGHTON AREA GEOPHYSICAL INVESTIGATION	1st JUNE '77
A.G.R.	WOKURNA DDH 2	PLAN NUMBER
	COMPOSITE GEOPHYSICAL LOGS	77-559

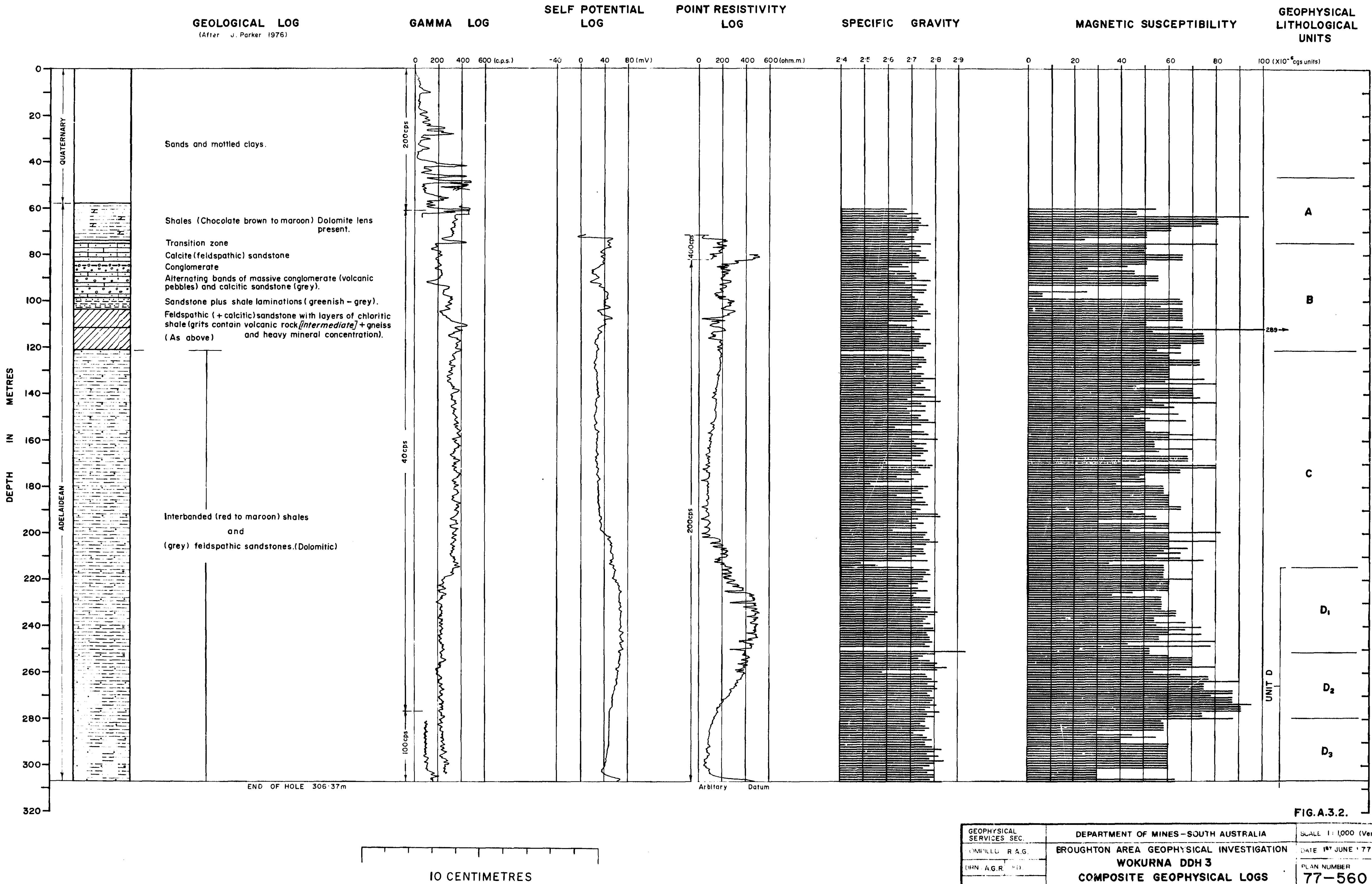


FIG. A.3.2.

GEOPHYSICAL SERVICES SEC.	DEPARTMENT OF MINES – SOUTH AUSTRALIA	SCALE 1 : 1,000 (Vert.)
COMPILED R.A.G.	BROUGHTON AREA GEOPHYSICAL INVESTIGATION	DATE 1ST JUNE '77
DRN A.G.R.	WOKURNA DDH 3 COMPOSITE GEOPHYSICAL LOGS	PLAN NUMBER 77–560

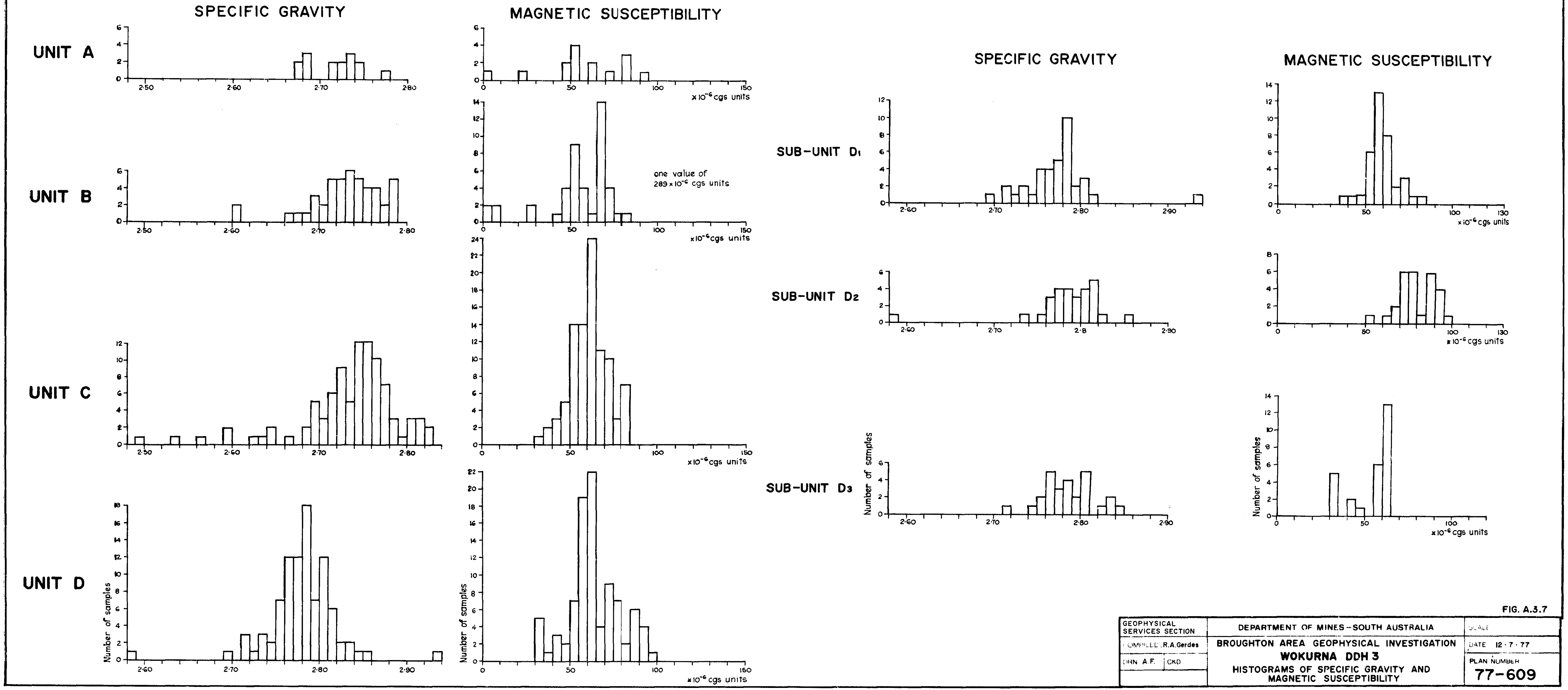


FIG. A.3.7

GEOPHYSICAL SERVICES SECTION	DEPARTMENT OF MINES–SOUTH AUSTRALIA	SCALE
COMPILED R.A.Gerdes	BROUGHTON AREA GEOPHYSICAL INVESTIGATION	DATE 12·7·77
DRN A.F. CKD	WOKURNA DDH 3	PLAN NUMBER
	HISTOGRAMS OF SPECIFIC GRAVITY AND MAGNETIC SUSCEPTIBILITY	77-609