DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 79/73

THE PRECAMBRIAN GEOLOGY AND GEOPHYSICS OF THE COOBER PEDY 1:250 000 SHEET

GEOLOGICAL SURVEY

REGIONAL GEOLOGY DIVISION

By

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D.M.E. No: 422/62
G.S. No: 6191

CONTENTS

*Petrographic thin section descriptions are available on request.

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ABSTRACT

The crystalline basement of COOBER PEDY comprises portion of the northern part of the Gawler Craton. Outcrop is scattered and generally intensely weathered.

Sediments that included sandstone arkose and banded iron formation were deposited during the Late Archaean to Early Proterozoic on an Archaean basement. Metamorphism reaching granulite facies grade occurred at about 2400 Ma, accompanied and followed by syn- to post-orogenic granites, equivalent to the Glenloth Granite. Collectively these metasediments and foliated granites form the Mulgathing Complex considered to constitute much of the basement of the southern half of COOBER PEDY.

Similar metasediments and gneisses associated with banded iron formations at Mt. Christie on TARCOOLA and at the Mt. Woods Inlier on BILLAKALINA give contrasting ages of 2400 Ma and 1550 Ma respectively. This poses a problem to be resolved.

A second metamorphic event reaching upper amphibolite facies and showing evidence of retrogression, represents the Middle Proterozoic Kimban orogeny of south-eastern Eyre Peninsula. The intrusion of Gawler Range Volcanics around 1,500 Ma marked the consolidation of the Gawler Craton.

Eight basement provinces have been interpreted. Their overall trend is northeast to east, similar to that obtained for the overall trend of observed layer-parallel foliations.

A prominent fault belt, comprising the Karari, Wallira and Faulkness faults, may separate basement which was strongly deformed and metamorphosed during the Kimban Orogeny near the centre of the map area (Province 3) from less affected rocks of the Mulgathing Complex to the south (Province 2).

A fault bounded northeasterly continuation of the Tallaringa Trough on TALLARINGA is interpreted with maximum seismic interpreted depths of about 400 m.

The most northerly known outcrop of Gawler Range Volcanics (Province 7) in South Australia occurs in the vicinity of Perfection Well on the northeastern margin of the Gawler Block.

Following cratonization, epeirogenic movement along prominent northeast, northwest and east northeast directions resulted in the formation of the Adelaidean-Palaeozoic Officer Basin and the Permian Arckaringa Basin.

INTRODUCTION

This report details and summarises geological and geophysical studies of the Precambrian crystalline basement of the COOBER PEDY 1: 250 000 map sheet. A history of the mapping program will be described in a later report.

The basement of COOBER PEDY and adjacent areas forms part of the northern Gawler Craton (Fig. 1) defined by Thomson (1970) as that part of the Australian Shield in South Australian that stabilised during Middle Proterozoic times, having subsequently undergone only epeirogenic movement and brittle deformation. He referred to the area of outcrop as the Gawler Block.

Thomson's (1970) Gawler Craton differs from that of Rutland's (1973) more expansive concept of the Arunta-Gawler Province. This is made up of an infractrustal province, the Gawler Nucleus, separated by the Musgrave-Fraser system (formed between 1400-1020 Ma) from a supra-crustal province to the north and west. A major phase of plutonism named the Pre-Carpentarian plutonism marks the time of cratonisation (1900-1700 Ma).

Rutland (in prep. 1980) uses the term Gawler Province to include the Lower Proterozoic orogenic domains (exposed basement) named the Fraser, Musgrave, Willyama and Gawler orogenic domains, the last being comparable to Thomson's (1970) Gawler Block.

On southeastern Eyre Peninsula, good outcrop has enabled recognition of a detailed stratigraphy and structural and metamorphic history of that part of the craton. This has not been possible for the northern part of the craton because of intense weathering and lack of outcrop. Emphasis has consequently been given to geophysics in interpretation of regional geology and structure.

GEOLOGY

Outcrop on COOBER PEDY is almost entirely confined to the southern half of the map sheet, and is highly weathered and scattered (Encl. 3). The geology is described under six divisions (the map symbol is shown after each heading).

Undifferentiated basement (AB)

This map unit consists of kaolin and kaolin-quartz rocks, non-foliated to foliated, fine grained to pegmatitic and with quartz reefs and stringers. Also included in this unit are outcrops photo-interpreted as basement.

Metasediments etc. (ABm)

Metasediments such as banded iron formations, quartzites, meta-arkoses, and layered and foliated acid rocks and granulites, comprise this unit.

Banded iron formation, oxidised quartz-magnetite granulite and banded gneiss outcrop in the vicinity of Commonwealth Hill. The best outcrop is described by Whitten (1960) as, "mainly medium to coarse grained ferruginous quartzites made up of ¼ inch to 1 inch bands of coarse haematite (much weathered to limonite), separated by similar bands of sugary quartz". Whitehead (1976a) described one specimen from Commonwealth

Hill as 'strongly metamorphosed banded iron formation', which contains 60-70% quartz and 30-35% oxidised magnetite. The grain size of quartz is coarser grained than is usually seen in South Australian jaspilites.

A prominent outcrop near Cross Roads Bore, richer in iron, has been described as an oxidised quartz-magnetite granulite or strongly metamorphosed banded iron formation (Whitehead, 1976a).

An iron oxide-bearing banded gneiss, near Thunderbolt Tank, may have been a low grade banded iron formation (Whitehead, 1976a). It is only 1-2 m thick and occurs with quartzite and clay-quartz rocks.

These bodies apparently have limited lateral extent and are generally lensoid in shape. Along strike from several outcrops of banded iron formation the iron and quartz content decreases with increasing kaolinized ?silicate minerals, reflecting in part at least, a primary sedimentary origin for the banded iron formation.

Little can be said of the metasediments associated with the banded iron formations, because of their highly weathered nature. Microcline, plagioclase, cordierite, muscovite and rounded zircons have been identified in less weathered gneisses. The textures of some specimens have been interpreted as granulitic, modified by granulation, shearing and re-crystallisation.

Twelve kilometres east of Sandstone Outstation, metasediments outcrop in the floor of several lakes. They are layered quartzites, being feldspathic, garnetiferous and micaceous in part. No foliation is conspicuous and grains form an equigranular matrix. Mineral assemblages are:

qtz + k feld + plag $\pm$ garn $\pm$ bio

Layered and granulitic rocks of acid composition outcrop throughout the southern and western parts of the map sheet. Mineral assemblages are:

qtz + k feld + plag + garn + bio (general)

qtz + k feld + hypersth + bio (rare)

Generally a foliation is not evident and a layering, or banding is only weakly defined.

Northwest of Cross Roads Bore there is considerable variation over a few metres both in the texture and composition of granulites. The dominant mineral assemblages are:

qtz + ortho peth

orthopy + hypersth

qtz + plag + k feld

Textures range from granuloblastic equigranular with smooth to curved grain boundaries, to a ribbon structure where quartz has been mobilised under some stress and recrystallised giving smooth to irregular boundaries.

Granulitic and layered acid rocks have been intersected in Wallira No. 2 (altered biotite-pyroxene granulite) (Townsend, 1973) and also in one of Utah Development Co. coal exploratory holes, biotite+chlorite+feldspar gneiss or granulite (Envelope 2410). These are located respectively on the northern margin of the Wallira and Lake Phillipson Troughs. At Fitzgeralds Dam, basement that forms part of the Fitzgerald basement high, outcrops through a thin cover of Mesozoic and Cainozoic sands (Encl. 3). It is the most northerly basement outcrop of the map sheet and has been variously described as potassic gneiss, granite or gneissic granite and quartz-feldspar ?granulite (Whitehead, 1967a; Steveson, 1976).

Granitoid rocks (AᵽP)

White porphyritic granodiorite outcrops east of Sandstone Outstation in the floor of a small claypan. Non-foliated coarse grained granodiorite intrudes fine-grained gneiss of similar composition. Laths of plagioclase in the granodiorite have a weak preferred orientation and quartz is elongate but has not been recrystallised (Whitehead, 1976b). It may be equivalent to the Glenloth Granite.

Granites (Ᵽ)

Near Surprise Bore are sheared and deformed granites that are foliated in part. Some are characterised by laths of pink potash feldspar, up to 1.5 cm long, and others by ovoid blue quartz. They are similar to rocks of the Balta Granite and the Engenina Adamellite on BILLAKALINA (Benbow and Flint, 1979).

Basic dykes (Ᵽβ)

Doleritic dykes have only been observed in the vicinity of Commonwealth Hill, where they occur in a east-northeasterly trending zone in close proximity to a banded iron formation. They are weakly layered and are apparently un-metamorphosed. However, a specimen collected by A. Williams (Vitols, 1974) indicat a complex postcrystallisation history that may have involved regional metamorphism.

Diorite with up to 5% magnetite was intersected in drill holes southwest of Wirrida O.S. within the area of an intense aeromagnetic anomaly (Dampier Mining Company, Envelope 3334).

Volcanics (Ᵽα)

Brown porphyritic rhyolite outcrops at Perfection Well and is considered part of the Gawler Range Volcanics. Drilling and seismic surveys by the South Australian Department of Mines and Energy (Nelson, 1971, a,b) indicate a sub-areal extent greater than 100 km^2. 'Felspar porphyry' has been intersected in a bore (5738-00034) in the central southern part of the map sheet.

METAMORPHISM AND GEOCHRONOLOGY

An acurate determination of the history and grade of metamorphism is not possible because of weathering and the restricted mineral assemblages.

The mineral assemblage most commonly seen in rocks belonging to the Mulgathing Complex is:

qtz + k feld + plag + bio + garn

and less commonly:

qtz + k feld + hypersth + bio

qtz + orthopy + hypersth + k feld + plag

qtz + k feld + plag + clinopy + bio

plag + orthopy + clinopy + bio

A high grade metamorphic event, upper amphibolite to granulite facies is indicated by:

(1) granuloblastic textures typical for the granulite grade,

(2) the general absence of muscovite,

(3) the occurrence of bi-pyroxene gneisses and

(4) the mineral assemblages.

Radiometric dates of gneisses east of Sandstone Outstation lie on the isochron determined for rocks from Mt. Christie, giving a minimum age for this metamorphic event of 2417 $\pm$ 59 Ma (Rb/Sr, model 3 isochron, initial ratio of 0.7036 $\pm$ 0.0015, decay constant 1.42×10^{-11}) (Webb, 1977).

The analyses for this rock were regressed with data for a specimen of gneissic granite from Fitzgeralds Dam (APm) and several specimens from TALLARINGA. They were found to produce an isochron of 2458 $\pm$ 60 Ma (initial ratio of 0.7014 $\pm$ 0.0012) (Webb, and Whitehead, 1977).

A second metamorphic event, of lower grade, has been petrographically recorded in a few specimens. Lowder (1973) says of the porphyroblastic gneiss west of Aurora Tank, "there is evidence of several periods of metamorphism. The second is of lower grade than the first but still at least amphibolite facies since no muscovite is formed from the potash feldspar". Alteration of the microcline porphyroblasts is slight, whilst a little of the biotite has been altered to chlorite and some of the quartz feldspar and biotite has been recrystallised to a finer grain size. The gneiss has been dated at 1539 Ma (K-Ar biotite; K=0.0119, atom% B=4.72 x 10^{-10} yr^{-1}, e=0.584 x 10^{-10} yr^{-1}) and this is considered to date the second metamorphic event (Webb, 1974).

Granite gneiss from Wallira No. 1 is thought to have recrystallised under the amphibolite facies of regional metamorphism. It has been dated at 1493 $\pm$ Ma (K-Ar, biotite; K=0.0119 atom%, B=4.72 x 10^{-10} yr^{-1}, e=0.584 x 10^{-10} yr^{-1}) and Webb (1970) considered "the gneiss may have formed at an earlier time and the younger biotite dates may have been over printed by some later event...". It has been noted after re-examination of core from Wallira No. 1 and Wallira No. 2 that the Sr^{87}/Sr^{86} ratios extrapolate to a value of 0.703 to 0.704 about 2500 Ma ago, thus it has been concluded the basement here is part of the Mulgathing Complex (Webb, 1977).

Granitic rocks near Surprise Bore, have been extensively sheared and have a weak foliation. Radke (1975) states that a metamorphosed volcanic from here has undergone probable greenschist metamorphism.

The porphyritic rhyolite at Perfection Well is considered to be part of the Gawler Range Volcanics. It has not been subjected to metamorphism and the emplacement is considered to mark the consolidation of the Gawler Craton at about 1 500 Ma (Thomson, 1970).

STRUCTURAL GEOLOGY

Structural Elements

The layering of banded iron formations and of quartz-feldspar rich rocks may exhibit a very weak parallel foliation or pass along strike into a foliation seen in gneisses richer in weathered silicates and biotite: this is described as a layer-parallel foliation.

The stereo plot of 78 observations shows a broad spread about an axis trending northeasterly and plunging 60° (Fig. 2).

Isoclinal folds in banded iron formation at Commonwealth Hill exhibit no axial plane foliation or distinct cleavage but one specimen indicated a weak foliation at an angle to both fold axis and banding (Whitehead, 1976).

A lineation has been seen in pelitic metasediments at several widely spaced localities, which has a northeasterly preferred direction.

The Karari Fault and Karari Fault Zone

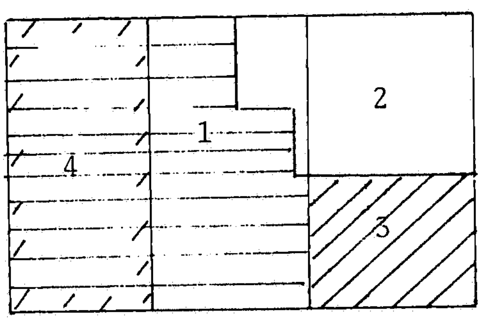
A prominent northeast topographic feature on western COOBER PEDY and on eastern TALLARINGA marks a fault named by Hall and Townsend (1971) the Karari Fault. The fault, a prominent photo-lineament, occurs on the southeastern side of a ridge mantled by silcrete that drapes down slope. Thus it appears the southern block has been downthrown, at least during Cainozoic times. This is supported by thickening of Quaternary sands to the southeast.

The Karari Fault was considered part of the east-west Wallira Fault (Hall and Townsend, 1971) until seismic work indicated that the major downthrown movement had occurred to the north (Milton, 1971). The Karari Fault is part of a zone named the Karari Fault Zone (Finlayson, 1979) which is indicated by parallel aeromagnetic anomalies, by a seismic

TABLE I

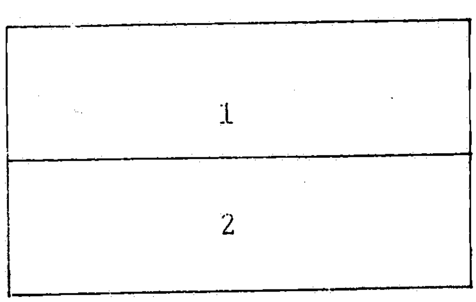
Regional Aeromagnetics

Area	Spacing (kilometres)	Elevation (metres)	Flown by	for	on	Published
1	1.6 N.S.	152 Agl.	BMR	SADME	1958	1971
2	8 E.W.	456 Bar.	Aeroserv.	Delhi	1961/62	1971
3	3.2 E.W.	152 Agl.	BMR	SADME	1966	1971
4	2.4 or 16 N.S.	608 and 760 ASL	Adastra Hunting	Exoil NL.	1964/65	Env. 527, 549, 1809.



Regional Gravity

1	6.4 x 6.4 km^2	-	SADME	SADME	1968/69	1971
		-	SADME	SADME	1969	1971



profile and by outcropping basement on the northern side.

The amount of vertical displacement across the Karari Fault Zone west of Dingo Flat Gate on southern TALLARINGA is of the order of 1000 metres (Milton, 1975) and east of Wallira West No. 1 is at least 300 metres and more likely is much greater (Milton, 1971).

The Karari Fault Zone extends southwestwards to the Great Australian Bight and northeastwards to the Peake and Denison Ranges. Over the Coober Pedy Ridge its presence is not indicated by bouguer, gravity or aeromagnetic features. Near the township of Coober Pedy, a number of parallel drainage lines and silcrete capped ridges suggest its continuation.

The Wallira Fault

The Wallira Fault marks the junction between two provinces of highly contrasting magnetic intensity and bouguer gravity values. The Wallira Fault is at least 50 kilometres long and may continue along the length of the Coober Pedy Ridge. The amount of vertical or horizontal displacement is not known. Unlike the Karari Fault it has no surface expression thus it probably has not been active in Holocene times.

GEOPHYSICS

Gravity

Gravity surveys were made in 1968-69 at 6.4 kilometres (four mile) spacings over COOBER PEDY, to help locate targets for a seismic survey in the search for hydrocarbons (Hall and Townsend, 1969). During the seismic survey of Milton (1970) gravity readings were also made at the shot hole locations. Results of these surveys formed the basis for the Bouguer Gravity Anomaly Map of COOBER PEDY (Hall *et al*., 1971).

One of the most prominent features is the positive bouguer gravity belt coincident with the Coober Pedy Ridge (Fig. 7). Here it is oriented almost east-west but on BILLA KALINA it trends northwesterly over the Mt. Woods Inlier. Bouguer gravity values increase toward the east, reaching values of almost +40 milligal. Mapping of the Mt. Woods Inlier (Flint and Benbow, 1977) indicates that banded iron formations and iron-rich metasediments are in part responsible for this positive Bouguer gravity belt.

The other major positive anomalous area (0 to +10 milligal) occurs in the south and is part of a belt that extends southwestly to the northwest part of TARCOOLA. It is in this area that the Archaean banded iron formations of Commonwealth Hill and Mt. Christie occur.

North of this positive gravity area, values gradually decline to reach minimum values of -36 to -38 milligal where troughs, named the Wallira and Lake Phillipson Troughs, confirmed by drilling (Townsend 1975) have been located. A cross-section through Wallira No. 2, of basement depth and bouguer gravity (Fig. 6) indicates that the sediments of these deep troughs are not the only factor contributing to these low values. On TALLARINGA, basement outcrops in this -20 to -30 milligal belt indicating it comprises low density rocks, in particular acid intrusives and layered and gneissic acid rocks. These are also responsible for the observed negative bouguer gravity values. A small increase in gradient occurs where dense sediments fill the troughs.

Another feature of note is the steep gradient on the northern side of the Wallira Trough, which is the position of the Wallira Fault.

Aeromagnetics

A number of aeromagnetic surveys have been made over COOBER PEDY (see Table I). The survey by the BMR in 1958 gives the most adequate coverage since the flight lines were 1.6 kilometres apart, N-S, with a flight height of 150 m above ground level. The least satisfactory survey for interpretation covers the northeastern quadrant, where flight lines 8 kilometres apart, were flown 300 metres above ground level. This area needs to be reflown to enable a better understanding of this part of the Coober Pedy Ridge and its continuation on to BILLA KALINA.

A brief appraisal of the aeromagnetic data has been made, without reference to the original data, using the aeromagnetic map of total intensity for COOBER PEDY. This involved delineating anomalies at the point of inflection and grading them according to the dominant amplitude range. Anomalies are described as having good to reasonable linearity or being non-linear. This interpretation is primarily concerned with the area covered by the BMR survey.

TABLE II

Zone Type	Dominant Amplitude (gamma)	
1	>100	
2	100-200	Non-linear
3	250-500	
4	500-1000	
5	>1000	
6	>50	
7	50-100	
8	100-200	Linear
9	200-300	

11	500-1000
12	1000-2000
13	2000-5000
14	>5000

The area of interpretation can be divided into seven broad provinces, each with a characteristic aeromagnetic signature or pattern (Figs. 3,4).

Province I (aP1)

This is made up of a number of moderate to high intensity linear anomalies (Zone types 11-13, average 11). Their orientation varies but there is a strong northeast to east component. This area coincides in part with a regional gravity high (0 to +10 milligal). The higher intensity anomalies (Zone type 12-13) are considred to have banded iron formations as their likely source although drilling by Dampier Mining Company (Env. 3334) indicates diorite is also responsible in part. A number of lower magnetic intensity anomalies (Zone type 11) may represent folded basic metasediments or granulites.

Province II (aPII)

This is an area of low magnetic intensity with a number of low to intermediate intensity anomalies (Zone types 7-11). The regional magnetic intensity diminishes gradually towards the north. Layered and gneissic acid metasediments and granitic intrusives outcrop in this area. There are also minor discontinuous banded iron formations.

An almost circular anomaly denoted 11 a, may be a basic intrusive, six kilometres in diameter and at a depth of approximately 800 metres. It occurs at the junction of two faults.

A number of conspicuous narrow northwest low intensity anomalies (Zone types 7-10) are interpreted to be basic dykes.

Province III (aPIII)

This covers an area of northeast to east-trending high intensity linear anomalies (Zone types 13-14). It is fault bounded and separated from Province II by the Wallira Fault. From the work of Flint and Benbow (1977) the source of the anomalies is considered to be banded iron formations.

Province IV (aPIV)

This province is one of moderate to low magnetic intensity with values decreasing to the northwest and north. Considering the continuity and spacing of contours it is considered to mark a continuation of the Tallaringa Trough and to be an area of probable acid metasediments.

A conspicuous linear anomaly of intermediate intensity (Zone type 9-11) is interpreted to be a basic dyke. It has been emplaced parallel to the Karari Fault Zone.

A large area, designated IVa, one of low intensity and of non linearity may mark an acid intrusive.

Province V (aPV)

This is an area of high intensity linear and non-linear anomalies (Zone types 13 and 4-5) which are likely to have banded iron formations as their source. It is fault bounded on its southeastern margin, coincident with a LANDSAT-1 lineament.

Province VI (aPVI)

This is an area of regionally low aeromagnetic intensity with broad anomalies (Zone types 9-10). It has acid gneiss and intrusive rocks as likely source rocks.

Province VII (APVII)

This is a province of low aeromagnetic intensity with a number of northeasterly trending low intensity anomalies (Zone types 9-10). It coincides with a southwesterly continuation of the Mabel Creek High and is coincident with a positive Bouguer gravity anomaly. It possibly reflects metasediments with basic horizons.

Seismic Work

During 1969 seismic work was extended to the southern and western parts of the Arckaringa Basin after a hydrocarbon potential was indicated for the Boorthanna Trough (Milton, 1969). Permian coal-bearing sediments were already known from Lake Phillipson Bore which was drilled for water in 1905 (Ludbrook, 1961). Seismic work begun in 1969 (Milton, 1970), was extended in 1970 over the Lake Phillipson and Tallaringa Troughs (Milton, 1971).

Dimensions of features delineated (refer to Fig. 5) are:

1. Wallira Trough approx. 50 x 8 kilometres, 1 672 metres deep at the eastern end, oriented eastwest, offset approximately 3 kilometres to the north of the regional gravity low.
2. Lake Phillipson Trough 44 x 6 kilometres, 1 200 metres deep at the northwest end, oriented northwesterly, in the centre of a gravity low of -38 milligal.
3. Robin Trough 6 x 1½ kilometres, 600 metres deep, oriented northeasterly, coincides with an area of Bouguer gravity of 0 to -10 milligal.
4. Long Creek Trough 8 x 5 kilometres, 910 metres deep, oriented ?northwesterly coincident with a Bouguer gravity low of -28 milligal.

5. Coober Pedy Ridge 128 x 25 kilometres, shallowest point is 30 metres below surface, oriented east-northeast coincides with a positive Bouguer gravity anomaly (+20 milligal).

6. Mabel Creek High oriented northeasterly across the northwest corner of the sheet, coincident with a positive Bouguer gravity anomaly on MURLOOCOPPIE.

7. Shallow Broad Basin oriented ?northeasterly between the Coober Pedy Ridge and the Mabel Creek High, an extension of the Tallaringa Trough. The deepest point is greater than 200 metres below sea level.

8. Fitzgerald Basement High 29 x 6 kilometres, highest point is near Fitzgeralds Dam where basement outcrops. It coincides with a negative Bouguer gravity area (as low as -18 milligal).

Work by Nelson (1971b) in the search for railway ballast for the Tarcoola-Alice Springs Railway indicated the easterly extension of a fault bounded basement high north of Lake Phillipson Bore. This is named the Fitzgerald Basement High, which near Fitzgeralds Dam crops out through Cainozoic and Cretaceous sediments. The outcrop is granite gneiss or gneissic granite, covering an area of only a few hundred square metres. A few short seismic traverses indicate the basement slopes from 12 metres near Fitzgerald Dam to 46 metres (below ground level) 8 kilometres south of Robin Rise.

The Wallira and Lake Phillipson Troughs coincide with an arcuate low gravity belt, between outcropping crystalline basement to the south and the Coober Pedy Ridge.

The reflection seismograms over the Lake Phillipson Trough are of good quality and indicate four reflecting horizons.

They are the top of the Permian, the top of shales in the Lower Permian Unit 1, the top of the Permian Unit 2 and the Precambrian. In the Lake Phillipson Trough a further reflector has been observed around 910 metres just above the high speed basement reflector. It may represent dolomitic sediments of the Observatory Hill Beds which have been intersected in Wallira West No. 1 (Townsend, 1971).

The results over the Wallira Trough were poorer, with a lack of correlation between refraction and reflection horizons because of the narrowness and greater depth of the trough. The Lake Phillipson Trough is apparently more structurally complex on its northern and eastern margins and further work was recommended to clarify this (Milton, 1970).

Seismic refraction profiles were also shot in the Perfection Well area in the search for railway ballast. Basement depths ranged from 18.5 metres to over 136 metres (depth limit of equipment used) where a narrow north-south trough was indicated. A drill hole was placed where the shallowest basement was indicated and intersected porphyry at 20.6 metres. Nelson (1971b) considered porphyry to be the major component of the basement based on the refraction velocities and also the low magnetic intensity. It is a negative Bouguer gravity area.

A number of short refraction traverses were used to outline the Coober Pedy Ridge more accurately and indicated depths ranging from 30 to 106 metres. The drillhole at CPB 7 intersected metamorphised basement of adamellitic composition at 31.6 metres (Nelson, 1971b).

DISCUSSION AND CONCLUSIONS

Provinces of COOBER PEDY

The basement of COOBER PEDY may be divided into a number of provinces, based on a synthesis of geophysics and geology (Fig. 7).

1. Aeromagnetic province 1 (aPI) is coincident with a northeasterly trending belt of positive bouguer gravity. The banded iron formations of Commonwealth Hill outcrop in this area and these trends can be traced southwest to include the banded iron formations of Mt. Christie on TARCOOLA.

   The banded iron formation at Mt. Christie, where several magnetic horizons are indicated (Gerdes, 1975) has been interpreted to be part of a "complex antiform (Gerdes, 1975) with a north-northeasterly trend and northerly plunge" (Daly, 1978). Associated rock types are quartz+feldspar+biotite+garnet gneiss and schist and quartz-feldspar+biotite+garnet+cordierite gneiss (Daly, 1978).

2. A broad area in the southern half of the map sheet has low bouguer gravity and aeromagnetic intensity (aPII) both showing a northerly regional decline in value and reaching their minimum at the Wallira and Lake Phillipson Troughs.

   Acid gneisses, schists and layered rocks outcrop throughout the central and western parts. Leucocratic gneisses with low specific gravity and magnetic susceptibility are responsible in part for the low Bouguer gravity anomaly on TALLARINGA (a continuation of the Wallira Gravity Low) rather than a thick sedimentary cover.

2a. This sub-province is characterised by two high intensity aeromagnetic anomalies (aPIIIa) which occur in a negative Bouguer gravity area midway between the Wallira and Robin Troughs.

3. The seismically located Coober Pedy Ridge is coincident with aPIII and a belt of high Bouguer gravity. It can be traced eastward on to BILLA KALINA where basement crops out as the Mt. Woods Inlier. On COOBER PEDY only a few drill holes penetrate basement. Wallira 2 encountered altered biotite-pyroxene granulite and a coal exploratory hole of Utah Development Co. encountered biotite+chlorite+ feldspar gneiss or granulite (Env. 2410).
At the Mt. Woods Inlier, banded iron formations, magnetite-rich granofels, and gabbros having high specific gravity and magnetic susceptibility are responsible in part for the high positive aeromagnetic intensity and Bouguer gravity values.

4. A northeast to east trending province, regarded in part as an continuation of the Tallaringa Trough on TALLARINGA is characterised by low Bouguer gravity coincident with aPIV. A prominent linear aeromagnetic anomaly parallel the Karari Fault Zone, may be a basic dyke.

4a. This sub province, which has non-linear aeromagnetic character, may be a granitic intrusion or rhyolite extrusion.

5. aPV coincides with a negative Bouguer gravity area on the southeastern margin of the Mabel Creek basement high. The high intensity aeromagnetic features may be banded iron formations and/or basic dykes.

6. This is the Mabel Creek High, an area of positive Bouguer gravity which coincides with aPVI.
7. In this region Gawler Range Volcanics crop out and have a much greater sub surface extent in the southeastern part of the map sheet.
8. The Fitzgerald Basement high is regarded by Nelson (1971b) to have a similar magnetic character to the area around Perfection Well, i.e. aPVII. Granite gneiss variously described as granulite and gneissic granite crops out Fitzgeralds Dam and is thought to be the northwest of major component of this province. The basement high coincides with a negative Bouguer gravity belt.

The provinces interpreted on the western margin of COOBER PEDY are in agreement with the aeromagnetically interpreted provinces on TALLARINGA (Finlayson, 1979).

Regional Structure

Conspicuous trends in this northern part of the Gawler Craton are northeast, northwest, east-northeast to east.

The overall trend of provinces 1, 4, 5 and 6 is northeast and aeromagnetically interpreted fold trends have a similar orientation. This is generally the case for the western margin of the craton on NULLARBOR and FOWLER where Roberts (1975) described a 'rim zone' bounded by the Karari and Pitumba Faults. This area he interpreted to be one of the following:-

a. isoclinally folded and overturned banded iron formations and basic volcanics (that dip generally towards the southeast).
b. extensive basic dyke intrusions.
c. high grade metamorphics.

On COOBER PEDY this model is not applicable, for shallow basement occurs on the northern side of Karari Fault and further, the boundary between provinces 2 and 3 for example does not trend parallel to it. The area between the Karari Fault and the continuation of the Pitumba Fault on COOBER PEDY is one of high grade metamorphics with banded iron formations in Province 1 and 3.

Strong northeast-striking shears and faults occur in the northern part of the craton. Dominant is the Karari Fault and Karari Fault zone, the Pitumba Fault and to a lesser degree a lineament which lies on the northeastern margin of province 1. The latter can be traced to BILLA KALINA where strongly sheared and recrystallised leucocratic gneisses outcrop which belong to pE3 of Flint and Benbow (1977). They lie in a negative Bouguer gravity 'corridor', the continuation of Province 8. They have been radiometrically dated at 1577 $\pm$ 192 Ma (Webb, 1977), which contrasts with a age of 2458 $\pm$ 60 Ma for the gneisses at Fitzgeralds Dam.

On the northeastern margin of the Gawler Craton are a number of northwesterly oriented magnetic dykes (Fig. 8). On COOBER PEDY they are conspicuous in Province 2 (Fig. 7). Thomson (1977) considers them to be of Sturtian age.

The Lake Phillipson and Long Creek Troughs have a similar northwesterly orientation and so too does the boundary between province 2 and the Mt. Woods Inlier, marked by the Faulkness Fault (Flint and Benbow, 1977). Movement may have taken place along these faults in the Holocene as is indicated by lineaments and drainage.

The other dominant preferred orientation is east-northeast to east, shown by the Wallira Trough the Wallira Fault and the trends within Province 3.

Both the Faulkness and Wallira Faults mark the junctions between basement of contrasting geophysical properties. They are normal faults probably initiated at the end of the Kimban

Orogeny and are features along which epeirogenic movement has occurred.

The most detailed knowledge of structural geology in the general area pertains to the Mt. Woods Inlier (Flint and Benbow, 1977). Three deformational phases have been recognised; an early layer-parallel foliation is overprinted by at least two deformational events. The stereoplot of 71 layer-parallel foliation observations at Mt. Woods yields a broad scatter about a possible fold axis plunging 25^{o} toward 250^{o}. This compares with a possible fold axis plunging about 60^{o} toward 45^{o} for COOBER PEDY (based on 78 broadly spaced more steeply dipping observations).

Northerly fold axial directions are indicated for the Mt. Christie area on TARCOOLA (Daly, pers. comm. 1979) whilst aeromagnetically interpreted banded iron formations in this region (Province 2 of Gerdes (1975) outline a northeasterly oriented complex of fold axes (Gerdes, 1975).

Regional Geology

Rocks of similar metamorphic grade and composition outcrop on TALLARINGA, TARCOOLA and BILLA KALINA. Banded iron formations at Mt. Christie, which lie in the southwesterly continuation of province 1 and those of the Mt. Woods Inlier, have a similar outcrop appearance. They are thin and discontinuous and drill core (for Mt. Woods and Mt. Christie) shows them to be greenish black and white banded gneisses. Some bands are almost pure magnetite other have:

qtz + magn + diop + hypersth + amph

which may have interlaminae of: micro feld + plag

The amphibole represents retrogressed silicate. Relict granuloblastic textures have been preserved.

The leucocratic gneisses of province 2 are a common rock type on TALLARINGA, the Mt. Woods Inlier (in PE3 of Flint and Benbow 1977) and around Earea Dam on TARCOOLA for example. They probably reflect a similar metamorphic grade as they are gneisses comprising qtz + k feld + plag ± bio ± garn which may or may not retain relict granuloblastic textures. Shearing and recrystallisation is often seen.

For the Mt. Woods Inlier the cordierite-almandine sub-facies of the granulite facies has been proposed (Flint and Benbow 1977). Common mineral assemblages are:

qtz + micro + plag + bio + garn + cordier

qtz + micro + plag + cordier + bio + magn

qtz + micro + plag + cordier + sillim + magn

and textures are granoblastic and granuloblastic. Cordierite is common at Mt. Woods but this does not appear to be the case on COOBER PEDY.

For the Mt. Christie area common mineral assemblages are:

qtz + micro + plag + bio + garn

qtz + micro + plag + bio + garn + cordier + tr. sillim

Relic granuloblastic textures have been preserved and it is evident that the metamorphic grade is very similar.

The quartz-microcline-plagioclase-biotite gneisses that are interlayered with the Mt. Christie banded iron formations have been dated at 2417 ± 59 Ma (Webb, 1976). This is regarded as a minimum age for the granulite grade of metamorphism.

The banded iron formations at Mt. Woods have been much more remobilised and brecciated, having been intruded by diorite, gabbro and granite. The metasediments associated with them are unlike those seen elsewhere, particularly the conspicuous banded granofels. This suggests they lie in a different stratigraphic position to those of Mt. Christie and Commonwealth Hill.

Radiometric ages of the metasediments at Mt. Woods, Ph1 1564 ± 97 Ma and Ph3 1577 ± 92 Ma (Rb/Sr) (Webb, 1980) are much younger than the Archaean - Lower Proterozoic dates on COOBER PEDY, TARCOOLA and TALLARINGA. In fact these ages are even younger than that obtained for the Engenina Adamellite (1641 ± 38 Ma (Rb/Sr)) which whey clearly pre-date.

This is an enigmatic situation with rocks of similar lithology and metamorphic grade giving such vastly different ages. Further work is required to understand the apparent anomaly. In contrast to what is stated in Flint and Benbow (1977), the rocks of Province 3 and the Mt. Woods Inlier may be areas strongly remobilised and metamorphosed during late Kimban times now separated by the Faulkness, Wallira and Karari Faults from areas much less affected.

Summary of Geological History

1. Deposition of sediments that included sandstones, arkoses and banded iron formations on an Archaean basement in Late Archaean to Early Proterozoic times.
2. Deformation with tight isoclinal folding having northeast to east axes. Formation of a layer-parallel foliation. Metamorphism from low amphibolite to granulite facies grade dated at 2458 ± 60 Ma. Intrusion of syn-to post orogenic granites equivalent to the Glenloth Granite. The metasediments and intrusives are referred to by Daly et al. (1979) as the Mulgathing Complex.
3. Mulgathing Complex further deformed and retrogressively metamorphosed during the Kimban Orogeny. Metamorphic grade reached amphibolite to granulite facies. Intrusion of the syn-orogenic Engenina Adamellite.
4. Intrusion of the Balta Granite.
5. Extrusion of the Gawler Range Volcanics marking the consolidation of the Gawler Craton at about 1 500 Ma.

6. ?Sturtian intrusion of northwest-trending basic dykes.
7. Epeirogenic movement during Cambrian times resulting in formation of the Officer Basin.
8. Epeirogenic movement during Lower Permian times resulting in the formation of the Arckaringa Basin. Comparatively minor epeiorogenic movement has since taken place.

ACKNOWLEDGEMENTS

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M.C. BENBOW

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APPENDICES

Record of Petrography (Refer to 1:250,000 geological map sheet for location of specimens)

RECORD OF PETROGRAPHY

Coober Pedy 1 000 000 map sheet

5839 RS 1	Adamellite
5839 RS 2	Potassic gneiss
5839 RS 3	Granite gneiss
5839 RS 4	Quartz - feldspar granulite
5839 RS 5	Granite
5839 RS 6	Granite
5839 RS 8	Chlorite-quartz-plagioclase cataclasite
5839 RS 44	Granite gneiss
5839 RS 45	Layered Granite gneiss

Ingomar 1 000 000 map sheet.

5838 RS 1	Rhyolite
5838 RS 2	Rhyolite
5838 RS 3	Rhyolite
5838 RS 4	Rhyolite
5838 RS 5	Granulite or hydrothermally altered granodiorite

Phillipson 1 000 000 map sheet.

5739 RS 1	Feldspar-quartz-biotite gneiss
5739 RS 2	" " " "
5739 RS 4	Granite gneiss
5739 RS 5	Adamellitic rock
5739 RS 6	Layered gneiss
5739 RS 7	Altered biotite schist
5739 RS 8	Metamorphosed igneous rock
5739 RS 9	Metavolcanic
5739 RS 22	Sheared metamorphic

Woorong 1 000 000 map sheet

5739 RS 1	Metamorphosed hornfels gabbro
5738 RS 2	Weathered metasediment
5738 RS 3	?Granulite
5738 RS 4	Weathered metamorphic
5738 RS 5	Banded iron formation
5738 RS 6	?Granulite
5738 RS 7	Acid gneiss
5738 RS 8	Banded iron formation
5738 RS 9	Acid gneiss
5738 RS 10	Banded iron formation
5738 RS 11	Charnockite
5738 RS 12	"
5738 RS 13	Feldspathic granulite
5738 RS 14	Pyroxene bearing granulite
5738 RS 15	Felsic granulite

5738 RS 16	Pyroxene bearing granulite
5738 RS 17	Adamellitic gneiss
5738 RS 18	Foliated Adamellite
5738 RS 19	" "
5738 RS 20	Garnet bearing granulite
5738 RS 21	" " "
5738 RS 22	Banded iron formation
5738 RS 23	Acid gneiss
5738 RS 24	Acid rock
5738 RS 25	Acid granulite
5738 RS 26	Acid gneiss
5738 RS 27	Metamorphosed acid volcanic
5738 RS 28	Sheared granite
5738 RS 29	?Igneous rock
5738 RS 30	Microgranite
5738 RS 31	Micaceous gneiss
5738 RS 32	Gneiss
5738 RS 33	Dolerite
5738 RS 34	"
5738 RS 35	Gneiss
5738 RS 36	Quartz-mica schist
5738 RS 37	Quartz
5738 RS 38	Adamellite

Yerarda 1 000 000 map sheet

5639 RS 1	Porphyritic microgranite
5639 RS 3	Altered pyroxene granulite
5639 RS 7	" " "
5639 RS 9	Metamorphosed adamellite

Jumbuck 1 000 000 map sheet

5638 RS 2	Altered microgranite
5638 RS 3	Acid gneiss
5638 RS 4	Banded gneiss
5638 RS 5	Metasediment
5638 RS 7	Acid gneiss
5638 RS 8	Crushed granitic rock
5638 RS 9	Acid gneiss
5638 RS 10	" "
5638 RS 11	" "
5638 RS 12	Feldspathic, micaceous quartzite
5638 RS 15	Meta arkose
5638 RS 16	Garnetiferous metasediment
5638 RS 17	Potassic granite/pegmatite
5638 RS 21	Remetamorphosed acid gneiss
5638 RS 23	Porhyritic granodiorite
5638 RS 24	Granodiorite
5638 RS 25	Kaolinized ?granite
5638 RS 26	Quartz-feldspar-cordierite granulite
5638 RS 28	Granitic gneiss
5638 RS 33	Quartz-muscovite schist
5638 RS 37	Granitic gneiss
5638 RS 38	" "
5638 RS 39	" "
5638 RS 40	" "

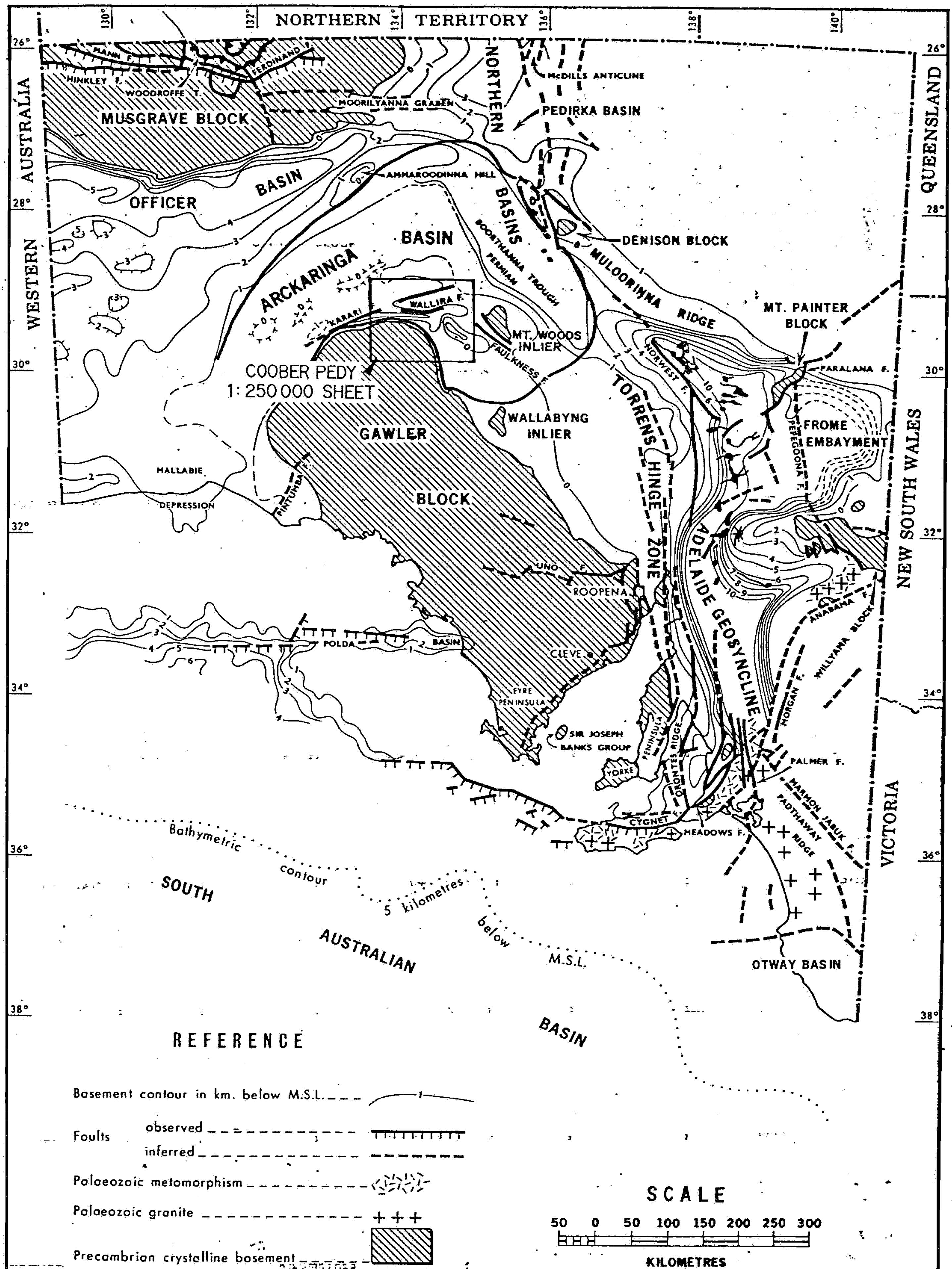


Fig. 1

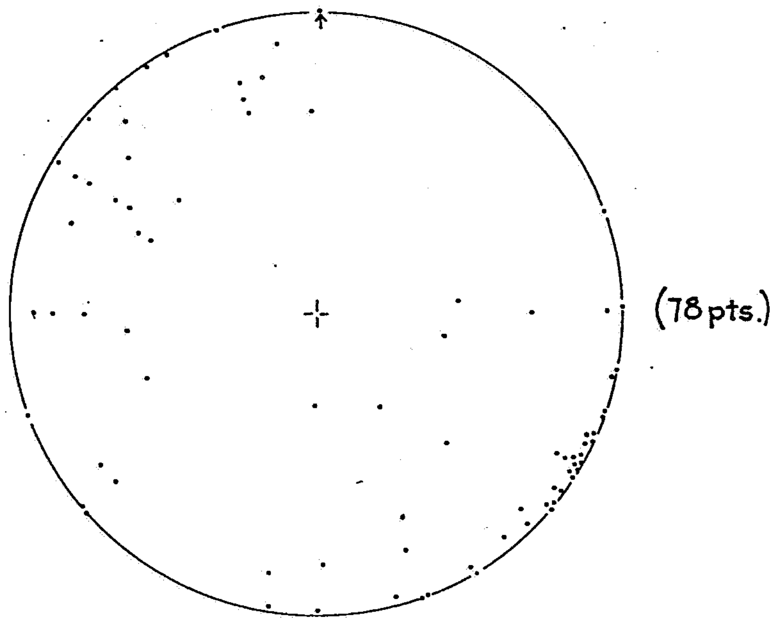
Compiled — B. P. Thomson, 1970
Modified — M. Benbow, 1979

SADME

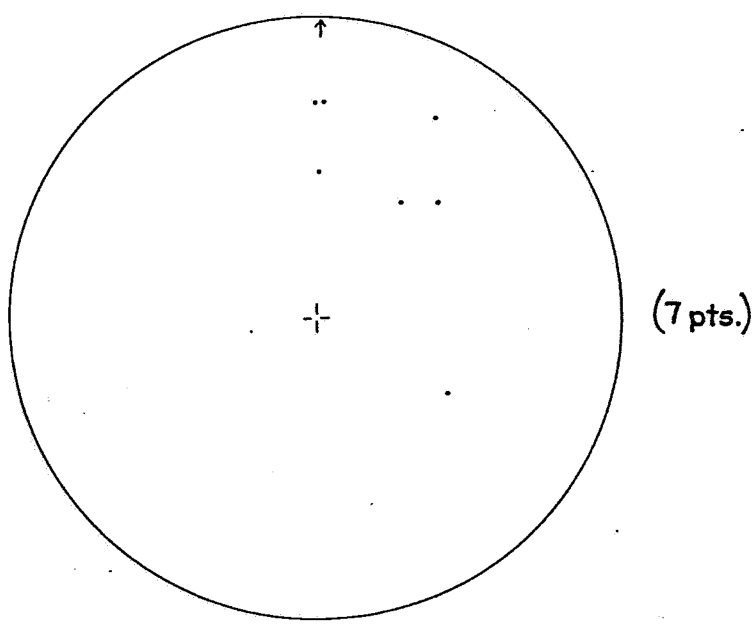
COOBER PEDY 1:250 000
LOCATION & STRUCTURAL SETTING

S14103

LAYER PARALLEL FOLIATION



FOLD AXES

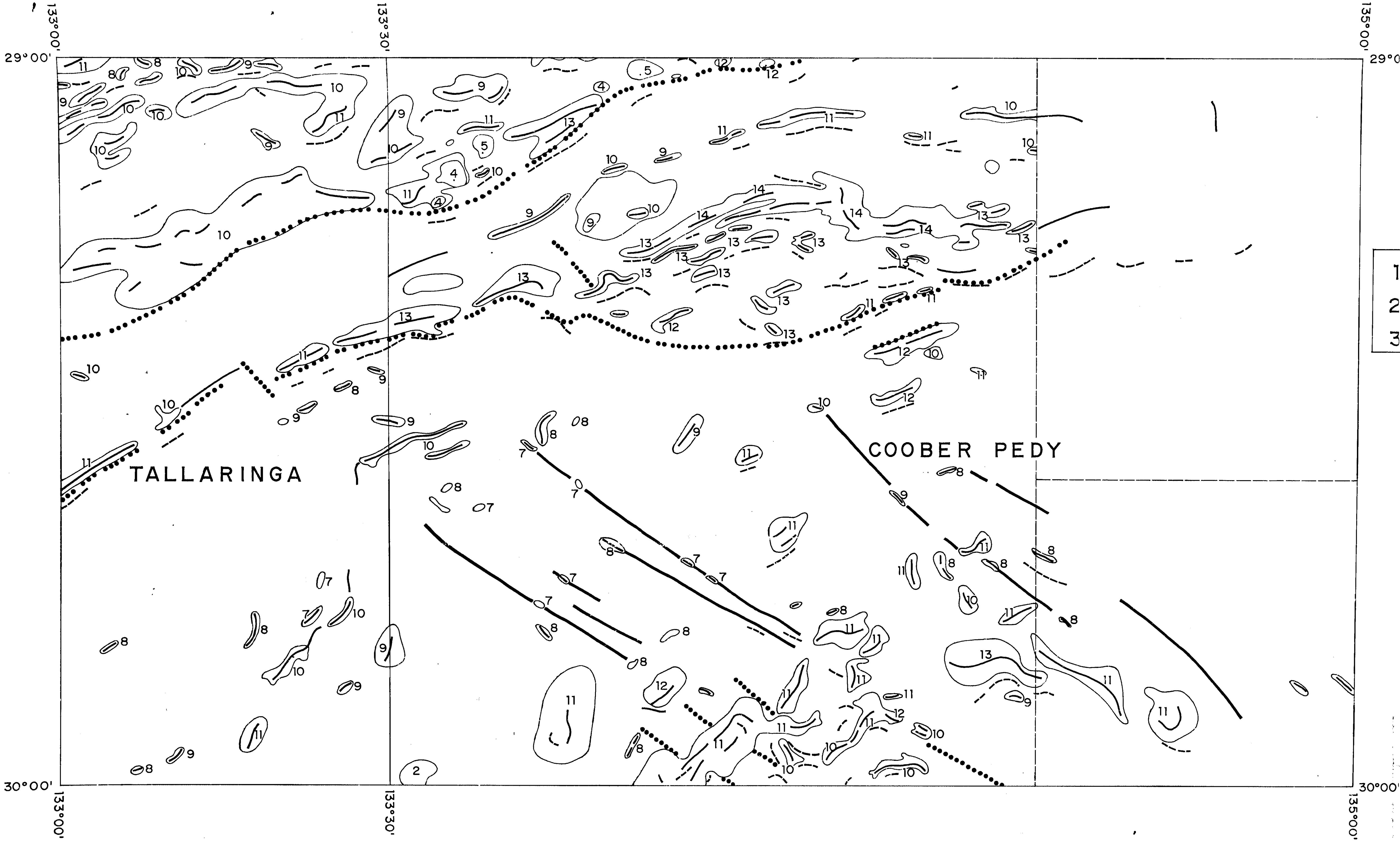


Lower hemisphere equal area projections

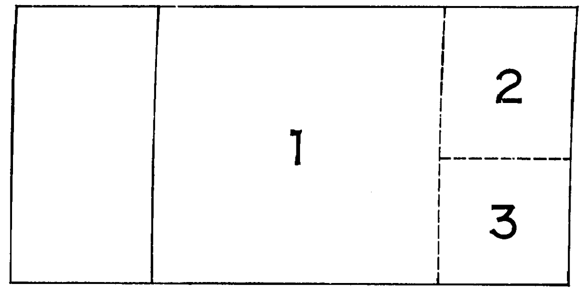
Fig. 2

	DEPARTMENT OF MINES—SOUTH AUSTRALIA	Scale:
Compiled: M.C.B.	GAWLER BLOCK-COOBER PEDY 1:250 000 Sheet STRUCTURAL DATA	Date: 9/6/77
Drn. / Ckd.		Drg. No. S 12720
Regional Mapping		

500—9.75 F9882 O



AEROMAGNETIC SURVEYS



	LINE SPACING (Km)	STATION SPACING (Km)	ELEVATION (m)	FLOWN BY	FOR	ON
1	1·6 N.S.	≈0·6	152 A.G.L.	B.M.R.	S.A.D.M.	1958
2	8 E.W.	≈ 8	456 B.A.R.	AEROSERV.	DELHI.	1961/62
3	3·2 E.W.	≈0·6	152 A.G.L.	B.M.R.	S.A.D.M.	1966

REFERENCE

Positive trend ....

Negative trend ....

Anomaly boundary of zone 10

Fault ....

Dyke ....

Fig. 3

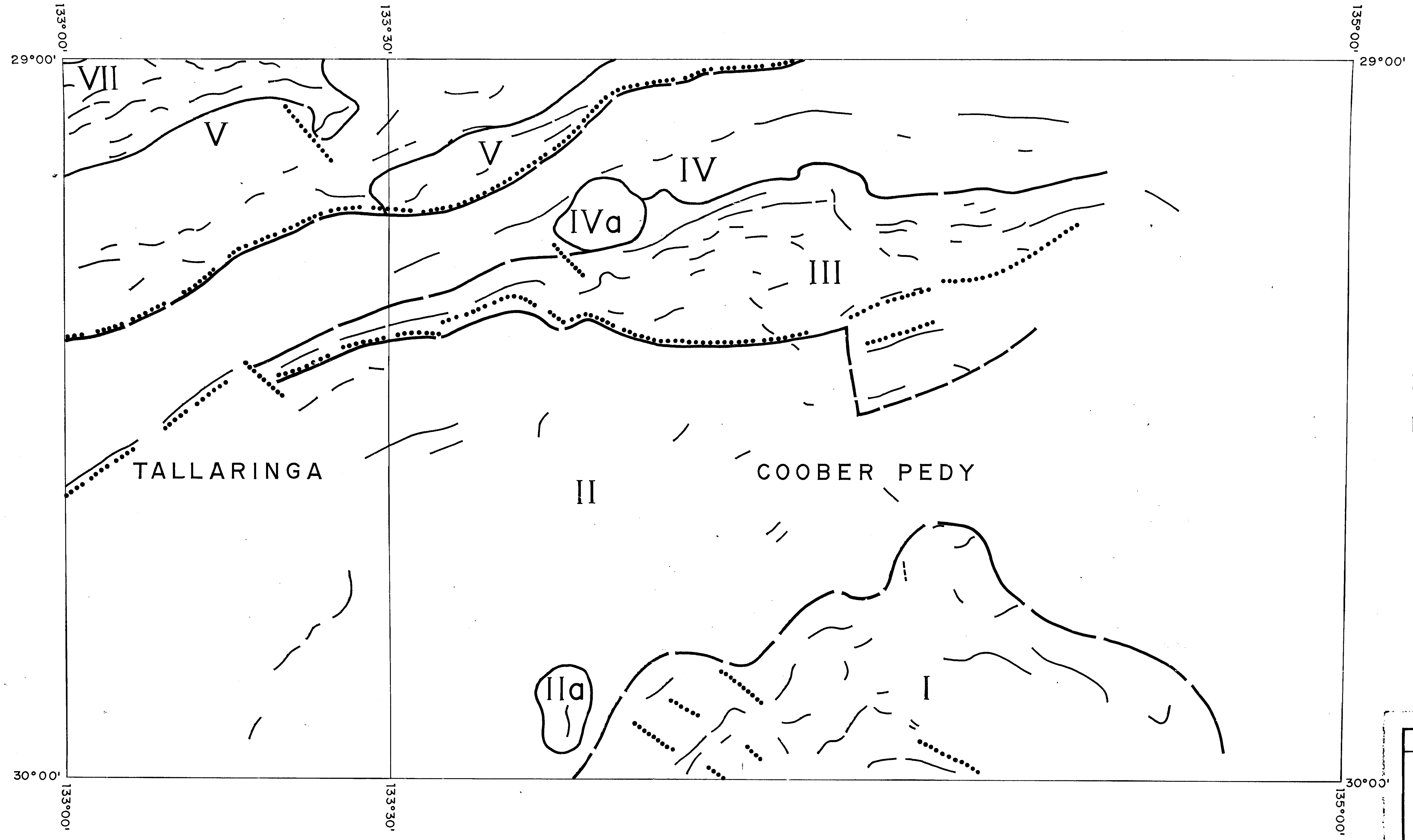
DEPARTMENT OF MINES–SOUTH AUSTRALIA

COOBER PEDY & PART TALLARINGA 1:250 000 SHEET AREAS

AEROMAGNETIC ANOMALIES & FEATURES

	COMPILED M.C.B.	DRN J.A.G.	SCALE 1:500 000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE June, 77	77-574

Job No. 1451



REFERENCE

Magnetic Province IV

Magnetic Province boundary ....

Magnetic trend ....

Fault ....

Fig. 4

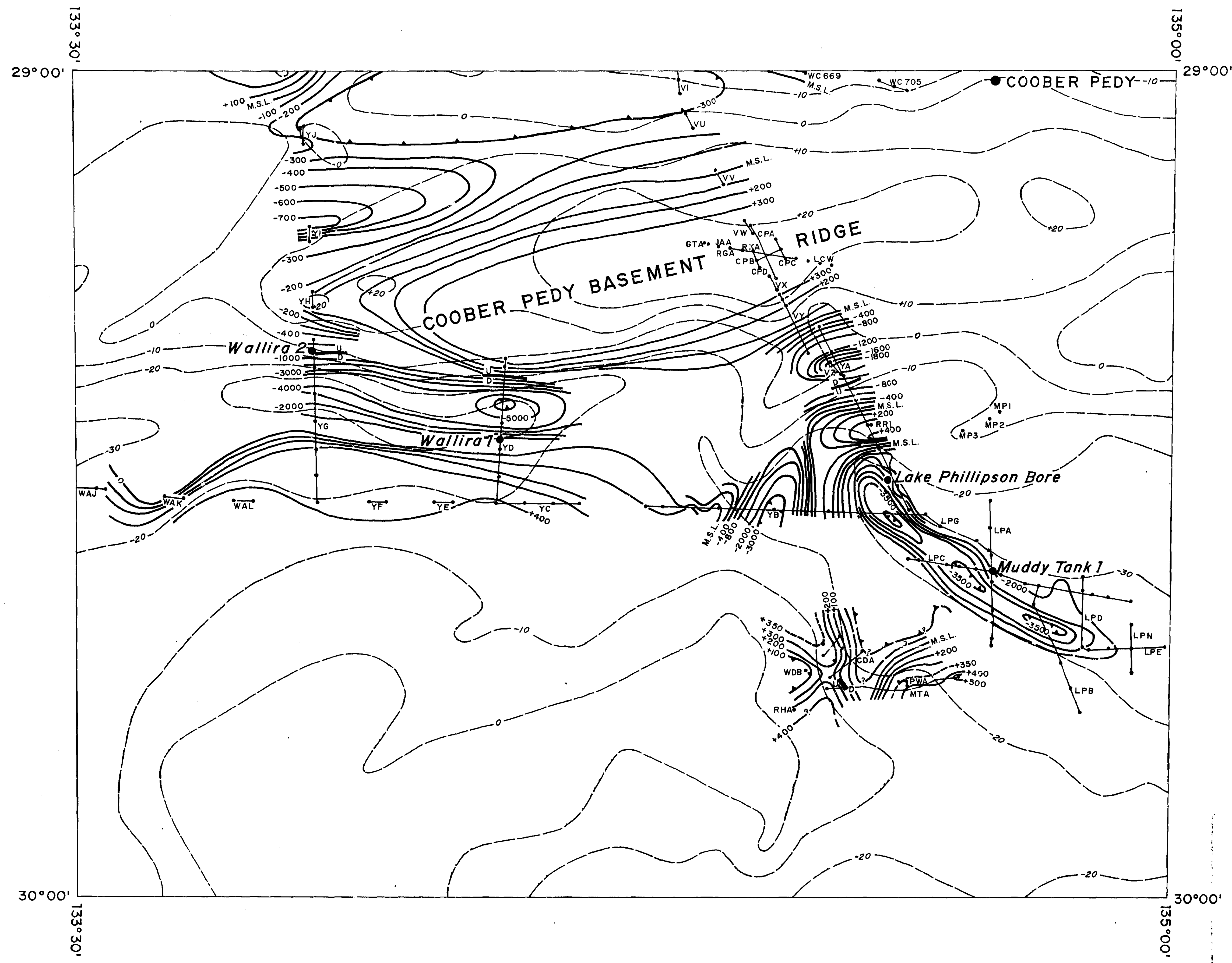
DEPARTMENT OF MINES–SOUTH AUSTRALIA

COOBER PEDY & PART TALLARINGA 1:250 000 SHEET AREAS

AEROMAGNETIC TRENDS & PROVINCES

	COMPILED M.C.B.	DRN J.A.G.	SCALE 1:500 000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE June, 77	77-575

Job No. 1451



REFERENCE

Bouguer gravity contours

Contours of seismic depth to crystalline basement

Seismic traverse

Fault

References

Milton, B.E., 1970, 71

Nelson, R.G., 1971 a, b

Fig. 5

DEPARTMENT OF MINES–SOUTH AUSTRALIA				
COOBER PEDY 1:250000 SHEET AREA **SEISMIC DEPTH TO CRYSTALLINE BASEMENT AND TRAVERSES**				
	COMPILED M.C.B.	DRN J.A.G.	SCALE 1:500 000	PLAN NUMBER
DIRECTOR OF MINES		CKD	DATE June, 77	77-576

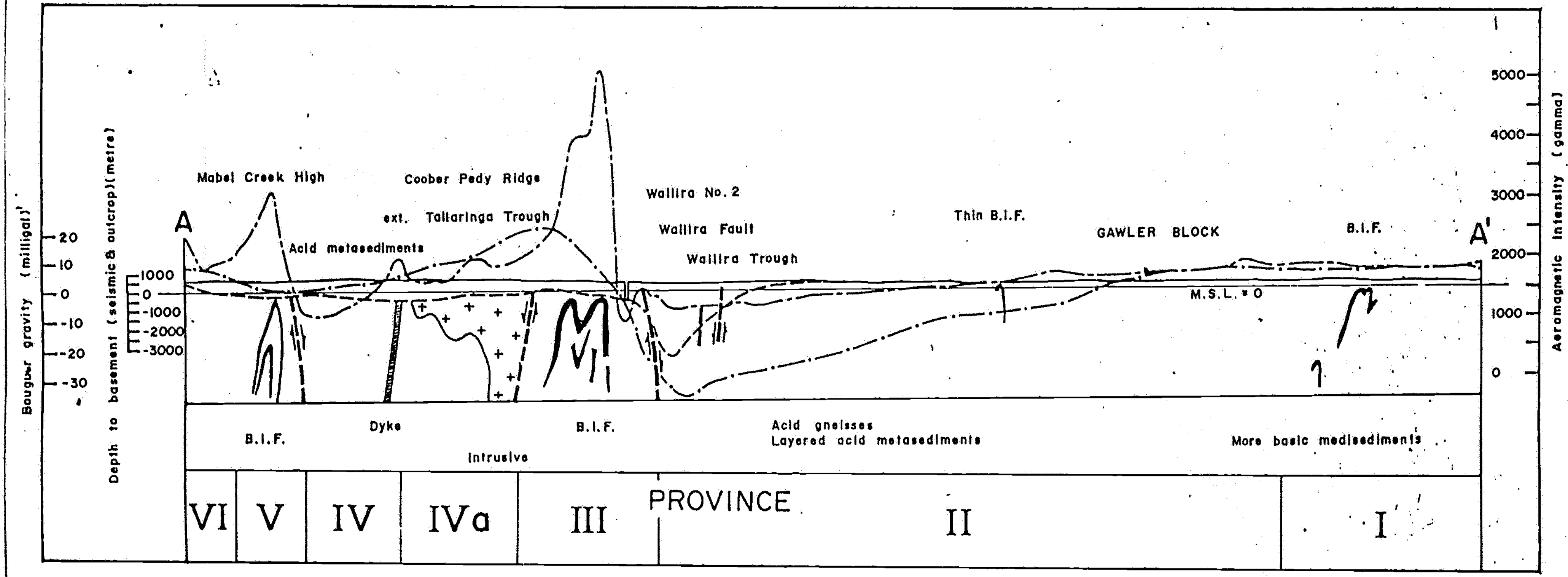
Job No. 1451

S.A. DEPARTMENT OF MINES

COOBER PEDY 1:250 000

SECTION A—A'

Geophysical Profiles & Interpreted Geology



REFERENCE

Land surface ....

Seismic and boréhole and outcrop profile on depth to basement ....

Aeromagnetic profile ....

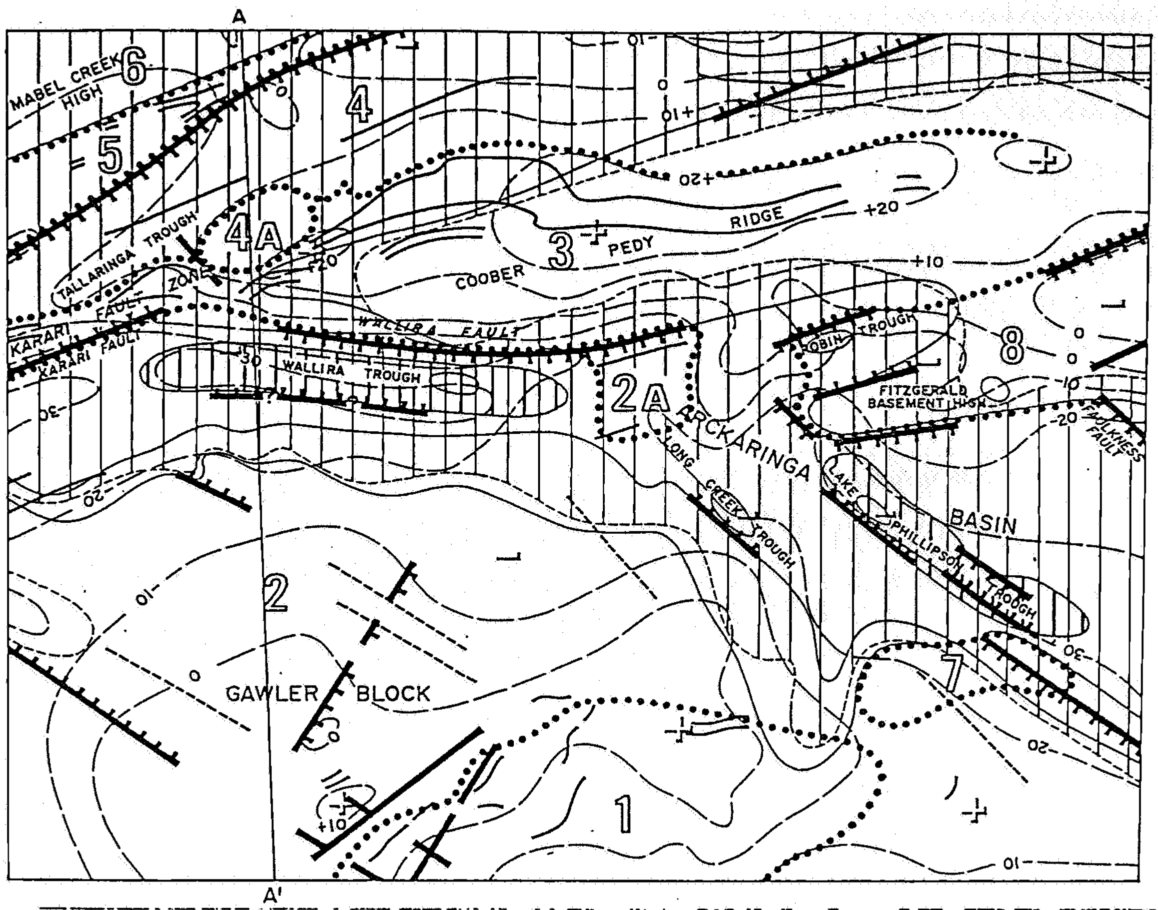
Bouger Gravity profile ....

Banded Iron Formation .... B.I.F.

Scale: 1:500000	Date: 24/7/77	Drg. No. S- 12726

Fig. 6

COMPILED BY M.C. BENBOW



Palaeozoic cover of Arckaringa Basin — Permian

Lower Palaeozoic cover of ? Officer Basin — ? Cambrian

Archaean and Proterozoic of Gawler Craton showing depth to basement in metres.

+150
0
-600
-1200

Basement province (5)

Bouguer gravity anomaly contours (milligals) (+20)

Aeromagnetic features — <100 gamma, basic dykes...

<3000 gamma

>3000 gamma

Fault showing downthrown side

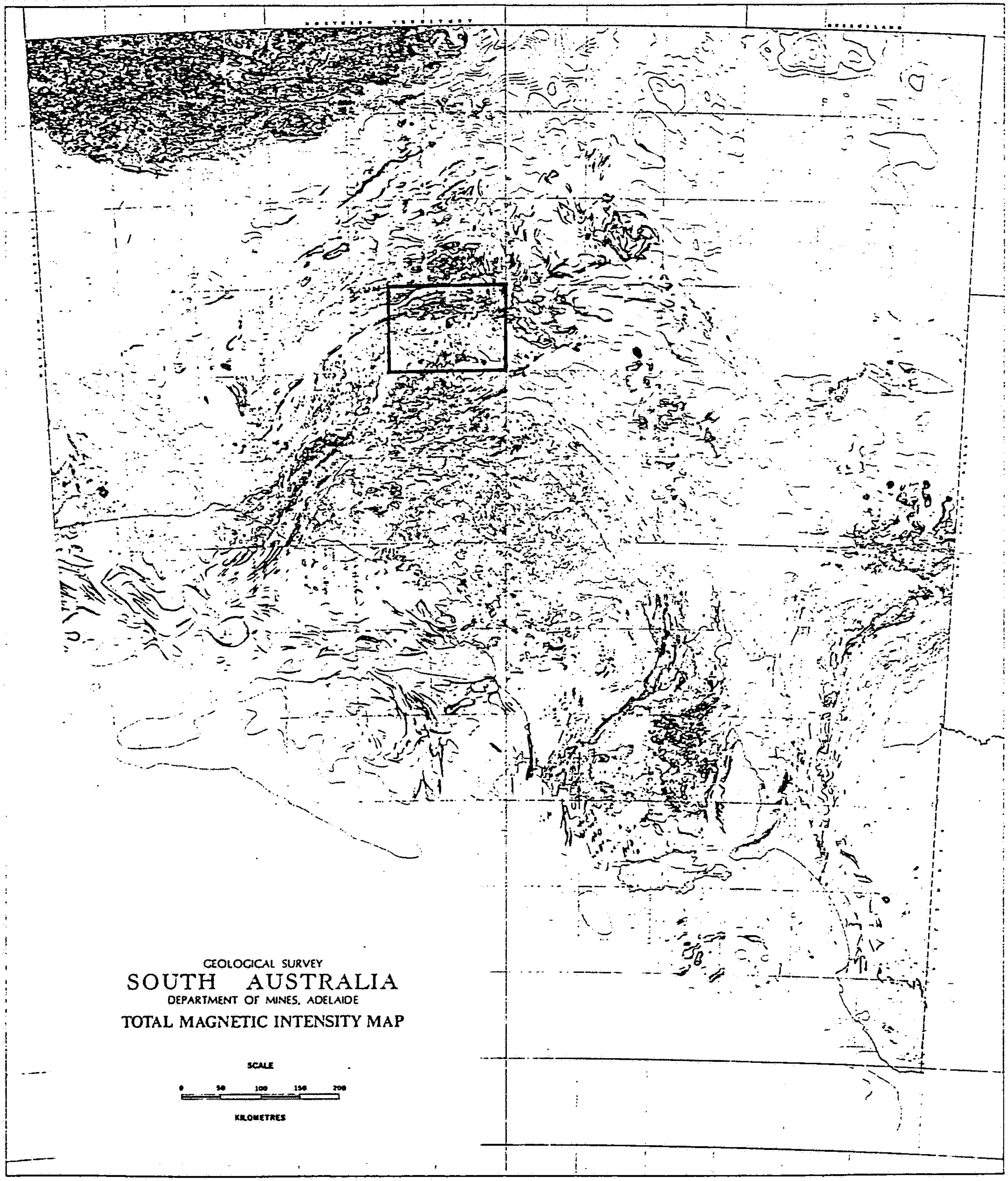
Fault

Geological section A A'

Fig. 7

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE 1:1000 000
COMPILED M.C.B.	COOBER PEDY 1:250 000 SHEET	DATE 21 · 6 · 79
DRN / CKD.	TECTONIC SKETCH	PLAN NUMBER
	BASEMENT AND PALAEOZOIC COVER ROCKS	S14106

1451



Coober Pedy 1:250 000 Sheet

Fig. 8

S14107

1451

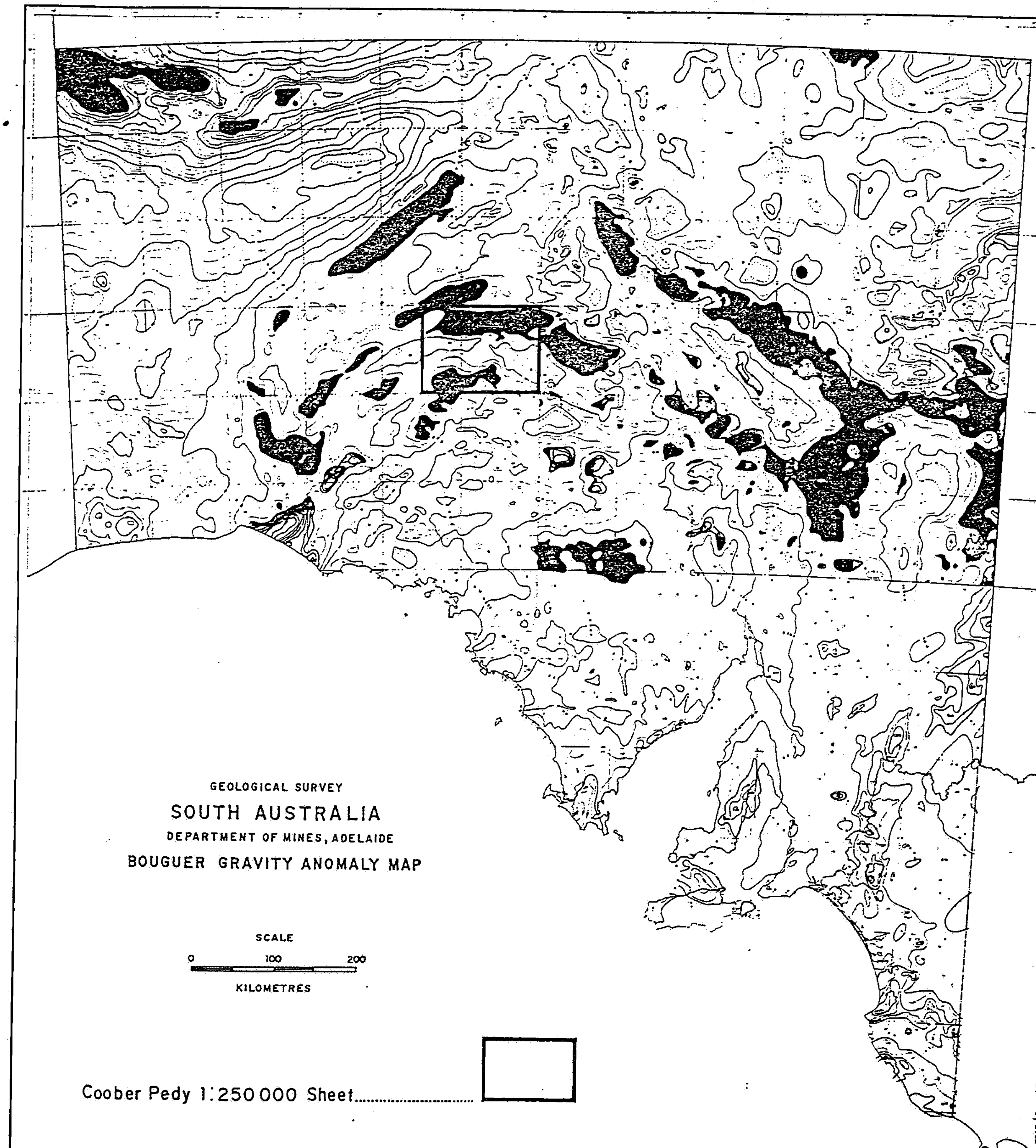
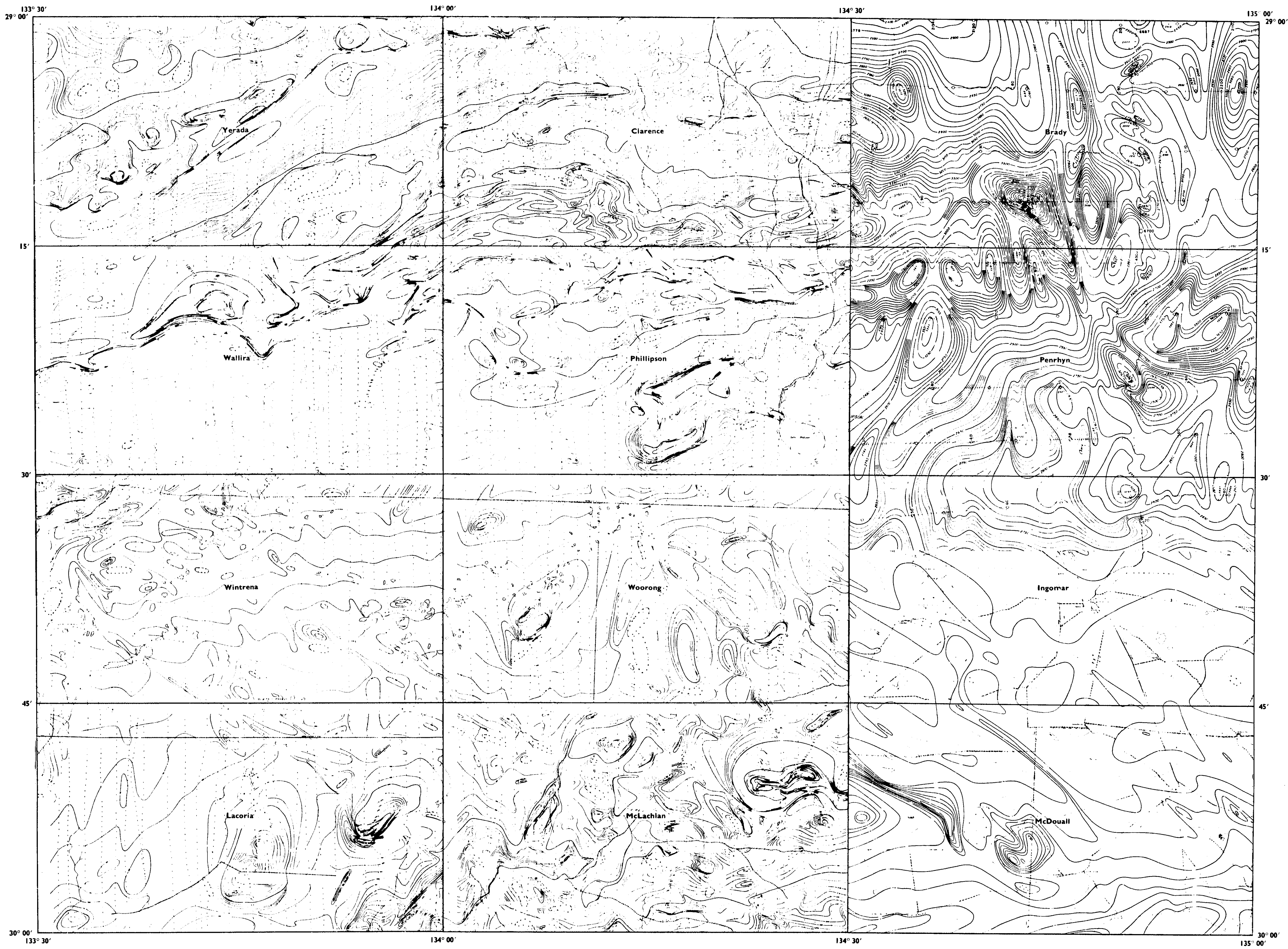


Fig. 9

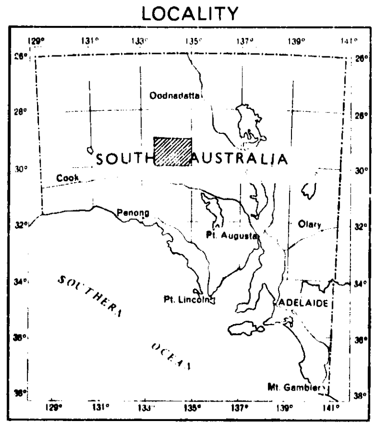
S14108

COOBER PEDY

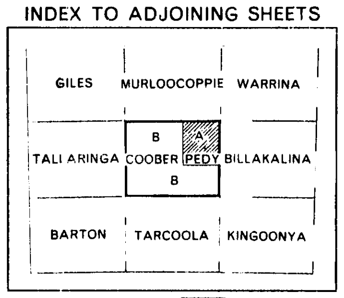
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES, ADELAIDE



LOCALITY



INDEX TO ADJOINING SHEETS

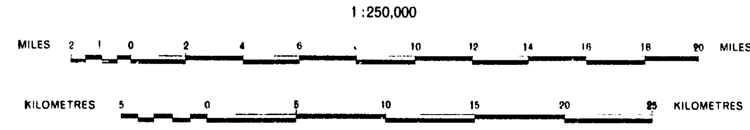


A Delhi Survey Area

B S.A. Department of Mines Survey Area

SCALE

1 : 250,000



Published 1971

AEROMAGNETIC MAP OF TOTAL INTENSITY

NOTE

This map is compiled from airborne magnetic surveys conducted by Aero Service Corporation for Delhi Australian Petroleum Ltd under Commonwealth subsidy and from data obtained from surveys flown by the Bureau of Mineral Resources on behalf of the S.A. Department of Mines.

The total magnetic intensity at 1,500 feet barometric level (Delhi survey area) and at 500 feet above ground level (S.A. Dept. of Mines survey area) was recorded continuously using a Gulf fluxgate magnetometer. Uncontrolled photo mosaics were used to navigate and plot flight lines at intervals as shown. The results of the surveys were reduced and corrected for regional variation by Aero Services Corporation (Delhi survey area) and by computers of the Exploration Geophysics Section of the S.A. Department of Mines (S.A. Dept. of Mines survey area). Photographic reduction and preparation at 1:250,000 scale by Cartographic Division, S.A. Department of Mines.

G. F. Whitten, M.Sc., Supervising Geologist, Exploration Services Division

Compiled under the direction of L. W. Parkin, M.Sc., A.S.T.C., Government Geologist

Issued under the authority of the Honourable D. A. Dunstan, M.P., Minister of Development and Mines

Published by the Geological Survey of South Australia as a contribution to the Geophysical Atlas of Australia

LEGEND

MAGNETIC CONTOURS (values in gammas) 3000

FLIGHT LINES ....

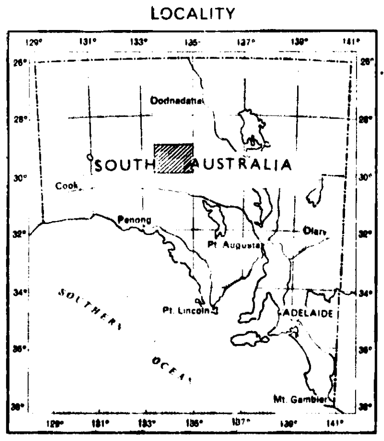
COOBER PEDY

71-418
Bb

COOBER PEDY

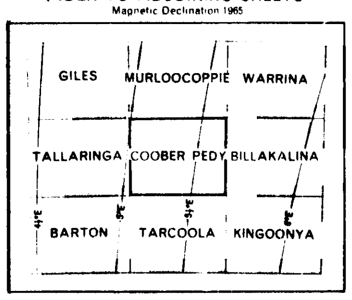
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES, ADELAIDE

LOCALITY



INDEX TO ADJOINING SHEETS

Magnetic Declination 1965



Annual Variation + 2 minutes

SCALE

1:250,000

MILES 2 0 2 4 6 8 10 12 14 16 18 20 MILES

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

Published 1971

BOUGUER ANOMALY MAP

Density 1.90 gm/cm^3

Compiled by J. McG. Hall, Geophysicist, I. S. Rowan, Geophysicist, I. J. Townsend, Geologist, R. A. Gerdes, Assistant Senior Geophysicist.

Map preparation by Cartographic Division, S.A. Department of Mines.

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This map was compiled from gravity readings taken by the South Australian Department of Mines. Acknowledgement is made of the Bureau of Mineral Resources whose Isogal stations provided references to absolute gravity values. The Bouguer results are gravity values adjusted for latitude and elevation obtained from barometric levelling referred to S.A. Department of Lands Bench Marks (elevation correction 0·070 milligals/foot). Results reduced by the Exploration Geophysics Section, S.A. Department of Mines, D. McPharlin, B.Sc., Senior Geophysicist.

G. F. Whitten, M.Sc., Supervising Geologist, Exploration Services Division.

Compiled under the direction of L. W. Parkin, Government Geologist, Director of Mines.

Issued under the authority of the Honourable D. A. Dunstan, M.P., Minister of Development and Mines.

LEGEND

Bouguer Anomaly Contours (contour interval 2 milligals) .... +20

Gravity Anomaly:

- High ....
- Low ....

Gravity Station:

- S.A. Department of Mines ....
- S.A. Department of Mines (marked) ....
- B.M.R. Isogal ....

Road, Track ....

Railway ....

Watercourse, Playa ....

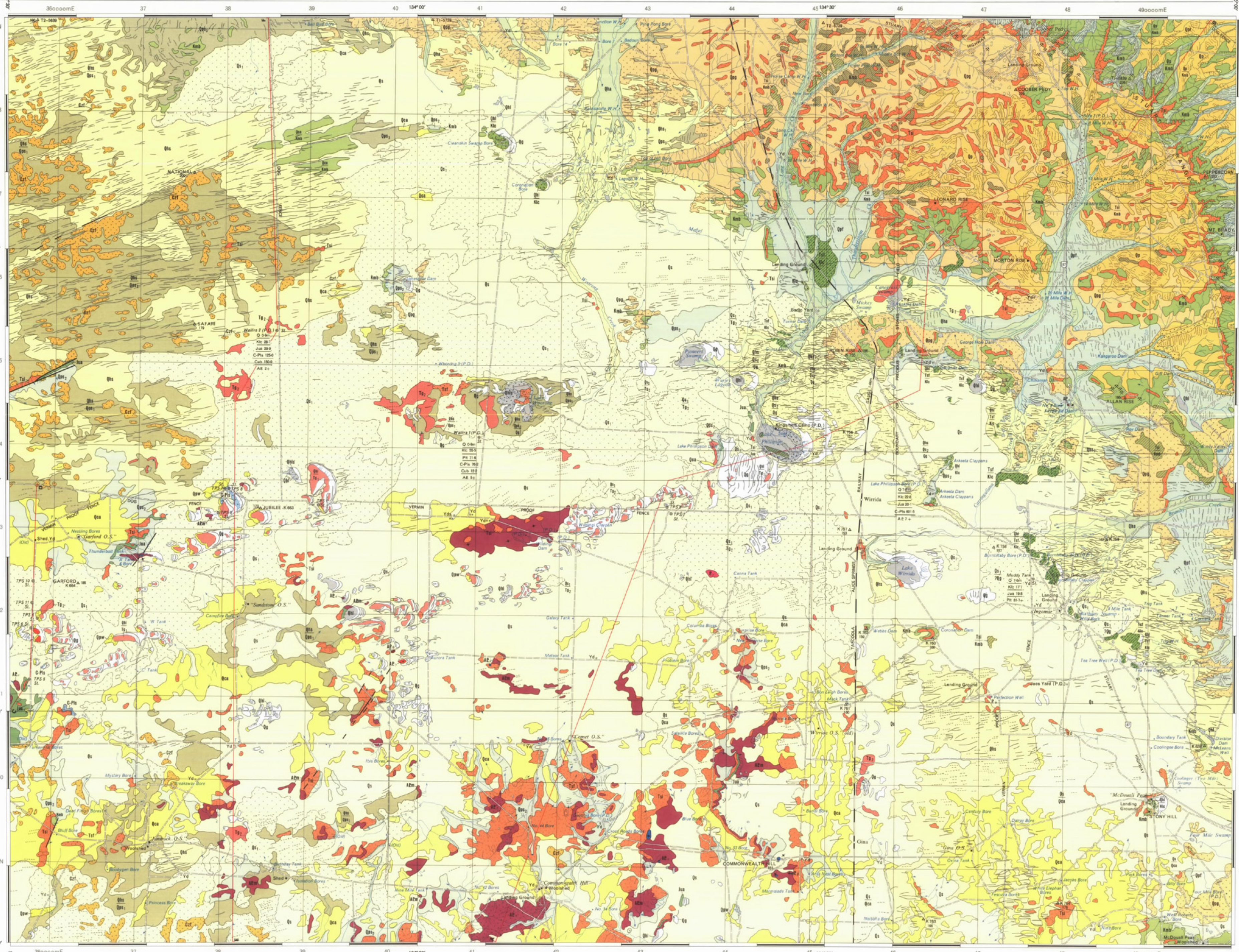
Vermin Proof Fence ....

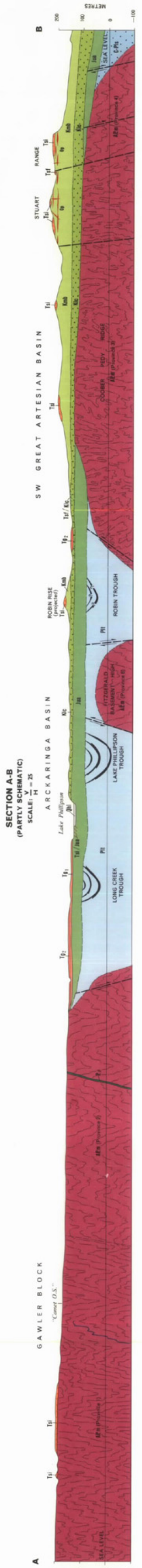
COOBER PEDY

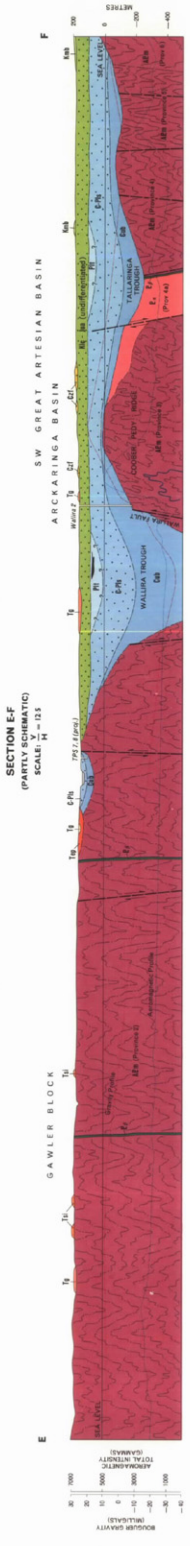
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY ADELAIDE

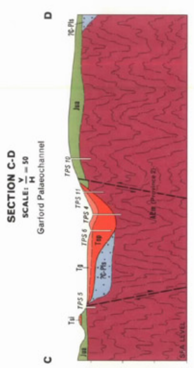
AUSTRALIA 1:250 000

S.A. GEOLOGICAL ATLAS SERIES SHEET SH 53-6 ZONE 5









FIRST EDITION 1981

GEOLOGICAL SURVEY SOUTH AUSTRALIA

REFERENCE

SAND PLAINS

CAINOZOIC — QUATERNARY — HOLOCENE

- Qs — Undifferentiated sand cover of the sand plains. Fluvial influence most evident over the Gawler Block (includes all units younger than Qg).
- Qs₁₋₂ — Undifferentiated orange-brown to red-brown sands, calcareous and, more rarely, gypseous in part. Qs_2 excludes Qhs.
- Qhl — Lake deposits of clays, silts and sands, thin salt crusts and algal oozes. May overlie older lake deposits as in Lake Phillipson (equivalent to Qps).
- Qhls — White to grey and pale red aeolian, reworked lake sands. False spits and bars and beach deposits of Lake Phillipson.
- Qhs — Sands of longitudinal dunes of Great Victoria Desert. Base of dunes formed by Qps, in part.
- Sands of low-lying sand rises and thin, reworked sand spreads.
- Qhs_1 — Sands, with some drainage, related to the margin of the Stuart Range and Uplands. Anastomosing drainage and dune complex.

PLEISTOCENE

- Qps — Sand spreads, clayey to silty in part, weakly to moderately indurated. Includes at least two 'hardpan' horizons; the lower has a weak carbonate paleosol (Qp_{c5}) of carbonate lined cracks, bedding planes and carbonate filled or lined ?worm burrows; the upper is redder in colour with only weak carbonate developed. Forms the core of Qhs. Gilgai developed in some areas.
- Qps_2 — Thin alluvial and aeolian sand spreads, often with silcrete and gilgai in the south.
- Qps_1 — Red sands generally infilling depressions. Minor gilgai. Associated with minor 'buckshot' sand spreads and silcrete outcrop over Gawler Block.
- Qpo — Light orange to red-brown, pink and white aeolian calcareous sands. Weak carbonate accumulations along bedding planes. Bioturbated in part. May equate to Qps (Rock Relation Diagram only).
- Qla — Orange to red-brown sands. Carbonate paleosol, Qp_{c4}, of soft to hard small carbonate lumps (Rock Relation Diagram only).
- Qca — Undifferentiated calcrete.
- Qpw — WINTRENA FORMATION: Red-brown to orange-brown clayey to silty poorly sorted sands. Conspicuous carbonate paleosol (Qp_{c2b}) of vertically oriented soft to hard, pale orange, nodules to irregularly shaped fragments in the top.
- Red-brown sands with massive sheet calcrete, Qp_{c2a} (Rock Relation Diagram only).
- Qa — Aeolian pink-white gypseous sands and silts of lunettes and spreads. Massive stratified crystalline and powder gypsum. May include younger lunettes. 'Cowpat' gypsum covered.
- T-Q — Unnamed white to green sands, clayey at the base and poorly sorted. Orange, red and black mottling, Qp_a, superimposed (Rock Relation Diagram only).
- Czf — Relict ferruginous duricrust ($T_{f2, si3}$) with overlying, reworked dark brown or black 'buckshot' gravels and red sands.

TERTIARY — MIOCENE

- Tg_2 — GARFORD FORMATION: MILLERS CREEK DOLOMITE MEMBER EQUIVALENT: White dolomitic limestone, sandy in part, with locally abundant polished and rounded silcrete pebbles. Rare freshwater gastropods *Rivisessor* sp. and *Physastra rodingae*. Commonly capped by calcrete.
- Subcrop with overlying calcareous sands of Qpw and Qpo. Qs_1/Tg_2.
- Tg_1 — BILLA KALINA CLAY MEMBER EQUIVALENT: White dolomitic palygorskite clays, green pearly palygorskite and sepiolite clays. Thinly covered by Qhl in claypans.

PALEOCENE-EOCENE

- Tsi, Tsf — Undifferentiated silcrete and ferruginous silcrete.
- Silicification and ferruginisation of older units.
- Ts — Fine to very coarse poorly sorted sands and conglomeratic sands. Clasts include rounded quartzite cobbles and boulders, angular to rounded quartz pebbles and occasional reworked silcrete pebbles. Silicified to a massive 'greybilly' silcrete, $T_{?si1, si2}$. Ropy or pseudo-flow nodular and columnar structures. May be ferruginised black, T_{f1} (Rock Relation Diagram only).
- Tep — PIDINGA FORMATION: Clean, well sorted sands, carbonaceous sands, silts, clays and lignite. May be silicified to a massive 'greybilly' silcrete, $T_{si1, ?si2}$.
- Deep white kaolinized and bleached profile, T_b, seen in Kmb and older units (Rock Relation Diagram only).

STUART RANGE AND UPLANDS

- Black ferruginous gibber mantle on Quaternary units.
- Qha — Unconsolidated sands and gravels, clayey and silty in part, of drainage channels. May overlie and rework fluvial facies of Qpp and Qpg. Drainage channels become more choked by Qhs near the sand plains.
- Qh — Grey-brown unconsolidated gravelly clays, silts and sands (Rock Relation Diagram only).
- Qpf — Floodplain deposits of Qpg and Qpp, often characterized by north–south gilgai developed in Qp.
- Talus and fan deposits of Qpg and Qpp on the eastern side of the Stuart Range.
- Qps_3 — Red-brown sands, clayey in part, with black 'buckshot' sand and gravel spreads with widely spaced gilgai.
- Qp — BENITOS CLAY: Red-brown to brown clay to silty clay. Prismatic clay (Qp_s) developed within and mantled by silcrete gibber. Vertically structured gypsum paleosol (Qp_{g3}) in the base ('LOVEDAY SOIL'). 'Hardpan' in the upper part (may have weak carbonate lined tubules and fractures) overlain by red-brown prismatic structured clay (Qp_{s8}-CALLABONNA SOIL). Closely spaced gilgai.
- Qpp — OOLGELIMA GRAVEL: Weakly indurated gravels, sands, silts and clays. Minor interbedded prismatic structured clay (Rock Relation Diagram only).
- Qpr — Soft massive gypsum powder exposed in scarps on the eastern side of the Stuart Range. Probably equivalent to Qp_{g3} but may include older horizons.
- Qpg — GIDDINNA FORMATION: Red clays and silts, gravelly and sandy in part and moderately indurated. COOBER PEDY PALEOSOL, Qp_i, a red 'hardpan', biscuity to platy in structure with porous vesicular texture and manganese coating, developed in the upper part. Weak to moderate carbonate paleosol, Qp_{c3}, developed in the 'hardpan'. May include Qpx and older units.
- Qpg_1 — Sandy facies along the northern margin of Klc. Thin cover of sandy equivalents of overlying units.
- Qpx — Colluvial and alluvial sediments, weakly consolidated when cemented by light brown to white gypsum powder, Qp_{g2}, and indurated when cemented by horizontally structured calcrete, Qp_{c2} (Rock Relation Diagram only).
- Qpy — Colluvial and alluvial silty sediments (bleached Kmb clasts prominent) cemented by massive gypcrete, Qp_{g1}, and rarely by massive calcrete, Qp_{c1}. ?Termite burrows and nests filled by red silts developed primarily in Kmb (Rock Relation Diagram only).
- Czn — Silty and clayey colluvial breccias and gravels. ?Termite nests. Jasper breccia ($T_{f2, si3}$) or puddingstone, maroon and cream coloured, developed within Czn and on Kmb (Rock Relation Diagram only).
- Jasperization of older units.
- Tsi, Tsf — Undifferentiated silcrete and ferruginous silcrete.
- Silicification and ferruginisation of older units.
- Ts — Colluvial clay, silt and breccia. Minor conglomerates. Silicified as on sand plain region (Rock Relation Diagram only).

SUCCESSION OF GREAT ARTESIAN BASIN

MESOZOIC — CRETACEOUS — APTIAN — MARREE SUBGROUP

- Op, Kmb — BULLDOG SHALE: Marine grey to dark grey shales and silty shales, minor sandstone lenses, strongly bioturbated. Minor concretionary limestone with mollusc casts. Upper part is strongly altered, bleached, ferruginised and/or silicified during multiphase weathering events (?late Cretaceous to Pleistocene). Includes common and precious opal (Op). Basal part of marginal marine grey shales, with thin sand lenses and silty shales, cone-in-cone and sandy limestones and ferruginised calcareous siltstones. Horizons of well rounded cobbles and boulders of predominantly quartzite, acid porphyry and banded chalcedony. Rare quartzite clasts with Devonian bivalves and brachiopods. Boulders numerous in far northeast and becoming rarer towards west. Lowermost cobble and boulder horizon may correlate with boulder bearing horizon of the CADNA-OWIE FORMATION type section.

NEOCOMIAN

- Klc — CADNA-OWIE FORMATION: MOUNT ANNA SANDSTONE MEMBER: Conglomeratic and feldspathic sandstones (often ferruginised black in outcrop) containing abundant clasts of porphyritic rhyolites and dacites, white quartz and quartzites, calcareous in part. Sharply overlain by Kmb.

JURASSIC

- Jua — ALGEBUCKINA SANDSTONE: Crossbedded white kaolinitic sandstones, gritty clays and clays. Conglomeratic in part with pebbles and cobbles of rounded to angular white to blue quartz and various basement lithologies. Dark grey to grey carbonaceous and massive clays, sandy in part, with rare fossil plant stem fragments.

SUCCESSION OF ARCKARINGA BASIN

PALAEOZOIC — CARBONIFEROUS-PERMIAN

- Plt — MOUNT TOONDINA FORMATION: Upper part of interbedded sandstone, siltstone, carbonaceous shales and coal. Minor calcareous pyritic sandstone. Lower part of pale to dark grey, non-carbonaceous, partly calcareous sandstones, siltstones and shales (Rock Relation Diagram and Section only).
- C-Pls — STUART RANGE FORMATION: Grey-green compact clay, thin silt lenticles, minor slumping and bioturbation. Diamictite towards base. Bleached white in outcrop.
- Cub — BOORTHANNA FORMATION: Diamictitic clays, sandy to bouldery and pebbly to bouldery sandstones and conglomerate. Calcareous in part (Rock Relation Diagram and Section only).

SUCCESSION OF OFFICER BASIN

CAMBRIAN

- Єo — OBSERVATORY HILL BEDS: Alternating limestones and dolomitic mudstones (Rock Relation Diagram only).

CRYSTALLINE BASEMENT OF GAWLER CRATON

PROTEROZOIC

- GAWLER RANGE VOLCANICS: Brown porphyritic rhyolite, weak subvertical layering. ?EALBARA RHYOLITE EQUIVALENT.
- Dark green gabbro and diorite dykes.
- ENGENINA ADAMELLITE and BALTA GRANITE: Medium to coarse grained porphyritic granite, weakly foliated, and fine grained dark porphyritic and non-porphyritic acid igneous rocks.

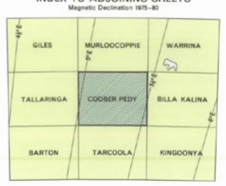
ARCHAEAN-EARLY PROTEROZOIC

- MULGATHING COMPLEX: Undifferentiated and weathered. Kaolin and kaolin-quartz rocks, non-foliated and foliated, fine to very coarse grained and quartz reefs and stringers.
- White gneissic and porphyritic granodiorite.
- Banded iron formation, quartzite (garnetiferous and micaceous in part). Layered and foliated leucocratic rocks composed of quartz + potash feldspar + plagioclase ± biotite ± garnet. Granulites (quartz + potash feldspar + plagioclase + orthopyroxene). Granuloblastic textures common. Granitic gneiss of Fitzgerald Dam and east of "Sandstone O.S." Radiometric age 2458±60 Ma—(Rb/Sr).
- Metamorphosed porphyroblastic microline + plagioclase + quartz + biotite gneiss. Radiometric age (of second metamorphic event) 1539 Ma (K/Ar, biotite).

GEOLOGICAL BOUNDARY	WATERHOLE OR SOAK — W.H.
FAULT	BORE, WELL — W
GEOLOGICAL SECTION — A B	TANK — T
METAMORPHIC FOLIATION (VERTICAL)	DAM
TREND OF FOLIATION	RAILWAY WITH SIDING
STRATIGRAPHIC BORE — St.	HIGHWAY WITH NATIONAL ROUTE NUMBER
MINING AREA (OPAL), SMALL, LARGE	SECONDARY ROAD
ESCARPMENT	TRACK
MESA, PEAK	BOUNDARY FENCE
EPHEMERAL STREAM	HOMESTEAD — "Ingomar"
FLOODPLAIN	YARD — Yd
SWAMP	TRIANGULATION STATION
CLAYPAN OR SALTPAN	IDENTIFIED POINT (ELEVATION IN METRES) — 186

INDEX TO ADJOINING SHEETS

Magnetic Declination 1975–80



Geological mapping and compilation by M. C. Benbow, B.Sc., with contributions by V. Vitols, B.Sc., L. C. Barnes, B.Sc.(Hons.), G. W. Krieg, B.Sc.(Hons.), P. A. Rogers, B.Sc.(Hons.), G. M. Pitt, B.Sc., A. F. Crooks.

C. R. Dalgarno, M.Sc., Supervising Geologist, Regional Geology Division.

Base map compiled by the Department of Mines and Energy in 1978, from 1964, 1973, 1976 photography.

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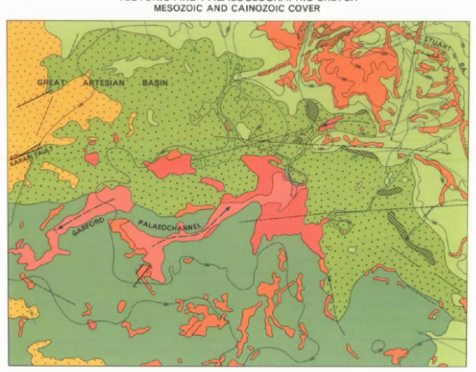
TECTONIC AND PALAEOGEOGRAPHIC SKETCH
MESOZOIC AND CAINOZOIC COVER



Czn		Stuart Range escarpment
Czf		Topographic contour (20 metre interval)
Tg_2		Base of Kmb (in metres a.s.l.)
Tg_1		Fault (showing downthrown side)
Tsi, Tsf		Lineament
Kmb		Miocene palaeochannel
Klc and Jua undifferentiated, Klc ferruginised		
Jua		

SCALE
1 : 250 000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

PRINTED IN AUSTRALIA
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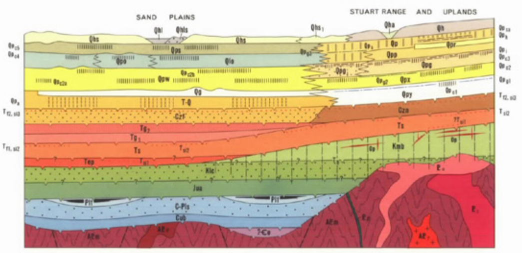
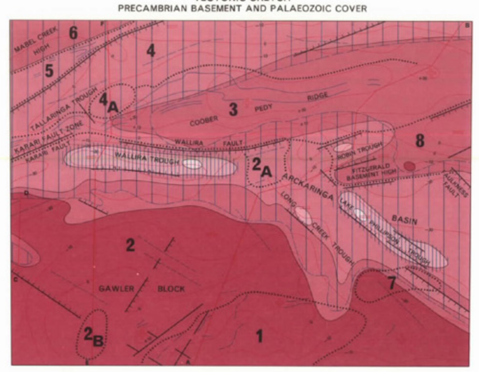
SOUTH AUSTRALIA

Grey numbered lines indicate the 10,000 metre Australian Map Grid.
Universal Transverse Mercator Projection. Australian Geodetic Datum, 1966.

ROCK RELATION DIAGRAM
SHOWING WEATHERING PROFILES AND PALEOSOLS



TECTONIC SKETCH
PRECAMBRIAN BASEMENT AND PALAEOZOIC COVER



Permian-Carboniferous of Arckaringa Basin		Bouguer Gravity Anomaly contours (milligals)
Cambrian of ?Officer Basin		Gravity highs and lows
Archaean and Proterozoic of Gawler Craton showing depth to basement (in metres): −150, M.S.L. 0, 600, 1200		Aeromagnetic features—low intensity; < 3000 gammas; > 3000 gammas
		Fault
		Fault showing downthrown side
Basement province (refer to Explanatory Notes) — 2		Geological section — A B

Copies of this map may be obtained from the Geological Survey of South Australia, Department of Mines and Energy, Adelaide, or the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T. Printed for the Geological Survey of South Australia as a contribution to the Geological Map Series of the Commonwealth.