COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1964/31

ANDAMOOKA AND TORRENS AIRBORNE MAGNETIC AND RADIOMETRIC SURVEYS, SOUTH AUSTRALIA 1962

by

G.A. YOUNG

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ILLUSTRATIONS

SUMMARY

An airborne magnetic and radiometric survey of the Andamooka and Torrens four-mile areas was flown in 1962. This Record deals with analyses of the magnetic and radiometric results.

The magnetic data reveals two types of magnetic basement associated with Precambrian rocks (a) an igneous-metamorphic basement of probable Archaean age and (b) a region of basement fracture. The first type is at depth of 1000 to 2000 ft below ground level in the Andamooka and north Torrens areas, west of the Torrens Lineament. The second type is in the south-west of Torrens area.

Sediments within the Torrens Basin thicken to the east. The Torrens Lineament has magnetic expression in the Andamooka area but not in the Torrens area.

Displacement of magnetic contours in the south of the Andamooka area indicates a block movement of 12 miles in a direction N50°E.

Moderate magnetic disturbance is observed in the region about Pernatty Lagoon where economic copper and manganese mineralisation is known.

The level of gamma radiation is generally low throughout the entire area. A marked local increase in gamma radiation at the northern tip of Lake Torrens may represent an area of near-surface igneous rock. Two areas of very low gamma radiation have axes parallel to known faults, which are associated with the block movement observed from magnetic data.

1. INTRODUCTION

During March and April 1962, the Bureau of Mineral Resources, Geology and Geophysics made an airborne magnetic and radiometric survey of the 1:250,000 map areas of Andamooka and Torrens in South Australia at the request of the Department of Mines, South Australia. These areas lie between latitudes 30°00 S and 32°00 S and longitudes 136°30'E and 138°00'E. Aerial photography used in the survey and geological mapping used in this Record were provided by the Department of Mines.

The object of the survey was to determine basement structures and thickness of sediments in the Torrens Basin and areas of possible mineralisation in the Proterozoic outcrops.

Two geophysical surveys employing the magnetic method have been made in localities of known economic mineralisation near the survey area. Ground magnetic observations over manganiferous areas in the Pernatty Lagoon locality (McPharlin, 1949) indicated that magnetic anomalies with amplitudes ranging to 50 gammas are associated with these deposits. McPharlin suggested that these magnetic anomalies may be caused by limonite masses associated with the manganese ore.

A geophysical test survey of the Ediacara field was made by the Bureau of Mineral Resources in 1946 (Richardson, 1946). Techniques employed included electromagnetic, potential ratio, self-potential, magnetic, and resistivity. Results indicated that electromagnetic anomalies were associated with gossan bodies; however, the magnetic anomalies produced by these bodies were very small and of no diagnostic value.

Clarence River Basin Oil Exploration Co. N.L. drilled the Woomera No. 1 bore to a depth of 2005 ft in 1958 (B.M.R., 1960a). Four formations penetrated were believed to be of Cambrian or Proterozoic age. The nature of the beds suggested that the area has no petroleum prospects.

2. GEOLOGY

The geology of the region in, and about, the survey area is illustrated in Plate 1 which is based on B.M.R. (1960b). The most significant era is that of the Precambrian, in particular that defined by the Adelaide Geosyncline of the Upper Proterozoic.

Quoted hereunder are some of the relevant geological notes regarding this region (B.M.R., 1962, pp.28-30):

> 'In South Australia, Upper Proterozoic sedimentation was initiated by the development of a large mobile shelf, extending from Kangaroo Island through the Flinders Ranges and Olary region, northwards through the Peake and Denison Ranges and thence north and west. This zone, bounded on the west by Archaean rocks of the Gawler Nucleus, developed into the Adelaide Geosyncline. Sedimentation was influenced by zones of instability, where periodic uplift and rapid erosion alternated with subsidence. Continued sinking of the shelf enabled the accumulation of up to 40,000 feet of sediments under generally shallow-water conditions.
>
> The initial stage of sedimentation was the development of basal conglomerates and sandstones which transgressed the Archaean basement. Volcanoes were active in some areas, particularly in the northern Flinders Ranges, the Barrier Ranges north of Broken Hill in New South Wales, and the

Gawler Ranges in the northern part of the Eyre Peninsula (where large bodies of porphyry are thought to have been extruded at this time). A period of carbonate deposition followed. Local uplift and folding accompanied the onset of a period of widespread glaciation. Glacigene sediments overlapped on to areas of basement rocks in unstable zones to the north-east, particularly the northern Flinders Ranges and the Olary region; and also in the area south-east of the Musgrave Ranges. The continued sinking of the floor of the geosyncline permitted the accumulation of up to 25,000 feet of sediments reflecting glacial and interglacial conditions. The closing phases of Proterozoic time, in the central and northern portions of the geosyncline, were marked by a period of general relative stability and warmer conditions, associated with the widespread development of continental deposits, overlapping extensively to the west on to the foreland areas. In the southern portion of the geosyncline, (along the present site of the south-eastern Mount Lofty Ranges), intermittent unstable conditions gradually developed. The beginning of Cambrian time was marked by increasing instability, which resulted in local uplift, folding, erosion, and subsidence. An extensive unstable belt, in which a greywacke assemblage was deposited, developed in this region.

Away from areas affected by movements, sedimentation was more or less continuous, with significant development of limestone and continued sedimentation on to foreland areas. In the Flinders Ranges conditions remained generally stable, and limestone deposition was succeeded by a rapid accumulation of terrigenous sediments. Finally, a period of folding and widespread diastrophism brought sedimentation within the geosyncline to a close.

The Lower Palaeozoic orogeny deformed the sediments of the Adelaide Geosyncline into a complex system of folds, which has been only slightly modified since that time. Deformation generally was achieved by the jostling and warping of the Archaean basement of the geosyncline, with consequent complex folding and faulting of the overlying Upper Proterozoic and Cambrian sediments, and frequent development of en echelon fold patterns. The foreland areas, with their thin veneer of sediments, were subject to only minor folding and warping. Granites intruded the geosynclinal area.

West of Lake Torrens, the extensive overlap of Upper Proterozoic and Cambrian sediments onto the foreland country suffered only minor folding.

On eastern Eyre Peninsula gentle folding was followed by granitic intrusion'.

Sedimentation subsequent to that of the Adelaide Geosyncline is limited to an overlapping of Mesozoic sediments of the Great Artesian Basin in the north and to Tertiary sediments in the Pirie-Torrens Basin in the east.

The major structural features are illustrated in Plate 2 (Fenner, 1927; Dickinson & Sprigg, 1953) and may be broadly classified as the stable western foreland, the Torrens sunklands, and the Flinders horst. Fenner (1930, p.10) wrote that this region of South Australia 'represent(s) major tectonic features that form the southern portion of what is suggested to be a great broken zone extending northwards across Australia, and separating the more stable western from the less stable eastern portion'.

It was also suggested that the western fault of the sunklands area may have a large horizontal component of movement. Fenner (1930, p.8) stated 'Lincoln and Torrens faults ... are certainly almost rectilinear, as delimited by both geological and physiographic evidence; and the difference in elevation, though in many cases marked and regular, may perhaps be described as "neither strong nor persistent". Certainly these western faults have characters which distinguish them from those of the eastern boundaries of the sunklands'.

Dickinson and Sprigg (1953) subdivided the western foreland into the Stuart Stable Shelf and the Gawler Cratonic Nucleus. The Gawler Cratonic Nucleus is noted for its extensive metasedimentary series in which massive calcareous, graphitic, and iron formations are prominent, together with extrusive and intrusive feldspar porphyries which crop out over large areas in the Gawler Ranges.

Dickinson and Sprigg (op. cit.) considered that in the region of the Stuart Stable Shelf the 'flat-lying Adelaidean, Cambrian, Mesozoic, and Early Tertiary sediments form extensive veneers covering the Older Precambrian which occurs at shallow depths, but outcrops only sporadically.'

The most-recent geological information available in Andamooka and Torrens four-mile areas is shown in Plates 4, 6, 9, and 10 based on data supplied by the Department of Mines, South Australia.

Rocks exposed in both areas are predominantly of Upper Proterozoic age and consist of sediments of the Adelaide Geosyncline which include shale, siltstone, sandstone, limestone, quartzite, and slate.

Shale, siltstone, and sandstone of Cretaceous age are widespread in the north and west of the Andamooka 4-mile area. Tertiary sediments have been encountered in boreholes to the immediate east of Lake Torrens (Chebotarev, 1958).

Quaternary alluvium and sandplains are common throughout both areas; in addition salt lakes are particularly widespread in the Torrens 4-mile area. Lake Torrens dominates the eastern part of both areas, reflecting a major structural feature.

There is no known outcrop of igneous rock in either area; however, to the immediate south-west of the Torrens 4-mile area Gawler Range porphyry, of possible Cambrian age, intrudes the exposed Archaean basement (Johns & Solomon, 1953). To the south-east near Wilkatara, a diabase sill and a basaltic flow have been identified in the Upper Proterozoic strata (Brunschweiler, 1956, p.64).

Economic geology

Metals. Known economic mineralisation within, and adjacent to, the survey area is restricted to two localities, namely copper and manganese deposits of the Mount Gunson - Pernatty Lagoon district (Dickinson, 1942 & 1953) and silver-lead deposits of the Ediacara district (Broadhurst, 1947).

The copper and manganese deposits occur along the western margin of Pernatty Lagoon in depressions occupied by salt lakes or sand dunes.

The copper deposits comprise shallow, flat, irregularly-tabular bodies in sub-horizontal sandstones and are typical 'Red Bed' occurrences, deposited from meteoric waters, possibly by the action of sulphur bacteria. The original copper showings were due to accidents of erosion, and extensive deposits may lie at shallow depth below the uneroded tablelands.

The manganese deposits have a generally similar origin and are associated with a dolomitic limestone horizon in these flat-bedded sediments.

At the Mount Gunson, Gunyot, and Sweet Nell mines the copper occurs wholly as oxidised minerals, viz. chlorides, sulphates, carbonates, and chrysocolla, with a little chalcocite. At the Pernatty workings, however, the minerals are principally sulphides, viz. chalcocite, covellite and bornite, with subordinate atacamite and malachite. The copper minerals occur partly as replacements of the sediments, partly as concretions along bedding and fracture planes, and tend to occur on definite stratigraphic horizons. They are far removed from any outcropping igneous rock and their origin is obscure.

The manganese deposits occuring along the western shoreline of Pernatty Lagoon are associated with a bed of manganiferous dolomite, and show some tendency to parallel the major joints of the dolomite, which trend north-west. The ore occurs as soft blue ore, largely wad, and a darker, harder variety, containing much psilomelane and some pyrolusite (Dickinson, 1953).

Broadhurst (1947) described the Ediacara silver-lead deposits as occurring in a Cambrian limestone plateau underlain by a thick series of quartzite and sandstones. The plateau, 3 miles long and 1 mile wide occupies a basin structure which is probably less than 530 feet in depth and is located at latitude 30°52'S, longitude 138°07'E.

The majority of the deposits, and all the productive ones, occur along bedding planes and are mainly confined to the transition beds between the limestone and sandstone, these beds appearing to have provided planes of weakness along which shearing occurred.

Primary ores were probably galena with bunches or seams of tetrahedrite, which has a high silver content. The galena was largely or wholly altered to cerussite.

Pyrite and haematite have also been noted in the transition beds.

Oil. In an assessment of the search for oil in South Australia Ward (1944, p.35) expressed the view that 'With regard to the Tertiary basins of deposition that are marginal to Gulf St. Vincent and Spencer Gulf, it may be said that stratigraphic features suitable for the creation of traps may possibly exist, even if no evidence of their existence has yet been furnished. Perhaps such a trap accounts for the trace of oil found in the northern extension of the Pirie-Torrens basin near Lake Torrens, on Wilkatana Station. Very many boreholes have been drilled in these marginal basins in search of water, without revealing any traces whatever of oil. The prospects of future discoveries in these areas generally are not considered to be hopeful'.

Santos Ltd subsequently drilled 24 boreholes at Wilkatana during 1956 and 1957, the borehole depths ranging from 45 to 2199 ft. In many of these, shows of oil and gas were obtained in both Tertiary and Cambrian sediments. These findings have directed interest to the Cambrian sediments around Lake Torrens which probably cover a large area, beneath Tertiary cover in most parts. (BMR, 1959).

3. INTERPRETATION

Magnetic results

Magnetic results from the Andamooka and Torrens areas are presented in Plates 3, 4, 5, and 6. Total magnetic intensity profiles, produced by the 'Speedomax' recorder have been reduced by pantography to an exact overall scale of 1:250,000 by controlling the positions of the flight traverse lines at longitudes 136°30'E, 137°00'E, and 138°00'E.

Plates 3 and 5 present the magnetic profiles related to idealised grids of flight traverse lines in the Andamooka and Torrens areas. These grids, for convenience of illustration, have scales of 1:250,000 (east-west) and 1:62,500 (north-south). Plates 4 and 6 show a selection of the magnetic profiles superimposed on the latest geological information available in the two areas. The probable error in positioning this magnetic data is estimated to be $\pm\frac{1}{4}$ mile (east-west) and $\pm\frac{1}{2}$ mile (north-south).

The magnetic profiles presented in Plates 3, 4, 5, and 6 illustrate the various anomaly-types recorded. The interpretation of the magnetic data is presented in Plates 7 and 8. These plates show magnetic anomaly trends, estimated depths to magnetic basement rock, and contours of the basement surface. The parameter used in depth estimation is that relating the horizontal extent (He) of an anomaly's maximum slope to the depth (D) of burial of the magnetic source according to:

$$D = 1.3 \times He$$

The magnetic trends indicate two distinct types of magnetic basement. One type is located south-west of the Commonwealth Railway in the Torrens area and is characterised by low-amplitude, elongate magnetic anomalies which are due to near-surface vertical tabular bodies. These anomalies trend N40°W paralleling the Gairdner Lineament and commonly extend for 50 miles. S.A. Mines Department aeromagnetic map of the Mullaroo one-mile area shows that the Gairdner Lineament has associated with it a similar magnetic anomaly to that recorded in the south-west of the Torrens area. This anomaly delineates the south-western boundary of this type of magnetic basement.

The second type of magnetic basement is located north-east of the Commonwealth Railway. It is within 1000 to 2000 feet of ground level in the area broadly delineated by the Torrens Lineament, Longitude 136°45'E, and the Commonwealth Railway, and is characterised by well-developed magnetic trends which have amplitudes commonly exceeding 500 gammas and lengths rarely exceeding 10 miles. The anomalies follow three dominant trends which parallel ancient fault lineaments of the Archaean area.

Group 1 - Trends striking N40°W paralleling Gairdner Lineament

Group 2 - Trends striking north paralleling Torrens Lineament in the Torrens area

Group 3 - Trends striking N40°E paralleling Lincoln Lineament.

The character of the magnetic anomalies produced by the shallow basement in the Andamooka area is similar to that of an igneous-metamorphic complex basement. It is probably Archaean rock at a shallow depth similar lithologically to that immediately west of the Torrens Lineament in the Peake and Denison Ranges (Glaessner and Parkin, 1958, p.10). These ranges lie north of the survey area.

The magnetic basement in the Andamooka area and the northern part of the Torrens area probably corresponds to a stable zone and the region between this and the Gawler Cratonic Nucleus may represent a zone of fracturing and faulting. The linear magnetic anomalies in the south-western part of the Torrens area are interpreted as an indication of igneous activity along lines of weakness, the resulting magnetic basement possibly being of Upper Proterozoic age or younger.

The magnetic-anomaly trends A-A to G-G indicate abrupt changes in the general level of the magnetic intensity caused by contrasts in the magnetic properties of the basement rocks. These trends appear to subdivide the survey area into a region of generally-high magnetic intensity, commonly associated with intermediate to basic Archaean basement and areas of generally-low magnetic intensity commonly associated with more-acidic basement rocks.

Basement rock susceptibility contrasts calculated from these anomaly trends are listed below :

Magnetic-anomaly trend	Susceptibility (c.g.s. units)
A-A	1000 - 3500 x 10^{-6}
B-B	1000 - 2000 x 10^{-6}
C-C	1000 x 10^{-6}
D-D	1000 x 10^{-6}
E-E	1500 x 10^{-6}
F-F	1000 x 10^{-6}
G-G	1500 x 10^{-6}

The Torrens Lineament has magnetic expression in the Andamooka area, particularly between latitudes 30°15'S and 31°00'S. Although little vertical movement is apparent along the lineament itself, the magnetic basement deepens eastward from this structure.

In the Torrens area there is no magnetic expression of this lineament. However, the magnetic data indicate that the basement is relatively shallow west of longitude 137°30'E but deepens eastwards at a similar rate to that observed in the Andamooka area.

The magnetic anomalies with trends D-D and E-E north and east of Pernatty Lagoon show the typical asymmetrical form produced by a basement contact involving two rock types of markedly different susceptibilities. These magnetic anomalies are interpreted as a continuation of a known fault mapped in the south of the Andamooka area.

A lateral basement movement of nine miles in a direction N 120°W is interpreted from the displacement of trends D-D and E-E. There is no magnetic anomaly directly associated with this inferred structure.

No variation in magnetic basement elevation appears to be related to the magnetic-anomaly trend A-A in the Andamooka area; however, the association of intense local magnetic anomalies with limited north-south elongation does suggest a structural source for these magnetic features.

Intense local magnetic disturbance is also evident along the Torrens Lineament near Andamooka Island and to a lesser extent along the inferred fault north and east of Pernatty Lagoon. These anomalies probably represent igneous activity or mineralisation along lines of weakness caused by major faults. Ground investigations are required to assess the direct relation of these anomalies with economic mineralisation or their association with economic deposits of the Pernatty-Lagoon (copper and manganese) type (McPharlin, 1949).

Two faults, which lie to the west of Andamooka Island and trend approximately N50°E, appear to define a basement structure interpreted as a block movement of approximately 12 miles N50°E across the Torrens Lineament. Evidence for this structure lies in the local shallowing of the magnetic basement east of the lineament (Plate 7) and in the displacement of magnetic anomalies. The displacement of magnetic anomalies is well illustrated in Plate 3 by the anomaly near longitude 130°45'E, Lines 34 to 40. It is of interest to note that no magnetic anomalies appear to be directly associated with the two faults.

Radiometric results

Radiometric results from the Andamooka and Torrens areas are presented in Plates 9 and 10. Profiles of radioactive intensity recorded by the inboard scintillograph have been adjusted to an exact overall scale of 1:250,000 using a similar process to that adopted for the preliminary profiles of total magnetic intensity. Plates 9 and 10 present the radioactive profiles, recorded on alternate lines, superimposed on the latest geological information available in the two areas. Areas where the radioactive intensity level increases significantly are indicated on these plates.

Discrete radiometric anomalies, assessed from both the inboard and outboard scintillographs as resulting from sources with an areal extent less than 300 ft in radius, are also shown on these plates.

The probable error in the positioning of this radiometric data is estimated to be $\pm\frac{1}{4}$ mile (east-west) and $\pm\frac{1}{2}$ mile (north-south).

The radiometric profiles show that the level of gamma radiation is generally low throughout the entire area, which is to be expected in a region where igneous rocks are not known to crop out.

An increased level in gamma radiation is associated with localities where the Cambrian quartzite (reference P7 on Plates 9 and 10) crops out; in fact it appears that the radiometric data broadly differentiate between areas where the sediments are either older or younger than this rock. It is apparent that sand plain, sand dune, and alluvium of Quaternary age, Cretaceous sediments, and Cambrian sediments (P8) produce a very low level of gamma radiation

Recent lacustrine deposits generally show a similar level in gamma radiation to that recorded in areas of P7 outcrop. It is therefore considered that this radioactivity is produced by salts derived from drainage of P7 areas, which in Lake Torrens entails drainage from the area west of the lake. An extremely-well-defined change in the level of gamma radiation occurs along the eastern shore of Lake Torrens owing to the area of superficial cover of Quaternary alluvium.

The well-defined radioactive intensity 'low', whose axis exactly parallels the Torrens Lineament, in the vicinity of Andamooka Island is attributed to the effect of the water table in the lake locally restricting gamma radiation. Surface waters were observed in the lake during the course of the survey following moderate rains.

It is suggested that similar radioactive intensity 'lows' in Island Lagoon and Lake Macfarlane may also have resulted from the level of the water table. In the outline of areas associated with decreases in gamma radiation there are distinct trends that are commonly orthogonal to the Torrens Lineament. Two such features are those which strike N50°E about Lake Mary and Woomera and have axes parallel to known faults (cf. magnetic results).

A small area of marked increase in gamma radiation is shown at the northern tip of Lake Torrens straddling the Torrens Lineament. This area warrants investigation by ground radiometric survey to assess the cause and significance of the local abnormal gamma radiation, since it may define an area of near-surface igneous rock.

Four radiometric anomalies due to localised sources were recorded in the Andamooka area; their locations are shown in Plate 9. The anomaly near Andamooka Island warrants investigation by ground survey.

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APPENDIX

OPERATIONAL DETAILS

STAFF:

Party Leader	:	G.A. Young	
Geophysicists	:	F.E.M. Lilley	
Senior radio-technician	:	P.B. Turner	
Geophysical assistants	:	K.A. Mort C.J. Braybrook	
Pilots	:	Capt. P. Korsman First Officer D. Baker	TAA
Aircraft maintenance engineer	:	R. McNamee	TAA

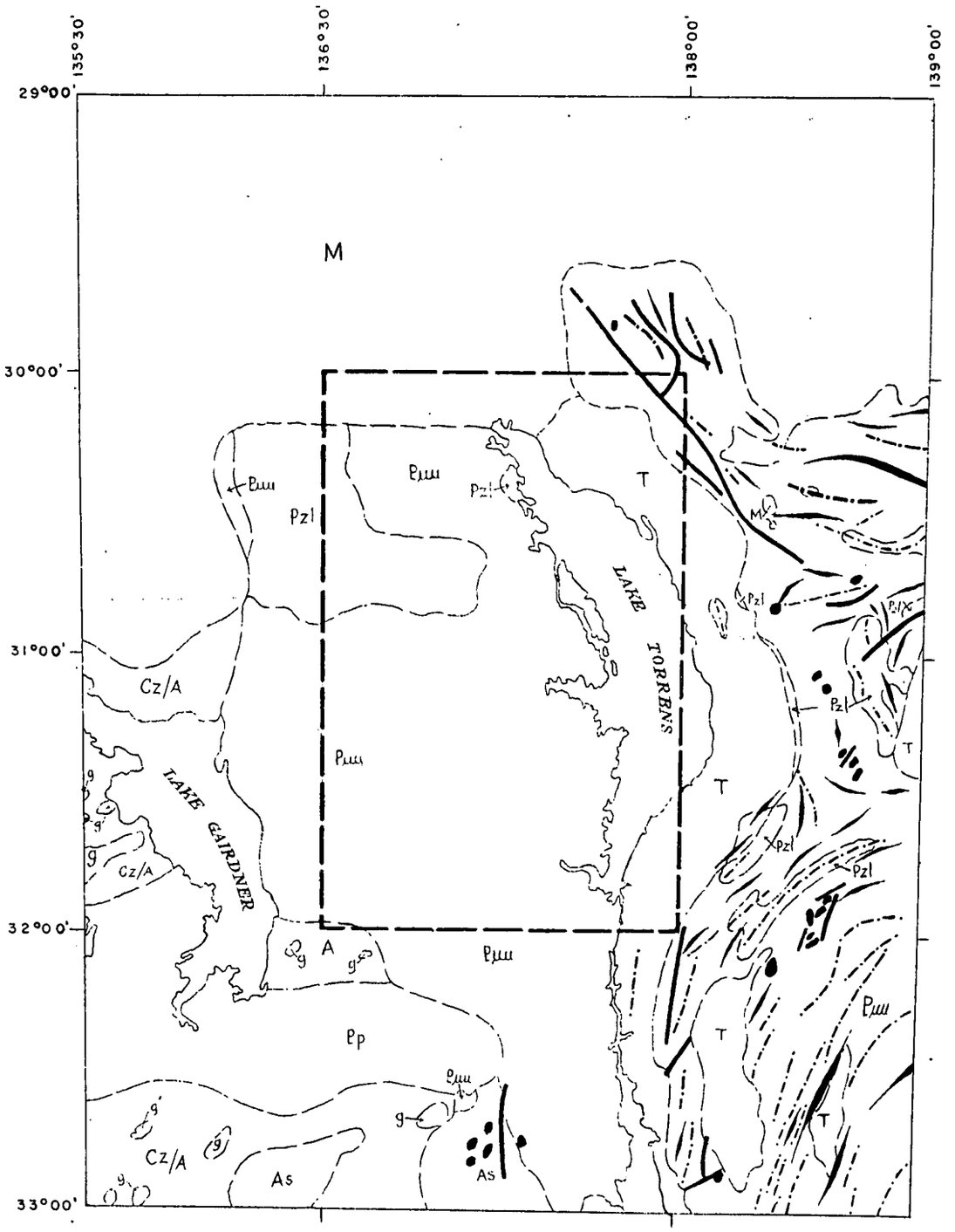
EQUIPMENT:

Aircraft	:	DC.3, VH-MIN
Magnetometer	:	MFS-4, saturable core fluxgate, tail-boom instillation, coupled to 'Speedomax' recorder.
Scintillographs	:	Twin-crystal MEL scintillation detector heads inboard and outboard (the latter suspended from a cable 200 ft below aircraft)
Camera	:	'Aeropath', 35-mm strip
Radio-altimeter	:	STR30B, frequency-modulated type

SURVEY SPECIFICATIONS:

Altitude	:	500 ft above ground level
Line spacing	:	One mile
Line orientation	:	East
Tie system	:	Single lines spaced 15 mile apart
Navigation control	:	Aerial photographs
Sensitivity (MFS-4)	:	100 gammas/in

PLATE 1



GEOLOGY

AFTER TECTONIC MAP OF AUSTRALIA

SCALE

MILES 40 0 40 80 MILES

LEGEND

Cz	CAINOZOIC UNDIFFERENTIATED
T	TERTIARY
M	MESOZOIC UNDIFFERENTIATED
Pzl	LOWER PALAEOZOIC
Pμμ	UPPER PROTEROZOIC
—	FAULT
~	ANTICLINE
-·-·-	SYNCLINE
A	ARCHAEAN UNDIFFERENTIATED
As	ARCHAEAN SEDIMENTS AND METASEDIMENTS
Pp	PROTEROZOIC ACID GRANITE PORPHYRY
g	UNDIFFERENTIATED ACID GRANITE PORPHYRY
●	UNDIFFERENTIATED INTERMEDIATE TO BASIC HYPABYSSAL VOLCANIC CENTRES

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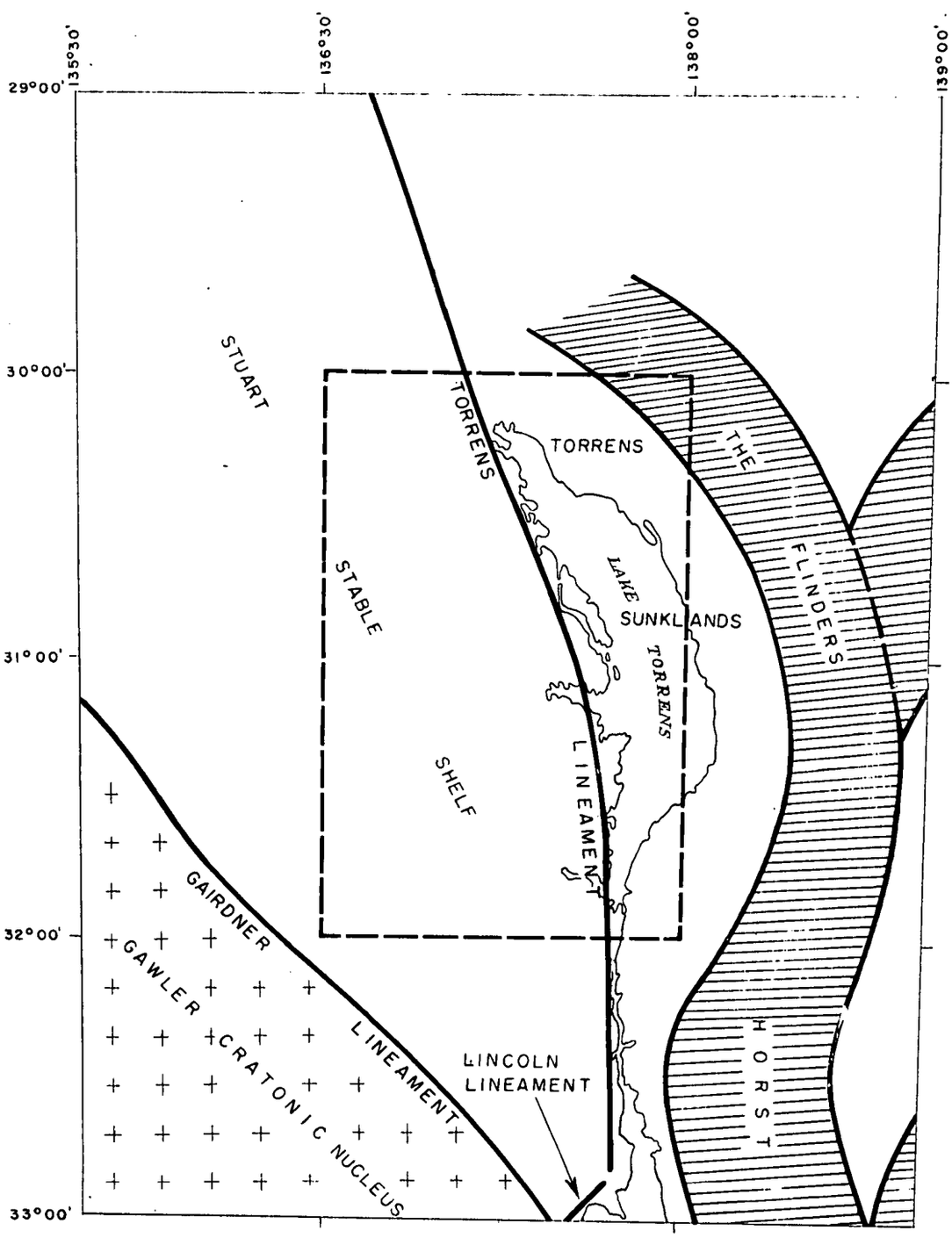
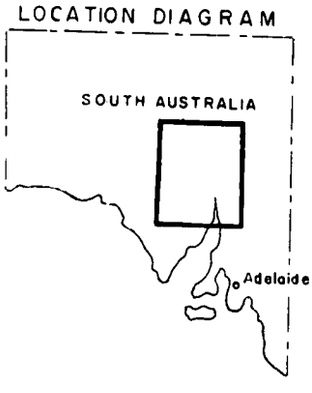
PLATE 2



MAJOR GEOLOGICAL STRUCTURE

(AFTER FENNER, 1927; DICKINSON & SPRIGG, 1953)

LOCATION DIAGRAM



SCALE

MILES 40 0 40 80 MILES

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TO ACCOMPANY RECORD No. 1964/31

ANDAMOOKA
SOUTH AUSTRALIA

INDEX OF ADJOINING SHEETS

BILLAKALINA	CURDIMURKA	MARREE
KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA

LOCATION DIAGRAM

TOTAL MAGNETIC INTENSITY PROFILES

AIRBORNE SURVEY, ANDAMOOKA-TORRENS, SA 1962

EAST - WEST SCALE: 5 0 5 10 15 20 MILES; 5 0 5 10 15 20 25 30 KILOMETRES

NORTH - SOUTH SCALE: 1 0 1 2 3 4 5 MILES; 1 0 1 2 3 4 5 6 7 KILOMETRES

APPROX. PROFILE SCALE: 1,000 gammas, 500, 0

EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 500 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART.

THE TOTAL MAGNETIC INTENSITY PROFILES WERE RECORDED BY A RECTILINEAR RECORDER, AND HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL INTENSITY OF 10 GAMMAS PER MILE IN A DIRECTION S 6° W.

THE FLIGHT-LINES, WHICH ALSO SERVE AS BASELINES TO THE PROFILES, HAVE BEEN DISPLAYED WITH AN ARBITRARY SEPARATION OF ONE MILE AND WERE CONTROLLED IN LONGITUDE ONLY NEAR THE EASTERN AND WESTERN BOUNDARIES OF THE MAP.

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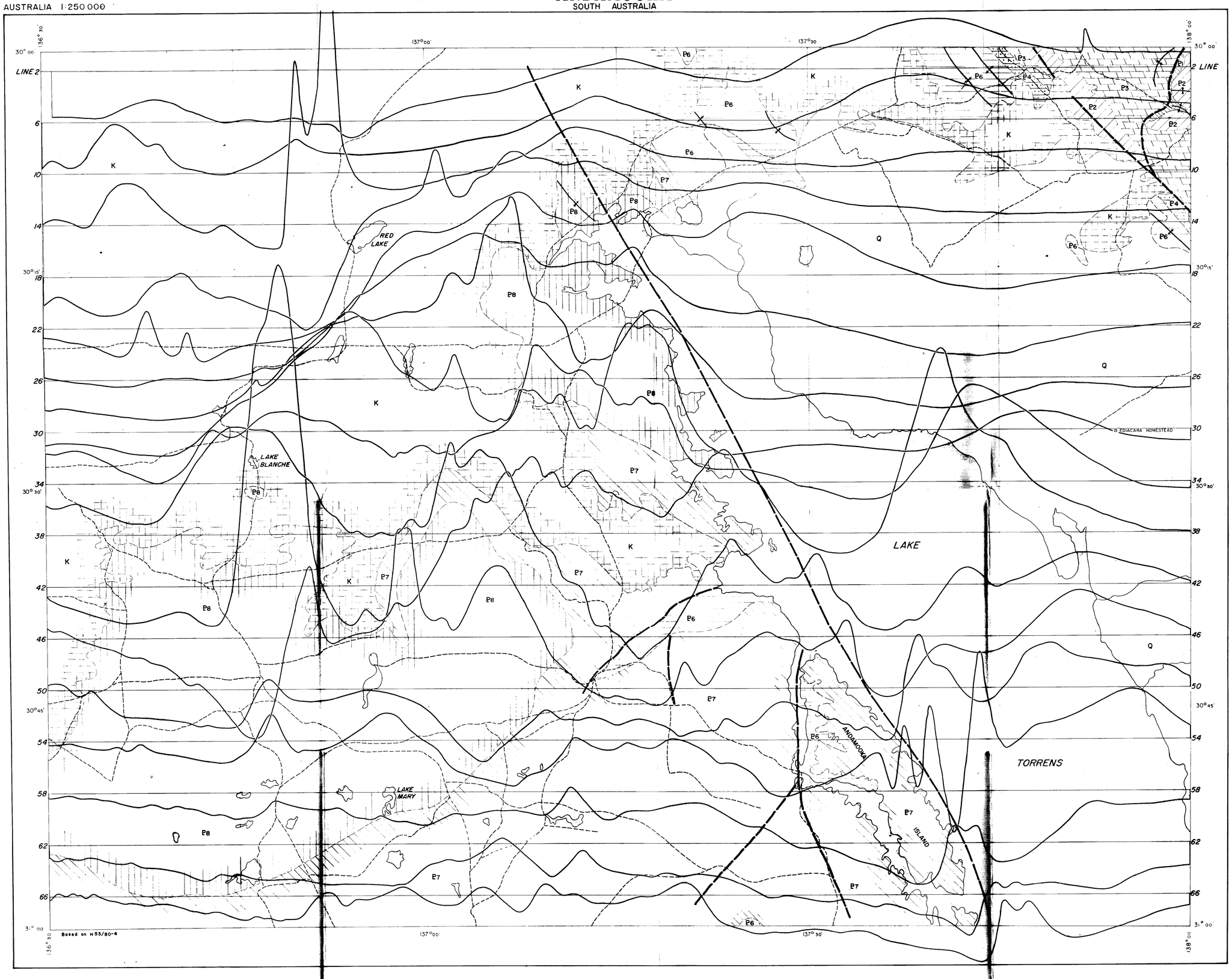
AUSTRALIA 1:250 000

ANDAMOOKA
SOUTH AUSTRALIA



Based on H 53/80-4

LEGEND

QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	P1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

- Geological boundary
- Anticlinal crest
- Synclinal trough
- Fault
- River or creek
- Railway
- Road or track
- Homestead

Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

6°30' True North / Magnetic North

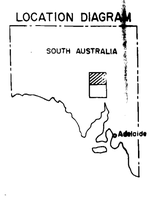
APPROX. PROFILE SCALE

1,000 gammas
500
0

INDEX TO ADJOINING SHEETS

BILLAKALINA	CURDIMURKA	MARREE
KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA

LOCATION DIAGRAM



AIRBORNE SURVEY, ANDAMOOKA – TORRENS, SA 1962

TOTAL MAGNETIC INTENSITY PROFILES
AND
GEOLOGY

SCALE

5 0 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETRES

EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC3 AIRCRAFT AT AN ALTITUDE OF 500 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART.

THE TOTAL MAGNETIC INTENSITY PROFILES WERE RECORDED BY A RECTILINEAR RECORDER, AND HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL INTENSITY OF 10 GAMMAS PER MILE IN A DIRECTION S 6°W. PROFILES RECORDED AT INTERVALS OF FOUR MILES ARE SHOWN ON THE MAP.

THE FLIGHT-LINES, WHICH ALSO SERVE AS BASELINES TO THE PROFILES, HAVE BEEN POSITIONED ON THE MAP WITH AN ACCURACY OF ± 1/2 MILE BY CONTROL AT LONGITUDES 136°30', 137°00' AND 138°00'.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H 53/81-5

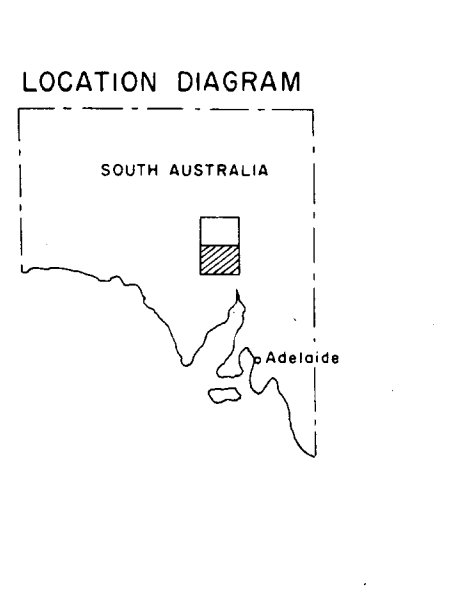
TO ACCOMPANY RECORD No. 1964/31

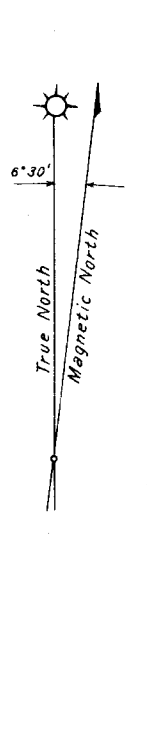
TORRENS
SOUTH AUSTRALIA

INDEX OF ADJOINING SHEETS

KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORROROO

LOCATION DIAGRAM

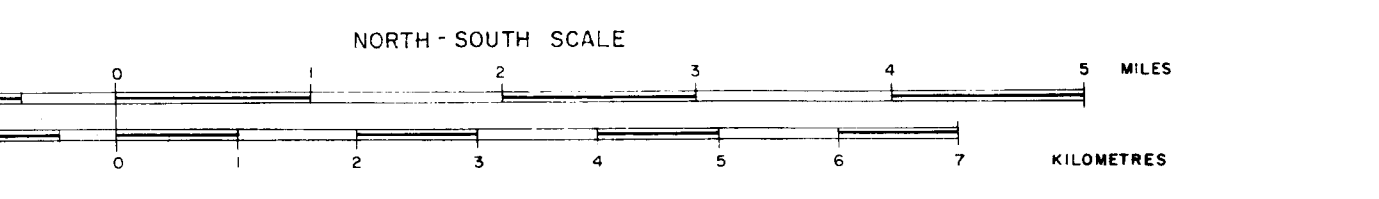




TOTAL MAGNETIC INTENSITY PROFILES

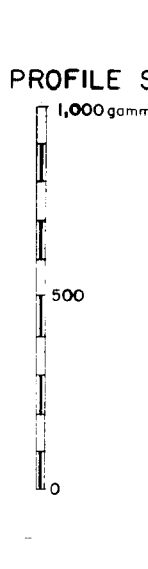
AIRBORNE SURVEY, ANDAMOOKA-TORRENS, SA 1962

EAST - WEST SCALE



NORTH - SOUTH SCALE

APPROX. PROFILE SCALE



EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 500 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART.

THE TOTAL MAGNETIC INTENSITY PROFILES WERE RECORDED BY A RECTILINEAR RECORDER, AND HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL INTENSITY OF 10 GAMMAS PER MILE IN A DIRECTION S 6°W.

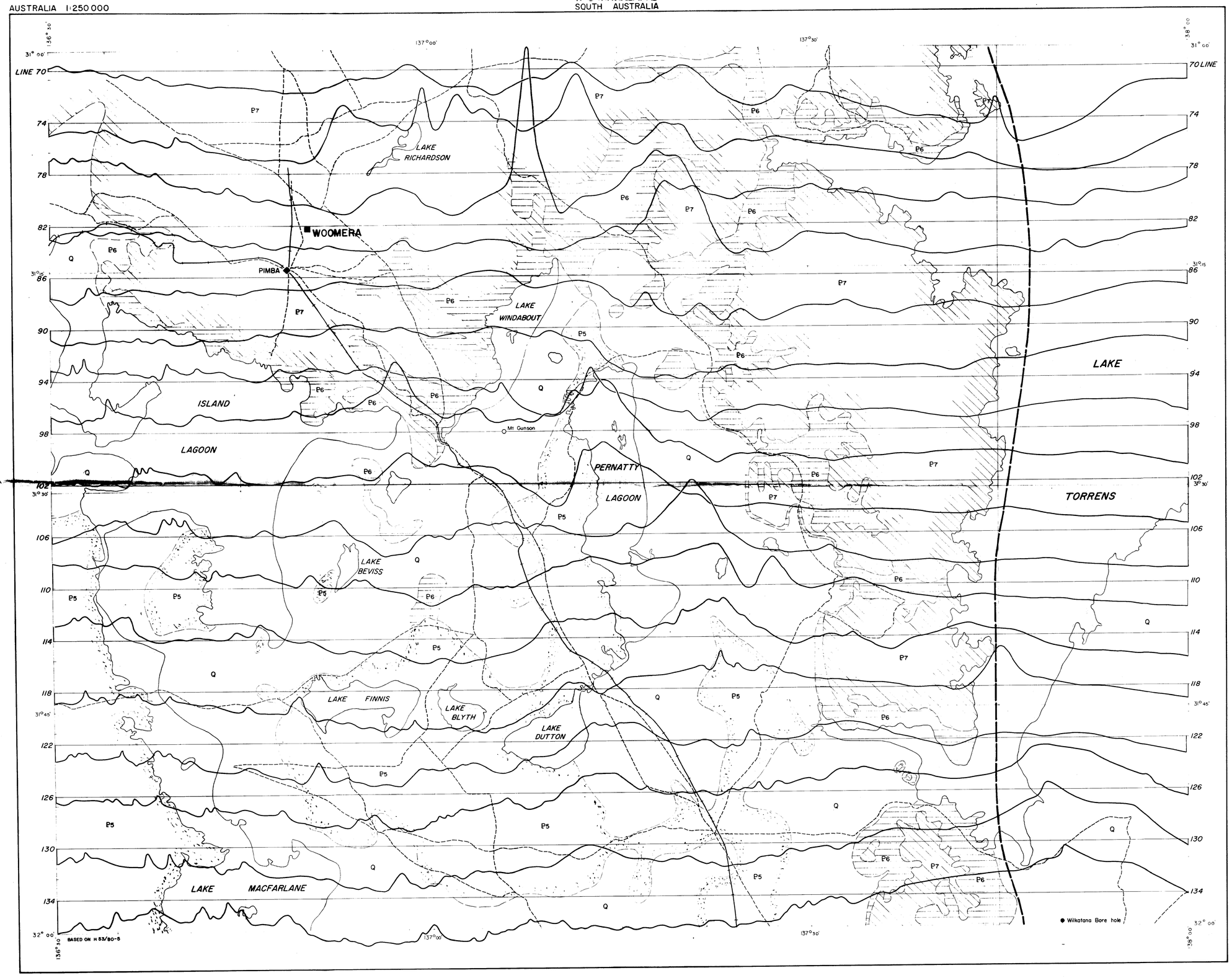
THE FLIGHT-LINES, WHICH ALSO SERVE AS BASELINES TO THE PROFILES, HAVE BEEN DISPLAYED WITH AN ARBITRARY SEPARATION OF ONE MILE AND WERE CONTROLLED IN LONGITUDE ONLY NEAR THE EASTERN AND WESTERN BOUNDARIES OF THE MAP.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. H53/B1-14

TO ACCOMPANY RECORD No 1964/31

AUSTRALIA 1:250 000

TORRENS
SOUTH AUSTRALIA



LEGEND

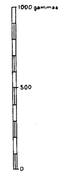
QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	P1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

- Geological boundary
- Anticlinal crest
- Synclinal trough
- Fault
- River or creek
- Railway
- Road or track
- Homestead
- Bore hole

Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

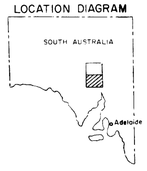
APPROX. PROFILE SCALE



INDEX TO ADJOINING SHEETS

KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORROROO

LOCATION DIAGRAM



AIRBORNE SURVEY, ANDAMOOKA – TORRENS, SA 1962

TOTAL MAGNETIC INTENSITY PROFILES AND GEOLOGY

SCALE

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETRES

EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC3 AIRCRAFT AT AN ALTITUDE OF 500 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART.

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Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H 53, Bi-3

AUSTRALIA 1:250 000

ANDAMOOKA
SOUTH AUSTRALIA

LEGEND

QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	P1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

- Geological boundary
- Anticlinal crest
- Synclinal trough
- Fault
- River or creek
- Railway
- Road or track
- Named place
- Homestead

Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

RED LAKE
LAKE BLANCHE
LAKE MARY
LAKE TORRENS
ANDAMOOKA ISLAND
"EDIACARA HOMESTEAD"

True North
Magnetic North
6°30'

BASED ON H53/80-4

INDEX TO ADJOINING SHEETS

BILLAKALINA	CURDIMURKA	MARREE
KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA

LOCATION DIAGRAM

MAGNETIC-ANOMALY TRENDS AND BASEMENT-DEPTH CONTOURS

AIRBORNE SURVEY, ANDAMOOKA – TORRENS, SA 1962

SCALE

0 5 10 15 20 MILES
0 5 10 15 20 25 30 KILOMETRES

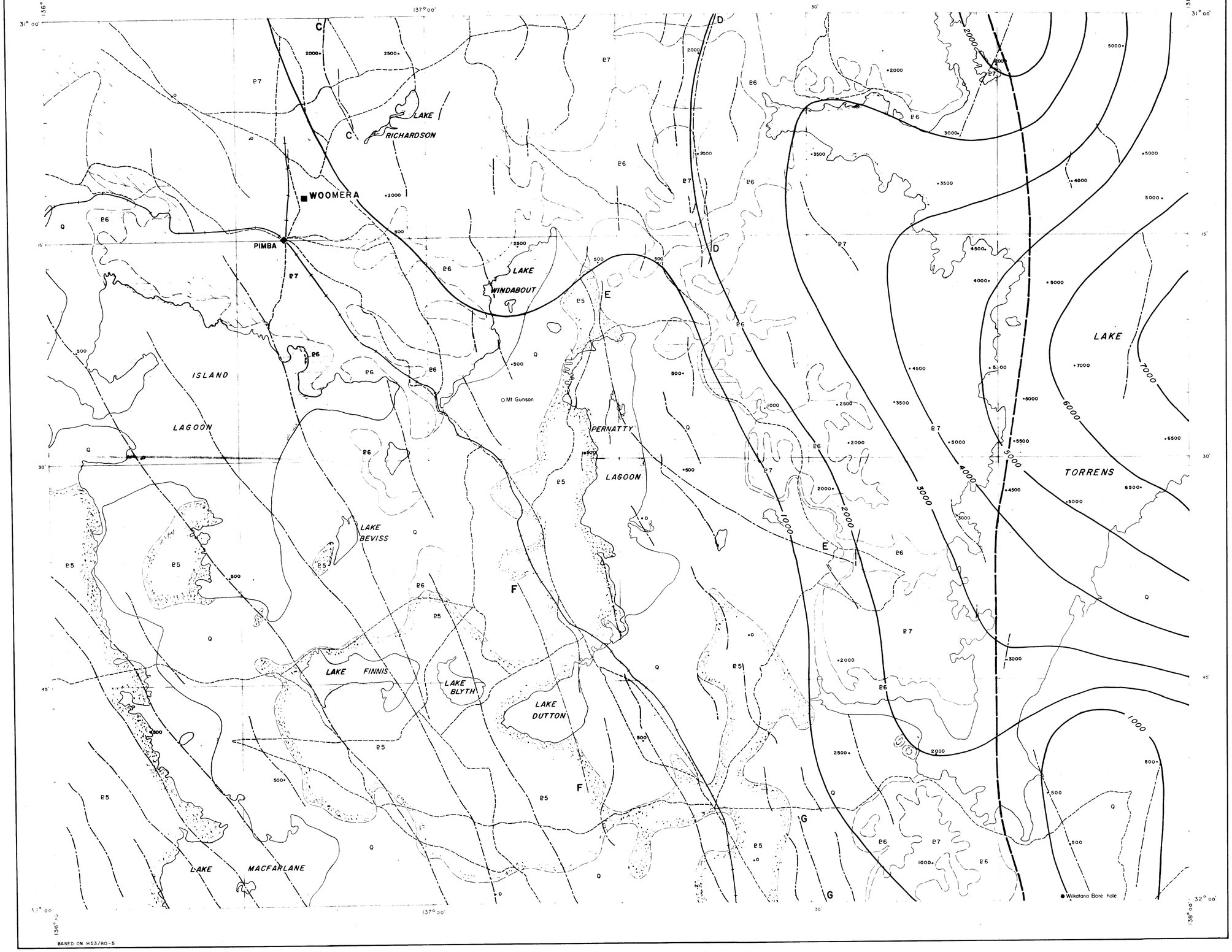
GEOPHYSICAL LEGEND

- MAGNETIC ANOMALY TREND
- •2000 ESTIMATED DEPTH TO MAGNETIC BASEMENT ROCK IN FEET
- DEPTH CONTOUR

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H53/B1-15

AUSTRALIA 1:250 000

TORRENS
SOUTH AUSTRALIA



BASED ON H53/80-5

LEGEND

QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	P1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

- Geological boundary
- Anticlinal crest
- Synclinal trough
- Fault
- River or creek
- Railway
- Road or track
- Named place
- Homestead
- Bore hole

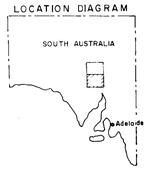
Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

True North / Magnetic North 6°30'

INDEX TO ADJOINING SHEETS

KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORROROO

LOCATION DIAGRAM



MAGNETIC-ANOMALY TRENDS AND BASEMENT-DEPTH CONTOURS

AIRBORNE SURVEY, ANDAMOOKA – TORRENS, SA 1962

SCALE

5 0 5 10 5 20 MILES
5 0 5 10 15 20 25 10 KILOMETRES

GEOPHYSICAL LEGEND

- MAGNETIC – ANOMALY TREND
- •2000 ESTIMATED DEPTH TO MAGNETIC BASEMENT ROCK IN FEET
- DEPTH CONTOUR

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H53/B1-16

TO ACCOMPANY RECORD No. 1964/31

AUSTRALIA 1:250 000

ANDAMOOKA
SOUTH AUSTRALIA

LEGEND

QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	P1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

- Geological boundary
- Anticlinal crest
- Synclinal trough
- Fault
- River or creek
- Railway
- Road or track
- Named place
- Homestead

Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

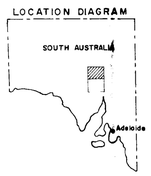
6°30' East Magnetic North

APPROX PROFILE SCALE
250 counts per second
0

INDEX TO ADJOINING SHEETS

BILLAKALINA	CURDIMURKA	MARREE
KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA

LOCATION DIAGRAM



RADIOMETRIC RESULTS
AIRBORNE SURVEY, ANDAMOOKA-TORRENS, SA 1962

SCALE
5 0 5 20 MILES
10 0 20 40 KILOMETRES

GEOPHYSICAL LEGEND

- RADIOMETRIC PROFILE
- ⊗3 RADIOMETRIC ANOMALY (ANOMALIES ARE NUMBERED FOR REFERENCE ONLY)
- RADIOACTIVE INTENSITY CHANGE EXCEEDING ½ × BACKGROUND
- RADIOACTIVE INTENSITY CHANGE EXCEEDING 1 × BACKGROUND

THE BARBED EDGE IS ON THE SIDE OF LOWER INTENSITY

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H 53/BI-7

TO ACCOMPANY RECORD No. 1964/31

AUSTRALIA 1:250 000

TORRENS
SOUTH AUSTRALIA

LINE 69 — 71 — 73 — 75 — 77 — 79 — 81 — 83 — 85 — 87 — 89 — 91 — 93 — 95 — 97 — 99 — 101 — 103 — 105 — 107 — 109 — 111 — 113 — 115 — 117 — 119 — 121 — 123 — 125 — 127 — 129 — 131 — 133 — 135 — LINE 69

136° 30' — 137° 00' — 137° 30' — 138° 00'

31° 00' — 31° 15' — 31° 30' — 31° 45' — 32° 00'

LAKE RICHARDSON
WOOMERA
PIMBA
LAKE WINDABOUT
Mt Gunson
ISLAND LAGOON
PERNATTY LAGOON
LAKE TORRENS
LAKE BEVISS
LAKE FINNIS
LAKE BLYTH
LAKE DUTTON
LAKE MACFARLANE
Wilkatana Bore hole

Based on H 53/80-5

LEGEND

QUATERNARY	Q	Sand plain, sand dunes, alluvium
CRETACEOUS	K	Shales, siltstones, sandstone
CAMBRIAN	P8	Shales, limestones
	P7	Quartzite
	P6	Siltstones, slates, sandstone
	P5	Sandstone, quartzite
	P4	Tillite, slate, sandstone
	P3	Dolomites, slates, sandstones, magnesites
	P2	Quartzites
UPPER PROTEROZOIC	L1	Slates, dolomites, sandstones

Sediments of the Adelaide Geosyncline

Geological boundary
Anticlinal crest
Synclinal trough
Fault

River or creek
Railway
Road or track
Named place
Homestead
Bore hole

Geological and planimetric detail after a map of the area prepared by Geological Survey of South Australia, Department of Mines

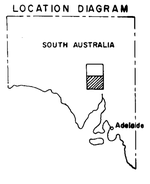
6°30'
True North
Magnetic North

APPROX. PROFILE SCALE
250 counts per second
0

INDEX TO ADJOINING SHEETS

KINGOONYA	ANDAMOOKA	COPLEY
GAIRDNER	TORRENS	PARACHILNA
YARDEA	PORT AUGUSTA	ORROROO

LOCATION DIAGRAM



RADIOMETRIC RESULTS
AIRBORNE SURVEY, ANDAMOOKA - TORRENS, SA 1962

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 10 KILOMETRES

GEOPHYSICAL LEGEND

RADIOMETRIC PROFILE
⊗3 RADIOMETRIC ANOMALY (ANOMALIES ARE NUMBERED FOR REFERENCE ONLY)
RADIOACTIVE INTENSITY CHANGE EXCEEDING ½ × BACKGROUND
RADIOACTIVE INTENSITY CHANGE EXCEEDING 1 × BACKGROUND
THE BARBED EDGE IS ON THE SIDE OF LOWER INTENSITY

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H53/B1-4

TO ACCOMPANY RECORD No. 1964/31