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GEOPHYSICAL APPRAISAL AND INTERPRETATION OF THE GAIRDNER 1:250000 SHEET AREA

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South Australia —

DEPARTMENT OF MINES

SOUTH AUSTRALIA

GEOPHYSICAL APPRAISAL AND INTERPRETATION OF THE GAIRDNER 1:250 000 SHEET AREA

by

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ABSTRACT

A qualitative interpretation of the aeromagnetic and bouguer gravity contours of GAIRDNER, 1:250 000 sheet area, was undertaken to help in geological mapping and in locating areas of interest for geochemical sampling. The magnetic zones and trends indicated possible folding and delineated two major fracture directions NW and NE. Twenty sites were defined by the intersection of magnetic zones and structures as areas of interest for a geochemical sampling programme.

INTRODUCTION

At the request of A.H. Blissett and B. Thomson, of the South Australian Geological Survey, Regional Mapping Division, a preliminary assessment and interpretation of the aeromagnetic, scintillometer and gravity surveys, which have been carried out in GAIRDNER, 1:250 000 sheet area is presented. The purposes of the assessment of this geophysical data are to assist the interpretation of the regional structures of the area and assess areas of possible interest with respect to mineralization, particularly around the granites and Gawler Range Volcanics, where regional stream sediment and rock chip geochemical sampling is being undertaken by the Department.

GEOLOGY

In the past, very little systematic geological mapping has been done in GAIRDNER, except for a photo-interpretation undertaken by Bennett

(1966) for the South Australian Department of Mines. This interpretation is shown in drawing No. 66-217/6, which is not shown in this report. This photo-interpretation was basically an outcrop map, and showed a large area of unresolved Gawler Range Volcanics, located west of Lake Gairdner. The remainder of the area is covered by Tertiary and Quaternary deposits.

Johns (1968) investigated the possible economic brine or evaporite deposits in Lake Gairdner. In his investigation of the lake sediments he states that "the lake does not owe its origin to down warping or graben subsidence, as it is surrounded and underlain almost entirely by acid igneous rocks." A number of drill holes intersected a feldspar porphyry, east of the lake at an approximate depth of 3 feet, as shown in drawing No. 72-773.

Mesozoic siltstones, tableland remnants of the Marree Formation Equivalents, occur north of Lake Gairdner around the transcontinental railway line.

Detailed geological mapping by companies has been mainly restricted to Harris 1:63 360 sheet area, in connection with the Glenloth Goldfield and the Earea Dam tin occurrence. The companies who have taken out Special Mining Leases in the area are, Australian Development N.L., Harvey et al (1966), S.M.L. 83; Asarco (Australia) Pty. Ltd., S.M.L.307, Kokatha Prospect, Dodds (1969); and Kennecott Exploration (Australia) Pty. Ltd. (1969) in the Lake Harris Prospect Area, S.M.L. 345. (Warner et al (1970)).

The detailed mapping at Earea Dam and Glenloth Areas, Harvey (1966) has been simplified and reduced onto a scale of 1:250 000, shown in drawing No. 72-773. The Glenloth Granite was mapped to include migmatic granite, porphyritic granite, biotite-granite and a foliated granite associated with high grade metamorphics. This granitic complex was intruded by aplite and

pegmatite veins, auriferous quartz veins and basic intrusions; i.e. dolerite and gabbro dykes. These basic dykes mapped were small in outcrop, and tend to have major orientation between 110 to 140 degrees, although one was orientated at 20 degrees.

This area was investigated geochemically by the South Australian Department of Mines, using stream and rock sampling techniques, for tin, molybdenum, copper and zinc. Anomalous values showing tin mineralization, probably too low grade to be of economic interest, and wide spread occurrences of anomalous molybdenum were recorded by Whitten and Wright. (unpublished).

Asarco (Australia) Pty. Ltd., S.M.L. 307, Kokatha Prospect, defined by latitudes 31°11'S and 31°18'S and longitudes 135°30'E and 135°20'E was geologically mapped and rock outcrop geochemically sampled as reported by Dodds (1969). The field geological mapping units are being revised by the South Australian Mines Department. Dodds (1969) reported from preliminary sampling data, that copper-nickel mineralization was restricted to the margin of a 'gabbro' and hornfels, and silver-lead-zinc mineralization occurred along the contact zone between the granite and porphyritic rhyolite. Drilling data has revealed that some of the sources of the aeromagnetic anomalies were basaltic rocks.

Kennecott Exploration (Australia) Pty. Ltd., held S.M.L. 345, defined by latitudes 31°00'S, 31°03'S and longitudes 134°04'E, 135°10'E situated on the north-west part of Lake Harris, north of Glenloth mines and south-west of Kingoonya. This area was geologically mapped and geochemically sampled by Warne et al. (1970). The geological mapping revealed a small outcrop of serpentine, tremolite schist and chlorite-actinolite schist located on the edge of Lake Harris.

The geochemical assays of rock samples indicated high nickel and chromium values located near the serpentine outcrop. This corresponds to a west-south-west, east-north-east trending aeromagnetic anomaly. This company undertook an auger sampling programme and conducted a ground magnetic survey over the area in an attempt to trace the nickeliferous zone beneath the lake alluvium. The ground magnetic contours, which will be considered later in this report are shown in drawing No. 72-763. The auger drilling in the lake edge was stopped due to the surface being too soft to support the drill. A summary of the geology and geochemistry is shown in drawing No. 72-764.

Daly (1971), reported on the mineral potential of the Lake Everard (S.E.) Prospect, S.M.L. 529, and stated that,

"The features XX' and YY' located approximately 6 miles south east of Blue Dam H.S. were interpreted from aerophotographs as a probable lineaments." This was considered by Daly (1971) to be evidence of zones of strong jointing or fractures within the volcanics. In this area anomalous Cu, Pb, Zn and Mn assay results were recorded, which were 845, 3250, 4450 and 1267 ppm respectively, compared with the mean background values of 48, 50, 113 and 487 ppm respectively. Further sampling showed an increase in Cu, Pb and Zn values at the intersection of the two features. This possible mineralization is associated with a fracture system interpreted from the magnetic data.

PREVIOUS GEOPHYSICAL SURVEYS

A. Aeromagnetic Data

The GAIRDNER 1:250 000 sheet area was flown by the Bureau of Mineral Resources (B.M.R.) in two parts, 1959 and 1961 on behalf of the

South Australian Geological Survey, Department of Mines. Both parts of the GAIRDNER were flown aeromagnetically and radiometrically along lines orientated east-west, with a ground clearance of 500 feet and a flight line spacing of 1 mile. The one mile areas of Acraman, Moonarie and Butterfield were flown in 1959 and the remainder in 1961. The airborne data of both surveys were reduced into the contour form, and published in 1961 and 1963 respectively by the South Australian Department of Mines at both 1:250 000 and 1:63 360 scales.

The radiometric data was also reduced by the Department in a profile form for both surveys at a scale of 1:250 000 and published in 1967. These profiles are incorporated in the GAIRDNER-STREAKY BAY plan, No. 67-83 for the 1959 survey, and CHILDARA-GAIRDNER plan No. 67-84 for the 1961 survey, not shown in this report.

Quilty (1962) interpreted the aeromagnetic and radiometric data of the CHILDARA-GAIRDNER survey 1961, classified the magnetic anomalies into two groups, based on magnetic intensities as given below:

Group	Range of Magnetic Intensity
1	between 500 to 1 000 gammas
2	between 1 000 to 2 000 gammas

Quilty, does not state the likely sources of these anomalies. The anomalies are shown in B.M.R. plan 1153/B1-2, not shown intthis report.

B. Gravity Data

In 1969, the Exploration Geophysics Section of the South Australian Department of Mines, conducted a helicopter gravity survey, with a station density of one station per 16 square miles. This particular survey covered the 1:250 000 sheet areas of KINGOONYA, GAIRDNER and YARDEA.

Survey procedures have been reported by Gerdes (1970) and the data was reduced for the Department of Mines by Amdel, using a computer reduction programme developed by Boyce (1970). The network system showing the original gravity and elevation misclosures before least squares network adjustment, after Gibson (1941), is shown in drawing No. 72-776 together with the Gravity Station Locations.

The mean and standard deviations for the gravity and elevation misclosures for GAIRDNER were 0.077, 0.066 milligals; and 17.8, 16 feet respectively. The survey network was tied to the following Bureau of Mineral Resources Isogal stations. Stations numbers and observed gravity values of these stations are given below:-

Place	Station Number	Observed Gravity
Lake Everard	6491 - 9118	979447.15 milligals
Tarcoola	6491 - 9101	979333.93 milligals

The elevation network was tied to nine Lands Department Bench Marks on the Pimba - Kingoonya and Kingoonya - Lake Everard roads. These bench marks are shown on the GAIRDNER gravity station map. The standard error on the barometric station elevations was 18 feet (5.5 m).

C. Groundmagnetic Data

In Asarco (Australia) Pty. Ltd., S.M.L. 307, Mr. J.E. Webb, a consulting geophysicist, considered that the Department of Mines magnetic contours of Harris and Kokatha suggested that the contours over the Kokatha Prospect indicated a general trend striking a little north of west, accompanied by a second trend direction approximately north-west. He estimated that the source depths were between 100 to 1 000 ft below surface, and considered that the sources were due to a band of basic intrusives within a mass of non-magnetic rocks such as granite and rhyolite. He also postulated two faults,

of which BB is possible, and AA is questionable.

Three grids were layed out in particular contact zones and some magnetic traverses were made. Shallow drill holes intersected altered 'basalt' at depths less than 60 feet (18.3 m) on grids I and III. This probably explains the source rocks of two magnetic anomalies.

Kennecott Explorations (Australia) Pty. Ltd., S.M.L. 345, Glenloth, Warne et al. (1970) was positioned around an aeromagnetic anomaly trending at 085° (WSW/ENE) on the northwestern side of Lake Harris. Magnetic data was recorded at 100 feet intervals on lines 800 feet apart in an effort to trace the basic ultrabasic body beneath the lake bed. Readings were taken on lines 400 feet apart over the prospect area shown in drawing No. 72-763.

Warne et al (1970) states that "a well defined, but moderately buried magnetic body, 4 000 feet wide, existed beneath the lake bed." He assumed that northern contact of this body coincided with the linear northern shore of the lake. The anomalous zone, consists of a series of separate anomalies (2 000 - 3 500 gamma readings), and sub-parallel to the major WSW/ENE trend. The anomaly in the southwest corner, was interpreted to be "produced by a body 1 500 feet long and 500 feet wide." It was considered to approximate to the extent of the exposed lateritised serpentine and the surrounding green schist area. The area immediately north of the serpentinite and schist was considered to be due to granitoid rocks.

INTERPRETATION OF AEROMAGNETIC CONTOURS

The aeromagnetic data are displayed in the contour form on drawing No. 65-658/6 which was drawn by the female computers of the Exploration Geophysics Section of the South Australian Department of Mines. The magnetic trends and zones are shown in drawing No. 72-778.

In this interpretation it is assumed that virtually the entire magnetic pattern reflects near surface lithological variations. An initial qualitative analysis of the contoured data, involves the delineation of magnetic trends and the subdivision of the area into magnetic zones. This was considered to be of particular value in satisfying the primary objective of this interpretation, namely to assist subsequent geological mapping and geological structure. The magnetic parameters used as a criteria to determine the zone-type are the degree of anomaly continuity from line to line (linearity) and the dominant amplitude r range representative of each zone. The specified amplitude ranges were chosen by inspection of the overall anomaly pattern. An understanding of the limitations of such a classification is a prerequisite for assessing the geological significance of the zones. These limitations are discussed by Gerdes et al (1970).

Analysis of magnetic trends

The magnetic trends interpreted from magnetic contours are biased by the personal method adopted by the contourer, if no trend analysis has been undertaken before contouring.

The most predominant trend direction are the anomalies trending at N40°W, which extend discontinuously for a maximum distance of 62 miles (100 km). This trend is parallel to the Gairdner Lineament as defined by Sprigg. Young (1964) recorded similar type anomalies in the B.M.R. aeromagnetic survey 1962 of ANDAMOOKA and TORRENS.

These anomalies were interpreted by Young (1964) who ascribed the "low-amplitude, elongate magnetic anomalies as being due to near surface, approximately 500 feet below ground level vertical tabular bodies." He considered that "these anomalies indicated igneous activity along lines of weakness, probably zones of fractures, or faults."

D. Tucker (1969) investigated some of these anomalies on the ground, using Jalander (Fluxgate) and Watts (Smidht Balance) magnetometers in the one mile areas of Eucolo and Yudnapinna. The results showed that the dykes were composite. He interpreted that the top of the dyke was at 500 feet below ground level with a width of less than 600 feet. The interpreted susceptibility contrast, after Tucker (1969) is as follows:

Range of Interpeted Susceptibility Contrast (cgs units)	Mean	Standard Deviation
0.20 to 1.30 x 10^{-3}	0.83 x 10^{-3}	0.41 x 10^{-3}

Tucker, considered that "the dykes do cut through the Marinoan sediments in the Eucolo," and states "The general dip of sediments in the north-west corner of TORRENS is to the north-west. Sediments of Marinoan age were recorded at a depth of near 1 000 feet in the Woomera No. 1 bore and interpolation to the survey area for Eucolo suggests that at least 1 000 feet of Marinoan sediments occur there".

Broken Hill Proprietary Company Limited, after aeromagnetic flying of S.M.L.s 204 and 205, conducted a ground magnetometer survey to delineate intense magnetic anomalies (assumed to be produced by dykes, which were interpreted to dip steeply to the south-west and striking at 215^{o}, Taylor (1970)). Drilling reported by Jones (1969), intersected weathered basic rocks at a depth of 20 feet, and fresh rock was intersected at an average depth of 90 feet. The basic rock was a medium-grained dolerite in drill holes PH32 and PH34. Drill hole PH33 intersected a fine grained rock, classified as a micro-pyroxene diorite. The latter may have been the fine grained margin of the dyke, Jones (1969).

These magnetic anomalies in GAIRDNER are probably of the same type as those encountered by B.H.P. in S.M.L.s 204 and 205 and those investigated by Tucker (1969).

Other magnetic trend directions are present in GAIRDNER. In the north western corner, anomalies have an overall trend of 060°, within the Glenloth Granite area. This area is surrounded by a zone with relatively random trends, and will be discussed later in this report. A similar trend of 060° is situated in the bottom centre of the area.

Magnetic zones and their significance

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

Zone Type	Anomaly Range	Characteristics
1	less than 50 gammas	Good Linear trend
2	50 to 100 gammas	" " "
3	100 to 200 gammas	" " "
4	200 to 300 gammas	" " "
5	300 to 500 gammas	" " "
6	500 to 1000 gammas	" " "
7	1000 to 2000 gammas	" " "
8	2000 to 5000 gammas	" " "
9	greater than 5000 gammas	" " "
11	less than 100 gammas	Poor Linearity
12	100 to 250 gammas	" "
13	250 to 500 gammas	" "

Zone Type	Anomaly Range	Characteristics
14	500 to 1000 gammas	Poor Linearity
15	greater than 1000 gammas	" "

Type 1 - Zones are considered to relate to lithological charges within metasediments or similar variations within granitic and/or gneissic areas.

Type 2 - Zones have probably the same source as type 1 zones, but are slightly more magnetic.

Type 3 - Zones are considered to relate to slightly iron rich metasediments and/or intermediate igneous rocks, diorites.

Type 4 - Zones are considered to contain more magnetic minerals than those of type 3 zones.

Type 5 - Zones are considered to relate to iron rich metasediments, (Jaspilites) ortho and para-amphibolites.

Type 6 - Zones and 7 - Zones are considered to correlate with meta basic (ortho-amphibolites) and ultrabasic rocks and low grade iron formations (Jaspilites). Two anomalies of type 6 zones, situated in the Kokatha area investigated by Asarco, Dodds, (1969) may correlate with basalt encountered in drill holes. The small type 6 - zone situated in the southwestern corner of GAIRDNER (Acraman 1:63 360) probably correlates to low grade iron formation; as interpreted from ground geological mapping, after Key (1969).

Type 8 - Zone is interpreted to correlate with iron rich banded ironstone deposit (Jaspilites).

Type 11 - Zones are interpreted as being either non-ferruginous metasedimentary rocks or near-homogeneous acidic igneous masses i.e. granite and/or granite gneisses or porphyry volcanics (Gawler Range Volcanics).

Type 12 - Zones are interpreted as being slightly more magnetic than type 11 - zones and correlated in the Gawler Range Volcanics in the southern central part of GAIRDNER.

Type 13 and 14 - Zones are interpreted as being basic or ultra basic igneous intrusive masses.

Comparison of zonal configuration and magnetic trends with mapped geology

As the geology of GAIRDNER is relatively unknown at present, the only areas of a direct comparison with rock types are in the Harris area, where considerable detailed geological mapping has been carried out by companies holding Special Mining Leases.

The geology mapped by Australian Development N.L. in the Glenloth-Earea Dam S.M.L. 83 Region 1, was compared with the aeromagnetic contours at the scale of 1 inch to 60 chains. The Glenloth Granite complex appears to be relatively non-magnetic, i.e. type - 11 zone. Some anomalies with the mapped granitic area are in areas of alluvial cover. The dioritic and gabbroic dykes at first glance do not appear to be shown in the magnetic contours. On inspection of the original contour cuts, they appear to be represented by magnetic anomalies with amplitudes between 50 to 100 gammas. Due to the flight line spacing, of approximately one mile, correlation for detailed trends is unpractical. These basic dykes have an approximate 140° strike.

Outcrops of quartz porphyry occur in the northern part of Harris, and appear to have magnetic anomalies of the order of less than 50 gammas. The interesting type - 6 zone trending at 070° occurs near low grade metamorphics (green schistose siltstone intruded by minor amphibolite) Dodds (1969). Kennecott, S.M.L. 345, investigated this area using ground magnetics, the results of which will be discussed later in this report.

The overall arcuate belt of magnetic zones of types 2, 3, 4, 5, 6 and 7 zones located on the assumed southern boundary of the Glenloth Granite probably relate to either ortho amphibolites or a contact metamorphic zone around the granite or a band of para-amphibolites. Basalt, was encountered by Asarco drill holes in the Kokatha Prospect, Dodds (1969), which occurs within the arcuate belt.

The type 7 zone in this area probably correlates with banded ironstones.

Interpretation of the Ground Magnetic Contours Surveyed by Kennecott in S.M.L.345

The geology, grid and geochemical contours for nickel and chromium; and magnetic contours after Kennecott Exploration (Australia) Pty. Ltd., are shown ind drawing No. 72-764 and No. 72-763 respectively. This latter data was trended and zoned using same zonal classification as previously described, (Drawing No. 72-762).

This grid area is divided by a strong east-west gradient PP' (along line 3 000N), which corresponds topographically to the edge of Lake Harris. This magnetic feature PP' is considered to represent either a lithological contact or a fault down throwing to the north.

The area to the north of PP' is generally composed of type 11 zone, and is considered to correlate with acidic igneous or metamorphic rocks. Quartz-porphyry (Gawler Range Volcanics) are known to outcrop north of this area. The magnetic type 4 zones, which have a trend between 120 to 140° are interpreted to represent basic dykes cutting through the acidic rocks.

The magnetic gradients and dislocations of magnetic zones types were used to define, possible faults OO' and QQ'.

The area located south of PP' and west of QQ' is dominated by a number of magnetic zones. The type 7 zones located in the south-west corner neat an outcrop of serpentinite. Drill hole data has revealed tremolite schist and actinolite - chlorite schist with amphibolite plugs, Warne (1970) et al. The main belt of type 5, 6 and 7 zones, probably correlate with a combination of this band of serpentite and basic schists enclosed in granitic rocks. These zones form a possible fold structure, with the axial plane trending approximately east-west. The type 6 zones located east of QQ' probably represent the same basic suite of rocks surrounded by granite-gneiss and/or non-magnetic metasediments.

The rock sequence, south of fault PP' is probably similar in rock types to the Cleve Metamorphics.

INTERPRETATION OF BOUGUER GRAVITY CONTOURS

The gravity station location and network diagram are shown in drawing No. 72-776 and the bouguer contours are shown in drawing No. 72-777, which are drawn for an elevation correction factor of 0.06 milligals per foot (density of 1.9 gm/cc). No terrain correction has been applied to the data.

The bouguer gravity contours show a marked regional gradient decreasing from south to north. There appears to be a number of steep gradients which are interpreted to represent lithological discontinuities, i.e. faults having a 075° trend direction. These features are located in Gairdner and Wirraminna.

The general positive area, in the southern part of GAIRDNER occurs over outcrops of Gawler Range Volcanics, which suggest at first inspection that these volcanics have a positive density contrast with the surrounding rocks.

Turner (1970) interpreted that the Gawler Range Volcanics are bordered in the south by a contemporaneous fault (Uno fault) and the volcanic complex forms an overall basin structure.

Surface samples of Gawler Range Volcanics (Porphyry) collected during the helicopter gravity survey, gave the following mean and standard deviations for specific gravities.

		Specific Gravity (gm/cc)	
Number of sample	Range	Mean	Standard Deviation
7	2.56 to 2.64	2.60	0.02

This density is low compared with the densities recorded for basement rocks (Cleve Metamorphics). It is suggested that the source of these regional anomalies is due to either high density rock below the volcanics, or a deep-seated source.

The gravity low located over the Glenloth Granite intrusion in Harris with an amplitude of 16 milligals, is interpreted to be produced by a large mass of granite going to considerable depth. A similar, but smaller gravity low occurs near the Hiltaba Granite in YARDEA.

The gravity high, with an amplitude of 8 milligals and trending of 130° in the southwest corner of GAIRDNER, probably relates to shallow metamorphic basement. It does not appear to be a basic mass, as the magnetic results do not indicate this.

The gravity high centred in Coondambo has an amplitude of 8 milligals and probably correlates to either a thick sequence, of near surface limestone of Cretaceous age and/or Cambrian (Andamooka Limestone) or basement rocks.

The small gravity high trending at 110 degrees in Harris, probably correlates with a belt of metabasic rocks and is reported in S.M.L. 345 by Kennecott Exploration (Australia) Pty. Ltd. The local gravity high situated at the southwestern corner of Wirraminna occurs in the neighbourhood of a magnetic type 8 zone, which has been interpreted as ironstone formations.

The main trend direction of the gravity anomalies can be grouped into two fundamental directions. The first group strikes between 130° to 160° and this direction is comparable with the magnetic NW trend direction in GAIRDNER. The second group strike between 070° to 110°, is approximately eastwest, and probably reflect cross structures, coincident with those fractures located from the magnetics.

INTERPRETED GEOPHYSICAL STRUCTURE

The interpreted geophysical structure as shown inmdrawing No. 72-779 is mainly based on the magnetic interpretation of magnetic trends and zones.

The most dominant feature is the northwest striking features, interpreted to be basic dykes, associated with fractures. The gravity gradients are suggestive of lithological discontinuities and may indicate down faulting to the east. The throw of the features is small of the order of 500 feet. A complementary set of fractures having an approximately NE trend were delineated mainly from the dislocation of magnetic anomalies. It is interpreted from the magnetic zones that a series of basic intrusions parallel this NE to SW fracture system.

Complex folding is suggested by the distribution of some of the type 3, 4 and 5 type zones in the centre of GAIRDNER and the type 7 zones in Harris. Evidence of folding was also found in the detailed ground magnetic data in S.M.L. 345. The generally fold axis direction has been interpreted to be east-west, but local variations are also present.

The area was divided on magnetic zone types into three province types, which are as follows.

Province type I, is interpreted to represent granitic areas as indicated by the area of the Glenloth Granite. The province type I in Kokatha may represent either a granitic area or a shallow sedimentary basin.

Province type II, is interpreted to represent and include most of the Gawler Range Volcanics, and covered areas. It is considered that these rock types extend eastwards and probably into TORRENS.

Province type III, is interpreted to represent an iron rich province, which includes basic igneous and metamorphic rocks.

CONCLUSIONS AND RECOMMENDATIONS

The magnetic trend assessment and zonal interpretation, and delineated structures should be of considerable value to the geological mapping, However, significance of each zone can only be ascertained during the course of mapping.

The interpreted geological structure from the aeromagnetic data is only tentative, and should be re-interpreted. In particular, dips of formations should be estimated in conjunction with regional mapping results and perhaps detailed geophysical groundwork.

The radiometric data in the present form is inadequate to plot the distribution of granites. The data should be corrected for variations in topographic clearance and presented in contoured form. It appears that some radioactive sources of restricted area are present in the western side of the area.

Areas of possible economic mineralization and interpreted structures are shown together in drawing No. 72-779. These areas have been selected

as being associated with discontinuities in the main NW dykes, caused by faulting similar to those advocated by Taylor (1970) in the Roopena and Corumna 1:63 360 sheet areas, and by marked intersections of magnetic zones with tectonic linear features.

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NB. 19th APRIL

Retiring Chairman's Address to the Geological Society of Australia Inc., S.A. Division, April 19, 1974

THE PETROLOGY AND STRUCTURE OF THE GAWLER RANGE VOLCANICS IN THE KOKATHA AREA, AND SOME ECONOMIC IMPLICATIONS

Dr. C.D. Branch

The Gawler Range Volcanics in the Kokatha area rest unconformably on Lower Proterozoic Glenloth Granite and amphibolite. The volcanics, dated about 1535 m.y. old, are intruded by the comagmatic Kokatha Granite, about 1520 m.y. old. The basal volcanic unit of mainly viscous pink to brown rhyolitic flows, tuffs, thin ignimbrites in simple cooling units, and spectacular amygdaloidal flows contains some interbedded andesite and basalt flows. An overlying compound cooling unit of red-brown rhyodacite ignimbrite grades from quartz-rich near the base to quartz-poor at the top. This is overlain by a succession of generally grey rhyolitic lavas, tuffs and thin ignimbrites in simple cooling units: near the top an avalanche breccia derived from a collapsed volcanic dome forms a widespread marker bed. The uppermost unit is a compound cooling unit of uniform dacite ignimbrite which ranges from black where densely welded to red-brown where moderately welded. The preserved volcanic sequence is about one kilometre thick.

In the Kokatha region the volcanic units form a shallow-dipping basin. However, within many flows and sheets, steep dips are common due to: (a) viscous flow in acid lavas; (b) upward flow of gas bubbles in amygdaloidal lavas; and (c) internal flow of partly solidified ignimbrites due to tectonic tilting following eruption (rheoignimbrites).

The volcanics are dominantly terrestrial, and display a variety of landforms ranging from domes to stratovolcanoes to volcanic plateaux: generally, all are modified by erosion which occured in periods up to 2 m.y. long between major eruptive episodes.

Although 1000 cubic kilometres of acid magma are preserved in the volcanics in the Kokatha area, and more than 50,000 cubic kilometres in all the Gawler Range Volcanics, related ore deposits are virtually unknown. This is probably because any hydrothermally altered and mineralized volcanics generally were eroded before being preserved under successive flows and sheets. Hence ore deposits related to the volcanics should be sought mainly in contemporaneous sediments around the margin of the volcanic province. Another potential location for ore deposits will be the greisenized roof zone of stocks of Kokatha Granite which intrude the volcanics, but the granite outcrops poorly and is mostly covered by sand; however, a study of major lineaments in the volcanics may enable the location of stocks to be predicted.

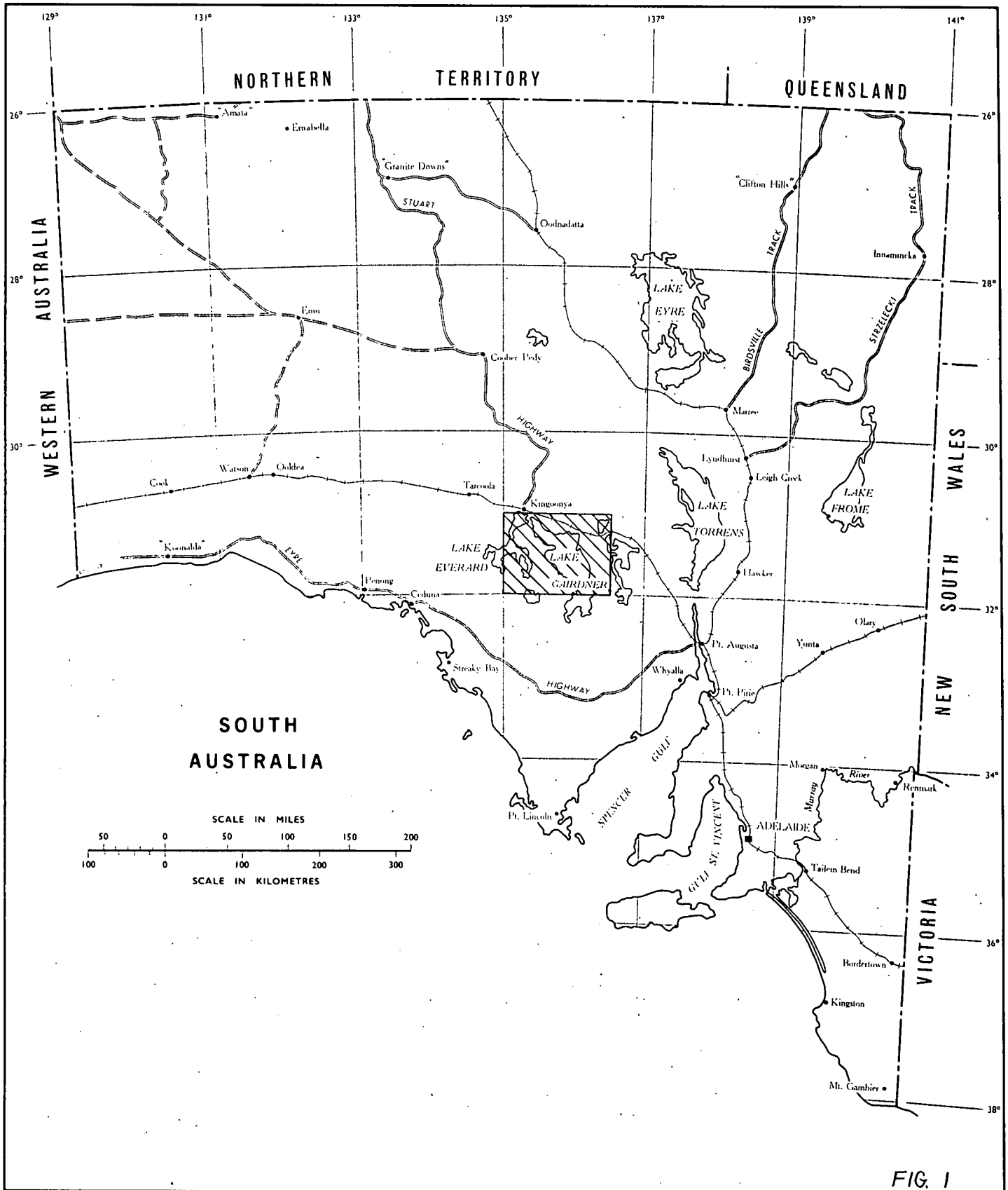
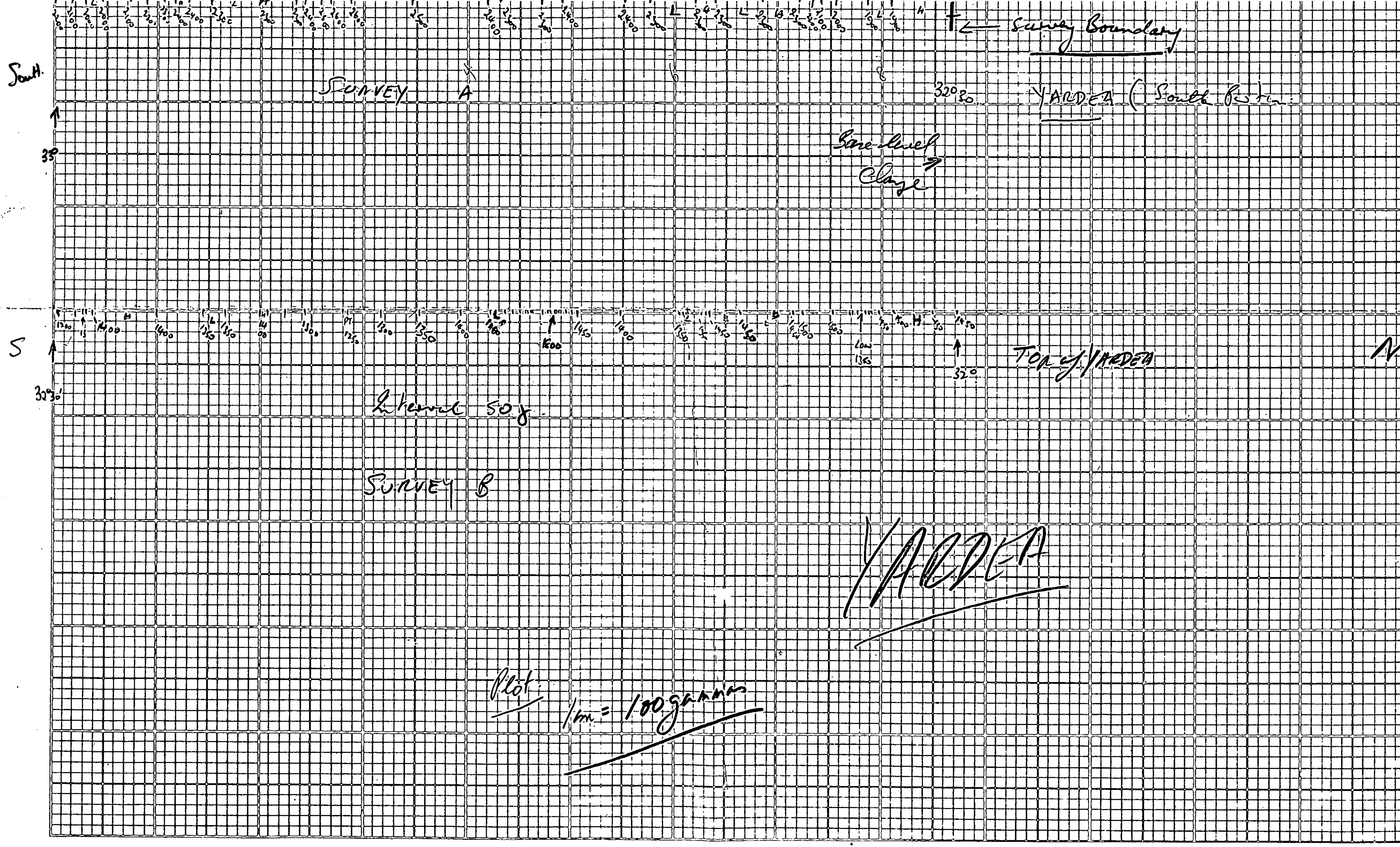
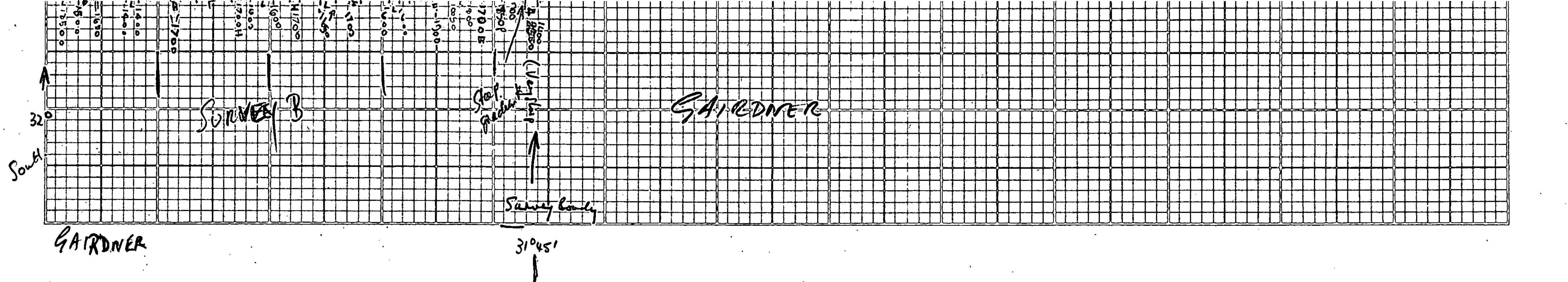


FIG. 1

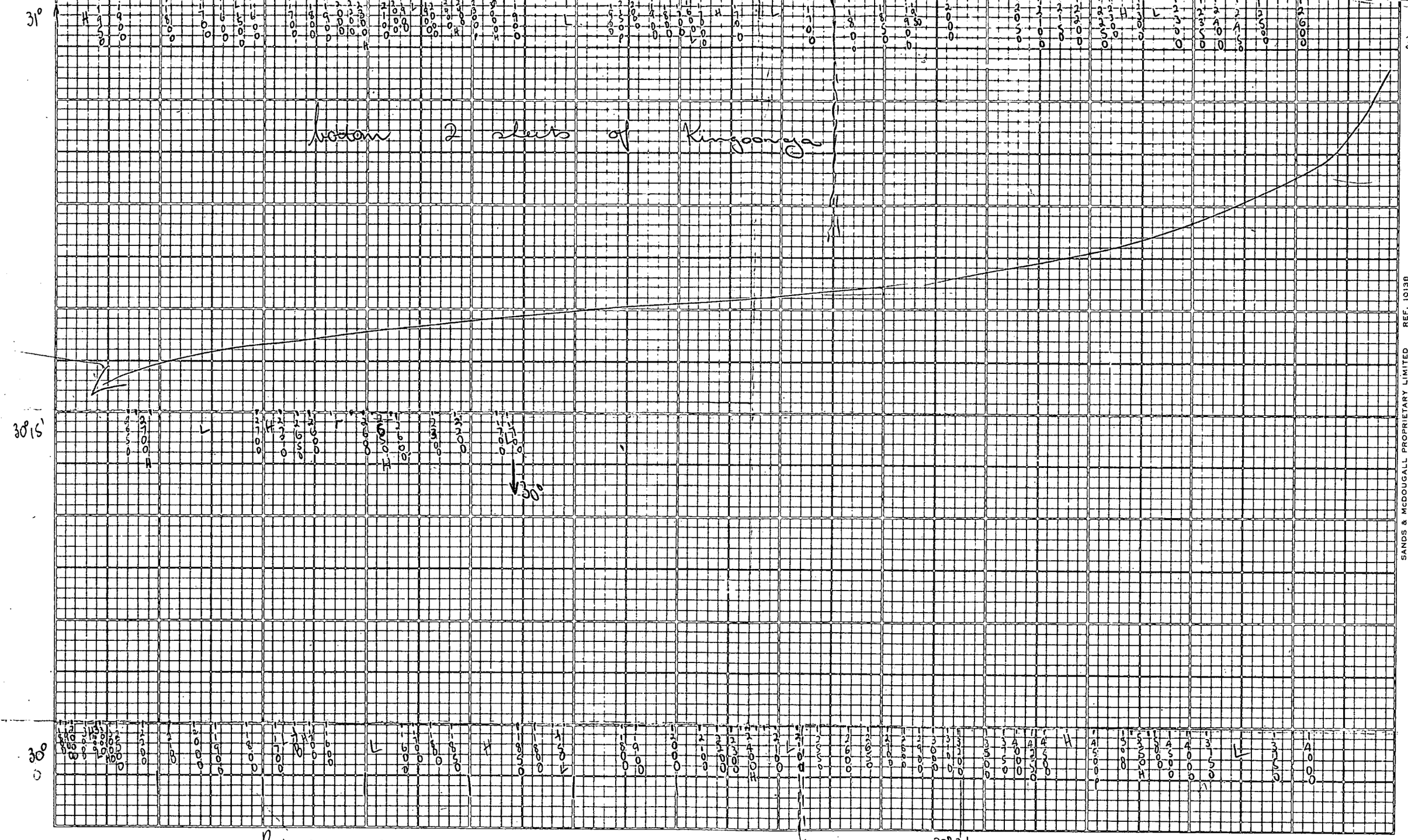
DEPARTMENT OF MINES —— SOUTH AUSTRALIA

Compiled. R.A. Gerdes	GAIRDNER 1:250,000	Date: 12 SEPT. 1972
Drn. D.J.M. Ckd. L.V.W.	LOCALITY OF AREA OF GEOPHYSICAL INVESTIGATION	Drg. No. S9982 Bf




320
South
SURVEY B
GAIRDNER
Survey Boundary
GAIRDNER
31°45'

SANDS & McDOUGALL PROPRIETARY LIMITED REF. 10136


31°
30°15'
30°15'
30°
Bottom 2 chains of Kingoonya
30°
BILLAKALINA
29° 30'
SANDS & McDOUGALL PROPRIETARY LIMITED
REF. 10130

S.M.L. 345

135°00' 135°30' 136°00' 136°30'

31°00' 15' 30' 45' 32°00'

Geology after T.V Harvey (1966) Aust. Development N.L. S.M.L. 83

LAKE HARRIS

Geology after Dobbs (1969) S.M.L. 307

"Kokatha"

Coondambo "Coondambo"

LAKE HANSON

LAKE HART

Wirraminna "Wirraminna"

Bore 28 Basement >28ft. deep

LAKE EVERARD

"Blue Dam"

"Glyde Hill"

High Cu, Pb and Zn Value

Bore 2 porphyry at 68ft

LAKE GAIRDNER

Bore F34 porphyry at 3ft

Bore F36 weathered porphyry at 6ft

Felspar porphyry (60ft thick) Bore

Bore 16 Basement >31 ft. deep

"Mahanewo"

"Lake Everard"

"Kumburta"

"Moonaree"

LAKE ACRAMAN

Key (1969) porphyry compared with the Hiltaba Granite

LEGEND

- Gawler Range Volcanics
- Photointerpreted Volcanics
- Basic Dyke
- Glenloth Granite
- M_L Metamorphics — schist[ore] siltstone and mini amphibolite dykes
- Kokatha Granite
- Basalt
- H Hornfels (Basic in composition)
- M_B Basic metamorphic schists
- Photo interpreted lineaments (joints) after Daly (1971)
- Special Mining Lease Boundary

1 MILE SHEET INDEX

HARRIS	COONDAMBO	WIRRAMINNA
KOKATHA	GAIRDNER	JOHNSTONE
EVERARD	HARPER	MAHENEWO
ACRAMAN	MOONARIE	BUTTFIELD

SCALE IN KILOMETRES

5 0 5 10 15 20 25 30

5 0 5 10 15 20

SCALE IN MILES

DEPARTMENT OF MINES — SOUTH AUSTRALIA

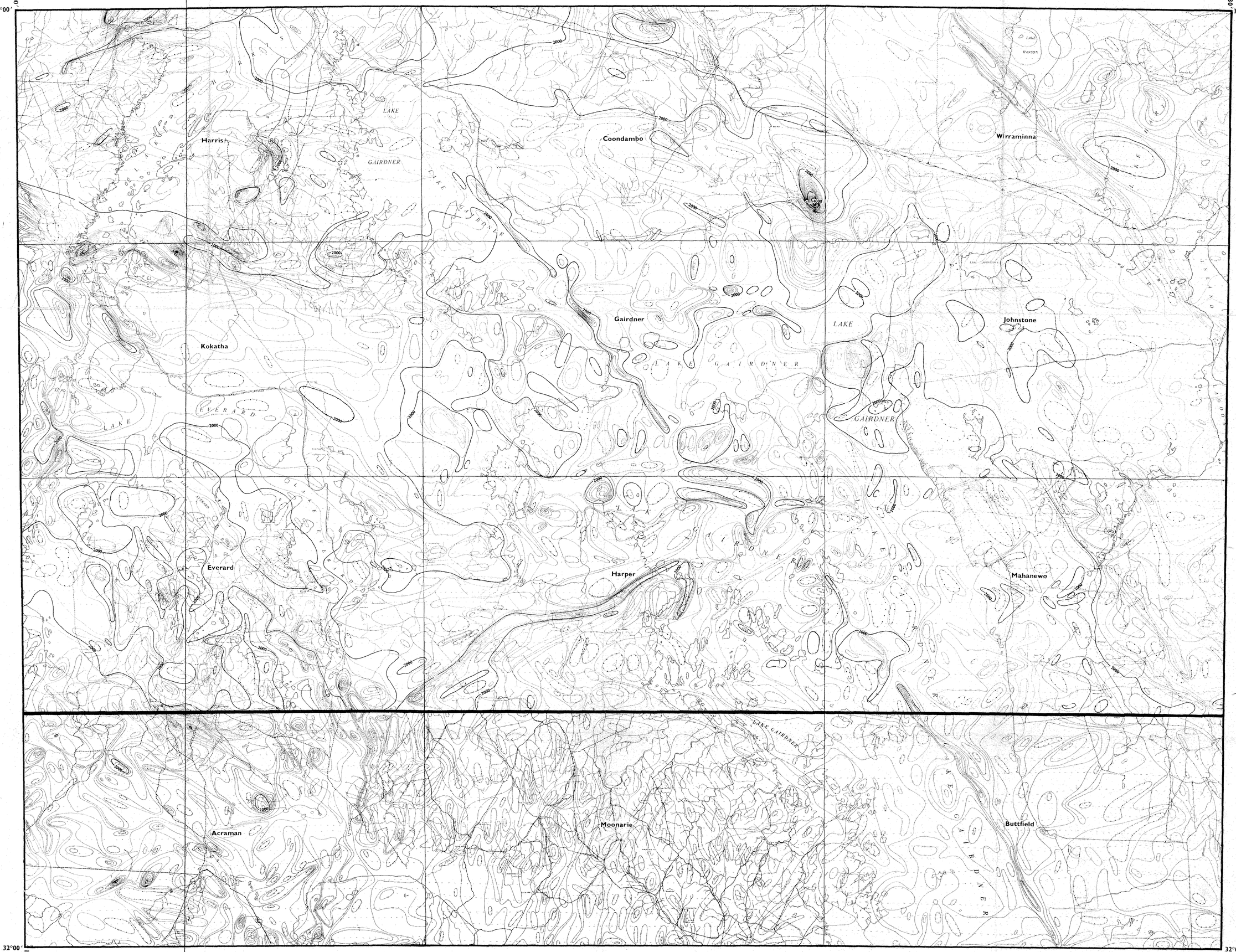
GAIRDNER 1:250,000

PRELIMINARY GEOLOGY (JULY 1972)

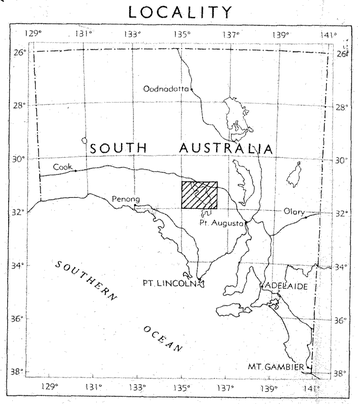
COMPILED FROM S.M.L.'S 83, 307, 345, AND PHOTO INTERPRETATION — BENNET (1966)

EXPLORATION GEOPHYSICAL SECTION	GEOPHYSICIST	Drn. RAG	SCALE: 1:250,000
		Tcd. D.J.M	DATE: 11 SEPT 1972
Director of Mines	SUP. GEOPHYSICIST	Ckd. LVW	72-773
		Exd.	Bf

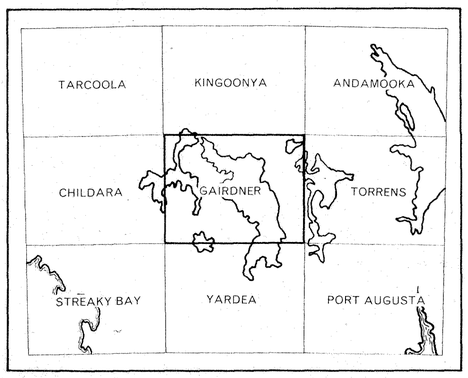
GAIRDNER



LOCALITY



INDEX TO ADJOINING SHEETS



SCALE

1 : 250,000

MILES 2 1 0 2 4 6 8 10 12 14 16 18 20 MILES

K 5 0

Published 1965

AEROMAGNETIC MAP OF TOTAL INTENSITY

NOTE

This map is compiled from airborne magnetometer survey conducted on behalf of the S.A. Dept. of Mines. The total magnetic intensity at 500 ft. above ground level was recorded continuously. The contours are corrected for normal regional gradient. Uncontrolled photomosaic assemblies were used to navigate flight lines and controlled base maps indicate aircrafts actual flight course as recorded on photographs taken with a 35 m.m. camera. Results reduced by S.A. Dept. of Mines, Geophysical Section under the supervision of the Senior Geophysicist. Compiled under the direction of T. A. Barnes, M.Sc., Government Geologist. Issued under the authority of the Honourable Sir A. Lyell McEwin, M.L.C.

LEGEND

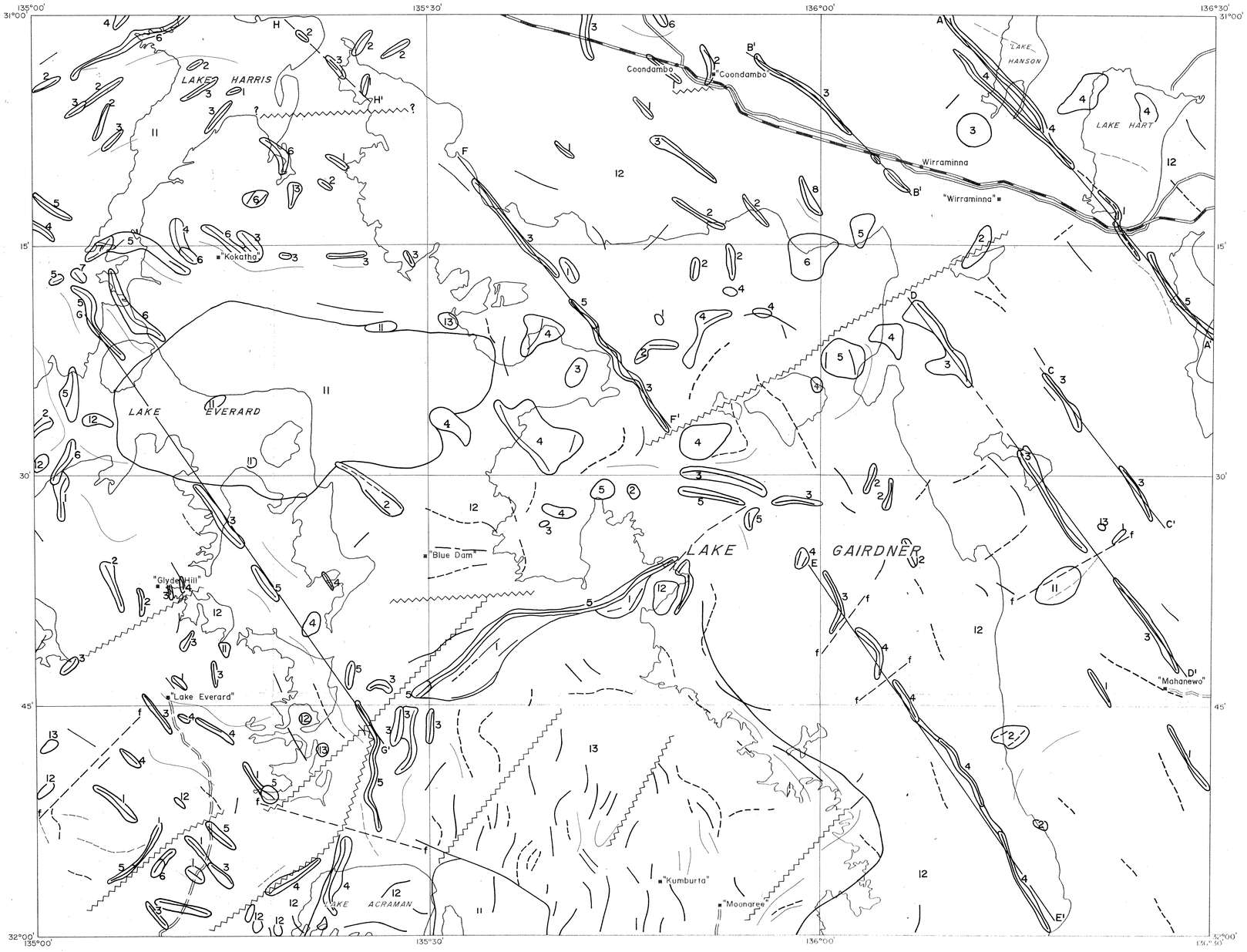
MAGNETIC CONTOURS (values in gammas) 2000

Roads shown thus:

J. E. Webb B.Sc A.S.A.S.M. Senior Geophysicist.

This 1 : 250,000 map reduced by the S.A. Dept. of Mines from published 1 mile sheets.

GAIRDNER
65-658/6
Bf



LEGEND

Positive magnetic trend

Positive magnetic trend (tentative)

Negative magnetic trend

Negative magnetic trend (tentative)

Magnetic type 4 zone (4)

Magnetic lineament

Cross fault f——f

Dyke and/or fracture B——B'

1 MILE SHEET INDEX

HARRIS	COONDAMBO	WIRRAMINNA
KOKATHA	GAIRDNER	JOHNSTONE
EVERARD	HARPER	MAHENEWO
ACRAMAN	MOONARIE	BUTTFIELD

SCALE IN KILOMETRES

5 0 5 10 15 20 25 30

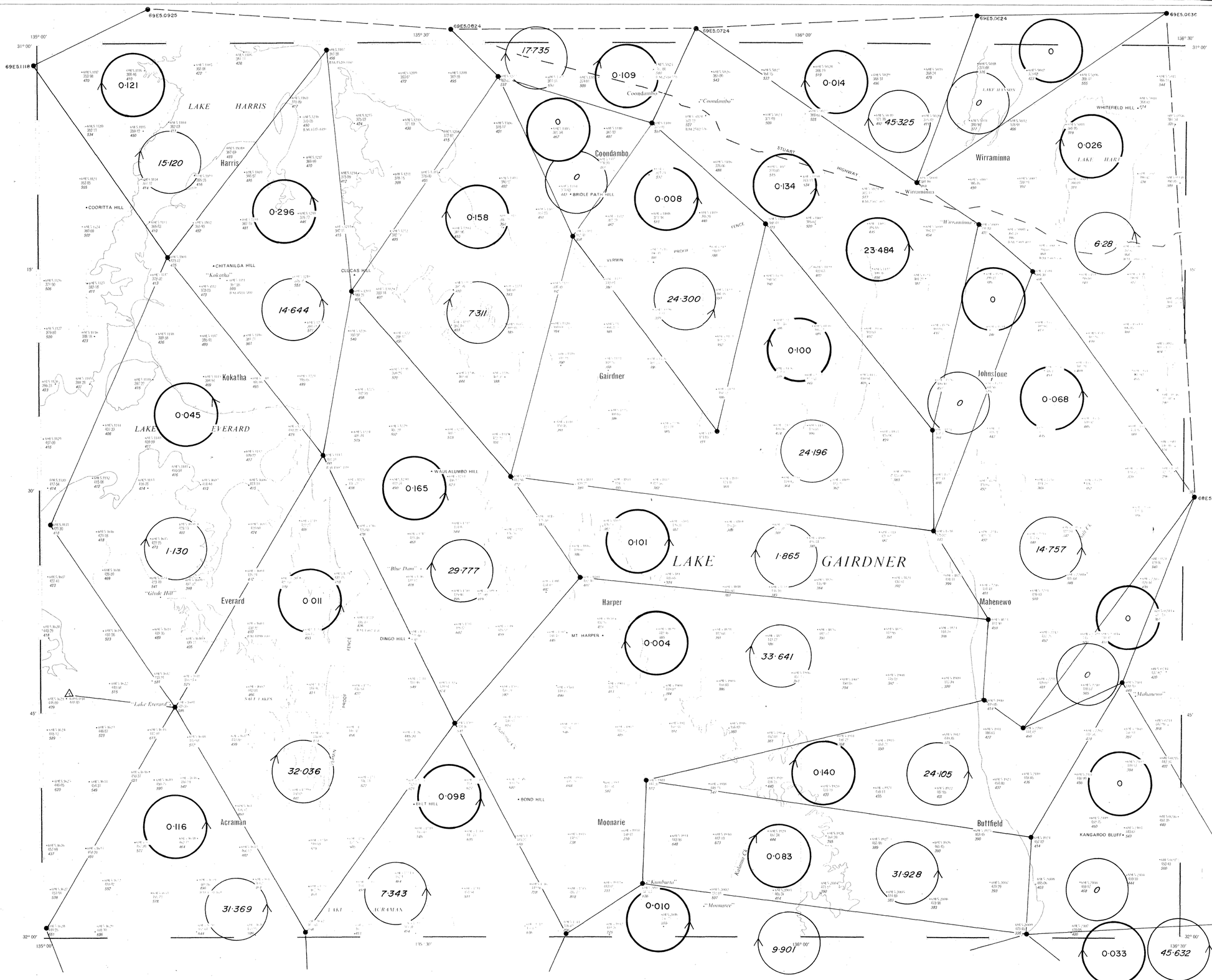
5 0 5 10 15 20

SCALE IN MILES

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GAIRDNER 1:250,000 INTERPRETATION OF MAGNETIC TRENDS AND ZONES

EXPLORATION GEOPHYSIC SECTION		Drn. R.A.G.	SCALE: 1:250,000
		Tcd. D.N.M.	DATE: 9 September 1972
Director of Mines		Ckd. A.F.	72-778 Bf
		Exd.	



LEGEND

Observed Gravity Network Misclosure (in milligals) — 0·14

Elevation Network Misclosure (in feet) — 24105

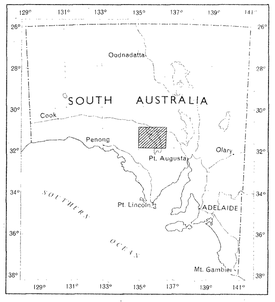
NOTE:

Clockwise arrow indicates positive value } from computer print out
Anticlockwise arrow indicates negitive value }

Tie point

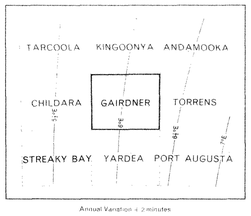
B.M.R. Isogal Station

LOCALITY



INDEX TO ADJOINING SHEETS

Magnetic Declination 1965



Annual Variation 4·2 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

GRAVITY STATION VALUES

Compiled by R. A. Gerdes, Assistant Senior Geophysicist, B. J. Taylor, Senior Technical Officer.

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

Printed for the Geological Survey of South Australia as a contribution to the Geophysical Atlas of Australia.

Data 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. After adjustment of gravity readings and barometric levels for the network by the method of least squares, the mean difference in elevation between barometric levels and Lands Department levels for the Bench Marks shown, was used to refer levels to Mean Sea Level, Port Adelaide. Probable error for barometric elevations of Bench Marks on this sheet is ± 18 feet. 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

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

Gravity Station Information:
- Station Identification Number
- Observed Gravity Reading in milligals (to obtain full value add 979,000)
- Reduced Barometric Level

Road, Track

Railway

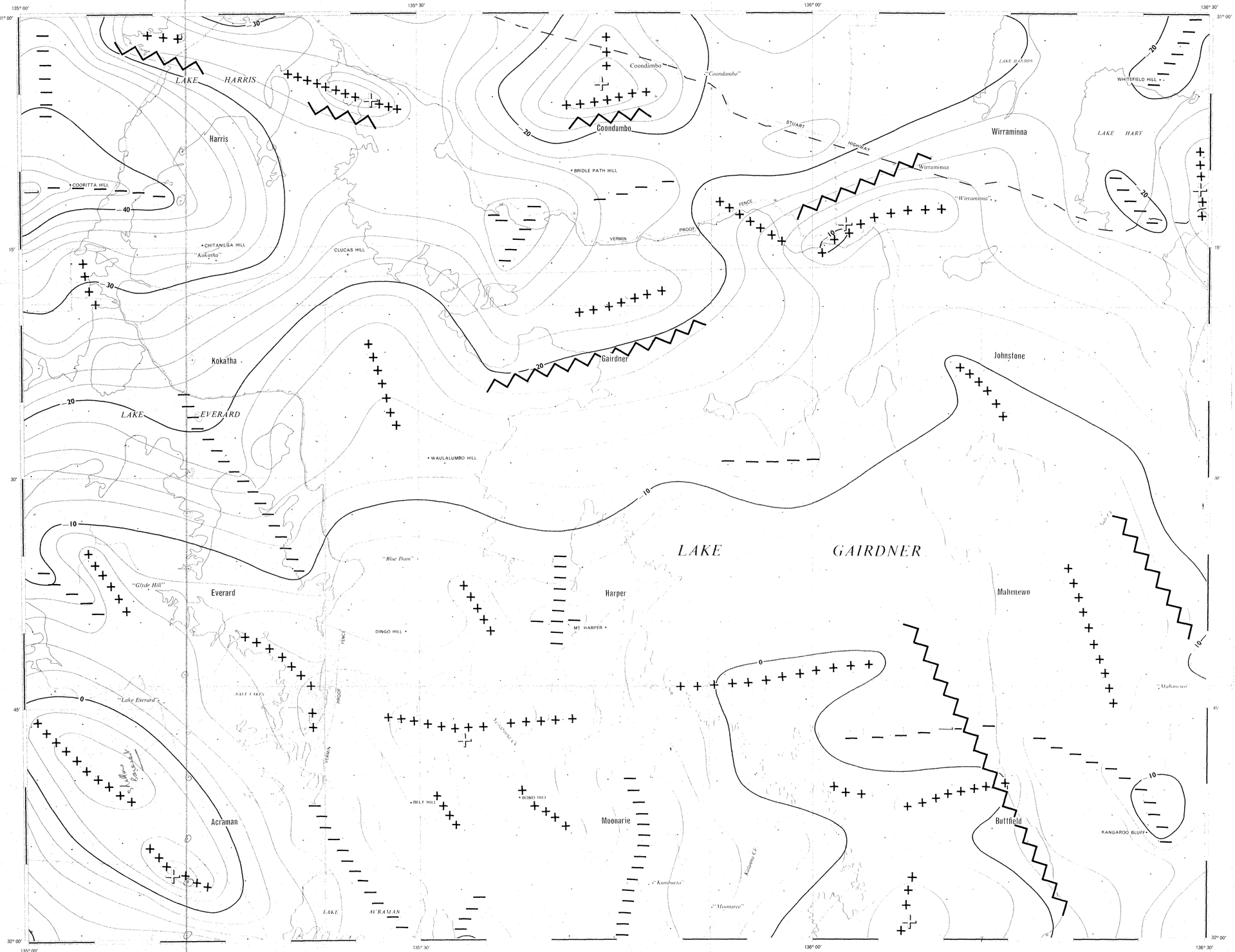
Watercourse, Playa

Vermin Proof Fence

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GAIRDNER 1:250,000 GRAVITY AND ELEVATION STATION — NETWORK

EXPLORATION GEOPHYSICS SECTION		Drn. R.A.G.	SCALE: 1:250,000
		Tcd. D.V.M.	DATE: 12 September 1972
Director of Mines		Ckd. A.F.	72-776 Bf
		Exd.	



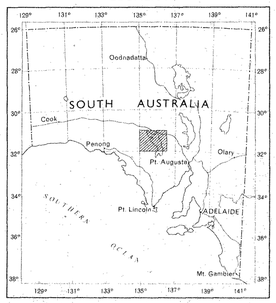
LEGEND

Positive Gravity Trend +++

Negative Gravity Trend – – –

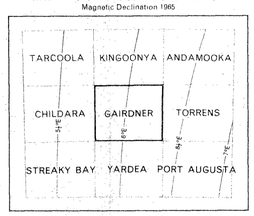
Steep Gravity Gradient

LOCALITY



INDEX TO ADJOINING SHEETS

Magnetic Declination 1965



Annual Variation 4·2 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

Compiled by R. A. Geirdes, Assistant Senior Geophysicist, B. J. Taylor, Senior Technical Officer.

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

Printed for the Geological Survey of South Australia as a contribution to the Geophysical Atlas of Australia.

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 0·060 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 .....

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GAIRDNER 1:250,000

BOUGUER ANOMALY CONTOURS AND GRAVITY TRENDS

EXPLORATION GEOPHYSICS SECTION		Drn. R.A.G	SCALE : 1:250,000
		Tcd. D.V.M.	DATE : 12 September 1972
Director of Mines		Ckd. A.F.	72-777 Bf
		Exd.	

135°00' 135°30' 136°00' 136°30'
31°00' 15' 30' 45' 32°00'

LAKE HARRIS
LAKE EVERARD
LAKE GAIRDNER
LAKE ACRAMAN
LAKE HANSON
LAKE HART

Coondambo
"Coondambo"
Wirraminna
"Wirraminna"
"Kokatha"
"Glyde Hill"
"Blue Dam"
"Lake Everard"
"Kumburta"
"Moonaree"
"Mahanewo"

Fold Axis
Fold axis

ZONE OF BASIC INTRUSIONS AND FOLDING

A A' B B' C C' D D' E E' F F' G G' H H'

f f

I II III

LEGEND

- Dyke or Fracture NW Trend — A A'
- Magnetic trends (folding)
- Major magnetic zone if around fold
- Probable basic intrusions
- Cross faults — f f
- Fractures (lineament)
- Magnetic lineament
- Gravity gradient — Discontinuity
- Province type — II
- Area of interest for Geochemical sampling (possible area of mineralization)

1 MILE SHEET INDEX

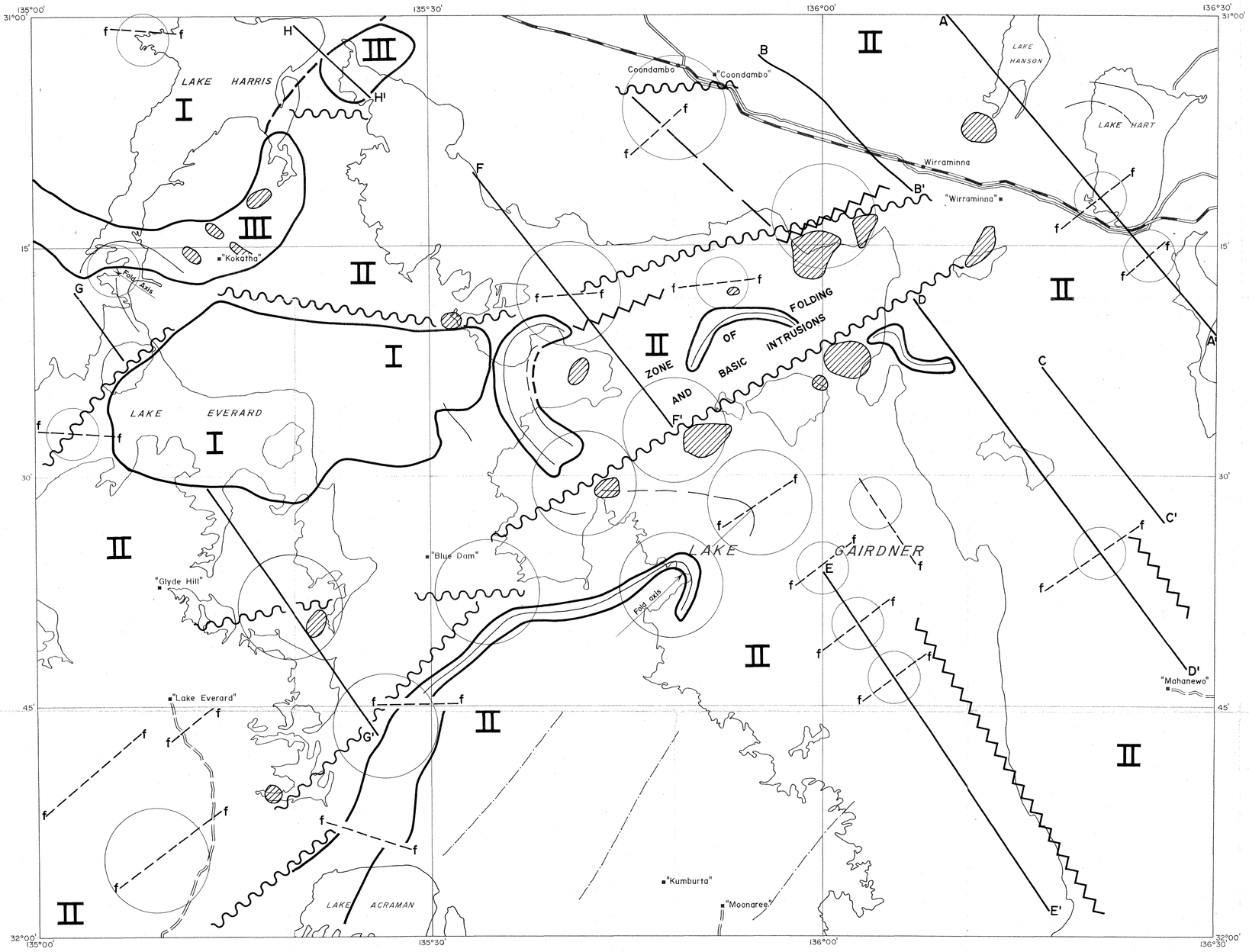
HARRIS	COONDAMBO	WIRRAMINNA
KOKATHA	GAIRDNER	JOHNSTONE
EVERARD	HARPER	MAHENEWO
ACRAMAN	MOONARIE	BUTTFIELD

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

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GAIRDNER 1:250,000 STRUCTURAL GEOPHYSICAL INTERPRETATION

EXPLORATION GEOPHYSICS SECTION		Drn. R.A.G.	SCALE: 1:250,000
		Tcd. D.V.M.	DATE: 12 September 1972
Director of Mines		Ckd. A.S.F.	72-779 Bf
		Exd.	



LEGEND

- Dyke or Fracture NW Trend — A A'
- Magnetic trends (folding)
- Major magnetic zone if around fold
- Probable basic intrusions
- Cross faults — f f
- Fractures (lineament)
- Magnetic lineament
- Gravity gradient — Discontinuity
- Province type — II
- Area of interest for Geochemical sampling (possible area of mineralization)

1 MILE SHEET INDEX

HARRIS	COONDAMBO	WIRRAMINNA
KOKATHA	GAIRDNER	JOHNSTONE
EVERARD	HARPER	MAHENEWO
ACRAMAN	MOONARIE	BUTTFIELD

SCALE IN KILOMETRES

5 0 5 10 15 20 25 30

5 0 5 10 15 20

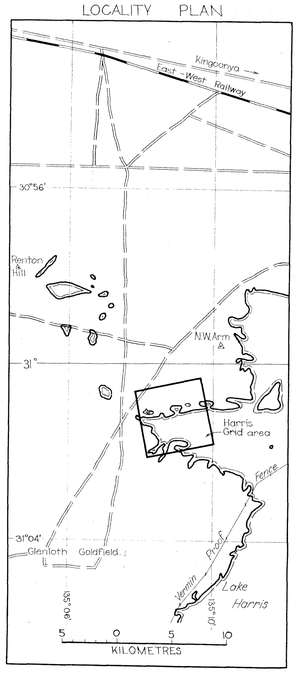
SCALE IN MILES

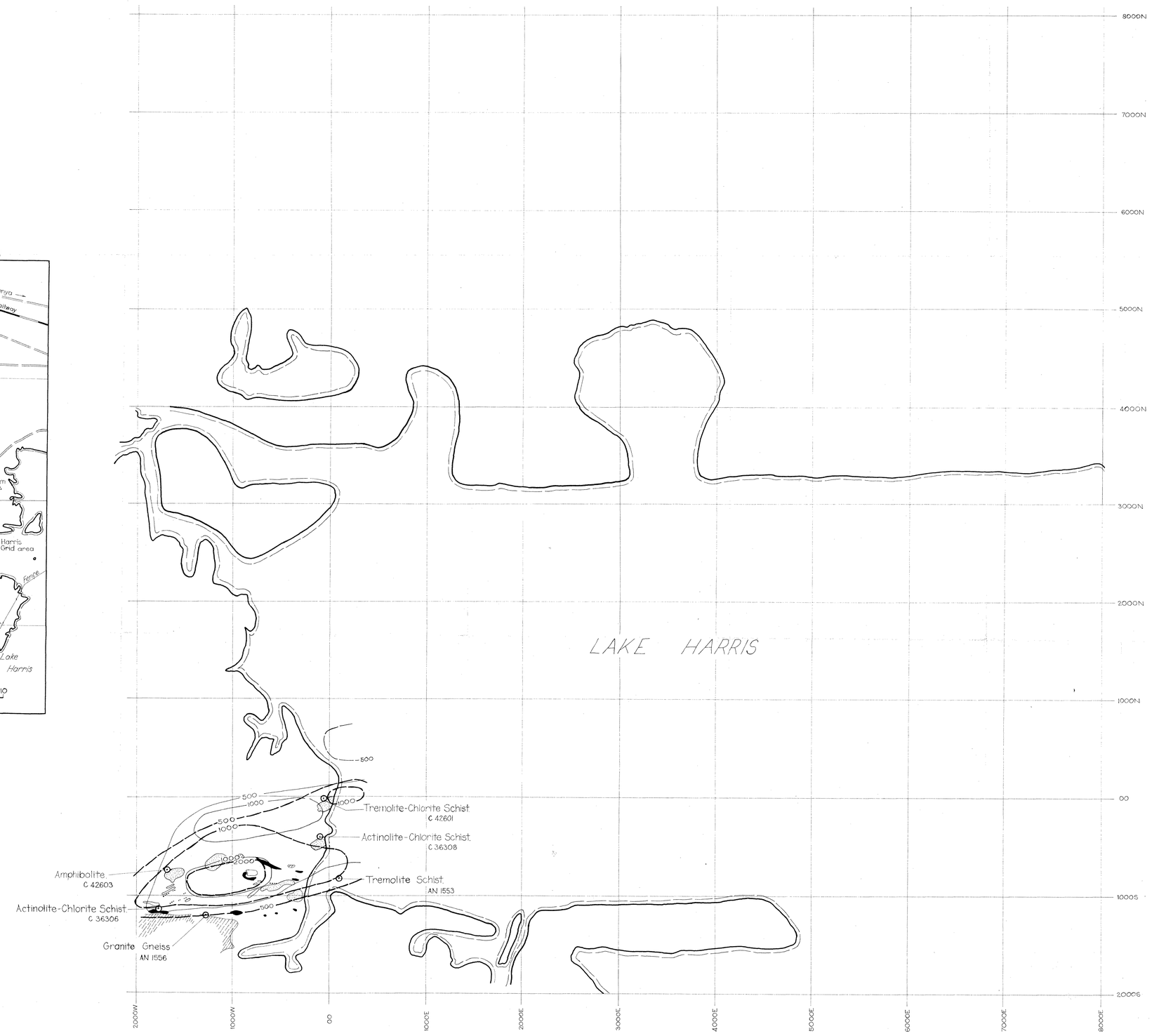
DEPARTMENT OF MINES — SOUTH AUSTRALIA

GAIRDNER 1:250,000 STRUCTURAL GEOPHYSICAL INTERPRETATION

EXPLORATION GEOPHYSICS SECTION		Drn. R.A.G.	SCALE: 1:250,000
		Tcd. D.V.M.	DATE: 12 September 1972
Director of Mines		Ckd. A.S.F.	72-779 Bf
		Exd.	

LOCALITY PLAN





Co-ordinate values in Feet.

North

LEGEND

- Green actinolite clay rock.
- Serpentine on clay rocks.
- Dolomite
- Quartz
- Acid metaseds.
- 1000 Nickel contours p.p.m. } from Auger Drill holes.
- 1000 Chromium contours p.p.m.
- Petrological sample points (Kennecott)

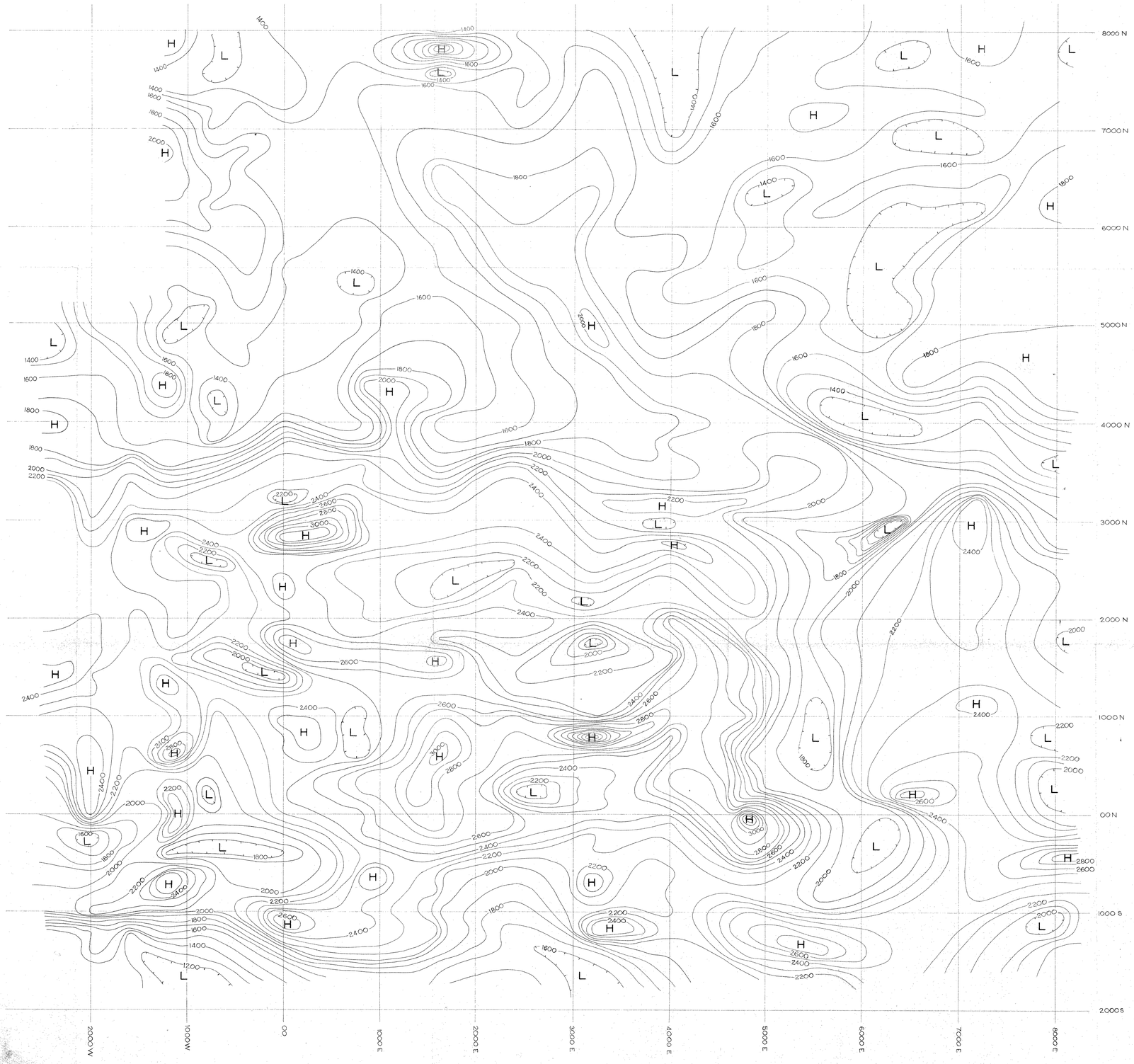
Lake Harris Grid

Harris 1:63,360 sheet area.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GEOLOGICAL AND GEOCHEMICAL SAMPLE CONTOURS OF NICKEL AND CHROMIUM — AFTER KENNECOTT EXPLORATION (AUST) PTY LTD SML 345

EXPLORATION GEOPHYSICS SECTION	GEOPHYSICIST	Drn. RAG.	SCALE: 1:6000 (ORIG)
		Tcd. S.J.C.	72-764 Bef
Director of Mines		Ckd. A.F.	
		Exd.	DATE: 6th SEPT. 1972



North

LEGEND

H Magnetic high.

L Magnetic low.

Contour interval is 100 gammas.

Scale in Metres

200 100 0 100 200 300 400 500

Scale in Feet

500 0 500 1000 1500

Grid co-ordinates in feet.

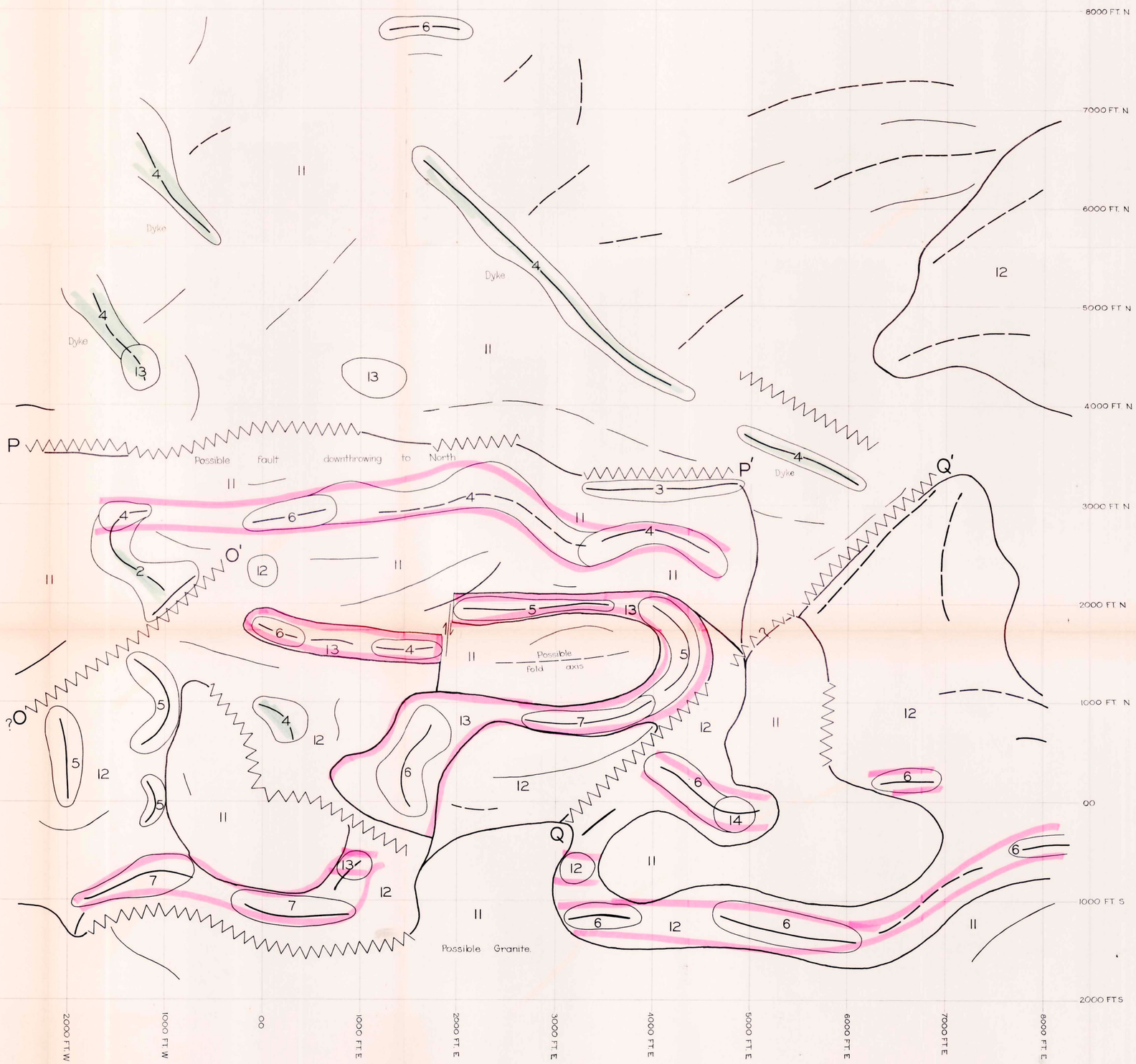
Ground magnetometer survey supplied by Kennecott Explorations (Australia) Pty. Ltd.

Harris 1:63,360 sheet area.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GROUND MAGNETOMETER SURVEY CONTOURS (GAWLER MUSGRAVE RECONNAISSANCE GRID) SML 345 GLENLOTH

EXPLORATION GEOPHYSICS SECTION	GEOPHYSICIST	Drn. R.A.G.	SCALE: 1:6 000 (ORIG)
		Tcd. S.J.C.	72-763 Ref.
Director of Mines		Ckd. A.F.	
		Exd.	DATE: 17 AUG 1972



North

LEGEND

- Positive magnetic trend.
- Positive magnetic trend (tentative)
- Negative magnetic trend.
- Negative magnetic trend (tentative)
- 4 Magnetic type 4 zone.
- PWP Magnetic lineaments

Scale in Metres
200 100 0 100 200 300 400 500
500 0 500 1000 1500
Scale in Feet

Magnetic survey data supplied by Kennecott Explorations (Aust) Pty. Ltd.

Harris grid area.
Harris 1:63,360 sheet area.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

MAGNETIC TREND AND ZONE INTERPRETATION OF GROUND MAGNETOMETER SURVEY SML 345

EXPLORATION GEOPHYSICS SECTION	GEOPHYSICIST	Drn. R.A.G.	SCALE: 1:6000 (ORIG.)
		Tcd. S.J.C.	72-762 Ref
Director of Mines		Ckd. A.F.	
		Exd.	DATE: 4th SEPT. 1972