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PRELIMINARY NOTES ON THE GEOLOGY OF THE EASTERN MARGIN OF THE EUCLA BASIN - FOWLER 1:250 000 SHEET AREA

by

J.B. FIRMAN
ASSISTANT SENIOR GEOLOGIST

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ABSTRACT

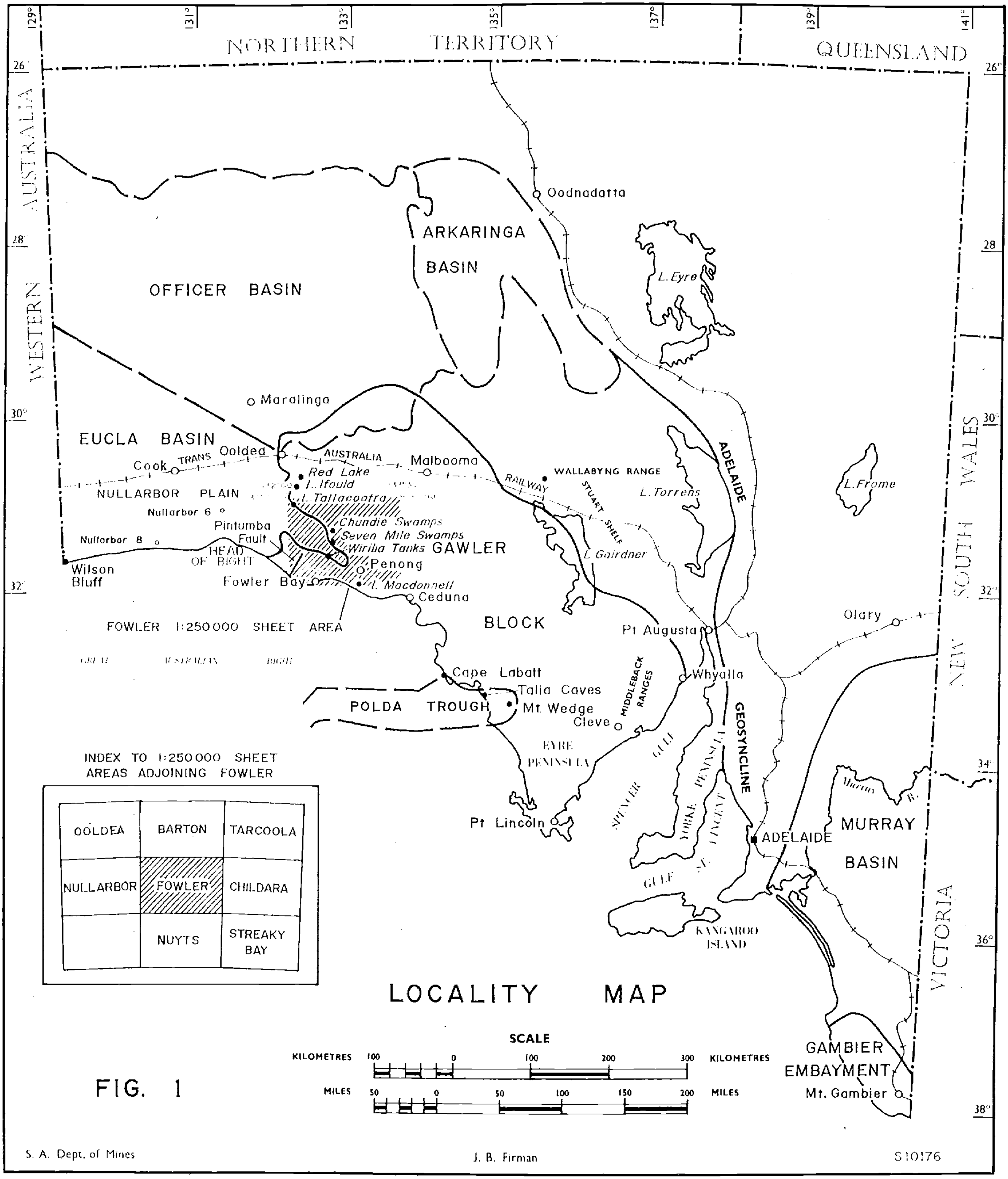
This report deals with the stratigraphy and economic geology of an area on the eastern margin of the Eucla Basin and the western margin of the Gawler Block. The area is centred upon the FOWLER 1:250 000 map area.

The stratigraphic section of the report, which provides a framework for the more detailed geological investigations connected with the search for economic mineral deposits, deals with Precambrian basement rocks, basin sediments and surficial deposits mainly of Cainozoic age. The oldest rocks in the area are gneisses and schists which are tentatively correlated with the Cleve Metamorphics. Recent age dating suggests that younger granites were probably emplaced a little more than 1500 m.y. ago, that is at the time of the Wartakan Phase of folding and acid volcanism which ended the Carpentarian orogenic cycle in the Gawler Block. Basin sediments of Palaeozoic and Mesozoic age occur in adjoining basins. The portion of the Eucla Basin within the map area contains up to 60 m (200 ft) of Cainozoic sediments overlying basement rocks. Cainozoic Pidinga Formation and Nullarbor Limestone crop out, and surficial deposits blanket the area.

Exploration for mineral deposits is recorded as long ago as 1885. Base metals, lignite, alunite, uranium, oil in adjoining basins, and brines have all been sought since that time. Current exploration is for uranium and thorium, which it is thought may be associated with lignite within Pidinga Formation. Despite much geological exploration, radiometric work and drilling, the source of the high radioactivity remains unknown and no economically important deposits of uranium have been discovered.

INTRODUCTION

This report deals with the geology of an area centred upon the FOWLER 1:250 000 map sheet. The principal sections deal with regional stratigraphy and with economic geology. The report provides



LOCALITY MAP

FIG. 1

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J. B. Firman

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a description of materials previously mapped on the FOWLER sheet at reconnaissance level by Walker (1969). The map units are essentially the same as those described for the NUYTS 1:250 000 sheet adjoining to the south by Walker and Botham (1969). Most of the surficial deposits have been formally named by the writer (Firman, 1969). Geological reconnaissance of FOWLER and the collection of granite samples from FOWLER and BARTON adjoining to the north is also recorded.

Detailed mapping was commenced in this area because of the current interest in the search for fossil fuels (uranium, coal, and oil and gas). An extended treatment of regional stratigraphy is provided, because the exploration for economic mineral deposits is not confined to the FOWLER area itself, and because the nature of the terrain - with small outcrops of basement rock in a vast expanse of surficial material - requires that local geology be placed in a proper regional setting to be at all meaningful. It is hoped that this stratigraphy will have wide application as detailed mapping continues and the search for mineral deposits is extended.

The FOWLER 1:250 000 Sheet is centrally placed within the area of interest. It is bounded by 31° and 32° south latitude and 132° and 133°30' east longitude. It includes about 1 500 000 hectares (5700 square miles) in the south-west of South Australia, and is situated on the eastern margin of the Eucla Basin (see Fig. 1). The northeast part of the area is out of Hundreds, and the southwest includes parts of Counties Hopetoun, Kintore and Way.

The Eyre Highway links Penong, the principal town, in the eastern part of the map area with Adelaide about 866 kilometres

(538 road miles) distant to the east-southeast. This highway is an inland route from West Australia to Port Augusta at the head of Spencer Gulf. The Flinders Highway is a coastal route which joins the Eyre Highway at Ceduna and provides an alternative route via Port Lincoln. Secondary and other roads provide access to most of the southwest part of the map area at the southern end of Eyre Peninsula. In the days of the sailing ketch, much of the produce of the region was carried by sea.

The report has been set out in much the same way as the Explanatory Notes to facilitate the preparation of that kind of report when detailed mapping of FOWLER has been completed. Detailed comment on structure and geological history will eventually be required for the final report. An assessment of structural lineaments is in progress as a separate study. A study of the geophysical data derived from oil exploration will prove of great value in so far as it aids a reconstruction of the structural evolution of the area. A detailed geological history must wait upon completion of the mapping.

All specialist comment available at the time of writing has been appended in order to form a proper basis for later work.

Previous Investigations

Pioneer contributions to the geology of the area were made by Tate (1878), Brown (1885) and Jack (1912). King (1951) has provided an important stratigraphy of the Ifould Lake (Lake Pidinga area). Unpublished reports of importance are those of Ludbrook

(1954), Shepherd (1959), Bleys and Campbell (1968), Campbell (1969), Clarke (1970), Forbes (1970), Westhoff (1971), and Lindsay and Harris (1973). A large number of reports have been written during development of the Lake MacDonnel gypsum deposit immediately south of the map area, and these have been recorded by Walker and Botham (1969). Earlier reconnaissance notes are given in Firman (1965) and in this report (Appendices 7 and 8).

The South Australian Department of Mines requested airborne magnetic and radiometric coverage of COOK, OOLDEA, BARTON, COOMPANA, NULLARBOR and FOWLER 1:250 000 sheet areas from the Bureau of Mineral Resources. A survey of COOK, OOLDEA and BARTON has been completed (Waller, Quilty and Lambourn, 1972). The other three areas were programmed for survey in 1972. A report is not available at the time of writing.

Climate

The climate of the map area is one of hot, dry summers with relatively mild nights, and cool winters with most rainfall during May, June, July and August. Average annual rainfall varies from about 30 cm (12 inches) in the south to about 20 cm (8 inches) in the north. Mean maximum temperatures vary from about 27°C (80°F) in the southwest to about 29°C (85°F) in the north-east. Annual average evaporation varies from about 150 cm (60 inches) in the south to 203 cm (80 inches) in the north.

Landform

The map area straddles the western edge of the Eucla Basin and the eastern margin of the Gawler Block, and it is all less than about 150 m (500 feet) above sea level. There is a rise of about 60 m (200 feet) inland from the coastal margin towards the strongly undulating coastal strip characterised by fossil aeolian dunes. This rise is abrupt in some places due to near-vertical cliffs. Further inland, this terrain gives way to the gently undulating surface of the Nullarbor Plain and northern Eyre Peninsula. There are only small changes in local relief. Some of these are due to stream incision and the formation of low cliffs along lake margins. Others are due to undulations on ancient surfaces or to local differences in elevation between dune crests and swales. Karst forms - mainly sinkholes - were developed in Cainozoic limestone and Bridgewater Formation both before and after the development of Middle Pleistocene calcrete. In most places, the sinkholes are now buried below younger dunes, but where they are exposed at ground surface they provide vertical connection with the groundwater surface. These solution features were probably developed during low stands of the Pleistocene sea.

REGIONAL STRATIGRAPHY

The stratigraphy of the FOWLER sheet is derived largely from reconnaissance traverses. Only the southern part of the sheet (FOWLER SH53-13) including 1:63 360 map sheets Penong, Bookabie and Coorabie has been mapped in detail (See map 73-120 in pocket).

The age, lithology, and stratigraphic relationships of the rock units within the map area are set out on the accompanying

STRATIGRAPHY OF FOWLER 1:250000 SHEET

CAINOZOIC	QUATERNARY	RECENT		Qre	SEMAPHORE SAND : Off-white and pale brown quartz and shell sands of the modern beach and coastal dunes.
				Qrm	MOLINEAUX SAND : Off-white and pale yellowish brown quartz sands of the inland dune fields overlying darker yellow and orange coloured sand with carbonate pipes in some places.
				Qrk	ST KILDA FORMATION : Pale grey shell deposits, shelly silts and clays. (May be mappable in some places on coastal margin following detailed mapping).
				Qry	YAMBA FORMATION : Dark grey silt, yellowish brown gypsum sand, off-white gypsum silt (gypsite)
		PLEISTOCENE	UPPER	Qlo, Qpo	LOVEDAY SOIL : Characteristic off-white carbonate patches and nodules of calcareous sands in undulating terrain (Qlo), and in pale brown aeolian calcareous silty sand of the WOORINEN FORMATION EQUIVALENT (Qpo).
			MIDDLE	Qpg	GLANVILLE FORMATION : Pale yellowish brown, silty, shelly limestone calcreted at the top (Outcrops too small to map).
				Qca	Calcrete in BAKARA SOIL : Off white moderately hard calcrete with RIPON CALCRETE at the base in many places.
				Qpb_1	BRIDGEWATER FORMATION:UPPER MEMBER : Pale brown cross-bedded calcarenite (aeolianite). Exposed in coastal cliffs, overlain by pale brown sand re worked from aeolianite inland. Small outcrops of LOWER MEMBER BRIDGEWATER FORMATION not differentiated
				Qpr	RIPON CALCRETE : Hard pale brown and pink massive and nodular calcrete with angular grey inclusions.
				Qpb_2	BRIDGEWATER FORMATION: LOWER MEMBER : Yellow-brown calcarenite (aeolianite). Exposed in coastal cliffs where it is characterised by vertical solution pipes and honeycomb weathering. Capped by RIPON CALCRETE or overlain by brown soil and WOORINEN FORMATION EQUIVALENT inland.
			LOWER	Qph	HINDMARSH CLAY EQUIVALENTS : Reddish mottled and oxidised clays and saprolites exposed in coastal cliffs and margins of inland lakes. (Not mappable).
				Qsi	Oxidised and silicified detritus of the KAROONDA SURFACE. (Not mappable).
	TERTIARY	MIOCENE		Tmn	NULLARBOR LIMESTONE : Yellow-brown hard recrystallised fossiliferous limestone
		EOCENE		Tep	PIDINGA FORMATION : Dark grey and red ferruginous sandstone (Generally subsurface; outcrops too small to map).
PROTEROZOIC	CARPENTARIAN			p€	Granite, adamellite, granodiorite, gneiss and granite gneiss of the GAWLER BLOCK.

TABLE 1

To accompany report by J B Firman

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stratigraphic table (Table 1).

Precambrian Basement Rocks

The FOWLER area has in its northeast part rocks of the Gawler Block. These rocks also crop out on BARTON which adjoins to the north. The various important sequences of the Eyre Peninsula are now outlined in order to establish a regional setting for detailed work on basement rocks of this area:

The Cleve Metamorphics include the Flinders "Gneiss", which is composed of hypersthene granulites and gneisses near Port Lincoln on Eyre Peninsula, and the Hutchison Group of amphibolite, quartzite and schist, which also includes an iron formation with dolomite and marble named the Greenpatch Metajaspilite. The latter is thought to be equivalent to the Middleback Group, which includes jaspilite, schist and dolomite of the Middleback Ranges.

The Cleve Metamorphics were folded into a system of mountain chains during the period of folding and regional metamorphism named the Kimban Phase. Isotopic ages for granulite metamorphism, granite gneiss and granite range from 1600 to 2000 m. yr. The Kimban Phase was active in early Carpentarian time.

Overlying the older basement deformed by Kimban folding in the Whyalla district is the Moonabie Formation of metaquartzite and conglomerate.

During the Charlestonian Phase of folding and plutonism, at about 1600 m.y. the Monabie Formation was folded and the Charleston and Burkitt granites were intruded. The Tarcoola Beds - which are composed of conglomerate, sandstone, shale and dolomite - the quartzites of the Wallabyng Range, and the moderately folded

Corunna Conglomerate are possibly equivalent formations of the same age. Extrusion of the Gawler Range Volcanics occurred about 1535 m.y., continuing until about 1500 m.y. when young dykes near Corunna were emplaced. The intrusion of Hiltaba and Kokatha granites occurred at this time in the Gawler Ranges area. These events mark the Wartakan Phase of folding and acid volcanism which ended the Carpentarian orogenic cycle in the Gawler Block.

For a detailed statement of basement geology in this region, the reader is referred to Thomson (1969 and 1970).

The following comments on the regional extent and configuration of basement rocks is derived from Waller, Quilty and Lambourn (1972):

"In 1954, aeromagnetic reconnaissance traverses were flown by BMR over the Eucla Basin; some of these crossed the area (COOK - OOLDEA - BARTON, JBF). Depth estimates showed that magnetic basement depth is about 700 metres or less in the eastern margin of the basin and between 0 and 200 metres over the Gawler Platform (Quilty & Goodeve, 1958).

"The region north of the area (COOK - OOLDEA - BARTON,JBF) was covered by aeromagnetic reconnaissance traverses in 1964 for Exoil Pty. Ltd., at an altitude of 700 metres above sea level. Groups of three traverses, oriented north-south and spaced 2 km apart, were separated by 15 km. Basement depth estimates along latitude 30°00'S range from sea level north of BARTON to more than 2 500 metres below sea level near the Western Australian border.

"An aeromagnetic survey was flown in 1966 over the Great Australian Bight for Outback Oil Company, at an altitude of 500 metres above sea level with north-south flight-lines spaced 10 km apart. Basement depth estimates ranged from sea level to 2 000 metres below sea level.

"The magnetic character of the crystalline basement delineated by the survey showed good correlation with known geology and with gravity data in the BARTON area of the Gawler Platform.

"Depths to crystalline basement and the basement topography were interpreted from the magnetic data in the COOK and OOLDEA areas. Troughs containing sediments up to 2 500 metres thick were delineated in both areas. Elsewhere the basement was shown to be 500 to 1000 metres deep with local areas less than 500 metres. The interpreted structures show reasonably good correlation with available borehole data and with gravity and seismic data."

The largest exposure of basement rock west of the Gawler Ranges and south of the Trans Australia Railway is the gneiss that crops out over a distance of approximately 13 km (8 miles) on the western margin of Lake Ifould. The lake was un-named in early works, but was later called Pidinga Lake(s) informally - probably after Pidinga Rock Hole etc. It is not to be confused with the small lake called Ifould's Lake which is a part of the present Lake Ifould. King (1951, p 33) states that:

"The gneisses which occur at Pidinga may be classified into three major groups:-

1. <u>Older Series of Gneisses</u> - The older gneisses are mainly dioritic in composition but also there are highly metamorphosed calcareous and siliceous sediments, amphibilites and plagioclase hornblende schists, occurring as irregular intercalations within

the dioritic gneisses. A characteristic of this group of rocks is the presence of abundant dyke-like intrusions and segregations of pegmatitic and aplitic appearance and composition.

2. Basic Rocks - Included here are metamorphosed basaltic dyke rocks and an occurrence of peridotite, all of which intersect the older series of gneiss.

3. Granitic Augen-Gneisses and Associated Migmatites - This group comprises uniform granitic rocks and related migmatites of younger origin.

The variety of gneisses recognised have in the majority of cases such complex inter-relations that it is not possible to map them as separate identities. The difficulties of interpretation are increased by the discontinuity of outcrops which has resulted from preferential erosion. The ridge of Precambrian rock probably owes its prominence to the resistance to weathering of the granitic members which recur as bold outcrops at intervals throughout the area. The other types are exposed only where creeks have dissected deeply into the sedimentary coverage, or as erosion platforms at the surface of the lakes.

The general foliation of the gneisses is reasonably uniform at each of the outcrops. The strike ranges from 10°E. of N., to 50°E. of N. and the dip is almost always vertical."

In the FOWLER area, basement rocks crop out in a number of isolated inland localities and in coastal cliffs. Good inland exposures of basement rock occur near Lake Tallacootra, and there are many smaller outcrops, most of which are shown on the accompanying FOWLER preliminary geological map (Pocket). Basement rocks have also been intersected in a number of bores. According to petrological reports, these rocks include granite, aplite, adamellite, granodiorite, gneiss of various compositions, schist and meta-quartzite (Appendix 1). Metamorphism of both igneous and metasedimentary rocks has occurred. Rock types collected are not dissimilar to those of the Cleve Metamorphics. Recent age dating suggests that granites were emplaced a little more than 1 500 years ago and that older basement rocks were possibly metamorphosed at this time. A comparison of petrological, geochronological and detailed field evidence from this area may eventually enable closer correlations to be made with known sequences elsewhere in the Gawler Block. The location of granite samples collected for age dating during this survey is shown on Fig. 2 (Pocket).

Pink feldspathic sandstones found southwest of the area at Cape Labatt, Talia Cave and Mt. Wedge resemble the late Carpentarian Corunna Conglomerate, but they may well be younger.

Clay (saprolite) in Lake Tallacootra was thought to be of Precambrian age by Campbell (1969, p. 8). But experience elsewhere in South Australia suggests that saprolites developed in basement rocks on basin margins are of about the same age as the sediments that occur in the adjoining basins. If this observation applies here, then the saprolite will prove to be much younger, that is of Mesozoic or Cainozoic age.

Basin Sediments

The stratigraphy of older rocks in the basin is set down in Parkin (1969) and Lowry (1970). The stratigraphy of younger basin deposits is described in Firman (1967 and 1969). Stratigraphic correlations of sediments in the South Australian portion of the basin with units elsewhere in South Australia are made in Ludbrook (1963 and 1969), Harris (1966), and Firman (1973, in press). Relationships between stratigraphic units in the South Australian portion of the basin and elsewhere in Australia are discussed in Sprigg (1967), Ludbrook (1969), and Lowry (1970). Important unpublished reports dealing with Eucla Basin stratigraphy are those of Ludbrook (1954) and Lindsay and Harris (1973).

Older sediments in the infrabasins within and below the Eucla Officer and Arckaringa Basins are briefly described because they record part of the sequence of events affecting basement rocks of the FOWLER area.

Palaeozoic

There is no record of Lower Palaeozoic sedimentation in this part of the Eucla Basin. Most known deposits occur north and east of the Gawler Block.

"According to Waller, Quilty and Goodeve (1972), the Cambrian surface lies at a depth of 300 metres or less in boreholes within the survey area (COOK - OOLDEA - BARTON, JBF) and 410 metres in Mallabie No. 1 bore south of the survey area, Cambro-Ordovician and Proterozoic sediments evidently constitute the major part of the sections in the basement troughs.

"The South Australian Mines Department carried out seismic refraction surveys in the Eucla Basin in 1965 (Kendall, 1967). The seismic traverses were located: (i) along the Eyre Highway near the head of the Bight; (ii) along longitude 130°30'; and (iii) southeast of Cook. From the results, it was inferred that there is a northwest-trending basement trough roughly 2 000 metres deep at the coastline near the head of the Bight. This trough was postulated to extend northward into the southern part of OOLDEA."

There are trends on the gravity map of the area Fig. 3 which, when considered together with lithologies, suggests that Lower Palaeozoic deposits of the Arkaringa Basin could possibly extend towards the present south coast margin. (B. Milton pers. comm.).

Although pink conglomeratic feldspathic sandstone cropping out at Cape Labatt, Talia Cave and Mt. Wedge could be equivalent to the Corunna Conglomerate of Late Carpentarian age, it could also be equivalent to the red feldspathic sandstone of the Pandurra Formation on the Stuart Shelf of Adelaidean age, or other similar lithologies of Palaeozoic age within the Adelaide Geosyncline. Claystones in Nullarbor No. 8 bore west of the map area have been recognised as of Lower Permian age by Harris and Ludbrook (1966).

Mesozoic

During the Triassic and most of the Jurassic, the present land area of the State was above sea level and sedimentation was restricted to thin terrestrial and lacustrine deposits.

Triassic and Jurassic Continental Sediments

Dark lignitic clays of upper Jurassic age are known from the Polda Trough which extends latitudinally from western Eyre Peninsula into the Great Australian Bight, possibly connecting with the Eucla Basin at the edge of the continental shelf.

Cretaceous

Cretaceous strata are the most widespread of the Mesozoic rocks in South Australia. Downwarping began early in the Cretaceous and large areas were inundated by the sea. These movements reached their maximum development before the late Cretaceous. By late Cretaceous time most of the basins had become filled with sediments and the environment gradually changed from marine to fluvio-lacustrine.

In the Eucla Basin, Lower Cretaceous sediments have been intersected in drill holes put down near the Trans-Australia Railway and in the southern part of the basin. Coarse basal arenites, resting upon crystalline basement or Permian sediments, are lithological equivalents of sandstones on the western margin of the Great Artesian Basin.

According to Dickinson (1958) "An isolated outcrop of porcellanite interbedded with gypseous and ferruginous clays very similar lithologically to definite Cretaceous sediments outcropping farther to the east in the vicinity of Tarcoola, suggests the possible presence of Cretaceous sediments beneath the sandhills east of the Nullarbor Plain. A feature of this outcrop is a definite, gently folded structure, not generally found in the Cretaceous rocks of South Australia". The outcrop is on the east side of Lake Ifould about 1.5 miles (2 km) southeast of Pidinga Rock Hole. Although this locality has not been visited during the present survey, it is likely that the similarities noted by Dickinson relate to the ?Tertiary weathering profile, rather than to sediments of Cretaceous age.

Cainozoic*

The Eucla Basin was shaped and infilled with younger sediments during the lower and middle Cainozoic. The portion of the Eucla Basin within the map area contains up to 60 metres (200 feet) of Cainozoic sediments overlying basement rocks. Sedimentary rocks older than Pidinga Formation do not crop out. Important sequences are exposed in the coastal cliffs, mainly on the adjoining NUYTS and STREAKY BAY 1:250 000 sheets.

Lower Cainozoic

In the southern coastal basins at the beginning of the Cainozoic uplift of the ranges and complementary subsidence occurred, and this was followed by marine ingression. Conditions of deposition were paralic and carbonaceous sands and silts, lignitic beds and low rank coals were laid down.

On the eastern side of the Eucla Basin, sedimentation began in the Middle Eocene with carbonaceous and pyritic clays, sands and silts of the Pidinga Formation. (For definition see Harris, 1966). This formation extends as far west as Nullarbor No. 6 and onto the Gawler Block in bedrock depressions as far as Malbooma (Lindsay and Harris, 1973). In some bores a coarse limonitic and glauconitic sand, the Hampton Sandstone, is present which may be the lithostratigraphic equivalent of the Kongorong Sand of the

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*Where fossiliferous sediments of known age are discussed, "lower Cainozoic is synonymous with "Lower Tertiary" and "middle Cainozoic" with "Middle Tertiary". "upper Cainozoic" includes fossiliferous "Upper Tertiary" sediments as identified herein and also younger deposits of probable Pleistocene age. Recent (Holocene) is used in this report as the youngest time term in the Pleistocene. In this way, both fossiliferous and non-fossiliferous deposits and paleo-surfaces can be properly described in a stratigraphic context.

Gambier Embayment.

According to Westhoff (1971, p. 4), in the Lake Ifould (Lake Pidinga) area relatively fresh basement rock is overlain by a considerable thickness of saprolite (highly weathered schist or gneiss) with remnants of less highly weathered rock included. Above the saprolite are sedimentary clays coloured grey, grey-brown or grey-green with numerous bands coloured red, brown and white. In several drill holes, a relatively hard bed grading from fine-grained quartzite to siliceous limestone has been recorded a few feet above the basement. Clays are not described as being characteristic of Pidinga Formation in the original definition of Harris (1966), but Lindsay and Harris (1973) record sideritic clay, which is probably Pidinga Formation, near Wirilia Tank. Westhoff (1971, p. 5) states that lignites, lignitic clays and lignitic sands are found to the north and west of Lake Ifould and that they overly the sequences of clays at Lake Ifould.

There is a possibility that some of the clays in the lake sequences described by various authors are of Pleistocene or younger age. Detailed mapping and drilling may be required to test this possibility.

In some places there are no clays: In the Pidinga area (hole 367-17) rounded quartzitic sand and gravels 100 feet (30 m) thick overlie basement (Westhoff, 1971, p. 5). A basal gravel of subangular weathered feldspar and quartz overlies basement rocks in the Seven Mile Swamps - Chundie Swamps area south of Lake Ifould (Clarke, 1970, p. 3). This may be equivalent to the rounded quartzitic sand and gravels above basement in hole 367-17 (See Fig. 4).

North and west of Lake Ifould, where lignites, lignitic clays and sands up to 160 feet (49 m) in thickness overly the basal clays, lignite lenses form minor traces in carbonaceous clay up to tens of feet thick. This carbonaceous sequence occurs from near surface in the lakes to as much as 200 feet (61 m) below ground surface. Carbonaceous clays and lignitic beds also occur in the Seven Mile Swamps - Chundie Swamps area. The carbonaceous sequence includes a thin fossiliferous limestone and it lenses out between holes 316-M10 and 316-M11 and does not extend onto the eastern part of SML 316.

Ferruginous sandstone overlies the carbonaceous sequence in Lake Tallacootra and in the Seven Mile Swamps - Chundie Swamps area. The indurated nature of the sandstone may mark an ancient paleosurface much younger than the sandstone itself. Pelecypod fossils and worm burrows have been found in this formation on SML 316 (Seven Mile Swamps).

There appears to be considerable lithological variation within Pidinga Formation: Westhoff (1971, p. 3) remarks that "...... due to the irregularity of the basement surface, numerous facies changes and several periods of erosion the sequence as described by King (1950) - 1951 this bibliography, J.B.F. - at Lake Pidinga is not representative of the area as a whole (SML 365 and 367 presumably - JBF).

Middle Cainozoic

In the southern basins, complementary uplift of the highlands and subsidence of the basin led to a marine transgression and the deposition of limestones during the middle Cainozoic. Conditions were relatively stable at this time.

In the map area, the inland margin of the middle Cainozoic sea is probably marked by the northwest-southeast trending chain of saline swamps from Red (Eagle) Lake to Seven Mile Swamps in the south. Near Lake Ifould the marine transgression resulted in erosion of part of the previously deposited sediments, which in some places were stripped down to the Precambrian basement (Westhoff, 1971, p. 3).

The major part of the sequence in the Eucla Basin consists of the Wilson Bluff Limestone, of Middle and ?Upper Eocene age. The limestone has a maximum thickness in South Australia of about 150 m (492 feet) and has a glauconitic bed at the base containing a Middle Eocene fauna (McGowran and Lindsay, 1969). The Wilson Bluff Limestone is widespread in the South Australian part of the basin, but has not been recorded further north and east than Waltabie Well and Colona Well near the Eyre Highway on the western side of FOWLER, (See Appendix 8 and Fig. 1). The Toolinna Limestone of Upper Eocene age (Lowry quoted in Lindsay and Harris, 1973) appears to be equivalent to the upper part of Wilson Bluff Limestone in the Nullarbor area. West of the map area, at Wilson Bluff and Head of the Bight, Wilson Bluff Limestone is succeeded by Abrakurrie Limestone of Oligo-Miocene to early Miocene age (see Ludbrook, 1954, Lowry, 1970, and Lindsay and Harris, 1973). This limestone is recorded only as far west as Koonalda and has not been found in the map area. The Nullarbor Limestone of late Lower and Middle Miocene age succeeded Wilson Bluff Limestone and Abrakurrie Limestone and is widespread west of the inland lakes from Red (Eagle) Lake to Seven Mile Swamps and west of the Pintumba Fault. Within the basin, the Nullarbor Limestone is about 30 m (100 feet) thick, but in the map area it is usually only a few feet thick. Westhoff (1971, p. 5) states that Nullarbor Limestone north and west of Pidinga Lake (Lake Ifould) contains quartz sand and that there are also numerous bands of quartzitic sand intercalated in the limestone. A similar marginal facies in Western Australia has been named Colville Sandstone (Lowry, 1970).

Siliceous material from the east-west line of shallow drill holes between Euria Well and Chundie Swamps resembles silcrete, which elsewhere in South Australia is emplaced between lower and upper parts of the Cainozoic sequence. Porcellanite has been described by King (1951, p. 31) and has been logged in some bores in the Ifould Lake area (Westhoff, 1971, Well No's 367-9 and 365-2), but its stratigraphic position (particularly with regard to lignitic beds) is not known.

Upper Cainozoic

Tectonic activity, which led to the break-up and elevation of the Cainozoic basins, commenced in the Late Miocene following the relatively stable conditions which were marked by deposition of marine limestone during the middle Cainozoic. Despite this activity, sedimentation continued in the southern basins until the late Pliocene. There is, however, no definite record of upper Cainozoic sedimentation in this area.

About 2 miles (3 km) north of Monburu Tank on the road from Colona Homestead to Ooldea (Fig. 4), the spoil adjacent to a collapsed well indicates a sequence of 3 feet (1 m) of brown soil over a few feet of pale yellow fine-grained sand and granule conglomerate overlying an unknown thickness of Nullarbor Limestone.

If this sequence is correctly reconstructed, then a thin sequence post-Nullarbor Limestone may occur in the area. As previously mentioned, some of the vari-coloured clay in lake sequences may be of younger age than the lower Cainozoic lignitic sequence with which it has been correlated by previous workers.

Yellow clay occurs in Lake Ifould and yellow sandy clay overlies ferruginous sandstone of the Pidinga Formation in Lake Tallacootra. This clay could be of Pliocene age. It might also correlate with yellow clay below Lower Member Bridgewater Formation on the coastal margin which is thought to be of lower Pleistocene age. Again, the clay could be as young as late Pleistocene Coomunga Formation which it also resembles.

Pleistocene deposits veneer most of the FOWLER map area and consequently dominate the pattern of distribution on the geological maps (Back Pocket). Because sub-surface geology is important in this area, a deliberate attempt has been made to select mappable units that show the real distribution of surficial deposits and also reflect important sub-surface boundaries.

Surficial deposits younger than late Pliocene marine sediments can be subdivided into three (unequal) major sequences of presumed Pleistocene age. Sedimentary evidence relating to middle and upper Pleistocene deposits in this area and to lower Pleistocene deposits elsewhere suggests a relatively long time span for the lower Pleistocene sequence.

Lower Pleistocene: Inland, lower Pleistocene deposits are widespread. They include saprolite developed on (?) lower Cainozoic, carbonaceous and older rocks and a structured, oxidised and silicified layer of detritus possibly marking the Karoonda Surface. On Eyre

Peninsula, material in this position includes the Yallunda Ferricrete and the Boston Bay Silcrete (Firman, 1967). Similar siliceous material at Lake Ifould (King, 1951, p. 29) and near the Chundie Swamps, and "ferruginous sand" mentioned by Campbell (1969, p. 20) near Red (Eagle) Lake may also be developed on and below the Karoonda Surface.

Grabens within the Torrens, Spencer and St. Vincent Basins all contain thick sequences of clay, sand and gravel assigned to Avondale Clay or Hindmarsh Clay. Hindmarsh Clay is typically developed within St. Vincent Basin where it overlies Carisbrooke Sand which - because of spatial relations with Dry Creek Sands and Hindmarsh Clay - is thought to be of Pleistocene age. This clay occurs on Eyre Peninsula. Clays exposed in low cliffs marginal to Chundie Swamps and in coastal cliffs near Ceduna (STREAKY BAY 1:250 000 sheet area) adjoining the FOWLER 1:250 000 sheet area may be of Pliocene age as previously indicated, but are probably Pleistocene.

Middle Pleistocene: The Quaternary glaciers which affected the highlands of eastern Australia and Tasmania did not extend into South Australia. However, the fluctuating sea level caused by glacio-eustasy had a profound effect on climate, coastal configuration and landscape development. The most prominent deposits of this age are the fossiliferous shallow marine and aeolian deposits of the Bridgewater Formation of the southern coastal margin. Probable equivalents are the thin discontinuous deposits of lacustrine limestone which overlie lower Pleistocene clastics and older rocks elsewhere in the State. The Mangatitja Limestone of the Officer Basin and other limestones near Maralinga, are probably the closest lacustrine deposits to the map area.

Overlying the Lower Member Bridgewater Formation in this area, and lacustrine limestones and older rocks elsewhere, is a distinctive calcareous duricrust called Ripon Calcrete, which is very widespread. The calcrete which marks an extensive paleosurface, the Ripon Surface, is now found in many places at the base of an ancient brown soil profile. On the coast it separates the Lower from the Upper Member of the Bridgewater Formation.

Moderately hard layers of calcrete younger than Ripon Calcrete are widespread throughout the State. These duricrusts characterize an ancient brown soil called the Bakara Soil and mark the paleosurface called the Bakara Surface. Inland, this calcrete is stratigraphically associated with the top of the Telford Gravel and other fluvial and alluvial deposits. In the map area, the calcrete occurs as a crust over Ripon Calcrete and older rocks, as randomly arranged layers within aeolinates of the upper Member Bridgewater Formation, and as a cap on the marine *Anadara*-bearing Glanville Formation of the coastal margin. Calcreted shell beds of this formation crop out east of Coorabie where they mark the *Anadara* High Sea.

Upper Pleistocene: Following uplift and deep dissection related to the last low stand of the sea prior to the Flandrian transgression, the Pooraka Formation was laid down as alluvial fans and as valley fill on highlands marginal to the Eucla Basin. In the map area, the deeper parts of valley fill containing disoriented calcrete clasts are probably equivalent. It is not likely that this material can be mapped or even clearly differentiated from the overlying aeolian sands of similar lithology.

During the upper Pleistocene, widespread aeolian deposition began in the southern part of the State with deposition of Woorinen Formation, a pale red-brown quartz sand mixed with carbonate silt. The un-named equivalent of this unit is well-developed in the map area. Horizons of nodular carbonate are found near the top of the Woorinen Formation equivalent. The carbonates and other relict features in soils mark younger brown soils included in the soil mantle called Loveday Soil, which was a distinctive feature of the Upper Pleistocene landscape.

The Pleistocene-Recent boundary appears to be marked in South Australia by the red Callabonna Clay. This material does not persist into the map area, but its equivalent, the yellow Communga Formation, may occur in Lake Ifould and Lake Tallacootra as previously mentioned, and may be present marginal to basement outcrops inland, and in the coastal cliffs.

Recent: Amongst the Recent (Holocene) deposits of the highlands on the margin of the Eucla Basin are talus of the ranges and alluvium on the basin margins. Polymict gravels containing well rounded materials are derived from older sedimentary deposits. Monomict gravels - usually subangular rather than rounded - are common adjacent to older basement rocks, weathering silcrete pans, and in the modern stream courses. Similar deposits in the map area are talus along cliff margins of the inland lakes and coastal cliffs, and a mantle of thin gravels on the crests of calcreted aeolianite dunes.

Modern sediments of Lakes Eyre, Torrens, Frome, Gairdner and other smaller lakes of northern Eyre Peninsula are thin evaporites consisting of gypsiferous silts with halite crusts. Similar lacustrine sediments in the map area are referred to Yamba Formation. The best known occurrence of lacustrine (?estuarine) gypsum is that at Lake MacDonnell on the coastal margin south of Penong and immediately outside the map area. (Dickinson and King, 1949 and 1950).

Gypsum dunes near the margins of the inland lakes north of the map area are probably of late Pleistocene to Recent age because they lie close to the present lake surface. A fossil horizon of gypsite - off-white silt size gypsum - commonly occurs near the dune surface, and is present elsewhere in the landscape as an aeolian layer or as an impregnation in Callabonna Clay and older units. Similar materials occur in the map area, notably at Lake MacDonnell, but also on the margins of inland lakes, the Chundie Swamps and in shallow lakes near Fowlers Bay.

Stratigraphic relationships of the various deposits of the Holocene are better displayed on the coastal margin. The deposits of the Flandrian transgression are distinctive. The most widespread is the St. Kilda Formation containing shallow marine sands, estuarine muds and shelly deposits of the beach ridges occurring in restricted outcrop near the town of Fowlers Bay, but not shown in the accompanying map. These deposits intertongue with other sequences including the gypsiferous Yamba Formation, and the coastal dune sands called Semaphore Sand. Yamba Formation east of Coorabie is developed within a topographic feature which was the strand of an ancient bay when Glanville Formation and the later St. Kilda Formation were deposited.

The southern dune fields overlie upper Pleistocene Woorinen Formation or its equivalents and older units. They include a northern belt of reddish Fulham Sand inland beyond the FOWLER map area, a southern belt of yellow Molineaux Sand and a coastal belt of Semaphore

Sand.

According to Westhoff (1971, p. 1) " .... a series of red sand dunes averaging 35 feet (11 m) in height are found in the north-eastern part of the leases." (S.M.L.s 365 and 367 - J.B.F.). These may be referred to Fulham Sand rather than Molineaux Sand.

The Fulham Sand also occurs on the margin of St. Vincent Gulf. Here shelly deposits marking the highest stand of the Flandrian transgression overlie lower phase Fulham Sand with carbonate pipes and are overlain by younger layers of dune sand. A similar sequence occurs in the Murray River valley, where older Bunyip Sand with carbonate pipes is apparently overlain by riverine Coonambidgal Formation. (Although the River Murray deposits are far from this area they may be the only model presently available for comparison with younger channel deposits of possible economic significance in this part of the Eucla Basin).

Aeolian gypsum sands of the dunes overlying or marginal to lacustrine beds of Yamba Formation occur around Chundie Swamps and other salt lakes. In the Murray Basin, aeolian gypsum deposits of this kind are interbedded with Bunyip Sand and contain a subfossil horizon of gypsite tentatively correlated with a layer widespread throughout the inland. Evidence from inland areas suggests that the base of the gypsiferous dunes in some places may be as old as the late Pleistocene.

Semaphore Sand marks the modern coast. It appears to be derived from and deposited upon Bridgewater Formation, beach ridges of St. Kilda Formation and recent off-shore bars. As previously noted, the older layers in Semaphore Sand probably intertongue with St. Kilda Formation and Yamba Formation.

ECONOMIC GEOLOGY

History of Exploration

Early exploration - probably for gold and base metals - is indicated by the presence of shallow shafts in Proterozoic basement rocks near Lake Ifould. The occurrence of lignite in this lake was first noted by Brown (1885). Subsequent reports in the Record of Mines of South Australia for 1908 and in Mining Reviews published in 1926 and 1933 deal with this deposit (see section on lignite for references).

During the 1940's some prospecting for copper was carried out in the area including Lake Tallacootra and Seven Mile Swamps (Campbell, 1969, p. 1). An inspection of the lignite deposit in Lake Ifould during 1948 was reported by Dickinson (1949). During this work, alunite was discovered (see Armstrong, 1950).

In the 1950's, active exploration for uranium and oil was being carried out over a wide area in South Australia. Some general prospecting is indicated by old lease pegs from this time (Campbell, 1969, p. 7). Abnormal radioactivity in the Nine Mile Swamps (sic) and Lake Tallacootra areas was investigated in 1954 by T.A. Barnes (1954). Some highly radioactive areas were also investigated by a geologist working for Mr. Laws, a local landowner. (Clarke, 1969, p. 3).

In the 1960's exploration for fossil fuels continued. In the search for oil, an early airborne magnetometer survey was made by the Bureau of Mineral Resources. (Quilty and Goodeve, 1958), and aeromagnetic surveys were flown by Geophysical Associates Pty. Ltd. (Hammons, 1966). Seismic surveys were made out by the South Australian Department of Mines (Kendall, 1967). In the search for uranium, ground and airborne scintillometer surveys were made and drilling commenced. This work was carried out on behalf of Australasian Mining Corp. Ltd. by Minoil Services and other contractors. An airborne magnetic and radiometric survey was made by the Bureau of Mineral Resources (Waller, Quilty and Lamboum, 1972). An interest in lignite has been maintained during the search for uranium. (Smith, 1971, and Appendices 5 and 6). Exploration for non-metallics other than lignite resumed in 1967 with the investigation of lake sediments and brines for potash alum (King, 1970).

Mineral Deposits

Radioactive Minerals

Abnormal radioactivity was found associated with a brown ferruginous sandstone in the Lake Tallacootra and "Nine Mile Swamp" (presumably Seven Mile Swamps) areas in 1954 (Barnes, 1954). Analysis of samples showed that they did not contain appreciable amounts of uranium and no further action was taken. Campbell (1969, p. 3) records the investigation of highly radioactive areas by a geologist employed by a local landowner at this time. The recent exploration for uranium began in 1969, when Campbell investigated the areas of high radioactivity within the lake beds in the area.

The Exploration Locality Map (Fig. 4 and enlargements Figs. 5 and 6) brings together information from a large number of other plans. The map provides a cross-reference between this report and important company reports listed in the bibliography. Some idea of the scope of earlier exploration now on open file in the Department of Mines can be gained from a study of Fig. 4 alone.

Comparison of radioactivity measurements made at different times and with different instruments should not be attempted.

The following account of the early reconnaissance derives from Campbell (op. cit.).

A scintillometer with detachable probe was used for background reconnaissance and for down-hole logging of shallow holes put down with a hand auger. The auger holes and shallow costeans were put down in areas with high gamma background radioactivity.

Anomalous radioactivity is restricted to isolated areas from 5 (2 m) to 200 feet (61 m) in extent. High radiation ".... in many instances greater than 50 000 counts per minute" (Campbell, op. cit., p. 3) appeared to be associated with Lower Cainozoic clastics, particularly a ferruginous sandstone, and yellow clay and sand in and around saline lagoons. The anomalous radioactivity "...... appears to be directly related to relatively recent lagoonal deposition" (Campbell, op. cit., p. 3).

Radium in minor proportions has been tentatively identified as the major radioactive source. Other radioactive minerals are present and are geochemically anomalous.

According to Westhoff (1971), three Special Mining Leases were subsequently procured by the company (316, 365 and 367 - J.B.F.). Aerial radiometric surveys were conducted over these leases. During the first of these carried out by Clarke (1969), airborne traverses were made over all the lakes and granite gneiss exposures were examined over a wide area. Clarke reported that Precambrian outcrop gave counts close to background, except for outcrops on Oolabinna and Poondinga 1:63 360 sheet areas which gave up to 4 times background (65 cps) and "must be regarded as a possible primary source of radioactive material". He also stated that radioactivity was strongest at the southern end of Seven Mile Swamps where the lake was deepest and best defined. He thought that the water was itself radioactive or that radioactivity may have come from recent deposits within the lake.

An airborne radiometric and magnetic survey was carried out in the COOK - OOLDEA - BARTON area by the Bureau of Mineral Resources in 1970 (Waller, Quilty and Lambourn,1972). This work showed that "......The airborne radiometric results have delineated localized sources of radioactivity corresponding with salt lake deposits in both the sand dune covered areas of BARTON and with salt lakes, claypans, and shallow depressions in the Miocene Nullarbor Limestone in COOK and OOLDEA. Certain radioactive anomalies correspond with mapped calcrete deposits in southwest BARTON". Radiometric sources located within the area covered by the present report are shown on Fig. 4.

A programme of drilling was subsequently undertaken on the eastern most lease, S.M.L. 316 (Clarke, 1970; Westhoff, 1971). According to Westhoff (1971, p. 2): "Drilling was contracted to Geosurveys of Australia Pty. Ltd. using a Mayhew 1 000 rig and water truck. It was initially planned to drill 7 000 feet (2134 m) but due to drilling difficulties, the programme had to be abandoned after drilling 3 600 feet (1097 m).

"The drill holes were located along a broad band extending from north-west of Red (Eagle) Lake, through Pidinga and Tallacootra Lakes towards Seven Mile Swamps, where low grade uranium (sic.) deposits had previously been discovered (see plan 367 - 2, Fig. 4 this report, J.B.F.). Within this band, the drill sites were located so as to provide minimum access difficulty to the rig and to minimise the thickness of hard near-surface limestone".

Pidinga Area

As used in this report, Pidinga Area means the terrain around Red (Eagle) Lake, Lake Ifould (Pidinga Lakes) and Lake Tallacootra. Much of the area is included in S.M.L.s 365 and 367. Features of interest in this area are shown on the Exploration Locality Map (Fig. 4).

According to Westhoff (1971), S.M.L.s 365 and 367 have a combined area of 1 805 square miles (4675 km^2) and are located about 50 miles (80 km) north-west of Penong. The road from Colona H.S. on the Eyre Highway to Ooldea Siding on the Trans-Australia Railway passes through S.M.L. 367.

Westhoff (1971) states: "Thirty-two holes, totalling 3 649 feet (1112 m, J.B.F.) were drilled on the two leases. Wherever possible, holes were to the Precambrian basement ..... holes were logged with a down the hole scintillometer probe. This probe detects gamma radiation which results from the radioactive decay of thorium, uranium the daughter products of these, or potassium".

This work showed that zones of anomalous radioactivity occur north and west of Lake Ifould and that they do not occur to the southwest. Readings up to 800 counts per second were obtained over a small area in Lake Ifould. In Lake Tallacootra, readings up to 250 counts per second were obtained in the northeast corner. There appeared to be no relationship in the two lakes between the deepest areas and high radioactivity. During this work S.M.L. 365 was not properly tested due to drilling difficulties.

Seven Mile Swamp Area

Intensive work following the 1969 reconnaissance of Campbell was first carried out between Euria Well and Chundie Swamps, north of Chundie Swamps, and around Seven Mile Swamps to the south. The area selected was covered by S.M.L. 316 and extended a maximum of about 53 miles (85 km) north-south and 20 miles (32 km) east-west to cover an area of 963 square miles (2494 km^2). The southeast corner was 24 air miles (39 km) from Penong (see Exploration Locality Map, Fig. 4).

Clarke (1969) records the results of an 8 day survey of S.M.L. 316 (half by 4 wheel drive vehicle and half by air). After inspection of outcrop and pits on Seven Mile Swamps, during which a ground scintillometer survey was made around the perimeter of the lake, he recommended drilling a circular pattern of holes around Seven Mile Swamps.

Hillwodd (1970) has reported the early phase of drilling.

"Approximately 4 000 feet (1219 m) of rotary drilling has been completed near the Seven Mile Lakes (sic.). Holes were spaced approximately 0.5 miles (0.8 km) apart. All holes have been gamma logged.

"Several radioactive horizons have been intersected but in most cases the radioaction has not been due to uranium or thorium. However, up to 250 parts/million uranium have been assayed in cuttings from hole M5".

Clarke (1970) reported on exploration for the year ended 15th June, 1970. He stated that 97 holes totalling 11 392'5" (3472 m) were put down over areas of anomalous radioactivity. This programme established the presence of low grade uranium mineralisation at shallow depths over large areas according to Clarke.

Samples showing high radioactivity from Seven Mile Swamps were commented upon by Dr. R. Davey of Amdel (Appendix 3, this report) as follows:

"It is suggested .... that secondary daughter products of uranium are present. The most likely element to be present is radium of mass number 226. This will precipitate out of solution as $RaSO_4$ and leave uranium as the uranyl (UO_2^{+4}) ion free to move further. It may be expected that secondary uranium will be found downstream from the daughter products and that primary uranium may be present upstream from the sample site".

Lignite

Lignite was first reported in Lake Ifould (Pidinga Lakes) by Brown (1885). Boring was carried out privately by Mr. Ifould in about 1885 and bore samples were tested. In his report, Brown stated that "The samples which have been analysed in the survey laboratory, give a generally large percentage of ash, varying from 15 to 50 per cent".

This early work was summarised by Ward (1926) as follows:

"In the bed of a dry lake, 32 miles to the S.E. of Ooldea, there is reported to be an outcrop of lignite that has been traced down the lake for two to three miles, and across it for half a mile. The Government Geologist inspected the place in 1885 and saw an opening 5 feet deep. The lignite was subsequently reported to have been bored and to have been 30 feet in thickness, overlying 9 feet of clay with ironstone and then another foot of lignite. No further boring was done. Mr. H.Y.L. Brown noted that the structure and shape of the wood were visible in the upper parts of the bed, which contained also small pieces of fossil gum or resin".

During test boring of alunite deposits in these lakes reported in Dickinson (1949 and 1950) a bore was put down to 48 feet (15 m) to test the lignite. Samples were analysed with the results shown in Appendix 6. Smith (1971) has provided further details: "Lignite has been reported in several drill holes on S.M.L. 316 (in Seven Mile Swamps and Chundie Swamps areas) and on S.M.L. 367 west and south of Red Lake. On S.M.L. 365 no lignite has been logged as yet, but when drilling is recommenced the delineation of further deposits may eventuate.

"To date, 129 rotary percussion holes have been drilled, for a total depth of 15 041 feet (4584 m, J.B.F.). Of these, 97 have been drilled on S.M.L. 316, 7 on S.M.L. 365 and 25 on S.M.L.367. Intersections of lignite have been made in 57 of these holes. Seven holes intersected lignite west and south of Red Lake on S.M.L. 367, none on S.M.L. 365 and 50 holes in the Chundie and Seven Mile Swamps area on S.M.L. 316. Of the 57 holes intersecting lignite, 19 holes went to basement whilst a number of the holes ceased in lignite, i.e. the thickness of lignite is greater than indicated by the lithologs.

"The depth of the lignite horizon is extremely variable as the sediments were deposited during Tertiary time on an undulating Precambrian basement. As a consequence of this, the thickness of the lignite lenses vary from minor traces in carbonaceous clay to tens of feet in many holes. Lignite occurs just below the surface in several of the salt lakes. Most of the lakes are covered by a thin veneer of Recent clays and silts. Depths to lignite, thickness of lignite logged etc. are listed in Appendix 1 (Appendix 5 this report J.B.F.). It should be noted however that the thicknesses quoted are extremely approximate, due to the drilling and sampling methods, and only extensive coring will give accurate values." (Drill hole locations are shown on figure 4 this report J.B.F.).

A most comprehensive list of reports on the occurrence of coal and lignite in South Australia - including reports on this area - is given in Dickinson, S.B. (1948). Fig. 5 shows various localities for which there is no adequate map in earlier reports.

Other Minerals

Oil and Gas

Although the FOWLER area straddles the eastern boundary of the Eucla Basin, the basement is at such shallow depth, and the area is so far removed from the infrabasins with oil and gas potential within and below the Eucla, Officer and Arckaringa Basins that no further discussion of oil and gas is warranted.

Alunite and Brines

Alunite was first collected at Lake Ifould during an inspection of lignite in that area (Dickinson, 1948). One sample contained 8.68 per cent potash and another 7.20 per cent potash. At that time, alunite was a potential source of potash and of aluminium. Subsequent test boring of one of the deposits (Armstrong, 1950; Willington, 1949) showed a probable reserve of 233 000 tons (236739 tonnes) of alunite averaging 7.33 per cent potash. King (1951, p. 29) thought that the alunite was not syngenetic, but a later feature. The origin of the deposits is discussed in King (1953).

The deposits were again test drilled in 1967 (King, 1970) during a programme designed to determine the quantity and composition of the alunitic clay and water-bearing lake sediments in the Pidinga-Tallacootra lake systems. Eight holes aggregating 284 feet (87 m) were put down. This work showed that the most extensive deposits of alunitic clay occurred in Lake C (the site of the earlier drilling reported by Armstrong), and that water-bearing sediments are confined to Lake C and a narrow strip of the main lake. Analysis showed the total potash content to be normal, and it was concluded that neither lake sediments nor lake brines were of commercial interest.

Miscellaneous

Evidence of early prospecting for gold and for base metals including copper has already been mentioned in the historical review. King (1970) reports that investigation of outcropping basement rocks in the Lake Ifould area and laboratory examination of selected specimens failed to reveal any evidence of base metal mineralisation. Ferruginous sand "high in aluminium" and possibly bauxitic has been mentioned by Campbell (1969, p. 20) near Red (Eagle) Lake. Gypsum is mined south of the map area from the extensive deposits of Lake MacDonnell. Common salt has also been won from the Lake MacDonnell area in the past. Gypsum (kopi) and common salt occur in and around the inland lakes, but the deposits are too small and too isolated to be of economic importance.

29th March, 1973
JBF:IA

J.B. FIRMAN

ASSISTANT SENIOR GEOLOGIST

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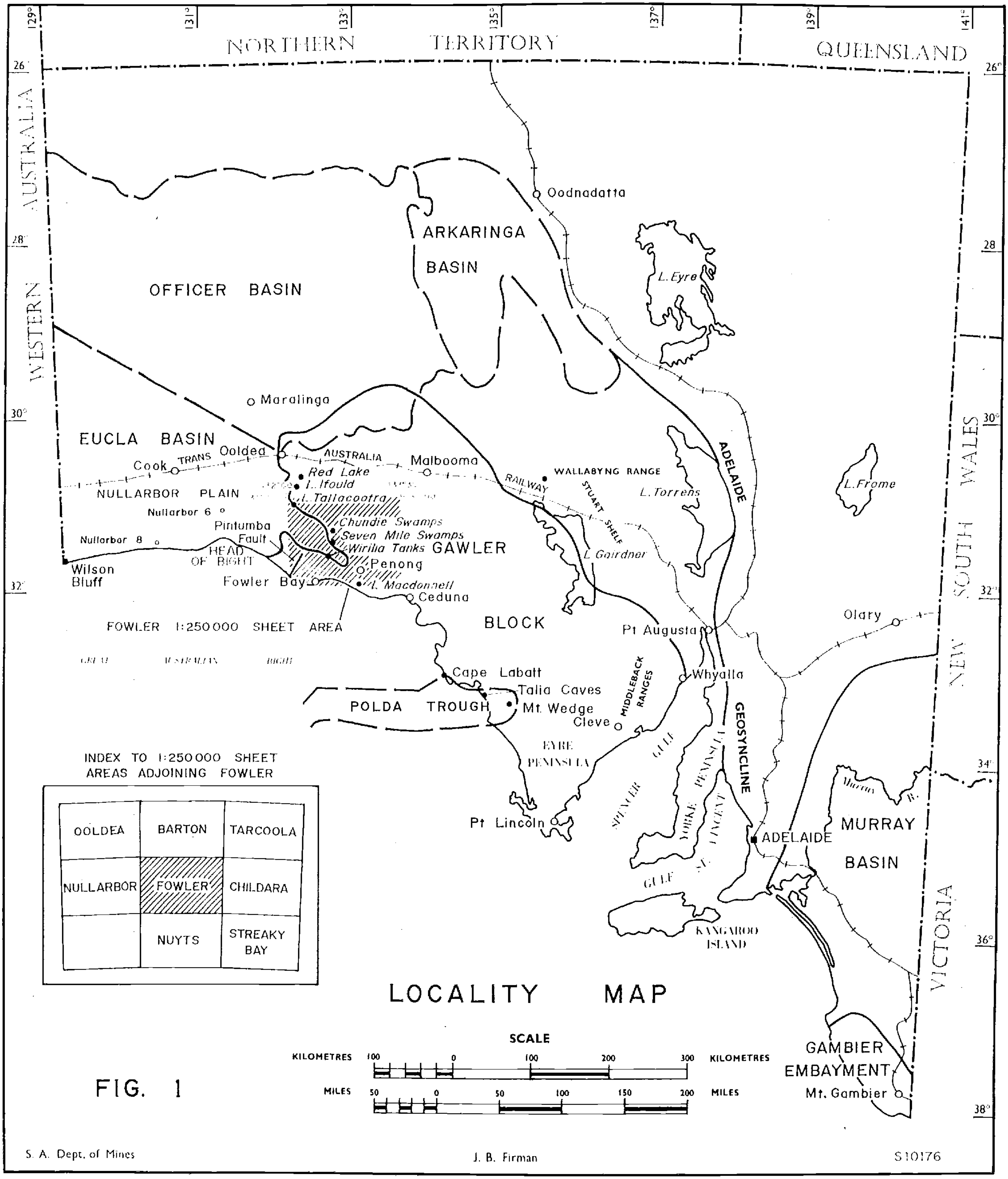
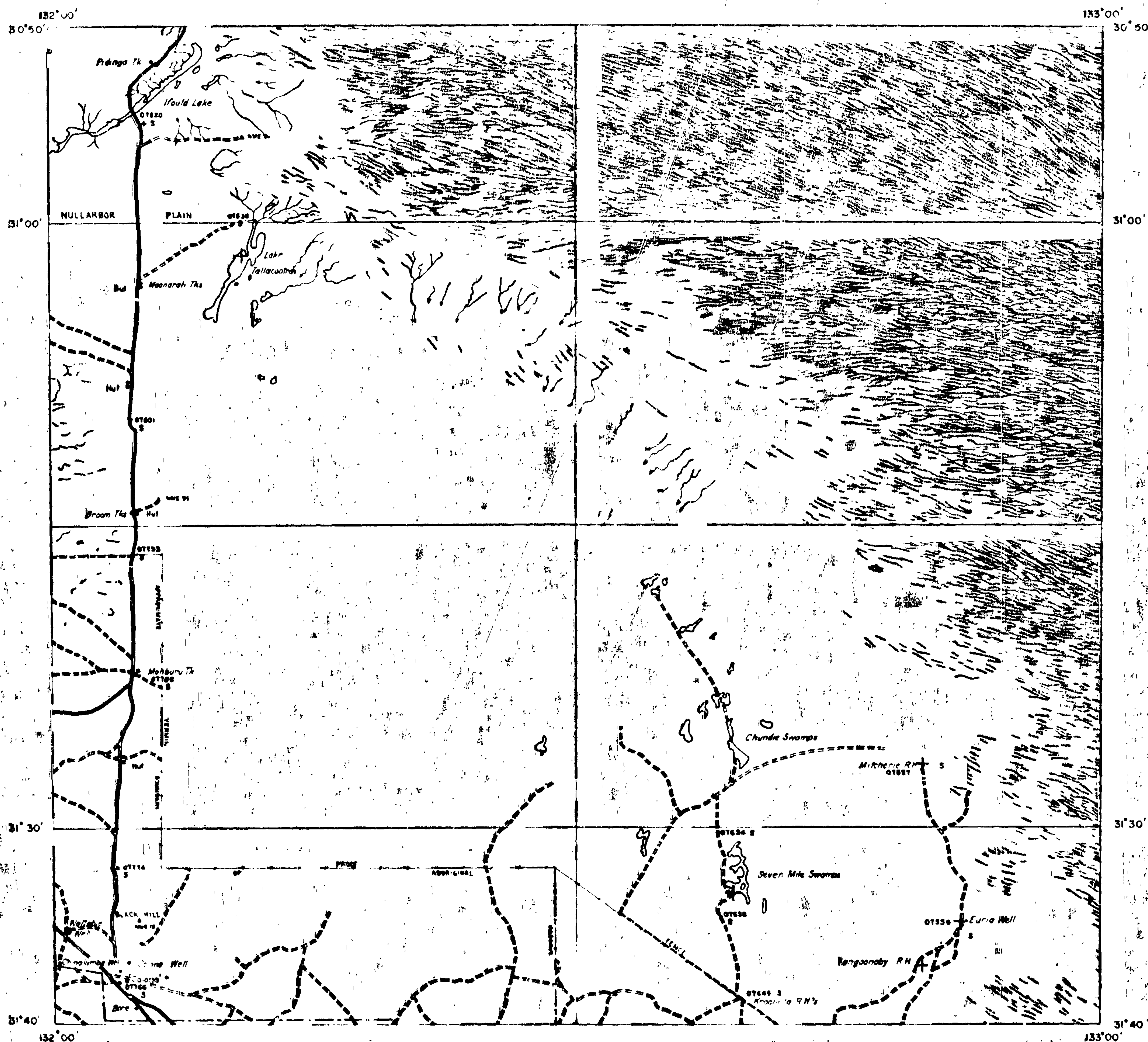


NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
NEW SOUTH WALES
VICTORIA
OFFICER BASIN
ARKARINGA BASIN
EUCLA BASIN
NULLARBOR PLAIN
GAWLER BLOCK
POLDA TROUGH
ADELAIDE GEOSYNCLINE
STUART SHELF
MURRAY BASIN
GAMBIER EMBAYMENT
Oodnadatta
Maralinga
Ooldea
Cook
TRANS AUSTRALIA RAILWAY
Malbooma
WALLABYNG RANGE
Red Lake
L. Ifould
L. Tallacootra
Nullarbor 6
Nullarbor 8
Pintumba Fault
Chundie Swamps
Seven Mile Swamps
Wirilia Tanks
HEAD OF BIGHT
Wilson Bluff
Penong
Fowler Bay
L. Macdonnell
Ceduna
FOWLER 1:250 000 SHEET AREA
Cape Labatt
Talia Caves
Mt. Wedge
Cleve
MIDDLEBACK RANGES
EYRE PENINSULA
Pt Lincoln
L. Eyre
L. Torrens
L. Gairdner
L. Frome
Pt Augusta
Whyalla
Olary
SPENCER GULF
YORKE PENINSULA
GULF ST. VINCENT
ADELAIDE
KANGAROO ISLAND
Murray R.
Mt. Gambier
INDEX TO 1:250 000 SHEET AREAS ADJOINING FOWLER
OOLDEA
BARTON
TARCOOLA
NULLARBOR
FOWLER
CHILDARA
NUYTS
STREAKY BAY
LOCALITY MAP
SCALE
KILOMETRES 100 0 100 200 300 KILOMETRES
MILES 50 0 50 100 150 200 MILES
S. A. Dept. of Mines
J. B. Firman
S10176

FIG. 1



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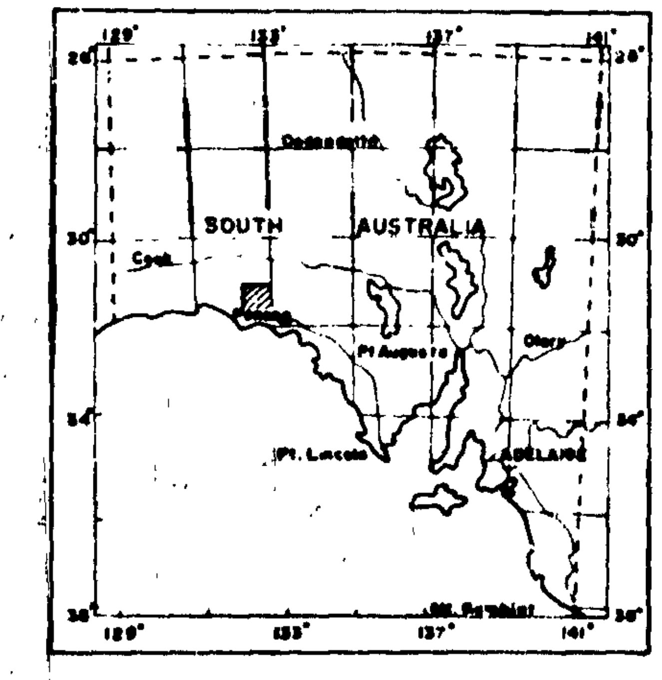
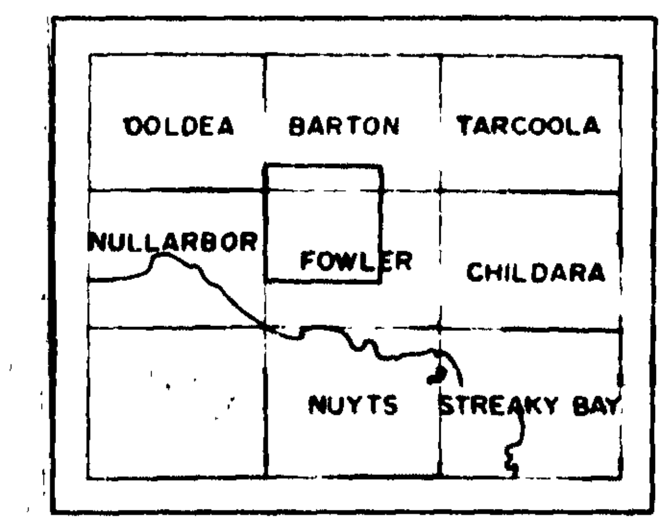




REFERENCE

Granitic rocks .... +

Sample Locality .... s

SCALE

1:250,000

KILOMETRES 0 5 10 15 20 25 KILOMETRES

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

Fig. 2

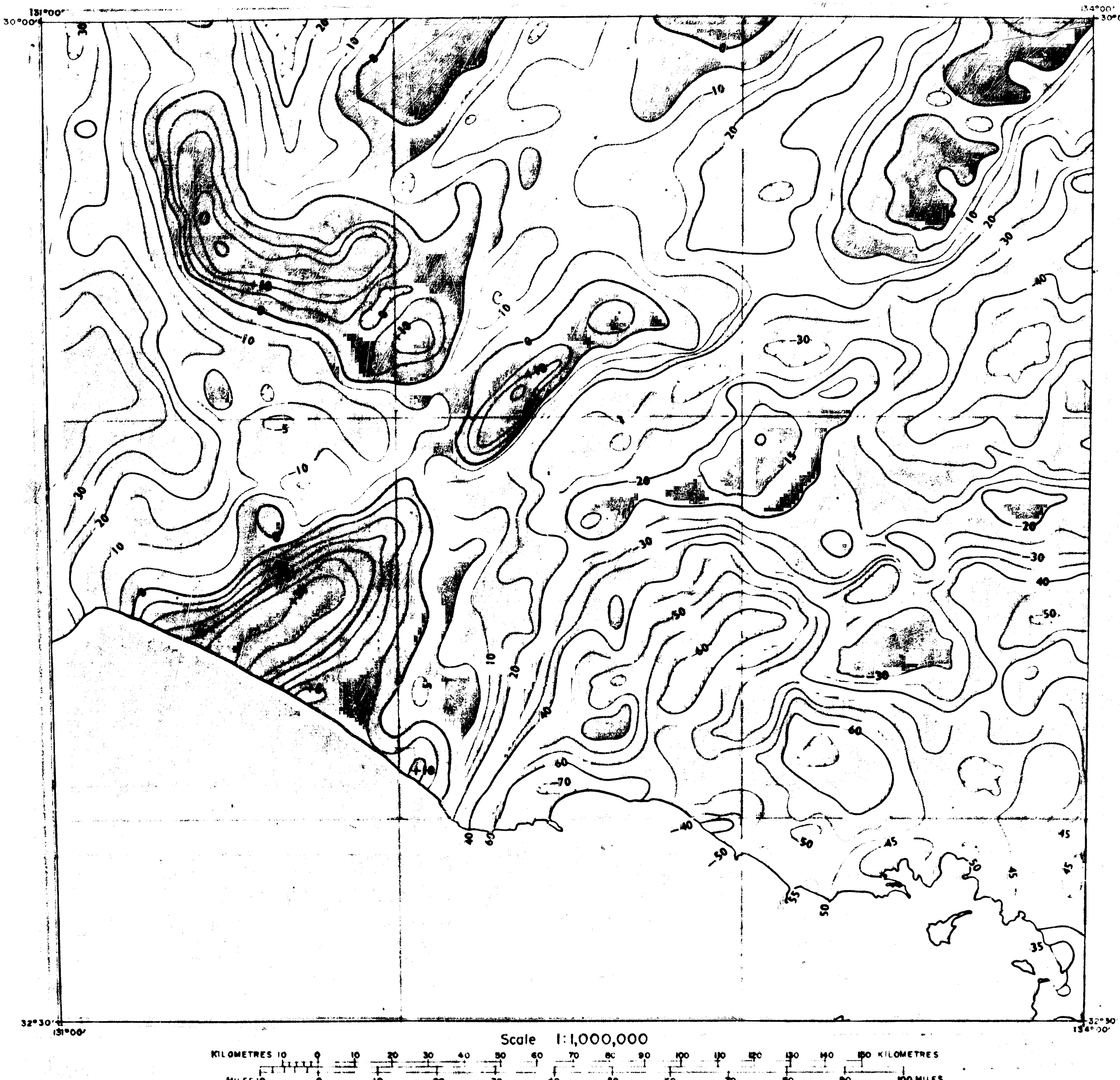
To accompany report by J B Firman

DEPARTMENT OF MINES — SOUTH AUSTRALIA

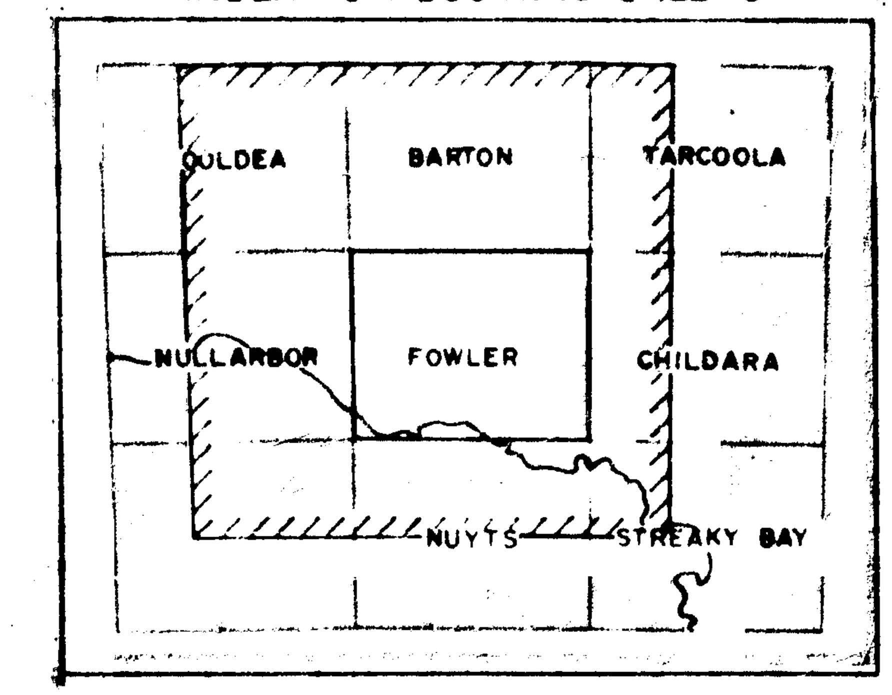
NORTHWEST PORTION OF FOWLER AND ADJOINING BARTON 1:250 000 AREAS

Showing granite sample localities and reference numbers for related traverse notes in Appendix 3

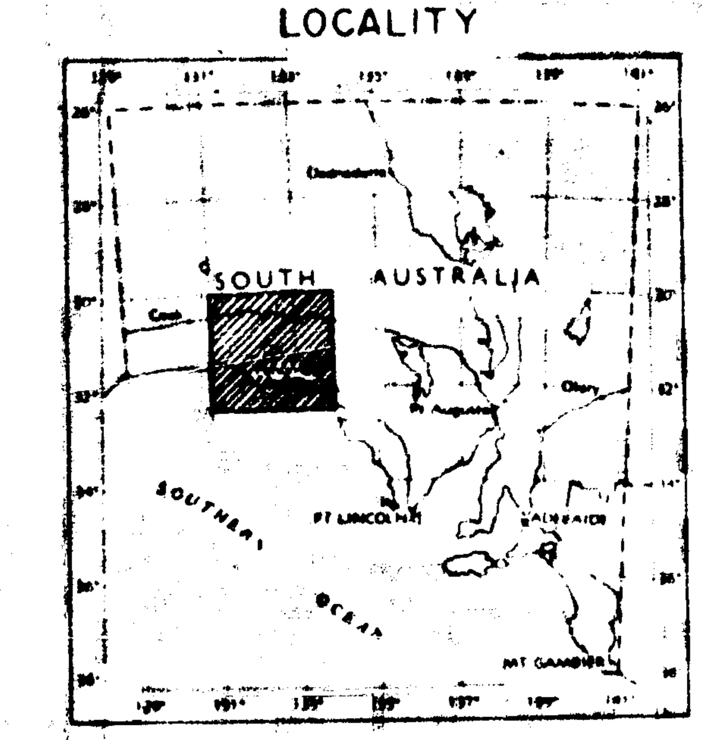
Regional Mapping Section	Drn.	SCALE 1 250000
	Tcd. J.A.A	73–108 AB+D
	Ckd.	
Director of Mines	Exd.	DATE:



INDEX TO ADJOINING SHEETS



LOCALITY



Contour Interval 5 Milligals

Compiled from Surveys by Bureau of Mineral Resources

1970 Density 2·2

Density value in g/cm³ used to compute Bouguer value

Elevation Datum . Mean Sea Level

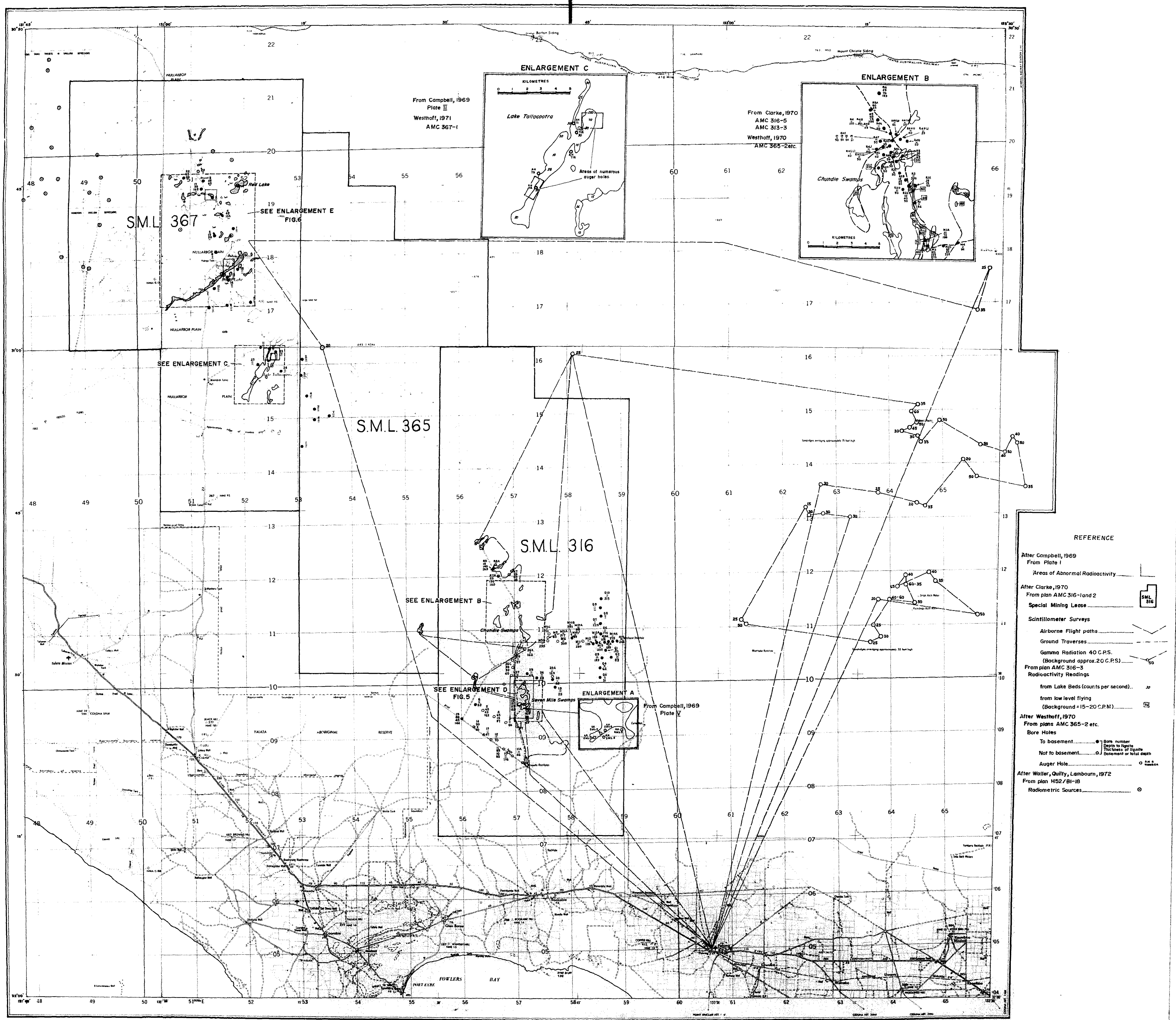
To accompany report by J.B. Firman.

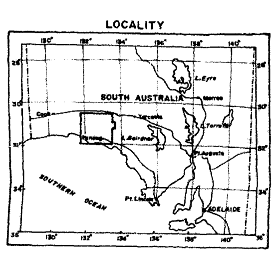
Fig. 3

DEPARTMENT OF MINES — SOUTH AUSTRALIA

BOUGUER GRAVITY ANOMALY MAP FOWLER 1 250,000 SHEET & ADJOINING AREAS

REGIONAL MAPPING SECTION		Drn.	SCALE 1:1,000,000
		Tcd.	73-109 AB+D
		Ckd	
Director of Mines		Exd	DATE March 1973





SCALE

KILOMETRES 5 4 3 2 1 0 5 10 15 20 25 KILOMETRES

DEPARTMENT OF MINES — SOUTH AUSTRALIA

Fig. 4
Exploration Locality Map
FOWLER 1:250000 SHEET and adjoining areas

Regional Survey	J. B. FIRMAN	Drn.	SCALE: 1:250000
		Tcd. J.A.F.	73-110
		Ckd.	AB+D
Director of Mines		Exd.	DATE: 7·3·73

Fig. 5

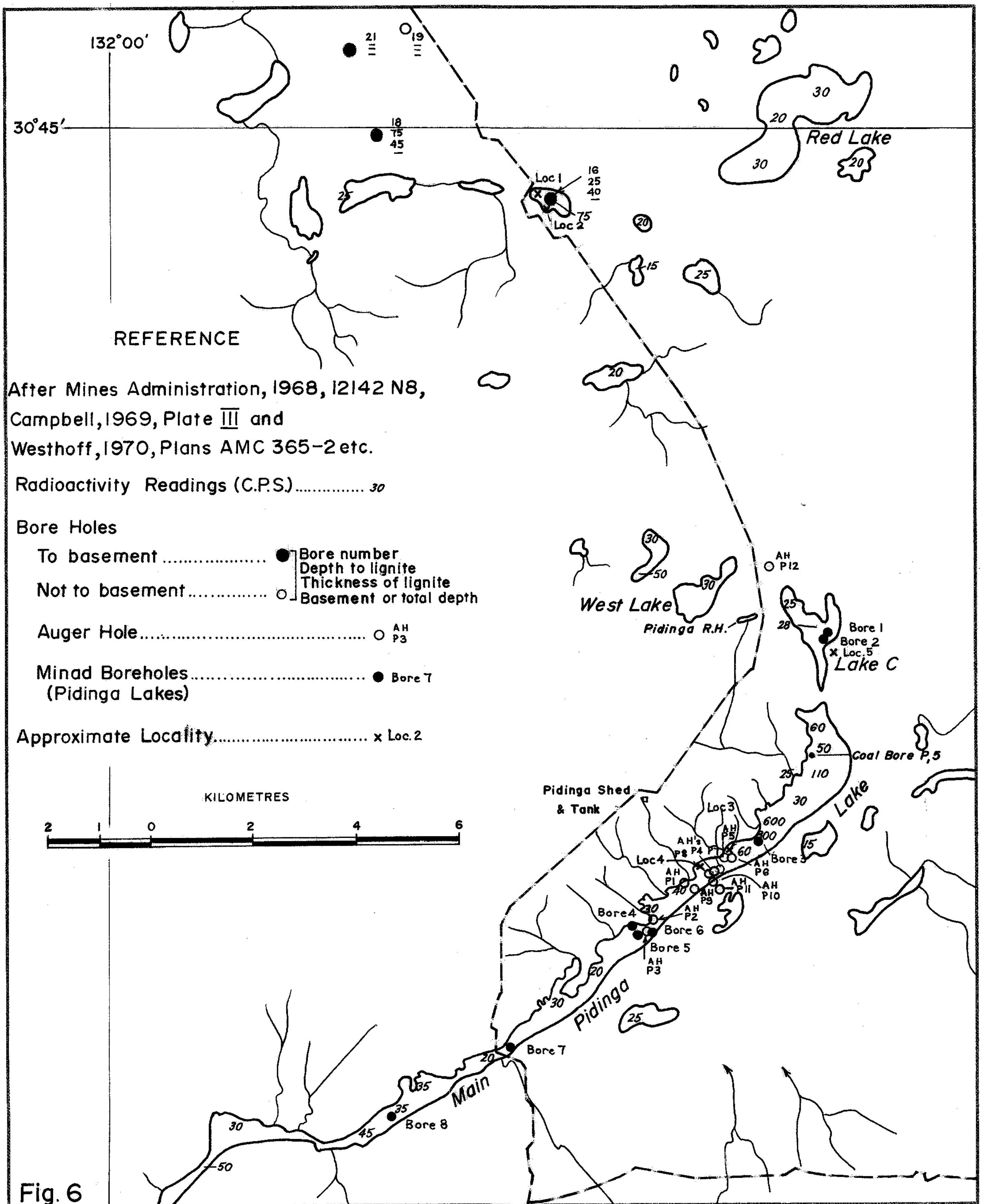
DEPARTMENT OF MINES — SOUTH AUSTRALIA

Exploration Locality Map

ENLARGEMENT D

ON FOWLER 1:250000 SHEET

Regional Survey	J.B. FIRMAN	Drn. —	SCALE: 1:13000
		Tcd. J.A.A	73 - 111 AB+D
		Ckd.	
Director of Mines		Exd.	DATE: 23·2·73



	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:100000
Compiled: J.B.F.	Exploration Locality Map	Date: 5·3·73
Drn. J.A.A. | Ckd.	ENLARGEMENT E On BARTON 1:250000 SHEET	Drg. No. S10199 AB+D

300–6,72 C5552

MISSING

Figure 7
Figure 8
Figure 9
Figure 10

STRATIGRAPHY OF FOWLER 1:250000 SHEET

CAINOZOIC	QUATERNARY	RECENT		Qre	SEMAPHORE SAND : Off-white and pale brown quartz and shell sands of the modern beach and coastal dunes.
CAINOZOIC	QUATERNARY	RECENT		Qrm	MOLINEAUX SAND : Off-white and pale yellowish brown quartz sands of the inland dune fields overlying darker yellow and orange coloured sand with carbonate pipes in some places.
CAINOZOIC	QUATERNARY	RECENT		Qrk	ST KILDA FORMATION : Pale grey shell deposits, shelly silts and clays. (May be mappable in some places on coastal margin following detailed mapping).
CAINOZOIC	QUATERNARY	RECENT		Qry	YAMBA FORMATION : Dark grey silt, yellowish brown gypsum sand, off-white gypsum silt (gypsite)
CAINOZOIC	QUATERNARY	PLEISTOCENE	UPPER	Qlo, Qpo	LOVEDAY SOIL : Characteristic off-white carbonate patches and nodules of calcareous sands in undulating terrain (Qlo), and in pale brown aeolian calcareous silty sand of the WOORINEN FORMATION EQUIVALENT (Qpo).
CAINOZOIC	QUATERNARY	PLEISTOCENE	MIDDLE	Qpg	GLANVILLE FORMATION : Pale yellowish brown, silty, shelly limestone calcreted at the top (Outcrops too small to map).
CAINOZOIC	QUATERNARY	PLEISTOCENE	MIDDLE	Qca	Calcrete in BAKARA SOIL : Off-white moderately hard calcrete with RIPON CALCRETE at the base in many places.
CAINOZOIC	QUATERNARY	PLEISTOCENE	MIDDLE	Qpb_1	BRIDGEWATER FORMATION:UPPER MEMBER : Pale brown cross-bedded calcarenite (aeolianite). Exposed in coastal cliffs, overlain by pale brown sand re-worked from aeolianite inland. Small outcrops of LOWER MEMBER BRIDGEWATER FORMATION not differentiated
CAINOZOIC	QUATERNARY	PLEISTOCENE	MIDDLE	Qpr	RIPON CALCRETE : Hard pale brown and pink massive and nodular calcrete with angular grey inclusions.
CAINOZOIC	QUATERNARY	PLEISTOCENE	MIDDLE	Qpb_2	BRIDGEWATER FORMATION:LOWER MEMBER : Yellow-brown calcarenite (aeolianite). Exposed in coastal cliffs where it is characterised by vertical solution pipes and honeycomb weathering. Capped by RIPON CALCRETE or overlain by brown soil and WOORINEN FORMATION EQUIVALENT inland.
CAINOZOIC	QUATERNARY	PLEISTOCENE	LOWER	Qph	HINDMARSH CLAY EQUIVALENTS : Reddish mottled and oxidised clays and saprolites exposed in coastal cliffs and margins of inland lakes. (Not mappable).
CAINOZOIC	QUATERNARY	PLEISTOCENE	LOWER	Qsi	Oxidised and silicified detritus of the KAROONDA SURFACE. (Not mappable).
CAINOZOIC	TERTIARY	MIOCENE		Tmn	NULLARBOR LIMESTONE : Yellow-brown hard recrystallised fossiliferous limestone
CAINOZOIC	TERTIARY	EOCENE		Tep	PIDINGA FORMATION : Dark grey and red ferruginous sandstone (Generally subsurface; outcrops too small to map).
PROTEROZOIC	CARPENTARIAN			p€	Granite, adamellite, granodiorite, gneiss and granite gneiss of the GAWLER BLOCK.

TABLE 1

To accompany report by J B Firman

S10124
AB, D

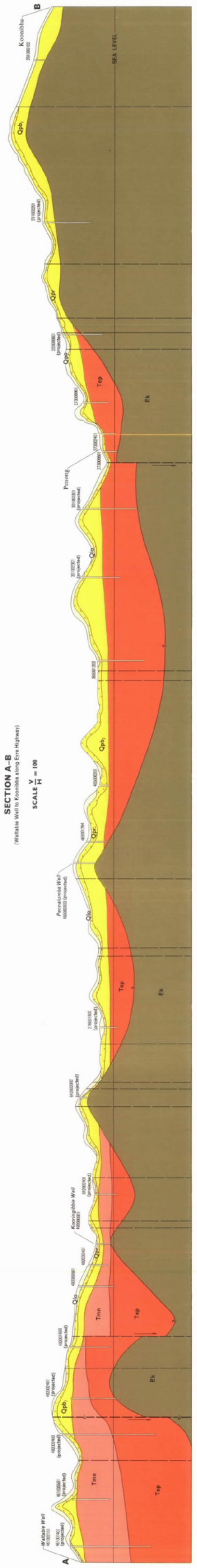
FOWLER

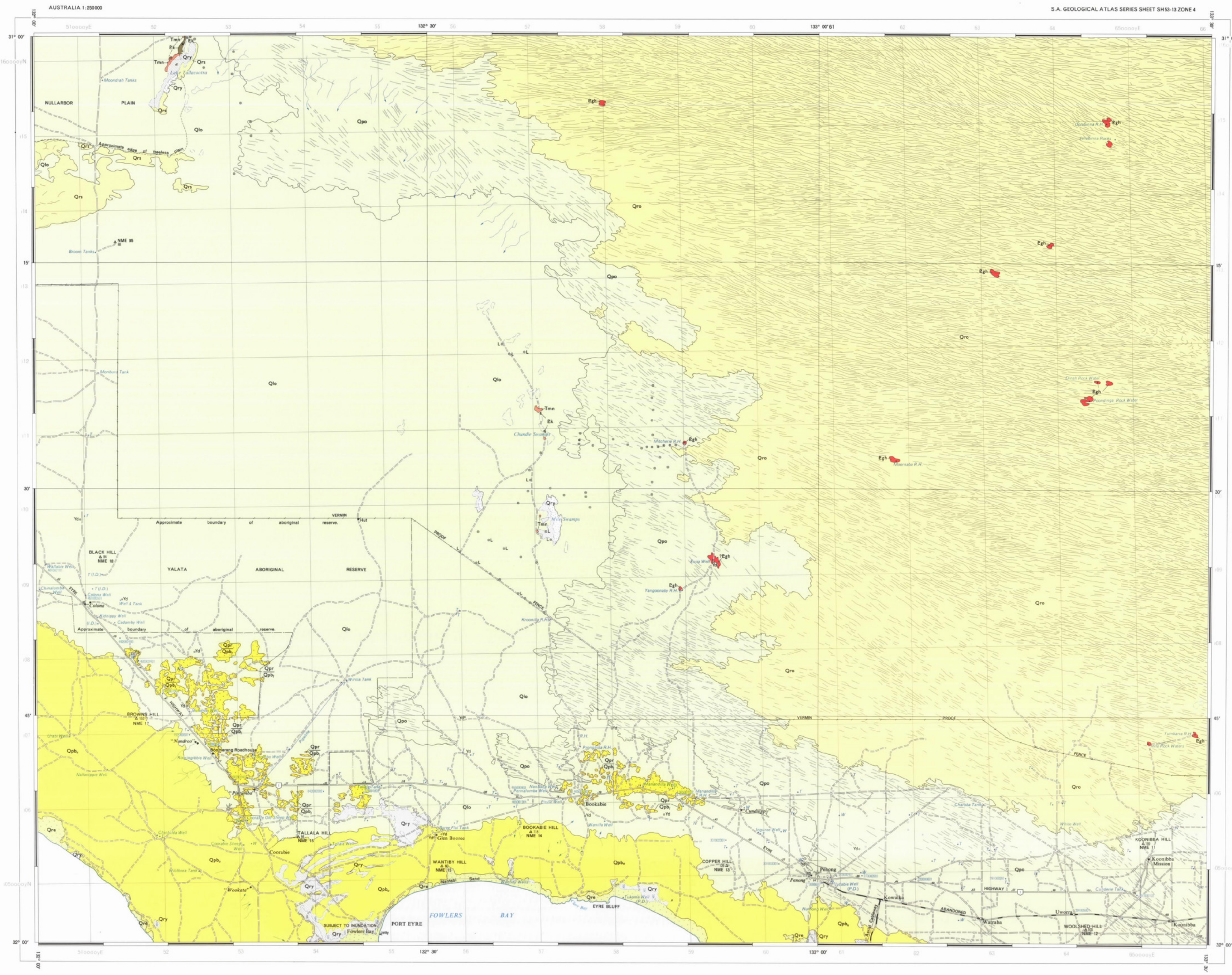
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

AUSTRALIA 1:250000

S.A. GEOLOGICAL ATLAS SERIES SHEET SH53-13 ZONE 4

FIRST EDITION 1975





REFERENCE

CAINOZOIC — QUATERNARY — HOLOCENE

- **Qre** — SEMAPHORE SAND: Off-white and pale brown quartz and shell sands of the coastal dunes and modern beach.
- **Qro** — MOORNABA SAND: Aeolian off-white and pale yellowish brown quartz sand overlying darker yellow and orange coloured quartz sand with soft carbonate pipes in some places. Inland dunes.
- **Qrs** — Aeolian pale brown calcareous quartz sand of the inland dunes.
- Gypsum dunes.
- **Qry** — YAMBA FORMATION equivalents: Beds of crystalline gypsum and impregnations in older rocks of the inland lakes and swamps. Dark grey silt, yellowish brown gypsum sand, off-white gypsum silt (gypsite) not differentiated. LE HUNTE FORMATION: Crystalline gypsum of lagoons and swamps on the coastal margin. Interbedded with ST. KILDA FORMATION and overlies GLANVILLE FORMATION.

CAINOZOIC — QUATERNARY — PLEISTOCENE

- **Qlo** — LOVEDAY SOIL: Calcareous earth (brown soil) with characteristic soft off-white carbonate patches and nodules. Undulating terrain.
- **Qpo** — WIABUNA FORMATION: Pale brown calcareous silty sand in which carbonates of the LOVEDAY SOIL have been developed. Mainly aeolian.
- **Qpbu** — BRIDGEWATER FORMATION; Upper Member: Pale brown cross-bedded calcarenite (aeolianite). Soil horizons of moderately hard off-white Bakara calcrete are contained within and cap the unit and the overlying GLANVILLE FORMATION in some places. Exposed in coastal cliffs. Overlain by pale brown sand re-worked from aeolianite inland. A thin veneer of calcreted Upper Member BRIDGEWATER FORMATION occurs east of Bookabie but is not shown on geological section.
- **Qpr** — RIPON CALCRETE: Hard pale brown and pink massive and nodular calcrete with angular grey calcrete inclusions.
- **Qpbl** — BRIDGEWATER FORMATION; Lower Member: Yellow-brown calcarenite (aeolianite). Exposed in coastal cliffs where it is characterized by vertical solution pipes, honeycomb weathering and rubified fossil soils. Capped by RIPON CALCRETE or overlain by brown soil and WIABUNA FORMATION inland.
- Fossiliferous sandstone near Chintumba Tank west of Chintumba Well (Nullarbor 1:250 000). Rock relation diagram only.

CAINOZOIC — TERTIARY

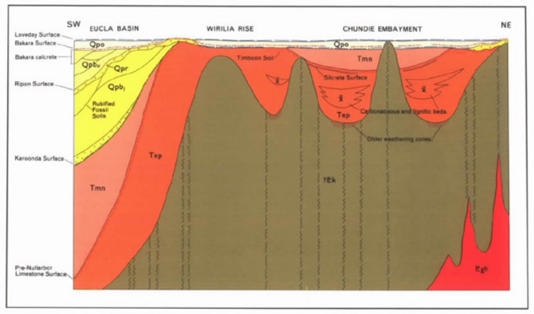
- **Tmn** (MIOCENE) — NULLARBOR LIMESTONE: Yellow-brown hard recrystallised fossiliferous limestone. WILSON BLUFF LIMESTONE on geological section west of Pintumba not differentiated. Contains quartz granules indicating equivalency with COLVILLE SANDSTONE in places. NULLARBOR LIMESTONE and the underlying PIDINGA FORMATION are extensively ferruginised and silicified where the Lower Pleistocene Karoonda Surface is exposed on the margins of inland lakes and swamps.
- **Tep** (EOCENE) — PIDINGA FORMATION: Pale brown, yellow and red quartz sands and gravels, carbonaceous and pyritic sands, silts and clays with thin beds of lignite. Paleogeological sketch, rock relation diagram and geological section only.

PROTEROZOIC (CARPENTARIAN)

- **Egh** — Adamellite, granodiorite, gneissic granite.
- **Ek** — ?CLEVE METAMORPHICS of the Gawler Block: Gneiss, granite-gneiss, schist and metaquartzite intruded by younger granite.

GEOLOGICAL BOUNDARY
FOLIATION, VERTICAL
MAIN ROAD
SECONDARY ROAD
TRACK
NATIONAL ROUTE NUMBER
RAILWAY
FIRST ORDER TRIANGULATION STATION
SPOT ELEVATION IN METRES
ACCURATE
APPROXIMATE
YARD
TANK
BORE
BORE WITH STATE REFERENCE NUMBER
MINERAL EXPLORATION BORE
CARBONACEOUS SEDIMENTS INTERSECTED
WELL
ROCKHOLE
DAM
EPHEMERAL STREAM
PLAYA LAKE OR CLAYPAN
SWAMP
HOMESTEAD — "Nundroo"
SAND DUNES

ROCK RELATION DIAGRAM



SCALE

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

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

PRINTED IN AUSTRALIA
A. B. JAMES, GOVERNMENT PRINTER
SOUTH AUSTRALIA

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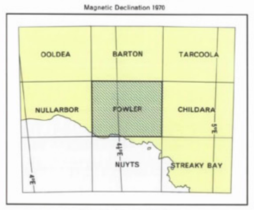
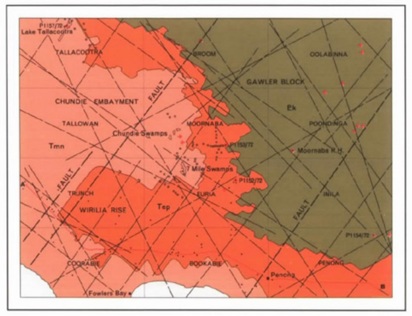


Annual Variation + 1 minute

PALEOGEOLOGICAL SKETCH



Minor Fault
Lineament
Geological section — A B
Mineral exploration bore
Younger granite
Granitic rock sample — P1157/72
Bore

Geological preparation by J. B. Firman, B.Sc.(Hons.)

B. P. Thomson, M.Sc., Supervising Geologist, Regional Geology Division

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

Compiled under the direction of B. P. Webb, M.Sc., Government Geologist, Director of Mines.

Issued under the authority of the Honourable H. R. Hudson, B.Ec., M.P., Minister of Mines and Energy.

Published 1975

Copies of this map may be obtained from the Geological Survey of South Australia, Department of Mines, 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.

BARTON

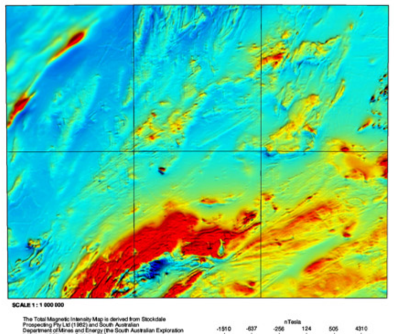
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY

AUSTRALIA 1:250000

S.A. GEOLOGICAL ATLAS SERIES SHEET SH 53-9

FIRST EDITION 1994

TOTAL MAGNETIC INTENSITY MAP

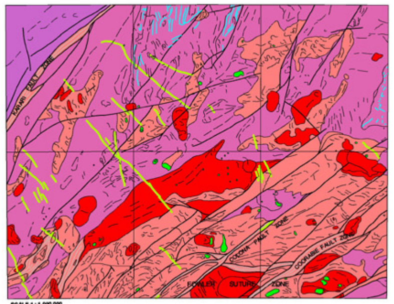


SCALE 1 : 1 000 000

The Total Magnetic Intensity Map is derived from Stockdale Prospecting Pty Ltd (1982) and South Australian Department of Mines and Energy (the South Australian Exploration Initiative, 1993) data. Grid size 100 metres.

Merging, gridding and image processing of the data was completed by G.Reed and P.Saunders of the South Australian Department of Mines and Energy.

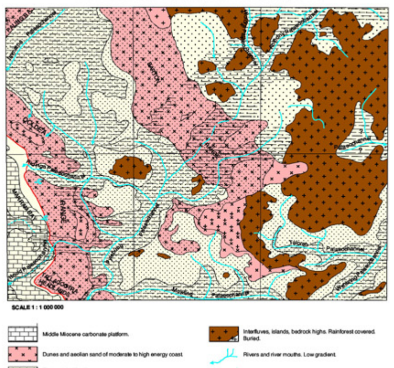
PRE CAMBRIAN - EARLY PALAEOZOIC TECTONIC SKETCH



SCALE 1 : 1 000 000

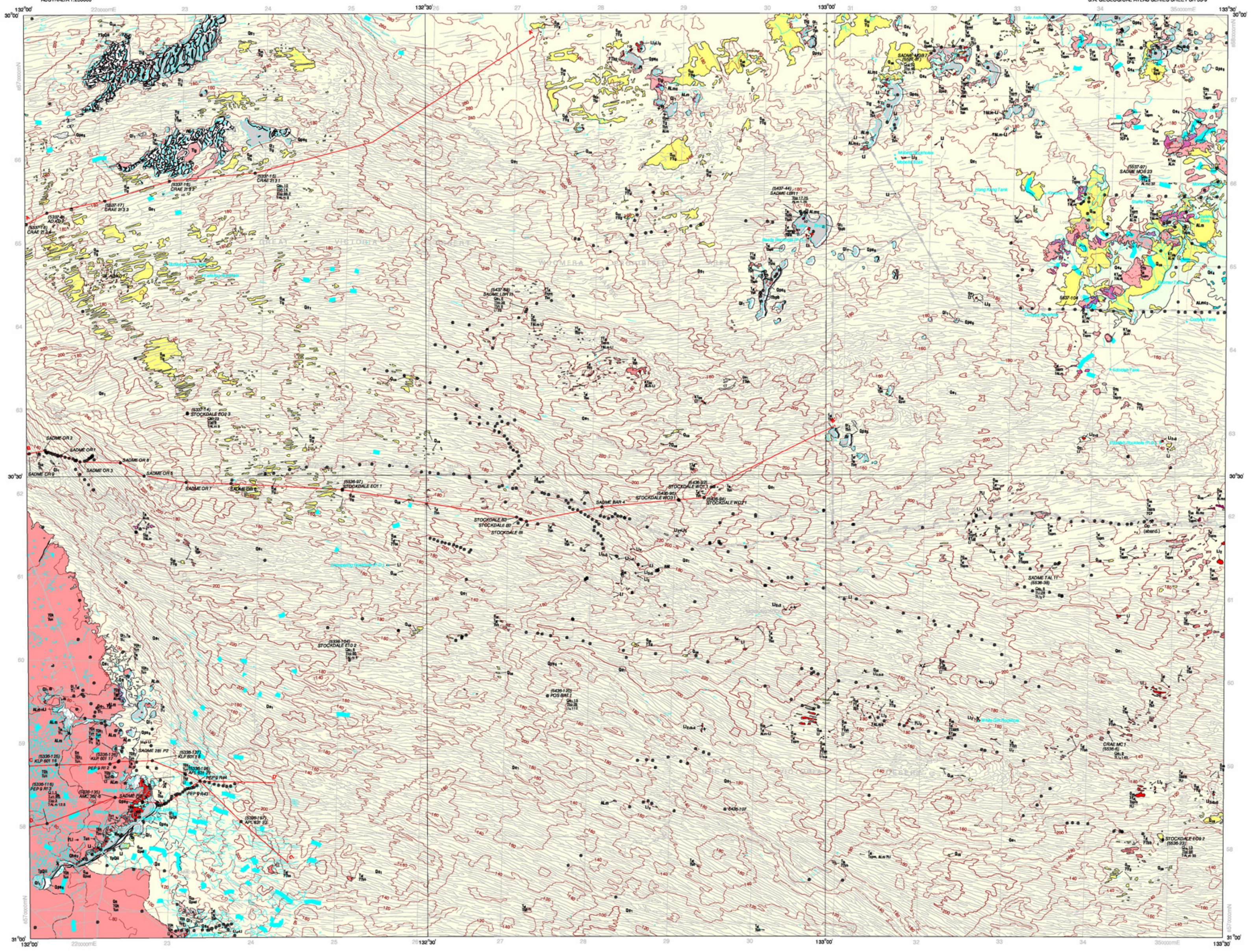
- Officer Basin sediments. Basement unknown.
- Gairdner Dyke Swarm dolerite dykes.
- Hiltaba Suite granitoids.
- Circular granitic and basic plugs.
- Late syntectonic granitoids and basics.
- Pre- to early syntectonic orthogneisses and paragneisses.
- Mulgathing Complex undifferentiated gneisses.
- Magnetic banded iron formation and paragneiss.
- Fault or shear zone boundary.
- Proterozoic mylonitic zone (may include reworked Archaean rocks).
- Geological boundary.
- Structural and lithological trend lines.

MIDDLE-LATE EOCENE GEOLOGY AND PALAEOGEOGRAPHY



SCALE 1 : 1 000 000

- Middle Miocene carbonate platform.
- Dunes and aeolian sand of moderate to high energy coast.
- Estuary inhabited by sponges.
- Estuary inhabited by sponges, carbonaceous.
- Shallow sea, coastal, estuary, interdistributary bay of which marine carbonate platform.
- Floodplain, river, lake, swamp.
- Interfluves, islands, bedrock highs. Rainforest covered. Buried.
- Rivers and river mouths. Low gradient.
- Eocene drainage buried by Miocene platform carbonates.
- Moderate to high energy coastline at the end of the formation of the Ooldea Range (youngest recognisable Eocene shoreline).
- Prevailing westerly wind direction; moderate intensity atmospheric circulation.



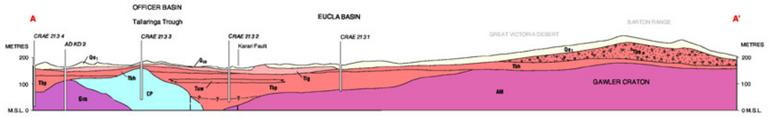
SCALE 1 : 250 000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

Grey numbered lines indicate the 10000 metre Map Grid

Transverse Mercator Projection, Australian Geodetic Datum, 1984.

SECTION A-A'



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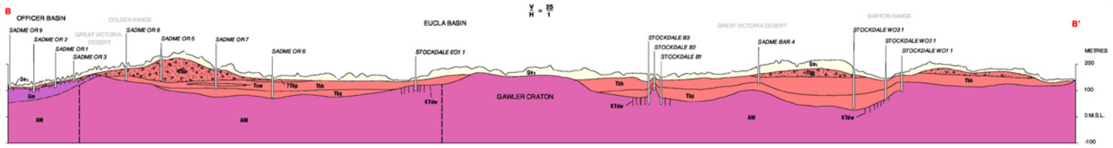
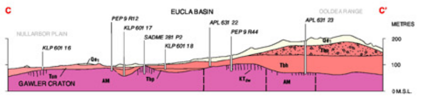


SECTION C-C'



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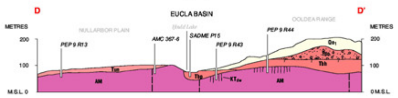
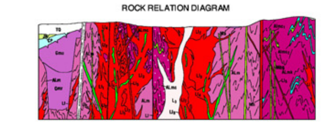


ROCK RELATION DIAGRAM



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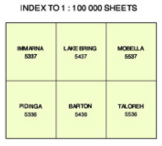

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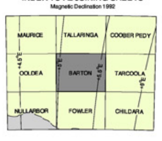
Magnetic Declination 1992



REFERENCE

EUCLA BASIN AND PALAEODRAINAGE

NULLARBOR PLAIN (Bunda Plateau) | PALAEOSOLS | GREAT VICTORIA DESERT

CAINOZOIC — QUATERNARY — HOLOCENE — PLEISTOCENE — TERTIARY

DELISSER FORMATION

LAKINA FORMATION

GARFORD FORMATION

NULLARBOR LIMESTONE

YARLE SANDSTONE

WILSON BLUFF LIMESTONE

OOLDEA SAND

HAMPTON SANDSTONE

PIDINGA FORMATION

MESOZOIC — T'EIGHT BASIN

MULGATHING TROUGH AND ARCKARINGA BASIN

PALAEOZOIC — OFFICER BASIN

OULDBURRA FORMATION

RELIEF SANDSTONE

GAWLER CRATON

GAIRDNER DYKE SWARM

HILTABA SUITE

GAWLER RANGE VOLCANICS

PROTEROZOIC

ARCHAEAN

Undifferentiated MULGATHING COMPLEX

KENELLA GNEISS

CHRISTIE GNEISS

GEOLOGICAL BOUNDARY — OBSERVED — INFERRED — UNCONFORMITY

FAULT — OBSERVED — INFERRED

FOLIATION — VERTICAL — INCLINED

INCLINED LINEATION

FOSSIL LOCALITY — SPONGE — WOOD — STROMATOLITE — PALYNOMORPH

EXPLORATION DRILLHOLE WITH MESA REFERENCE NUMBER

STRATA SEQUENCE (THICKNESS IN METRES)

GEOLOGICAL SECTION

TREND

RAILWAY

SECONDARY ROAD

TRACK

FENCE

YARD

TRIANGULATION STATION (ELEVATION IN METRES)

IDENTIFIED POINT (ELEVATION IN METRES)

TOPOGRAPHIC CONTOUR (INTERVAL 20 METRES)

MINE

OPAL

EPHEMERAL STREAM

CLAYPAN, SALTPAN

SWAMP

WELL

BORE

TANK

ROCKHOLE

Bibliographic Reference: Benbow M.C. et. al. 1994. BARTON map sheet. South Australia. Geological Survey. Geological Atlas 1:250000 Series, sheet SH53-9.

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

Published 1994.

Geological mapping and compilation by M.C. Benbow, B.Sc., A.F. Crooks, B.Sc., L.R. Rankin, B.Sc. (Hons), A.R. Martin, B.Sc. (Hons) and M.C. Fairclough, B.Sc. (Hons).

A.P. Belperio, Ph.D., Chief Geologist, Regional Geology Branch.

Cartography by Drafting Services Branch, Department of Mines and Energy. Generated from SA_GEOLOGY data base. Digital data available from the Department of Mines and Energy.

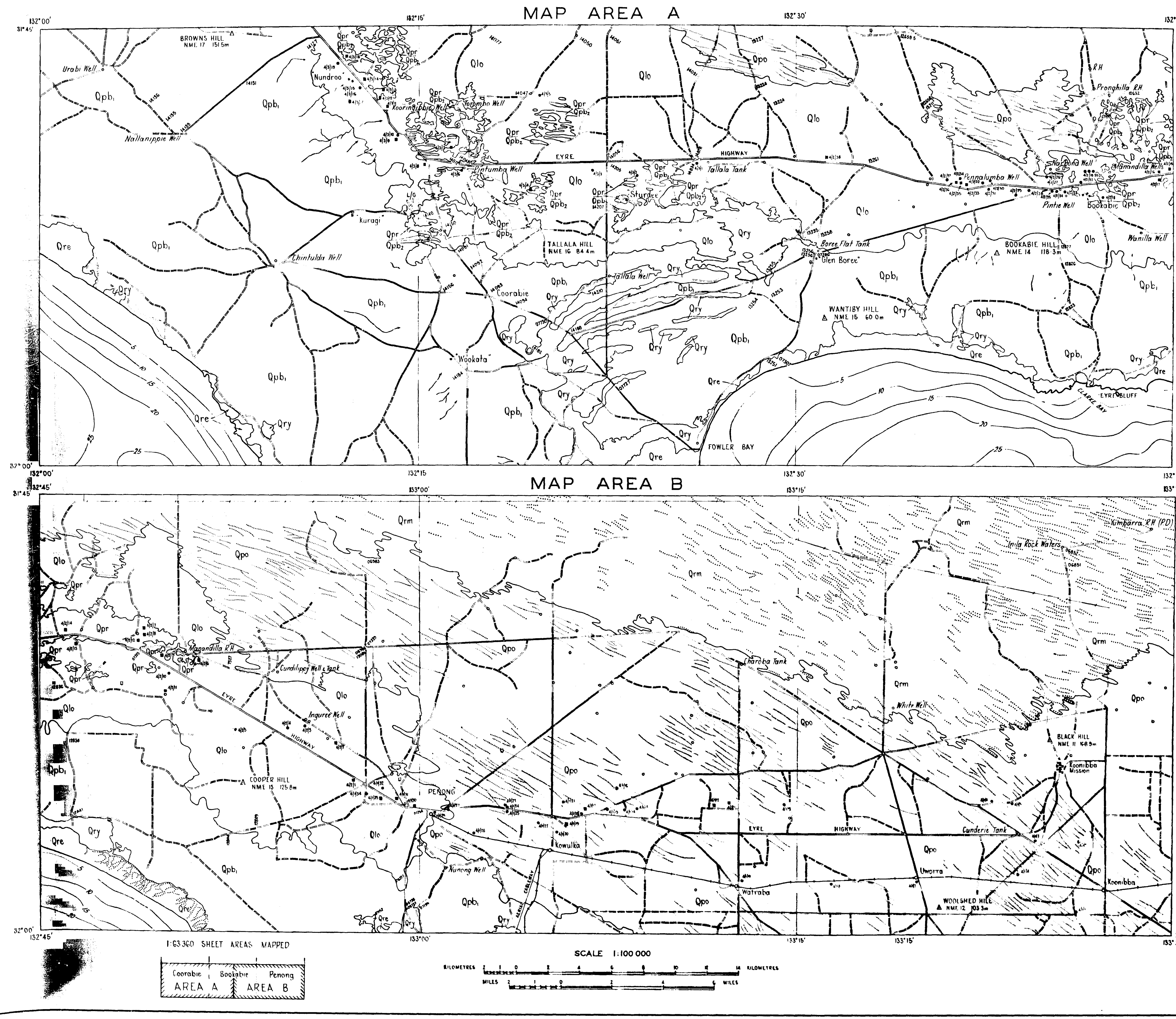
I.C. Dixon, Acting Chief Executive Officer, Department of Mines and Energy.

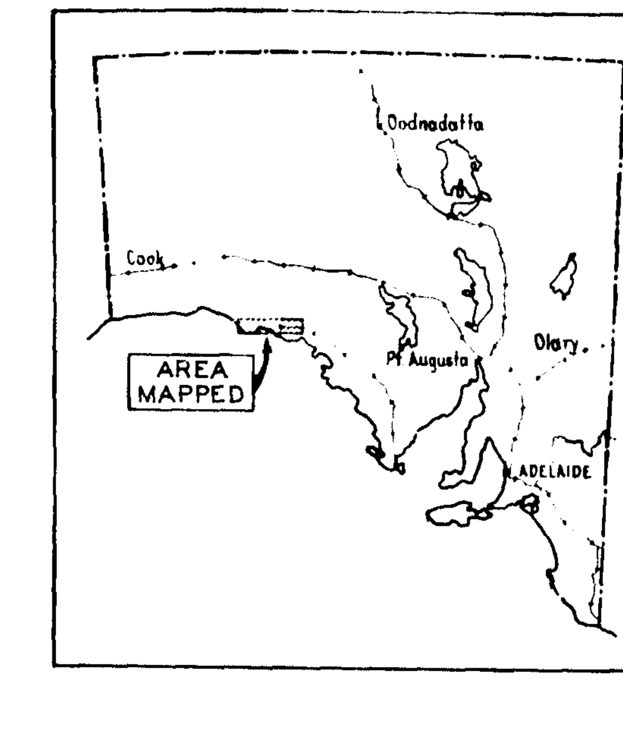
The Honourable D.S. Baker, M.P., Minister for Mines and Energy.

MINES AND ENERGY SOUTH AUSTRALIA

BARTON
SHEET SH 53-9

J200798_2255





LEGEND

CAINOZOIC

RECENT

- **Qre** — SEMAPHORE SAND: Off white and pale brown quartz and shell sands of modern beach and coastal dunes.
- **Qrm** — MOLINEAUX SAND: Off-white and pale yellowish-brown quartz sands of the inland dune fields, overlying darker yellow and orange coloured sand with carbonate pipes in some places.
- **Qry** — YAMBA FORMATION: Dark grey silt, yellowish brown gypsum sand, off-white gypsum silt (flour gypsum).
- **Qlo / Qpo** — LOVEDAY SOIL: Characteristic off white carbonate patches and nodules of the calcareous sands in undulating terrain (Qlo), and in pale brown aeolian calcareous silty sand of the WOORINEN FORMATION EQUIVALENT (Qpo)

PLEISTOCENE

- **Qpb_1** — BRIDGEWATER FORMATION: Upper Member; Pale brown cross bedded calcarenite (aeolianite). Exposed in coastal cliffs, overlain by pale brown sand reworked from aeolianite inland. Small outcrops of Lower Member, BRIDGEWATER FORMATION not differentiated.
- **Qpr** — RIPON CALCRETE: Hard pale brown and pink massive and nodular calcrete with angular grey inclusions
- **Qpb_2** — BRIDGEWATER FORMATION: Lower Member; Yellow-brown calcarenite (aeolianite). Exposed in coastal cliffs where it is characterised by vertical solution pipes and honeycomb weathering. Capped by RIPON CALCRETE or overlain by brown soil and WOORINEN FORMATION EQUIVALENT inland

Geological boundary

Highway

Secondary road

Minor road or track

Railway

Dog Fence

Homestead

Trigonometrical Station

Bore, as shown in Rpt Bk 59/75 Eyre Highway Terrain Survey
Bore reference reads as Plan 4 / Strip 2 / Number 36

Well, as shown in Rpt Bk 59/75 Eyre Highway Terrain Survey
Well reference reads as Plan 4 / Strip 1 / Number 12

Sample location reference

Bore, Well or Tank

Fathom line

DEPARTMENT OF MINES — SOUTH AUSTRALIA

GEOLOGICAL MAP
PORTION OF FOWLER 1:250 000 SHEET
Coorabie, Bookabie and Penong 1:63 360 sheets

REGIONAL SURVEYS DIVISION	GEOLOGIST	Drn. J B F	SCALE: 1:100 000 (original)
		Tcd. R H	73-120 AB+D
		Ckd.	
Director of Mines	SUP. GEOLOGIST	Exd.	DATE: January 1973

APPENDICES

1. Petrography

2. Analysis for Uranium and Thorium.

3. Note: Uranium and its Daughter Products.

4. Log of Lignite Test Bore (1948) and Analyses.

5. Lignite Intersections made during Drilling for Australasian Mining Corporation Ltd. on S.M.L.'s 316, 365 and 367.

6. Analyses of Bore and Chip Samples from Drilling on Australasian Mining Corporation Ltd. S.M.L.'s 316, 365 and 367.

7. Traverse Notes.

8. Logs of Bores and Wells adjacent to the Eyre Highway.

APPENDIX 1

PETROGRAPHY

Report MP1262-69: Petrography of Nineteen Rocks from the BARTON and FOWLER Map Sheets. A. Kelly.

Report MP4169-69: Petrology of Five Rocks from the FOWLER 1:250 000 sheet. P. Simpson.

Report MP60-71: Six Rocks from the FOWLER 4-Mile. P.J. Simpson.

Preliminary Report: Rocks from the FOWLER and BARTON 1:250 000 sheets. Extract from Progress Report No. 12 of 1/1/122 (In Prep.). A.W. Webb and G.G. Louder.

Petrography of Nineteen Rocks from the
BARTON and FOWLER map sheets

AMDEL REPORT NP1262-69

YOUR REFERENCE:	Application dated 2/10/68; Attention: Miss N.C. Walker
MATERIAL:	Rock Specimens (19)
LOCALITY:	Barton and Fowler 1:250,000 sheets
IDENTIFICATION:	P557 to P575/68
DATE RECEIVED:	3/10/68
WORKED REQUIRED:	Petrographic examination; comparison with previous samples; comments on suitability for age dating.

Investigation and Report by: A. Kelly

PETROGRAPHY OF NINETEEN ROCKS FROM THE BARTON AND FOWLER MAP SHEETS

SUMMARY

(Note: The letters U, S and X refer to age dating - see next section.)

Sample No.			Rock Type
1:	P557/68	(U)	Metamorphosed, porphyritic granodiorite.
2:	P558/68	(U)	Strongly sheared, microcline, oligoclase quartz gneiss.
3:	P559/68	(U)	Sheared meta-granodiorite.
4:	P560/68	(U)	Sheared meta-granodiorite.
5:	P561/68	(U)	Very coarse, sheared granite gneiss.
6:	P562/68	(S)	Quartz diorite.
7:	P563/68	(X)	Quartz-microcline-oligoclase-biotite gneiss (meta-sediment ?).
8:	P564/68	(U)	Sheared quartz-microline-oligoclase gneiss.
9:	P565/68	(U)	Strongly sheared, coarse, granite gneiss.
10:	P566/68	(U)	Cataclasised granite gneiss.
11:	P567/68	(U)	Coarse, quartz-oligoclase-biotite gneiss (sheared granodiorite).
12:	P568/68	(S)	Coarse, porphyritic granite.
13:	P569/68	(S)	Coarse biotite-muscovite granite.
14:	P570/68	(X)	Aplite (probably metamorphosed).
15:	P571/68	(S)	Granite.

Sample No.	Rock Type
16: P572/68	(X) Metamorphosed porphyritic aplite xenolith.
17: P573/68	(S) Contaminated biotite adamellite with hornblendic xenoliths.
18: P574/68	(X) Porphyritic micro-grandiorite (?xenolith).
19: P575/68	(S) Contaminated biotite-hornblende adamellite with xenoliths as for 17.

SUITABILITY OF ROCKS FOR AGE DETERMINATION

Two main series of rocks are distinguished according to the degree of metamorphism they have experienced.

The first series is a group of dynamically metamorphosed gneisses of "granitic" affinities which are characterized by moderate or severe cataclasis accompanied by varying degrees of granoblastic recrystallization.

In the case of the "granitic" rocks, the biotite is almost entirely recrystallised. In most examples some feldspar porphyroclasts remain, together with recrystallised, granulated material.

One might expect the metamorphic episode to have reset the geochronometer, the extent of the redistribution of the key trace-elements depending on various factors which would require specialist assessment. Ages ranging from younger than the primary crystallisation to that of the metamorphic episode can be expected.

The second series of rocks is an undeformed and metamorphosed group of granitic rocks in which the minerals are, to all appearances, suitable for age dating by the general methods in use for such rocks.

Other rocks deserving separate consideration are a metasediment and two hornfelsed aplites.

CONCLUSIONS

Rocks regarded as most suitable for age determination are marked "S" on the Summary above.

Those regarded as unsuitable because of post-crystallisation metamorphism and which would, at best, yeild a younger age than their primary crystallisation time are indicated as "U".

Those rocks requiring special consideration are marked "X".

(The effects of contamination, evidenced by the abundance of xenoliths as in Nos. 17 and 19, are not known by the writer.)

COMPARISONS WITH EARLIER SAMPLES

1. P487, 89, 92, and 93/68 (Amdel Report MP906-69)

The first pair of these four rocks are of high metamorphic grade, containing such minerals as cordierite, garnet and sillimanite which are absent in the present series. It was suggested in that report that these rocks belong to the Archaean basement complex.

The latter pair are sheared microcline granites and do not contain the high metamorphic grade mineral assemblage of the former pair.

This pair is similar to sheared granitic rocks of the current series.

2. P79/68 - P97/68 (Amdel Report MP2768-66)

This rock series includes adamellite, amphibolites, aplites, granodiorite, granite and a single high-grade metamorphic "granitic" gneiss.

Hornblende is a common constituent of this group whereas the mineral is found only in minor amounts in the current series apparently as a product of assimilation of xenoliths in adamellites.

Comparison of the two suites indicates similarities between the granitic and sheared granitic types in each case; the series P79/68 - P97/68 is distinguished by an abundance of amphibolite rocks which are absent in the current series.

While individual similarities could be detailed, the writer feels that the comparisons are best made by the field geologist who can combine the petrographic information provided here with field data and direct comparison of hand specimens.

The more recent acid intrusives may be closely related in the two suites but the relations of the sheared rocks cannot be reliably assessed without field data.

Another, perhaps pertinent, suggestion is that the appearance of hornblende contamination in the adamellites of the current series (P573, P574, P575/68) may indicate a proximity to the amphibolitic suite in the Tarcoola area.

PETROGRAPHY

Sample: 1:P557/68: TS21803

Location:

BARTON. Near Pidinga shed tanks.

Rock Name:

Metamorphosed, porphyritic granodiorite.

Hand Specimen:

A medium-grained, melanocratic, grey and white crystalline rock of approximately 1 mm apparent grain-size with scarce, coarse, pinkish phenocrysts commonly 5 cm across. The phenocrysts are somewhat lenticular and indistinctly defined. The rock has a coarser and lighter coloured "granitic" marginal phase about 2 cm wide, which is evidently gradational into the body of the darker rock.

Thin Section:

A visual estimate of the constituents gives the following:

	%
Quartz	50
Oligoclase	40
Biotite	10
Clinozoisite and epidote	2
Microcline	1
Opaques	Trace
Sphene	Trace
Apatite	Trace
Sericite	Trace
Calcite	Trace

The rock texture is relict-porphyritic and "granitic" (hypidiomorphic-granular) modified by a later episode of recrystallization under dynamic metamorphic conditions. Relict phenocrysts are composed mainly of oligoclase and lesser quartz, reduced to subequant grains locked by marginal granulation and recrystallisation with the matrix minerals. The grain-size of the matrix was ca. 1 mm, but granulation and recrystallisation have produced an inequigranular, foliated intergrowth of less deformed plagioclase grains of ca. 1 mm size in a matrix of finer minerals of 0.1 - 0.5 mm grain-size. Rare relict biotite grains persist as much altered ?chloritic material. However, practically all the biotite is granoblastic and fairly uniformly distributed. Clinozoisite is of similar occurrence to biotite, and microcline occurs as rare, interstitial grains.

Comments:
The rock is of igneous origin but has subsequently experienced dynamic metamorphism which has resulted in extensive recrystallisation.

Sample: 2: P558/68: TS21804

Location:
BARTON. Near Pidinga shed tanks.

Rock Name:
Strongly sheared, microcline, oligoclase, quartz gneiss.

Hand Specimen:
A coarse-grained, pink, strongly foliated rock of "pegmatitic" appearance. Irregular, dark, biotitic, sinuous laminae are of minor occurrence only. The remainder of the rock consists mainly of white and pink feldspar grains up to 1 cm across which appear to be granulated by shearing, forming a flaser-structure.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Microcline	40
Sodic oligoclase	40
Quartz	15
Biotite	5
Sericite	Trace

The rock texture is cataclastic; feldspar augen, generally with microcline "eyes" up to 1 cm across occur together with granulated and recrystallised, finer material down to 50 microns in grain-size but generally tending to range up to coarser sized material.

Quartz occurs as the finer material only.
The plagioclase occurs mainly as the finer, recrystallised material, but a small proportion exists as coarse porphyroclasts, as in the case of microcline, and a small proportion also myrmekitically intergrown with quartz, commonly embaying coarser microcline grains.
Biotite is granoblastic and occurs as trains of subhedral grains commonly 0.5 mm long, occasionally associated with fine-grained sericite.

History:
The rock has the features of a dynamically metamorphosed pegmatite.

Sample: 3: P559/68: TS21865

Location:
BARTON: Near Pidinga shed tanks.

Rock Name:
Sheared, meta-granodiorite.

Hand Specimen:
A pink and grey coarse gneiss of medium to coarse grain-size bearing equant, subhedral feldspar grains commonly 2-4 mm across in a slightly finer-grained matrix. Unevenly distributed pinkish foliae accentuate the gneissic structure of the rock.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Oligoclase	50
Quartz	35
Biotite	10
Clinozoisite	3
Microcline	2
Muscovite	1
Opaque, Sphene, Apatite, Sericite, Zircon	Trace

The rock texture is cataclastic modifying a former "granitic"

texture. The relict plagioclase of the former rock, granodiorite, has resisted granulation to a much greater extent than the quartz and dark minerals and the grains of the mineral are sub-rounded or subhedral but otherwise retain their former grain-size of 2-4 mm. Antiperthitic texture is common in the plagioclase.
The matrix, as in No.1 above, is a finer, granulated and recrystallised allotriomorphic-granular intergrowth of the minerals listed above. Rare areas of secondary myrmekite also occur.

History:
The rock has an altered granodioritic compositon. Relict textures indicate a derivation from such a rock-type through dynamic metamorphism.

Sample: 4: P560/68: TS 21806

Location:
BARTON: near Pidinga shed tanks.

Rock Name:
Sheared meta-granodiorite

Hand Specimen:
A coarse-grained, slightly foliated, grey and white rock of "granitic" appearance.
Apparent grain-size is 2-3 mm for the abundant feldspars and finer for the darker minerals.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Oligoclase	50
Quartz	30
Biotite	20
Microcline	1
Sphene	1
Clinozoisite	1
Zircon)	
Apatite)	Trace
Opaques)	

Grain sizes and textures are essentially similar to those in Nos.1 and 3 above, with minor differences being the rarity or absence of antiperthite and myrmekite respectively in this rock.
As in the other rocks cited, biotite is granoblastic.
Sphene is a particularly abundant accessory in this rock.

History:
The mineralogical and textural features indicate a sheared granodioritic origin.

Sample: 5: P561/68: TS21867

Location:

BARTON: Pidinga rock hole.

Rock Name:
Very coarse, sheared granite gneiss

Hand Specimen:
The rock is a very coarse-grained gneiss, predominantly pink with thin, contorted, black, micaceous foliae wrapped around pink feldspar porphyroclasts commonly 1-2 cm across.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Microcline	60
Quartz	15
Oligoclase	10
Biotite	5
Clinozoisite	5
Muscovite	3
Sphene	1
Epidote) Apatite) Zircon) Opaque)	Trace

The rock texture is cataclastic modified by extensive recrystallisation.
As noted above, porphyroclasts of microcline, and rarely oligoclase, form roughly 40% of the rock. The remaining light coloured minerals form an intimately mixed allotriomorphic

aggregate which includes rare occurrences of myrmekite. Grain-size of this mixed material ranges upwards from 0.05 mm. The darker minerals are granoblastic and occur as narrow stringers. Epidote commonly reaches 1 mm in grain size and ranges up to 4 mm long in certain subhedral grains. Certain grains of the mineral show post-formational fracturing. Sphene occurs as brown, prismatic crystals 1 mm long enclosed by epidote.

History:
This rock has experienced considerable dynamic metamorphism (shearing and recrystallisation) and has the composition and general relict features of a coarse granite.

Sample: 6: P562/68: TS 21808

Location:
BARTON: Lake Pidinga.

Rock Name:
Quartz diorite.

Hand Specimen:
A medium-grained, melanocratic, grey and white igneous rock of dioritic appearance and 1-2 mm grain-size. A poorly defined foliation is apparent.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Plagioclase (oligoclase)	80
Biotite	15
Quartz	5
Muscovite	1
Opaque)	
Apatite)	Trace
Sericite)	

The rock texture is hypidiomorphic-granular modified very slightly by intergranular shearing movement which has caused minor marginal granulation and recrystallisation. Grain-size of the feldspar is ca. 1-2 mm. Unlike the previous examples 1-5,

the primary minerals are well preserved; the plagioclase shows traces of relict zoning and incipient sericitisation and has an oligoclase composition.
Biotite occurs as mosaic grains of ca. 1mm size and is evidently primary but has suffered slight granulation. Muscovite occurs partly in association with biotite.

History:
This rock is a quartz diorite and the degree of alteration is only slight.

Sample: 7: P563/68: TS21809

Location:
FOWLER: West edge of L. Tallacootra.

Rock Name:
Fine-grained, quartz-microcline-oligoclase-biotite gneiss. (meta-sediment ?).

Hand Specimen:
A pale grey and whitish-pink, medium to fine-grained, finely foliated gneiss. Occasional pinkish lenses 3-4 mm thick and several centimetres long occur parallel to the foliation direction.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Quartz	30
Microcline	30
Oligoclase	30
Biotite	10
Muscovite	2
Epidote)	
Sphene)	
Apatite)	Trace
Goethite)	
Calcite)	
?Allanite)	

The rock texture is granoblastic; minerals form a fairly equigranular mosaic of 0.1 - 0.2 mm grain-size with occasional lenticular areas in which microcline and quartz predominate. These latter areas are evidently a localised

lateral secretion of minerals from the body of the rock.
Traces of myrmekite also occur.
Biotite flakes are aligned, marking a rough foliation.

History:
Textural and mineralogical indications are that the rock is a metamorphosed, possibly granitised, sediment.

Sample: 8: P564/68: TS21810

Location:
FOWLER: west edge of Lake Tallacootra.

Rock Name:
Sheared-quartz-microcline-oligoclase gneiss.

Hand Specimen:
A strongly foliated pink gneiss of medium to coarse grain-size and containing very little dark mineral material.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Quartz	50
Microcline	40
Oligoclase	10
Biotite	2
Muscovite	Trace

The testure is cataclastic modified by recrystallisation. Porphyroclasts, mainly of microcline with a minor proportion of oligoclase, are commonly 1 mm across but occasionally up to 1 cm or more in length. These form only a few per cent of the specimen for the bulk of the rock is finely granulated and recrystallised material mainly 0.1 mm in grain-size. The micas are strongly aligned and occur as granoblastic flakes approximately 0.5 mm across.

History:
The rock is a gneiss of granitic affinities which has experienced dynamic metamorphism resulting in extensive granulation and recrystallisation.

Sample: 9: P565/68: TS21811

Location:
FOWLER: West edge of Lake Tallacootra.

Rock Name:
Strongly sheared, coarse granite gneiss.

Hand Specimen:
A cataclastic gneiss consisting of coarse pink feldspar porphyroclasts up to 1 cm across in a dark grey, granulated matrix.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Microcline	45
Quartz	40
Biotite	10
Oligoclase	5
Apatite, Epidote, Muscovite	Trace

The rock has a cataclastic texture similar to that of the previous rock.
Biotite is granoblastic and occurs as trains of subhedral flakes generally 0.5 mm across. Traces of myrmekite also occur.

History:
The rock is a cataclasised gneiss of coarse granite affinities.

Sample: 10: P566/68: TS21812

Location:
FOWLER: West edge of Lake Tallacootra.

Rock Name:
Cataclasised granite gneiss.

Hand Specimen:
A coarse "granitic" gneiss with augen of pink and white feldspar grains up to 1 cm long set in a pink and grey, granulated matrix.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Microcline	50
Quartz	20
Oligoclase	15
Biotite	5
Muscovite)	
Opaque)	Trace

The rock texture is essentially similar to that of Nos.8 and 9 above, but differs in the presence of coarse porphyroclasts of plagioclase which do not occur in those rocks.

History:
As for Nos. 8 and 9.

Sample: 11: P567/68: TS21813

Location:
FOWLER: East edge of Lake Tallacootra.

Rock Name:
Coarse quartz-oligoclase-biotite gneiss (sheared granodiorite).

Hand Specimen:
A coarse-grained, light-coloured black and white rock of foliated structure. The specimen is inhomogeneous, grading from medium grey to whitish laminae depending on the biotite content.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Quartz	55
Oligoclase	40
Biotite	5
Hematite)	
Zircon)	Trace
%Allanite)	

The rock texture is cataclastic but crushing effects are less apparent owing to the development of a coarse-grained

recrystallised (granoblastic) texture in the granulated material.
Plagioclase is the most resistant major mineral and remains as sub-rounded clasts commonly 2-3mm in diameter.
Quartz occurs as flattened and strained grains in coarse lenses while biotite forms finer grains 0.1 - 0.5 mm.
No potash feldspar was noted.

History:
The rock has the features of a dynamically metamorphosed granodiorite. The biotite is recrystallised. The inhomogeneity is evidently the result of metamorphic segregation, although a migmatitic origin cannot be dismissed on the available evidence.

Sample: 12: P568/68: TS21814

Location:
FOWLER, Mitcherie Rockhole.

Rock Name:
Coarse, porphyritic granite.

Hand Specimen:
A leucocratic, porphyritic, pinkish granite containing very coarse, pink feldspar phenocrysts approximately 4 cm long in a corase grained matrix of 5-10 mm grain-size.

Thin Section:
A visual estimate of the constitueuts gives the following:

	%
Orthoclase (microperthite)	50
Quartz	25
Oligoclase	15
Biotite	8
Sphene	1
Opaque)	
Zircon)	
Chlorite)	Trace
Sericite)	
?Apatite)	

The rock texture is allotriomorphic-granular and typically granitic.

Biotite is virtually unaltered and commonly poikilitically encloses fine grains of the accessory minerals listed under "trace" amounts above. These grains average 0.1 mm in grain-size.
Sphene occurs as rare, coarse anhedral grains 1-2 mm long generally surrounded by radial cracks in the adjacent minerals.
The plagioclase is an oligoclase which shows traces of zoning and incipient sericitisation.

History:
This rock is a granite which has suffered little or no alteration since its primary crystallisation.

Sample: 13: P569/68: TS21815

Location:
Evira rock hole.

Rock Name:
Coarse biotite-muscovite granite.

Hand Specimen:
A uniform, coarse-grained, pink and grey granite of 5-15mm apparent grain size. Traces of coarse muscovite are apparent in addition to the more normal biotite.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Orthoclase (micro-perthite)	50
Quartz	45
Oligoclase	10
Biotite	4
Muscovite	1
Chlorite) Opaque) Sericite)	Trace

The rock texture is typically granitic (allotriomorphic-granular).
Orthoclase has a braided perthite structure and may also include discrete, fine grains which commonly have sericitised

cores and clear overgrowths; these grains being plagioclase. Plagioclase has a zoned, predominantly sodic oligoclase composition and incipient sericitisation of cores is a common feature; generally the plagioclase has a finer grain-size (2 mm) than the orthoclase (5-15 mm).
Traces of late-stage albitic plagioclase and quartz also occur intergranularly.
Biotite is associated with minor muscovite, and is partly altered to chlorite. As in No.12 above, the mineral includes tiny grains of accessory minerals.

History:
Apart from traces of deuteric alteration this rock is virtually an unmetamorphosed granite.

Sample: 14: P570/68: TS21816

Location:
Euria Water Hole.

Rock Name:
Aplite (probably metamorphosed).

Hand Specimen:
A slightly porphyritic, fine to medium grained, pinkish acid igneous rock. Quartz, pink feldspar and traces of muscovite are apparent.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Orthoclase	50
Oligoclase	35
Quartz	10
Muscovite	5
Opaques)	
Sericite)	Trace
Biotite)	

The rock texture is allotriomorphic-granular and grain-size is generally ca. 0.5 to 1 mm.
Rare phenocrysts of quartz of 4 mm diameter are extensively fractured and marginally intergrown with matrix minerals.

The orthoclase is partly perthitic and rare graphic intergrowths with quartz occur (?replacement).
Plagioclase generally shows traces of minute myrmekitic quartz intergrowths. Muscovite is generally highly irregular in outline but unstrained; occasional radial growths occur.
Relict outlines of a former opaque mineral are represented by skeletal ?magnetite and clay.
The orthoclase is dusted by sub-micron ?hematite and is incipiently sericitised.

Conclusions:
Replacement features such as graphic and myrmekitic intergrowths, plus the fractured nature of the quartz phenocrysts and the presence of altered (relict) opaques, indicate a period of non-dynamic (contact) metamorphism of an aplitic rock type.

Sample: 15: P571/68: TS21817

Location:
Yangoonaby Rock Hole.

Rock Name:
Granite.

Hand Specimen:
A coarse-grained pink and grey granite of 5-10mm average grain-size. Rare, very coarse phenocrystic pink feldspar crystals ca. 4 cm long occur.
The rock is very similar in appearance to No.13, above.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Orthoclase (microperthite)	50
Quartz	35
Oligoclase	10
Biotite plus chlorite	4
Muscovite	1
Opaque)	
Zircon)	Trace
Sericite)	

This rock is virtually identical mineralogically and texturally to No.13 previously described.

The only difference is in grain-size, for this particular rock is slightly finer-grained and contains rare coarse orthoclase phenocrysts.
The biotite is more extensively altered to chlorite in this rock to the extent of about half of that mineral. This is probably due to weathering rather than deuteric alteration.

History:
The rock is a virtually fresh granite and is apparently a slightly finer-grained equivalent of No.13.

Sample: 16: P572/68: TS21818

Rock Name:
Metamorphosed porphyritic aplite (zenolith).

Hand Specimen:
A slightly porphyritic pinkish rock of general aplitic appearance. Feldspar phenocrysts up to 2 cm long, and finer grained, glassy quartz phenocrysts about 5 mm across occur, each forming an estimated 2-3% of the rock.
The feldspars are partly altered to a creamish material.

Thin Section:
A visual estimate of the constituents gives the following:

	%
Orthoclase	60
Quartz	25
Oligoclase	10
Altered biotite	3
Muscovite	1
Opaque	Trace

This rock has a remarkable texture - a graphic replacement of orthoclase by quartz. Similar replacement of oligoclase occurs to a lesser extent.
The relict grain-size of the rock matrix is generally 0.5-1mm; the replacement quartz forms rods of 10 microns diameter.
Biotite is largely altered to chlorite and muscovite occurs as ragged, disseminated grains throughout the rock.
The quartz phenocrysts are extensively cracked and marginally intergrown with the matrix. The creamish feldspar phenocrysts

are heavily sericitised plagioclase. (The coarsest pink feldspathic areas are evidently portions of the contiguous granite.)

History:
This rock is evidently similar and related to No.14 described above. The advanced graphic replacement is explained by the more severe thermal metamorphism of this rock which occurs as a xenolith. The similarity with No.14 supports the deduction that that rock (No.14) is in fact metamorphosed and earlier than the granite (No.13).

Sample: 17: P573/68: TS21819

Location:
Rock Hole 1 mile S of Inila Rock Hole.

Rock Name:
Contaminated biotite adamellite with hornblende xenoliths.

Hand Specimen:
A coarse, leucocratic, pale pinkish-grey granitic rock with occasional diffuse, melanocratic xenolithic areas. One side of the specimen has very coarse, pink feldspar phenocrysts up to 5 cm long. The apparent grain-size of the remainder of the rock is 2-5 mm.

Thin Section:
A visual estimate of the constituents gives the following:

Adamellite:	%
Microcline	40
Oligoclase	35
Quartz	10
Biotite	15
Hornblende	2
Sphene	1
Epidote)	
Zoisite)	
Opaque)	Trace
Chlorite)	
Zircon)	
Sericite)	

Xenolith: (most basic portion)	%
Oligoclase	60
Hornblende	30
Biotite	5
Quartz	2
Sphene	2
Epidote)	
Zoisite)	
Sericite)	Trace
Opaque)	

The rock texture is typically granitic (hypidiomorphic-granular).
The ferromagnesian minerals, biotite and hornblende have similar colours (dark kahki tones) and form grains roughly 1 mm across.
Biotite is undeveloped and shows traces of chloritic alteration along certain cleavage laminae.
Hornblende forms similar, subhedral grains which commonly poikilitically enclose quartz, indicating a secondary origin. Occasional grains of hornblende are also replaced by sphene, which mineral commonly forms coarse euhedral grains 1 mm long. The plagioclase is a zoned oligoclase which shows some sericitisation and saussuritisation of the cores.
Traces of myrmekite are developed.

History:
The bulk of the rock has a granite composition whereas the xenoliths are more dioritic in composition.
The development of hornblende and sphene appears to be due to assimilation of basic materials.

Sample: 18: P574/68: TS21820

Location:
Rock Hole 1 mile S of Inila Rock Hole.

Rock Name:
Porphyritic micro-granodiorite (?xenolith).

Hand Specimen:
A fine to medium grained, black and white, crystalline, porphyritic rock of less than 0.5 mm grain-size.

Thin Section:

A visual estimate of the constituents gives the following:

	%
Oligoclase	50
Biotite	20
Quartz	20
Hornblende	5
Sphene	1
Opaque	1
Epidote	1
Microcline	1
Sericite	1
Chlorite	1

Grain-size is generally 0.3-0.4mm; phenocrysts form about 5% of the rock, have a grain-size of 2mm and are of plagioclase. The rock texture is hypidiomorphic-granular, the plagioclase, a strongly zoned oligoclase, having a well developed prismatic, subhedral form. As in No.17, above, the hornblende and sphene have features which indicate a granoblastic origin rather than derivation by primary crystallisation.

The plagioclase has incipiently sericitised cores.

History:

The rock is very similar to the xenolithic material described in No.17 above.

Without field evidence this cannot be verified microscopically. Otherwise the rock has the composition of a hornblende granodiorite.

Sample: 19: P575/68: TS21821

Rock Name:

Adamellite (with coarse feldspar phenocrysts and zenoliths).

Hand Specimen:

This rock is essentially similar to No.17 above.

Thin Section:

As for the adamellite described in No.17.

Petrology of Five Rocks from the
FOWLER 1:250,000 sheet

27th June, 1969.

AMDEL REPORT MP 4169/69

YOUR REFERENCE:	Application dated 21/5/69.
MATERIAL:	5 rock samples.
LOCALITY:	Fowler 1:250,000 sheet.
IDENTIFICATION:	As listed.
DATE RECEIVED:	22/5/69.
WORK REQUIRED:	Petrographic description: suitability for age dating: comparison with previous basement rocks.

Investigation and Report by: P. Simpson.

PETROLOGY OF 5 ROCKS FROM THE FOWLER 1:250,000 SHEET

SUMMARY

Number	Rock Name
P77/69	Quartz-feldspar-biotite-hornblende gneiss
P78/69	Meta-adamellite
P79/69	Meta-adamellite
P80/69	Meta-adamellite
P81/69	Meta-adamellite

SUITABILITY FOR AGE DATING

In all cases metamorphism is indicated and it is therefore unlikely that dating would reveal the age of the parent. However, some insight into the age of the last metamorphic event may be obtained. It should be noted that the grade of metamorphism is not firmly established, but is possibly lower amphibolite facies. Minerals such as plagioclase have probably not recrystallized during metamorphism and may still bear some chemical characteristics of the parent rock. Other minerals such as quartz have apparently been remobilized and now bear the character of the metamorphism. Yet other minerals, for example white mica, are probably produced as a result of metamorphism.

These factors, coupled with moderate alteration of biotite and plagioclase, make age dating by a whole rock determination suspect.

Potassium-argon dating of the hornblende in P77/69 should be reliable. Although it is usually partly altered, biotite may be useful, particularly in P77/69.

Whole rock determinations might be possible as indications of the age of metamorphism, however, as noted above, plagioclase probably has not completely recrystallized, and may cause complications.

COMPARISON WITH OTHER BASEMENT ROCKS

Amdel Report MP 906/69. P485, 86, 88, 90, 91/68 and P487, 89, 92, 93/68.

The first group are medium grained sandstones which show little or no metamorphic or tectonic effects. The others except P493/68 have textural affinities with granitized sediments. P493/68 has possible igneous affinities.

Amdel Report MP 1262/69.

Many of the nineteen rocks covered in this report have probable igneous affinities. Six of the rocks, P562, 68, 69, 71, 75/68 are virtually unmetamorphosed and are not deformed. Of the other rocks P557, 59, 60, 61, 65, 66, 67, 70/68 are probably metamorphosed igneous rocks.

Three of the rocks in the present study, P79, 80, 81/69, have probable igneous affinities and in this most closely resemble the eight rocks in MP 1262/69. However, in only one rock, P77/69 was a gneissic texture strongly developed, whereas in the previous report gneiss was applicable to 7 rocks although not all of these are of igneous affinities.

Thus, although there are metamorphic rocks of probable igneous origin in all reports, the character of metamorphism is somewhat different.

Sample: P77/69: TS 23268

Location:
FOWLER 1:250,000 sheet, Oolabinna 1-mile sheet. Lat. 31°16'S Long: 133°12'E.

Rock Name:
Quartz-feldspar-biotite-hornblende gneiss.

Hand Specimen:
The rock is medium to fine grained with a well defined foliation or gneissosity developed by the separation of the light and dark coloured minerals.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	20-25
Plagioclase	15-20
K-feldspar	35-40
Biotite	5-10
Hornblende	3-5
Epidote	1-2
Sphene	trace
Apatite	trace
Opaques	trace

Although the rock is inequigranular it is mainly coarse grained and allotriomorphic. Parallelism of the micas produces a coarse gneissosity.
Plagioclase is generally unzoned and has a composition oligoclase-andesine, it is commonly saussuritized. The twin lamellae are not uncommonly bent. A subgraphic intergrowth of plagioclase and K-feldspar is developed on grain boundaries between these two phases. K-feldspar, which is perthitic, has traces of weakly developed grill twinning characteristic of microcline, the crystals are anhedral and contain numerous inclusions of biotite and apatite, as well as relict plagioclase.
Quartz is generally finer grained than the feldspars, it is anhedral with shadowy extinction. In many cases it has complex sutured grain boundaries suggestive of recrystallization if in fact the original rock is igneous.
The femic minerals have a ragged appearance, they are commonly loosely associated and are attended by sphene with epidote and chlorite as replacement minerals. Biotite has pale yellow to olive green or brown pleochroism while hornblende has yellowish green to bluish green pleochroism and an extinction angle of 30°.
The rock has been metamorphosed sufficiently to induce the recrystallization of quartz and has also been physically deformed. No definite evidence was found to support igneous parentage for this rock.

Sample: P78/69: TS 23269

Location:
FOWLER 1:250,000 sheet, Oolabinna 1-mile sheet.
Lat. $31^{\circ}16'$S. Long. $133^{\circ}12'$E.

Rock Name:
?Adamellite gneiss.

Hand Specimen:
The rock is medium to fine grained with pink K-feldspar crystals generally coarser than the other minerals. It has a poorly developed foliation which is best displayed on weathered surfaces.

Thin Section:
An optical estimate of the constituents gives the following:-

	%
Quartz	30-35
K-feldspar	30-35
Plagioclase	20-25
Biotite	3-5
Epidote	1
Sphene	trace
Opaque	trace
White mica	trace
Apatite	trace
Chlorite (after biotite)	1

The rock is inequigranular and allotriomorphic: there is a rough gneissosity developed by the orientation and segregation of micas and fine grained quartz.
Plagioclase with a composition oligoclase is generally unzoned and saussuritized, it commonly has corroded margins when adjoined by K-feldspar. K-feldspar is coarsely perthitic and may have a poorly defined grill twinning. It is generally much fresher than plagioclase. Small irregular patches of myrmekite are not uncommon close to perthite.
Biotite which has pale yellow to olive green ieochroism occurs as small irregular flakes in "trains". It is commonly partially replaced by chlorite or epidote. Sphene is quite rare but is usually associated with the opaque minerals.
Quartz has two habits, firstly as anhedral crystals with shadowy extinction and secondly as small crystals with sutured boundaries suggestive of recrystallization in fractures. White mica is secondary to the first episode of crystallization, it occurs as a replacement mineral of the feldspars and also with quartz healing fractures. The rock has suffered physical deformation and metamorphism. From the above data igneous parentage is at best only speculative.

Sample: P79/69: TS 23270

Location:
FOWLER 1:250,000 sheet, Oolabinna 1-mile sheet.
Lat. 31°10'S, Long. 133°23'E.

Rock Name:
Meta-adameilite.

Hand Specimen:
The rock is coarse grained with coarser ink K-feldspar crystals (2-3 cm long) with quartz tending to form clots, giving a porphro-granitic texture.

Thin Section

An optical estimate of the constituents gives the following:-

	%
Quartz	30-35
K-feldspar (perthite)	30-35
Plagioclase	25-30
Biotite	1-2
Zircon	trace
Chlorite (after biotite)	trace
White mica	trace
Opaques	trace
Apatite	trace
Carbonate (secondary vein)	trace

The rock is coarse grained with an allotriomorphic texture, it is inequigranular.
Plagioclose has a composition albite-oligoclase, it is seldom zoned but is commonly saussuritized. K-feldspar exhibits the characteristic grill twinning of microcline, it is commonly coarsely perthitic and in such cases has numerous inclusions of highly altered plagioclase.
The development of white mica as an alteration product of the feldspars, particularly plagioclase is pronounced. Small, ragged flakes of biotite, which include apatite and zircon haloes, are commonly partially replaced by chlorite. The opaque minerals are loosely associated with biotite and are commonly partially replaced by ?limonite.
Quartz has shadowy extinction and has highly complex, sutured boundaries suggestive of recrystallization. The rock has been partially recrystallized and the development of carlsbad twinning in the feldspars is suggestive of an igneous parent.

Sample: P80/69: TS 23271

Location:
FOWLER 1:250,000 sheet, Oolabinna 1-mile sheet. Jellabinna rocks.

Rock Name:
Meta-adamellite.

Hand Specimen:
The rock is coarse grained with a granitic texture. Pink K-feldspar tends to form larger crystals than the other minerals while quartz forms clots, giving a mosaic effect on weathered surfaces.

Preliminary Report

Rocks from the FOWLER and BARTON 1:250 000 sheets

Extract from Progress Report No. 12 of

1/1/122 (In Prep.)

by

A.W. Webb and G.G. Louder

February, 1973.

Thin Section:
An optical estimate of the constituents gives the following:-

	%
Quartz	25-30
K-feldspar (microcline perthite)	35-40
Plagioclase	25-30
Biotite	1-2
Chlorite (after biotite)	trace
Apatite	trace
Epidote	trace
Opaques	trace
White mica	1
Zircon	trace

The rock, although inequigranular, is mainly coarse grained with allotriomorphic texture.
Plagioclase is commonly saussuritized, it is zoned and has an average composition of albite to oligoclase.
Evidence of incipient replacement by K-feldspar is accorded by the corrosion of plagioclase boundaries adjoining K-feldspar. Also there are numerous inclusions of altered plagioclase within the K-feldspar crystals.
Generally K-feldspar is a coarse perthite which commonly displays the characteristic grill twinning of microcline. It tends to form large crystals (3-4 mm) which have a rather shadowy extinction and occasional carlsbad twinning. Quartz has been at least partially crystallized under stress. It occurs as large masses, parts of which have shadowy extinction and suturing developed. Elsewhere quartz has smooth grain boundaries, particularly when it occurs as inclusions in the feldspars.
Biotite forms ragged flakes with inclusions of apatite and zircon. It is commonly partially replaced by chlorite and epidote. Opaque minerals are loosely associated with biotite. The rock has probable igneous affinities, suggested by the presence of carlsbad twinning, however, much of its original quartz has been recrystallized during metamorphism. It is probable that at least some K-feldspar has recrystallized as well.

Sample: P81/69: TS 23272

Location:
FOWLER 1:250,000 sheet, Broom 1-mile sheet. Lat. 31°04'S Long. 132°43'E.

Rock Name:
<u>Adamellite gneiss</u>.

Hand Specimen:
Very large (2-3 cm long) K-feldspar crystals are set in finer grained quartz, plagioclase and biotite giving a porphyritic texture. There is a rough alignment of K-feldspar crystals which are commonly simply twinned parallel to their long dimension.

Thin Section:
An optical estimate of the constituents gives the following:-

	%
Quartz	30-35
Microcline perthite	35-40
Plagioclase	20-25
Biotite	2-3
Chlorite (after biotite)	trace
White mica	trace
Opaques	trace
Epidote	trace
Apatite	trace
Allanite	trace

The rock is inequigranular and allotriomorphic. A rough gneissosity is developed by the elongation and "flow" texture of quartz.
Quartz generally occurs as elongated anhedral crystals with sutured boundaries and shadowy extinction as a groundmass to the larger, better formed feldspar crystals. The quartz wraps around the feldspars in a manner similar to flow or trachytic texture. Larger crystals of quartz (up to 3 mm) are observed. They are elongated and invariably exhibit shadowy extinction.
Plagioclase has a composition of albite to oligoclase, it is commonly indistinctly zoned and invariably saussuritized.
K-feldspar on the other hand is quite fresh, it has inclusions of plagioclase and "rounded" quartz. It is commonly coarsely perthitic and grill twinned. The simple twinning observed in hand specimen was not evident in thin section, only one rather vague carlsbad twin was observed.
Biotite is commonly partially replaced by chlorite, allanite and epidote.
On the supposition that plagioclase crystallized before much of the K-feldspar and that some of the latter may be igneous (carlsbad twinning) the rock has a probable igneous parent. It has however been metamorphosed at least to sufficient a grade to produce the recrystallization of quartz and the probable remobilization of some K-feldspar.

Six Rocks from the FOWLER 4-Mile

Our Reference: MP 1/13/0

21 August, 1970.

The Director,
South Australian Department of Mines,
Box 38, Rundle Street Post Office,
ADELAIDE. S.A. 5000.

REPORT MP 60-71

YOUR REFERENCE:	Application dated 2/7/70.
MATERIAL:	6 rock specimens.
LOCALITY:	FOWLER 4-mile sheet.
IDENTIFICATION:	P316-70 - P321-70
DATE RECEIVED:	3/7/70
WORK REQUIRED:	Oriented thin sectioning and petrographic description.

Investigation and Report by: P.J. Simpson.

Officer in Charge, Mineralogy/Petrology Section: Dr. K.J. Henley.

for N. Draper
Director.

SIX ROCKS FROM THE FOWLER 4-MILE

1. INTRODUCTION

This suite contains rocks of metasedimentary origin and plutonic aspect. The plutonic rocks belong to the calc-alkaline series and are adamellite and granodiorite. The metasediments are characterized by generally high silica contents (over 50%). In general foliation is poorly developed; in nearly all cases the foliation is caused by the parallel alignment of a micaceous mineral or by parallel orientation of elongate quartz grains. The presence of oligoclase in P318/70 - P320/70 suggests moderate to high grade regional metamorphic conditions, probably amphibolite facies. P317/70 contains a more albitic plagioclase; this does not necessarily imply a lower grade of metamorphism as the rock appears to be somewhat deficient in calcium and no epidote is present.

2. COMPARISON WITH P167/70 - P174/70 (TS 24849-24856) AND P192/70 - P195/70 (TS 24874 - 24877)

In the first suite, P167/70 - P174/70 from the basement of Nullabor Bore 7, several rock types occur including granite gneiss, meta-quartzite and biotite schists. These differ from the present suite in the following respects:

1. Granite gneiss of Nullabor No. 7 contains significantly altered feldspars; P316/70 is closest to this group although less altered.

2. Meta-quartzite in Nullabor No. 7 tends to be fine grained with quartz strongly elongate and the impurities concentrated in bands of fine grained material. This texture is different to that observed in the present suite where quartz is medium grained, is less elongate, and impurities are dispersed.

3. Biotite schists from Nullabor No. 7 appear to be very impure quartzites, and they have similar textures to those described above. Again the main difference between the groups of rocks is a textural one.

The second suite P192/70-195/70 from Guinewarra Bore are characterized by the presence of 'granite' containing reddened, altered feldspar, quartz and biotite. These characteristics make this suite of rocks a marked contrast to P316/70-P321/70.

It should be noted that the rocks of the present suite, with the exception of P316/70, have in excess of 60% quartz. This high silica content, while indicating a sedimentary origin, also means that large variations in rock type and texture can be expected because of local composition variations. Although it is unlikely that these rocks correspond to the 'granitic' rocks of Nullabor No. 7 and Guinewarra, a correlation of schists and metaquartzites may be possible, however, the presence of muscovite in all the metasediments in the group P316/70-P321/70 implies that this correlation cannot be made petrographically.

3. PETROGRAPHY

Sample P316/70: TS 25187:

Location:
Imala Rockhole.

Rock Name:
Porphyritic biotite adamellite.

Hand Specimen:
Medium grained intergrown quartz, feldspar and biotite with a few porphyritic feldspar crystals up to 1 cm across.

Orientation of Section:
Not specified.

Thin Section:
An optical estimate of the constituents gives the following:-

	%
Quartz	20-25
Microcline	25-30
Plagioclase	25-30
Biotite	10-15
Sphene	Trace-1
Opaques	1-2
Zircon	Trace
Apatite	Trace
Amphibole	Trace-1
Myrmekite	2-3

This rock is an inequigranular, xenomorphic to subidiomorphic intergrowth of quartz, feldspar and biotite. The texture is porphyritic granitic.

Plagioclase is twinned on the Carlsbad and Albite laws, the latter twins are generally tapered. The composition indicated by measurement of twin extinction angles is oligoclase. Many grains are compositionally zones; the core is more calcic that the outer parts. The grainsize of this mineral varies from about 1.5 to 0.5 mm. Many grains are lath-shaped. Alteration to sericite is common; it affects the cores of the grains to a greater extent than the outer rims.

K-feldspar generally has the distinctive 'tartan' twinning of microcline. This mineral appears to be homogeneous. Alteration is negligible but where present it generally involves sericitization. The grainsize is again variable; the larger grains are about 2 mm across and the smaller ones 0.5 mm.

Quartz grains average about 0.5-0.7 mm, most are xenomorphic and clear but in some cases, especially close to plagioclase grains, myrmekite is developed.

Biotite is strongly pleochroic from straw yellow to reddish brown or olive green; the latter colour is predominant. Both colour varieties appear to be the same generation. Some biotite is interleaved with chlorite or with clinozoisite. Some grains have inclusions of zircon with haloes. Grainsize is generally in the range 0.5 to 1.0 mm.

There is a tendency for biotite to form aggregates with the green amphibole (?hornblende) opaques, sphene, apatite and zircon.

In general sphene and opaques are intimately related, the sphene forming fringes on the opaque grains.

The abundance of zircon is a noteworthy feature, grains are up to 0.6 mm across and generally occur close to biotite.

The amphibole is pleochroic in emerald green tints; generally the grains are small (less than 0.5 mm) and subidiomorphic.

The rock has igneous affinities. The somewhat coarser grainsize of some K-feldspar than the rest of the rock gives a poorly developed porphyritic texture.

Sample P317/70: TS 25188:

Location:
North arm of Tallacootra,

Rock Name:
Meta-quartzite with sheared granodiorite.

Hand Specimen:
Specimen contains a band of grey fine-grained quartzite in a white and grey quartz and feldspar intergrowth. Elongation of quartz in the latter is obvious on cut surface.

Orientation of Section:
Across the boundary of quartzite and quartz-feldspar tock, parallel to foliation.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Meta-quartzite	
Quartz	90-95
K-feldspar	5-10
Altered biotite	1.2
Muscovite	Trace
Plagioclase	Trace
?Granodiorite	
Quartz	55-60
K-feldspar	5-10
Plagioclase	25-30
Altered biotite	5-7
Muscovite	Trace

The section examined has two distinct rock types exhibited. The first is a metaquartzite and in this rock quartz is fine-grained, seldom exceeding 0.5 mm and generally elongated parallel to the boundary with the igneous rock. The feldspars, K-feldspar being dominant, are more equant and are larger; they are up to 1.0 mm. Altered biotite forms small plates in stringers oriented parallel to quartz elongation. Plagioclase has a lower refractive index than quartz and is therefore either albite or oligoclase.

The second rock type is a sheared granodiorite, it is distinguished by a significantly larger grainsize (often exceeding 1 mm) and an increased proportion of plagioclase and biotite at the expense of quartz.

Plagioclase in this rock type has a higher refractive index than quartz and is therefore more calcic than oligoclase. Albite law twins are tapered in some grains and Pericline twins occasionally developed; both these features are indicative of stress.

Coarse-grained K-feldspar (perthite), plagioclase and less commonly quartz up to 2mm across are surrounded by fine-grained silicates with altered biotite. In these fine-grained areas quartz tends to be elongate to the foliation in the quartzite.

The boundary between the two rock types is diffuse in places but along some parts a change in grainsize is clearly discernable.

The granodiorite is leucocratic and is sheared and partly recrystallized. There are close similarities between this rock and the adjacent quartzite; the most striking are the similar biotite alteration (although this may be superficial) and the parallel orientation of foliations in both rocks. The different composition of plagioclase and its marked variation in proportions indicates that these rocks are of different origin.

Sample P318/70: TS 25189:

Location:
North Arm of Tallacootra.

Rock Name:
Quartz-feldspar-biotite schist.

Hand Specimen:
A fine-grained massive grey, siliceous rock. There is very weak foliation.

Orientation of Section:
Parallel to faint foliation.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	60-65
Plagioclase	20-25
Biotite	5-7
Opaques	Trace
Sericite	Trace
K-feldspar	5-10

Equigranular polygonal quartz and K-feldspar with lath-shaped plagioclase form the bulk of this rock. Small brown biotite flakes have a subparallel orientation across the section examined.

The quartz and feldspar grains are generally in the size range 0.1-0.2 mm although some smaller ones are present. Biotite flakes seldom exceed 0.1 mm in length.

Plioclase composition is albite as measured by maximum extinction angles of Albite law twins combined with refractive index measurements.

Sample P319/70: TS 25190:

Location:

North arm of Tallacootra.

Rock Name:
Quartz-feldspar-biotite gneiss.

Hand Specimen:
A foliated, gneissic rock containing bands and lenses of leucocratic minerals interspersed with fine-grained mafic minerals.

Orientation of Section:
Perpendicular to foliation.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	65-70
K-feldspar	10-15
Plagioclase	10-15
Biotite	5-7
Muscovite	Trace

The rock consists of an inequigranular, xenoblastic intergrowth of quartz and larger porphyroblastic feldspar with bands of enriched in biotite. Feldspar porphyroblasts are up to 4.5 mm but most are smaller (2-3mm): quartz is variable from a few microns to about 2mm with 0.3-0.8 mm being the most common size range. Biotite flakes generally do not exceed 0.5 mm.

Plagioclase composition is oligoclase; Albite law twin planes are marked by the growth of sericite.

Biotite is a pleochroic dark brown to yellow variety and the flakes have a strong preferred orientation parallel to the banding. A small amount of muscovite is associated with biotite. Some quartz grains are elongated parallel to this direction as well.

The assemblage quartz + feldspar + biotite, the foliation and the abundance of quartz suggest regional metamorphism of a sedimentary rock (argillaceous) to the amphibolite grade, for this rock's history.

Sample P320/70: TS 25191:

Location:

Seven Mile Swamps.

Rock Name:

Quartz-feldspar- 2 mica rock.

Hand Specimen:

The rock contains abundant brownish glassy quartz and white feldspar. Muscovite plates have a preferred orientation.

Orientation of Section:
Perpendicular to mica foliation.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	80-85
Biotite	2-4
Muscovite	5-7
Altered K-feldspar	2-3
Opaques	Trace-1
Zircon	Trace
Apatite	Trace
Plagioclase	2-3

The rock consists of inequigranular irregularly shaped interlocked quartz grains with isolated altered feldspar crystals. Plates of biotite and muscovite occur sporadically through the rock. Quartz ranges in size from 4 mm to a few microns. White altered feldspar grains are about 0.5 mm across. Muscovite plates reach 1 mm and biotite is generally smaller than this.

Plagioclase has a refractive index close to quartz and is therefore probably oligoclase. It is twinned on the Albite law and most grains are highly sericitized, alteration occurs preferentially along twin planes in some cases.

Zircon and apatite generally occur in or close to one of the micas.

The very high quartz content suggests a sedimentary (arenaceous) or metasomatic origin for this rock. Probable amphibolite facies regional metamorphic is indicated by the presence of slightly calcic (oligoclase) plagioclase. A suggestion of sedimentary banding is given by a concentration of plagioclase across the width of the slide examined.

Sample P321/70: TS 25192:

Location:
Seven Mile Swamps.

Rock Name:
Quartz-feldspar-muscovite rock.

Hand Specimen:
A coarse grained rock containing yellowish glassy quartz, white feldspar and muscovite. A weak foliation is evident in the orientation of muscovite.

Orientation of Section:
Parallel to muscovite orientation.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	40-45
Plagioclase	35-40
K-feldspar	2-3
Muscovite	10-15

Large phenocrysts (2-4mm) of plagioclase and K-feldspar are surrounded by an intergrowth of quartz, feldspar and muscovite.

Plagioclase is twinned on the Albite law; its composition is oligoclase and in places it is sericitized. Twins in some grains are tapered or disrupted and some grains are bent.

Quartz grains are xenoblastic and inequigranular; the grains seldom exceed 0.5 mm across. The margins of some grains are smooth but others are sutured.

Muscovite flakes are generally within the range 0.5-1.0 mm and are oriented subparallel across the width of the section examined. There is no other foliation in the rock.

This is a leucocratic rock of igneous origin.

Sample: P1152/72: TS29726: PS

Location:
Yangoonbay R.H., FOWLER 1:250 000 Sheet

Rock Name:
Granite

Hand Specimen:
This is a coarse-grained, leucocratic rock with light pinkish-orange feldspar and clear quartz. Biotite and muscovite flakes are also visible. The average grainsize seems to be between 5 and 10 mm.

Thin Section:
The rock is too coarse-grained for the thin section to be representative. However, staining of a rock slab shows that potash feldspar is dominant. The thin section shows that plagioclase is also present and that the potash feldspar is microperthitic. Both feldspars are clouded and the placioclase is compositionally zoned. The greater part of the thin section seems to be composed of a single crystal of potash feldspar, at least 2 cm across. Most of the remainder is made up of anhedral grains of quartz, 3-5 mm in size. These appear to be unstrained.

Some muscovite occurs as a replacement product of plagioclase but flakes of primary muscovite, up to 2 mm in the section, are also present. Biotite is also a primary constituent and some flakes are partly chloritised.

The rock is suitable for Rb-Sr dating and probably also for K-Ar dating, using either muscovite or biotite.

Sample: P1153/72: TS29727: PS

Location:
Mitcherie R.H., FOWLER 1:250 000 sheet.

Rock Name:
Adamellite

Hand Specimen:
This is a coarse-grained rock with abundant pink and greenish-white feldspar; quartz and biotite are also evident. The feldspar grainsize averages 5 to 10 mm.

Thin Section:
Generally speaking this rock is quite similar to P1152/72. It does, however, have a higher proportion of plagioclase, making it an adamellite. The two feldspars occur as large anhedral grains, together with quartz, which in this case shows some undulose extinction. Microperthitic microcline, slightly clouded, is the potash feldspar and the plagioclase shows patchy alteration - much of it is actually quite fresh.

Dark minerals make up about 5% of the rock and biotite is chief among these. Minor chloritisation affects some biotite flakes, which range up to 3 mm in size in the section. Sphere and opaques, in grains up to 2 mm are relatively common, expecially in clusters together with biotite. These clusters also contain numerous smaller crystals of apatite and some zircon and monazite. Allanite is also present.

The rock is suitable for either Rb-Sr or K-Ar dating, the latter using a biotite concentrate.

Sample: P1154/72: TS29728: PS

Location:
Inila R.H., FOWLER 1:250 000 sheet

Rock Name:
Granodiorite

Hand Specimen:
The rock is medium-grained except for occasional large (>1 cm) feldspar crystals. White feldspar, slightly smokey quartz and black biotite are all abundant.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	20-30
Microcline	15-20
Plagioclase	40-50
Biotite	10
Sphene	1-2
Opaques	1
Hornblende	trace
Accessories	trace

The texture is allotriomorphic granular in this rock. Some plagioclase is altered but most appears relatively fresh. Compositional zoning is present in the plagioclase and there is a little myrmekite. The microcline shows good cross-hatched twinning and is also mostly quite fresh. Quartz grains show some undulose extinction and slightly sutured boundaries. The average grainsize of the felsic minerals is about 3 mm.

Greenish-brown biotite is the chief mafic component and many flakes are partly altered to chlorite. Sphene and opaques are quite common, and other accessories include apatite, zircon, monazite and epidote. In a few places there are irregular small grains of green hornblende.

The rock is a granodiorite which is well suited to Rb-Sr dating. Provided sufficient unaltered biotite can be separated, it should also be well suited to K-Ar dating.

Sample: P1155/72: TS29729: PS

Location:
Yumbarra R.H., FOWLER 1:250 000 sheet.

Rock Name:
Adamellite

Hand Specimen:
The rock is fine to medium-grained and somewhat friable due to weathering. Pale pink feldspar, quartz and biotite are all present.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	20-30
Potash feldspar	30-40
Plagioclase	30
Biotite	5-10
Accessories	1-2

The rock has an allotriomorphic granular texture with a grainsize mostly below 2 mm. The potash feldspar is slightly perthitic and most appears to be microcline. It is generally clear or only very slightly clouded. Plagioclase, on the other hand, is moderately to heavily clouded and sericitised. Quartz grains show moderate to strong undulose extinction and some appear to be recrystallised.

Biotite is the chief mafic mineral, occurring as flakes averaging 0.5 - 1 mm in size. Many biotite flakes have been partly or wholly replaced by epidote and/or chlorite. Other flakes contain lenticular bodies of prehnite along cleavage planes in the biotite.

Accessory minerals consist of sphene, opaques, allanite, apatite, tourmaline and zircon.

This rock is an adamellite. Numerous fractures are evident in thin section, corresponding to the rocks friability on hand specimen. The rock should be suitable for Rb-Sr dating. It is probable that sufficient unaltered biotite could be obtained if a K-Ar date were required.

Sample: P1156/72: TS29730: PS

Location:
Ifould Lake, BARTON 1:250 000 sheet.

Rock Name:
Granodioritic gneiss

Hand Specimen:
This is a medium-grained, mesocratic rock, with quartz white to grey feldspar, and micas. Some foliation is evident.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	40
Potash feldspar	?trace
Plagioclase	40-50
Biotite	5-10
Muscovite	4
Accessories	trace -1

The rock consists of somewhat porphyroblastic crystals of plagioclase, mostly between 1 and 3 mm in size, in matrix of stained and recrystallised quartz, with micas and minor fine-grained feldspar. No potash was recognised in thin section but two small spots reacted positively when a rock slab was stained with sodium cobaltinitrite. In some plagioclase crystals the twin lamellae are curved due to deformation. Patches of recrystallised plagioclase are present, with a grainsize below 0.1 mm. These patches include some myrmekite. The plagioclase crystals show only slight and patchy alteration to sericite and clay. The recrystallised quartz has a very variable grainsize, from >0.05 mm to 1 mm, and undulose extinction is a prominent feature.

The micas form flakes which average 0.5 mm in size and are rarely over 1 mm long. Muscovite and biotite are generally intergrown with one another and they tend to form trains which wrap around plagioclase crystals, but with a distinct preferred orientation overall.

Accessory minerals in this rock consist of carbonate, apatite, zircon, monazite, opaques and possible rutile.

This is a low-moderate grade, regional metamorphic rock, with a granodioritic or tonalitic composition. The presence of muscovite rather than potash feldspar indicates that the metamorphic grade is not high. For this reason, and also because of the absence of hypersthene, the rock could not be described as a charnockite. The muscovite does not appear to be a retrograde product.

The rock is suitable for Rb-Sr dating, although the metamorphism may not have been of high enough grade to homogenise the sample, with the result that a Rb-Sr date may give a pre-metamorphic age. K-Ar dating could be carried out using either biotite or muscovite, although biotite would be preferable, and this should give the age of metamorphism.

Sample: P1157/72: TS29731: PS

Location:
Lake Tallacootra, FOWLER 1:250 000 sheet

Rock Name:
Granitic gneiss

Hand Specimen:
The rock is rich in pink feldspar crystals of up to at least 1 cm in size. Some white feldspar is present, as well as quartz and fine dark mica. There is a distinct foliation as well as compositional layering, and the two are not parallel.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	20-30
Microcline	50-60
Plagioclase	10-20
Biotite	5
Muscovite	1
Accessories	Trace

Large crystals of microcline (up to 1 cm) are the dominant feature of this rock. These crystals, either porphyroblasts or relicts of a pre-existing rock, are set in a matrix composed largely of re-crystallised quartz and feldspar, with a granoblastic texture.

Microcline crystals are slightly clouded in places, but are largely fresh. Plagioclase, which occurs as smaller (2 mm) porphyroblasts and in the matrix, tends to be a little more altered, mainly to sericite. Some plagioclase occurs as small grains of myrmekite. Most of the feldspar in the matrix is recrystallised microcline.

Both micas occur in flakes, mostly below 0.5 mm in size. Biotite is clearly the dominant mica and appears to be quite fresh. The micas mainly occur in loose aggregates or trains, which tend to wrap around the porphyroblasts. There is a general though not well pronounced orientation for these trains and the mica flakes within them are sub-parallel.

The accessory minerals in this rock are mainly allanite, apatite and opaques.

This is a regional metamorphic rock, of granitic composition. The presence of prograde muscovite, even with the abundant microcline, restricts the metamorphic grade to medium intensity. Rb-Sr dating could be carried out on this rock, although the date might give a pre-metamorphic age. K-Ar dating of the biotite should be satisfactory and will give the age of metamorphism.

APPENDIX 2: REPORT AN3711/69.

ANALYSIS FOR URANIUM AND THORIUM

by

G.R. HOLDEN

REPORT AN3711/69

ANALYSIS
%

Sample mark	Uranium oxide U_3O_8	Thorium oxide ThO_2
Th 1-1	0.005	0.005
1-2	0.005	0.005
1-3	0.005	0.005
1-4	0.005	0.005
2-1	0.005	0.005
2-2	0.005	0.005
2-3	0.005	0.005
2-4	0.005	0.005
2-5	0.005	0.005

NOTE:

1. All samples submitted have been analysed for U_3O_8 and ThO_2, by x-ray fluorescence spectroscopy which is a specific but not extremely sensitive method of analysis. One can say with some certainty that both metals, if present all are in concentrations of less than 50 ppm.

2. On the other hand the total radioactivity, if expressed as U_3O_8 would indicate concentrations of U_3O_8 ranging from close to zero in Sample Th 1-4 to approximately 1.0 % in Sample Th 2-3.

APPENDIX 3:

THE BEHAVIOUR OF URANIUM AND ITS DAUGHTER PRODUCTS

by

Dr. R. Davy

Note to accompany A.M.D.E.L. report

AN.3711/69

THE BEHAVIOUR OF URANIUM AND ITS DAUGHTER PRODUCTS

There are four main isotopes of Radium. These with their half lives are as follows.

		Decay by	
^{234}Ra	3.64 days	α	emission
^{226}Ra	1620 years	α	
^{225}Ra	14 days	β	
^{223}Ra	11.2 days	α	

(Ref. Barnett & Wilson p20-24)

If Radium is present in a rock at all, it is likely to be present as radium with a mass number of 226 units.

Radium is commonly found in nature in pitchblende and in nearly all known cases it is associated with uranium. Indeed the fact that it exists at all can only be because of the proximity of uranium, since, with its relatively short half life, over long periods of (geological) time, it will decay completely unless regenerated by the decay of uranium.

The relevant decay series is as follows, starting with the parent, and longest living, isotope $^{238}_{92}U$

	Decay		Half Life	
$^{238}_{92}U$	α		4.5×10^9	years
$^{234}_{90}Th$ (UX_1)	β		24.5	days
$^{234}_{91}Pa$ (UX_2)	β		1.14	minutes
$^{234}_{92}U$ (U_{II})	α		2.69×10^5	years
$^{230}_{90}Th$ (Io)	α		8.3×10^4	years
$^{226}_{88}Ra$	α	(mainly)	1620	years (approx)

Eventually this series reaches stability at

$^{206}_{82}Pb$

The emission by which elements are transmuted is either α or β. Several of the elements of this series, however, also emit γ radiation, and ^{226}Ra is one of these. Thus in a γ-ray radiometric count Ra will be distinguished and shown as a peak on a curve of relative counts versus energy level of emission at an energy level of 188 KeV. This energy level is characteristic for ^{226}Ra and for no other element. Other decay products in the same series which produce radiation do so at other energy levels.

In the specimens being analysed it is believed that little uranium and thorium are present, but that peaks indicating daughter products of uranium are present. The only daughter products of ^{238}U which give peaks in the energy range chosen are ^{214}Bi and ^{214}Pb. Since ^{235}U is always associated with ^{238}U this is also likely to be present if ^{238}U is also present. In these samples all daughter products appear to be present (though the peak for ^{226}Ra has been slightly transposed).

The high radioactivity, therefore, of the samples may be due to ^{214}Bismuth, ^{214}Lead or ^{226}Radium.

The purpose of this report is to discuss whether uranium can be separated from its daughter products in nature. The environment or the samples under analysis was that of an arid, saline sand or sandstone.

There are two main possibilities, either the uranium has been leached from its original site leaving its daughter products behind or, alternatively, both uranium and its daughter products have been continuously leached, but, at the place represented by the samples, there has been a change of conditions which has caused precipitation of the daughter products.

If the first alternative is chosen, it implies that there must have been a drastic change in climatic conditions. For many years there must have been a stable, non-leaching environment, then in comparatively recent geological time conditions have changed to allow the uranium to be leached out yet leave daughter products in sufficient quantities for the results obtained.

It is not possible to be categorical but the following factors are valid:

Uranium

(a) Uranium is highly mobile in alkaline, oxidising conditions except in the presence of vanadium and phosphate ions.

(b) Uranium will move in carbonated water as a complex uranyl carbonate. If the "primary" U-mineral is carnotite, this is not soluble. Normal conditions for movement of U in carbonated waters are reducing and alkaline/acid.

(c) Uranyl hydroxide is slightly soluble in both acid and alkaline conditions. Solubility increases in strongly alkaline solutions.

(d) Uranyl ions (UO_2) are "somewhat mobile" in weakly acid solutions (and in neutral and alkaline solutions in the presence of CO_2).

(e) Uranium may be later removed by organic matter or by a number of reducing agents (such as H_2S).

(f) Uranyl nitrate, sulphate and chloride are all quite soluble, especially the nitrate and sulphate.

Radium

(a) Radium is associated with uranium as a daughter product and can only be regenerated by decay of uranium.

(b) Its equilibrium ratio with uranium is 3.4×10^{-7}g Ra/g U.

(c) Its chemistry is that of an alkaline earth element.

(d) This means that its sulphate and carbonate are insoluble; its nitrate and chloride slightly soluble and its fluoride very soluble.

(e) In the presence of gypsiferous solutions, therefore radium with precipitate as the sulphate together with barium. The common ion effect will render this precipitation more complete.

(f) Radium is believed to be removed from solution by adsorption on clay (Hawkes and Webb 1962)

Lead

(a) Lead sulphate is very insoluble

(b) In conditions with $SO_4^{=}$ in solution, lead will be precipitated as the sulphate.

(c) The half life of ^{214}Pb is 26.8 minutes.

(d) The concentration of ^{214}Pb in equilibrium with 1 g U is of the order of 10^{-10}-10^{-11} g/g U.

In the given conditions therefore - that of a saline environment with SO_4 present - both radium and lead will be precipitated and uranium has a chance to continue migrating.

Bismuth

(a) Bismuth compounds are insoluble in neutral waters or weakly acid or alkaline solutions with the formation of the basic oxide.

(b) Under the conditions noted above bismuth will remain as the oxychloride except when the solutions are highly saline.

It is suggested therefore that secondary daughter products of uranium is present. The most likely element to be present is radium of mass number 226.

This will precipitate out of solution as RaSO and leave uranium, as the uranyl (UO_2^{++}) ion free to move further. It may therefore be be expected that secondary uranium will be found downstream from the daughter products and that primary uranium may be present upstream from the sample site.

Despite these remarks it is very unusual to find uranium daughter products with the uranium so thoroughly leached out. When leaching occurs there is disequilibrium but usually sufficient uranium remains for detection.

It is recommended that the detection of uranium and thorium be attempted in the samples in question by the most sensitive chemical techniques, notwithstanding the fact that X.R.F. analyses have confirmed the virtual absence of both metals in concentrations of economic interest.

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APPENDIX 4:

LOG OF LIGNITE TEST BORE (1948) AND ANALYSES

From Dickinson, S.B. (1950).

PIDINGA

No. $P_1$5 BOREHOLE

Drilling commenced 30/11/48; completed 6/12/48. (Driller; F.J. Hockley).

Depth From ft.	in.	To ft.	in.	Description
Surface		2	6	Yellow and brown clay, with gypsum.
2	6	6	6	Carbonaceous sand.
6	6	8	6	Clay, with lignite fragments.
8	6	11	0	Grey sand, with lignite fragments.
11	0	11	6	Grey shale.
11	6	13	6	Dark reddish-brown sand, with lignite.
13	6	14	0	Grey carbonaceous shale.
14	0	15	0	Carbonaceous sand.
15	0	20	0	Brown sand, with lignite fragments.
20	0	22	0	Carbonaceous sand.
22	0	23	6	Lignitic clay.
23	6	29	3	Lignite.
29	3	30	9	Light-grey shale.
30	9	34	6	Grey shale, with lignite.
34	6	35	6	Lignite, with alunitic clay.
35	6	36	6	Light-grey clay, with lignite.
36	6	41	6	Lignitic sand, with pyrites.
41	6	42	6	Lignitic clay.
42	6	47	0	White and grey alunitic clay.
47	0	48	0	Grey clay, with some carbonaceous material.

Drilling was discontinued at 48ft.

Core logged by E. ANDERSON, Geologist.

PROXIMATE ANALYSIS

Depth from		Depth to		Moisture	Volatile matter	Fixed carbon	Ash
ft.	in	ft.	in	per cent	per cent	per cent	per cent
2	6	6	6	6.24	17.24	12.81	63.71
6	6	11	0	7.67	25.30	14.82	52.21
11	0	16	0	6.73	24.49	13.29	55.49
16	0	21	0	6.96	22.61	14.37	56.06
21	0	23	6	5.00	17.41	10.85	66.74
23	6	26	6	11.38	37.15	28.25	23.22
26	6	29	3	9.45	41.21	29.43	19.91
30	9	34	6	5.51	27.22	13.47	53.80
34	6	35	6	9.91	39.80	27.54	22.75
35	6	41	6	8.78	39.77	25.36	26.09

Calorific values and sulphur determinations were carried out on lignite samples taken at 23ft. 6in.-29ft. 3 in. and 34ft. 6in.-41ft. 6 in. with the following results:

CALORIFIC VALUE AND SULPHUR DETERMINATION

Depth from		Depth to		Thickness		Calorific value	Sulphur
ft	in	ft	in	ft	in	Btu./lb.	per cent
23	6	29	3	5	9	7,990	3.10
34	6	41	6	7	0	7,427	6.95

APPENDIX 5:

LIGNITE INTERSECTIONS MADE DURING DRILLING FOR AUSTRALIAN MINING CORPORATION LTD. ON S.M.L'S 316, 365 and 367.

From a report by P.C. Smith
Minoil Services Pty. Ltd.

APPENDIX 1

Drill Holes with Lignite Intersections

Drill Hole Number	Total Depth	Depth to Lignite	Thickness of Lignite	COMMENTS
367 - 3	210'	45'	65'	Hole to basement - sand and silt predominating lower part.
367 - 4	270'	45'	105'	Hole to basement - 20% clay last 25'.
367 - 5	70'	15'	55'	Hole probably to basement - Lignite content variable in last 20'.
367 - 16	87'	15'	40'	Hole to basement - Lig. content varies from 20-70%.
367 - 17	325'	30'	165'	Hole to basement - Lig. content variable from 100%-15% (generally >55%).
367 - 18	215'	75'	45'	Hole to basement - Lig. content from 20-85%.
367 - 22	175'	65'	20'	Hole to basement - Lig. content low approximately 30%.
316 - 1D	124'	15'	25'	Hole not to basement - Lig. content > 20, <50%.
316 - 1E	49'	20'	30'	Hole not to basement - Lig. content > 30, <40%.
316 - 4	87'	65'	15'	Hole not to basement - Lig. content > 40, <60%.
316 - 5	162'	45'	45'	Hole not to basement - Lig. content >10 <30%.
316 - 11	160'	85'	10'	Not to basement. Lig. approximately 25%.

APPENDIX 1 (Cont'd)

Drill Hole Number	Total Depth	Depth to Lignite	Thickness of Lignite	COMMENTS
316 - 14	90'	50'	15'	Not to basement. Lig. approximately 25%.
316 - 15	144'	80'	45'	Probably to basement. Lig. approximately 85% from 100% to 10%.
316 - 20A	123'	Minor lignite at approximately 110' (not definite). Not to basement.		
316 - 26	57'	30'	30'	Not to basement. Lig <20% approximately 10%.
316 - 26A	162'	50'	110'	Not to basement. Lig. > 15 <60%.
316 - 28	63'	40'	20'	Not to basement. Lig. approximately 30%.
316 - M3	270'	20'	105'	Possibly to basement. Lig > 20 and up to 100%.
316 - M3A	100'	30'	70'	Not to basement greater thickness of Lig > 50 <100%.
316 - M3C	335'	95'	50'	To basement. Lig. > 15 <100 More Lig. in lower part.
316 - M5	80'	67'	13'	Not to basement. Lig. percentages not logged.
316 - M5A	277'	125'	10'	Not to basement. Lig. approx-imately 25%. Further traces down hole.
316 - M5B	295' 2nd lens.	85' 200'	100' 20'	Not to basement. Lig > 25 <100%. Lig > 20 <85%.
316 - M6	300'	75'	110'	To basement. Top part sandy. Lig. > 15 <90%.

APPENDIX 1 (Cont'd)

Drill Hole Number	Total Depth	Depth to Lignite	Thickness of Lignite	COMMENTS
316 - M10B	285'	140'	30'	To basement. Top approximately 20% increasing to 90% at approximately 170'.
316 - R1	186'	20'	60'	To basement. Top approximately 25% increasing to 100% near 80'.
316 - R2	300'	25'	115'	Close to basement. Lig. 10% <25%. Poor quality and discontinuous.
316 - R2A	50'	10'	40'	Hole ceased in Lig. Lig. >10 <100%.
316 - R2B	50'	15'	35'	Hole ceased in Lig. Lig. >10 <100%.
316 - R2C	50'	15'	35'	As Above.
316 - R2D	50'	25'	25'	Hole abandoned in Lig. from 5 - 100%.
316 - R2E	50'	25'	25'	As Above.
316 - R3	245'	30'	130'	Probably to basement Lig. >5 <100% Mainly high quality.
316 - R4	225'	60'	75'	Probably to basement Lig. > 15 <100% high quality.
316 - R4B	80'	60'	20'	Not to basement. Lig> 50% <100% hole ceased in lignite.
316 - R4C	50'	25'	25'	Hole ceased in Lig. from 50% up to 100%.
316 - R4D	59'	52'	4'	Approaching basement? Poor quality Lig.
316 - R4E(1)	50'	20'	30'	Ceased in Lig. from 30-100%. richer near base.

APPENDIX 1 (Cont'd)

Drill Hole Number	Total Depth	Depth to Lignite	Thickness of Lignite	COMMENTS
316 - R4E(2)	50'	20'	30'	Ceased in Lig. from 100% Lig. near base.
316 - R4E(3)	50'	20'	30'	Ceased in Lig. from 30-100%.
316 - R4F	95'	55'	40'	Hole ceased in Lig. Lig >25 <100%.
316 - R4G	50'	10'	40'	Hole ceased in Lig. Lig > 15 <85%. Richer near base.
316 - R4H	50'	15'	35'	Hole ceased in Lig. Lig > 30 <100%. Richer near the base.
316 - R4I(1)	50'	20'	30'	Hole ceased in Lig >10 <80% Richer near the base.
316 - R4I(2)	50'	23'	27'	Hole ceased in Lig. Increasing percentage near base.
316 - R4J	50'	15'	35'	Hole ceased in Lig. Lig from 65% near top to 100%.
316 - R4K	50'	15'	35'	Hole ceased in Lig. Lig. from 20% near top to 80%.
316 - R4KA	20'	15'	5'	Hole ceased in Lig. Lig. 20%.
316 - R4L	50'	20'	30'	Hole ceased in Lig. from 50-100% increasing towards base.
316 - R4M	50'	20'	30'	Hole ceased in Lig. from 30-85% increasing in percentage towards base.
316 - R4N	50'	20'	30'	Hole ceased in Lig. Lig. from 50-90%. Increasing in percentage towards base.

APPENDIX 1 (Cont'd)

Drill Hole Number	Total Depth	Depth to Lignite	Thickness of Lignite	COMMENTS
316 - R5	350'	65'	45'	Hole not to basement. Lig. >20 <100%.
	2nd lens	125'	10'	Lig. approximately 25%> perhaps fallen?
316 - R6	183'	25'	70'	Hole to basement. Lig. 25 <100% increasing towards base.
316 - R7	35'	25'	10'	Hole ceased in Lig. Lig. approximately 70%.
316 - R7A	150'	20'	130'	Hole ceased in Lig. Variable content >15 <100% lenses of sandstone within
316 - R8	269'	15'	140'	Probable basement Lig.>25 <100%. Increase towards base.

APPENDIX 6:

ANALYSES OF CORE AND CHIP SAMPLES FROM DRILLING ON AUSTRALASIAN MINING CORPORATION LTD. S.M.L'S. 316, 365 AND 367.

A.M.D.E.L. Reports extracted from SMITH (1971)

APPENDIX 1

Amdel Analyses.

Report AN 2852/71

367-5A - fresh core sample

Report AN 3501/71

316/R4D - core sample
/R5 - rotary chips
/M5 - rotary chips
/R1 - rotary chips
/R3 - rotary chips
/M3C - core sample
/R8 - rotary chips

NOTE:

367-5A was a fresh core sample and representative of the lignite.

316/R4D and 316/M3C were core samples from previous drilling for uranium.

315/R5, /M5, /R1, /R3, /R8 were chips samples from previous rotary drilling for sedimentary uranium and were contaminated with silts, clay and drilling mud and are included only as an indication of lignitic material.

23 February 1971

AMDEL REPORT AN3501/71

YOUR REFERENCE:	Order 873
MATERIAL:	Lignite
IDENTIFICATION:	As listed
DATE RECEIVED:	10/2/71

Analysis by: R.J. Buckley

AN2852/71

ANALYSIS

Sample No.	% Ash	Calorific Value B.T.U./lb	% Volatile	% Fixed Carbon
367-5A	19.4	9,300	45.3	35.3

Above results on a moisture free basis

Moisture as received

10.3%

2 February 1971

AMDEL REPORT AN2852/71

YOUR REFERENCE:	Order No. 767
MATERIAL:	Core samples
IDENTIFICATION:	367-5A
DATE RECEIVED:	33/12/70

Analysis by: M. Hollister

ANALYSIS
%

Sample Mark		Moisture	Volatile Matter	Fixed Carbon	Ash
			As received basis		
316/R4D	56-58	3.70	17.0	9.7	69.6
R5	70-75	2.35	12.1	2.45	83.1
M5	69-70	5.10	15.7	11.2	68.0
R1	35-40	4.40	24.0	14.3	57.3
R3	50-55	4.30	23.3	13.5	58.9
M3C	60-70	7.90	28.9	22.4	40.8
R8	140-145	5.00	22.8	16.2	56.0
			Dry basis		
316/R4D	56-58		17.6	10.1	72.3
R5	70-75		12.3	2.6	85.1
M5	69-70		16.6	11.8	71.6
R1	35-40		25.1	14.9	60.0
R3	50-55		24.4	14.1	61.5
M3C	60-70		31.3	24.5	44.2
R8	140-145		24.0	17.0	59.0

APPENDIX 7

TRAVERSE NOTES

(1) Reconnaissance Traverses and Granite Sampling FOWLER (and BARTON) 1:250 000 sheets.

(2) Traverses to map 1:63 360 sheet areas: Penong, Bookabie and Coorabie

(3) East-West Traverse across FOWLER during Terrain Survey Pt. Augusta - Ceduna (from Rept.Bk. 59/75).

(1) Reconnaissance Traverses and Granite Sampling
FOWLER (and BARTON) 1:250 000 sheets

Friday, 6th October, 1972

07723 Coorabie 1-Mile

0000

Traversing Fowlers Bay through Coorabie, Trunch, Tallowan, Tallacootra 1-Miles to BARTON 4-Mile.

07727

(004.3) Flat-lying shelly limestone. Calcreted and possibly
Sample: Ripon Calcrete position. Separate name may be required.

07730 Pale brown and yellowish brown mottled gypsum sand. Some aggregated to sand size from silt size material. Weak effervescence with H Cl.
All flats are Yamba Formation equivalent.

07733 Coorabie

(010.6)

07739 Eyre Highway junction.

(016.6) Ripon Calcrete occurs as clasts in calcrete in Bakara Soil exposed in roadside excavations. Lumps of Bridgewater Formation also occur. Possible that rounded hills in this area are Upper Member, or that some are of these can be separately mapped. Valleys contain deep brown soil and this should be mapped separately.

07742 Nundroo

(19.7) Trunch 1-Mile

07761 Benchmark 3228

(037.9) Shallow brown soils over gently undulating rises.

07762

(039.2) Return towards Colona Well.

07766 Turn north to Colona H.S. and Colona Well.

07768 Ripon Calcrete as a small outcrop on hill top north of Colona Well. Surrounded by brown soils.

07774 Fence. Brown soils continue to the north. Low hills are a mile or so across the top and valleys are also about the same distance across.
Local relief about 50 feet.

Tallowan 1-Mile.

07781 Monburu Tank. Ripon Calcrete occurs as debris in a younger calcrete pan.

07783 Collapsed well. Spoil indicates a sequence of 3 feet of pale brown soil over a few feet of pale yellow fine grained sand and granule conglomerate, over an unknown thickness of hard Nullarbor Limestone.

07785 Road junctions from southwest.

(062.6)

07793 Vermin proof fence

(070.5) Flat to gently undulating plain veneered with brown soil. Moderately hard calcrete cementing calcareous fine grained sand. Pale brown sand above calcrete is full of hard fine granule clasts (Ripon detritus?).

Tallacootra 1-Mile

07796 Broom tanks. Set in a circular depression, possibly an

(073.0) infilled doline. Spoil around old well is sparry limestone.

07801 Sand dunes. Fine grained calcareous sand containing carbonate silt. Sand is pale brown and is derived from underlying brown soil.

07803 Moondrah Tanks. Edge of dunes.

7th October, 1972

07803 Moondrah Tanks

0000

07809 Henry Tanks

(005.7) Plains country with thin brown soils over calcrete in Bakara Soil with clasts of Ripon Calcrete

BARTON 4-Mile

07820 Sample: West of Colona-Ooldea road in granite gneiss north of the granite gneiss - Qfe contact.

FOWLER 4-Mile

Tallacootra 1-Mile

07830 Henry Tanks. To Lake Tallacootra.

(0000)

07838 Sample: L. Tallacootra. Intersection of road with top of granite hill on west margin of lake at crossing.
Return to Henry Tanks.

07846 Henry Tanks. Traversing south to Moondrah Tanks.

07852 Moondrah Tanks.

Tallowan 1-Mile

07878 Edge of northwest-southeast trending rise looking over lower ground to south-west. Possible fault.

07883 Top of rise similar to that at 07878. From this point looking S.W. there appears to be an extensive lowland with another rise about 1 mile southwest of the Eyre Highway in the distance. Possibly calcrete dune "ranges" as in S.E.

Trunch 1-Mile

07888 Eyre Highway. To Ceduna.

07999 Ceduna

Traversing to Euria Well etc. to collect granite samples 3.10.72

Penong area.

Bookabie 1-Mile

07519	Turn-off near Bookabie - Nabona Well for 7-Mile swamps. Tracks too obscure, traverse abandoned.
7530	Turn-off Eyre Highway.
(0000)	To Yangoonaby R.H. via Monandilla Well.

Euria 1-Mile

07539	Turn east on N. side of vermin-proof fence. All brown soils over gently undulating terrain with scattered calcrete float on the rises.
40+	Turn north along fence.
07542	Southern boundary of Molineaux Dunes.
46	End of fence. Track turns northwest for Yangoonaby.
07548	Junction.
07550	Return to junction. Two miles of running on left fork. Not heading right direction.
07553	Cleared area where track after heading west intersects a north-south trending road.
07557 Photo: Sample:	Outcrop of granite. Stream course intersecting outcrop has two concrete walls across it. Although there are small areas of calcrete float in this area, there is not enough to map, and the patch on Euria 1-Mile in this area should be removed.
07558	Camp at Euria Well.

Traverse Euria Well to Chundie Swamps and Seven Mile Swamps. 4.10.72

Euria 1-Mile

07558	Base camp

Moornabie 1-Mile

07564	Road junction. Left fork.

07568 Small low outcrop of coarse grained pink granite. A
Photo: small square steel water tank marks this site.
Sample: Granite.
Heading west for Chundie Swamps.

07569+ Drill site on south side of road. Put down through kaolinitic granite. Some ferruginous sandstone - possibly a weathering cap on granite - is also present. The sandstone is coloured dark red and yellow ("Tertiary" colours). 29 samples were recovered at this site (200 feet?). 7 upper samples are through ?Tertiary sand.

07570 Drill site south of road. Similar to last site except only 16 samples through weathered granite can be seen, together with a small heap of yellow mainly fine-grained polymodal sand.

07570+ Drill site. 22 samples taken in coarse-grained weathered granite.
36 small bags of samples remain.
All holes open.

07570+ Drill site south of road. Weathered granite spoil on dump.

07571

(000.4 m) Drill site north of road. A well marked track heads due north from this point, although actual junction is uncertain. Irregular mound of weathered granite from drill hole.
Another track heads south from 100 yds. west of this point.

07571 Red and yellow ferruginous sandstone cuttings amongst

(000.8) pale grey gravel-size angular fragments of sandstone with silica cement. Non-calcareous.

07572 Drill site north of track. 8" diameter casing in open

(001.3) drill hole. Hole put down through ferruginous sandstones into weathered granite. Small fragments of strongly silicified sandstone (?silcrete) occur on spoil heap. Possibly 17 sandstone samples.

07573 Drill site north of road. Open drill hole through

(002.5) ?Tertiary sand into weathered granite.

07575 4 samples through brown soil, 2 samples through

(003.7) red-brown fine grained sand, 5 through silcreted sandstone, 1 in hard ferruginous sandstone and then into weathering granite (20 samples) at base.

07576 Drill site east of road. Put down through ferruginous

(005.3) sands into lignite over weathered granite.

07577 Drill site west of road. 'Hole put down through

(006.4) ferruginous sands into fine-grained carbonaceous sands and into top of weathered granite.

Note: Holes have been put down about 1-mile apart. Probably began 0.5 mile apart at east end. Holes now stop on entering granite.

07578 Hole put down through brown soils (2 samples) into dk.

(007.4) red-brown fine-grained sandstone and then into pale yellow and grey fine-grained sands with gravel at the base overlying weathered granite.

07579 Drill site west of road which heads south at this point.

(008.3) Grey carbonaceous sands over weathered granite.

07579 Low gypsum dunes about 5 feet high.
0-6" pale brown gypsiferous sand
6-12" off-white polygonal-structured gypsum crust
12"+ yellow brown cemented gypsiferous sand.
Chundie Swamps.

Photo: Wombat burrows below weakly cemented gypsiferous sands.

(008.9) Drill site east of road. Light yellowish brown gypsum cemented sand at top. Below is a sequence of lignitic sands with lignite beds.
200 yards north of this point is a low rise of dark grey weathering ferruginous sandstone. Very well cemented with limonite.

07500 Road junction on west side of Chundie Swamps. Heading north.
The limestone, which is pale brown and contains well-rounded grains of quartz, occurs at the same elevation as the ferruginous sandstone and a few feet higher than the carbonaceous sands.

07580 Lake margin. Here limestone can be seen to overlie

(009.6) ferruginous cap on the carbonaceous sandstone sequence. Limestone occupies low rises along west margin of lake.

07581 Drill hole on east side of road. Limestone on west side

(10.8) of lake for about 1 mile. Check ferricrete on cliffed lake margins.

07583 Ferruginous sandstone within the lake in this area

(012.2)	is thoroughly silicified (silcrete) Gypsum with off-white crust forms marginal dune on E. side of lakes.
07584	Road junction at drill site marked by bulldozer scrape.
(013.4)	No track.
0785	
(014.8)	
(015.4)	North-northwest trending ?fault-line scarp. West block up.
07587	Road junction. Turn right.
(016.0)	
07589	Drill hole. Northern lakes. Road junctions from rear left.
07595	Return to Chundie Swamps near supposed Road junction at northern end.
07596	Camp
(0000)	
	Traversing north of Chundie Swamps to northwest trending feature. 5.10.72
07598	Start at 004.4 about 1 m east of caravan heading magnetic north.
07603	East side of small lake. Note gypsum dunes occupy a belt
(007.0)	on the east side of lakes about ½ mile wide. All dune-form Woorinen equivalent.
07612	Northwest trending rise with brown soil veneer, but not dune form.
(016.7)	Open salt bush country in contrast to Myall scrub to south.
07613	Top of rise due east of 016.7
(017.3)	High ground at about same elevation to north. Low ground everywhere to S. May be structural feature on margin of Eucla Basin. No Qca at all in this area. Return to Chundie Swamps.
07627	Chundie Swamps.
(0000)	

07630 Turn-off from Chundie Swamps - Mitcherie Road to Seven Mile Swamps.

07632 Turn left to Seven Mile Swamps.

(004.5)

07633 Straight-road trends 060° magnetic. ?Seismic line.

(005.8)

07634 Roads join from northwest and east. Road exposes

(006.7) small outcrop of calcrete in Bakara Soil which also contains granules of re-worked Ripon Calcrete. This occurs on a small scarp bordering the low lake country to the south.
Where is the northern boundary?

Mornaba 1-Mile

07634 Small outcrop of limestone on road. Yellow coloured

(007.2) patch on preliminary sheet is open pattern of salt bush growing on brown soil, and not calcrete as shown.

Euria 1-Mile

07639 Limestone crops out at lake level throughout this terrain.

(012.1) No granite outcrop visible from road.

07644 Scarp. Appears to separate higher land to north from lower land to south.

07645 Kroonilla R.H.

Bookabie 1-Mile

07658 All brown soil in Woorinen Formation equivalent to this point. Small outcrop of off-white calcrete in Bakara Soil.

07669 Eyre Highway Junction

(041.8)

07723 Fowlers Bay.

(2) Traverses to Map 1-Mile Sheets[1] 1:63 360 Sheet areas

Penong[2]: Mileages 06708-06780, 06819-06908, 06908-07077, 07142-07198, 12926-12954, 13036-13134.

Bookabie: Mileages 07241-07361, 07519-07558, 12606-12750, 12750-12838.

Coorabie: Mileages 13208-13258, 13942-14104, 14104-14210,

1. Penong and eastern half of Bookabie form the southern half of southeast FOWLER SH53-13. Coorabie and the western half of Bookabie form the southern half of southwest FOWLER SH53-13. Some notes on adjoining 1-Mile Sheets are included here also.

2. Traverse of 24.9.72 (Mileage 06819-06908) includes data on granite sampling.

Penong 1-Mile

Includes some notes on Bookabie, and Sinclair and Charra (NUYTS 1:250 000).

Penong 1-Mile

(0000) Ceduna Caravan Park.

06708 Koonibba automatic P.O. at road junction 21 miles from Ceduna.

06710 Cunderie Tank.
Terrain from Ceduna to this point is all aeolian dune with Loveday Soil. Small outcrops of hard calcrete occur, but these are not mappable.

Bookabie 1-Mile

06734 Penong. Traversing south.

06738 Road junction. Extensive samphire flats to the south are off map.

Sinclair 1-Mile

06751 White sands of Pt. Sinclair are Semaphore Sand. Samples examined are finely comminuted shell.

Bookabie 1-Mile

06756 Southern slopes of aeolianite dunes on northern margin of Samphire swamps are covered by at least 5 feet of aeolian sand with Loveday Soil carbonates. Shown on Fowler preliminary as Bridgewater Formation.

06757 Small quarry exposes hard Ripon Calcrete. Thin veneer of younger brown soil in surrounding paddocks. Calcrete is massive and at least 3 feet thick with lamina structure and grey clasts in most places. Nodular structures also occur.

Penong 1-Mile

06761 Nunong Well. Ripon Calcrete at least 10 feet thick and possibly 20 feet is exposed in the well. Crudely and horizontally layered. This terrain could be mapped as Ripon Calcrete or as Lower Member Bridgewater Formation, or both. Possibly extends east and west as shown on preliminary map.

06764 Penong.

06769 En route to Ceduna. Turn off to Kowulka.

06771 Kowulka. Railway has been pulled up leaving sleepers and formed track only. No Ripon Calcrete, only younger brown soil. Note northwest trending dunes show brown soils. Irregular pattern to south is Ripon Calcrete and Bridgewater Formation.

06780 Pit 10 feet deep south of road.

0-6"	Light brown fine sand.
6" - 1'0"	Rubbly calcrete. Soft to moderately hard.
1'0"- 4'6"	Pale brown silty fine sand.
4'6"- 5'0"	Discontinuous horizon of hard platy calcrete. Pink with dark grey clasts. Probably reworked Ripon Calcrete.
5'0"- 10'	Yellow fine sand with abundant nodules of pink carbonate with grey inclusions. Possibly Lower Member Bridgewater Formation.

24.9.72

Traversing Ceduna - Yumbarra R.H. and collection of granite samples.

Penong 1-Mile

06819 Ceduna.

Note: Southeast corner of Penong sheet could be remapped to show calcrete. Area shown at present as calcrete is mainly brown soil.

06844 Major road junction northeast of Koonibba Mission.

06848 Close-spaced dunes vegetated with eucalypts and spinifex. Molineaux or Fulham type dune sands.

06851 Small outcrop of biotite granite. Not enough breakable material to sample.

06852 Sample: Outcrop of coarse-grained biotite granite with large phenocrysts of feldspar and scattered zenoliths of grey fine-grained rock.

06854 Leaving Inila Rock Waters for Yumbarra R.H.

06858 Sample: Yumbarra R.H. Small outcrop about 30 m across and cropping out on slope at ground surface.
Return to south.

Note: Terrain is strongly undulating, the crests being ½m-1 mile across. Relief 30-50 feet. Dunes, which are only a thin veneer, are up to 20' high on the old surface. Subsurface, possibly basement highs, or possibly an "archipelago" in Tertiary-Pleistocene time.

Note: Small rises in interdune areas are marked by Ripon Calcrete.

06865 Vermin proof fence.

06870 Boundary on Penong mosaic of Molineaux over aeolian dunes with Loveday Soil. Very vague and must be approximate.

06875 Road junction. No Molineaux between 06870 and this point.

06879 (Extra running). Southern margin of Molineaux dune field.

06888 Railway line. No track remains. Ripon Calcrete is developed in and over L.M. Bridgewater Formation. No Molineaux Sand in this area.

06891 Eyre Highway junction. No Molineaux. All younger brown soil in Woorinen Formation equivalent. Calcrete rubble is abundant in fields south-east of junction, but traverse to south shows that it is not extensive enough to map.

06908 Ceduna End of traverse.

25.9.72

06908	Ceduna
	Penong 1-Mile
06934	Brown soils throughout this landscape. Heading N. to check Molineaux body.
16938	All brown soils in Woorinen equivalent from 34 to 38.
06945	Vermin proof fence. Entrance to Yumbarra National Park. Brown soils appear to dominate from 06938 to this point where yellow Molineaux Sand is dominant. Possibly cleared land marks an embayment in dunes. Sand is all quartz sand and does not effervesce with HCl. Patches of carbonate silt and irregular rhizonodules of carbonate are exposed under yellow quartz sand in some places. Possibly younger carbonate zone in dunes.
06946	Dune pattern possibly extends no further south than this point, although limy brown soil is probably re-worked. The dune pattern is possibly composite, being inherited from eroded remnants of features as old as L.M. Bridgewater Formation in places.
06953	Heading east.
(06938)	
06956	Yellow sands of Molineaux Dunes are present on crests of rises only. Landscape to south appears to be all older aeolian Woorinen equivalent.
06957	Yellow Molineaux sand caps ridges. Southern limit of dune field. Traversing west.
06961	Traversing northwest.
(06938)	
06968	Round tank.
06968.5	Molineaux Sand. Southern margin of dune field.
06972	Intermittent Molineaux Sand from 68.5 to this point. All on southern margin of dunes.
06977	No Molineaux between 72 and 77. Heading north.
06979	Southern boundary of Molineaux dunes is about 2 dunes south of this point.
06982	Traversing west.

(06977)	No Molineaux between 72 and 77. Heading north.
06979	Southern boundary of Molineaux Dune is about 2 dunes south of this point.
06982	Traversing point
(06977)	
06988	All brown soil in Woorinen equivalent. Heading north.
06993	Southern margin of dune fields.
07004	Turn south on Pt. Sinclair Road at Penong.
	<u>Charra 1-Mile</u>
07020	Old Salt Works. ML759 has been pegged over this area. Small dumps of salt have been made on the lagoon margin. Remains of two sheds mark old workings.
07077	Traverse ends at Ceduna.
<u>Note</u>:	Ripon Calcrete cropping out onshore at Ceduna (Thevenard 1-Mile, STREAKY BAY 1:250 000) contains shells. Shell of a later "reef" also infills cavities in the calcrete.

27.9.72

Penong 1-Mile

Traversing southwest corner of Penong sheet.

Sinclair 1-Mile

07142 Pt. Sinclair base camp.

07150 Gypsum lake ¼ mile south of 06730. Samphire flats have a bioturbated gypsum crust over 6 inches of pale brown sand over a hard pan of off-white gypsum.

Bookabie 1-Mile

07150 Turn west.

07152 Semaphore Sand. Modern dunes derived by erosion of brown soils. All finely comminuted shell derived ultimately from Bridgewater Formation.

07164 Low dunes on lake area are somewhat calcareous gypsum sand.

(06738)

Penong 1-Mile

07169 From 164 to this point, brown soils in Woorinen equivalent occur. To the south of this point, calcrete rubble occurs on the tops of rises.

17174 Well southeast of Kowulka.
0-5' Brown soil.
5-25' Ripon Calcrete. Water at the bottom.

Charra 1-Mile

07189 Brown soils with scattered small O.C. of Ripon Calcrete. Terrain gently undulating and without older dune trends of Woorinen equivalent.

07198 A few small outcrops of Ripon Calcrete occur on the rises, but this area is mainly veneered with brown soil, not calcrete as shown in legend of preliminary 1:250 000 sheet.

3.11.72

Traversing Penong 1-Mile to check extent of dune-form Woorinen Formation equivalent.

12926 Turn-off to Koonibba.

12929 All brown soil from 26 to this point. Trends can be seen on photos, but not on ground.

12931 Dune form Woorinen Formation equivalent from 29 to this point and continuing. Calcrete occurs at ground surface on crests and also in swales. Form predates drape of brown soil. Calcrete is Ripon Calcrete, so dune form must derive from L.M. Bridgewater Formation or older.

12933 Change in landform to south where strong undulating terrain is present. Brown soil continues.

36 Dune-form Woorinen equivalent appears to continue to this point.
Road junction

43 Deep pits north of road. 0-2 feet of brown soil rests upon 6 feet of U.M. Bridgewater Formation with abundant clasts of Ripon Calcrete probably Pooraka equivalent. Surrounding terrain is flat to gently undulating and typical of the landscape where this unit occurs.

12947 Turn south. From Woolshed Hill to this point brown soil without significant dune form appears. This could be mapped with either dune form or non-dune form brown soil.

<u>Charra 1-Mile</u>

12949 Calcreted U.M. Bridgewater Formation forms low hills and also occurs as a thin veneer over Ripon Calcrete in places. This is coastal margin terrain and is to be differentiated from the brown soil to the north.

<u>Penong 1-Mile</u>

12954 Eyre Highway. Possible dune-form brown soil.

Note: Pooraka Formation equivalent could be present in many places, but may not appear at ground surface. Woorinen Formation equivalent is probably valid, except that in some places the dune form is much older.

1.11.72

Traversing Bookabie Sheet

12606 Penong

(0000)

12627 Traverse starts

12632 Dog proof fence. Rises are mound-shaped and valleys are all filled with brown soil. Ripon Calcrete crops out on all the rises.

<u>Euria</u> 1-Mile

12635 East-west Dog proof fence. Approximate southern limit of dune form brown soils.

12636+ Dunes continue. Fence across road.

<u>Bookabie</u> 1-Mile

12649 Eyre Highway

12650 Turn northwest along road to northwest corner of <u>Bookabie</u> 1-Mile.

<u>Euria</u> 1-Mile

126595 Saltbush plains. Brown soil veneer. This contrasts with brown soil on rolling terrain of coastal margin and brown soil of dune form Woorinen equivalent.

12665 Tank and yard.

(058.4) Calcreted fine-grained calcareous quartz sandstone. Calcrete is moderately hard layer of Bakara Soil. Seems to be present on inland part of salt bush plains.

12666 Return via route out.

<u>Bookabie</u> 1-Mile

12682 Eyre Highway

12750 End of traverse Ceduna.

<u>Note:</u> West of jetty at Ceduna, Ripon Calcrete is developed in and over L.M. Bridgewater Formation. This rested upon vertically structured clayey sand with red mottles, possibly Hindmarsh Clay equivalent.

12750 Ceduna Traversing Bookabie 1-Mile

12795 Penong.

12798 Strongly undulating with thin brown soil veneer.

12802 Road junction. Terrain as at 98.

12804 White patches on photos this area are of Semaphore Sand. Also northern margin of calcreted upper member Bridgewater Formation.

12810 Samphire flats underlain by pale brown gypsum sand with patches of soft off-white crystalline gypsum. Open water occurs at the inland edge of Semaphore Sand

12818 Bay. Ripon calcrete, pink with dark grey angular inclusions and quite hard, occurs up to 10 feet above sea-level and is overlain by 25 feet of U.M. Bridgewater Formation with moderately hard calcreted layers each up to 1 foot thick. U.M. Bridgewater Formation contains numerous pink and grey clasts ranging in size from boulders of Ripon Calcrete down to sand size fragments.
To the west of the bay Ripon Calcrete in multiple layers up to 10 feet thick overlies yellowish orange carbonate sand of L.M. Bridgewater Formation. Close-spaced vertical pipes are very common.
Bridgewater Formation also occurs in off-shore stacks.

12823 Road junction. Strongly undulating landform veneered by brown soil, probably over U.M. Bridgewater Formation.

12826 Northern slope of major ridge. Plains to north are probably Ripon over L.M. Bridgewater Formation. Brown soils continue north as an overlay with Ripon Calcrete exposed on hills.

12833 L.M. Bridgewater Formation veneered by brown soil. Ripon Calcrete occurs in road cuttings.

12836 Ditto

12838 Outcrop (on hill top overlooking sea) of off-white calcrete in Bakara Soil. This ridge is possibly all U.M. Bridgewater Formation (extending a mile or so to the north).

4.11.72

Ceduna

Traversing south of Eyre Highway 7 miles east of Penong to check dune-form brown soil and Bakara Soil calcrete boundaries.

13036 Dune-form brown soils continue to this point.

13038 Dune-form brown soils continue south to this point. Rolling terrain to south with scattered outcrops of calcreted U.M. Bridgewater Formation.

Charra 1-Mile

13047 Lake MacDonnell gypsum works

Sinclair 1-Mile

13059 North side of Pt. Sinclair. Granite gneiss forms the headland and is overlain by a weathered zone (not inspected) and then 20 feet of aeolianite with abundant vertical pipes. This massive unit does not show cross-bedding as does the Upper Member. Above this is 20 feet of Ripon Calcrete, pink with grey inclusions and containing re-worked nodules. In some places, the Ripon Calcrete is a sedimentary breccia or conglomerate composed of aeolianite with scattered clasts of angular breccia or rounded conglomerate of gravel up to pebble size. Cross-bedded aeolianite with dark grey grains re-worked from Ripon Calcrete in-fills depressions on the old Ripon Surface and is up to 25 feet thick.

Bookabie 1-Mile

13070 Near 06757 of previous traverse. Abundant calcrete of Bakara Soil over Ripon Calcrete. Include as coastal terrain with U.M. Bridgewater Formation. To the north this gives way to rolling terrain veneered by brown soil with outcrops of Ripon Calcrete common.

Bookabie 1-Mile

13073 Terrain from 13070 is all undulating L.M. Bridgewater Formation overlain by Ripon Calcrete which crops out in many places and is veneered nearly everywhere by a thin brown soil. Show as brown soil of the non dune-form type.

Bookabie

13075 Brown soil non dune-form.
Heading north.

13081 Southern limit of Woorinen equivalent. All rolling

(06988) terrain veneered with thin brown soils and having numerous

(07339) small inliers of Ripon Calcrete between here and Penong.

13134 Return to Penong and Ceduna.

Bookabie 1-Mile

Includes notes on Coorabie, Penong, and Sinclair and Charra on NUYTS 1:250 000 sheets.

28.9.72

Traversing Pt. Sinclare base to Fowlers Bay

07241 Bore

Bookabie 1-Mile

07277 22.5 miles from Penong on turn-off to Fowlers Bay from Eyre Highway. All brown soil over calcrete to this point. Appears to be no justification to map as Ripon Calcrete as on preliminary FOWLER 1:250 000. Small rounded hills of the Bookabie area proper could be mapped as Ripon Calcrete perhaps.

07286 Turn south to Fowlers Bay. Brown soils continue.

Coorabie 1-Mile

07297 Fowlers Bay. Units are: Semaphore Sand, Yamba Formation equivalent of samphire flats, coastal sands (brown soils) and Ripon Calcrete of the coastal cliffs.

07302 Rises in the coastal tract are topped by off-white moderately hard calcrete from U.M. Bridgewater Formation. Perhaps this zone can be mapped as U.M. Bridgewater Formation in places or as a composite of coastal brown soil on U.M. Bridgewater Formation. Semaphore sand is all comminuted shell from Recent beaches, but contains the grey grains possibly derived originally from Ripon Calcrete. Pale brown sand of the coastal brown soils is also fossil fragment sand, but individual grains are frosted, pale brown and much finer grained.

Bookabie 1-Mile

07325 Thin brown soil over hilly Ripon Calcrete. Map units should be aeolian Woorinen equivalent, soil mantle on undulating terrain (for which parent material is same age), Ripon Calcrete and calcrete of Bakara Soil (marking the coastal margin).

07327 Southern margin of dune formation Woorinen equivalent. Some ridges in this landscape are capped by Rippon Calcrete, which suggests that the dune shapes may be pre-Ripon.

Penong 1-Mile

07336 East side of Bookabie mosaic. All dune form Woorinen equivalent.

07339 South to Penong.
Brown soils with aeolian form continue to east side of mosaic.

Sinclair 1-Mile

07361 Pt. Sinclair base camp.

Coorabie 1-Mile

Includes some notes on Bookabie

5.11.72

Traversing north from Pennalumba Well.

13208	Brown soils on Bookabie 1-Mile occur as a veneer on gently undulating terrain. Not dune-form.
13211	Near southern margin of brown soil in Woorinen Formation equivalent.
13214	Eyre Highway. Continuing traverse to west.
	Change <u>Bookabie</u> 1-Mile to <u>Coorabie</u> 1-Mile
13221	Rolling topography with a veneer of brown soil continues. Heading north to locate southern edge of dune-form Woorinen equivalent.
13224+	Rolling terrain with thin brown soil over Ripon Calcrete continues to this point. Well. Ripon Calcrete and calcreted aeolianite of Upper Member Bridgewater Formation are both found here.
13225	Southern limit of dune-form Woorinen equivalent.
13227	Dune form Woorinen equivalent shows on photos, but local relief very subdued on ground. Return to Eyre Highway.
13232	Starting point on Eyre Highway. South towards Fowlers Bay.
13233	Thin veneer of calcreted aeolianite over Ripon Calcrete.
13246	Fowlers Bay.
13251	Coastal heath on sandy over U.M. Bridgewater Formation. Turn north to check boundaries. Semaphore Sand is towards the beach from this point.
13253	Well calcreted upper member Bridgewater Formation extends across ridge to south of this point and here gives way to Ripon Calcrete in valley floor.
13254	Calcreted U.M. Bridgewater Formation forms major ridge.
13255 Sample:	Shells from shell bed below calcrete.

Section

0-6"	Pale greyish brown shelly gypsiferous fine sand.
6"-18"	Light brown silt.

18"-2'0 Calcreted shell bed
24" + Oyster bed. Anadara

Note: 18"-24" + is probably Glanville Formation.
Adjacent ridge to east is U.M. Bridgewater Formation.

Bookabie 1-Mile

13256 U.M. Bridgewater Formation extends from 13254 to this point where it forms a thin veneer of softer calcreted aeolianite with abundant fossil wasps nests over pink Ripon Calcrete.

13258 Eyre Highway. From 256 to this point is all brown soil, possibly all Ripon Calcrete and older units below the soil cover.

13.11.72

13942 Ceduna

14028 Coorabie 1-Mile. Traversing north to check extent of dune form Woorinen equivalent.

14031 This terrain is all dune-form but relief is very low and trends cannot be seen on ground. Some calcrete on rises, but not enough to suggest ancient dune trends.

1043 Turn northeast to check dune trends. Note that bare rock ground mantled with Ripon Calcrete debris occurs south of the road and that Ripon Calcrete trends are reflected in trends of Woorinen equivalent to the east.

14047 Tank. Thin brown soil veneers Ripon Calcrete in this area.

14056 All terrain from 14047 to this point in veneered with brown soil. No bare rock ground.

14075 Ripon Calcrete on low mound shaped hills throughout from 56 to 75.

14077+ Fence and road junction. Brown soil over calcrete. Terrain interrupted by wide shallow valleys. Possibly inland of L.M. Bridgewater Formation boundary, and in the Chundie Swamp type of terrain where soil mantles rest upon Tertiary.

14087 Turn-off Eyre Highway for Fowlers Bay via Coorabie.

14091 Terrain to north is Ripon Calcrete, terrain to south is marked by brown soils and lowlands. This point is possibly the zone between Ripon Calcrete and U.M. Bridgewater along the coastal margin.

14094 Approximate northern margin of calcrete in Bakara Soil over Ripon Calcrete and possibly U.M. Bridgewater Formation.

14104 Fowlers Bay Base Camp.

14.11.72

14104 Traverse to northwest corner of Coorabie 1-Mile.

14127 Pale greyish brown soil and scattered float of calcreted U.M. Bridgewater Formation indicates coastal complex.

Note: Soils southwest of Eyre Highway are deep brown soils as a veneer on a very gently undulating landscape.

19133 Outcrop of U.M. Bridgewater Formation coated with off-white carbonates and calcreted by moderately hard calcrete of Bakara Soil.

14135 Strongly undulating terrain of small rounded hills.
Note: The U.M. Bridgewater Formation could be mapped here in much the same way as the Ripon Calcrete is mapped N of the Eyre Highway. However, so much of this unit is veneered by brown soil elsewhere that it would not be a practicable procedure.

14136 Same terrain continues to northwest probably to northwest corner of sheet. Heading southeast.

14150 Eyre Highway to Fowlers Bay. Hard Ripon Calcrete near ground surface back about one mile (to 14149). Eastern boundary of coastal complex and U.M. Bridgewater Formation is probably north of this point. U.M. Bridgewater Formation occurs here as a veneer on Ripon Calcrete and the photo pattern reflects the form of older L.M. Bridgewater Formation.

14155 Coastal complex. Heading south.

14167 Coastal cliffs. L.M. Bridgewater Formation is overlain by calcrete and by U. Bridgewater Formation with wasps nests, rhizonodules etc. Lower Member is yellowish orange and massive with large vertical pipes and is cross-bedded in places.

14171 Gypsum. Small flat marked by samphire. Gypsum is a pale brown sand with off-white patches and with lenses of dark grey gypsiferous muck. Turn-off to Cape Adieu.

14184 High point in landscape. Outcrop of U.M. Bridgewater Formation. Broad valley to south is marked by brown soil.

14187 U.M. Bridgewater Formation. On lake margins, the limestone is shelly and has a crude polygonal structure a few feet across. Glanville Fm. contains Anadara.

14187+ Beach ridge of St. Kilda Formation. Shell is mainly Katelysia. Return via Coorabie to intersection with Eyre Highway. Traverse east. Turn south at 14205.

14207 Surface slopes gently south to this point at the bottom of broad valley. All brown soils with Ripon Calcrete on isolated ridges to the east. At 14207 Ripon crops out in paddocks.

14210 Top of ridge, U.M. Bridgewater Formation. Terrain to north is Ripon Calcrete overlain by brown soil.

Ceduna End of traverse

3. East-West Traverse across FOWLER during Terrain Survey along Eyre Highway from Pt. Augusta to Ceduna (Rept.Bk. 59/75).

See also "Bore Logs" following in this appendix and derived from the same source.

12592	0-6"	Brown sand
	6-9"	Rubble calcrete of gravel size.
	9"-3'	Brown sand scattered limy nodules
12594	Calcrete float on dunes to south.	
12595	Entrance to Koonibba. Shallow quarry.	
	0-12"	greyish brown sand
	12"-24"	Pale brown sand with scattered nodules
12596	Road junction	
12601	Road junction. Dunes continue. Scrapes show sandy brown soil profiles with soft carbonates	
12610	Scrapes show 3' of brown soil profile.	
12610+	0-6"	Light brown fine sand with a few scattered nodules
	6"-1'6"	Pale brown fine sand and scattered small limy nodules
	1'6"-2'0"	Off white limy fine sand with scattered small nodules. Becoming soft. Calcrete in places.
	2'0"-7'0"	Light brown limy fine sand with numerous small hard limy nodules, and patches of lime.
	7'0"-10'0"	Very gravelly fine sand (Abundant small nodules very grey in limy reddish brown sand.
12617	Sandy brown soil profile at least 3' deep.	
12622	Discont. calcrete in brown soil. Crops out at surface on dune ridge.	
12623	Quarry brown soil 4' deep.	
12632	Sandy brown soil in quarry 4' deep. See Bookabie mosaic. Boundary at 12633.	
12639	Strongly undulating. Hills up to ½ mile across. Valleys up to 1 mile.	
	0-6"	Light brown sand with hard irregular nodules of calcrete
	6"-9"	Platy brown hard calcrete
	9"-15"	Pebbly calcrete. Pebbles in contact.
	15"-2'6"	Reddish brown sand.
Sample 10	2'6"	Hard calcareous sandstone Calcreted sand.
12644	Camp	
12644	<u>Sunday 16.8.64</u>	
	Valley floor soils brown 2' deep. North side.	

12645	0-6"	Light brown fine sand and poorly developed platy calcrete	
	6-12"	Light reddish brown sand very compact.	
	12-18"	Dark red brown compact sand.	
	18-30"	Horizon of weakly cemented, pale brown sand with pebble sized calcrete	
	30"+	Pale brown limy sand.	

This profile shows several periods of re-working.

12646 Sand dune unit continues.

12647 Sand. Calcrete 3' deep on top of rise.

12651 Brown soil at least 3' deep in extensive flat.

12653 Brown soil profile 4' deep; top of rise.

12665 Pintumba

12667 Brown soil 3' deep with weak platy calcrete

12668 Heavy calcrete. Blocks up to 4 x 2 x 1. Some larger.

Photo 2 This sort of material occurs on all rises from 12664 to this point - and further. Note the distinctive hummock shapes. New unit 12673. See Trunch Mosaic.

12679 Trunch mosaic. Gently undulating unit with brown soil at surface and with only a few floaters of calcrete. Seems that dune unit continues from about 12671 to this point and beyond.

12679	0-6"	Pale brown limy fine sand with very small limy nodules.
	6-24"	Off white limy nodule and pebble-sized calcrete.
Photo 6	24-4'0"	Light reddish brown fine sand with scattered lime nodules

12680 Sandy brown soil with thin hard platy calcrete.

12687 Sandy brown soil continues through this area. At least 1-2ft deep. But calcrete may be present under brown soil in some places.

12689 Thin sandy brown soil over hard calcrete.

APPENDIX 8

LOGS OF BORES AND WELLS ADJACENT TO THE EYRE HIGHWAY ON FOWLER 1:250,000 SHEET

See Rept.Bk. 59/75 for additional hydrological information, and refer to accompanying geological map for locations.

Locations on map are shown thus: 4/1/1. This refers to Plan 4, Strip 1, Bore 1 (Hd. Catt, Section 1) in the following logs and provides a cross reference to original plans accompanying Rept.Bk. 59/75.

Bore	Section	Strata passed through		Remarks
		PLAN 4 Strip 1: Koonibba to Penong		
1	1	At about 50' to dense aplitic granite trace of water in bottom, never equipped.		Chatana Trial Folder 1/1A Hd. Catt.
2	1	No details - Total 68'		Bore No. E Hd. Catt.
3	17	No details - Total 54'		Bore No. A Hd. Catt.
4	1	No details - Total 38'		Bore No. F Hd. Catt. Plan 147-1/1
5	17	Sand caving in - Total 30'		Bore No. C Hd. Catt.
6	17	0 - 2'	Limestone soil.	Bore No. B. Folder 9/- Hd. Catt.
		2 - 10'	Light greenish brown sandy limestone.	
		10 - 20'	Light yellow brown marl and limestone.	
		20 - 35'	Light yellow brown limestone and weathered granite fragments.	
		35 - 102'	Light grey weathered granite.	
7	50	0 - 10'	Light brown sandy limestone.	Bore No. A Folder 19/- Hd. Catt.
		10 - 20'	Buff fine grained dense nodular limestone.	
		20 - 22'	Red brown and grey clayey fine sand with limestone nodules.	
		22 - 35'	Buff fine-grained dense nodular limestone.	
		35 - 55'	Cream fine sand with grit and nodules of white clay.	
		55 - 155'	Cream clay with mica and abundant quartz grit.	
		155 - 215'	Samples missing.	
		215 - 240'	Grey weathered medium-grained granitic gneiss.	

Bore	Section		Strata passed through	Remarks
		240 - 250'	Grey soft weathered fine-grained mica schist.	
		250 - 270'	Grey fine-grained granitic gneiss.	
8	27	0 - 8"	Brown loam soil and limestone rubble.	Bore No. A Folder 7/- Hd. Catt.
		8" - 2'6"	Cream coloured calcareous clay and limestone rubble.	
		2'6" - 14'	Hard nodular travertine limestone.	
		14 - 28'	Pale yellow brown fine siliceous sand, occasional grit and gypsum crystals.	
		28 - 28'6"	Hard grey granite bedrock (resembles Black Hill granite).	
9	32	0 - 18'	Brown rubbly limestone.	Bore No. A Folder 18/- Hd. Catt.
		18 - 35'	Light brown rubbly marl.	
		35 - 150'	Decomposed granite, very micaceous and poor in quartzite.	
10	21	0 - 12'	Pale brown fine carbonaceous sand and sandy limestone.	Bore No. A Folder 17/- Hd. Catt.
		12 - 35'	Brown sandy clay with limestone gravel.	
		35 - 52'	Pink sandy clay with gravel and carbonaceous fragments.	
		52 - 65'	Red brown clayey sand with quartz and limestone gravel.	
		65 - 78'	Mottled red brown-grey sandy clay.	
		78 - 90'	Pale brown sandy clay with rounded quartz gravel and particles of weathered gneiss.	
		90 - 110'	White gritty clay with abundant muscovite.	
		110 - 114'	Pale brown sandy clay with abundant mica, quartz and particles of decomposed gneiss.	

Bore	Section		Strata passed through	Remarks
		114 - 115'	Brownish grey coarse quartz gravel with felspar and mica and some weathered gneiss.	
11	22		Lime rubble. Limestone. Red clay. Yellow sand. Clay. Yellow sand. Red sand. Yellow sand.	Bore No. B Folder 1/4 Hd. Bagster.
		65'	Decomposed granite with mica.	
12	22		Micaceous granite. Gneiss from 40'.	Well No. A.
13	6	0 - 11'	Travertine and pink clay.	Bore No. B
		11 - 16½'	Red sandy clay.	Folder 2/-
		16½ - 27'	Yellow sand and clay.	Hd. Bagster
		27 - 133'	Soft grey micaceous schist-seams of red gneiss.	
		133 - 134½'	Hard yellow micaceous gneiss.	Bore No. B.
		134½ - 150'	Grey gneiss (quartz, felspar, biotite).	
14	6	0 - 3'	Brown sandy soil with some calcareous nodules.	Bore No. A.
		3 - 20'	Brown clay limestone gravel.	Folders - 10/- 1/2.
		20 - 40'	Red sandy clay with calcareous nodules.	Hd. Bagster.
		40 - 45'	Brown fine sand with some clay and abundant muscovite.	
		45 - 65'	Greyish brown highly weathered gneiss.	
15	6	0 - 3'	Brown sandy soil.	Bore No. A.
		3 - 20'	Pale brown clayey limestone rubble.	Folder 12/- Hd. Bagster.
		40 - 62'	Pale brown clayey sand with calcareous nodules.	
		62 - 85'	Pale brown clayey sand and grit with calcareous frags.	
		85 - 100'	Grey-white gritty clay with abundant mica.	
		100 - 110'	No sample. Driller reports white clay with mica.	
		110 - 125'	No sample. Driller reports white clay with mica.	

Bore	Section	Depth	Strata passed through	Remarks
16	32	0 - 3'	Soil.	Bore No. A Folder Nos. 1/3, 15/-
		3 - 20'	Pinkish buff marly limestone.	
		20 - 28'	Red brown rubbly sandy marl.	
		28 - 34'	Pinkish buff very micaceous quartz deficient decomp. granitic rock.	
		34 - 56'	Off white ditto.	
17	5M		No details - Total 90'	Well A
18	5M		No details - Total 90'	Well B
19	4N		No details - Total 85'	Well A
20	4N		Water in 8 ft. of decomposed mica schist. Quartz pebbles.	Bore C
		97 - 100'	Mica schist.	
		105	Calc. gravel - mica schist (Decomposed).	
21	5W	0 - 3'	Sandy soil.	Bore A Folder 11/- Hd. Bagster
		3 - 15'	Brown rubbly limestone.	
		15 - 20'	Cream, brown and green rubble marl.	
		20 - 34'	Light red brown very sandy marl.	
		34 - 58'	Red marly sand.	
		58 - 72'	Cream very micaceous silty-?schist derivative.	
22	8	0 - 1'	Brown soil.	Bore A Folder 11/-
		1 - 2½'	Brown calcareous clay.	
		2½ - 10½'	Hard nodular travertine limestone.	
		10½ - 17'	Grey sandy clay.	
		17 - 34'	Brown sandy clay.	
		34 - 37'	Pale yellow fine siliceous sand.	
		37 - 43'	Pale yellow fine siliceous sand.	
		43 - 45'	Brick red fine siliceous sand.	
		45 - 51'	Fine yellow-brown siliceous sand.	
		51 - 57'	White sand and grit.	
		57 - 85'	Fine golden-yellow micaceous sand.	
		85 - 92'	Pale yellow micaceous sand.	
		92 - 94'	Pale yellow micaceous sand and quartz grit (water).	

Bore	Section		Strata passed through	Remarks
23	9	No details - Total 40'		Well B. Hd. Burgoyne.
24	9	0 - 2'	Brown soil.	Bore A. Folder 7/- Hd. Burgoyne.
		2 - 4'	Pale brown calcareous clay.	
		4 - 6'	Cream coloured calcareous clay and limestone rubble.	
		6 - 11'	Nodular travertine limestone.	
		11 - 16'	Brown calcareous clay and limestone rubble.	
		16 - 24'	Fine mottled grey and yellow clayey sand (siliceous).	
		24 - 50'	Yellow-brown clay (samples lost).	
		50 - 54'	Pale yellow and fine siliceous sand and some clay.	
		54 - 60'	Mottled white and yellow fine siliceous sand with some clay.	
		60 - 72'	Yellow siliceous sand and considerable muscovite.	
		72 - 76'	Coarse quartz sand.	
25	8	0 - 6'	Creamy white travertine limestone.	Bore C Folder 18/- Hd. Burgoyne
		6 - 15'	Grey brown travertine limestone and some marl.	
		15 - 30'	Brick red silt and very fine sand.	
		30 - 35'	Brick red silt and very fine sand with ferruginous grit and gravel.	
		35 - 45'	Light brown silty and very fine sand.	
		45 - 60'	Dark brown silty fine sand with grit and gravel some of which amphybolitic.	
		60 - 75'	Palepink micaceous clay.	
		75 - 90'	Whitish and blue mica and some clay.	

Bore	Section		Strata passed through	Remarks
26	7	0 - ½'	Brown soil.	Bore A. Folder 14/- Hd. Burgoyne.
		½ - 7'	Nodular travertine limestone.	
		7 - 15'	Calcareous clay and limestone rubble.	
		15 - 36'	Brick red ochreous sandy clay.	
		36 - 40'	Fine white siliceous sand-red mottlings.	
		40 - 51'	Very fine white siliceous sand and sandstone.	
		52 - 64'	Brick red ochreous fine siliceous sand.	
27	24	0 - 10'	Cream travertine limestone.	Bore B.
		10 - 20'	Creamy travertine limestone with some marl.	
		20 - 38'	Pale pink marly fine sand with some calcareous grit and gravel.	
		38 - 42'	Yellowish cream slightly silty fine to coarse sand.	
28	24	0 - 5'	Pale pink travertine limestone.	Bore A. Folders 15/- and 2/7. Hd. Burgoyne.
		5 - 18'	Pale browny cream travertine limestone.	
		18 - 25'	Pale browny cream travertine limestone with some marl.	
		25 - 31'	Brown marl with travertine limestone rubble.	
29	Town Lot	No details - Total 90'		Bore TA. Folder No. 23/- Hd. Burgoyne.
30	12	No details - Total 29'		Station Horse Well C. Hd. Burgoyne Plan 147-1/1
31	12	No details - Total 7'		Bore No. A Hd. Burgoyne Minyaoola Well Plan 147-1/1

Bore	Section	Strata passed through	Remarks
32	12	No details - Total 11'6"	Bore No. E Folder No. 32/4 Hd. Burgoyne Racecourse.
33	84	No details - Total 35'	Well No. A Hd. Burgoyne Plan 147-1/1
34	84	No details - Total 12'	Bore No. D Hd. Burgoyne Folder 32/5 Racecourse.

Bore	Section	Strata passed through	Remarks
1	33	<u>PLAN 4 Strip 2: Penong to Tallala Tank</u>	Well No. A Hd. Cohen
2	7	Over whitish clay (or marl)	Bore No. 2 B. Shipard Hd. Cohen.
4	6	5 ft. Clay 6 " Rock 20 " Hard rubble 9 " Rock	Bore No. D Hd. Cohen Folder No. 1/9 M.G. Oats, Penong
5	23	0 - 2' Calcareous sandy topsoil. 2 - 4' Pinkish sandy limestone. 4 - 11½' Travertine. 86 - 104' Pinkish medium grained very calcareous sand. 104 - 108' " " " 108 - 128' Red coarse slightly calcareous sand.	Bore No. A. Folder No. 5/- Hd. Cohen G.J. Edwards
6	6	No details - Total 25'	Well No. A. Hd. Cohen R. Dunn
7	12A	No details - Total 17'	Well No. A Hd. Giles G. Law
8	12A	No details - Total 36'	Bore No. B. Hd. Giles G. Law
9	12B	No details - Total 40?	Well No. A Folder No. 1/8 Hd. Giles R. Dunn
10	8A	No details - Total 30'	Bore No. A Hd. Giles C. Brook

Bore	Section		Strata passed through	Remarks
11	7	0 - 20' 20 - 35' 35 - 52' 52 - 77'	Pink sandy marl and lime-stone. Pink sandy marl - some large quartz grains. Pink very sandy marl. Pink sandy marl.	Bore No. A Folder No. 4/- Hd. Giles G.J. & J.L. Edwards Ceduna. Non-productive.
12	16	No details -		Bore No. A Hd. Giles
13	8	No details - Total 27'		Bore No. A Hd. Giles G. Law
14	11	No details - Total 30'		Mannadilla Well No. B Folder No. 1/6 Hd. Giles
15	10A	No details - Total 35'		Garden Well A Hd. Giles G. Law
16	10A	No details - Total 27'		Well No. B Folder No. 1/5 Hd. Giles G. Law
17	9	No details - Total 47'		Well A Folder No. 1/4 Hd. Giles
18	8	0 - 20' 20 - 40' 40 - 45'	Pale brown sandy clay with limestone gravel. Pale brown marly lime-stone gravel. Pale brown dense sandy clay with limestone nodules.	Bore No. A Folder No. 8/- Hd. Magarey J.H. Murray & Sons.
19	16		Hard limestone to 19'. Soft limestone - little pipe clay in bands rock bottom.	Bore No. B Folder No. 7/5 Hd. Magarey J. Miller.

Bore	Section		Strata passed through	Remarks
20	16	0 - 19'	Hard limestone. Soft limestone. Little pipe clay in bands. Rock bottom.	Bore No. C Folder No. 7/5 Hd. Magarey J. Miller.
21	16	0 - 19'	Hard limestone. Soft limestone. Little pipe clay - in bands Rock bottom.	Bore No. D Folder No. 7/5 Hd. Magarey
22	16	0 - 19'	Hard limestone. Soft limestone. Little pipe clay - in bands. Rock bottom.	Bore E. Folder No. 7/5 Hd. Magarey
23	W.Res.	No details - Total 43'		Bookabie Govt. Well T/A Hd. Magarey F. Gray.
24	62	17 - 3' 3 - 17' 17 - 22'	Brown sandy soil. Buff rubbly limestone. Pinkish-white limestone.	Bore No. B. Folder No. 12/- Hd. Magarey F. Gray
25	62	0 - 3' 3 - 19'	Sandy soil. Light buff limestone.	Bore No. A Folder No. 11/- Hd. Magarey F. Gray
26	13	0 - 16' 16 - 27' 27 - 35' 35 - 36'	Limestone. Not stated. Sand-pipe clay. Gravel.	Bore No. D. Folder No. 7/4 Hd. Magarey J. Dunn
27	13	Limestone and calcite		Old Well A Folder No. 1/8 Hd. Magarey Dunn (not used)

Bore	Section		Strata passed through	Remarks
28	12	0 - 5'	Brown calcareous soil.	Bore No. C
		5 - 14'	Pink calcareous clay.	Folder No. 3/-
		14 - 17'	Brown gritty clay.	Hd. Magarey
		17 - 19'	Travertine limestone.	I.A. Gray
		30 - 36'	Brown clay with limestone nodules.	
29	12	0 - 1'	Brown soil.	Bore No. B
		1 - 16'	Travertine limestone.	Folder No. 4/-
		16 - 36'	Pink pale brown calcareous sand-aeolianite.	Hd. Magarey
		36 - 51'	Cream coloured calcareous sand-aeolianite.	
		51 - 66'	Yellow-orange fine sand and grit - slightly calcareous.	
		66 - 72'	White clay with ironstone nodules.	
30	13	0 - 3'	Soil.	Bore No. E
		3 - 20'	Light brown sandy limestone.	Folder No. 9/-
		20 - 32'	Yellow brown very sandy marl.	Hd. Magarey L.J. Dunn Abandoned
		32 - 50'	Yellow pink slightly gritty marl.	
		50 - 68'	White, pink and light brown silty clay.	
		68 - 125'	White and pink micac. kaolinitic gritty clay - (?bedrock derivative).	
31	12	0 - 3'	Light brown soil	Bore No. D
		3 - 18'	Travertine limestone.	Folder No. 5/-
		18 - 33'	Pale brown fine calcareous sand - some siliceous aeolianite.	Hd. Magarey I.A. Gray
		33 - 38'	Orange coloured fine calcareous sand - some siliceous aeolianite.	
		38 - 42'	Hard sandy limestone-fine grained.	
		42 - 56'	Light brown calcareous sand - porellanite pebbles aeolianite.	
		56 - 57'	Fine yellow siliceous sand.	

Bore	Section	Strata passed through		Remarks
		PLAN 4 Strip 3: Tallala Tank to Nundroo		
1	18A	0 - 15'	Red clay.	Bore B. Folder 1/4 Hd. Caldwell
		30'	Limestone.	
		50'	Various clays.	
		At 51'	Sand, grey green.	
2	32	No details - Total 16'6"		Bore No. A Folder 1/5 Hd. Caldwell
3	20B	20'	Limestone.	Bore ?B Folder 1/3
		24'	Clay with gravel.	
		24'	Granite.	
4	B		Travertine, fossiliferous calc. sandstone. Hornblende gneiss.	Well (S.cnr.) Folder 2/3. Hd. Sturdee Well in hollow.
5	21	0 - 15'	Pinkish travertine.	Bore No. A Folder 12/- Hd. Sturdee.
		15 - 25'	Greenish to pale buff soft limestone.	
		25 - 40'	Yellow fine sand.	
		40 - 58'	Yellow fine sand some coarse fragments.	
		58 - 67'	Red brown sandy marl.	
		67 - 89'	Buff sandy marl.	
6	17		Nodular limestone. L.S. sand. Red. calc. sand. Total 68'	Bore No. A Pintumba Well Folder 2/2 Hd. Sturdee
7	24		Yellow fossiliferous calcarenite.	Well A. Turcmba Well Folder 2/5 Hd. Sturdee
		0 - 66'	Alluvium, Marine limestone. Yellow sand and ste.	
8	16	No details - Total 75'		Old Well C Folders 4/1 & 4/2. Hd. Sturdee.
9	16	No details - Total 56'6"		Folder 4/6 Bore No. A Hd. Sturdee.

Bore	Section		Strata passed through	Remarks
32	9	0 - 4'	Brown soil.	Bore No. G
		4 - 17'	Buff limestone and marl.	Folder No. 10/-
		17 - 32'	Light brown to cream nodular rubbly limestone.	Hg. Magarey G. Mahar
		32 - 51'	Yellow calc. gritty sandstone.	
		51 - 58'	Light brown clay and grit.	
		58 - 65'	Red to maroon micaceous gritty clay -? granitic derivative.	
33	9	62'	Clay and cream sand to 62'	Well No. B Folder No. 1/2 Hd. Magarey Maher's Well
34	9	This sample was taken 3' below bottom of fresh water, which makes about 400 g.p.d. Fresh water in white pipe clay, quartz and quartz sand.		Bore No. H Folder No. 2/10
35	9	Limestone on mica and hornblende schist and qte with granite veins.		Pennalumba Well C Folder No. 1/5 Hd. Magarey.
36	9	Limestone and granite. Travertine 1st., alluvial sand and clay, amphibolite and granite.		West Well D Folder No. 1/5 Hd. Magarey Pennalumba Well
37	9	0 - 4'	Brown soil.	Bore No. F
		4 - 17'	Nodular travertine limestone.	Folder Nos. 6/- & 6s/-
		17 - 32'	Fine calcareous sand - aeolianite.	Magarey G.P. & B. Mahar.
		32 - 42'	Brown siliceous sand - some clay and grit.	
		42 - 59'	Very fine brown siliceous sand.	
		59 - 69'	Quartz gravel and white clay (near bedrock)?	
		69 - 75'	Quartz and sand.	
38	7A	No details - Total 45'		Well No. A Folder No. 1/2 Hd. Nash J. Murray

Bore	Section	Strata passed through		Remarks
10	16	No details - Total 48'6"		Bore No. B Folder No. 4/7 Hd. Sturdee.
11	3	0 - 3' 3 - 20' 20 - W.L.	Travertine. Trav. sandstone. Timbered. Gneissic granite dump.	Well A. Hd. Brown Folder 1/1 Kooringibbie Govt. Well.
12	3		Limestone Total 58'6"	Bore No. B. Folder No. 2/10 Hd. Miller.
13	3	No details - Total 56-58'		Well D. Folder 1/10 Hd. Miller.
14	3	No details -		Well B. Fox's Well Hd. Miller Folder 1/4.
15	4	0 - 18' 18 - 50' 50 - 61'	Travertine and travertinised sandstone. White calc. rubbly clay. Yellow (horizontal) fossiliferous sandstone.	North Well No. A Folder 2/2 Hd. Miller
16	4	No details - Total 63'		Well D. Folder 1/5 Hd. Miller.
17	4	No details - Total 60'		South Well C Folder 2/1 Hd. Miller.
18	3		Travertine and fossiliferous sandstone on dump.	Well C Folder 1/9 Hd. Miller.
19	5A	0 - 45' 45 - 58' 58 - 68' 68 - 77' 77 - 85' 85 - 98' 98 - 101'	Travertine. Calcareous sandstone (aeolianite) Hard yellow aeolianite Yellow clayey " Hard calcareous sandstone. Yellow aeolianite. Yellow calcareous coarse sand.	Bore A. Folder 4/- Hd. Miller.

Bore	Section		Strata passed through	Remarks
		101 - 111'	Dark yellow calcareous sandy clay.	
		111 - 115'	Dark yellow quartz sand.	
20	16	No details - Total 85'		Stotts Well E Folder 9/1 Hd. Miller.
21	16		Travertine, sandstone and find sand on dump.	Well A Folders 2/3 & Hd. Miller
		0 - 70'	Limestone on white green and yellow sand and clayey grit.	

Bore	Section		Strata passed through	Remarks
		PLAN 5. Strip 1: Nundroo to Waltabie Well (See FOWLER 1:250 000).		
1	16	No details - Total 100'6"		Bore D Folder 2/9 Hd. Miller.
2	16	53 - 105' 105 - 115' 115 - 125' 0 - 30'	Brown clay. Fine white sand. Coarse yellow sand. Limestone on green and white clay and sand.	John's Bore C Folder No. 7/- & 1/3. H.R. Alchurch & E.H. Johns Hd. Miller.
3	21	0 147'	Old well limestone (SKETCH) pipe clay stone sandy clay Water	Bore C Folder No. 2/5 Hd. Miller E.H. Johns & Sons.
4	21	0 - 30' 30 - 55' 55 - 78' 78 - 90' 90 - 105' 105 - 135' 135 - 142'	Well Grey clay sand. White clay sand. Grey sandy clay. Grey sandy clay. Soft brown sandstone. Grey sand.	Bore A Folder No. 8/- Hd. Miller H.R. Alchurch.
5	21	No details - Total 26'		Bóre B Folder No. 2/8 & 2/6. Urabi Pastoral Co. Hd. Miller.
6	21	0 - 27' 27 - 100'	Limestone. Dark brown clay Yellow clay beneath.	Big Paddock Bore D. Folder No. 2/7 Hd. Miller Urabi Pastoral Co.
7	24	0 - 108'	Fossil III limestone.	Bore B Folder No. 1/7 Hd. Miller.
8	6		Limestone conglom. (Near cryst. fossil) L.S. (Older sand or sandstone).	Cadamby Well Folder 1/1 Hd. Lucy.

Bore	Section		Strata passed through	Remarks
		PLAN 5. Strip 1: Nundroo to Waltabie Well (See FOWLER 1:250 000).		
1	16	No details - Total 100'6"		Bore D Folder 2/9 Hd. Miller.
2	16	53 - 105' 105 - 115' 115 - 125' 0 - 30'	Brown clay. Fine white sand. Coarse yellow sand. Limestone on green and white clay and sand.	John's Bore C Folder No. 7/- & 1/3. H.R. Alchurch & E.H. Johns Hd. Miller.
3	21	0 147'	Old well limestone (SKETCH) pipe clay stone sandy clay Water	Bore C Folder No. 2/5 Hd. Miller E.H. Johns & Sons.
4	21	0 - 30' 30 - 55' 55 - 78' 78 - 90' 90 - 105' 105 - 135' 135 - 142'	Well Grey clay sand. White clay sand. Grey sandy clay. Grey sandy clay. Soft brown sandstone. Grey sand.	Bore A Folder No. 8/- Hd. Miller H.R. Alchurch.
5	21	No details - Total 26'		Bore B Folder No. 2/8 & 2/6. Urabi Pastoral Co. Hd. Miller.
6	21	0 - 27' 27 - 100'	Limestone. Dark brown clay Yellow clay beneath.	Big Paddock Bore D. Folder No. 2/7 Hd. Miller Urabi Pastoral Co.
7	24	0 - 108'	Fossil III limestone.	Bore B Folder No. 1/7 Hd. Miller.
8	6		Limestone conglom. (Near cryst. fossil) L.S. (Older sand or sandstone).	Cadamby Well Folder 1/1 Hd. Lucy.

Bore	Section	Strata passed through	Remarks
9	5	Dense cryst. ls. and soft white ls. on greenish and yellow argillaceous sand or sandstone (older III).	Kidnippy Well A Hd. Lucy Folder No. 1/4
10	Adj. Sec. 4	0 - 25' Limestone. 25 - 34' Yellow clay. 34 - 46' White limestone. 46 - 60' Limestone rubble. 60 - 85' Limestone. 85 - 96' Grey clay 96 - 110' Buff clay. 110 - 113' Limestone.	Bore No. B. Folder No. 2/- Hd. Lucy Aborigines Dept. Yatala Mission.
11	4B	No details - Total 112'	Bore No. C. Folder No. 1/7 Hd. Lucy Yalata Lutheran Mission.
12	B	No details - Total 684'.	White-Well A Hd. Lucy Colona Station.
13	Adj. Sec. 5	Travertine-limestone and W/Bluff limestone. Total 113'6"	Colona Well A Folder No. 1/3 Hd. Lucy Yalata Lutheran Mission.
14	13	Crystalline sand limestone on polyzoal limestone. Fossiliferous limestone. 0 - 141' Calc. sandstone and polyzoal limestone.	Chinalumba Well A Folder No. 1/2 Hd. Lucy Yalata Mission.
15	21	Travertine Null-Col-, W/Bluff 1st. Crystalline fossiliferous and softer chalky ls. on clay and rubble (older III)	Waltabie Well A Folder No. 1/5 Hd. Lucy.
16	15	Recent fixed sand ridges and trav. overlying Nullarbor Limestone.	Well A Hd. Lucy.