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NOTES ON THE TARCOOLA 1:250 000 PRELIMINARY GEOLOGICAL MAP

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

NOTES ON THE TARCOOLA 1:250 000 PRELIMINARY GEOLOGICAL MAP

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9th January, 1975.

Rept.Bk.No. 75/2
G.S. No. 5543
D.M. No. 338/72

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File No. 75/2 (19–24) Security 1 (26) Published [ ] (28)

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02.1 [ ]

03 Author(s) DALY S.J.

03.1 [ ]

04 Map Locations 37

Locality TARCØØLA 1:250000 SHEET

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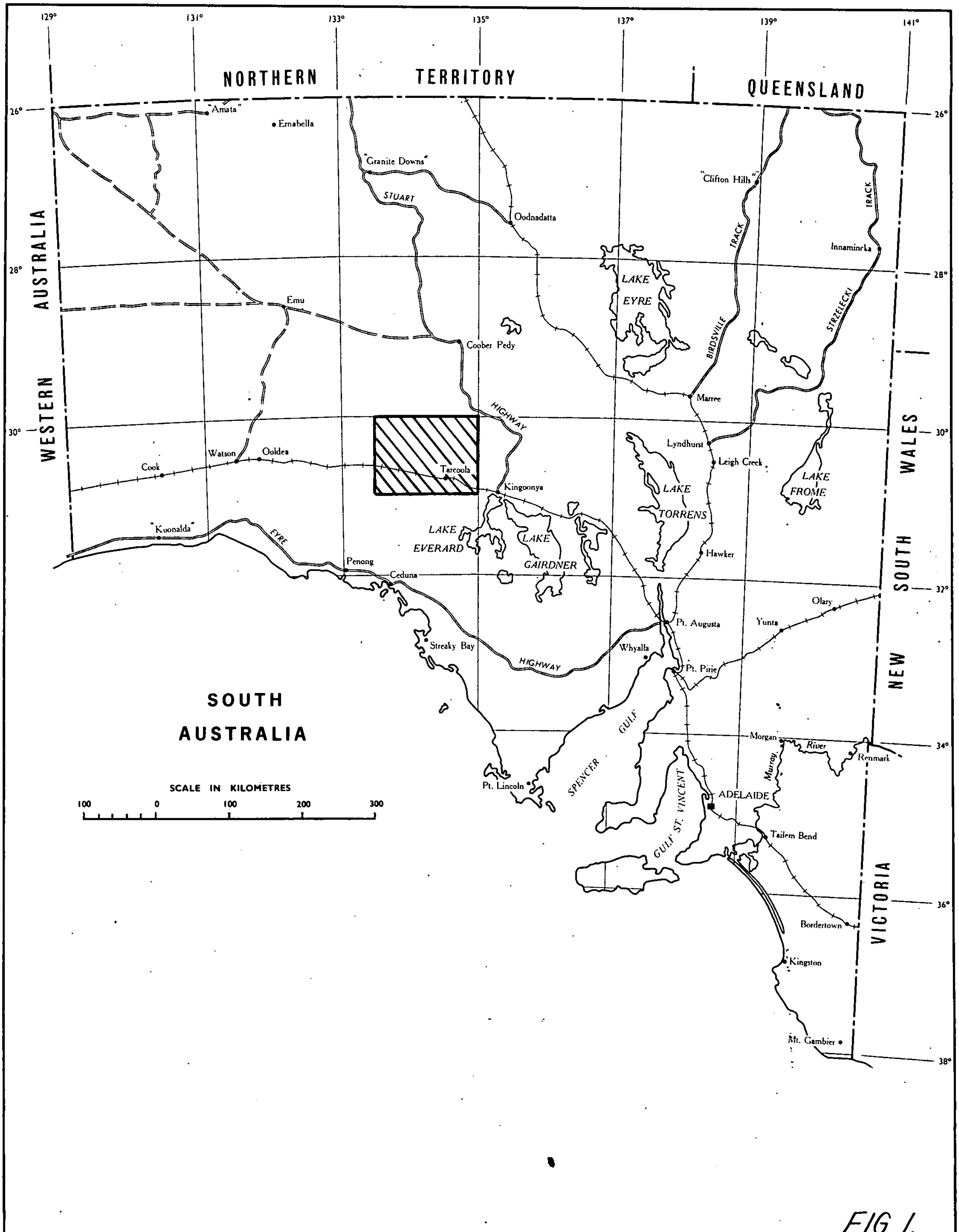

FIG 1.

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Compiled. S. Daly

Drn. DJM Ckd.

TARCOOLA 1:250 000 SHEET LOCALITY PLAN

Date: 10 Oct. 1974

Drg. No. S11035 Bb

P.F. No. S5850 994.2

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 75/32
G.S. No. 5543
D.M. No. 338/72

NOTES ON THE TARCOOLA 1:250 000 PRELIMINARY GEOLOGICAL MAP

ABSTRACT

The TARCOOLA map area lies in western South Australia within the older Precambrian shield area, the Gawler Craton.

Cleve Metamorphics (Lower Proterozoic) are represented by quartzo feldspathic metasediments with interbedded iron formations. These rocks are intruded by basic and ultrabasic rocks and possibly granites, now metamorphosed. Carpentarian granites and basic to intermediate-basic dykes intrude the above metamorphics.

The overlying Tarcoola Beds are composed of conglomerate, quartzite, siltstone and claystone but contain tuff beds suggestive of possible partial contemporaneity with the Gawler Range Volcanics. One preliminary K/Ar date on granite intruding the above rocks is 1521 m.y. (Webb, 1969).

Permian carbonaceous mudstones are known from one drill hole. Younger sedimentary rocks include the Lower Cretaceous Cadna-owie Formation (sandstone) and Bulldog Shale, Tertiary Pidinga Formation and Pleistocene calcrete.

INTRODUCTION

The following notes briefly summarize the geology of the TARCOOLA 1:250 000 sheet area, and are intended to accompany the preliminary geological map (Daly, 1974).

A comprehensive list of references is included and private company investigations, which have provided much valuable information, are tabulated in Appendix A.

For details of early exploration, previous work done and investigations of banded iron formations refer to Whitten (1960; 65; 66a, b, c; 68, a,b.).

A short reconnaissance of the area was done in January, 1972 by the author and student geologists. In July 1974 systematic field mapping was begun and should continue in 1975.

A preliminary geological map was compiled from all data available prior to July 1974, together with photointerpretation of Department of Lands black and white aerial photographs at a scale of 1:57 000.

GENERAL GEOLOGY

TARCOOLA (i.e. TARCOOLA 1:250 000 sheet area) lies in the northern part of the Gawler Block, a now stable area of basement rocks partly covered by thin sediments, Permian to Recent in age. No Adelaidean sediments are known. More information concerning complex basement rock relationship may be found in Thomson (1966, 69, 70, 74).

The oldest rocks are quartzo-feldspathic metasediments with interbedded banded iron formations. The iron formations have been correlated by Whitten (1966 b) with those forming part of the Cleve Metamorphics in the Middleback Ranges, and hence these rocks are regarded as Cleve Metamorphics equivalents. Thomson (1970) correlates the Cleve Metamorphics with the Lower Proterozoic Mount Bruce Super Group of the Hammersley Basin in Western Australia.

Basic and ultrabasic rocks (now metamorphosed) intrude these quartzo-feldspathic rocks and are treated here as part of the Cleve Metamorphics. Foliated granitic rocks, possibly partially mobilized acid gneisses, within the metasediments similarly are included within the Cleve Metamorphics. Basic and intermediate basic dykes, of possible Carpentarian age, intrude the Cleve Metamorphics.

The Cleve Metamorphics and associated older granitic rocks are unconformably overlain by the Proterozoic (Carpentarian) Tarcoola Beds, a little-metamorphosed sedimentary sequence which includes sandstones, quartzites, shales and conglomerates. Thin tuffaceous bands are interbedded with sediments in the lowest part of the sequence.

Gawler Range Volcanics outcrop in the central and southern portions of the sheet. The volcanics are layered and are known to include porphyritic and tuffaceous rhyolites, rhyolites and rhyodacites, but insufficient work has been done to establish the sequence. Dykes of Gawler Range Volcanics intrude the Tarcoola Beds.

Younger granites, correlated with the Hiltaba and Kokatha granites which outcrop on YARDEA and GAIRDNER, intrude all older rocks.

Permian carbonaceous mudstones (in the subsurface only) are known in one locality, northwest of Malbooma, but a more widespread occurrence is likely.

Shallow Tertiary carbonaceous sands and clays are known on the southern portion of the sheet and may also be far more widespread. Recent sand dunes mantle at least half of TARCOOLA.

STRATIGRAPHY

Lower Proterozoic to Carpentarian Metamorphic Rocks

(1) Iron Formations of the Cleve Metamorphics

Fine-grained quartz hematite rocks, with sedimentary structures preserved, outcrop at Wilgena Hill, (Whitten, 1966a, 1968 b.). The sequence exposed is estimated to be 760 metres thick dipping easterly at 50-70°. Bands of hematite jaspilite 1.5-24 m wide are separated by zones of no outcrop 3-30 m wide. Minor outcrop of shale and quartzite may be interbeds.

The jaspilite sequence, the base of which is concealed, is unconformably overlain by the Tarcoola Beds and is intruded by dykes of Gawler Ranges Volcanics trending in a northwesterly direction.

Banded iron formation is exposed just to the north of Hopeful Hill, on Wilgena (i.e. Wilgena 1:63360 sheet area). Sand dunes surround the small outcrop.

A discontinuous banded iron formation outcrops at Kenella Rock (Wilgena). The relationship with adjacent rock types is complex, (Abadon Holdings N.L. SML 680). Iron formations outcrop also in the central and western portions of TARCOOLA, interbedded with metasediments.

The metamorphic grade of the banded iron formations increases in a westerly direction (Whitten, 1965, 1968 b). Medium-grained magnetite metajaspilites outcrop near Muckanippie (Muckanippie) and West Well (Mulgathing) passing into coarse-grained metajaspilites at Mt. Christie (Coates).

The jaspilite sequence at Wilgena Hill is considered by Whitten (1966 b) to be equivalent to the jaspilite outcrops in the western portion of the sheet (separated by younger granitic intrusives and Gawler Range Volcanics) although possibly not the same horizon. Gerdes (1974) from aeromagnetic data suggests that there may be as many as four separate horizons and the jaspilites are now not continuous.

A small domal structure has been postulated (Whitten, unpublished notes) on the western portion of Coates. Details of this and related structures are not known because of the discontinuity of the jaspilite horizons and a complex folding history. For ore grade, estimated tonnages and possibilities for benefication see Whitten 1965, 68a, Otter Exploration N.L., SML 638, 639.

(2) <u>Quartzo-feldspathic and other associated metamorphic rocks</u>

Metamorphic rocks of amphibolite to granulite metamorphic grade outcrop on the eastern portions of the Wilgena 1-mile sheet (Australian Development N.L. SML 83; Abadon Holdings N.L. SML 436). The oldest rocks (outcropping to the south and east of South Lake) are coarse-grained quartz-feldspar and quartz-feldspar garnet gneisses interlayered with bands of augite and hornblende-augite granulites. These rocks may grade into granitic gneiss of migmatitic granite. The foliation trend of these rocks is dominantly north westerly. To the northwest of South Lake there are foliated granitic rocks and intrusive granites which are possibly a more mobile portion of these granitic metasediments. The granitic rocks and garnet gneisses are intruded by northeasterly to northerly-trending gabbroic and microdiorite dykes, (Carpentarian), which are cut by dominantly northwesterly trending dykes of Gawler Range Volcanics. (Australian Development N.L. SML 83).

Foliated granitic rocks at Earea Dam contain gold-bearing quartz reefs. Tin occurs in quartz greisen veins in garnet gneisses at South Lake.

Metamorphic rocks also outcrop in the central and western portion of TARCOOLA. Outcrop is poor, discontinuous and thoroughly weathered, possibly due to the abundance of intrusive granites of Lower Proterozoic to Carpentarian age.

Coarse-grained quartz-mica-feldspar gneisses outcrop on Mulgathing and are accompanied by abundant quartz float. On the central portion of Coates hematite-rich quartz-mica-feldspar schist and gneiss outcrop. On the western edge of this area near Mt. Christie clinopyroxene-hornblende-plagioclase "granulite", quartz-feldspar-garnet gneiss and quartz-feldspar-mica schists outcrop. The foliation direction is predominantly northeasterly.

The outcrops shown as Cleve Metamorphics on the preliminary map include poorly exposed and very weathered granitic rocks of unknown age. These rocks may be equivalent to the gneissic Glenloth Granite (Compston, Crawford and Bofinger, 1966) on GAIRDNER or younger granites of Carpentarian age.

Sheared zones within these older granitic rocks contain quartz limonite veins which may contain anomalous base metal sulphides (see Langsford, 1972; Kennecott Exploration (Australia) SML 261, 333, 491; Abadon Holdings N.L., SML 681 or EL 55, SML 682 or EL 54; Archean Exploration Pty. Ltd., SML 505; Sibenaler, 1974).

(3) Basic and ultra-basic rocks

Basic augite-hornblende granulites occur interbanded with garnet-feldspar gneisses south and west of South Lake (Australian development N.L. SML 83). Basic rocks also outcrop at Hopeful Hill (Wilgena). These rocks are altered pyroxenites or peridotites containing slightly anomalous zinc and lead.

Basic and ultrabasic rocks also outcrop on the western portion of the TARCOOLA sheet. These rocks are interlayered with the quartzose metasediments or in-faulted zones within the metasediments and have been mapped in detail: see Kennecott Exploration (Australia) SML's 261, 333, 491.

Outcrop is poor due to severe weathering. Reliable indicators associated with these rocks are chalcedonic slab-like weathering residuals.

Basic rocks (including the Lake Barry ultramafic) adjacent to banded iron formations carry anomalous nickel values. Detailed work done by Kennecott however indicates that sulphide mineralization is not present and cations are derived from silicate lattices, probably after olivine. Basic rock types with kimberlitic affinities, according to Otter Exploration N.L., SML 643, 644, are now weathered to limenite and magnetite-rich montomorillonite clays in Muckanippie. Basic rock types outcropping at Blackfellow Hill, Skuse Hill and Chilarski Rise (Coates) are now schistose tremolite-phlogopite-montmorillonite clays and basic rock types associated with the Durkin iron formations are now serpentine clays.

Carpentarian igneous rocks and sediments

(1) Basic and intermediate-basic intrusive rocks

A coarse-grained andesine-hornblende- and ilmenite-rich rock (diorite) outcrops on Muckanippie and Carnding (Kennecott Exploration (Australia) SML. 491; Langsford, 1972). This rock is intruded by dykes of Gawler Range Volcanics and granitic rocks which may be Hiltaba-Kokatha equivalents. At Lake Barry the diorite intrudes a very weathered ultrabasic considered to be part of the older metamorphic basement complex.

Narrow diorite dykes intrude older metasediments three miles south of Coates Hill. The dykes trend in a northeasterly direction, and may be of similar age to those outcropping near South Lake (Wilgena) (Australian Development N.L. SML 83).

(2) Older granite

In the vicinity of the Tarcoola mine area, Tolmer Hill and Brown Hill (just to the north of the mine area) the Tarcoola Beds rest nonconformably on a mica-poor medium to coarse pink leucogranite, a possible Burkitt Granite equivalent. Drilling has confirmed that this contact is a sedimentary one (Whitten, 1968a). A tentative rubidium-strontium date of 1507 ± 120 m.y. (Webb & Lowder, 1972) was obtained from core in diamond drill-holes 1, 2 and 3.

The age is not considered to represent the age of emplacement because dykes of young granite and Gawler Range Volcanics intrude the granite in the mine area and presumably have affected the rubidium-strontium date. The age of the granite therefore has not yet been conclusively established and may possibly be as old as the Burkitt Granite on PORT AUGUSTA.

A minimum K/Ar age of 1550 million years has been obtained for biotite from an adamellite at Coladding Rock Hole about 11 km NW of Tarcoola (Webb, 1969; Turner, 1969).

This locality is the site for a 305 m cored vertical diamond-drillhole (Coladding 1) drilled by the Department of Mines for Australian National University heat flow measurements in 1971.

(3) Tarcoola Beds

The rocks of the Tarcoola gold field were first named the Tarcoola Series in 1953 by Dickinson and Sprigg. The "series" was then considered to be Cambrian or older. Later Whitten (1966b) named these sediments the Tarcoola Beds. No formal description has yet been published nor is the complete sequence known. The Tarcoola Beds have been correlated with the Corunna Conglomerate outcropping in the Corunna Range, Eyre Peninsula (Thomson, 1969).

The Tarcoola Beds outcrop on Wilgena, Tarcoola, Carnding, Malbooma and Kychering (Abadon Holdings N.L. SML 436, 682, 683). The lithology of these sediments includes feldspathic sandstones and quartzites with interbedded siltstones and shales. Towards the base there is a conglomerate containing jaspilite fragments.

The base of the sequence is exposed at Wilgena Hill, Tarcoola mine area, Brown Hill and Tolmer Hill. At Wilgena Hill the Tarcoola Beds rest unconformably on or are faulted against the Wilgena Hill Jaspilite (Whitten, 1966a).

However, at the Tarcoola mine area, Tolmer Hill and Brown Hill the Tarcoola Beds rest non-conformably on an older granite. The basal unit of the Tarcoola Beds outcropping in the Tarcoola mine area is a conglomerate containing fragments of laminated hematite jaspilite pebbles with a hematite sericite quartz matrix, overlain by a pink gritty arkose with an occasional jaspilite pebble. At Tolmer Hill the arkose underlies a banded iron formation conglomerate. Green tuffs occur above and below the conglomerate. No green tuffs have been found in the mine area.

At Brown Hill the basal unit is approximately two metres of pink to greenish thin-bedded siltstone (similar to that found at Wilgena Hill) overlain by a massive jaspilite conglomerate. Green tuffs and pink arkose occur above the jaspilite conglomerate.

At Wilgena Hill fine-grained green and red laminated siltstone underlie a poorly developed discontinuous quartzitic conglomerate containing red chert, milky quartz and jaspilite fragments. Massive white quartzites overlie the conglomerates. The jaspilite conglomerate is 0.6 to 2 metres thick at Tolmer Hill, increasing to 4 metres at Brown Hill to the east.

The rock types overlying the jaspilite conglomerate are poorly exposed flaggy quartz sandstones, shale (carbonaceous in part within the mine area, Ridgeway and Johns, 1949), and siltstones. Approximately ~~30~~ 115 metres above the conglomerate there is a massive quartzite between 15 to 38 metres thick which forms the prominent quartzite ridges seen at Tolmer Hill and the Tarcoola mine area.

The remainder of the sequence at Tarcoola and Tolmer Hill is interbedded quartzites, sandstones and siltstones with siltstone-claystone becoming the predominant lithology towards the top. Altered grey-green siltstones outcropping in the railway ballast quarry represent the youngest unit in this area.

The strike and dip of the sediments outcropping at the Tarcoola mine area, Tolmer Hill and Dark Hill (4 kilometres to the south of Tolmer Hill) are the same. If the succession between Tolmer Hill and Dark Hill is continuous, the Tarcoola Beds are more than 3 050 metres thick (Abadon Holdings N.L. SML 682).

A cross-bedded feldspathic sandstone outcropping at Malbooma overlies similar sediments to those at Tarcoola and Tolmer Hill and may therefore be the youngest unit known.

To the south of Malbooma at Mt. Finke, a heavy mineral banded (martite) cross-bedded feldspathic sandstone-quartzite is overlain by a thick sequence of grey-green sandstone-quartzite. It has been included here as part of the Tarcoola Beds, and may also represent an upper part of the Tarcoola Beds sequence.

Small outcrops to the north and northeast of Mt. Finke, although not inspected on the ground, have been photointerpreted as Tarcoola Beds.

In the Tarcoola mine area quartz reefs and veins containing gold occur approximately perpendicular to strike and also parallel to strike (Ridgeway and Johns, 1949; Ridgeway, 1951; Brown, 1901, 1908). The richest gold occurs at the intersection of the quartz reefs and carbonaceous shales. Associated with the gold is abundant pyrite, with lesser amounts of galena, chalcopyrite and lead carbonate. The quartz veins also occur in the older granite and gold has been mined from these veins. Gawler Range Porphyry dykes and Hiltaba-Kokatha Granite equivalents intrude the Tarcoola Beds. Elsewhere gentle folding with associated doming and faulting has occurred. Although dykes of Gawler Range Volcanics have been found intruding the Tarcoola Beds contact with the main mass is not seen. Crystal tuffs in the base of the sequence are possibly older volcanics or may be an early phase of the Gawler Range Volcanics.

(4) Gawler Range Volcanics

The Gawler Range Volcanics outcrop extensively in the central and southeastern portion of the TARCOOLA sheet area.

Rocks in Ealbara are reddish brown to greyish pink rhyolites and porphyritic rhyolites and rhyodacites. Layering within the volcanics on Ealbara strikes just south of west with a steep dip to the south. Tuffs of rhyolitic composition outcrop at Mentor Hill (Ealbara); small irregular folds with amplitudes of up to 10 cm occur within the tuff.

Dykes of Gawler Range Volcanics intrude the Cleve Metamorphics in the western and eastern portion of the sheet area and intrude the Tarcoola Beds to the north of Wilgena Hill and the mine area. The dykes are thought to be younger than the main mass of the volcanics (Blissett, 1974, pers. comm.). The age of the Gawler Range Volcanics according to Compston, Crawford and Bofinger (1966) is 1535 ± 25 m.y.

(5) Granites intrusive into Tarcoola Beds

These granites are pink to red medium to coarse grained mica-poor granites which weather to a saccharoidal texture and red brown colour. The granites outcrop extensively in the central and southern portions of the sheet area. Granitic rocks on adjoining CHILDARA are thought to be of similar age (Blissett & Vitols, 1974).

There is no doubt these granites intrude the Tarcoola Beds, e.g. at Peela Well and Konkaby Rock hole (Tarcoola); Gilbraltar Rocks (Carnding) and at Malbooma (Malbooma) (Abadon Holdings N.L. SML 683). They are consequently possibly penecontemporaneous with the Hiltaba Granite which intrudes the Gawler Range Volcanics on YARDEA.

A K/Ar date of 1521 m.y. was obtained by Webb (1969) on biotite from the granite (Turner, 1969) at Gibraltar Rocks, but further isotopic analyses are required in this region.

Microgranites with a greater abundance of mica and small biotite-rich xenoliths occur within these granites, e.g. outcrop just south of Birthday Hill, and may be of similar age or slightly younger. The granite at Gilbraltar Rocks appears to be intermediate between the two types.

Granite was found in contact with a welded rhyolitic tuff at Mentor Hill. The outcrop near the contact zone is poorly exposed, however rhyolite fragments have a bubbly and irregular texture possibly due to reheating of the tuff; the granite was unaltered. The volcanics along the contact zone were kaolinized.

Granitic dykes and plugs cross-cut the quartz veining with associated gold at Tarcoola Hill. The suite of granites is therefore interpreted as being younger than the Gawler Range Volcanics, Tarcoola Beds and gold mineralization at Tarcoola.

Permian Unnamed Sediments

Permian sediments have recently been established in one shallow drillhole two miles southeast of Durkin outstation (Coates) (Nissho-Iwai EL 48).

A sequence of carbonaceous mudstones occurs between 15.5 m and 103.4 m in drillhole No. 35. Total depth of the hole is 103.4 m.

Permian spores have been recovered from intervals 44.2-45.7 m, 54.9-56.4 m, 67.1-68.6 m, 71.6-73.2 m, (Harris, 1974, pers.comm.).

The spores indicate a non-marine environment of Early Permian age. These sediments if correlated with the Permian of the Arckaringa Basin may be equivalent in time if not in facies to the Stuart Range Beds. The Stuart Range Beds are marine. The lower part of the unit consists predominantly of sandstone and siltstone with shale interbeds and minor carbonates and the upper part of the unit interbedded coals, carbonaceous shales and siltstones (Townsend, 1973; Wopfner, 1970).

Carbonaceous mudstones have been recorded in four other nearby bores in the same area, but no palynological work on these sediments has been done.

Permian sediments may occur in the northeastern portion of TARCOOLA beneath Mesozoic sediments. The nearest recorded Permian occurs at Muddy Tank No. 1 (Harris, 1972), three miles northeast of Ingomar Homestead on the COOBER PEDY sheet area. Blue shales recorded in water bores on the most southwestern portion of the BILLAKALINA sheet may also be of Permian age.

Cretaceous Sediments

(1) Cadna-owie Formation

The lower Cretaceous Cadna-owie Formation (Wopfner, 1969; Wopfner, Freytag & Heath, 1970) is thin and discontinuous where capping crystalline basement rocks. Elsewhere the Cadna-owie Formation may be extensive, but is obscured by Tertiary and Recent sediments.

The lithology of this formation includes very coarse sand to granule size quartz sandstones with a finer sand and clay matrix and occasional clay galls. Pebbles and cobbles of milky quartz and laminated quartzite occur within the coarse sands; porphyry pebbles are rare. At the top of this unit there are medium to fine clayey sands.

Bore information indicates the Cadna-owie Formation is the main aquifer for underground water in the Tarcoola sheet area, and is at least 30 m thick. Jurassic sands may underlie the Cadna-owie Formation in the Bulgunnia Homestead area (Jack, 1931).

Low hills of Cadna-owie Formation outcropping just to the east and south of Mentor Hill (Ealbara) and on the eastern edge of Tarcoola are capped by granule-size quartz grains cemented with iron oxides.

(2) Bulldog Shale

The Bulldog Shale (Freytag, 1966) outcrops in the most north-eastern corner of Bulgunnia. Outcrop is poor. The sediments are typically fine clayey siltstones and often occur as small angular bleached fragments scattered on the surface. Quartz pebbles and quartzite boulders are rare. There is a gradual transition from the medium to fine sands of the Cadna-owie Formation, outcropping on the southern portion of Bulgunnia, to clayey siltstones and claystones of the Bulldog Shale in the most northeasterly corner.

Subdivision between the two units is tentative.

Tertiary Sediments and Fossil Soil Units.

(1) Pidinga Formation Equivalents

Tertiary sands and clays are known to occur in shallow bores in Coates, Wynbring and Malbooma (Ward, 1940; Hillwood 1960, 1964; Nissho-Iwai EL 48; Johns, 1973).

Bores 9, 19, 20, 10, 21, 22 drilled by the South Australian Department of Mines for the Commonwealth Tarcoola to Alice Springs Railway Project (Carosone, 1972a, 1972b, 1972c, 1973) also penetrated Tertiary sediments.

Tertiary sands and sandy clays are possibly very extensive on the southern portion of TARCOOLA, underlying the large salt lakes on Tarcoola, Wilgena and Kychering.

The lithology of the sediments includes red-brown, greenish-yellow, buff to white silty clays and clayey sands, calcareous in part. Interbedded grey and brown carbonaceous clays and lignites, with associated wood fragments, occur within the multicoloured sandy and silty clays. Coarser sandy lenses may contain granules of hematite and magnetite.

On weathered basement the sandy clays become more gritty and micaceous.

These sediments are considered to be equivalents of the Pidinga Formation (Harris, 1966) of Middle Eocene age (W. Harris, 1974 pers. comm.) and are at least 60 m in thickness (Hillwood, 1964). Recent drilling by Nissho-Iwai (Aust. Pty. Ltd.) (EL 48) in the Warrior Outstation area indicate the sands may overlie Mesozoic and Permian sediments.

Silcrete

Silcrete or siliceous duricrust occurs throughout the sheet area as a bouldery layer capping extensively kaolinized rocks. A more detailed description of the duricrust profile with accompanying bleaching and silicification may be found in Wopfner and Twidale (1967).

The silcrete is a silicified granule-to pebble-size quartz rock with a finer greyish matrix (possibly originally fine sand or clay) varying to a rock containing no pebbles or granules of quartz. The siliceous duricrust appears to reflect the lithology of the formation on which it is developed, with no apparent reworking or resilicification. Plant fragments were found in a fine-grained silicified rock on Ealbara and may represent fragments of Cretaceous or Tertiary plants.

Quaternary

Laminated, slabby and nodular calcrete occurs throughout TARCOOLA on weathered rocks of all ages. The calcrete may be as much as 2 metres thick e.g. calcrete capping weathered granitic gneiss at Wynbring; or as a thin skin, a few cm thick. Laminated nodular calcretes develop around more resistant talus fragments e.g. granitic rocks. Red brown to pale brown, silty to sandy soils with calcrete fragments form a thin cover and small bushes e.g. saltbush grow commonly on this unit.

Red to reddish brown sandy soils are extensive and may contain pebbles of silcrete and granules of ferruginous ?silcrete. Mulga (*Acacia aneura*) and other small acacias grow on sandy soils, and with increasing depth, eucalypts and Casuarina e.g. the dune fields south of the Transcontinental Railway. In the southern portion of the sheet area there are numerous salt lakes containing poorly consolidated gypsiferous clayey sands and silts and surrounded by pink to white, often brilliant white, powdery gypsum dunes capped by a soft platy crust. Crystalline gypsum layers occur at depth. Reddish brown siliceous sands may cover the gypsum dunes.

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B S Forbes

8th January, 1975
SD:JG

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APPENDIX A

Company	Special Mining Lease	Title Report *	Security Envelope No.
Abadon Holdings N.L.	436	Tarcoola-Glenloth	1409 I,II, III, IV
"	619	Tarcoola South	1818
"	620	Tarcoola West	1822
"	680	Hopeful Hill-Kenella Rock	2071
"	(or EL56)	Carters Well	2276
"	681	Mt. Mitchell-	2072
	(or EL55)	Glenloth	2282
"	682	Tolmer Hill-	2073 I & II
	(EL54)	Tarcoola	2275
"	683	Malbooma	2074
Archean Exploration Pty.Ltd.	505	Mt. Finke	1557
Australian Development N.L.	83	Glenloth-Earea Dam	650 I,II
Kennecott Exploration (Australia) Pty. Ltd.	261	Reconnaissance of Tarcoola area	1131
"	333	Mulgathing	1187
"	491	Mulgathing	1510 I, II, III, IV
Nissho-Iwai Co. (Aust.Pty.Ltd.)	EL 48	Warrior	2390
Otter Exploration N.L.	638	Fingerpost Hill)	1857
	639	West Well)	
	643	Lake Barry)	1858
	644	Aristarchus)	

*For location of lease area see Figure 3.

APPENDIX B - NOTES ON ECONOMIC GEOLOGY

The following notes summarise very briefly private company and some Departmental investigations in the TARCOOLA 1:250 000 sheet area prior to July 1974.

Further information may be obtained from the original company reports filed with the South Australian Department of Mines and listed in Appendix A.

The early history of the Tarcoola Blocks Mine was prepared by R.K. Johns (Ridgeway and Johns 1949) from early Mining Reviews and annual reports of the Government Geologist.

Details of other gold occurrences and the tin mine at South Lake, have been derived from Brown's Record of Mines (Brown, 1908).

Gold

(1) Gold-bearing quartz reefs (<1 m in width) cross-cut a sequence of moderately dipping carbonaceous siltstones, quartz sandstones and massive quartzites outcropping 2 km west of Tarcoola. The veins occur approximately perpendicular to strike of the sediments and are generally vertical or steeply dipping. Very rich zones occur where the quartz veins cross-cut carbonaceous siltstones (often referred to as the front and back 'slates'). Two strike faults displace the quartz reefs. The greatest known vertical displacement measured from the McKechnie Reef is about 40 m and horizontal displacement about 20 m.

In 1893 alluvial gold was discovered at the eastern end of Tarcoola Range (Brown, 1894). In 1900 the first gold leases were pegged when the Fabian and Ward reefs were found (Riedgeway and Johns, 1949). Early in 1901 the Dedman, Minnis and Sullivan Reefs were discovered.

By May 1901 the Tarcoola Blocks Company, formed in 1900, had built a battery to process the ore.

In 1912 35,230 tonnes of ore had been processed for the return of 1,267,400 grammes of gold, an average of 35.97 g/tonne.

In 1912 the Tarcoola Blocks battery closed down and the Government Battery commenced operation.

By 1917 five of the main reefs had been worked to No. 2 level (76 m) and three (Fabian, Western Branch and McKechnie) to No. 3 level (107m) and the mine shaft (consisting of three compartments and 3.6 m x 1.2 m size) had been completed to a depth of 111.2 m. In 1918 the Tarcoola Blocks Company ceases operation.

The mine was then worked spasmodically by a number of lessees until 1947. Ore had only been recovered from between level one and the surface: the lower levels had been flooded since 1917.

In 1947 Standard Mining N.L. reopened the mine and dewatered the workings to just below level 2. Some retimbering was done. Only 4 482 tonnes of ore carrying 207 240 grammes of gold had been mined by 1953 when the mine was again closed.

In 1970 the mine area was held again under lease by the Inland Mining Company and a small amount of mining was done from level 1.

In 1973 Emperor Mines entered into an option agreement with Inland Mining. An extensive drilling program was planned and systematic sampling of the mine begun. By January 1974 the water in the mine was just below No. 3 level and some retimbering in the main shaft had been done. Due to pumping difficulties the water had again risen to level 2 by June 1974.

The option agreement between Emperor Mines and Inland Mining was not approved by the Australian Government and in July 1974 all operations ceased. No drilling had been done. No further mining by Inland Mining, the present lessee, has been done.

All reefs on level 2 and above have been worked out, i.e. completely removed. Similar ore grades could be expected if the workings were extended in level 3 and between levels 2 and 3. The reefs may extend well below level 3.

Total production for the Tarcoola Blocks Mine (1901-1955) is 45 420 tonnes from which 1 737 200 grammes of gold have been recovered (Av 38.25 g/tonne). Since then less than 2 500 grammes have been recovered. The average grade is unknown.

An additional 587 000 grammes of gold were produced from other leases within the Tarcoola gold field. The following mines were the major producers from these leases; Tarcoola Perserverence 157 200g. (5074 tonnes), Welcome Home 58 850g (2914 tonnes), Curdnatta 48 080g (1845 tonnes), Warrigal South 44 540g (1042 tonnes), Government Mine 31 840g. (873 tonnes) and White Hope 28 900g (888 tonnes).

The richest reef in the field remains however Fabian's Reef (Tarcoola Blocks Mine) producing (since 1922) 321 900 grammes from 6 450 tonnes (49 g/tonne). The greater proportion of gold production from the mine since 1922 has been from this reef.

Total production of the Tarcoola gold field (1902-1955) is 2 325 000 grammes from 68 750 tonnes (33.8 g/tonne).

(ii) In 1899 gold was discovered near Earea Dam (Wilgena). The gold occurred in quartz veins within foliated granitic rocks.

Greatest mining activity occurred during 1900-1906 and 1930-1941 with the production of 53 837 grammes of gold from

1876 tonnes of ore. The Wilgena Enterprise was the richest mine, producing 45 927 grammes from 1 479 tonnes of ore.

In latter years the mine has been worked spasmodically, however, no production has been recorded.

(iii) Gold was also mined for a short time in 1926 from the Muckanippie gold prospect 15 km east of Mulgathing Homestead. Gold-bearing quartz veins occur in micaceous foliated granitic rocks. The deposit was very small and soon worked out.

(iv) A small amount of gold has been recovered from Tolmer Hill (Malbooma) 9 km west of the Tarcoola mine and Dark Hill 2 km south west of Tolmer Hill. Quartz veins occur within quartzites of the Tarcoola Beds.

Tin

Cassiterite was first discovered in 1899 at South Lake, approximately 3 km south of Earea Dam (Wilgena). The tin occurs in quartz greisen veins within a garnet-bearing quartzo-feldspathic gneiss on the southern edge of the lake. A small shaft has been dug and possibly up to 100 Kg. of ore extracted (No production figures has been recorded).

The area has been prospected by the private exploration companies Australian Development, Abadon Holdings and by the South Australian Department of Mines. It is thought from this work that the quartz-bearing tin veins are too low grade to be of any economic importance. Geochemical exploration has indicated that slightly anomalous copper, lead and zinc also occur in this area and are possibly derived from ultrabasic dykes, now granulites, within the granitic metasediments.

Exploration is hampered by a cover of extensive sands, gravels and thick calcrete. Abadon Holdings at present holds E.L. 56 in this area.

Iron

In 1958 exploration for iron ore was initiated by the South Australian Department of Mines (Whitten 1968a). Subsequently total reserves of 5-15 million tonnes/30m depth of magnetic meta-jaspilite were proven at Mt. Christie, Fingerpost Hill and George Hill in the Coates 1 mile sheet area. (Refer to Whitten 1960b, 1965 for methods of calculation and detailed investigations). The ore grade varied between 30-35% Fe, benefication producing ore of approximately 60% Fe with a recovery rate of 80%. At the same time reserves of 40-60 million tonnes of hematite jaspilite/30 m depth were estimated at Wilgena Hill (Wilgena), with an additional 6-10 million tonnes/30 m. from nearby outcrops. The ore grade (from surface samples only) is approximately 40% Fe. Concentrates of about 60% Fe can be produced with a recovery of 60-80%.

The ore reserves were at that time considered to be subeconomic.

In 1972 Otter Exploration N.L. (SML 638, 639) re-evaluated the Mt. Christie magnetite deposit. Consideration was given to pipeline transportation of magnetite slurry to the coast. Cost evaluation of this method was done by Goldsworthy Mining Limited (W.A.). As a result of this investigation the company concluded that the iron ore is at present uneconomic. Size of the deposit, distance from the coast and high phosphorus content of the ore were the major factors which contributed to this decision.

Coal

(i) Poor quality coal was first discovered in the Malbooma area in 1938 (Ward, 1940). Boring contractors whilst drilling for water on Mulgathing Station had penetrated carbonaceous clays with thin lignitic horizons in the region south of Warrior out-station and west of Malbooma siding. A sample collected by Mr.

Ward from bore S30 (9.6 Km. west of Malbooma) from interval 19.2 m - 36.6 m had an ash content of 64%.

In 1960 further exploratory work was done by the South Australian Department of Mines (Hillwood 1960, 1964). Five borehole sites were chosen to verify the quality of the coal reported in this region. Only Bore No. 1 drilled 12.87 km west of Malbooma and 1.6 km north of the Malbooma-Wynbring road struck coal. Poor quality coal occurred between 21.6 m and 34.4 m with an ash content of up to 66%. One interval between 25.3 m and 26.8 m contained coal with an average ash content of 16%, and fixed carbon content of 24%. No further work was done because of poor quality, discontinuity of the lignite horizons and distance from Port Augusta. (For comparison the Triassic Leigh Creek coal has an ash content of 10-25% with a fixed carbon content of 35-46%).

Recent exploration for sedimentary uranium by Nissho Iwai (E.L. 48) has proved more extensive Tertiary deposits in this area, the carbon content of the carbonaceous sediments however, have not been tested.

Considering the large area of possible Tertiary sediments much more work would be necessary to prove or disprove the TARCOOLA area as a source of low grade brown coal and sedimentary uranium.

(ii) Carbonaceous Permian mudstones occur in the subsurface near Warrior out-station (Coates) (Nissho Iwai E.L. 48). The sediments are equivalent to the Stuart Range Beds and the Boorthanna Formation (Harris pers. comm.) in the Arckaringa Basin. The youngest Permian unit, the Mount Toondina Beds, which contains commercial quantities of brown coal in the Lake Phillipson area, however, is missing. There is a good possibility that the Mount Toondina Beds may exist to the north and north east of Mulgathing Station i.e. on Mulgathing and Bulgunnia.

Base metals

In 1968 Kennecott Explorations (Australia) Pty. Ltd. initiated exploration for base metals, in particular nickel, in the western portion of TARCOOLA in Mulgathing, Coates, Muckanippie, Carnding and Wynbring.

An aeromagnetic survey was carried out over the lease area, followed by detailed ground magnetics, geochemistry, auger and percussion drilling (Refer to Gerdes 1974 for reappraisal of the aeromagnetic data).

Principal areas of interest were very weathered basic and ultra basic rocks adjacent to banded iron formations at Skuse Hill and Blackfellow Hill (Coates).

(i) Magnesium-rich soils at Skuse Hill gave nickel values between 200-3000 ppm nickel. Values from weathered green tremolite-chlorite-montmorillonite rock obtained by power augering ranged from 500-1000 ppm nickel (maximum 2850 ppm), 500-1500 ppm chromium with cobalt and zinc generally less than 100 ppm (maximum 200 ppm). Copper values varied between 30 and 200 ppm.

A ferruginous rock outcropping in this area, assayed 420 ppm nickel and 2250 ppm lead. Values in moderately fresh rock obtained by percussion drilling were low, nickel 500-900 ppm and copper 10-120 ppm.

(ii) Soil sampling outlined weak anomalous nickel values in the Blackfellow Hill area.

Power augering was carried out to test these zones. The following values were obtained chromium 300-3000 ppm, nickel 200-1000 ppm (maximum value 2250 ppm), and copper 30-150 ppm. Zinc and cobalt were generally less than 100 ppm (maximum 400 ppm).

Three percussion holes were drilled. Metal values obtained from weathered clayey tremolite-phlogopite rock were; chromium 200-3000 ppm, nickel 200-600 ppm, lead <30 ppm, zinc 30-150 ppm and copper 30-200 ppm.

In both areas copper values are higher than expected from an ultramafic rock, however no further work was recommended. Cations were thought to have been derived from silicate lattices, not from sulphide mineralisation.

(iii) An ultramafic plug approximately 0.8 km in diameter was located near Lake Barry (Carnding). The weathered ultramafic contains montmorillonite clay, phlogopite, altered pyroxene with accessory minerals olivine, plagioclase, apatite, ilmenite and magnetite; and is intruded by coarse grained diorite and reddish granite. Thirty five auger holes were drilled from 3.6 m-11 m in depth, along north-south and east-west section lines. The following values were obtained:-

Metal	Lowest Value p.p.m.	Highest Value p.p.m.	Approx. Normal Value p.p.m.
Ni	44	4200	700
Co	5	350	100
Cu	0	310	60
Pb	5	200	25
Zn	5	500	100
Cr	40	790	350
P_2O_5	0.05%	0.95%	0.45%
Ba	70	10,000	800
Sr	80	2,500	800
Y	0	50	10
Ti	50	20,000	10,000

(After Kennecott SML 491)

Metal values in the ultramafic zone were erratic. Further work was abandoned because it was felt the ultramafic was not of uniform composition and metal values were due to original silicate mineralogy with no sulphide mineralisation.

Further drilling would be necessary to fully evaluate this ultramafic.

Of great interest are anomalous P_2O_5, Ba, Sr, Y and Ti values. Similar values occur in undersaturated alkaline basic rocks. These rocks commonly occur in association with carbonatites. No relation may exist. However, analysis for zirconium fluorine and niobium could be carried out. Similarly uranium and thorium may be present. (Carbonatites commonly contain magnetite, apatite and zircon with characteristic anomalous niobium, phosphorous, barium, strontium, lanthanum and yttrium values). Weathered ultrabasic rocks outcropping at Chilarski Rise (Coates) and in Wigetty Paddock (Muckanippie) contain similar traces of rare earths.

Otter Exploration (SML 643 644) resampled ultramafic rocks (bottom hole spoil from Kennecott's drilling) at Skuse Hill, Blackfellow Hill, Aristarchus Rise, and Lake Barry. In addition to those elements determined by Kennecott, Otter included manganese, vanadium, rubidium, cesium, lanthanum, cerium, erbium and scandium, with the following results.

Values for nickel, cobalt, copper, zinc, chromium, lead and phosphorus were very similar to those obtained by Kennecott for the Lake Barry Area (see table). Lanthanum, cerium, erbium, cesium and scandium were not detected. Values for the remainder are as follows; yttrium 0-110 ppm, strontium 0-1500 ppm, barium 0-1500 ppm, rubidium 0-100 ppm, vanadium 30-100 ppm and manganese 160-7300 ppm.

The heavy mineral fraction was studied for kimberlite indicator minerals, chrome diopside, pyrope garnet and picroilmenite. None were found. The bulk of the heavy mineral fraction (98%) was magnetite and ilmenite. The remainder was zircon, sphene and monazite.

Further sampling using a bulldozer was recommended by Otter at Durkin Laterite Hills, Snake Rocks Paddock and Wigetty Paddock. Snake Rocks is of particular interest because of the presence of silicified carbonate boulders and float of a phlogopite apatite rock.

The result of work done by Kennecott and Otter is still inconclusive due to poor outcrop and deep weathering. The ultramafic rocks may either be associated with kimberlite or carbonatite intrusives according to known trace element compositions.

Base metals in foliated or sheared 'granitic' rocks

(1) Pinding Rocks Area (Kychering):

Anomalous copper 50-800 ppm, lead 100-8000 ppm, silver 1-500 ppm, bismuth 5-1500 ppm and tungsten 50-500 ppm were detected in quartz-limonite veins in extremely poorly outcropping quartz sericite rock just south of Pinding Rocks (Langsford, 1972). Similar values were obtained by Archean Exploration N.L. It is of interest that one sample assayed 5 ozs/ton silver.

In the same area of poor outcrop a low order zinc anomaly (40-60 ppm) was outlined by Archean Exploration N.L. Samples collected from two hand auger holes (to 1.7 m) drilled by Langsford (S.A.D.M.) were also weakly anomalous (30-300 ppm). Further work was recommended. (Archean Exploration N.L., SML 505, Langsford, 1972).

(ii) Granite north of Coates Hill (Coates):

Anomalous copper 100-350 ppm and molybdenum Av 3 ppm were detected in rock chip samples from a sheared granitic rock 3½ km north of Coates Hill (Kennecott SML 333, 491). The shear is an extension of a fault in the Blackfellow Hill area where anomalous Cu/Ni values occur (see page 30). Further work in this area was recommended (Langsford, 1972).

(iii) Mulgathing Prospect - Top East paddock (Mulgathing):

Anomalous copper 100-350 ppm and molybdenum 3-20 ppm were detected in quartz-limonite veins in a yellowish weathered granite outcropping at the Mulgathing Prospect in Top East Paddock (Kennecott SML 491, Langsford 1972) 15 km. north of Mulgathing Homestead. One sample collected by Kennecott assayed 1500 ppm copper and 8 ppm molybdenum. No further work has been done.

TARCOOLA

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA

DEPARTMENT OF MINES ADELAIDE

AUSTRALIA 1:250,000

REFERENCE

CAINOZOIC	QUATERNARY — RECENT	Qra	Alluvial deposits, silts, sands and gravels
		Qrt	Talus slope deposits, gravels
		Qrs	Reddish dune sands and sand spreads
		Qrg	Aeolian gypsum dunes, powdery white to pink gypsum capped by a soft peaty crust
		Qrl	Saline and gypsiferous clays and silts
	PLEISTOCENE	Qca	Platy and nodular calcrete; may include at depth calcreted granite, granite gneiss
		Fe	Ferruginous gravel, may be related to ferruginous silcrete. Adjacent to jaspilite outcrops indicates extent of scree
	TERTIARY	Tsi	Dense pale olive grey to cream grey silcrete
		Tsu	Multicoloured fine to coarse sands, barite in part (subsurface only)
MESOZOIC	CRETACEOUS	Klb	BULLDOG SHALE. Fine grained clayey siltstone, sandstone
		Klc (Fe)	CADNA-OWIE FORMATION. Fine to medium grained sandstone, some pebbly sandstones with cobbles of laminated quartzite and quartz. Rare pebbles of GAWLER RANGE VOLCANICS. Sandstones ferruginised in part.
PALAEOZOIC	PERMIAN	P	Unnamed carbonaceous mudstones (subsurface only)
PROTEROZOIC	CARPENTARIAN	p€k	KOKATHA & HILTABA GRANITE EQUIVALENTS. Medium to coarse grained pink to reddish granite.
		p€v	GAWLER RANGE VOLCANICS. Porphyritic rhyolite, rhyo-dacite, dacite, welded tuffs locally magnetite rich.
		p€t	Tarcoola Beds. Dolomitic shales, sandstones, massive white quartzites, heavy mineral banded sandstones. Basal conglomerate contains jaspilite fragment
		p€b	"Older granite" = BURKITT GRANITE EQUIVALENT. Pink, medium to coarse grained, mica poor
		p€d	Basic and intermediate basic intrusives. Includes coarse grained diorite, outcropping on Muckanippie and Yarnding, intruded by dykes of GAWLER RANGE VOLCANICS and possibly KOKATHA & HILTABA GRANITE EQUIVALENTS; diorite dykes south of Coates Hill and microdiorite and gabbro dykes near South Lake
LOWER PROTEROZOIC		p€ / p€a	Basic and ultrabasic rocks. Altered gabbro, pyroxenite, augite diopside granulites; includes the ultramafic of Lake Barry. A chlorite, phlogopite, tremolite, feldspar, olivine rock.
		BIF	Banded Iron Formations. Quartz haematite or quartz magnetite rocks (the magnetite may be altered to martite)
		p€	Acid Metamorphic Rocks. Schist and gneiss of amphibolite and granulite grade; includes strongly weathered granitic rocks and foliated granitic rocks of unknown age.

Bedding, strike & dip 60

Fault ....

Dyke ....

Trend of layering ....

Built-up area

Road sealed surface first class; route marker

Road sealed surface second class; mileage

Road loose surface all weather

Road loose surface dry weather

Road unimproved earth

Track, foot or pack; footbridge

Embankment; cutting

Gate; cattle grid

Bridge road; bridge railway

Railway multiple track

Railway single track

Light railway or tramway

Station; siding; station with siding

Telephone line; power transmission line

Fence; stone wall

Levee or dyke; quarry

Mine; windpump; yard

Building (s); church; school

Post office; wireless transceiver; cemetery

Airport or airfield; landing ground

Control point major, minor; astronomical

Spot elevation in feet, accurate; approximate

Bench mark, mud; gravel

Waterhole; water tank; dam; dry lake

Lake, river or stream perennial

Lake, river or stream intermittent

Dam or weir; falls; rapids

Drain or ditch perennial, intermittent

Spring perennial, intermittent; ricefields

Marsh or swamp; perennial, intermittent

INDEX TO ADJOINING SHEETS

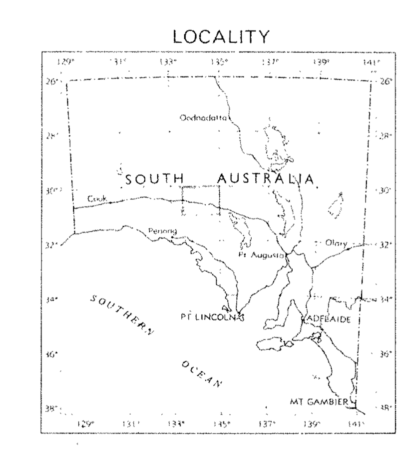
WALLARINGA	COOBER PEDY	BILLAKALINA
BARTON	TARCOOLA	KINGOONYA
FOWLER	CHILDARA	GAIRDNER

SCALE

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

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

LOCALITY



TARCOOLA

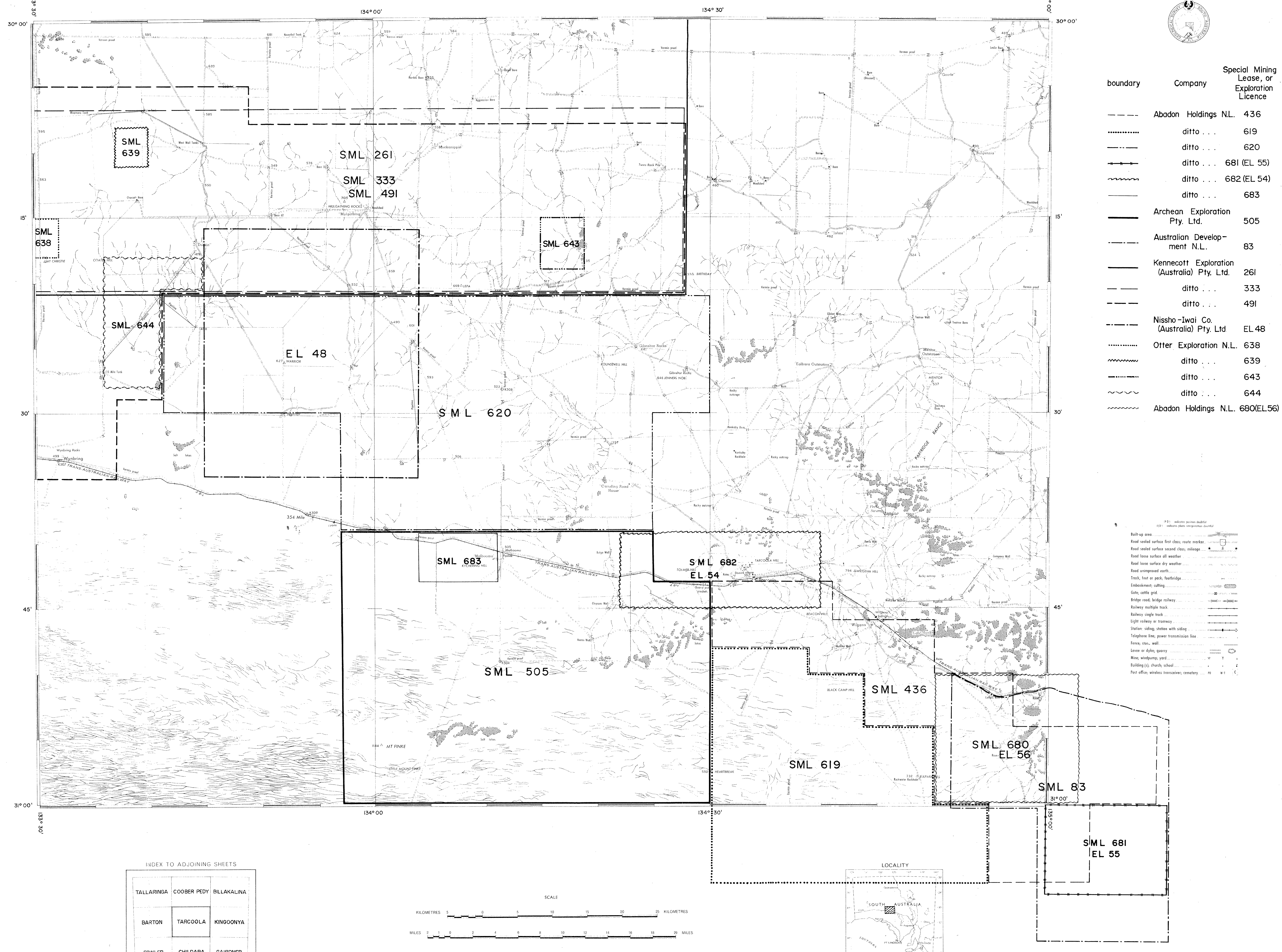
SHEET SH53-10 ZONE 5

PRELIMINARY EDITION—JULY 1974

SUBJECT TO AMENDMENT

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

TARCOOLA



TARCOOLA 1:250 000 SHEET
SPECIAL MINING LEASES AND EXPLORATION LICENCES

74-902