EXPLANATORY NOTES

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Primary Industries and Resources SA

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1:250 000 Geological Series

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Explanatory Notes for the CHILDARA 1:250 000 Geological Map

*Gary M Ferris and Martin C Fairclough

Mineral Resources Group

Geological Survey Branch

*now with Intermet Resources Pty Ltd

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Government of South Australia
Primary Industries and Resources SA

Division of Minerals and Energy Resources
Primary Industries and Resources South Australia
7th floor, 101 Grenfell Street, Adelaide
GPO Box 1671, Adelaide SA 5001

Phone	National	(08) 8463 3204
	International	+61 8 8463 3204
Fax	National	(08) 8463 3229
	International	+61 8 8463 3229
Email	pirsa.minerals@saugov.sa.gov.au	
Website	www.minerals.pir.sa.gov.au	

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Gary M Ferris and Martin C Fairclough

INTRODUCTION

CHILDARA lies between latitudes 31°00` and 32°00` south and longitudes 133°30` and 135°00` east (Fig. 1). The eastern part of the map area comprises the large sheep grazing pastoral leases of North Well, Lake Everard and Kondoolka, with access via station tracks from the main graded dirt road from Wirrulla to Kingoonya. The Kalanbi area in southwest CHILDARA comprises smaller land holdings used for cereal growing. The majority of the map area falls within the Yellabinna Regional Reserve (Fig. 1) with public access tracks located along the Vermin Proof Fence (VPF), or Googs Track, which traverses the park from Kalanbi Gate northwards to Malbooma Siding west of Tarcoola.

Regional mapping of CHILDARA was based on interpretations from Department of Lands colour aerial photographs at a scale of 1:86 950 (Surveys 3327 and 3334). Basement outcrop within CHILDARA is sparse which makes interpretations from airborne magnetic data and scattered drillhole data invaluable. Geological boundaries were transferred to topographic bases prepared by the Spatial Information Services Branch of PIRSA at aerial photograph scale.

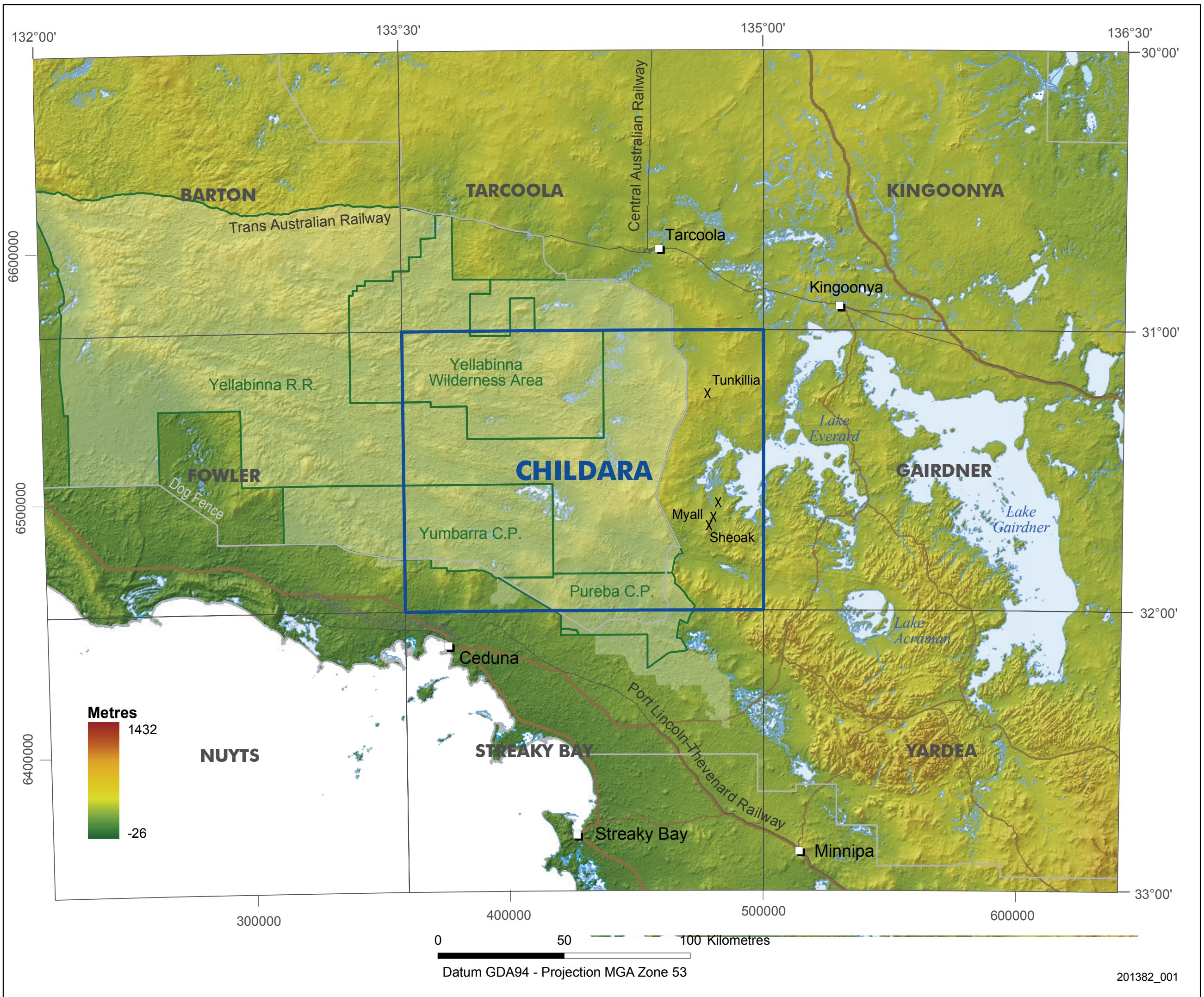


Figure 1. **Location Map**

BACKGROUND

The CHILDARA 1:250 000 map area is located on the western Gawler Craton (Fig. 1), an ancient crystalline shield comprising Archaean, Palaeoproterozoic amd Mesoproterozoic metasediments, volcanics and granites that has been tectonically stable since 1450 Ma (Thomson, 1975; Parker, 1993). Basement outcrop is poor and is restricted to scattered, low sheets of granite and inselbergs over much of the area except for the Gawler Ranges to the east (Fig. 2). Brown (1885), during an expedition from Ceduna to Mount Finke, commented on granite inselbergs in northwestern CHILDARA.

Bennett (1968) produced a preliminary geological map of part of CHILDARA. Blissett and Vitols (1974) carried out a helicopter survey to collect samples and map basement outcrops on the western Gawler Craton. This survey formed the basis for the previously unpublished 1:250 000 geological mapping (Blissett, 1980). Samples were assayed for a range of elements including base metals and gold (see Fig. 3 in Blissett and Vitols (1974) for sample locations and assay values). Company mineral exploration has been restricted to the more accessible areas along the eastern and southwestern sections of the map area.

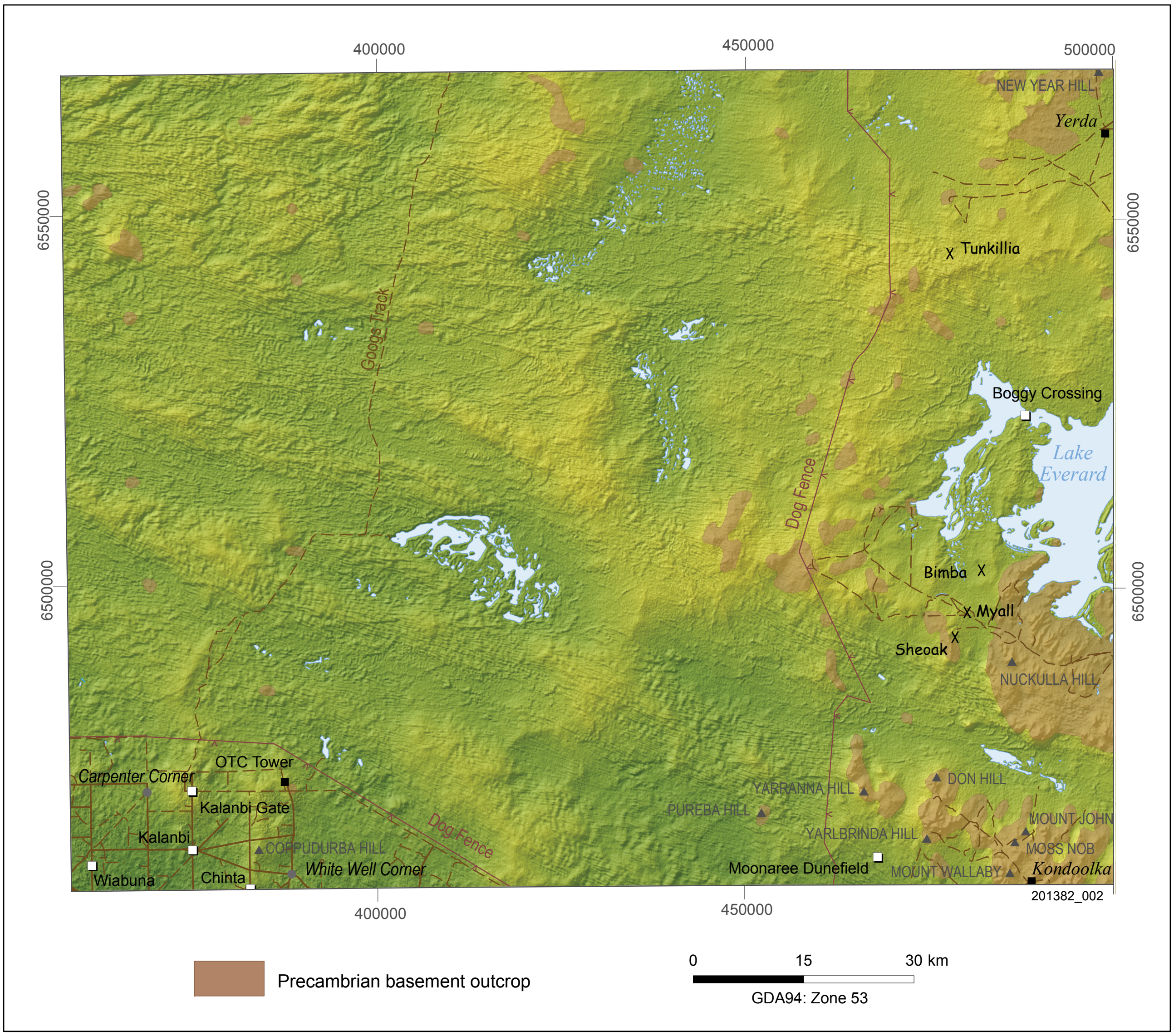


Figure 2. Digital Terrane Model image showing physiography and Precambrian basement outcrops

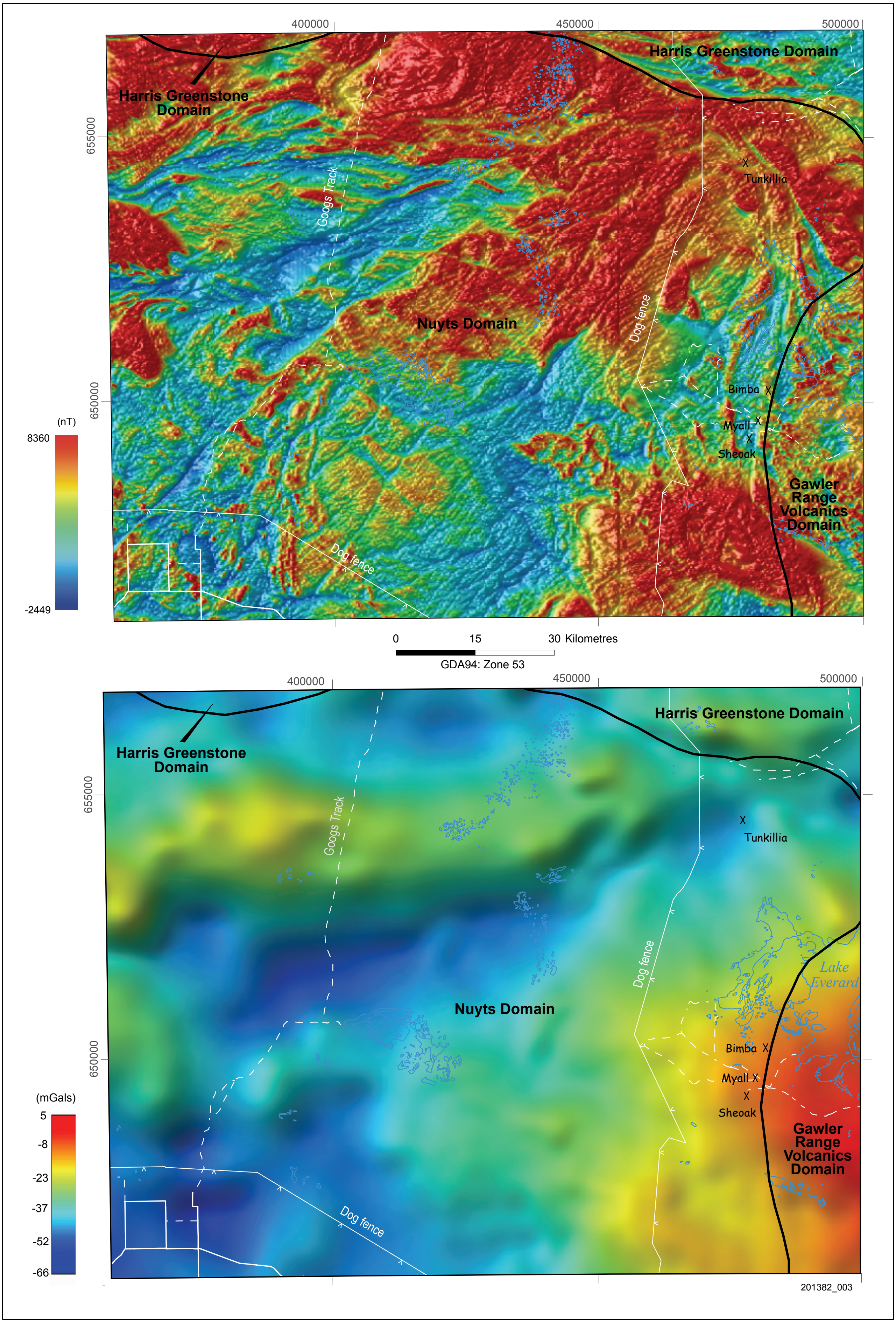


Figure 3. CHILDARA total magnetic intensity (TMI) image, Bouger gravity image with Tectonic Domains modified from Daly et al, 1998.

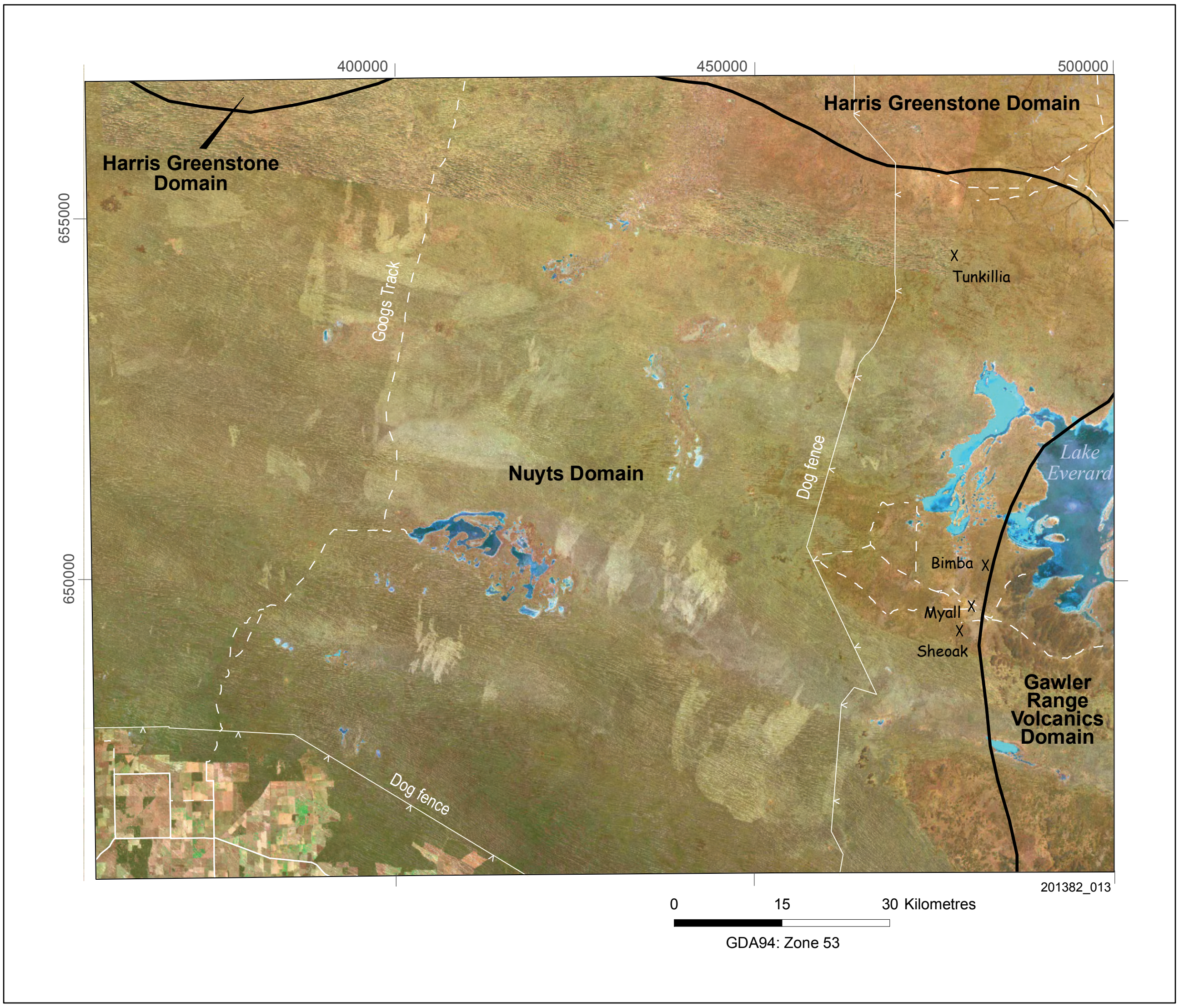


Figure 3. continued

Major mineral exploration interest in the CHILDARA region began after the discovery of the Tunkillia gold prospect in 1996. During 1996, calcrete sampling by Helix Resources NL and Equinox Resources NL delineated gold anomalies at Tunkillia and Nuckulla Hill within the Yarlbrinda Shear Zone (YSZ) (Figs 3–4). The Tunkillia prospect is located at the northern end of the YSZ where the north-south trending shear zone is reoriented to the northwest by the Yerda Shear Zone. Martin (1996) reported that mineralisation is hosted by variably deformed granite, which has been extensively hematite and/or silica-sericite-chlorite altered. Areas 223 and 191 are located within a demagnetised zone, with gold mineralisation associated with steeply dipping high-grade veins within an envelope of essentially barren, but highly altered granite. At Area 223, mineralisation occurs over a strike length of 500 m and between 10–120 m wide with a high-grade zone 10–25 m wide yielding individual 4 m samples containing up to 32.4 g/t (Martin, 1996).

Within the central part of the YSZ, Equinox Resources NL delineated gold mineralisation at Myall, Sheoak and Bimba prospects. Rock types range from brecciated granite to syenogranite, quartz diorite, adamellite and mylonitic gneisses, which have undergone amphibolite-facies metamorphism (Parker, 1996). Post-peak metamorphic sericitisation and quartz veining were followed by calc-silicate ± epidote veining ± chlorite ± adularia ± quartz ± fluorite or calcite (Parker, 1996). Gold grades range from 7 m at 3.1 g/t including 3 m at 6.2 g/t within drillhole NHAC 26 at Sheoak, to 3 m at 1.67 g/t (NHAC 150) and 5 m at 1.71 g/t (NHAC 152) at the Bimba prospect (Daly et al., 1998).

The first geophysical study of the area was carried out by the Bureau of Mineral Resources Geology and Geophysics (BMR) in 1961 in the search for iron ore deposits using reconnaissance airborne magnetic and radiometric surveys over most of CHILDARA (Quilty, 1962). BMR also conducted a regional gravity survey by helicopter which included CHILDARA during 1970 (Pettifer and Fraser, 1974).

High-resolution aeromagnetic data flown by World Geoscience Corporation, Geoterrex and Kevron during 1992–95 has greatly enhanced the exploration potential of the western Gawler Craton. Major structures have been delineated including the YSZ which extends for ~170 km and trends north-south along the western margin of the Gawler Range Volcanics (GRV), but is reorientated to the northwest where it intersects the Koonibba Fault and the Yerda Shear Zone (Fig. 3).

Further fieldwork was undertaken by Ferris in the late 1990s and early 2000, including helicopter surveys of more isolated exposures. This work involved regional mapping and sampling from which much of the geochemical analysis discussed in these notes are derived. Ferris (2001) provides in depth details on the Proterozoic lithologies and their relationships of CHILDARA.

HISTORICAL NOTES

Prior to European settlement in 1836, the CHILDARA region was inhabited by the Wirangu tribe (Tindale, 1940). The Kokatha tribe inhabited the rocky outcrops within the vicinity of Lake Everard Homestead.

In the search for pastoral land, the State government initiated expeditions during the 1850s, but thick scrub to the west of Yarlbrinda Hill halted these expeditions (Threadgill, 1922). In 1858, explorer John McDougall Stuart crossed the western part of CHILDARA from north to south as part of his expedition to the interior of the continent (Stuart, 1858). The expedition party found water within a creek draining a large isolated hill which Stuart named Mount Finke. Travelling west from Mount Finke for ~30 km, the party turned south due to inaccessible thick scrub and finally reached the coast on the western shore of Denial Bay (opposite present township of Ceduna) in August 1858.

Sheep grazing stations were established at Lake Everard, Arcoordaby (now part of North Well) and Kondoolka in 1868, 1870 and 1871 respectively (Richardson, 1925).

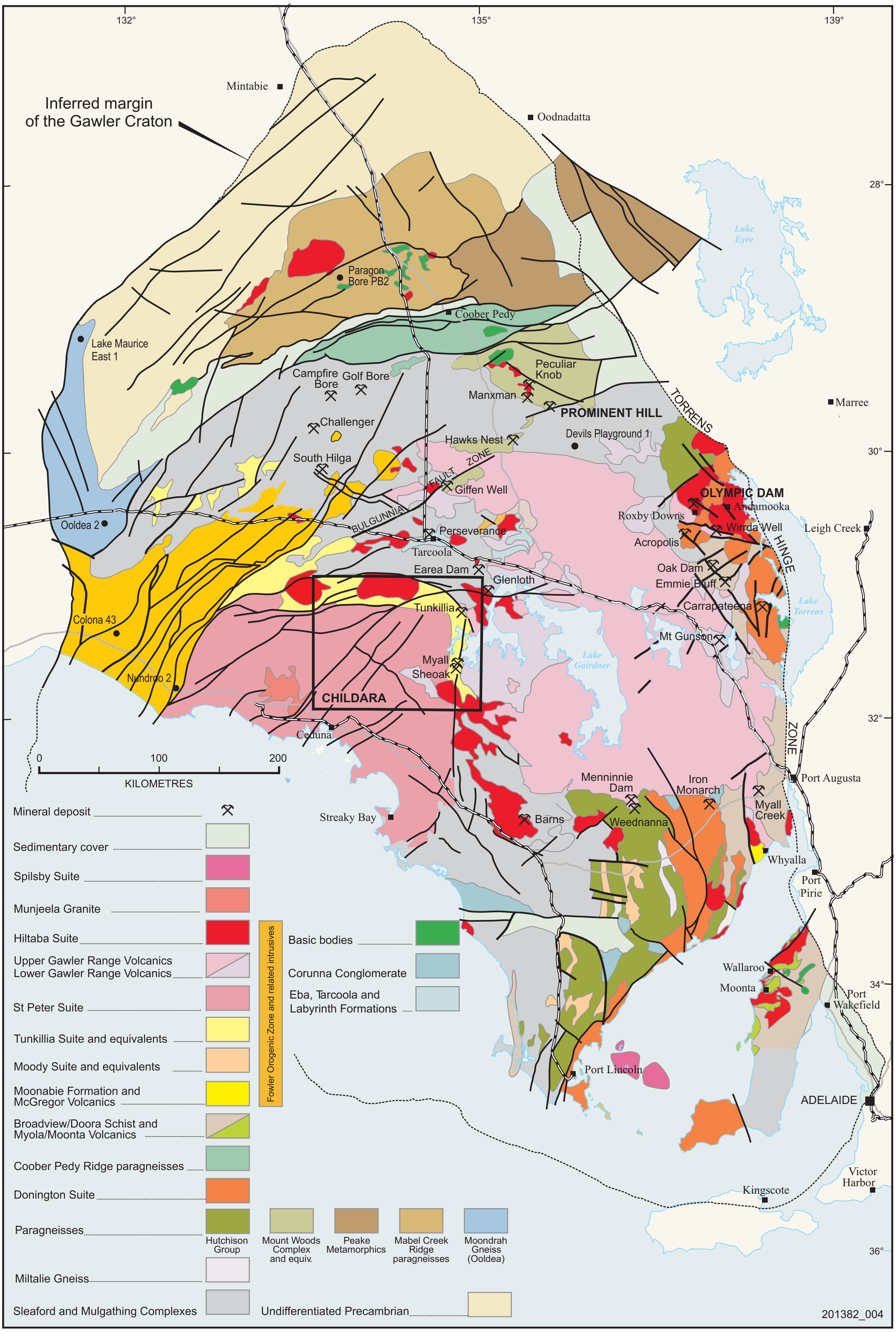


Figure 4. Regional geological and tectonic setting (modified from Daly et al, 1998)

CLIMATE AND PHYSIOGRAPHY

CHILDARA lies between latitudes 31°00` and 32°00` south and longitudes 133°30` and 135°00` east (Fig. 1). CHILDARA has a semi-arid climate with long, hot summers during which the temperature commonly exceeds 35°C, and short cool winters. Rainfall ranges from 330 mm on the coast at Ceduna to <170 mm at Kingoonya in the north. Rainfall is variable, with long periods of drought common. Good rains occasionally occur during thunderstorm activity.

The terrain on CHILDARA is 100–150 m above sea level and is dominated by sand dunes of the Great Victoria Desert. The Gawler Range Volcanics in the Lake Everard area and Hiltaba Suite granite exposures in the Kondoolka area form long ridges and isolated hills which rise up to 75 m above the surrounding plains. Within the volcanics, dacitic units form prominent hills whilst the rhyolites are more subdued. Granite in other parts of the map area generally crop out as low isolated sheets within areas of scrub (Fig. 5).

A series of playa lakes occupying topographic depressions, usually associated with areas of parabolic or network dunes occur across central CHILDARA (Fig. 6).

Plate 1. Topography of the CHILDARA area (photo 403082).

Regional mapping of CHILDARA was based on Department of Lands colour aerial photographs at a scale of 1:86 950 (Surveys 3327 and 3334). Geological boundaries were transferred to topographic bases prepared by the Spatial Information Services Branch of PIRSA at aerial photograph scale.

STRATIGRAPHY

Five main Precambrian rock sequences are recorded on CHILDARA which broadly correlate to:

1. Glenolith Granith of the Archaean Mulgathing Complex.
2. 1690–1670 Ma Tunkillia Suite.
3. 1630–1608 Ma St Peter Suite.
4. 1595–1575 Ma Gawler Range Volcanics and Hiltaba Suite Granite.
5. ~1560 Ma Munjeela Granite.

Only very limited metasedimentary precursors to these magmatic events are recorded, and the nature and age of surrounding metasedimentary rocks are unkown.

ARCHAEAN

Archaean rocks on the western Gawler Craton belong to the Mulgathing Complex (Daly et al., 1979; Daly 1985, 1986). Only the Glenloth Granite crops out on CHILDARA. Daly and Fanning (1990) report a preliminary U-Pb crystallisation age of 2440 Ma for the Glenloth Granite.

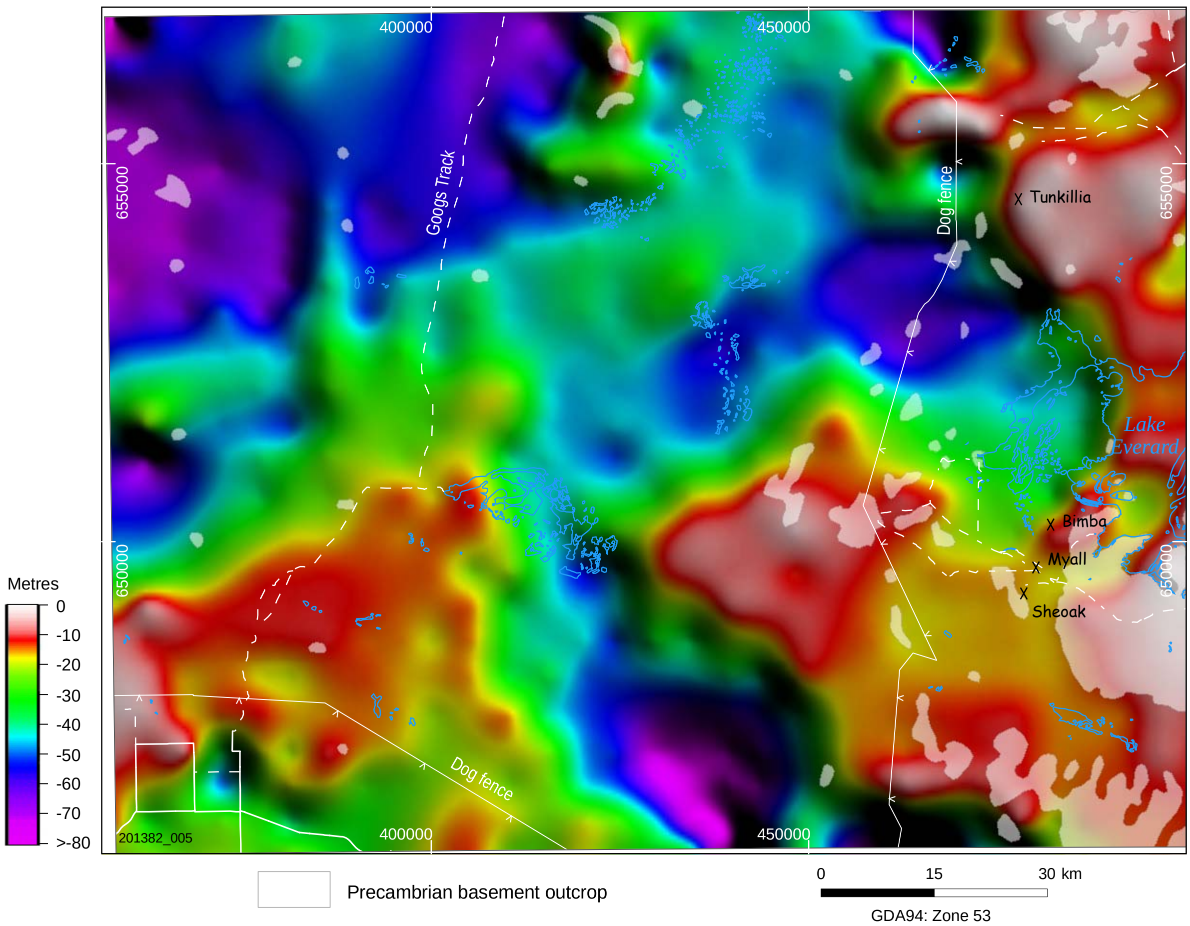


Figure 5. Depth to basement image derived from open file drillhole data with superimposed generalised Precambrian basement outcrops.

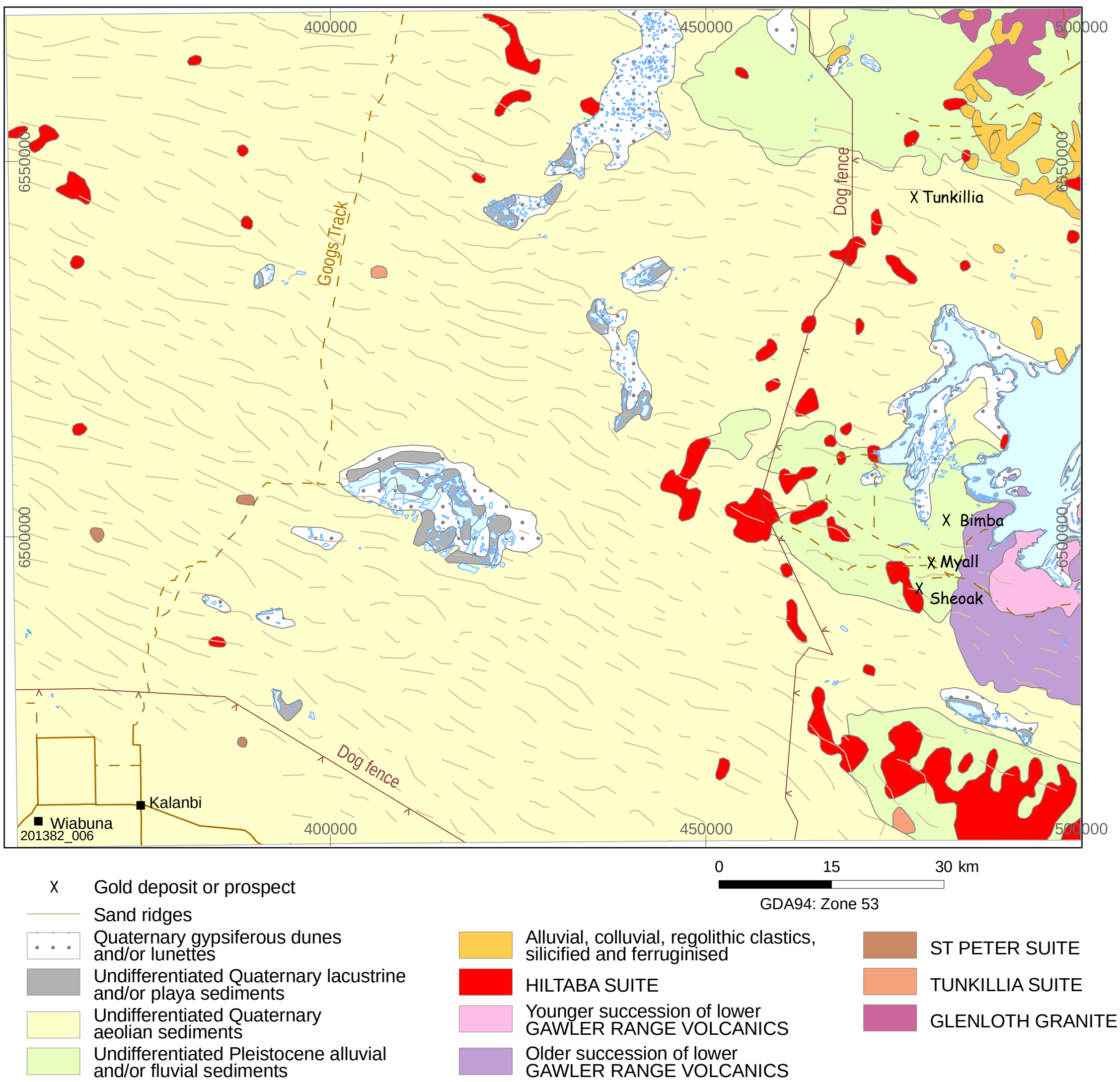


Figure 6. Simplified geology of the CHILDARA sheet.

Plate 2. Outcrop of Glenloth Granite on northeastern CHILDARA. Photo 403083.

Glenloth Granite (ALmg)

The Glenloth Granite varies from granite to granodiorite in composition, is poorly to well foliated, medium to coarse grained, and varies from pinkish brown to grey in colour. It consists predominantly of quartz, microcline with subordinate plagioclase, and contains angular remnants of layered quartz–feldspar–biotite–hornblende gneiss, and convoluted biotite and hornblende-rich schlieren.

On northeastern CHILDARA, quartz-feldspar–biotite granite, interpreted to be Glenloth Granite crops out in the New Year Hill area. Furthermore extensive areas of kaolinised granite, capped by silcrete, crop out which are interpreted to represent weathered Glenloth Granite.

PALAEOPROTEROZOIC

Undifferentiated Palaeoproterozoic basement

Within the CHILDARA area, interpreted Palaeoproterozoic units including metasediments and orthogneisses occur as enclaves in younger rocks. At Rocky Point on STREAKY BAY, Palaeoproterozoic St Peter Suite granite intrudes quartzofeldspathic orthogneiss that possibly represents Palaeoproterozoic basement. At Point Sinclair, enclaves of well-foliated, quartz–feldspar–¬¬biotite–garnet schist occur within Mesoproterozoic Munjeela Granite. Rafts of metasedimentary enclaves are present in Hiltaba Suite granite within the Kondoolka Batholith. West of Childara Outstation, enclaves of andalusite-biotite hornfels occur within Tunkillia Suite granite. These metasediments represent the undifferentiated basement rocks.

Mylonite from an outcrop west of the Vermin Proof Fence (VPF), comprises thinly laminated, alternating pink and brown to grey layers, similar in appearance to mylonite from south of Yarlbrinda Hill. Mason (1998) reported that the precursor was possibly a fine-grained, feldspathic silty sediment.

Plate 3. “Magic carpet” metasedimentary enclave within Munjeela Granite at Point Sinclair (on NUYTS) (photo 403084).

Plate 4. Hand specimen of pebbly meta-conglomerate and meta-siltstone enclave within Hiltaba Suite granite from the Kondoolka Batholith (width of view is 12 cm) (photo 403085).

Tunkillia Suite Ln

The Tunkillia Suite is defined from Helix Resources NL drillhole LED 10 in Area 223 of the Tunlillia gold prospect on CHILDARA and from outcrops at Lakeside and south of Childara Outstation on Lake Everard Station (Ferris and Schwarz, 2004). Rocks within the Yarlbrinda Shear Zone belong to the Tunkillia Suite (Ferris and Schwarz, 2005). The Tunkillia Suite represents a suite of comagmatic late Palaeoproterozoic (1690–1670 Ma), I-type intrusives and rhyolite, mafic and aplite dykes.

SHRIMP U-Pb analyses of zircons from foliated granite from the Tunkillia prospect (hole LED 10 155–157 m) gave an upper intercept age of 1686±5 Ma (Fanning et al. 2006), which represents crystallisation age. This is similar to the date obtained for a foliated, rhyolite dyke, intruded into foliated granite southwest of Childara Outstation (sasmple R1124960), which recorded a magmatic age of 1680±10 Ma.

Based on the regional mapping, six main lithologies were delineated, Ln_{1-6}.

Orthogneiss (Ln_1)

This unit includes a variety of coarse-grained, megacrystic granites to augen gneisses ranging in composition from granite (K–feldspar dominant) to quartz syenite. These rocks are altered, partly recrystallised and variably deformed.

The main exposures occur along the edges of lakes north of Fyne Dam, in an area Equinox Resources NL called Lakeside. The rocks comprise a series of comagmatic, coarse-grained augen gneisses, with some coarse orthoclase augen up to 15 mm in diameter, but averaging 1–5 mm. Quartz content varies from 15–40% and is extensively recrystallised to fine-grained (0.5–1 mm) grains; rare elongated grains up to 4 mm in length occur. Plagioclase content varies from 10–20%, with grains up to 8 mm in length, but averaging <1 mm and is commonly altered to sericite and albite. Biotite is present as an accessory phase and is mostly recrystallised and altered to leucoxene. Minor outcrops of coarse grained, augen granite gneiss are located south and southwest of Childara Outstation.

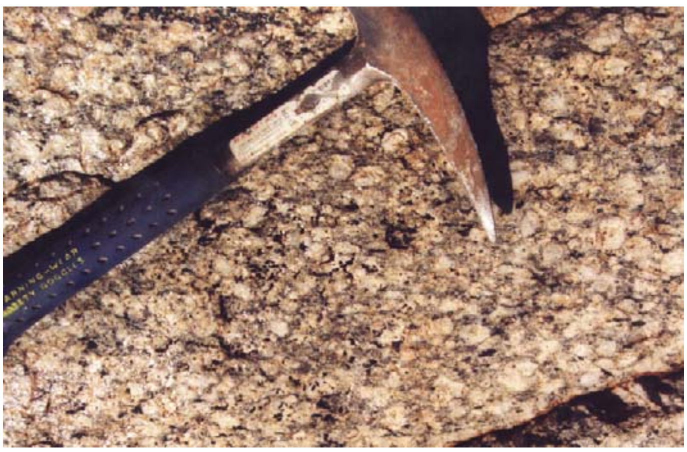


Plate 5. Outcrop of coarse grained, augen granite gneiss located at Lakeside (photo 403086).

Granite (Ln_2)

This unit comprises variably deformed, grey to pink, medium to coarse-grained, adamellite, quartz syenite to granodiorite. K-feldspar and plagioclase are common, with both occurring as blocky euhedral crystals and smaller anhedral grains. The coarser grains represent better–preserved primary igneous grains, whereas the smaller grains show the effects of dynamic regional deformation and metamorphism. There are no diagnostic metamorphic minerals available to positively identify the grade of metamorphism, but the style of deformation is consistent with upper greenschist to amphibolite facies.

At Lakeside, medium- to coarse-grained granite crops out as low discontinuous sheets and tors. The granite contains sub-equal amounts of coarse K-feldspar grains up to 15 mm in length, with finer grained plagioclase and quartz.

West of Childara Outstation, medium-grained, foliated granite crops out. The original texture of the rock has been extensively altered by regional deformation producing a granoblastic mosaic of K-feldspar, plagioclase (albite), quartz and minor biotite.

Southwest of Childara Outstation, granite crops out as a prominent linear ridge. The rock ranges from slightly deformed with only quartz being recrystallised producing a foliation to narrow mylonite zones in which all minerals are completely recrystallised.

Plate 6. Outcrop of granite south west of Childara Outstation showing narrow mylonite zone (photo 403087).

Plate 7. Hand specimen of Yarlbrinda Hill showing coarse grained, K-feldspar dominant granite, exhibiting both ductile and brittle deformational fabrics (photo 403088).

South of Tunkillia base camp, granite crops out as low sheets and rounded tors. Rock type ranges from granodiorite to biotite monzogranite to adamellite gneiss. Alkali feldspar and plagioclase are present in nearly equal amounts with minor primary biotite. Alkali feldspar is present as large, blocky crystals up to 12 mm in length. Plagioclase is much more fine-grained up to 4 mm in length and commonly altered to sericite. Quartz is moderately abundant and has been completely recrystallised. Biotite is randomly scattered throughout the rock and has been extensively replaced by chlorite. Minor fine grained, recrystallised biotite occurs in thin anastomosing lamellae which suggests a S-C fabric (Purvis, 1998a).

Webb (1978) obtained a tentative Rb–Sr age of 1640 Ma for two samples from Yarlbrinda Hill. Yarlbrinda Hill comprises predominantly protomylonitic granitoid gneiss, with coarse-grained lenticular red K-feldspar (up to 30 x 8 mm) and finer-grained cream to red lenticular plagioclase grains. Petrological examination shows that the original rock comprised a medium- to coarse-grained potassic granite, which was subsequently deformed under ductile conditions, producing lenticular feldspar augen and prominent foliation development (Purvis, 1997). Later, more pervasive brittle deformation produced microfracturing of coarse feldspar grains and recrystallisation of original quartz into irregular lenses and incipient veins. Yarlbrinda Hill also contains abundant pseudotachylite development.

Plate 8. Outcrop of pseudotachylite at Yarlbrinda Hill (photo 403089).

Mylonite (Ln_3)

At several localities, narrow (up to 3 m wide) mylonite zones are observed within precursor granitoids, aplite and rhyolite dykes. North of Fyne Dam, two narrow mylonite zones occur within megacrystic gneisses of Ln_1 and granite of Ln_2. The most prominent mylonite zone is ~3 m wide and crops out ~50 m to the east of a narrow (~20 cm wide) mylonite zone.

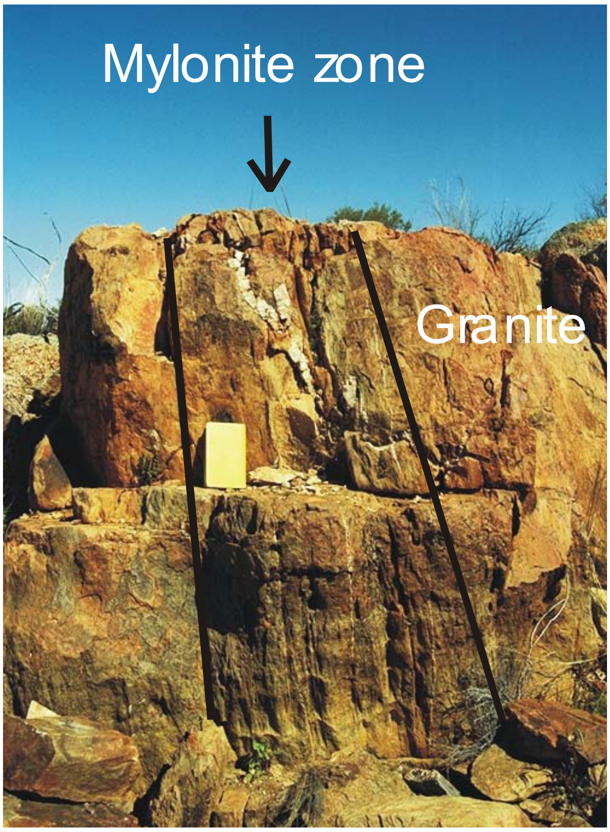


Plate 9. Outcrop of mylonite at Lakeside (photo 403090).

Mafic dykes (Ln_4)

Thin (<10 m wide) dykes of fine to coarse-grained amphibolite intrude units Ln_1 and Ln_2. These dykes do not crop out well, and are present as scattered float, which generally define the trend of the dykes. The rock has a characteristic dark green crystalline appearance, which in thin section displays a relict igneous texture, modified by regional metamorphism and deformation. This has resulted in the recrystallisation of precursor minerals, and the development of foliation. Mason (1998) reported that the original rock was a dolerite, comprising phenocrysts of plagioclase, ?pyroxene and ?Fe-Ti oxides, within a finer groundmass, which suffered regional lower amphibolite facies metamorphism, producing the assemblage plagioclase, hornblende and opaques.

Rhyolite, rhyodacite dykes (Ln_5)

Deformed, porphyritic rhyolite dykes intrude granite gneiss (Ln_2) southwest of Childara Outstation. The dykes have chilled margins and are similar to dykes of the Moonamby Dyke Suite (Ma_5), which intrude the Gawler Range Volcanics, but are deformed. SHRIMP dating of zircons yielded a magmatic age of 1680±10 Ma (Fanning et al., 2006). This date provides a minimum age for the host granite and also a maximum age for deformation within the Yarlbrinda Shear Zone.

Plate 10. Detailed view of deformed rhyolite dyke, near Childara Outstation showing elongate, ribbon quartz grains and relatively undeformed feldspar grains (photo 403091).

South of Childara Outstation near the airstrip, a brick–red, fine-grained, spherulitic rhyolite intrudes granite and augen gneiss. The rock is not foliated and its stratigraphic position is uncertain. As it does not appear similar to nearby volcanic units of the younger Glyde Hill Volcanic Complex, it has been placed within the Tunkillia Suite.

Aplite Dykes (Ln_6)

North of Fyne Dam, narrow (up to 0.2 m wide) aplite dykes intrude coarse-grained augen gneiss and granite (Ln_1 and Ln_2). These dykes trend north–south and dip 073° to the east. ~1 km to the south along an east–west track and within a nearby creek, off-white, felsic crystalline rock with a moderately strong foliation occurs as scattered float. The rock comprises quartz and feldspar with minor muscovite, which defines a foliation. The fine-grained nature of the rock suggests that it originated as an aplite, which was subsequently deformed and recrystallised.

Plate 11. Narrow aplite dykes north of Lakeside (photo 403092)

St Peter Suite Lp

The St Peter Suite (Flint et al., 1990), encompasss defines a suite of comagmatic granitoids which outcrop along the coast from Streaky Bay to Rocky Point, west of Ceduna. Flint et al. (1990) defined five units Lp_1, Lp_2, Lp_3, Lp_5 and Lp_6.

Descriptions of the defined St Peter Suite lithologies from Flint et al., (1990) and Ferris (2001) are based on coastal outcrops predominantly from with the NUYTS and STREAKY BAY 1:250 000 map sheets. Limited isolated St Peter Suite outcrops are interpreted from within CHILDARA.

Lp_1 comprises pink, fine to medium-grained granite, and adamellite, grading to a medium to coarse-grained, pink to red granite that varies from weakly to moderately well foliated.

Lp_2 is a series of dolerite, diorite, amphibolite and lamprophyre dykes, which intrude Lp_1, Lp_3 and Lp_5. In the Kalanbi area, a suite of ultramafic to intermediate rocks were drilled in the search for nickel sulphides. Rock types include troctolite, olivine hypersthene gabbro, olivine gabbro and amphibolites. Purvis (1983) divided these ultramafic units into three groups:

1. cumulate metagabbros, locally rich in magnetite±apatite derived from a relatively fractionated magma (tholeiitic basalt composition)
2. troctolite, olivine hypersthene gabbro and olivine gabbro of cumulus origin, but from a less fractionated magma than group 1
3. chloritic metaperidotite or metapyroxenite.

These rocks are thought to be correlated with Lp_2.

Lp_3 is a suite of fine- to medium-grained adamellite to granodiorite dykes, which intrude Lp_1. At Point Brown and Smooth Pool, some dykes show magmatic banding along the margins (Berry and Flint, 1988) and other areas show zones of complex mingling between units. Knight (1997) reported trondhjemite at Point James, and tonalite at Cape Beaufort and Rocky Point, which are correlated with Lp_3 and Streaky Bay granodiorite of Dove (1997).

Plate 12. Magmatic banding at Point Brown within Lp_3 (photo 403093).

Plate 13. Complex mingling relationships of the St Peter Suite (photo 403094).

Lp_5 is a suite comprising medium-grained, porphyritic adamellite to granodiorite. Lp_6 intrudes all other units and comprises pink, medium-grained, porphyritic granite containing pale pink microcline phenocrysts up to 15 mm.

A sample from a granodiorite dyke from Point Brown on STREAKY BAY (Lp_3) was dated by Ferris (2001) using single and multi-grain IDTIMS analyses of zircons (Fanning, 1997). Five of the six zircon grains analysed yielded discordant U–Pb analyses, which produced an upper concordia intercept age of 1619±15 Ma. However, one zircon grain yielded a concordant $^{207}Pb/^{206}Pb$ age of 1620±4 Ma, consistent with the crystallisation age for the St Peter Suite obtained by Rankin and Flint (1991). Knight (1997) dated a tonalite (Lp_3) from Cape Beaufort using the Kober technique and recorded a Pb–Pb zircon crystallisation age of 1608±8 Ma. Previous mapping on CHILDARA did not record any occurrences of St Peter Suite age rocks. However, regional mapping and geochronology by Ferris (2001) has demonstrated that the St Peter Suite is widely distributed on CHILDARA.

Northeast of Ceduna, several outcrops of fine to medium-grained, pink to pale orange adamellite to granodiorite (Lp_7) are generally poor, comprising low, isolated sheets. Sample R389873 comprised a weakly foliated hornblende–biotite granodiorite with distinctive small aggregates of magnetite–sphene–zircon–apatite, which suggest an I-type affinity (Purvis, 1998b). SHRIMP zircon analyses of a sample of granodiorite gave a weighted mean $^{207}Pb/^{206}Pb$ age of 1616±6 Ma Fanning et al., 2006) An outcrop of deformed granodiorite from northern CHILDARA (sample R444813) gave a weighted mean $^{207}Pb/^{206}Pb$ age of 1613±4 Ma (Ferris, 2001).

Outcrops of leucocratic granite to adamellite, containing minor Ca-rich garnet were mapped near the former OTC Station northeast of Ceduna (Lp_8). These rocks are strongly foliated, trending 020°, with a strong quartz fabric in which the quartz c-axes are roughly parallel to the foliation (Purvis, 1998b).

The presence of garnet suggests a possible S-type affinity, but the presence of sphene indicates sufficient activity of CaO within the melt to produce a Ca-rich garnet, which indicates an A-type affinity. The presence of rare fluorite enclosed in biotite also supports an A-type affinity (Purvis, 1998b).

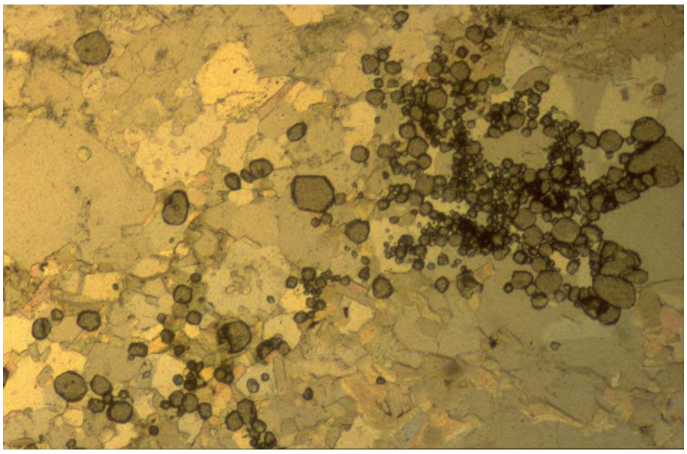


Plate 14. Thin section of leucocratic granite from near the former OTC station, north of Ceduna showing aggregate of garnet grains (field of view is 0.5 mm) (photo 403095).

Southwest of Yarlbrinda Hill is a small rockhole of pink to pale orange, medium-grained mylonitic granite gneiss (Lp_9), comprising K-feldspar (45–55%), quartz (~30%), plagioclase (10%) and minor biotite. In thin section, feldspar augen are totally recrystallised and the groundmass is rich in fine-grained K-feldspar with a strong fabric. SHRIMP zircon analyses gave a weighted mean $^{207}Pb/^{206}Pb$ age of 1611±7 Ma, which is thought to represent the crystallisation age (Ferris, 2001). This outcrop is part of a pluton southwest of the Kondoolka Batholith, which suggests that both of these plutons formed as part of the tectonothermal event that produced the St Peter Suite to the west. South of Yarlbrinda Hill, two low outcrops of foliated, gneissic adamellite consist of porphyroblastic, K-feldspar and finer grained plagioclase crystals within a fine-grained quartzofeldspathic matrix. Webb (1978) obtained a tentative Rb–Sr date of 1640 Ma, similar to that obtained for Yarlbrinda Hill. Based on geochemistry, these are interpreted as part of the St Peter Suite.

MESOPROTEROZOIC

Gawler Range Volcanics

The Mesoproterozoic Gawler Range Volcanics (GRV) (Thomson, 1966) are a sequence of bimodal volcanics, which crop out over an area of 25 000 km^2 within the central Gawler Craton (Fig. 3). They comprise subaerial felsic volcanics, dominantly as lava flows, domes and dykes, with minor ashflow and ignimbrite layers.

The GRV was divided into two broad groups, the upper and lower sequences, based on structural differences (Blissett, 1986). Blissett (1986) and Blissett et al. (1993) defined the lower sequence as a series of moderate to steeply dipping ignimbritic dacite–rhyodacite–rhyolite units, with minor breccia and lava flows, that were erupted from localised vents within the Kokatha (Chitanilga Volcanic Complex, Branch, 1978), Lake Everard (Glyde Hill Volcanic Complex) and Paney areas. Blissett (1986) and Blissett et al. (1993) defined the upper sequence as a voluminous series of flat–lying to slightly dipping, porphyritic, ignimbritic, rhyodacite to dacite sheets, including the extensive Yardea Dacite.

Flint (1993) reported that the felsic units of the upper and lower sequences have similar chondritic trace-element patterns, whilst U–Pb zircon ages from Fanning et al., (1988) of 1591±3 and 1592±3 Ma, respectively are statistically indistinguishable. This indicates that the break between the upper and lower units was geologically short and did not reflect any significant geochemical difference.

Stewart (1992) divided the GRV into a developmental phase and a mature phase, based upon geochemical and isotopic differences. The developmental phase comprises basalts to high silica rhyolites, erupted from localised centres including Lake Everard, Kokatha, Tarcoola and Toondoolya Bluff. The mature phase is chemically and isotopically more homogeneous than the developmental phase, and comprises the voluminous Yardea Dacite, Eucarro Dacite and Nonning Rhyodacite.

Blissett (1975) defined the Glyde Hill Complex volcanic package, located near Lake Everard and centred near Glyde Hill Outstation. The Glyde Hill Volcanic Complex comprises a series of dacite, rhyodacite and rhyolite units erupted from a discrete volcanic centre in the Lake Everard area separate from the Chitanilga Volcanic Complex (Branch, 1978) to the north or the main Yardea Dacite unit to the east. Geochemical studies suggest that the Glyde Hill Volcanic Complex, together with the Chitanilga Volcanic Complex, and the Toondulya Bluff sequence to the south, have a common petrogenesis (Flint, 1993). Giles (1977) reported that the volcanic pile in the Lake Everard area comprises a sequence of conformable, strongly welded crystal and/or vitric and/or lithic tuffs of ashflow origin, lava domes, localised lava flows and shallow intrusives in the form of plugs and dykes. The volcanics are entirely subaerial and there is evidence for at least one major period of erosion. The Yantea Rhyodacite, in places occupies palaeo-valleys within older units (Giles, 1980).

Giles (1977) defined eleven units, which comprise the Glyde Hill Volcanic Complex; these unit names will be used to describe the stratigraphy of the Lake Everard area.

Childara Dacite (Myc)

The base of the Glyde Hill sequence is the Childara Dacite (Giles, 1977), which is at least 200 m thick; the base is covered by alluvium. The basal section comprises a dark grey basaltic andesite, which crops out north of Childara Outstation and grades into a massive, purplish red to red–brown dacite.

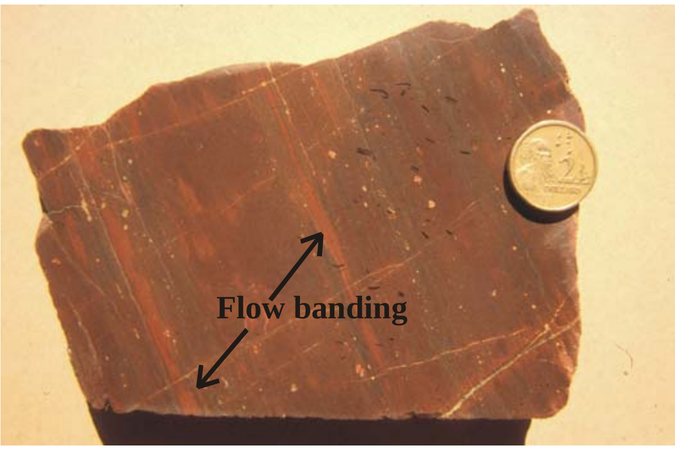


Plate 15. Hand specimen of Childara Dacite showing flow banding and the generally phenocryst poor nature (photo 403096)

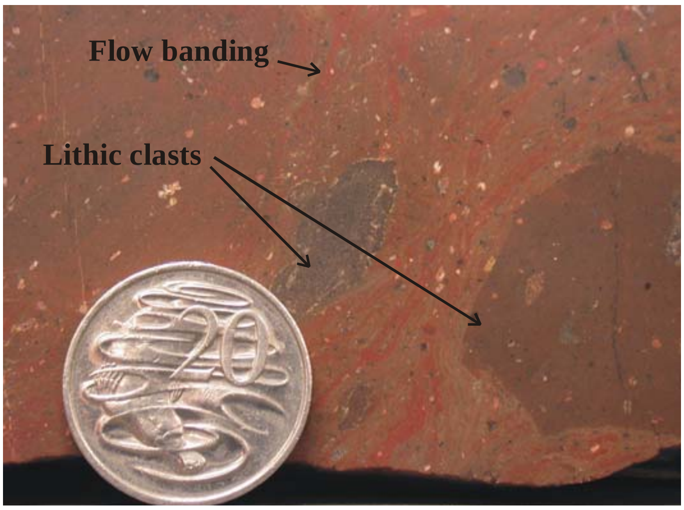


Plate 16. Hand specimen of Childara Dacite showing fine flow banding and coarse lithic clasts (photo 403097).

Plate 17. Thin sediment layer showing syn-sedimentary microfaults along with compaction and water-escape structures. (width of view is 4 cm) (photo 403098)

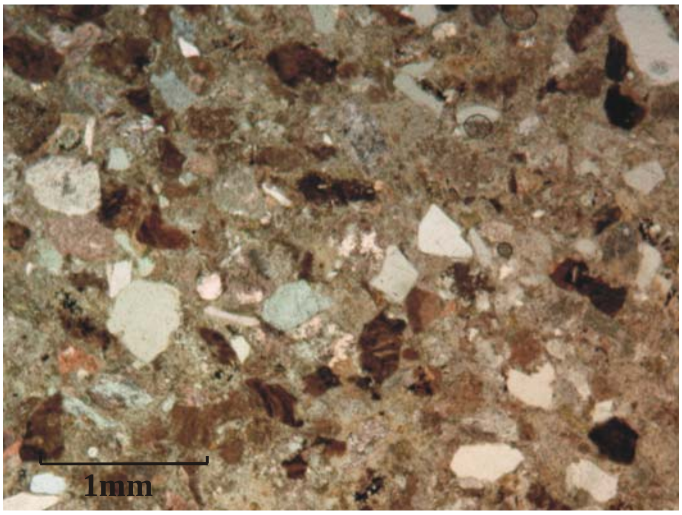


Plate 18. Thin section showing detail of poorly sorted, angular fragments from above sample (photo 403099).

Plate 19. Thin epiclastic unit within Childara Dacite showing prominent graded bedding (photo 403100).

The Childera Dacite is characteristically phenocryst poor (~2–10%) with phenocrysts of plagioclase and less commonly clinopyroxene and pyroxene. The Childara Dacite is predominantly aphyric, massive to partly flow banded, comprising a series of lava flows, separated by localised epiclastic layers. The basal basaltic andesite is massive, dark grey to black, comprising a fine-grained mosaic of plagioclase microlites with rare opaques and chlorite (Giles, 1980). This grades into the more widespread red-brown dacite unit.

At one location, the Childara Dacite contains coarse lithic clasts and fine wispy layering (pseudo-fiamme texture). In thin section, this is observed as flow layering with no evidence of fiamme. The coarse lithic fragments most likely represent accidental lithics, hence suggesting the Childara Dacite is a lava flow.

Thin epiclastic layers deposited in water are found separating lava flows. These sediments comprise layers poor in alkali feldspar alternating with alkali potassium feldspar ± plagioclase–rich sediments with abundant pumice fragments. These layers are generally thin (~20–30 cm), but one layer is ~1–1.5 m thick and shows pronounced slump structures including box-folds. Hand specimens show a prominent water-escape structures and are characterised by poorly sorted, angular grains, indicating deposition from a high-energy source, most likely a fluvial system depositing sediments due to decrease in flow. The immaturity of these sediments, suggest they have not travelled far from source. The dip of these layers varies from moderate (35° to the south) to shallow (10° to the south). The difference in dip may reflect a varied pre-existing topography. These sediments are localised and are evidence for intermittent reworking of volcaniclastic material including pumice, within small lakes and river systems during a hiatus in volcanic activity.

The basal dacite above the sediment layers is generally highly vesicular indicative of gas-rich lava. Vesicles are infilled with quartz and chlorite. In thin section, the Childara Dacite shows irregular flow layering with clay present in some layers. The groundmass comprises microcrystalline, red K–feldspar with minor, subhedral to euhedral phenocrysts of albite to sericite altered plagioclase grains up to 4 mm in length. Rare ferromagnesian phenocrysts, possibly originally hornblende, are present, but are altered to chlorite, epidote and sericite. Round and resorbed quartz phenocrysts up to 1 mm in diameter are rare.

Giles (1977, 1980) reported the Childara Dacite represents several ash-flow tuff sheets erupted relatively rapidly. However, the presence of patchy flow layering, rarity of lithic fragments, lack of broken phenocrysts, and homogeneity of the unit over large distance, indicate that the Childara Dacite is most likely a high-temperature, low-viscosity lava. Sediment layers, representing breaks in lava flows comprise a variety of reworked volcaniclastic particles including pumice. The presence of pumice suggests an airfall component, but the source of the pumice is unknown. Textures including slump structures and water-escape structures indicate deposition within water, most probably small lakes and rivers developed between flows.

Mangaroongah Dacite (Mym)

Conformably overlying the Childara Dacite is the Mangaroongah Dacite. The Mangaroongah Dacite ranges in composition from basaltic andesite (56.7 wt% SiO_2) to porphyritic red–brown dacite (69.2 wt % SiO_2).

Plate 20. Hand specimen of Mangaroongah Dacite showing characteristic red feldspar phenocrysts (photo number 049092).

The Mangaroongah Dacite comprises a mixed phenocryst population including fine- to coarse–grained K–feldspar, unaltered plagioclase locally rimmed by K–feldspar, reddish albite to sericite altered euhedral plagioclase phenocrysts and extensively resorbed plagioclase phenocrysts. The groundmass comprises randomly oriented albitised plagioclase microlites within a mass of microcrystalline, reddened K-feldspar with minor chlorite and magnetite. The upper zones of flows are vesicular, with vesicles infilled with chlorite, epidote and quartz.

Rare outcrops contain elongated vesicles, which idicate way-up and flow directions. Northeast of Childara Outstation, vesicles strike 150–160° and dip 45° to the east. This outcrop also contains blocky peperite and hyaloclasite, which indicates contemporaneous volcanism and sedimentation

(Busby-Spera and White, 1987; Hanson and Schweickert, 1982). Sediments were possibly deposited within a restricted lacustrine environment.

The Mangaroongah Dacite is clearly distinguishable from the Childara Dacite in hand sample by increase in phenocryst abundance (up to 15–20%). Giles (1977, 1980) reported the Mangaroongah Dacite is a strongly welded, crystal–vitric tuff of ash-flow origin, comprising several restricted cooling units. However, the presence of flow-aligned elongated vesicles, peperite and the absence of lithic clasts indicate that the Mangaroongah Dacite is most likely a silicic lava.

Plate 21. General view of outcrop of Mangaroongah Dacite containing blocky peperite and hyaloclasite (photo 403102).

Plate 22. Detailed view of hyaloclastite showing reddish dacite and purple sediments (photo 403103).

Arburee Rhyolite (Mya)

The Arburee Rhyolite conformably overlies and intrudes the Mangaroongah Dacite, and comprises porphyritic rhyolite, which is easily recognisable in the field by its characteristic orange weathering colour. Unweathered samples are purple-grey in colour, and contain coarse-grained, euhedral K-feldspar, medium-grained quartz phenocrysts, altered plagioclase and minor pyroxene.

Blissett (1975, 1977a/b, 1980, 1985) included the Arburee Rhyolite within the Wheepool Rhyolite, which crops out north of Lake Everard Homestead. However, Giles (1977, 1980) demonstrated that geochemically, petrographically and stratigraphically, the Arburee Rhyolite is a localised rhyolitic flow and not related to the Wheepool Rhyolite.

Giles (1977, 1980) interpreted the Arburee Rhyolite as a lava dome produced by a series of lava flows. The linear nature of outcrop, and the viscosity of acid lavas indicate that the Arburee Rhyolite was possibly erupted from a linear, eastwest trending fissure.

Karkulta Rhyolite (Myk)

Conformably overlying the Mangaroongah Dacite, is a small outcrop of porphyritic rhyolite, flow-banded rhyolite and rhyolitic breccia referred to by Giles (1977) as the Karkulta Rhyolite. Giles (1980) reported that the Karkulta Rhyolite occurs at the same stratigraphic level as the Arburee Rhyolite, but contains biotite associated with plagioclase phenocrysts. Giles (1980) suggested the rhyolite breccia represents a site of erosion of a former lava dome, but field evidence including the monomict nature of clasts and the apparent jigsaw fit of the clasts suggest an autoclastic breccia. The Southern margin of this unit is located within a creek and shows evidence of later erosion and reworking to produce a volcaniclastic breccia.

Plate 23. Outcrop of Karkulta Rhyolite showing monomict autoclastic breccia (photo 403104).

Bunburn Dacite (Myb)

The Bunburn Dacite (Giles, 1977) is a laterally extensive unit, trending roughly eastwest. It varies between 30–100 m thick and ranges in composition from basaltic andesite (58.8 wt % SiO_2) to rhyodacite (69 wt % SiO_2). The Bunburn Dacite is characteristically phenocryst poor, with rare, fine to medium-grained, K-feldspar phenocrysts within a devitrified groundmass, with a microlitic to microlitic-spherulitic texture defined by feldspar microlites (Giles, 1977, 1980).

The Bunburn Dacite shows localised layering from millimetre to centimetre scale. An outcrop along southern Lake Everard shows layering dipping steeply (62°) to the south-southeast. The angle of the dip may indicate proximity to a vent buried under lake sediments or a possible ramp structure.

The Bunburn Dacite contains prominent perlite which range in size from <1 cm diameter up to 50 cm diameter which are termed macro-perlite. The perlite indicates that the Bunburn Dacite was a glass-rich lava. In thin section, prominent perlitic textures are preserved; the groundmass comprises well-oriented microlites of alkali feldspar. Some parts of the outcrop show prominent radial fractures.

Yamagishi and Goto (1992) report that subaqueous rhyolite lavas from Southern Hokkaido, Japan, contain perlite up to 6 cm in diameter, which they term macro-perlite. They suggest the macro-perlite resulted from thermal stress fracturing due to primary quenching of water and not hydration. The size range of perlitic fractures seen at the Lake Everard outcrop may be the result of initial joint spacing within the rock produced by hydration of original glass, with macro-perlite formed in zones of widely spaced joints. Macro-perlite was only observed at this one outcrop, with finer perlite (generally <1 cm in diameter) observed at all other outcrops. This may suggest that the glassy lava cooled more rapidly at this location due to the presence of surface water.

Plate 24. Detailed view of prominent layering within the Bunburn Dacite with patches of almost spherical perlite (photo 403105).

Plate 25. Outcrop of weathered macro perlite (photo 403106).

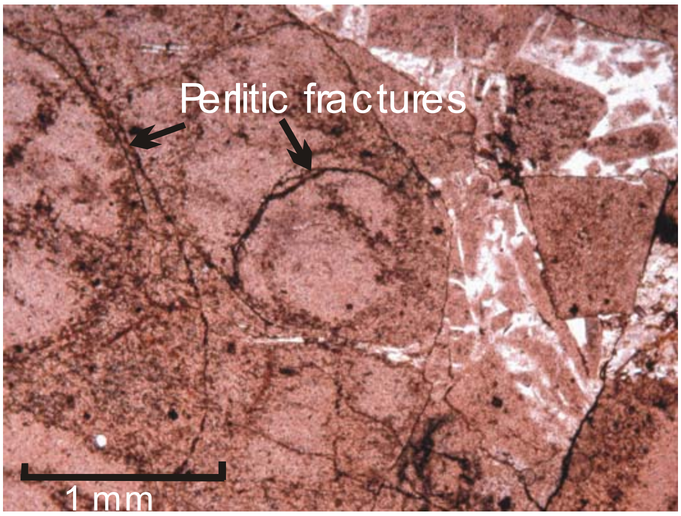


Plate 26. Thin section showing perlitic fractures within basaltic andesite (Bunburn Dacite) (photo 403107).

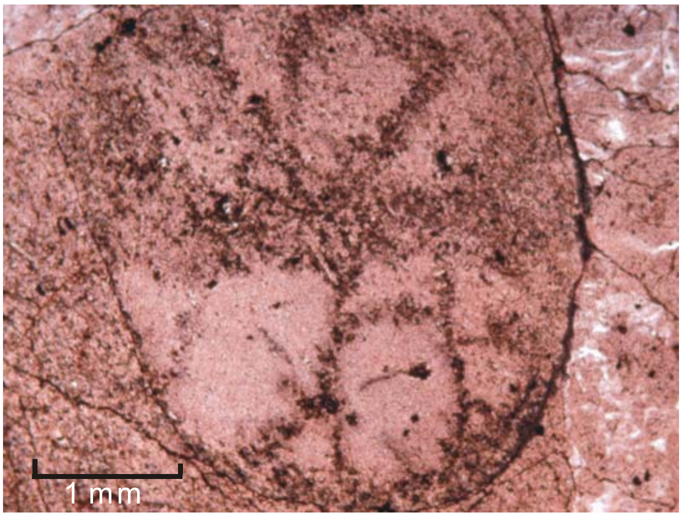


Plate 27. Detailed view of thin section showing large spherical perlite (photo 403108).

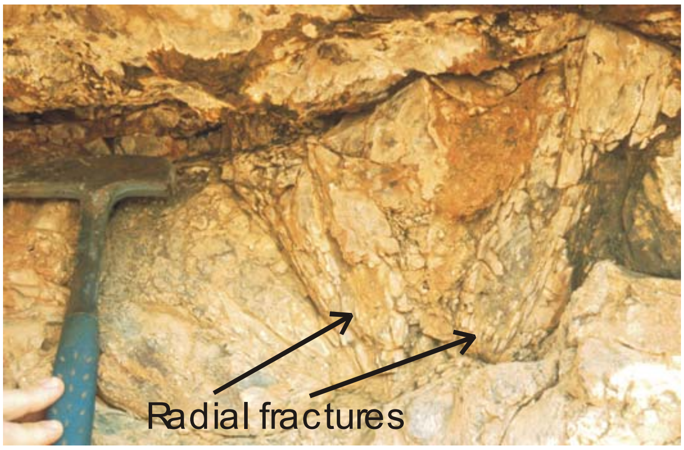


Plate 28. Outcrop along edge of Lake Everard showing prominent radial fractures within macro-perlitic Bunburn Dacite (photo 403109).

Giles (1980) interpreted the Bunburn Dacite as a simple cooling unit of ash-flow origin, with zones of autobrecciation near the top due to the effects of gas streaming. However, the presence of prominent layering, macro-perlite and absence of lithic fragments favour a silicic lava origin.

Baldry Rhyolite (Myl)

The Baldry Rhyolite outcrops predominantly on GAIRDNER and was included within the Wheepool Rhyolite by Blissett (1980). However, Giles (1977, 1980) interpreted the Baldry Rhyolite as a local rhyolite unit, which overlies the Bunburn Dacite.

The Baldry Rhyolite comprises white to off-white, rhyolite containing medium-grained quartz phenocrysts with flattened lithic and pumice fragments and abundant spherulites and lithophysae. Giles (1980) reported the Baldry Rhyolite retains the original vitroclastic texture, which indicates a pyroclastic origin. Giles (1977) called this unit a rheoignimbrite due to the semi-continuous flow banding indicative of flowage during welding. Outcrops along the edge of a lake east of Apostles Tank contain numerous spherulites and lithophysae, within a densely welded rhyolitic ignimbrite.

Plate 29. Specimen of Baldry Rhyolite showing prominent flow layering (photo 403110).

Plate 30. Large lithophysae showing elongation due to flow (photo 403111).

Plate 31. Large lithophysae ('thunder egg') with smaller lithophysae on the surface (photo 403112).

Nuckulla Basalt (Myn)

The Nuckulla Basalt (Giles, 1977), is a massive, dark green to grey, fine-grained basaltic lava flow which crops out over a limited area near Nuckulla Well and Dam. It conformably overlies the Bunburn Dacite, but the contact is marked by ~3 m of sediment. The basalt is plagioclase-rich with albite to sericite altered plagioclase laths to 0.3 mm in length with minor, fine-grained (<0.1 mm) clinopyroxene.

Plate 32. Hand specimen of Nuckulla Basalt showing the phenocryst poor nature of this unit (photo 403113).

Plate 33. Thin sediment layer which occurs at top of Nuckulla Basalt (photo 403114).

West of Nuckulla Tank, a thin sediment layer overlies the Nuckulla Basalt. This layer has been interpreted as an air-fall tuff by Giles (1980), but a volcaniclastic origin is favoured.

Yantea Rhyodacite (Myy)

The Yantea Rhyodacite (Giles, 1977) disconformably overlies several older volcanic units and comprises massive, brick red, porphyritic rhyodacite grading to dacite, containing coarse-grained phenocrysts of K-feldspar and chlorite (after clinopyroxene) within a devitrified matrix (Giles, 1977, 1980). The brick red colour is due to limonite staining within the groundmass (Giles, 1977).

Prominent flow layering was observed with moderate dips to the west, and several layers up to 3 m thick of spherulites were observed throughout the Yantea Rhyodacite.

Plate 34. Prominent flow layering dipping to the west within the Yantea Rhyodacite (photo 403115).

Plate 35. Spherulites within the Yantea Rhyodacite (photo 403116).

Giles (1980) reported the Yantea Rhyodacite to be up to 150 m thick, and composed of at least four, simple cooling units of welded ash-flow tuffs separated by thin non-welded tuffs and lapilli tuffs. However, the lack of lithic fragments, presence of flow banding and the homogeneous porphyritic nature of the rock suggest a silicic lava origin.

Whyeela Dacite (Myh)

The Whyeela Dacite is the youngest extrusive unit in the Glyde Hill Volcanic Complex (Giles, 1977), and conformably overlies the Yantea Rhyodacite. It is up to 100 m thick and is confined to a semicircular structure ~8 km across located on GAIRDNER.

Moonamby Dyke Suite (Myz)

The Moonamby Dyke Suite (Giles, 1977) is a series of red, highly porphyritic rhyolite and rhyodacite dykes up to 100 m wide and 18 km long, which intrude the Glyde Hill Volcanic Complex. The dykes trend north to northeast, branching and become thinner northwards. They all have chilled margins. The dykes are possibly related to intrusion of the Hiltaba Suite, as several dykes contain plugs of granite similar in appearance to nearby outcrops of Hiltaba Suite granite. The dykes only occur along the western margin of the Lake Everard Volcanic Complex.

Plate 36. Hand specimen of Moonamby Dyke Suite showing characteristic porphyritic nature (photo 403117).

The dykes are slightly variable but have a porphyritic appearance and are easily recognisable in the field by their characteristic rounded "tor" appearance, compared to the highly jointed, "blocky" volcanics.

Hiltaba Suite (Mh)

The Hiltaba Suite is a variable suite of massive granitoids found on the Gawler Craton, which range in composition from granite to granodiorite. Texturally the Hiltaba Suite is variable, ranging from high-level, sub-volcanic, porphyritic granite, equigranular, medium- to coarse-grained granite to microgranite.

On CHILDARA, there are no observable contacts between the Hiltaba Suite and the Gawler Range Volcanics, but the intrusive nature is well documented regionally elsewhere on the Gawler Craton.

Hiltaba Suite granite crops out on eastern CHILDARA, and is characteristically a red-pink, fine to coarse grained, massive, K-feldspar dominant granite. In the Kondoolka area, the Hiltaba Suite outcrops as large inselbergs. The Kondoolka Batholith is a large zoned, composite intrusive, which shows considerable textural and geochemical variation.

Plate 37. Hand specimen porphyritic Hiltaba Suite granite (photo 403118).

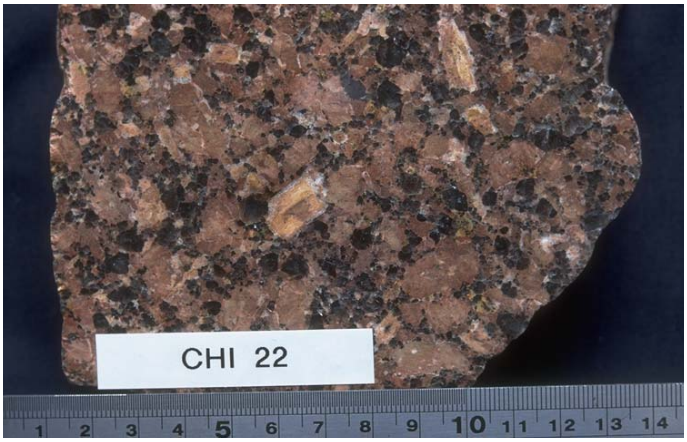


Plate 38. Hand specimen of coarse grained Hiltaba Suite granite (photo 403119).

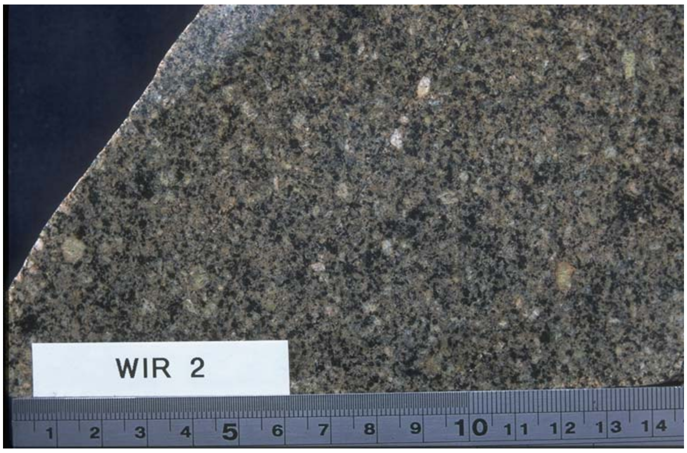


Plate 39. Hand specimen of Hiltaba Suite microgranite (photo 403120).

Plate 40. Large outcrop of Hiltaba Suite granite from the Kondoolka Batholith (photo 403121).

Multigrain zircon analysis of massive, coarse grained granite within the Kondoolka Batholith gave a crystallisation age of 1580±7 Ma (Fig. 7). On regional aeromagnetic images, the Batholith clearly crosscuts the shear zone and so the data helps constrain the deformation within the Yarlbrinda Shear Zone (Ferris, 2001).

On Lake Everard Pastoral Lease, numerous outcrops of Hiltaba Suite granite are located west of Childara Outstation. Several outcrops previously mapped as Hiltaba Suite have been incorporated within the Tunkillia Suite based on structure and limited geochronology. Outcrops in the Meelera Rockhole area contain coarse-grained, equigranular and porphyritic granite phases, which suggests that these are two slightly immiscible variants of the same magma.

The Hiltaba Suite is generally massive with little or no evidence of deformation. Multigrain zircon analysis of a grey, mica-foliated plagioclase+quartz+K-feldspar+biotite granodiorite on northern CHILDARA, gave an age of 1592±11 Ma, with some inheritance of older zircons at 1714±12 Ma. The 1592±11 Ma age is interpreted as the crystallisation age, which implies that foliation development was either syn–emplacement or post-emplacement.

Granite at Arcoordaby Rockhole is coarse grained with K-feldspar grains up to 25 mm in length and has a prominent foliation trending 087° defined by biotite and mafic enclaves. A sample from Arcoordaby Rockhole was dated at 1578±12 Ma using the Kober Pb-Pb method (Stewart and Foden, 2001).

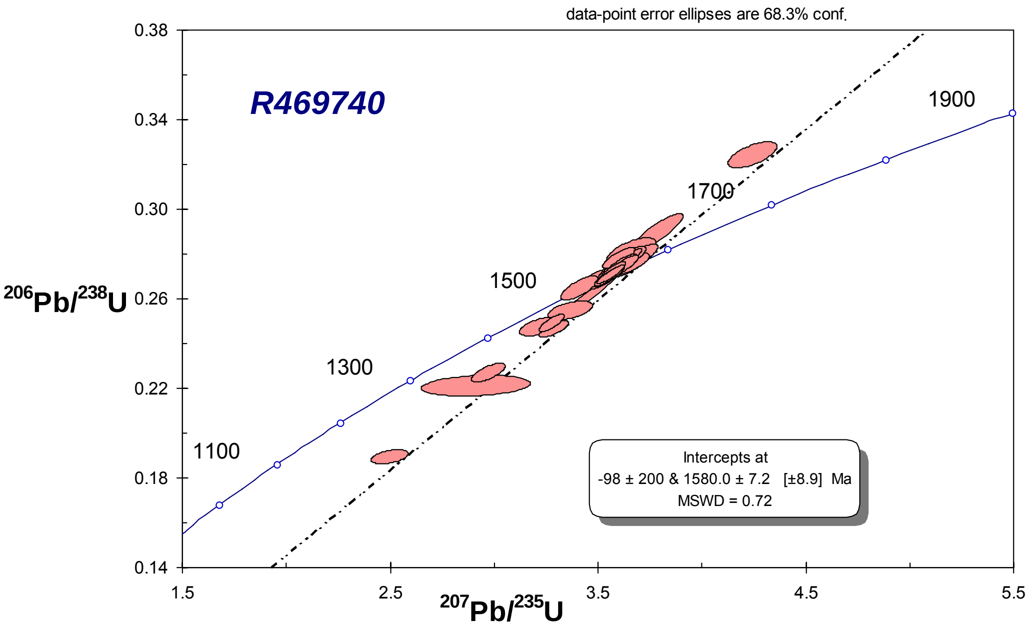


Figure 7. **U-Pb concordia plot from Kondoolka Batholith sample (see Ferris, 2001 for original data).**

Plate 41. Coarse grained Hiltaba Suite granite from Arcoordaby Rockhole (photo 403122).

The Kondoolka Batholith crosscuts the Yarlbrinda Shear Zone, but exhibits no evidence of the foliation forming event evident elsewhere on northern CHILDARA. The accepted time range for the Hiltaba Suite is 1595–1575 Ma and this suggests that deformation occurred within that interval, but post emplacement of the Kondoolka Batholith at ~1580 Ma.

Gabbro (Mh?)

South of Childara Outstation, dark green to grey, coarse–grained anorthosite to gabbroic anorthosite crops out. The rock contains coarse–grained, grey, plagioclase, which ranges in size from 1–7 mm in length, and dark green patches of chlorite, possibly after hornblende or pyroxene. Weak layering is evident in outcrop, but no tectonic foliation observed, which suggests that the rock intruded post shearing within the Yarlbrinda Shear Zone, although the distribution and shape of the gabbro does not necessarily support this.

The gabbro/anorthosite body forms a prominent magnetic feature on the northern margin of the Kondoolka Batholith. However, the rock contains accessory magnetite and has a low magnetic susceptibility, which suggests the magnetic source is located below the surface expression, and may represent a layered complex.

Plate 42. General view of low, scattered outcrop of gabbro/anorthosite south of Childara Outstation (photo 403123).

Plate 43. Detailed view of gabbro from above outcrop (photo 403124)

Munjeela Granite (M-u)

The Munjeela Granite (new name) comprises medium- to coarse-grained grey, equigranular, muscovite–biotite ± garnet granite. The Munjeela Granite does not crop out on CHILDARA and is defined from exposures on FOWLER (Munjeela Rockhole) and NUYTS (Point Bell and Point Sinclair). Granite at Munjeela Rockhole comprises massive, muscovite–biotite syenogranite to adamellite with some very coarse microcline crystals and coarse muscovite to 8 mm in grainsize. Part of the outcrop contains accessory garnet up to 2 mm in diameter.

Granite from Point Sinclair is similar to Munjeela Rockhole, but granite at Point Bell is foliated with feldspar augen elongate parallel to the foliation, which strikes 030°–060°. The presence of muscovite and garnet suggests an S-type granite. Granite from Munjeela Rockhole has an Sm-Nd depleted mantle model age of ~2120 Ma (K Stewart, University of Adelaide, pers. comm., 1998). SHRIMP dating of zircons was attempted, but the zircon grains are metamict and three analyses produced a range of discordant results between 1560–1900 Ma.

Electron microprobe dating of monazite grains was undertaken by Ferris (2001) at CODES using the technique reported in Montel et al. (1996). Seventeen spots were analysed, and 14 gave a weighted mean age of 1562±15 Ma.

Rb-Sr analyses of five samples from Point Bell (5533 RS 65-69) produced an isochron age of 1507±29 Ma (Webb et al., 1986). Rb-Sr analyses of one sample from Point Sinclair produced an age of 1535 Ma assuming an initial 87Sr/86Sr ratio of 0.705 (Webb et al., 1986).

The Munjeela Granite has a characteristic smooth, low magnetic intensity appearance on regional aeromagnetic data and two small plutons are interpreted to have intruded along the Koonibba Fault on CHILDARA.

Plate 44. General view of Munjeela Rockhole (photo 403125).

Plate 45. Detailed view showing coarse grained microcline crystal (photo 403126).

Quartz Blows

On northern CHILDARA, massive quartz blows, which form a prominent topographic high, crop out at New Year Hill. The quartz blows are up to 300 m in length and up to 100 m wide, but are mostly narrow, linear ridges of milky white quartz, oriented predominantly north-south and are subvertical to vertical. West of New Year Hill quartz is folded and sheared. These blows indicate possible eastwest extension and may be related to movement on the Yerda Shear Zone to the south.

Plate 46. Detailed view of rodded quartz from west of New Year Hill (photo 403127).

CAINOZOIC

Approximately 50% of CHILDARA is located within the Eucla Basin, a major Tertiary depocentre. The Eucla Basin formed in response to the separation of Australia and Antarctica during Tertiary times (Benbow, 1993). Global sea level fluctuations during the Tertiary resulted in the deposition of various marine carbonate and fluvial to marginal marine sediments. Deposition was greatest during the Middle to Late Eocene with four major units deposited; Pidinga Formation, Hampton Sandstone, Ooldea Sand and Wilson Bluff Limestone.

Around the Basin margin large channel networks which drained areas of crystalline basement and supplied vast quantities of sediments into the Eucla Basin.

Pidinga Formation (Tbp)

There are no known outcrops of Pidinga Formation (Harris, 1966) on CHILDARA and the only known occurrences are from drill holes. The Pidinga Formation comprises predominantly carbonaceous clay, silt and sand, with poor quality lignite (Rankin, et al., 1996) and ranges in age from Middle to Late Eocene (Lindsay and Harris, 1975; Alley and Benbow, 1989; Alley and Beecroft, 1993). The Pidinga Formation appears confined to topographic lows such as palaeodrainage networks.

Extensive exploration drilling by Carpentaria Exploration Co. Ltd in the search for sandstone-type uranium deposits accurately defined the geography of the Narlaby Palaeochannel (see the mapsheet for details). A total of 1503 holes were drilled on CHILDARA and STREAKY BAY, with up to 80m of Pidinga Formation intersected. Within the Narlaby Palaeochannel, the Pidinga Formation comprises variably reduced to oxidised, fine-grained to gravelly, sub-angular to rounded, fluviatile sands and silts with carbonaceous clays (Rankin and Flint, 1991).

The sands comprise dominantly quartz with accessory pyrite, zircon, rutile and iron oxides. Binks and Hooper (1984) divided the Pidinga Formation into a lower sequence of coarse to gravelly sands with minor clay, and an upper sequence of fine to medium-grained sands and silts with interbedded clays, overlain by carbonaceous clays within the western part of the palaeochannel.

On STREAKY BAY, the top of the Pidinga Formation records a marine to marginal marine facies which is interpreted to represent a period of marine transgression at the end of the Eocene. There is no evidence of this transgression on CHILDARA.

Binks and Hooper (1984) report that the provenance for the Pidinga Formation within the Narlaby Palaeochannel, was the Mesoproterozoic Hiltaba Suite and Palaeoproterozoic granites and gneisses, with little or no input from the Gawler Range Volcanics. However, Farrand (1988) reported the presence of detrital embayed quartz of probable volcanic origin, which suggests that all of the above units probably supplied sediment to the Narlaby Palaeochannel. This has important implications for further exploration of the Yaranna Uranium Prospect, the lower grade peripheries of which extend onto southern CHILDARA.

On central CHILDARA, the Pidinga Formation was drilled by BHP Ltd in the search for Tertiary lignite. This lake system represents a former palaeodrainage system which flowed north to northeast, hence, a major topographic high on central CHILDARA existed during the Eocene.

Garford Formation (Tig)

The Garford Formation comprises up to 100 m thick succession of oxidised, grey, green and cream, to black mud, minor carbonate and local basal and interbedded carbonaceous sand and grit, deposited within lacustrine, flood-plain, lagoonal swamp and locally evaporative environments (Benbow et al., 1995). Within the Narlaby Palaeochannel, the Garford Formation unconformably overlies the Pidinga Formation, and varies in thickness from <1 m to up to 100 m. Rankin and Flint (1991) report that within the Narlaby Paleochannel, the Garford Formation was deposited in lacustrine and fluviatile environments, which incised the underlying Pidinga Formation producing mesas of Pidinga Formation, surrounded and overlain by Garford Formation.

Hampton Sandstone (Tbh)

The Hampton Sandstone represents a major marine transgression within the Eucla Basin, during the Middle Eocene (Benbow, 1986; Rankin et al., 1996). The Hampton Sandstone comprises very fine, to coarse sand and grit, which was deposited as a sheet over the southwest part of CHILDARA. Locally, the Hampton Sandstone contains heavy minerals, which were deposited within the Eucla Basin by the surrounding palaeodrainage network, then reworked and concentrated by wave action into strandlines.

Major transgressive dune systems on BARTON include the Barton and Ooldea Ranges, which comprise thick accumulations of Hampton Sandstone up to 90 m thick, with an average thickness of 20–40 m (Rankin et al., 1996). On CHILDARA, exploration drilling suggests the thickness is much less, and no major heavy mineral bearing strandlines have been discovered.

Ilkina Formation (TpQii)

The Ilkina Formation comprises laminated clay, silt, and sand deposited within the Narlaby Palaeochannel, and crops out in lakes along the southwest margin of the Gawler Ranges (Rankin et al., 1996), and forms lake floors including Lake Bring on BARTON (Benbow et al., 1995). The Ilkina Formation was deposited within arid playa lakes, and reflects the marked change in climate, to increased aridity during the latter part of the Cainozoic.

Munjeena Formation (Topm)

The Munjeena Formation comprises poorly sorted conglomeratic sand, clayey sand and breccia, up to 3 m thick, which blanket areas of interfluves and palaeochannels around the margin of the Eucla Basin (Benbow, 1986a, 1993). Where the unit overlies pre-Tertiary rocks, it commonly contains rounded quartz pebbles which may be scattered throughout or form discrete flat lying horizons. The formation has been silicified to pedogenic silcrete; rare polished and rounded silcrete clasts indicate reworking of older silcretes.

Narlaby Formation (Tin)

The Narlaby Formation comprises fluvial to estuarine, fine to medium-grained, moderately to well-sorted sand with minor clay up to 60 m thick (Benbow et al., 1995).

Silcrete (Tsi)

On northern CHILDARA, thick sequences of kaolinised, crystalline basement is capped by siliceous duricrust, up to 3 m thick, termed silcrete. Lintern and Sheard (1998) define silcrete as a secondary cementation feature imposed on existing sediments or weathered rock, and identify two main types of silcrete. Pedogenic silcrete is formed within the soil, and groundwater silcrete forms at, or near the watertable (Lintern and Sheard, 1998).

On northeastern CHILDARA, the landscape is dominated by gently sloping ridges and mesas formed by erosion of a extensive silcreted plain by rivers during the Tertiary. Near New Year Hill, the siliceous duricrust has a columnar appearance which possibly reflects soil forming processes and contains coarse clasts of quartz derived from nearby quartz blows and granite.

Abundant low outcrops of “grey billy” silcrete, and lag deposits of grey silcrete and ferruginous silcrete are found on the lower slopes and plains on northeastern CHILDARA. These hard, grey to white, matrix supported silcretes, have clear, coarse, angular quartz grains and resemble porcelain in appearance. There is no direct evidence as to the age of silcrete, but silcrete horizons are widespread in northern South Australia. They are interpreted to be Tertiary in age based upon stratigraphic relationships exhibited elsewhere (ie: silcrete is developed on a range of Tertiary and older sediments, including the Hampton Sandstone).

Lintern and Sheard (1998) report the use of silcrete as a potential geochemical medium for gold exploration in areas of either poor or no calcrete development.

Calcrete (Qpca)

Calcium carbonate rich horizons are widespread on CHILDARA. On eastern CHILDARA, within pastoral country, calcrete is present as indurated sheets and nodular calcrete, and crops out where recent sediments have been removed (ie: roads and drains). Within the Great Victoria Desert calcrete is present in interdunal corridors and as indurated horizons within the core of dunes. Calcrete is widely used as a sampling medium for gold exploration on the Gawler Craton.

Plate 47. Calcrete present as indurated sheets and nodular calcrete, eastern CHILDARA (photo 403128).

Pooraka Formation (Qpr4)

A thin veneer of alluvial, reddish brown, sandy clay forms an apron of variable thickness over much of eastern CHILDARA.

Wiabuna Formation (Qpew)

On southwestern CHILDARA, aeolian, pale brown, calcareous sands and silts termed the Wiabuna Formation (Firman, 1977) is present as a veneer draping crystalline basement, with some remnant dunes still preserved. The type area for the Wiabuna Formation is located 19 km east of Penong on FOWLER, where it overlies the Bridgewater Formation. On southwestern CHILDARA, the Wiabuna Formation is host to the region’s cereal crops.

Moornaba Sand (Qhem)

The Moornaba Sand comprises orange to pale yellow, quartz sands which blanket the calcreted Pleistocene inland dunes of the Great Victoria Desert. The sand varies in thickness from 2–10 m and is stabilised by thick vegetation cover (Rankin and Flint, 1991). The sief-dune pattern of the Moornaba Sand mimics the underlying Pleistocene dunes, suggesting that the predominantly northwest to westerly wind regime persisted from the Pleistocene through to the Holocene.

Undifferentiated lake deposits (Qhl1)

The surface of playa lakes located on central CHILDARA associated with Lake Everard, contain a thin veneer (<5 m) of unconsolidated lake sediments. Sediments are predominantly brown to red-brown, sandy clay and silt, with scattered gypsum crystals, capped by a thin halite crust giving the lakes their characteristic white appearance. Quartz rich sediments, were deposited within lakes by wind from the surrounding dunes, and runoff from local drainage networks. These lakes are usually dry except after heavy rainfall.

Lakes on CHILDARA probably formed prior to the Holocene, during a period of wetter climate which reactivated palaeorivers. However, the sediments are thought to be Holocene in age with older sediments removed by deflation and accumulation in the leeside dunes (Rankin et al., 1996).

Gypsiferous dunes and spreads (Qhe4)

Within palaeodrainage networks surrounding playa lakes, are gypsiferous sediments and quartz dunes and spreads. Quartz sand is aeolian in origin sourced from surrounding dunes. Gypsum occurs in powder form, derived from the breakdown of gypsum crystals within the lake deposits (Qhl1) during dry periods. Bowler (1976) reported similar gypsiferous deposits in southern Australia were formed during the late Pleistocene (~17 000–18 000 years BP), probably just after the formation of the longitudinal dune network, which dominates the landscape.

Modern sand dunes and spreads (Qhe2)

On CHILDARA, parabolic and network dunes occur within local depressions. Crowe (1975) interpreted the formation of these dune types in depressed areas as the result of greater sand supply and different wind flow regime than operated in areas of longitudinal dunes. The orientation of the different dune forms suggests different wind regimes at different times. Bourne et al. (1974) report that modern-day sand moving winds are southwesterly at Kyancutta, on northern Eyre Peninsula.

TECTONIC AND STRUCTURAL DEVELOPMENT

CHILDARA is located on the western Gawler Craton, an ancient crystalline shield comprising Archaean, Palaeoproterozoic to Mesoproterozoic metasediments, volcanics and granites, which have been tectonically stable, with the exception of minor epeirogenic movements since ~1450 Ma (Parker, 1990, 1993). Thomson (1980), Parker (1990), Teasdale (1997) and Daly et al. (1998, Fig. 4) divided the Gawler Craton into tectonic subdomains based on structural, metamorphic and stratigraphic characteristics (cf. Fairclough & Daly 1995a,b and Fairclough et al, 2003). CHILDARA is located predominantly within the Nuyts Domain with the northern part of CHILDARA located within the Harris Greenstone Domain (Ferris et al., 2002), formerly part of the Wilgena Subdomain of Parker (1990). To the west of the Nuyts Domain, the Fowler Domain comprises late Palaeoproterozoic mafic and intermediate intrusives, intruded into metasedimentary rocks which subsequently underwent deformation during the late Palaeoproterozoic to early Mesoproterozoic Kararan Orogeny. These events also had a significant effect on the Nuyts Domain.

The Nuyts Domain comprises possible Palaeoproterozoic, ductile-deformed metasediments and meta-igneous rocks into which variably magnetic, Palaeoproterozoic to Mesoproterozoic granitoids were emplaced. The Nuyts Domain was previously interpreted to represent Archaean basement, but recent geochronology and isotopic analyses show juvenile crust produced during Palaeoproterozoic orogenic activity. The domain is broadly delineated by a distinctive gravity low, reflecting the predominantly felsic igneous composition. It is bound to the north by the Yerda Shear Zone and by the Coorabie Shear Zone to the west. The overlying Gawler Range Volcanics obscure the eastern boundary but it appears to be strongly controlled by the Yarlbrinda Shear Zone (Figs 3–4). The south east boundary remains problematic. A noticeable feature of the Nuyts Domain is the concentration of large Hiltaba Suite plutons around its structurally controlled northern and eastern margins (Fig. 4 and see Tectonic Sketch on CHILDARA mapsheet). Both deformed and undeformed plutons occur within shear zones bounding the Nuyts Domain, suggesting at least a partly syn-orogenic emplacement. Spatially, the plutons form an arcuate belt distinct from a similar belt to the northeast within the Olympic and Mount Woods Domains (Fig. 4). Based on empirical evidence, the Hiltaba Suite within, and adjacent to this belt appears to be associated with a quartz+sericite+chlorite+Au dominant style of mineralisation as opposed to iron oxide Cu-Au style of mineralisation in the Olympic and Mount Woods Domains.

The Gawler Ranges Volcanics Domain is a large area of dominantly felsic volcanics, which are flat lying and relatively undeformed. Lower parts of the sequence contain interlayered basalts. U-Pb zircon dating for the Wanganny and Yardea Dacites give ages of 1591±3 and 1592±3 respectively (Fanning et al., 1988). The boundaries are coincident with the distinct elliptical magnetic signature of the domain. Recent work (Morrow and McPhie, 2000) indicates that the greater part of the Gawler Range Volcanics, originally interpreted as predominantly ignimbrites (Blisset, 1980), may infact be lavas.

The Harris Greenstone Domain comprises supercrustal Archaean ultramafic (komatiite) and mafic volcanics (Hoatson et al, 2005) and Archaean aluminous metasediments (Christie Gneiss), felsic extrusives and/or intrusives (Kenella Gneiss) and syn-tectonic acid intrusives (Glenloth Granite) (Daly and Fanning, 1993). Mafic/Ultramafic packages in the Christie Domain are generally intrusive whereas in the Harris Greenstone Domain they are dominantly extrusive (Fig. 4). This may be due to significantly different crustal levels exposed within the different domains. Alternatively, the intrusive and extrusive ultramafics may be different geological units. Hoatson et al. (2005) have studied these units in detail on TARCOOLA and much of the subsurface geology of the Harris Greenstone Domain on CHILDARA is inferred. Linear magnetic highs in the northeast portion of the mapsheet between outcrops of Glenloth Granite are inferred to be mafic to ultramafic lithologies. The Yerda Shear Zone represents the southern boundary of the Harris Greenstone Domain and the northern boundary is a lithological zone boundary with the Wilgena Subdomain.

Fanning et al., (1988) outlined three major megacycles or tectonic events for the formation of the Gawler Craton:

1. 2700–2300 Ma — Late Archaean sedimentation and volcanism followed by early Palaeoproterozoic plutonism and metamorphism (Sleaford Orogeny).
2. 2000–1700 Ma — initial basin/platform sedimentation followed by widespread plutonism, metamorphism and deformation (Kimban Orogeny) with local volcanism and continental sedimentation.
3. 1650–1450 Ma — anorogenic acid magmatism including extensive felsic volcanism, high level granite plutonism and local intracontinental clastic sedimentation.

Based on geochronology on the western Gawler Craton Teasdale (1997) outlined five major tectonothermal cycles, specifically for the western Gawler Craton:

1. Late Archaean – early Proterozoic (~3.0–2.4 Ga) cycle involving sedimentation, complex ductile deformation and granulite facies metamorphism (Sleaford Orogeny).
2. Magmatism, high-grade metamorphism and deformation during a late Palaeoproterozoic orogeny (1.74–1.65 Ma).
3. Massive anorogenic, felsic magmatism at 1.63–1.58 Ga.
4. High-grade metamorphism and deformation during a compressional orogeny at 1.54–1.49 Ma.
5. Amalgamation and reworking of the western Gawler Craton along major shear zones at 1.2–1.1 Ga.

The Harris Greenstone Domain is interpreted to form a small part of the basement in northeastern CHILDARA. On adjacent adjacent TARCOOLA basement largely comprises a larger area of supercrustal Archaean ultramafic (Lake Harris Komatiite) and mafic volcanics along with Archaean aluminous metasediments (Christie Gneiss), felsic extrusives and/or intrusives (Kenella Gneiss) and syn-tectonic acid intrusives (Glenloth Granite) (part of the Mulgathing Complex of Daly and Fanning, 1993). Deformation of the oldest portions of the Mulgathing Complex during the Sleafordian Orogeny was accompanied by intrusion of the Glenloth Granite, which is the only part of the sequence that outcrops on CHILDARA. Effects of the Sleafordian Orogeny are recorded in Archaean crust throughout the Gawler Craton but very little is known of Sleafordian kinematics as many original structures have been reworked by later tectonic events. The onset of high-grade metamorphism is thought to have occurred ~2600 Ma (Fanning et al., 1988) with the most pervasive, peak granulite-facies metamorphism occurring between 2440–2420 Ma. Waning stages of the orogeny are recorded by Rb–Sr whole rock geochronology at ~2300 Ma (Webb et al., 1986). Daly and Fanning (1993) have interpreted the Glenloth Granite as a concordant to discordant segregation derived from the Kenella Gneiss.

Proterozoic granitoid rocks constitute the most voluminous rock type on the western Gawler Craton, hence, any model for the tectonic evolution of the western Gawler Craton, must encompass extensive episodes of predominantly silicic magmatism.

Late Palaeoproterozoic to Mesoproterozoic silicic magmatism on the western Gawler Craton, provides a record of crustal evolution spanning ~130 my (~1690–1560 Ma). During this time, magmatism was not continuous, but occurred in four distinct phases, which appear to represent different tectonic settings. The four phases of magmatism as described in Ferris (2001) are:

1. 1690–1670 Ma Tunkillia Suite and equivalents, which represent a dominantly felsic suite with minor mafics.
2. 1630–1608 Ma St Peter Suite, a tonalitic to granitic suite, which tend to be sodic (Na2O>K2O), with fractionated HREE, negligible Eu anomalies and high Sr contents, suggesting their generation from relatively mafic sources at depths sufficient to stabilise garnet.
3. 1595–1575 Ma Hiltaba Suite/Gawler Range Volcanics, which are potassic (K2O>Na2O), and exhibit undifferentiated HREE patterns, negative Eu anomalies and low Sr contents, suggesting a shallower, more feldspathic source with abundant plagioclase.
4. ~1560 Ma S-type Munjeela Granite.

Silicic magmatism within the CHILDARA region represents a major addition of crustal material within the Gawler Craton, during the four magmatic events outlined above. The Nuyts Subdomain was formerly interpreted to comprise predominantly Archaean basement with minor Palaeoproterozoic to Mesoproterozoic intrusives. Based on regional mapping, recent geochronology (Ferris 2001; Teasdale, 1997) and Sm-Nd isotope analysis (Dove, 1997; Knight, 1997; Stewart and Foden, 2001), the Nuyts Subdomain does not contain any known Archaean rocks.

The Kararan Orogeny was defined by Daly et al. (1995, 1998) to describe high-grade metamorphism and associated deformation between ~1650–1540 Ma on the northern and western Gawler Craton. Daly et al. (1998) report that deformation associated with the Kararan Orogeny is related to continental collision between the eastern proto-Yilgarn Craton, in the northwest, and the central Gawler Craton-East Antarctic Craton (Mawson Continent) in the south. The name Kararan Orogeny is derived from the Karari Fault Zone, a major crustal feature on the northwestern Gawler Craton. The temporal relationships associated with the Kararan Orogeny are poorly constrained, due to lack of exposures along the northern margin of the Craton.

Daly et al (1998) reported the effective minimum age for the onset of the Kararan Orogeny was ~1650 Ma, defined by metamorphic zircons from the Ooldea Region. Magnetite-rich aluminous metasediments from DDH Ooldea 2 have a mineral assemblage comprising hypersthene-sillimanite and sapphirine-quartz, which indicate high-grade metamorphic conditions (>950°C and >9.5kb) (Teasdale, 1997). Using the Kober Pb-Pb technique, Teasdale (1997), reports that the main magmatic zircon forming event occurred at ~1690 Ma and these zircons were recrystallised at ~1653 Ma during the ultra-high temperature metamorphic event. Fanning, (1997) records zircon growth at ~1653 with inheritance at ~1700 Ma. This problem has not yet been resolved, however, burial of these sediments is regarded as occurring during the onset of the Kararan Orogeny, so that the metamorphic ages must be regarded as a minimum age for this event. Additional SHRIMP dating, by Fanning for Teasdale (1997), records abundant syntectonic intrusives from 1690–1670 in the Fowler Domain. This suggests that the Kararan Orogeny should be extended to 1690 Ma.

TUNKILLIA SUITE

Teasdale (1997) used the term Ifould Complex for variably deformed I-type granitoids and mafics at Lake Ifould in the western Gawler Craton. Ferris (2001) has defined a suite of comagmatic felsic and mafic granitoids within the Yarlbrinda Shear Zone and with a U-Pb zircon age of ~1680 Ma, as the Tunkillia Suite. Subsequently Ferris (2005) has included all Ifould Complex as defined by (Teasdale 1997) into the Tunkillia Suite. Daly et al., (1998) used Ifould Complex for all syntectonic Kararan Orogeny intrusives so that further subdivision would be individually named suites within this very large region.

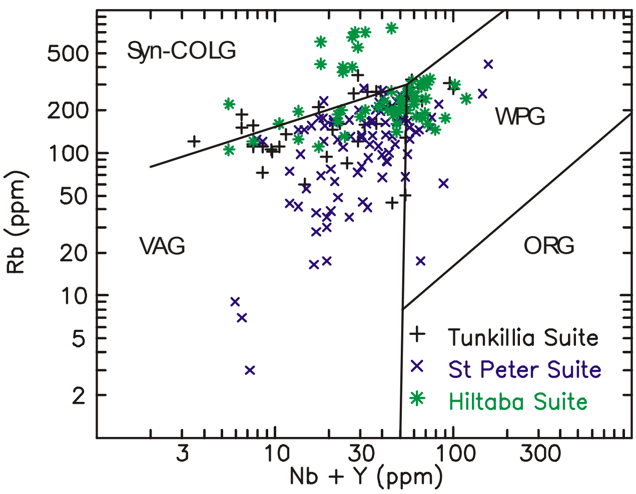
U-Pb dating and Pb-Pb dating of a deformed granodiorite from the Yerda Shear Zone, shows inheritance at ~1670 Ma (Ferris 2001; Stewart and Foden, 2001), suggesting 1690–1670 Ma magmatism was widespread within the northern part of the Nuyts Subdomain. Tunkillia Suite equivalents were intruded into the Coulta (Little Pinbong), Christie (Lake Ifould, Lake Tallacootra, Wynbring Rocks and Barton South) and Fowler Subdomains (White Gin Rockhole) outside of the

CHILDARA map sheet area. Daly et al. (1998) report deformation within the Fowler Subdomain is related to continental collision between the proto-Yilgarn craton to the northwest. Hence fabrics formed within the Fowler Subdomain are referred to as the D1 of the Kararan Orogeny. The lack of exposure within the area makes structural correlation difficult. Teasdale (1997) reports three major fabrics within the Nundroo Block of the Fowler Subdomain, an early tectonic foliation, which is overprinted by a steeply dipping stretching lineation. Narrow shear zones crosscut these fabrics. Detailed structural evolution of the Tunkillia Suite on CHILDARA is discussed in detail below within the framework of individual shear zones.

Samples from the Tunkillia Suite plot within the volcanic arc, syn-collision and within-plate granite fields on Rb v (Y + Nb) tectonic diagrams (Pearce et al., 1984) (Fig. 8). In detail, Childara Airstrip samples plot predominantly in the volcanic-arc field, whereas Lakeside samples plot in the syn-collision and within-plate granite fields. Vermin Proof Fence (VPF) samples straddle the syn-collision and volcanic- arc boundary. The St Peter Suite samples plot predominantly in the volcanic arc granite field on tectonic discrimination diagram from Pearce et al. (1984) (Fig. 8). Ultramafic/mafic rocks in the Kalanbi area are thought to be cumulates derived from a fractionated tholeiitic magma, which is responsible for their high FeO contents, and the presence of hypersthene (Purvis, 1983). The inferred crystallisation sequence for these rocks is olivine-chromite, plagioclase, pyroxene, magnetite, sulphides and apatite (Purvis, 1983).

The Tunkillia Suite and related Kararan Orogeny intrusives are dominantly felsic, with compositions including diorite, granodiorite, syenite and granite. SiO2 content ranges from 62.9–77.3 and with La values of ~30–400 (Fig. 17). The Suite shows a significant negative Eu anomaly, and HREE traces are relatively flat (Fig. 17). Average Eu/Eu* values are in the range 0.30–1.09.

The Tunkillia Suite is interpreted to have formed during continental collision within the Fowler Orogenic Zone to the west of CHILDARA, producing major crustal thickening, which resulted in the formation of a crustal suite of granites between 1690–1670 Ma (Teasdale, 1997). The Tunkillia Suite and equivalents are predominantly felsic with minor mafic dykes, but the full extent of this magmatic event is still unknown.



(VAG - volcanic arc granite, syn-COLG – syn-collision granite, WPG – within-plate granite, ORG – ocean-ridge granite)

Figure 8. **Rb-(Y+Nb) tectonic discrimination plot for Tunkillia Suite, St Peter Suite and Hiltaba Suite granitoids (after Pearce et al., 1984).**

ST PETER SUITE

Previously, the St Peter Suite was considered a minor magmatic event within the Ceduna to Streaky Bay area. However, this study and Ferris (2001) has demonstrated that the St Peter Suite magmatic event is not confined to coastal platforms from NUYTS and STREAKY BAY. The St Peter Suite magmatic event was a major crust-forming event within the Nuyts Domain. No known St Peter Suite magmatic rocks occur in other tectonic domains on the western Gawler Craton, hence it is unique to the Nuyts Domain occurring on NUYTS, STREAKY BAY, ELLISTON and CHILDARA 1:250 000 map sheets.

The St Peter Suite was originally thought to represent a late- to syn-Kimban Orogeny intrusive (i.e.: member of the Lincoln Complex) based on presence of a deformational fabric. However, U-Pb dating by Flint et al., (1990) recorded a concordant crystallisation age of 1620±4 Ma, indicating that the St Peter Suite was not related to the Kimban Orogeny. Deformation of the St Peter Suite is interpreted to be related to the Kararan Orogeny (Daly et al., 1998).

The St Peter Suite ranges in composition from gabbro through to granite, which is reflected in a SiO_2 histogram, with SiO_2 values being continuous other than minor gaps at 54–56 and 58–60 wt% (Fig. 9) which may be due to lack of sampling.

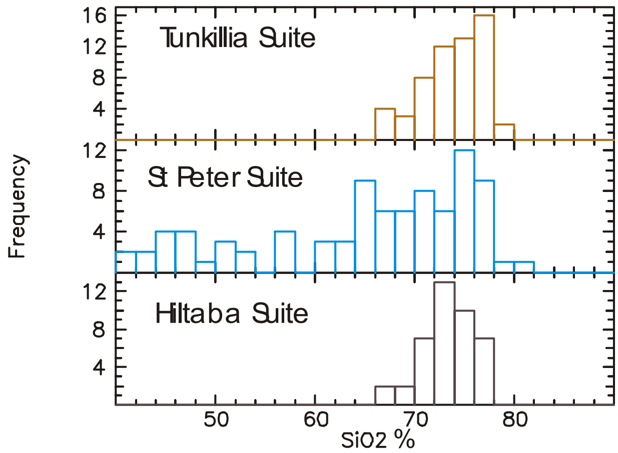


Figure 9. SiO2 histogram for the St Peter Suite (Hiltaba and Tunkillia Suites shown for comparison).

The major element chemistry of the St Peter Suite indicates calc-alkaline affinities and remain relatively enriched in CaO, MgO and FeO at high SiO_2 contents. This, and their wide composition range and unevolved trace element compositions, suggest they have affinities to arc-type plutonic suites developed in convergent plate settings (i.e.: so-called VAG of Pearce et al., 1984, or Cordilleran I-type granites, Pitcher, 1983). This is supported by tectonic discrimination diagrams using trace elements, and by other features such as late Ba depletion and Nb depletion, all of which are recognised as features of arc-type magmas. Knight (1997) reported a possible island arc setting for the St Peter Suite based on limited geochemistry, petrology and field relationships between units.

The St Peter Suite is characterised by a wide range of rock types including tonalite, granodiorite, monzogranite, quartz diorite, diorite, gabbro and anorthosite. Tonalites were intersected in drill holes in the Kalanbi area (Ferris, 2001), and crop out along the coast at Rocky Point, Cape Beaufort and Point James.

The Nuyts Subdomain is dominated by the addition of voluminous juvenile crust at 1620–1608 Ma, which appears related to the continental collision within the Fowler Subdomain to the west. Geochemical evidence suggests minor involvement of oceanic crust from the leading edge of the continent. The lack of major andesitic volcanics, which would be expected from the closing of an extensive oceanic crust, suggests that possibly only a small ocean or no ocean was developed, prior to amalgamation of the Nuyts, Wilgena and Fowler Domains.

As demonstrated by various geochemical diagrams (Figs 10–17), the St Peter Suite corresponds closely to magmatic arc granitoids. While their chemical characteristics indicate their evolution at a collision margin, the analyses do not clearly discriminate between island arc, or Andean type arc settings.

In the context of this study at ~1620 M, the St Peter Suite, a suite of tonalitic to granodioritic rocks, similar in chemistry to Archaean tonalite-trondhjemite-granodiorites, was emplaced within the Nuyts Domain. As with the Tunkillia Suite, the St Peter Suite has a geochemical signature consistent with emplacement within a volcanic arc setting. Alternatively continental extension between ~1640–1630 Ma could have resulted in mantle underplating, producing arc-like chemical signatures in the Tunkillia and St Peter Suites.

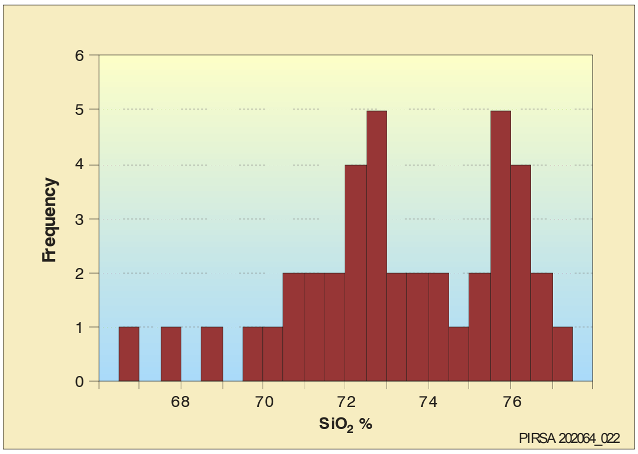


Figure 10. SiO2 histogram for the Tunkillia Suite and related Kararan Orogeny intrusives.

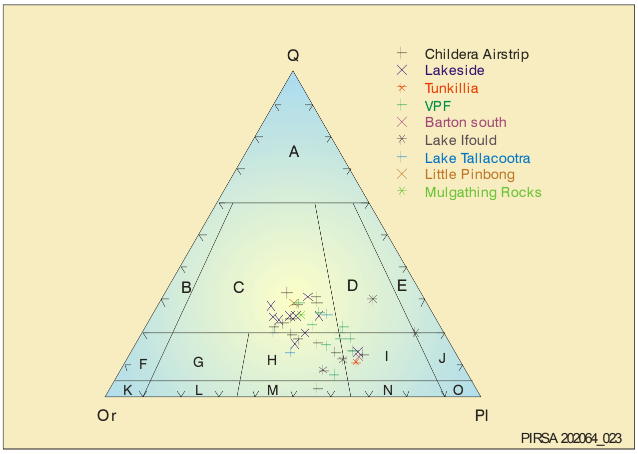


Figure 11. Streckeisen plots for the Tunkillia Suite and related Kararan Orogeny intrusives.
Legend: A = quartz-rich granitoid, B = alkali-feldspar granite, C = granite, D = granodiorite, E = tonalite, F = alkali-feldspar-quartz syenite, G = quartz syenite, H = quartz monzonite, I = quartz monzodiorite – quartz monzogabbro, J = quartz diorite – quartz gabbro – quartz anorthosite, K = alkali-feldspar syenite, L = syenite, M = monzonite, N = monzonite, N = monzodiorite – monzogabbro, O = diorite-gabbro-anorthosite.

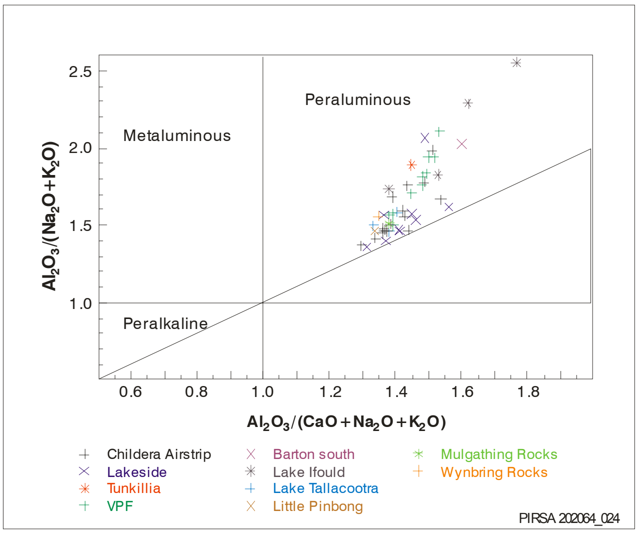


Figure 12. Meta-peraluminous plot for the Tunkillia Suite and related Kararan Orogeny intrusives.

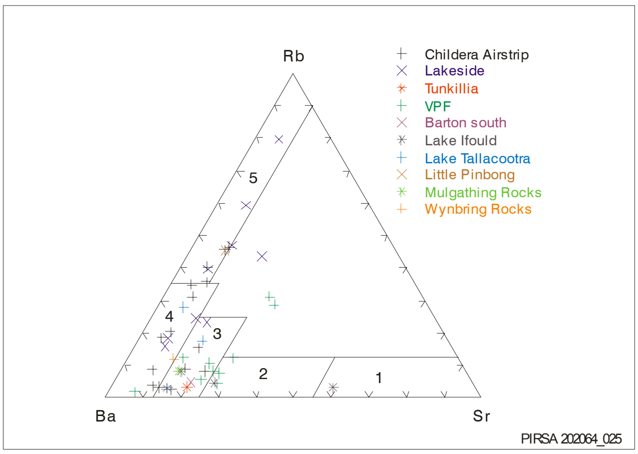


Figure 13. Rb-Ba-Sr plot for the Tunkillia Suite and related Kararan Orogeny intrusives. Fields: 1 Diorite, 2 Granodiorite, 3 anomalous granite, 4 normal granite, 5 strongly differentiated granite.

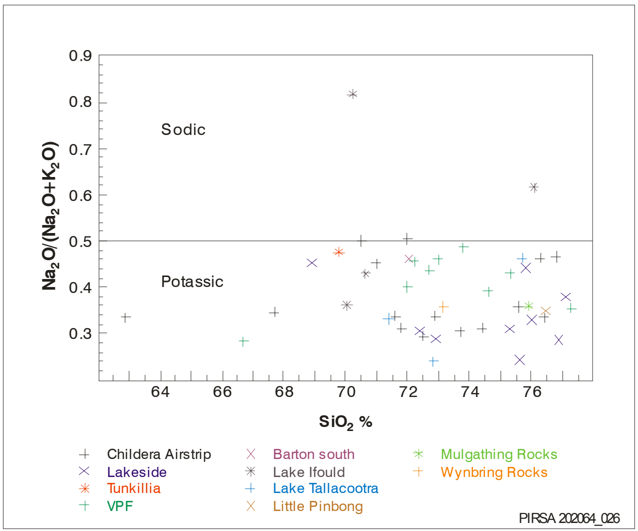


Figure 14. **Sodic versus potassic plot for the Tunkillia Suite and related Kararan Orogeny intrusives.**

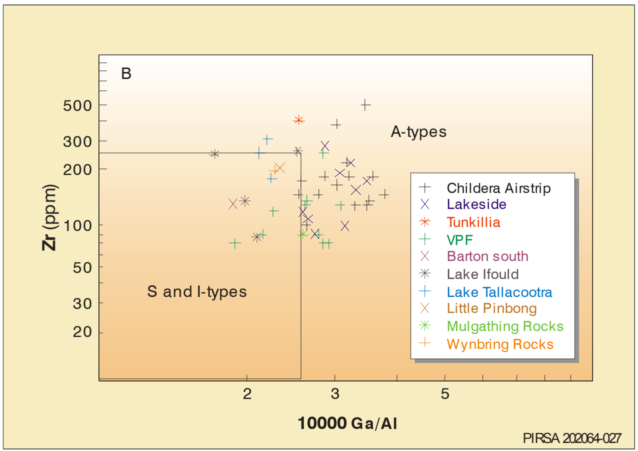


Figure 15. **GA/Al versus Zr for the Tunkillia Suite and related intrusives.**

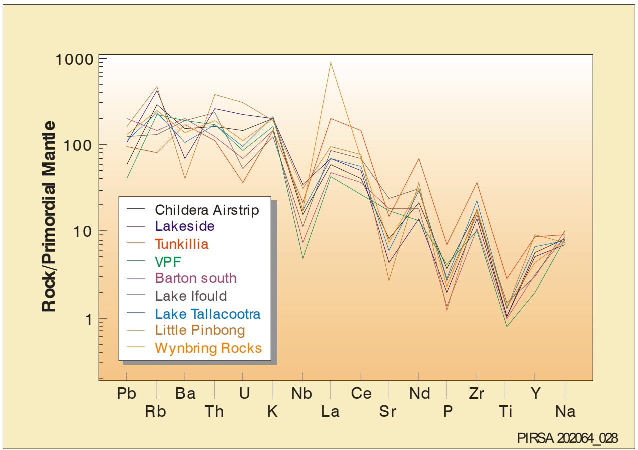


Figure 16. **Mantle-normalised incompatible-compatible plot of average values for the Tunkillia Suite and related intrusives.**

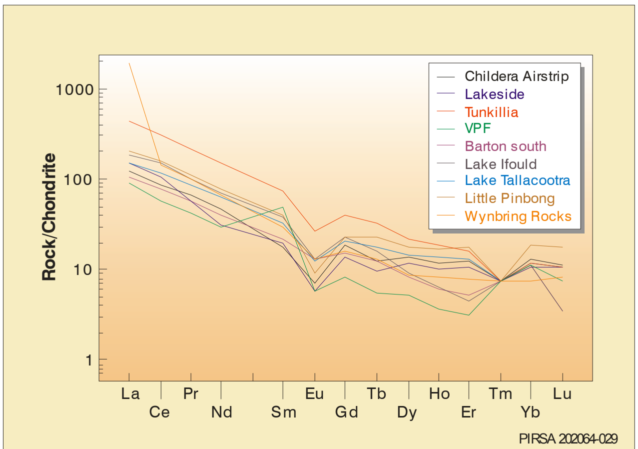


Figure 17. **Chondrite-normalised REE plot of average values for the Tunkillia Suite and related intrusives.**

The St Peter Suite ranges in deformation intensity from undeformed to mildly deformed to intesnely deformed within narrow mylonite zones. The dominant foliation trends roughly north-south, and is mostly vertical to steeply dipping. At Point Westall on STREAKY BAY, the St Peter Suite forms a series of vertical dykes with the foliation aligned parallel to the dyke margins. The St Peter Suite appears to have developed by a period of extension related to the initial continental collision to the west with a southward directed subduction of continental plate beneath the Nuyts Subdomain. This produced a breach in the crust and allowed the production of juvenile granites possibly within a back arc environment. This was short lived with a return to compressional setting, which resulted in a shift from initial calc-alkaline arc to monzogranite to granodiorite.

Both the Tunkillia Suite and St Peter Suite may have been emplaced on the south western margin of the arcuate Archaean core during north east dipping subduction. This represents a switch from subduction related convergence on the eastern margin of the craton (Myers et al., 1996; Betts et al., 2002) to the south western margin coincident with the end of the Kimban Orogeny in the east and onset of the Kararan Orogeny in the west.

HILTABA SUITE AND GAWLER RANGE VOLCANICS

The Hiltaba Suite/Gawler Range Volcanics magmatic event (~1595–1575 Ma) represents a major tectonic/tectonothermal event, which affected much of the Gawler Craton (Fig. 4). Geochemistry and Sm-Nd isotope analysis of the Hiltaba Suite shows that it is highly variable across the Gawler Craton. The suite is dominantly felsic, but intermediate lithologies are known from the northern Gawler Craton (Andamooka and Olympic Dam areas). εNd values for Hiltaba Suite granites within Nuyts Domain record positive values including 0.11 (Nunnyah Rockhole) and 1.19 (Wallala Rock) (Stewart and Foden, 2001) which suggest a depleted mantle source (Rollinson, 1993). Hiltaba Suite samples to the east of the Nuyts Domain record a range of negative εNd values indicating a continental crustal source (Stewart and Foden, 2001). Johnson and Cross (1991) record a mixed εNd signature, indicating a partial mantle source mixed with older Archaean crust from the eastern Gawler Craton.

Traditionally the formation of Hiltaba Suite/Gawler Range Volcanic magmatic event (~1595–1575) Ma has been attributed to development of a mantle plume within an anorogenic, intracontinental environment (Creaser, 1989, Flint, 1993, Stewart et al., 2001). An anorogenic interpretation was applied because the Hiltaba Suite was thought to be undeformed and contain relatively homogeneous geochemistry across the craton. However, evidence from the western Gawler Craton shows the Hiltaba Suite ranges from locally syn-tectonic, within the Yerda Shear Zone to post-tectonic undeformed, coarse-grained granite. Therefore at least some of the Hiltaba Suite was contemporaneous with activation of crustal scale shear zones. Sm-Nd isotopic analysis shows the Hiltaba Suite changes its isotopic characteristics from the western Gawler Craton, where it records juvenile basement rocks, to the Moonta-Wallaroo and Stuart Shelf regions of the eastern Gawler Craton , where it records Archaean to Palaeoproterozoic crust within the (Stewart and Foden, 2001).

The Hiltaba Suite/Gawler Range Volcanics magmatic event is the last major widespread plutonism within the western Gawler Craton (with the exception of local S-type Munjeela Granite and the Spilsby Suite). Contrary to previous anorogenic models, Daly et al. (1998), Ferris (2001) and Ferris et al., (2002) demonstrate that the Hiltaba Suite is an integral part of the deformation/tectonic history of the western Gawler Craton.

Associated with this magmatic event is major strike-slip movement within shear zones in the CHILDARA region. Contemporaneous, dextral strike-slip movement within the Yarlbrinda Shear Zone, producing a dominant north-south trending foliation (S1), and sinistral strike-slip movement within the Yerda Shear Zone resulted in the amalgamation of terranes. Stretching lineations switch from subhorizontal to subvertical within the Yarlbrinda Shear Zone, which may indicate deformation by oblique transpression. From regional evidence and interpretation of aeromagnetic data, the direction of major compressive stress was originally east-west, then reoriented to north-northwest/south-southeast on northern CHILDARA During this event, the triple junction of the

Yarlbrinda and Yerda Shear Zones with the Koonibba Fault Zone developed, and is interpreted to have produced a rotation of the major strain axes from north-south to the northeast/southwest. During this event, several prominent Hiltaba Suite plutons were intruded into the Yerda Shear Zone/Oolabinna Shear Zones (ie: the ‘frogs eyes’), possibly as a sheet within a zone of extension related to sinistral movement on the shear zones. U-Pb dating of magmatic zircons from a deformed granodiorite within the Yerda Shear Zone, recorded a crystallisation age of ~1592 Ma. The Kondoolka Batholith appears to have exploited a northwest trending fracture. Granite within the Kondoolka Batholith is undeformed and is dated at 1580±7 Ma, suggesting the main phase of deformation had ceased. Outcrops of St Peter Suite located south of Yarlbrinda Hill, record the dominant north-south trending fabric (i.e.: they show no evidence of rotation due to intrusion of the Kondoolka Batholith).

MUNJEELA GRANITE

The Munjeela Granite forms large regional plutons of low magnetic intensity on NUYTS and FOWLER. On CHILDARA, the Munjeela Suite forms two small plutons related to movement on the Koonibba Fault Zone, which are characterised by low magnetic intensity dilatational zones. The last major tectonic/tectonothermal event within the Nuyts Subdomain is the intrusion of the S-type Munjeela Granite at ~1560 Ma. Electron microprobe dating of monazite produced an interpreted crystallisation age of 1562±15 Ma (R.Berry, CODES, pers. comm., 2001). Granite at Munjeela Rockhole is undeformed, but equivalent granite at Point Bell, located within the Koonibba Fault Zone, shows evidence of sinistral strike-slip movement. The intrusion of the Munjeela Granite is the last major magmatic event on the western Gawler Craton and is the only known S-type granite on the Gawler Craton. The granite is interpreted to have formed as a result of a period of extension resulting in basin formation which subsequently underwent thermal relaxation producing a suite of S-type granites. The most likely tectonic environment may be a small back-arc basin with the subduction zone located to the east. The basin was subsequently closed during strike-slip motion on the Koonibba Fault Zone.

REGIONAL SHEAR ZONES

Regional shear zones are prominent features on aeromagnetic images of the western Gawler Craton, with some representing tectonic domain boundaries. On CHILDARA, the Yarlbrinda and Yerda Shear Zones and the Koonibba Fault Zone are the major shear zones (Fig. 3). The Oolabinna Shear Zone (Ferris, 2001, McClean & Betts, 2003)) is a newly defined shear zone to the south of and associated with the Yerda Shear Zone (Fig. 3). The Yerda Shear Zone is interpreted to represent a major crustal scale shear zone, separating Archaean rocks within the Harris Greenstone Domain from Palaeo- to Mesoproterozoic rocks within the Nuyts Domain. The Yarlbrinda Shear Zone and Koonibba Fault Zone are interpreted as shallower zones of deformation. Many of the shear zones show areas of intense alteration/ demagnetisation, which are now areas of low magnetic intensity.

Yarlbrinda Shear Zone

The Yarlbrinda Shear Zone is ~150 km in length and up to 12 km wide at the widest point, but is generally ~4 km wide from interpretation of images of geophysical data and exploration drilling at the Tunkillia Gold Prospect (see below). The Yarlbrinda Shear Zone is a brittle-ductile fault zone, which separates the western edge of the Gawler Range Volcanics from Tunkillia Suite and St Peter Suite granitoids. The Yarlbrinda Shear Zone trends roughly north–south but curves to the northwest on northern CHILDARA, and intersects the Koonibba Fault and Yerda Shear Zones (Fig. 4).

The Yarlbrinda Shear Zone is a foliated and lineated zone of deformation striking N-S to NNW-SSE. Foliations within the Yarlbrinda Shear Zone are shown in Figure 18. Throughout the shear zone the foliation is subvertical to steeply east dipping, and S-C fabrics and rotated porphyroclasts show that the shear zone records a dextral sense of shear (Simpson and Schmid, 1983; Passchier and Simpson, 1986; Hanmer and Passchier, 1991). Porphyroclasts showing dextral sense of shear from outcrops within the Yarlbrinda Shear Zone are shown below.

Within the Yarlbrinda Shear Zone, the style of deformation varies along strike. The dominant foliation within the granitoids is defined by the orientation of deformed/recrystallised quartz and aligned biotite flakes. Feldspar grains are generally well preserved. Plagioclase often shows evidence of sericite alteration, but K-feldspar grains are less deformed and form prominent augen up to 20 mm in length. At Yarlbrinda Hill, feldspar grains are extensively fractured within a brittle deformation regime, which crosscuts the mylonitic foliation.

At Tunkillia prospect, K-feldspar grains within protomylonitic rocks are present as coarse augen that are mostly unaltered, whereas, plagioclase grains are commonly extensively sericitised. Within the Yarlbrinda Shear Zone all types of mylonite are seen from protomylonite to ultramylonite, with narrow zones of phyllonite present at Tunkillia prospect.

Outcrops near Childara airstrip and the Lakeside prospect show a moderately well developed S-C foliation (Lister and Snoke, 1984). At Lakeside, the foliation strikes 340°–010° and dips steeply to the west. Asymmetric porphyroclast tails show the fault zone had a dextral sense of shear. The medium-grained granite at Lakeside is not as well foliated as the orthogneiss and in places shows evidence of west side-up dip-slip movement. Rhyolite dykes from an outcrop near Childara airstrip show evidence of dip-slip deformation, with a west side-up sense of movement.

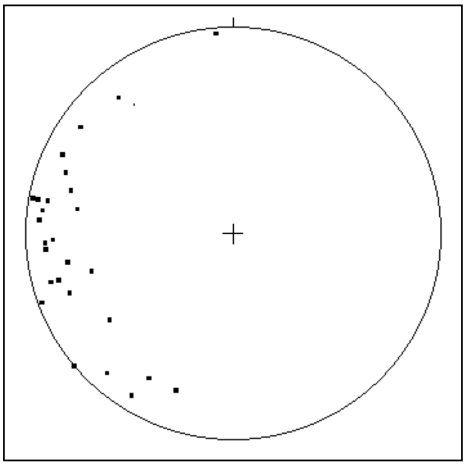


Figure 18. Equal area stereoplot of poles to the regional foliation within the Yarlbrinda Shear Zone

Mylonite zones in outcrop and drill material at Lakeside, along the Vermon Proof Fence (VPF) on northern CHILDARA, south of Yarlbrinda Hill and west of the VPF represent narrow zones of high strain. Mylonites vary from several cm up to 3 m wide and appear to have been formed preferentially within aplite dykes (Lakeside), rhyolite dykes (west of Childara Outstation) or metasedimentary units (west of VPF). The mylonite zones slightly crosscut the regional foliation indicating the mylonites are slightly younger but formed within the same north-south stress regime. At Lakeside, the mylonitic foliation strikes 030° and dips 82° to the west; foliation within the host granite strikes 350°–010° and dips 80° to the west. The mylonite contains a thin folded quartz vein in which the fold axis rotates from horizontal to parallel to the steeply dipping stretching lineation.

Mylonite from west of VPF is developed within possible metasediments. Mylonitic foliation strikes 010° and dips 70° to the west. In thin section, the foliation is crenulated illustrating a later period of deformation in which the regional stress was reoriented. Outcrops within the northern part of the Yarlbrinda Shear Zone are extensively foliated (mylonitic in part). The main foliation strikes 290°–315° and dips 70°–80° to the southwest. Localised, brittle structures trending 045°and dipping steeply east with minor alteration were observed.

Stretching lineations defined by mineral alignment are generally shallow plunging 10°–20° to the north to northwest, but at Lakeside, stretching lineations are steep, plunging 70°–80° to the south. The stretching lineation at Lakeside is an L-S tectonite produced by the combination of steeply plunging lineation and foliation. L-S tectonites form via noncoaxial strain, such as plane strain, reflecting simultaneous flattening orthogonal to the shear zone and constriction, or extension parallel to the shear zone (Davis and Reynolds, 1996). The coexistence of steep and shallow plunging lineations cannot be explained by pure simple shear and have recently been described from transpressive shear zones resulting from combined simple shear and orthogonal shortening (Johnson and Kattan, 2001). Oblique transpression produces a component of vertical movement of one block relative to the other block.

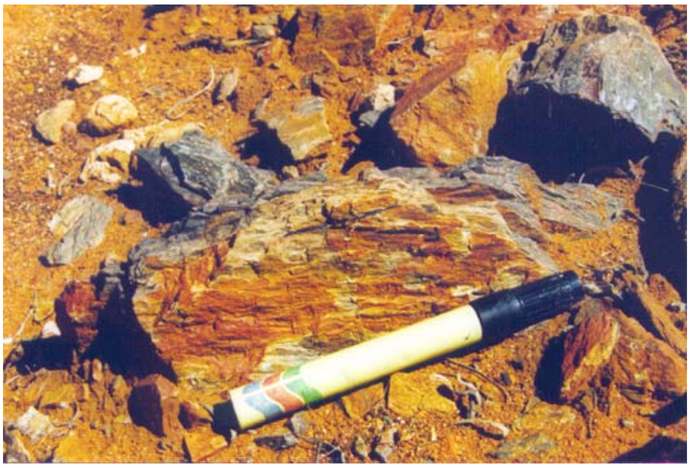


Plate 48. Shallow plunging stretching lineations south of Yarlbrinda Hill (photo 403129).

Plate 49. Steeply plunging stretching lineation at Lakeside (black line represents horizontal plane and pencil is parallel to the stretching lineation) (photo 403130).

Plate 50. Deformed granodiorite south of Tunkillia prospect with coarse feldspar grain showing dextral sense of shear (photo 403131).

The existence of both shallow and steeply dipping stretching lineations with the opposite dip within the Yarlbrinda Shear Zone requires some explanation. The dominant stretching lineation within the Yarlbrinda Shear Zone is shallowly plunging to the north. Steeply dipping or dip-lineated mylonite at Lakeside is interpreted to have been imposed upon aplite dyke precursor. A rhyolite dyke west of Childara Outstation shows evidence of both strike-slip and dip-slip deformation, with elongate quartz observed on both strike- and dip-surfaces. The dip-slip component of the deformation was late and relatively weak, and mostly observed within aplite and rhyolite dykes. A possible explanation for this is that the aplite and rhyolite dykes present a critical rheology contrast to the host granites and orthogneisses, hence they provided zones of weakness that localised the late dip-slip movement within the Yarlbrinda Shear Zone.

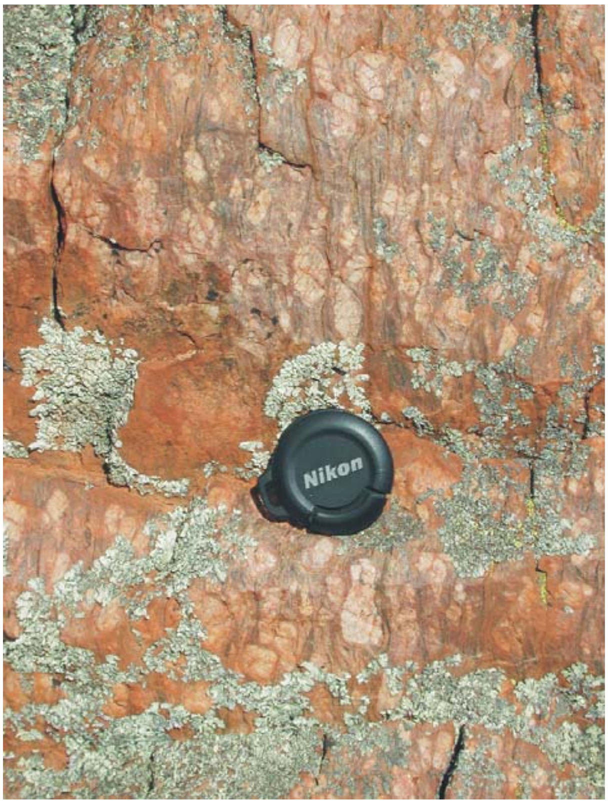


Plate 51. Vertical face showing subvertical lineation and ribbon quartz in a rhyolite dyke from outcrop southwest of Childara (photo 403132).

In thin section, deformation is mainly reflected by quartz grains which show plastic deformation forming ribbons within highly deformed rocks. Biotite is more stable and appears to wrap around quartz and feldspar aggregates. From these observation, the metamorphic grade is most likely greenschist facies (>400–<600°C: Winkler, 1974).

Plate 52. Folded, thin quartz vein (below main vein in picture). Fold axis rotates from horizontal to parallel to the stretching lineation (photo 403133).

Abundant, black pseudotachylite is present at Yarlbrinda Hill. In thin section, the rock is massive to partly laminated, containing fragments and finer comminuted grains of quartz, K-feldspar, plagioclase and opaque oxide within in finer quartz-biotite-chlorite rich matrix. The pseudotachylite crosscuts the mylonitic foliation at Yarlbrinda Hill, which confirms that brittle deformation post-dates the ductile deformation within the Yarlbrinda Shear Zone. Hence, the initial deformation occurred at deep crustal levels, which was followed by uplift and cataclasis.

In outcrop, rocks at Lakeside show evidence of two deformation events:

1. north-south shearing
2. crosscutting more brittle deformation trending 060°.

This implies a change in deformational environment from ductile to brittle regimes, and a major change in principal stress directions. Mylonite from west of VPF shows the main foliation is crenulated which also suggests a latter deformation not within the same stress orientation.

Relative chronology and timing of deformation within the Yarlbrinda Shear Zone

The earliest fabric within the Yarlbrinda Shear Zone is the N-S to NNW-SSW S0/S1 foliation, which was produced by N-S dextral strike-slip deformation with localised vertical shear. At the northern end of the shear zone, the foliation is rotated to the NNW due to sinistral strike-slip movement on the Yerda Shear Zone to the north. The foliation is steeply dipping with dominantly sub-horizontal stretching lineations. The shear zone was affected by a later phase of dip-slip deformation which produced steeply plunging stretching lineations. Poor exposure within the Yarlbrinda Shear Zone means there is no observable transition from shallowly, north plunging to steep south dipping stretching lineations. The stretching lineations switch from subhorizontal to subvertical along the Yarlbrinda Shear Zone indicating significant variation in finite strain consistent with an origin by oblique transpression. Drill holes located east of the “frogs eyes’ plutons show rapid change from vertical to horizontal foliation suggesting low angle thrusts. Unfortunately, the core is not oriented, hence no transport directions are deducible.

Petrology of quartz grains from granitoids at Lakeside shows evidence of an early phase of deformation which was overprinted by the main deformation event producing the regional foliation. Hence, there may be an older deformation event but it was within the same stress regime because the older deformation is not evident in mesoscopic outcrop observations.

The S1 fabric is dissected by NE-SW trending, brittle structures. Fault offsets are apparent on aeromagnetic images and show a sinistral sense of movement. This indicates a change in the orientation of the major compressive stress from N-S to NNW-SSE. This event produced a prominent tear in the shear zone at the inflection point at the northern end, and appears to have been associated with a major zone of alteration (demagnetisation of magnetite to haematite). The tear in the shear zone may be related to thrusting of granite east of the Yarlbrinda Shear Zone (north over south) (Martin 1996). This event also produced a major stepover or pull apart basin south of the Tunkillia prospect.

Mafic dykes that intruded into the host sequence of granitoids show evidence for late reactivation of the shear zone within the original stress field, which suggests a reversal of the compressive stress back to N-S.

The relative timing of deformation is bracketed by the age of the host rocks at ~1680 Ma and intrusion of the Kondoolka Batholith at ~1580 Ma. Intrusion of the Kondoolka Batholith appears related to dextral extensional movement on the shear zone providing space for granite emplacement. Granite within the Kondoolka Batholith is undeformed with the exception of minor brecciation/veining observed along the northern margin and the granitic body is most likely a stitching pluton. Syntectonic plutons of Hiltaba Suite were emplaced within the Yerda Shear Zone to the NW.

Pontifex and Hand (1997) report that the major mylonitic foliation at Tunkillia was reworked by a weak sericite-rich foliation due to an increasingly partitioned deformational event. Major alteration and gold mineralisation within the Yarlbrinda Shear Zone appears to have occurred late within the deformation cycle. The switch from N-S to NNW-SSE directed compression and related extension at stepovers was relatively quick and occurred at ~1590–1580 Ma (i.e.: intrusion of Kondoolka Batholith).

Yerda Shear Zone

The east-west trending Yerda Shear Zone separates the Nuyts and Harris Greenstone Domains. An outcrop of foliated granodiorite located within the Yerda Shear Zone has a U-Pb zircon age of 1592±11 Ma, which is interpreted to represent the crystallisation age. The foliation strikes northwest-southeast, and dips steeply to the west, with a shallowly plunging stretching lineation (20°→296°). Rotated porphyroclasts indicate a ?sinistral sense of shear.

The discovery of deformed Hiltaba Suite granite within the Yerda Shear Zone and recent geochronology of fabric formation within the Fowler Subdomain provides evidence that major crustal faults on the western Gawler Craton were active during the age of Hiltaba Suite emplacement. U-Pb isotope geochronology of metamorphic zircons in Nundroo DDH 3 on FOWLER indicates that mylonitic fabrics were still evolving within the Fowler Subdomain as late as 1537±10 Ma (Daly et al., 1995; Fanning, 1997).

Koonibba Fault Zone

The Koonibba Fault is one of a series of northeast trending structures which dissect the Gawler Craton. Outcrop within the Koonibba Fault Zone is rare, but stretching lineations where the fault zone is exposed at Point Bell, confirm the strike-slip nature of the Koonibba Fault Zone. Kinematic criteria in the form of fabric asymmetry and rotated porphyroclasts indicate localised sinistral movement, consistent with findings for other regional northeast trending faults (Rankin et al., 1989;

Teasdale, 1997). Porphyritic felsic mylonite within the Karari Fault Zone (drill hole Ooldea DDH3), show a sub-vertical foliation with steep down-dip stretching lineations (Teasdale, 1997). Teasdale (1997) reports that shear bands and asymmetric porphyroclasts indicate northwest-up with a component of sinistral strike-slip movement, which contradicts Rankin et al. (1989) who report an east up and sinistral strike-slip movement.

Structural interpretation of the aeromagnetic images indicates a significantly more complex picture than localised outcrop or drill hole data from along the Koonibba fault exhibits. Whilst the geophysical data show evidence for both dextral and sinistral strike-slip components along the major shears of the Fowler Suture zone (with the latter sense-of-shear dominating), outcrop scale observations are more consistent with dip-slip deformation. Stretching lineations in the Ifould Lake area generally pitch >60–70° to the north, within subvertical foliation planes. The orientation and asymmetry of rare composite fabrics (S-C mylonites) are consistent with an east-block-up, dip-slip component of movement. These observations indicate that sinistral strike-slip movement is locally only a minor component of the deformation, but the offset appears in plan view to be large.

Regional gravity and structural observations suggest that the Fowler Sub-domain has experienced extensive crustal compression, producing a compressed section of crust. Structural observations of outcrops within the Fowler Sub-domain, reveal steep stretching lineations indicative of vertical (dip-slip) movement about a steep movement plane.

ECONOMIC GEOLOGY

PREVIOUS EXPLORATION

Ferris and Fairclough (1996) reviewed the exploration history up to 1996 for the CHILDARA map sheet area, with an emphasis on mineral sands.

Uranium

The aero-radiometric Kokatha Survey flown by MESA in 1978 was the stimulus for uranium exploration on the western Gawler Craton. CRA Exploration Pty Ltd (CRAE) (SML 722) targeted the Middle Proterozoic Hiltaba Suite granite as a potential source of uranium mineralisation. Exploration comprised closely spaced helicopter borne scintillometer traversing, rock chip sampling, stream sediment sampling and water sampling. Initial rock sampling showed the Hiltaba Suite to contain slightly elevated but not economically significant U and Th levels. Drainage and water samples were low.

Aberfoyle Exploration Pty Ltd (EL 575) also targeted Hiltaba Suite granite as both a source of hard rock and sandstone type uranium mineralisation. Initial exploration was based on the Kokatha Survey which delineated several anomalies. Aerial photo-interpretation and field checking showed that several of these anomalies were related to outcrops of Hiltaba Suite granite. Follow-up rock chip sampling showed U and Th contents between 6–18 ppm and 180–320 ppm respectively.

Carpentaria Exploration Co. Pty Ltd (CEC) was the major explorer for sandstone-type uranium mineralisation within the Narlaby Palaeochannel. The Hiltaba Suite granite, which occurs at shallow depths over much of CHILDARA and STREAKY BAY, was seen as the potential source of uranium. Exploration models suggest that during Tertiary times, uranium within the Hiltaba Suite granite was weathered, transported and deposited within the former drainage system and absorbed onto carbonaceous clays of the Pidinga Formation.

Preliminary rock chip sampling showed the Hiltaba Suite to contain higher than background uranium contents. A total of 1503 rotary mud and reverse circulation (RC) holes delineated four main prospects (ie Yarranna 1–4). These all comprised sub-economic uranium mineralisation associated with redox fronts near the contact of the carbonaceous Pidinga Formation and the overlying oxidised sands of the Garford Formation (Binks and Hooper, 1984).

Exploration by CEC on EL 1274 also failed to delineate economic uranium mineralisation. A thermoluminescence (TL) study of quartz from pre-Tertiary rocks confirmed that the Hiltaba Suite was enriched in U and was the most likely source of mineralisation.

Base Metals

Abadon Holdings NL (EL 56) undertook an extensive exploration programme located mainly on TARCOOLA. Based on mineralisation located within the Tarcoola area, exploration targets included Au in quartz reefs (i.e.: Tarcoola Goldfield), Sn associated with quartz reefs and greisens (i.e.: South Lake), Cu in Tarcoola Formation (Tarcoola Goldfield) and base metals in hydrothermally altered adamellite. Exploration comprised photo-interpretation, regional mapping, reconnaissance magnetic and geochemical surveys and petrology. Initial regional exploration outlined two areas worthy of more detailed exploration, Hopeful Hill and Kenella Rock (East Lake). Both areas are located on TARCOOLA.

Detailed geological mapping, magnetic surveys and geochemical surveys were carried out in these areas. Some elevated base metal values were reported from geochemical sampling and nine percussion/diamond holes were drilled with several promising base metal intersections.

Afmeco Pty Ltd (ELs 618, 630, 684 and 868) drilled 24 holes (CHL 1–24) totalling 1123.3 m in the search for base metals on northern CHILDARA. Drill holes intersected a variety of rock types including deformed rhyolite, mafic igneous rock, Archaean granite gneiss and Hiltaba Suite Granite. Minor pyrite and/or chalcopyrite mineralisation was reported in several holes (CHL 1, 2, 13, 14 and 15) and hole CHL 21 showed minor U and Cu enrichment. No analysis for Au was carried out.

Utah Development Company (EL 757) explored for base metals within the Middle Proterozoic Hiltaba Suite and Gawler Range Volcanics on CHILDARA. 1224 rock chip and 39 stream sediment samples were collected and assayed for a range of elements with no anomalous values returned.

Amoco Minerals Australia Company (EL 1017) took up ground relinquished by Afmeco to search for base metals, gold and tin deposits of volcanic/hydrothermal origin. A geophysical interpretation by C. Anderson delineated 8 separate anomalies. Grid magnetic and gravity surveys were carried out over anomalies 1, 2 and 5, whilst magnetic surveys only were carried out over anomalies 7 and 8. Comlabs carried out geochemistry on 65 rock chip, 18 stream sediment and 7 soil samples. 7 drill core samples from Abadon Holdings NL drill hole DH 1A were submitted for analysis with the best results being 2000 ppm Cu, 4.9% Pb, 4.5% Zn and 1800 ppm Bi from a sulphide-chloritic-hematite zone within a green quartz-magnetite-pyroxene amphibole gneiss (altered BIF) interlayered with a quartzofeldspathic gneiss.

Mount Isa Mines Ltd (MIM) (EL 1111) drilled 13 rotary and percussion holes (RPN 1–12) in the search for Olympic Dam style mineralisation. End of hole samples were assayed for Au, Ag, and Sn. A composite from each hole was assayed for a wide range of elements and a silicate analysis. Geochemical assays were low and no mineralisation except for minor pyrite was observed in some percussion samples. Rock types intersected were predominantly amphibolites with varying magnetite content.

CEC (EL 1274) submitted 25 samples of carbonaceous clays and sands for a full geochemical analysis including Cu, Pb and Zn. Results were low with the highest value recorded being 4450 ppm Cu and 1.18% S.

EL 1315 was granted to CRA Exploration Pty Ltd to cover a regional gravity high located north of Kingoonya and adjoining areas of subcropping Archaean and Proterozoic basement, which may have potential for base metal and gold mineralisation. Interpretation of regional gravity data also outlined the possibility of a Middle Proterozoic sediment filled graben, which may have potential for Witwatersrand-style conglomerate-hosted gold mineralisation.

The main prospects outlined were the Lake Labyrinth and South Lake Prospects on TARCOOLA and KINGOONYA (see Youles 1991 and 1992 for exploration summary). The only area on CHILDARA is part of the Glenloth Gold Prospect. Two low amplitude aeromagnetic anomalies were delineated within the Glenloth Prospect and field inspection and rock sampling revealed the magnetic anomaly was due to outcropping foliated magnetic granite. Rock chip sampling returned no anomalous values and no further work was carried out on the Glenloth Prospect.

Gold

Placer Pacific Pty Ltd (EL 1390) considered that the TARCOOLA/CHILDARA area was similar to Archaean basement in the Yilgarn Block and may host several styles of mineralisation. Aeromagnetic interpretation showed a dominantly Archaean terrain with several Proterozoic granite intrusions. Aeromagnetic data showed a major decrease in magnetic intensity across a major unnamed W-NW fault zone. This was thought to represent two different tectonic blocks. Numerous linear structures were observed along with the main WNW structure with some offset noted on the northern block.

A structural interpretation of the fracture system was completed by L. Harris for Placer. The main feature was a possible E-W trending thrust (North over South). Structural data from known mineralisation at Tarcoola Goldfield and Glenloth Goldfield showed the importance of structure to mineralisation with Au concentrated in N-S fractures at the Tarcoola Goldfield and related to tensional fracture systems at Glenloth Goldfield and Earea Dam.

Drilling was designed to test areas where the magnetic gradient showed possible faulting and/or magnetic susceptibility reduction due to geochemical alteration. A total of 104 holes (TUN1–104) were completed, of which 70 (TUN1–70) were located on CHILDARA. Geochemical results were low with the best value being 91 ppb Au in TUN 97 (26–30 m). Nine other samples returned Au values >5 ppb:

Hole	**Depth** (m)	**Au** (ppb)
TUN7	38–40	33.0
TUN8	42–46	9.3
TUN37	32–36	25.0
TUN42	36–38	7.6
TUN84	42–46	21.0
TUN84	50–54	19.0
TUN84	58–59	11.0
TUN96	56–58	12.0

Rock types includes a variety of quartzofeldspathic gneisses, deformed and non deformed granites and mylonites.

EL 1414 and 1447 were granted to Tarcoola Gold Ltd to explore for Au within Middle Proterozoic Hiltaba Suite granite. A geophysical interpretation by P. Wozybun delineated two large Hiltaba Suite plutons on northern CHILDARA. Detailed ground magnetics was carried out and 49 holes (MFS01–49) were drilled targeting magnetic highs. Samples from each drill hole were analysed with 10 holes returning Au values >0.01 ppm. The highest value was 0.04 ppm in MFS47 (58–59 m).

EL 1505 was granted to BHP - Utah Minerals International to search for volcanic hosted epithermal Au within the Gawler Range Volcanics in the Glyde Hill and Chitanilga areas. Three stream sediment sampling programmes were carried out with the highest Au value being 2.3 ppb. The majority of samples returned values <1ppb Au and consequently the area was considered unprospective.

Utah Development Company (EL 757) assayed 1224 rock chip and 39 stream sediment samples for Au as part of a regional programme (see base metals section). The results were disappointing with all but one sample below the detection limit 0.05 ppm Au.

Amoco Minerals Australia Company (EL 1017) included Au as part of a multicommodity exploration programme. A total of 90 rock, stream and soil samples were assayed with no anomalous Au values returned.

Basement samples form MIM's drilling programme (EL 1111) were assayed for Au with no anomalous values returned. Geochemical analysis of rock chip sampling by CRA Exploration Pty Ltd (EL 1315) on the Glenloth Prospect returned no anomalous results.

Numerous exploration programs have been conducted on GAIRDNER around the historic Glenloth Goldfields, immediately adjacent to the northeast boundary of CHILDARA. Potential exists for similar style gold mineralisation within the map sheet area where Glenloth Granite outcrops north of Lake Everard. MIM's Range River Gold, in joint venture with Mount Isa Mines undertook exploration in this area, as part of their "Area B" (EL 2518), but no significant results were reported from blanket calcrete sampling up to 2003.

Ashton Mining Ltd applied for an EL (application DME 235/85) to explore for epithermal gold mineralisation within the Yardea Dacite. Landsat interpretation revealed a possible caldera structure. Reconnaissance field work reported only minor alteration and geochemical analysis of rock chip samples were negative.

The Tunkillia prospect is located ~660 km northwest of Adelaide with access via Glendambo, the graded all weather road to Kingoonya, then via station tracks. Tunkillia is located within Exploration Licence 2028 originally granted to Helix Resources NL in November 1994. Initial calcrete sampling in 1994 identified numerous anomalous zones of gold, which together define a large hydrothermal system associated with the Yarlbrinda Shear Zone.

The Tunkillia gold-in-calcrete anomaly has an extent of ~20 km² at the 10 ppb level and covers the northern termination of the Yarlbrinda Shear Zone (YSZ). Figure 19 shows calcrete anomalism within the YSZ and the major prospects that comprise the Tunkillia anomaly. To date, the best prospect is Area 223, which has been extensively drill tested and contains a JORC resource of 10.5 Mt grading 2.2 g/t Au (730 000 oz of contained gold (Fig. 20).

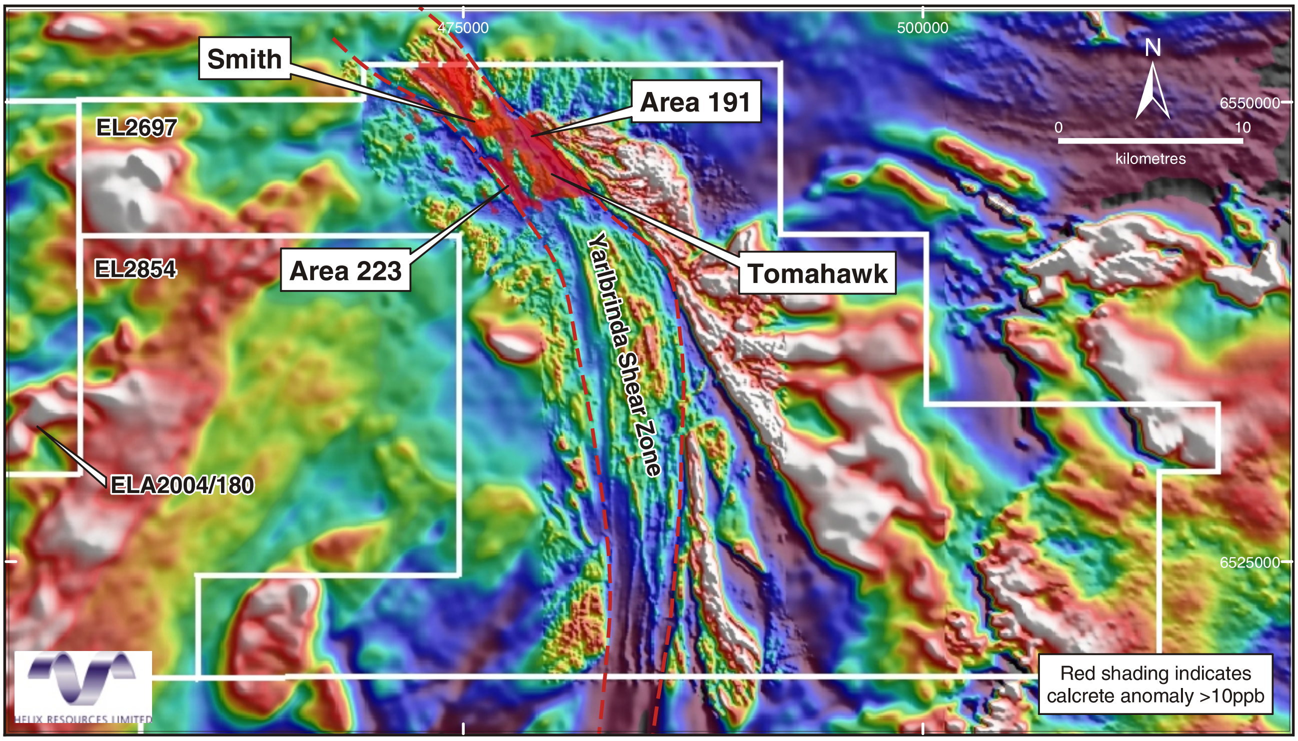


Figure 19. Total magnetic intensity image showing location of calcrete anomalies and prospects at Tunkillia

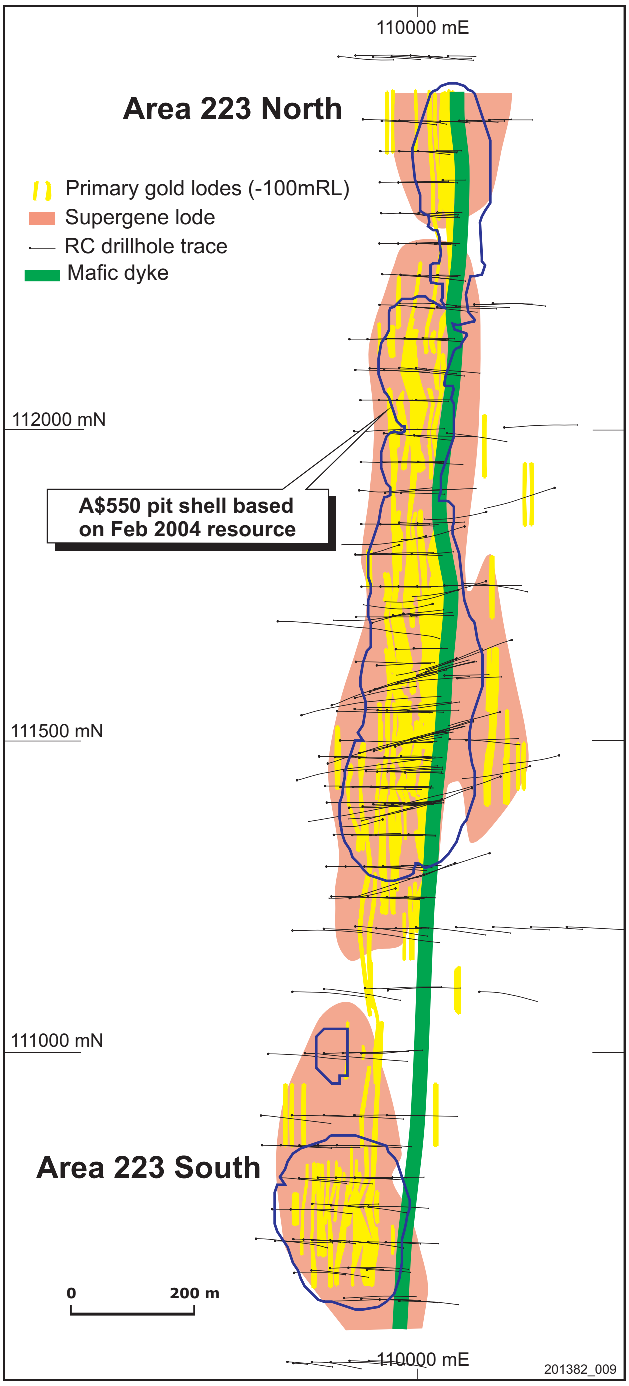


Figure 20. Area 223 drillhole location plan

Exploration completed by August 31 2004 included calcrete sampling and analysis, airborne magnetic and radiometric surveys, ground gravity and IP surveys, Rotary Air Blast (RAB), Reverse Circulation (RC) and diamond drilling, along with detailed structural analysis. The project is also the subject or ongoing numerical modeling collaborative research.

Host rocks to the Tunkillia Project area are medium to coarse-grained granitoids of the Tunkillia Suite (L1 and L2) that have been intensely sheared and brecciated within the YSZ. An idealised section through Tunkillia is presented in Figure 21, and structural data and block diagrams illustrating the main geometries in Figures 22–23.

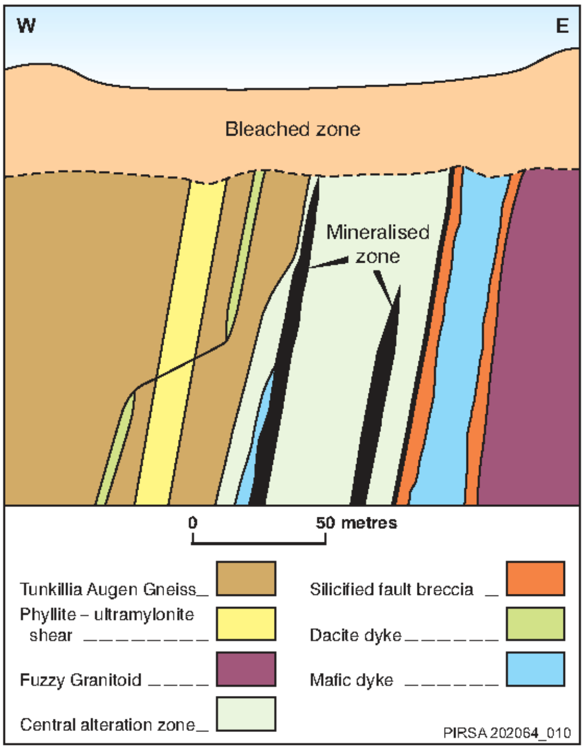


Figure 21. Generalised cross-section of the Tunkillia Prospect (Standish et al., 1997).

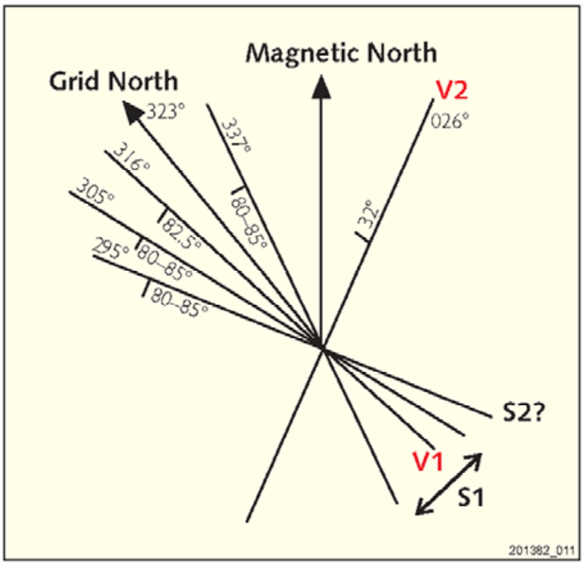


Figure 22. Summary diagram of main structural orientations from diamond drill core in Area 223 (after Standish et al., 1997).

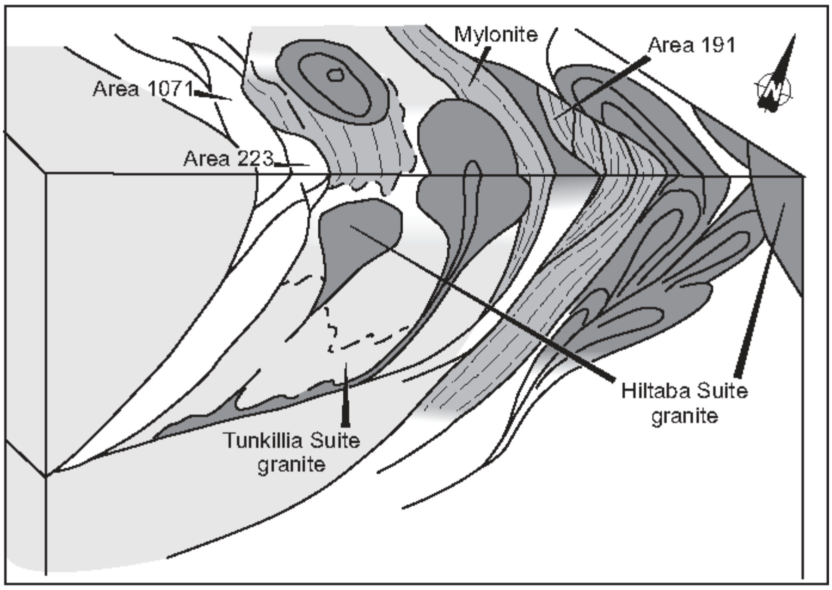


Figure 23. Schematic block diagram of structure within the Tunkillia region (Rankin, 1997).

Gold is hosted in narrow steeply dipping quartz veins (lode gold-style) and is associated with sulphides, dominantly pyrite with minor galena, within an alteration zone comprising sericite and chlorite. Some of the best gold intersections from Area 223 include:

- LRC012: 36 m @ 3.68 g/t Au (including 10 m @ 10.1 g/t)
- LRC037: 13 m @ 5.47 g/t Au (including 4 m @ 12.1 g/t)
- LRC237: 19 m @ 5.1 g/t Au (including 4 m @ 11.3 g/t)
- LRC033: 35 m @ 2.37 g/t Au (including 3 m @ 15.2 g/t)

The Tunkillia Project is located in the northern part of the YSZ where the zone has been reorientated to the north-northwest. Outcrop is sparse and confined to low, isolated outcrops south and west of Tunkillia, and patchy low outcrop along the vermin proof fence to the northwest. Within the Nuckulla Hill area to the south, Tunkillia Suite granitoids crop out at several locations north and south of Childara Outstation. These rocks have undergone regional deformation within the shear zone, which has produced a range of fabrics from a regional north–south, to north-northwest–south-southeast striking foliation with crosscutting mylonite zones. The main foliation strikes between 285°–340° (magnetic north) and dips steeply to the southwest. The mylonite zones strike north–south and dip steeply to the west. Gold mineralisation is hosted within quartz–sulphide veins. Two generations of veins are observed in drill core:

1. V1 veins — quartz±sulphide (predominantly pyrite with minor galena and sphalerite) veins which host mineralisation. Laing (1998) divided the V1 veins into a 'concordant to cleavage' set and a 'discordant to cleavage' set.
2. V2 veins — barren calcite±quartz and chlorite veins that post-date regional shearing.

The V1 vein set is sub-parallel to S1, which suggests that they were formed during the main shearing event. The V2 vein set does not correlate well with the S1 and V1 structural orientation; the main cluster strikes 026° and dips 32 ° to the northeast (Standish et al., 1997). Pontifex and Hand (1997) reported that V1 veins sometimes display a branching structure, suggestive of stockwork. The early veins have been overprinted by the mylonitic deformation. This is a characteristic feature of mesothermal lode deposits that show cyclic changes in fluid pressures from periods of lithostatic pressure to periods of sub-lithostatic to supralithostatic pressure (Cox et al., 1991). The vein network at Tunkillia is narrow and does not penetrate the wallrocks for any great distance. Mineralised zones are therefore likely to have been zones of high permeability and fluid flux at near lithostatic pressure during vein formation and mineralisation. In a regional context, the Tunkillia area shows evidence of extensive alteration. Large zones of demagnetisation are observed in aeromagnetic images, similar to the alteration described at Nuckulla Hill (Parker, 2003). Helix Resources NL defined a western and eastern zone produced during during alteration. Low-temperature hydrothermal gold deposits are characterised by high oxygen and sulphur fugacities. The oxidation of gold–sulphur complexes precipitates gold and sulphides.

Alteration appears to accompany and slightly post-date major deformation, with sericite-rich foliation evident within thin section, as well as altered, undeformed plagioclase grains. Undeformed rhyolite–rhyodacite dykes, that obviously post-date regional deformation, are selectively sericite altered. Hence, the introduction of the fluids appears to have been a long-lived or repeated process.

Tunkillia and other prospects within the Proterozoic gold-only province are almost certainly contemporaneous with Mesoproterozoic Hiltaba Suite magmatic–tectonic event, which raises the question of how much influence did the Hiltaba Suite intrusives have on the mineralisation. Ferris and Schwarz (2005) have presented a detailed isotopic and geochemical study of the host Tunkillia Suite (Figs 10–17). A detailed appraisal of the physic-chemical properties of the ore fluids at Tunkillia is presented in Ferris and Wilson (2004) summarising that the mineralising fluid at Tunkillia was of moderate to high temperature, relatively low salinity (<3.5 wt% NaCl), and with minor CO2. On a temperature versus salinity diagram, Tunkillia plots just above the field of Archaean lode deposits (not shown). The inferred trapping temperature for fluids related to gold precipitation at Tunkillia is 330–515°C, with an average of 412°C. Fluid inclusion data suggest that metamorphic fluid is a possibility because of the low salinity (<3.5 wt% NaCl) observed at Tunkillia, but the data do not preclude a mixing of magmatic and/or metamorphic fluids.

Although fluid inclusion data, indicates that mineralisation was associated with a low-salinity metamorphic fluid (Figs 24–25) sulphur and lead isotopes show a relationship to Hiltaba Suite granites. Delta34S values between –2.23 and 3.19‰ indicate a possible magmatic origin. Lead isotope data suggest a link to the Hiltaba Suite with some contamination from the host granitoids.

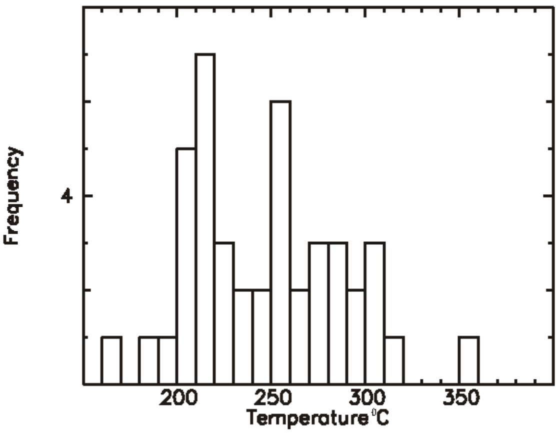


Figure 24. Histogram of uncorrected homogenisation temperatures, Tunkillia Prospect.

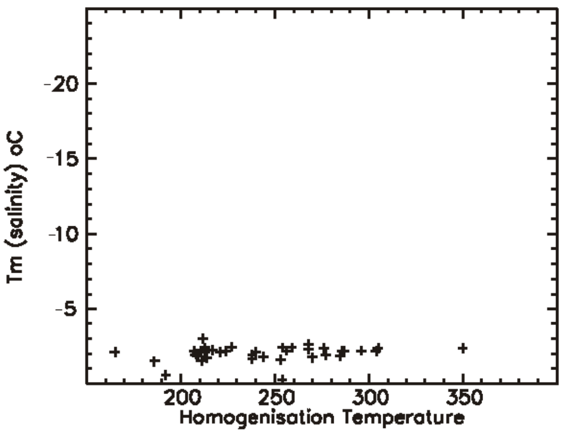


Figure 25. Tm (final melting temperature in degrees Celcius) versus temperature of homogenisation for Tunkillia samples.

A genetic model for Tunkillia is illustrated in Figure 26. In summary the Tunkillia gold prospect is hosted within Tunkillia Suite intrusives (1690–1670 Ma) that range in composition from adamellite to granodiorite, with minor mafic and rhyolite dykes. Mineralisation is hosted within quartz ± sulphide veins striking 325° and dipping steeply to the west. Ore shoots plunge moderately to the south. Sericite is the main alteration mineral, which constrains pH to 3.5–5. Fluid inclusion data show the mineralising fluids to have been of moderate temperature (~375°C), low salinity (up to 6 equivalent wt% NaCl, average <3.5 wt%), with minor CO2 content. Gold is associated with sulphides, dominantly pyrite. This association and the fluid type indicate that gold was transported as a Au(HS)2- complex within the pyrite stability field. Furthermore, sulphur isotope data suggest a magmatic source for sulphur.

The mineralisation was most likely related to fluid influx from syntectonic Hiltaba Suite granites emplaced within the active YSZ, which may have mixed with low salinity metamorphic fluids produced at depth. Structure appears to be the dominant control on mineralisation with the shear zone focusing the fluids and with fault intersections acting as trap sites. Resistivity inversion profiles of IP data demonstrated known mineralization from Area 191 to give anomalous resistive responses, illustrating further geophysical exploration techniques. More recent opinions suggest that mineralisation postdates the main ductile deformation episode (R. Flint, Minotaur Exploration Ltd 2007).

Mineralisation at Nuckulla Hill was discovered in a similar fashion to Tunkillia by Equinox Resources. Exploration licence EL2035 was granted in December 1994. Exploration commenced in 1995 within the Lake Everard area and was initiated following interpretation of new aeromagnetic and radiometric data along the YSZ 70 km to the south of the then undiscovered

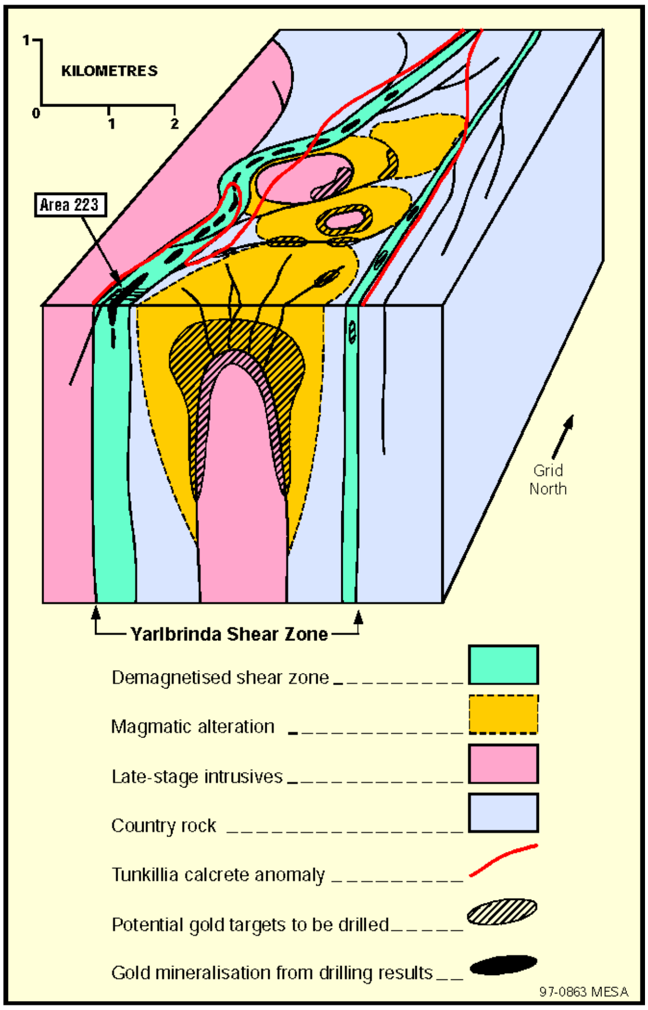


Figure 26. Tunkillia Prospect schematic conceptual model, courtesy of Helix Resources NL.

Tunkillia prospect. Regional calcrete sampling coupled with soil and rock chip sampling, located several geochemically anomalous areas which were further defined by infill calcrete sampling and ground magnetics. First pass drilling, comprising RAB (249 holes, total 10 381 m) and aircore (62 holes, 577 m) returned encouraging results in the form of several gold, copper and zinc intersections (best, 7 m at 2.47 g/t Au in hole NHAC 26).

Gold mineralisation was discovered in December 1995 at the Sheoak (78 ppb Au calcrete anomaly) and Myall prospects and 10 km to the north at the Bimba Prospect in early 1997. Gold mineralisation was first delineated along and just above, the contact between fresh Tunkillia Suite basement and weathered saprolite. A detailed low level aeromagnetic survey and various ground geophysical surveys were followed by drilling at both previously drilled and new prospects. The drilling program comprised diamond drilling (three holes for 491.5 m core), RAB, reverse circulation and aircore methods (total 318 holes, aggregating 17 136 m). While no economic mineralisation was encountered, it is considered that those prospects along the Yarlbrinda Shear Zone showing significant gold mineralisation (e.g. Bimba prospect with a 24–36 m wide gold-bearing zone still open to the north) warrant further testing.

At Sheoak NHDDH-1 was drilled to the west across a structural target to a depth of 271.5 m intersecting strongly altered brecciated granitoid (ranging from quartz diorite to adamellite), mylonitic gneiss, quartz-rich mylonitic schist (including a 65.2 m zone of 2–5% disseminated pyrite) and minor base-metal sulphide (galena+/-sphalerite+/-chalcopyrite). In general, Sheoak drill material has intense shearing and brecciation evident throughout and clay and sericite have replaced fibrolitic sillimanite suggesting mid – to upper amphibolite facies metamorphism prior to shearing and alteration (Parker, 1996). Early sericitisation and quartz veining was followed by calcsilicate veining with epidote, accompanied by chlorite, adularia, quartz and occasionally fluorite and calcite. Late-stage sericite to quartz-rich veins and shear zones and local prehnite and/or tremolite (+/- epidote +/-chlorite) indicate a long history of veining and alteration associated with fluids and movement of the Yarlbrinda Shear Zone (Parker 2003). Petrological studies reported in Parker (2003) have suggested that shearing involved a succession of fluids with temperatures from greenschist to zeolite facies (possibly 350 °C to less that 100 °C) in addition to varying pH and XCO levels. Thus the temperature ranges inferred overlap those of epithermal style deposits.

Geophysical exploration played a crucial role in delineating the Nuckulla Hill geology, mineralisation and structure. Equinox flew an aeromagnetic survey with a line spacing of 100–200 m at a height of 60 m in July 1996 to infill PIRSA 400 m line spaced aeromagnetic data. Reconnaissance ground magnetic surveys were then integrated directly over the mineralised zones. This data further highlighted the strong spatial relationship observed between demagnetised zones and alteration – also seen at Tunkillia. In November 1996, Equinox carried out gradient and dipole-dipole array IP/resistivity surveys to further delineate the prospect, but the technique was considered unsuccessful (Parker, 2003).

Minotaur Exploration joint ventured in the Nuckulla Hill project in 2005, immediately adjacent to their joint venture with Helix on the Tunkillia prospect area (and immediately south of their Deception Hill project). However the emphasis was on locating IOCG mineralisation similar to the Prominent Hill deposit discovered by Minotaur to the northeast of CHILDARA in 2001. Regional and infill gravity surveys defined a number of targets. Drill testing of two of these targets (NK05R001 and NK05R003) near Sheoak and Myall intersected sheared granitoids with extensive chlorite-epidote alteration. An angled RC hole was also drilled across the eastern margin of the Yarlbrinda Shear Zone. Exploration is ongoing at the time of writing.

Ni-Cr and Platinum Group Elements (PGE)

A large circular geophysical anomaly located ~20 km north of Ceduna on the SW corner of CHILDARA was the main target for Ni-Cr and PGE exploration. CRAE (EL 1090) proposed that the feature was a collapsed caldera with similar geophysical features to Olympic Dam. A total of 10 magnetic anomalies were outlined and tested by drilling. 29 holes (82CRC 1–14 and 83KRC 1–15) totalling 1200.1 m were drilled. Rock types intersected ranged from ultramafic to intermediate composition.

The main Kalanbi anomaly (Anomaly D) was modelled as a series of steeply dipping linear bodies, which were thought to be magnetic horizons within a layered intrusive. Drilling showed the anomaly was a layered sequence of mafic/ultramafic rocks. Overall, geochemical analyses were disappointing with only slightly elevated Cu, Zn and Pb.

Aberfoyle Resources Ltd was granted EL 1312 to assess the potential for PGE within mafic/ultramafic intrusive rocks outlined by CRAE (see above). No analysis for PGE was carried out by CRAE. Seven drill holes which bottomed in basic intrusives were sampled and recorded no anomalous values. No samples from drillholes with anomalous Cu, Ni and Cr were located in the PIRSA Glenside Core Library. No follow-up work was carried out and the Licence was relinquished.

In 1994, Hawk Investments Ltd (EL 1404) decided the area warranted further investigation for PGE. Due to the lack of analyses for Cr from CRAE's drilling, 73 holes (26 angled and 47 vertical) totalling 2 381 m were drilled along one line over the main Kalanbi anomaly (CRAE’s Line 2). It was assumed that any PGE would be concentrated in thin Cr rich layers possibly associated with Cu and Ni sulphides.

No Cr rich layers were intersected. Cr levels were relatively low with only three drill holes returning Cr values >1000 ppm. 10 samples with high Cr, Cu or Ni values were assayed for Pt, Pd and Au. Maximum values returned were 40 ppb Pt and 32 ppb Pd. A further 27 samples with slightly elevated Cu values were assayed for Au only with no anomalous values returned.

Petrology showed that the intrusive body was layered with respect to orthopyroxene and clinopyroxene with rare cumulate textures. Hassan (1987) reports that the rarity of cumulate structures suggests that Cr and PGE may never have segregated out into cumulate layers.

PIMA Mining NL, in Joint Venture with Pasminco explored the Kalanbi area straddling CHILDARA and STREAKY Bay for intrusive-related nickel and platinoids between 1994–99. Ground magnetic surveys were carried out 75 km northeast of Ceduna over an area of Tertiary and Cainozoic cover overlying basement of interpreted Mulgathing Complex and syntectonic Palaeoproterozioc intrusive rocks. Drilling of resultant anomalies (46 aircore holes, totalling 1863 m) yielded, at one locality, elevated Ni and Cr values (maximum 0.26% and 0.15% respectively) in weathered ultramafic lithologies. Calcrete sampling returned anomalous Au, Pb and Cu associated with shear zones. Elevated Co, Ni, Zn and As were also detected, but it was suspected that the degree of supergene metal anomalism evident has been suppressed by the effects on groundwater circulation of impervious intervals within younger cover. No calcrete sampling was carried out to investigate specifically the Cr/Ni drillhole anomaly and no further open file work was reported after 1999.

Lignite and Coal

EL 847 was granted to Dampier Mining Co. Ltd (BHP) in 1981 to explore for lignite/coal within possible graben like structures and topographic depressions marginal to the Eucla Basin. Regional aeromagnetic and gravity data showed a major SW-NE fault which records a significant change in magnetic and gravity intensity across the fault, suggesting that the western block has been downthrown. Six holes (NR1–6) were drilled to test this theory. All drill holes intersected shallow crystalline basement. No geochemistry was carried out.

Heavy Minerals

Mapping by MESA extended the margins of the Eucla Basin and delineated a series of coastal dunes (Ooldea, Barton and Paling Ranges; e.g. Benbow, 1983, 1990a,b and 1992) which have potential for heavy mineral sands. Aberfoyle Resources Ltd were granted EL 1520 and 1521 in 1985 to explore for heavy minerals on CHILDARA. Landsat and topographic maps delineated possible palaeoshorlines which were tested by RC drilling. 97 holes were drilled along existing tracks, but the prospective Eocence Hampton Sandstone was not intersected. No samples showed visible heavy minerals and the Licences were surrendered.

National Mineral Sands, Swan Reach NL and Peko Exploration Ltd (Ceduna Joint Venture) were major explorers for heavy minerals within the Eucla Basin, particularly along the Ooldea Range in 1994. The JV encompassed 12 Exploration Licences. EL's 1598, 1600, 1601 and 1721 were located on CHILDARA.

Geomorphic mapping by Australian Photogeologic Consultants showed several possible Eocene shorelines on CHILDARA. Drilling results were disappointing with no significant heavy minerals intersected. Holes EB 92-99 on Traverse 10 (EL 1598) intersected partially cemented Hampton Sandstone with low heavy mineral content. EB 100-110 on Traverse 11 (EL 1601) intersected shallow basement with no Tertiary sediments. Holes EB 459-474 on EL 1598 did not intersect significant mineralisation. No exploration was carried out on EL 1721 (see Ferris, 1994, for a full summary of heavy mineral sand exploration within the Eucla Basin).

Other Commodities

In 1993 Dominion Mining and Oil NL tested drill cores at the PIRSA Glenside Core Library for phosphate. Carbonate bearing Cambrian Observatory Hill Beds were tested by the qualitative method outlined in BMR Record 1965/77. The best result was in Albala Karoo Bore (COOK). Stockdale Prospecting Ltd included CHILDARA as part of a statewide exploration programme for diamonds. EL 834 was part of a series of ELs covering the Gawler Range Volcanics. Aerial photo-interpretation outlined 14 anomalies on CHILDARA of which 12 (Anomalies 1–12) were outside the Licence. Anomaly 13 was an area of overflow from a tank. No kimberlitic indicator minerals were found in samples of Anomaly 14. In total, 67 samples were collected covering the Gawler Range Volcanics, however all samples were negative and the Licences were relinquished.

Previous drilling by CEC had outlined areas of kaolinised basement on STREAKY BAY and CHILDARA. Five RC holes were drilled on EL 1274 to collect kaolin samples for potential paper coating clay. Only three holes intersected kaolin and 19 samples were forwarded to Amdel for brightness and particle size distribution. Two samples were forwarded to CSIRO Minerals and Geochemistry Division, Perth for viscosity determination of the <2*m fraction.

Results showed the clay to have poor rheological properties, brightness (raw and fired) and a high salt content rendering the clay unsuitable for the paper and ceramic industry.

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