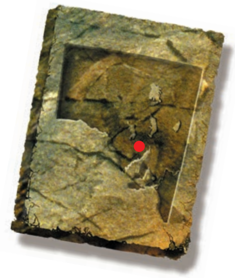

# The Cooyerdoo Granite: Paleo- and Mesoarchean basement of the Gawler Craton

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## Introduction

Until recently the Gawler Craton has been defined as a Neoarchean to Mesoproterozoic terrane, consisting of a Neoarchean to earliest Paleoproterozoic basement overlain and intruded by Paleoproterozoic to Mesoproterozoic volcanosedimentary basins and igneous suites (Daly and Fanning 1993; Daly, Fanning and Fairclough 1998; Hand, Reid and Jagodzinski 2007). The Neoarchean to earliest Paleoproterozoic basement occurs within two broadly equivalent c. 2555–2450 Ma volcanosedimentary and plutonic rock associations known as the Mulgathing Complex in the north and the Sleaford Complex in the south (Fig. 1; Daly and Fanning 1993; Swain et al. 2005; Reid and Daly 2009).

The existence of a Mesoarchean crustal component of the Gawler Craton has previously been inferred from Sm–Nd isotopic data (depleted mantle model ages, $T_{DM}$) and inherited zircons across the craton (Fig. 2; Daly and Fanning 1990; Daly and Fanning 1993; Fanning 2008).

Recent geochronology carried out by Geoscience Australia and the Geological Survey of South Australia as part of the Onshore Energy Security Program in the NE Eyre Peninsula provided the first direct dating of Mesoarchean crust in the Gawler Craton (Fraser et al. 2010; Fraser and Neumann 2010). Four samples of the Cooyerdoo Granite yielded crystallisation ages of c. 3150 Ma, demonstrating that at least parts of the Gawler Craton do indeed have a Mesoarchean basement

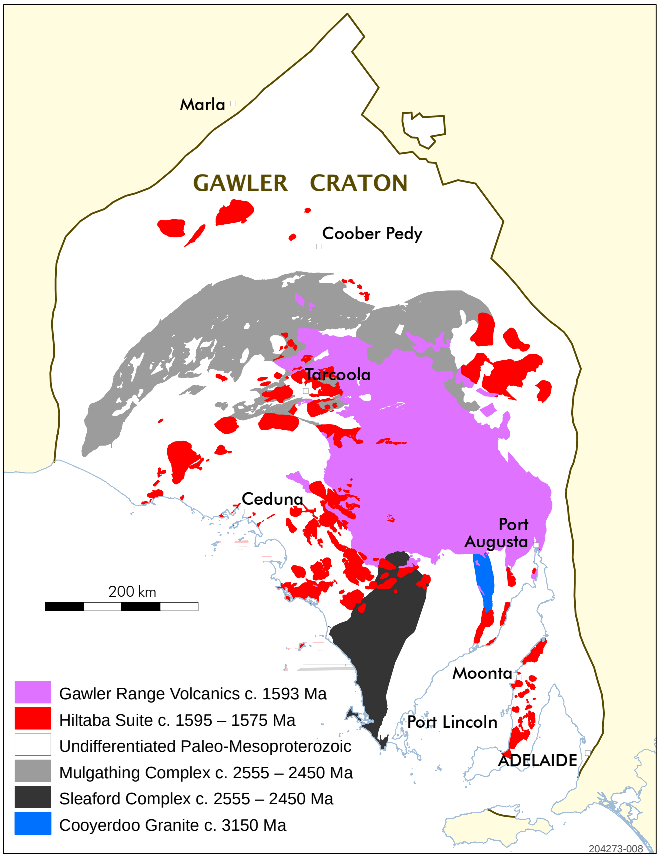


***Figure 1*** *Simplified solid geology map of the Gawler Craton.*

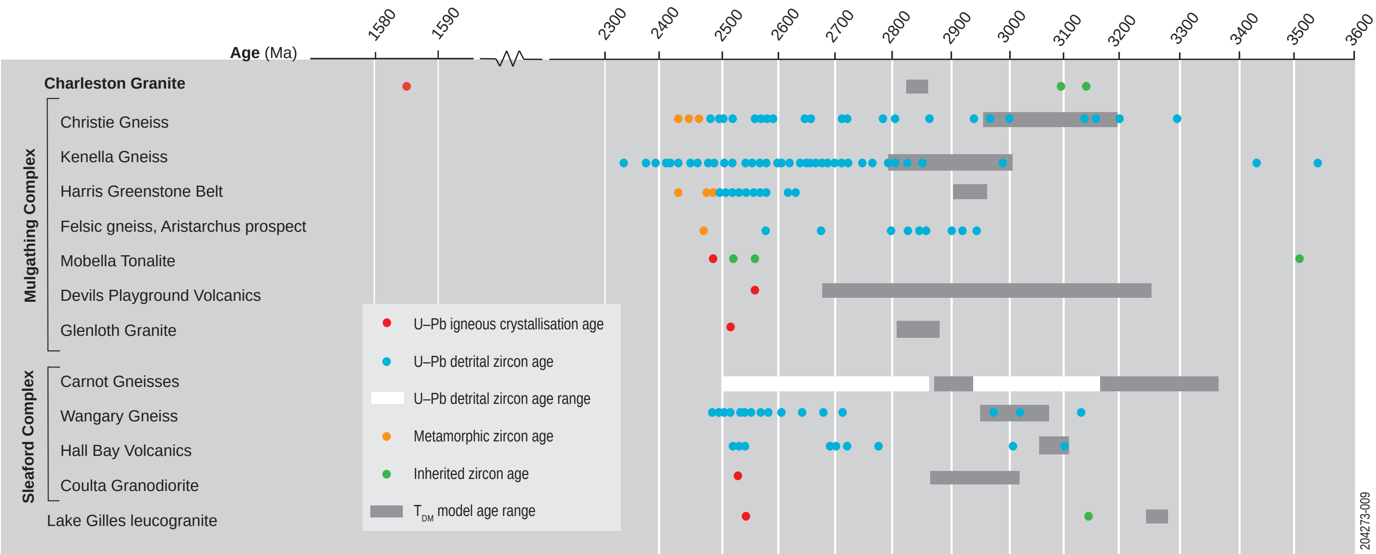


***Figure 2*** *U–Pb zircon and TDM model ages of the Charleston Granite, and Mulgathing and Sleaford complexes. Adapted from Swain et al. (2005), and containing data from Creaser and Fanning (1993), Swain et al.(2005), Jagodzinski, Reid and Fraser (2009) and Fraser et al. (2010).*

and providing new insights into the tectonic evolution of the craton (Fraser et al. 2010). This article provides a formal definition and description of the Cooyerdoo Granite and is presented in the context of ongoing mapping of the PORT AUGUSTA 1:250 000 map area.

## Previous studies

BHP was the first to informally use the term Cooyerdoo Granite (after Cooyerdoo Homestead) to refer to the granite outcrop directly to the east of the northern Middleback Range between Iron Knob and Iron Baron (Fig. 3) during exploration for iron ore in the late 1970s (Exploration Licence 266; Broken Hill Pty Co Ltd 1978). They described it as a syn-tectonic granite similar to the Narridy Creek granite (now differentiated into the Coolanie Gneiss and Carpa Granite) near Cleve on the Eyre Peninsula. The term was first used in publication by Parker, Fanning and Flint (1985) who referred to the Cooyerdoo Granite as a member of the Kimban-age Moody Suite (c. 1730–1700 Ma). In departmental mapping the granite has remained undifferentiated within 'Cleve Metamorphics' (Dalgarno et al. 1968) or Lincoln Complex

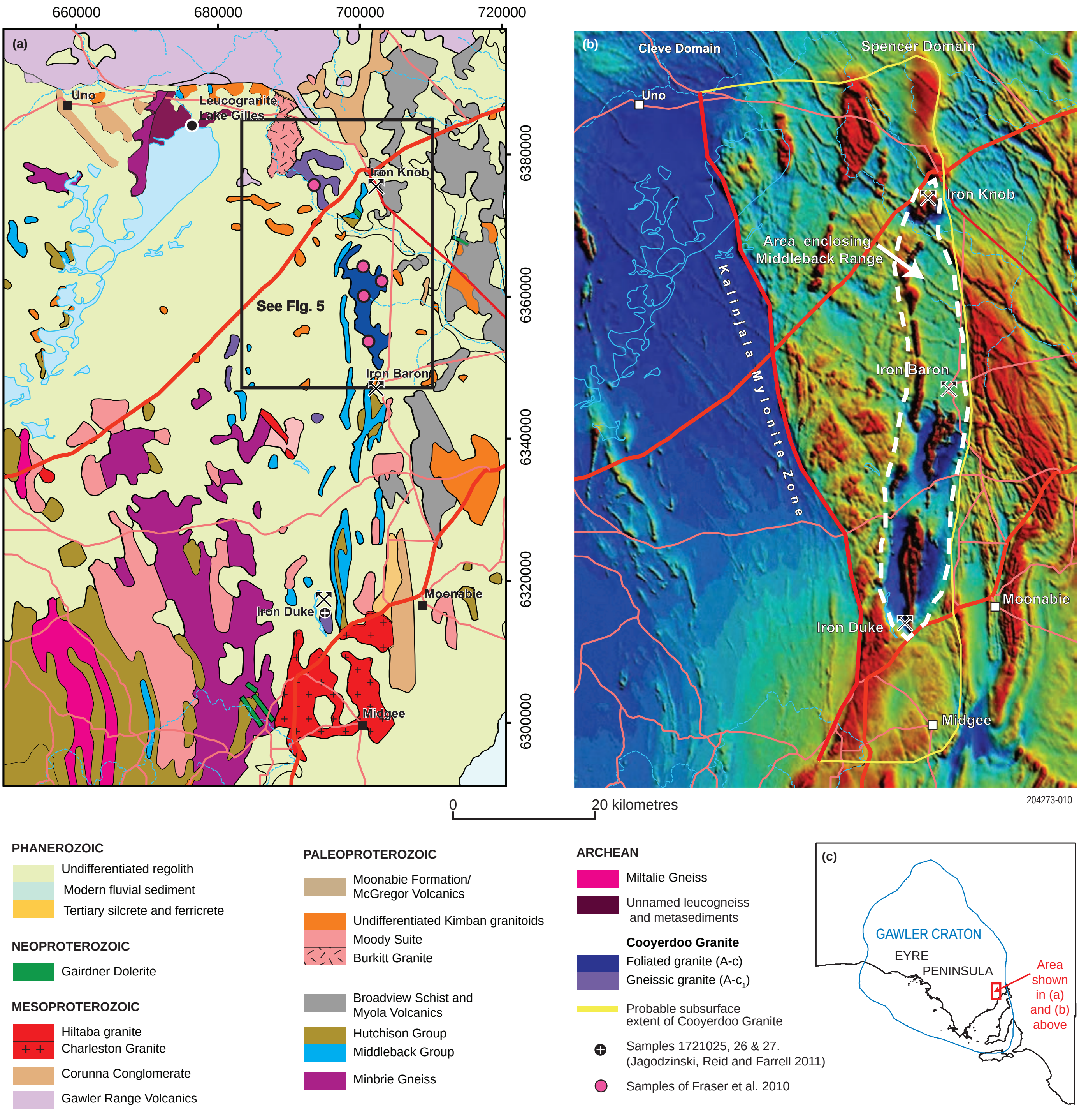


***Figure 3*** *(a)* ***Outcropping geology and*** *(b)* ***regional TMI of the NE Eyre Peninsula. Geographic extent of figure within the Gawler Craton is shown in*** *(c)*.

granitoids (Weste 1996). The recent study of Fraser et al. (2010) reporting Archean ages suggests the need for reconsideration of the definition of the Cooyerdoo Granite and its relationships with the surrounding rocks.

## Distribution and contact relationships

The Cooyerdoo Granite is exposed on the northeastern Eyre Peninsula flanking the entire length of the Middleback Range, extending over an area ~1600 km$^2$ (Fig. 3). It occurs as scattered outcrops of subhorizontal pavements and low tors. The largest area of continuous outcrop occurs to the east of the Middleback Range between Iron Knob and Iron Baron, extending over ~100 km$^2$. To the west of the Middleback Range there are a number of isolated outcrops of the Cooyerdoo Granite extending along the entire length of the ranges, from NW of Iron Knob to west of Iron Duke.

Few contact relationships are preserved between the Cooyerdoo Granite and the surrounding rocks. Its older age and the fact that the Cooyerdoo Granite flanks the Hutchison Group within the Middleback Range suggest that it is most likely basement to these metasedimentary rocks in this area. Exposures of deformed and commonly highly altered granite occur on the margins of the majority of the iron ore deposits in the Middleback Range, although the contact with the metasedimentary rocks are typically either unexposed or obscured by faulting (Miles 1955). The best exposure is on the eastern slope of Iron Baron where altered sheared potassium–feldspar–plagioclase–quartz–biotite granite is observed in structural contact with the Hutchison Group (Fig. 4). Although the age of these granites has most recently been inferred to be Kimban (Weste 1996), they were first interpreted by Miles (1955) as part of a 'granite complex' which he believed to be the basement to the Hutchison Group. Based on the lithological similarity between these leucogneisses and the Cooyerdoo Granite exposed elsewhere in the vicinity, it is likely that these basement rocks in the Middleback Range are also part of the Cooyerdoo Granite.

Recent U–Pb–Lu–Hf zircon and Sm–Nd isotope studies of the Hutchison Group show that the sediments within the Middleback Range have a maximum depositional age c. 2565 Ma and may in fact be Archean in age and comprise a package distinct from the Paleoproterozoic Hutchison Group metasedimentary rocks occurring elsewhere in the Gawler Craton (Szpunar et al. 2011). The detrital zircon age spectrum of the Cook Gap Schist, a member of the Middleback Group within the Middleback Range, contains a large 3150 Ma peak, suggesting that the Cooyerdoo Granite may have been exposed at the time the Cook Gap Schist was deposited (Szpunar et al. 2011).

*__Figure 4__ Contact between granite gneiss (west) and tightly folded iron formation of the Hutchison Group (east) at Iron Monarch Mine. View looking south.* (Photo 407564)

The contact between the Cooyerdoo Granite to the east of the Middleback Range and the Myola Volcanics and Broadview Schist, a sequence of Paleoproterozoic (c. 1790 Ma) terrestrial volcanics and sediments, is not exposed. In the regional total magnetic intensity (TMI) image it is defined by a sharp north-striking boundary between the low magnetic response of the Cooyerdoo Granite and the high magnetic response of the Myola Volcanics (Fig. 3b), which is parallel with the Kimban-aged (c. 1730–1700 Ma) fabric in the younger rocks and is likely to be a sheared boundary formed during the Kimban Orogeny.

The isolated outcrops of Cooyerdoo Granite to the west of the Middleback Range occur within an area of largely undifferentiated variably deformed Kimban-age granitoids and dolerites, Hutchison Group metasediments, and unnamed Archean leucogneiss and metasediments (Reid, McAvaney and Fraser 2008; Fig. 3). No contacts between the Cooyerdoo Granite and these rocks were observed to outcrop in the field, but in the TMI image the highly magnetic Kimban-aged Burkitt Granite appears to intrude the Cooyerdoo Granite, with the SE boundary modified by later shearing (Fig. 3).

The Cooyerdoo Granite is intruded by mafic dykes (their relationship with the granite is discussed further below) and is crosscut by undeformed aplite and pegmatite dykes of unknown age.

## Type locality

The type locality for the Cooyerdoo Granite (map symbol A-c) is defined as the area extending ~100 m radially around the point 701050mE, 6363550mN (GDA 94), ~4.5 km ESE of Cooyerdoo Hill on Cooyerdoo Station (Fig. 5). Geochronology and Sm–Nd isotopic sample 2008-371-080 (Fraser et al. 2010) lies within this type locality. The reference locality for the gneissic Cooyerdoo Granite (map symbol A-c$_1$; see below) is defined as the area extending ~100 m radially around the point 692300mE, 6376800mN (GDA 94), ~8 km WNW of Iron Knob on Corunna Station (Fig. 5). Geochronology and Sm–Nd isotopic sample 2008-371-085 (Fraser et al. 2010) lies within this reference locality.

## Petrology

The Cooyerdoo Granite is medium-grained and composed of plagioclase, perthitic orthoclase, quartz, minor biotite and opaque oxide, and accessory zircon and apatite (Fig. 6; Purvis 2010). The degree of deformation experienced by the Cooyerdoo Granite increases regionally from east to west, grading from weakly foliated granite (A-c) to the east of the Middleback Range to gneissic granite (A-c$_1$) west of the Middleback Range. The boundary between these two

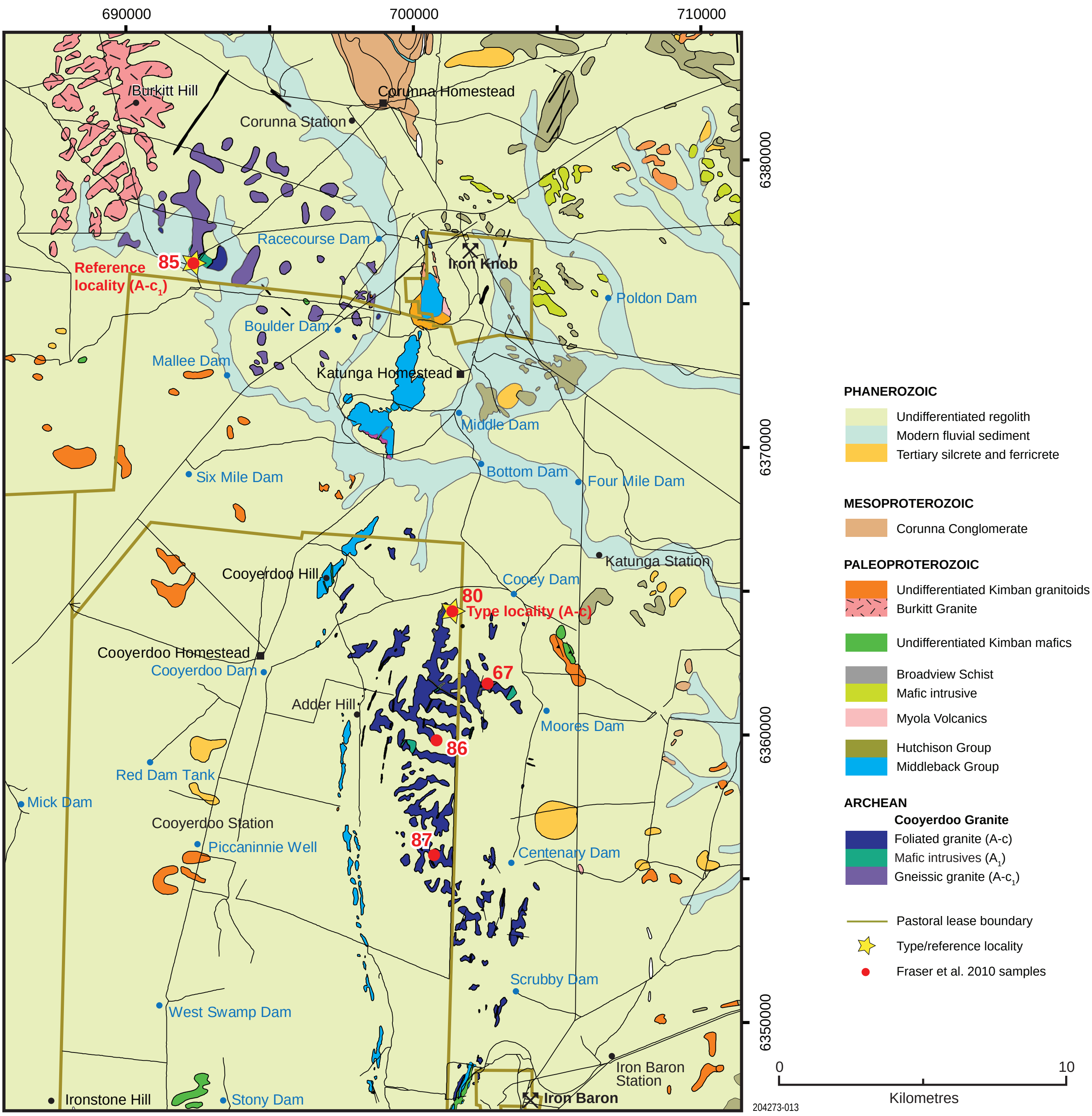


*Figure 5 Detailed geology of outcropping Cooyerdoo Granite surrounding the northern Middleback Range, showing the proposed type and reference localities. Map area is located in Figure 3.*

structural domains appears to be gradational, as at some localities directly to the west of the Middleback Range the texture of the Cooyerdoo Granite appears transitional between the weakly foliated and gneissic end-members.

The foliated granite is recrystallised and contains a sporadically developed weak to moderate foliation, defined by biotite and quartz ribbons wrapping feldspar, which strikes NNE and dips steeply to moderately to the east (Figs 7a, 8). The granite contains discontinuous, isoclinally folded feldspar and quartz-rich leucocratic bands (Fig. 7b) and biotite-rich schlieren (Fig. 7c), often elongate parallel to the foliation. Granodioritic compositional banding may be relict magmatic layering (Fig. 7d).

The gneissic granite is typified by a fabric ranging from gneissic to locally mylonitic. It contains gneissic compositional banding defined by orange-pink leucocratic bands and blue-grey biotite-rich bands (Fig. 7e). It contains a S to S–C fabric defined by elongate plagioclase and microcline, quartz lenses and biotite lamellae (Purvis 2010) and is tightly to isoclinally folded. Augen gneiss is developed locally, consisting of rounded plagioclase augen (up to 5 mm) and microcline megacrysts (up to 10 mm) wrapped by anastomosing ribbons of quartz and biotite lamellae with a S–C fabric (Fig. 7f).

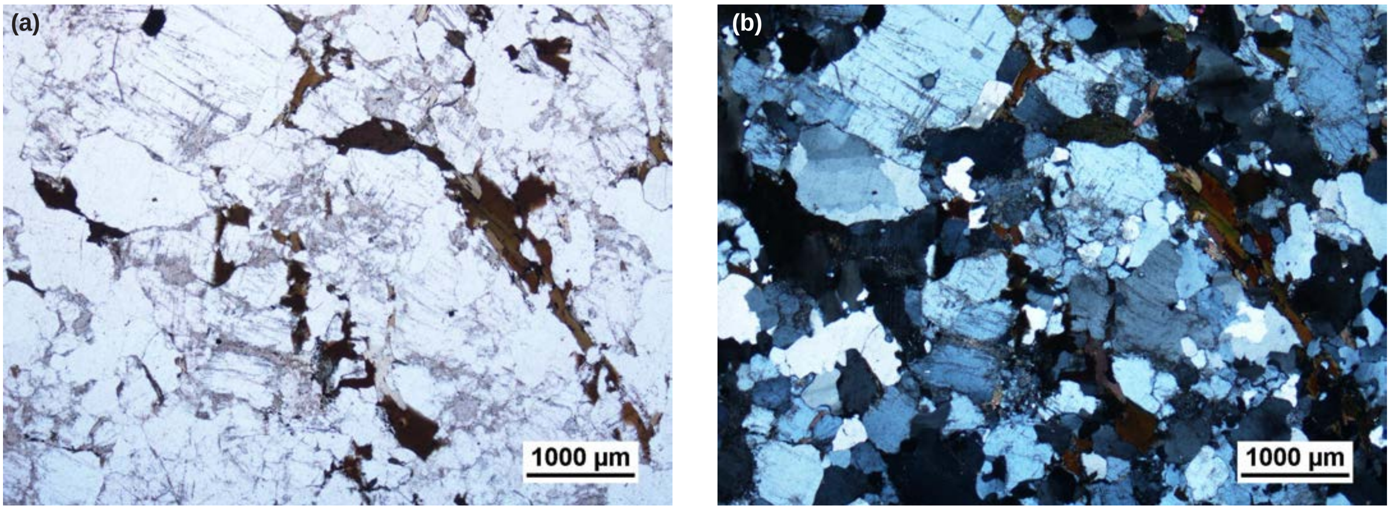


***Figure 6*** *Photomicrograph of Cooyerdoo Granite in **(a)** plane and **(b)** crossed-polarised light showing weakly foliated pleochroic brown biotite, partly sericitised orthoclase, plagioclase and anhedral quartz grains.* (Photos 410551, 410552)

## Geochemistry

The Cooyerdoo Granite plots within the granite and trondhjemite fields on a CIPW normative Ab–An–Or classification diagram (Fig. 9) and is a calcalkaline I-type granite (Chappell and White 2001; Le Maitre et al. 1989). $SiO_2$ contents range from felsic to intermediate (67–75 wt%). The Cooyerdoo Granite is weakly peraluminous, with an ASI (alkali saturation index) ranging from 1.00 to 1.13 (Frost et al. 2001), high in sodium (average 4.2 wt % $Na_2O$) and high in potassium (average 4.1 wt % $K_2O$). The major element oxides show linear trends on Harker diagrams, with $Al_2O_3$, CaO, $Fe_2O_3$ tot, MgO, MnO, $P_2O_5$ and $TiO_2$ decreasing, and $K_2O$ and $Na_2O$ increasing with increasing $SiO_2$.

When the trace elements are plotted normalised to primitive mantle, the Cooyerdoo Granite is elevated in large ion lithophile elements (e.g. Cs, Rb, K), Th and U with respect to the high field strength elements (e.g. Zr, Nb) and rare earth elements (REE; Fig. 10a). It is depleted in Ba, Nb, Sr, P and Ti, and enriched in Pb. When the REE are plotted normalised to chondrite, the Cooyerdoo Granite is moderately fractionated in light REE (average LaN/SmN = 6.52), depleted in Eu (average Eu/Eu* = 0.63), and has a fairly flat heavy REE signature (average GdN/YbN = 2.57; Fig. 10b). The trace and REE patterns of the Cooyerdoo Granite are similar to average Archean alkaline and peraluminous granites (Sylvester 1994), and igneous and meta-igneous lithologies of the Neoarchean Sleaford and Mulgathing Complexes of the Gawler Craton (Swain et al. 2005; Fig. 10).

## Geochronology and Sm–Nd isotopes

U–Pb zircon and Sm–Nd isotopic analysis has been carried out on four samples of the Cooyerdoo Granite from the exposure to the east of the Middleback Range (Fig. 3; Fraser et al. 2010). Three of these yielded a weighted mean age of 3157 ± 2 Ma and the fourth sample a slightly younger age of 3149 ± 3 Ma, most likely due to ancient Pb loss. Three samples contained inherited zircon aged c. 3215, 3240, 3250, 3300 and 3310 Ma. Importantly, no metamorphic zircon or isotopic disturbance of Sleafordian (c. 2450 Ma), Cornian (c. 1850 Ma), Kimban (c. 1730 Ma) or Hiltaba (c. 1590 Ma) age was detected. A sample of the gneissic Cooyerdoo Granite from NW of Iron Knob yielded a weighted mean age of 3151 ± 3 Ma, an inherited zircon aged 3176 ± 3 Ma, and four grains aged c. 2500 Ma interpreted to have grown during a high grade metamorphic or partial melting event (Fraser et al. 2010). No Cornian, Kimban or Hiltaba age zircon was detected. All dated samples of the Cooyerdoo Granite yielded similar Nd isotopic results with $\varepsilon_{Nd}$ (3150 Ma) values between –1 and +1 and $T_{DM}$ between 3400 and 3200 Ma.

## Deformational history

Metamorphic zircon growth at c. 2500 Ma in the gneissic Cooyerdoo Granite to the northwest of Iron Knob slightly predates the c. 2470–2420 Ma Sleafordian Orogeny which affected the Sleaford and Mulgathing complexes (Fanning, Reid and Teale 2007; Jagodzinski, Reid and Fraser 2009) and may represent a distinct event (Reid and Hand 2012), or a previously unobserved early phase of the Sleafordian Orogeny. It seems likely that the period of c. 2500 Ma zircon growth was the major fabric-forming event experienced by the Cooyerdoo Granite, responsible for the foliation and gneissosity, E–W deformational gradient and fabric-parallel isoclinal folding. Although no metamorphic zircon was detected in the weakly foliated Cooyerdoo Granite to the east of the Middleback Range, it is possible that this fabric also formed c. 2500 Ma, but that unlike the gneissic Cooyerdoo Granite the metamorphic grade did not reach temperatures high enough to grow metamorphic zircon.

There was no metamorphic zircon growth in the Cooyerdoo Granite during the Kimban Orogeny, despite a strong fabric of this age in the surrounding Paleoproterozoic sediments, such as the Hutchison Group, Broadview Schist, Myola Volcanics and Kimban-age granite gneiss (Parker 1993). It may be that the Cooyerdoo Granite was at a relatively high crustal level and did not experience temperatures high enough to undergo metamorphic zircon growth (Fraser et al. 2010; Reid, McAvaney and Fraser 2008).

The orientation of the fabric in the Cooyerdoo Granite and mafic dykes strikes NNE and is steeply dipping, and on a stereogram appears as a distinct population from the Kimban fabric in the surrounding Paleoproterozoic sediments and granites which locally strike WSW (Fig. 8). It is uncertain whether the present geographical orientation of the fabric in the Cooyerdoo Granite represents the original orientation of the c. 2500 Ma fabric, as it is quite likely it experienced some degree of rotation or overprinting during the Kimban Orogeny.

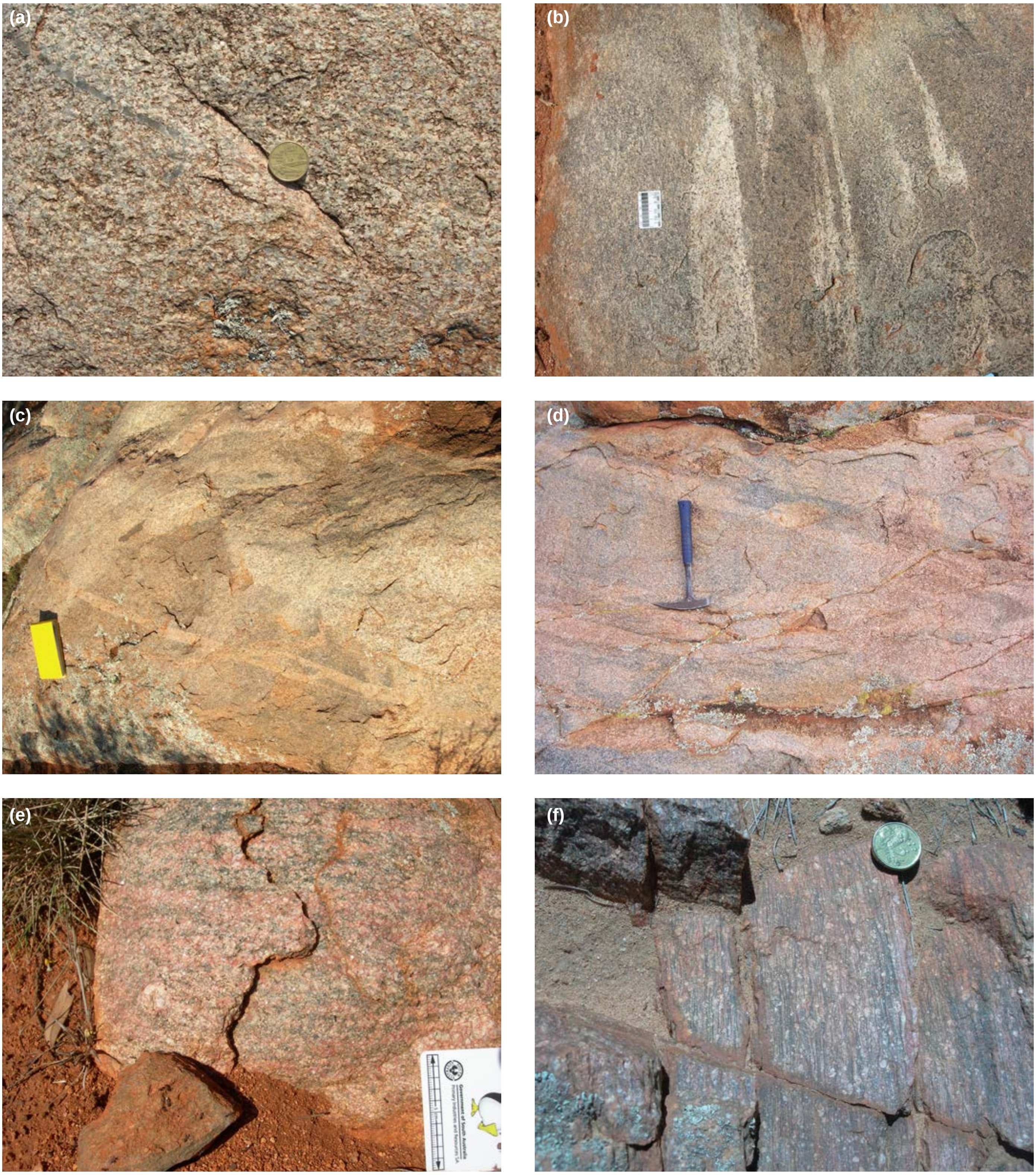


*Figure 7 Field photos of the Cooyerdoo Granite.* ***(a)*** *Weakly deformed granitic texture.* ***(b)*** *Leucosomes in granite aligned with the foliation (looking south).* ***(c)*** *Schlieren in granite crosscut by undeformed aplitic dyke (looking NE).* ***(d)*** *Shallowly dipping granodioritic compositional layering, possibly relict magmatic layering (looking SW).* ***(e)*** *Gneissic fabric (looking east).* ***(f)*** *Augen gneissic fabric (looking north).*
*(Photos 410553–410558)*

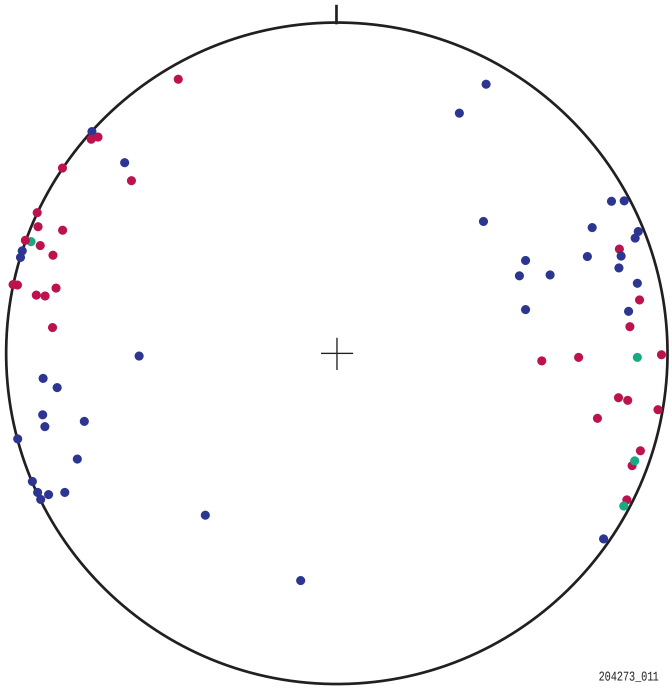


*Figure 8* *Equal area stereographic projection of poles to fabric in Cooyerdoo Granite and amphibolite mafic intrusive compared to Kimban fabric in neighbouring exposures of Hutchison Group, Broadview Schist, Wandearah Formation and Kimban granitic gneiss. Plotted using GeoOrient (Holcombe 2009).*

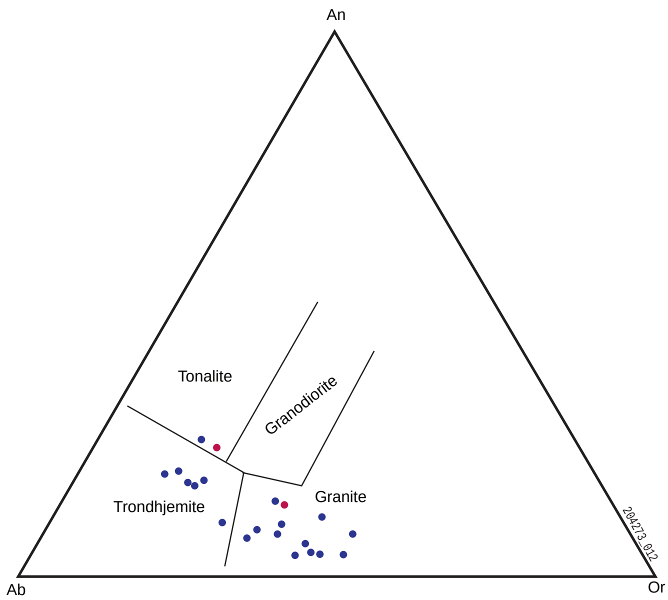


*Figure 9* *Ab–An–Or classification diagram displaying data for the Cooyerdoo Granite and c. 3250 Ma granitic gneiss west of the southern Middleback Range.*

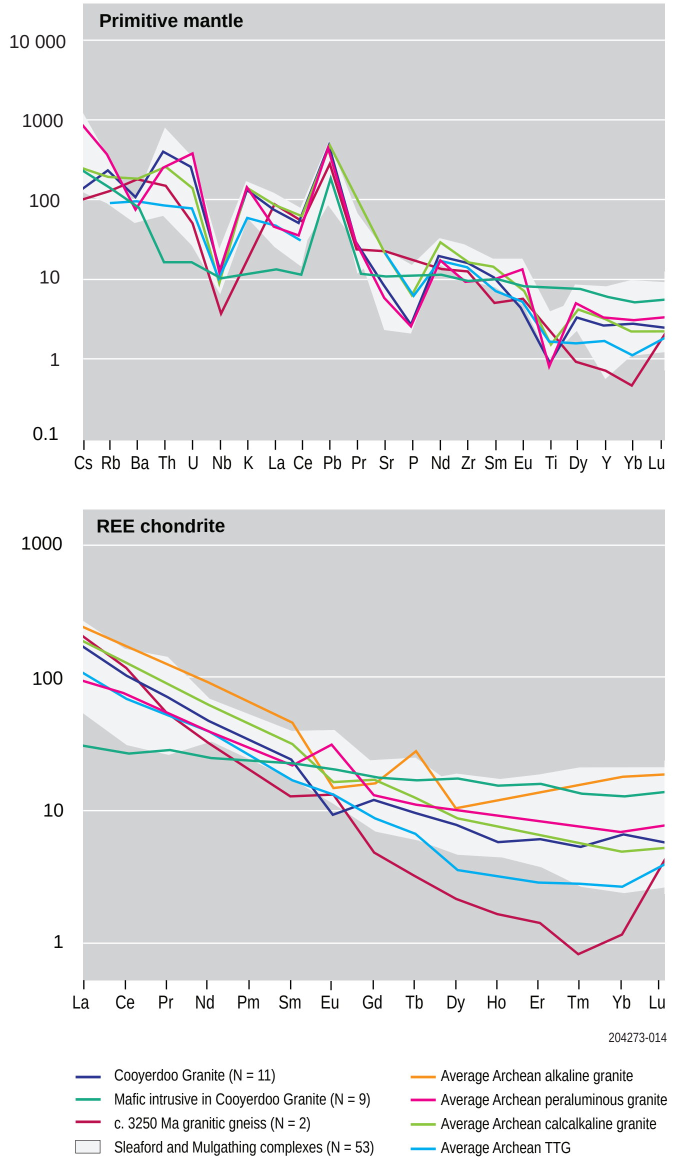


***Figure 10*** ***(a)*** *Trace element spidergram normalised to primitive mantle (Sun and McDonough 1989) and* ***(b)*** *REE spidergram normalised to chondrite (Bonython 1984) of the Cooyerdoo Granite and mafic intrusive, and c. 3250 Ma granitic gneiss compared to felsic igneous units of the Sleaford and Mulgathing complexes) and average values for Archean alkaline, peraluminous and calcalkaline granite plutons and Archean TTG (Sylvester 1994). Geochemical data derived from (Goodwin 2010; Schaefer 1998; Swain et al. 2005; Turner et al. 1993) and South Australian Resources Information Geoserver (SARIG). Plotted in GCDkit (Janousek, Farrow and Erban 2008).*

## Mafic intrusives in the Cooyerdoo Granite

The Cooyerdoo Granite to the east of the Middleback Range contains elongate mafic bodies which are typically orientated subparallel to the fabric in the granite (map symbol $A_1$; Fig. 5). They are exposed as low linear rubbly outcrops within the Cooyerdoo Granite (Fig. 11a), but the contact between the mafics and the granite is nowhere exposed. Note that the narrow linear, NW-trending anomalies in the aeromagnetic data (Fig. 3) are attributed to Neoproterozoic mafic dykes of the Gairdner Dolerite (Weste 1996).

The mafic rocks are dolerites, composed of green hornblende and plagioclase, large aggregates of opaque oxide, sparse quartz and accessory apatite (Fig. 11b; Purvis 2010). The deformation and metamorphism of the dolerites varies from recrystallised to weakly foliated to amphibolitic, and the fabric is parallel with the fabric in the granite (Fig. 8). No crosscutting relationships between the granite and mafics are preserved, but the mafics presumably intruded as dolerite dykes within the Cooyerdoo Granite. To the west of the Middleback Range there appear to be similar mafics associated with the Cooyerdoo Granite, although their identification is obscured by the presence of a younger suite of Kimban-age dolerites (Goodwin 2010; Parker and Flint 1983).

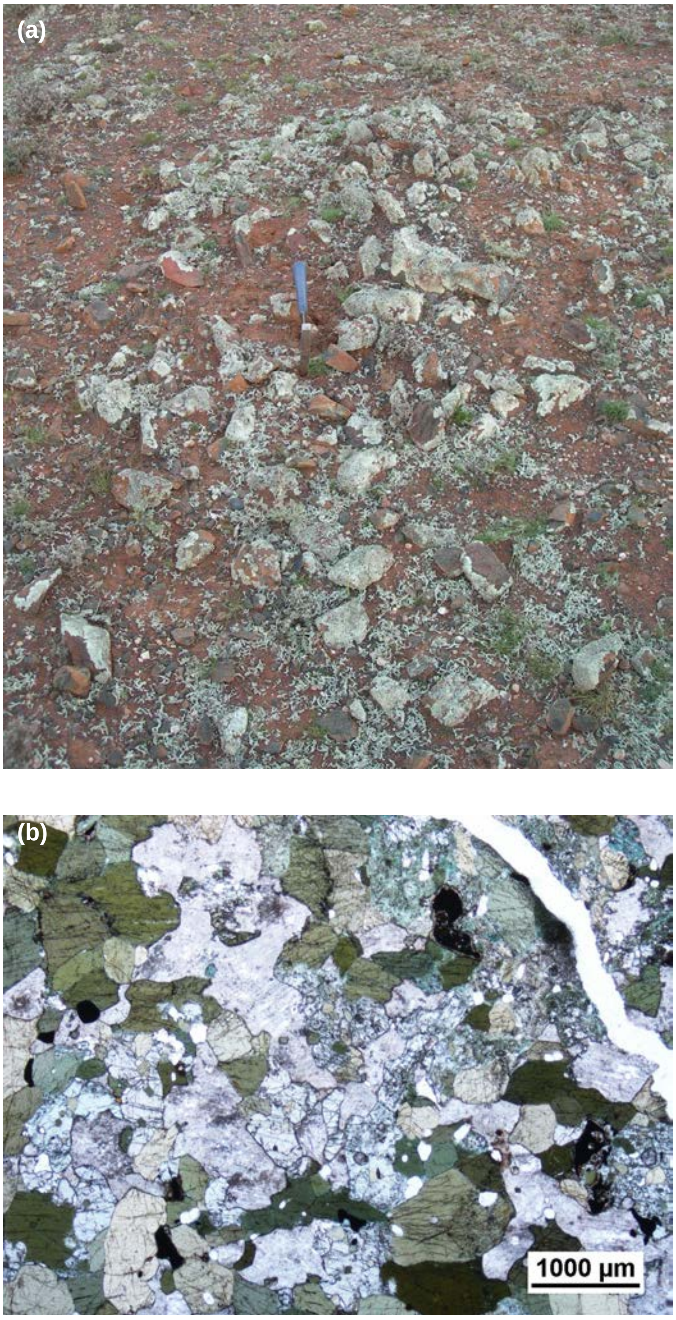


*Figure 11 Amphibolite mafic intrusive within the Cooyerdoo Granite. **(a)** Outcrop. **(b)** Photomicrograph (crossed-polarised light) showing poikilitic green subhedral hornblende with small quartz inclusions, pale green clinopyroxene and sericite-replaced plagioclase.*
*(Photos 410559, 410560)*

Given that the dykes contain the same fabric as the granite they must have intruded sometime between crystallisation of the granite at c. 3150 Ma and deformation at c. 2500 Ma, however, they have not yet been dated directly. They may be a late stage co-magmatic phase with the Cooyerdoo Granite, or they may have intruded in an early stage of the c. 2500 Ma event which is interpreted to have formed the fabric in the Cooyerdoo Granite. If the latter is the case, then these dykes would be approximately coeval with felsic magmatism to the west of the southern Middleback Range (Goodwin 2010; Jagodzinski, Reid and Farrell 2011) and with the leucogneiss at Lake Gilles (Fraser et al. 2010).

The mafics are calcalkaline to high-K calcalkaline. The majority of the mafics have a fairly flat trace element pattern when compared to primitive mantle, with enrichment in Cs, Rb, Ba and Pb, and a flat REE pattern (Fig. 10). Amphibolite samples associated with the Cooyerdoo Granite to the west of the Middleback Range yield a $\varepsilon_{Nd}$ between –0.21 and –9.58 assuming a 2500 Ma magmatic age, and $\varepsilon_{Nd}$ between –0.15 and +3.27 assuming a magmatic age of 3150 Ma. They have a $T_{DM}$ between 3080 and 3321 Ma (Goodwin 2010), suggesting that they incorporated some component of older crustal material if they crystallised between 3150 and 2500 Ma.

## Source of the Cooyerdoo Granite

The evolved isotopic signature ($T_{DM}$ 3400–3200 Ma) and inherited zircon data (≤3315 Ma) for the Cooyerdoo Granite suggest it is the product of melting of Paleoarchean crust which was likely to have been tonalite–trondhjemite–granodiorite (TTG) in composition (Fraser et al. 2010).

Recent *PACE* geochronology collaboration with Centrex Metals has identified a c. 3250 Ma granitic gneiss west of the southern Middleback Range (Fig. 3) which may be the source of the Cooyerdoo Granite (Jagodzinski, Reid and Farrell 2011). The gneiss is medium grained and composed of quartz, plagioclase, potassium feldspar, biotite and hornblende (Fig. 12).

Sample 1721026 from 7.5 km WNW of Iron Duke gave a weighted mean $^{207}Pb/^{206}Pb$ magmatic age of 3250 ± 8 Ma and a weighted mean $^{207}Pb/^{206}Pb$ age of 2507 ± 5 Ma, interpreted to be the metamorphic age (Jagodzinski, Reid and Farrell 2011). A xenolith (<5m wide) of a similar granite gneiss (1721025) from within a pink granite 5 km SW of Iron Duke contained zircons with cores with a weighted mean $^{207}Pb/^{206}Pb$ magmatic age of 3249 ± 4 Ma. The zircon cores were rimmed by zircon with a weighted mean $^{207}Pb/^{206}Pb$ age of 2507 ± 6 Ma, and are interpreted to represent the date of high-grade metamorphism and fabric development. This age of metamorphism of the 3250 Ma granitic gneiss is within error of that experienced by the Cooyerdoo Granite (Fraser et al. 2010). The host rock enclosing the xenolith was not dated, but is interpreted to be equivalent to another sample of fine to medium grained pink quartz–potassium feldspar–plagioclase–biotite leucogranite (1721027) in close vicinity to the enclave which gave a magmatic age of 1737 ± 5 Ma and inheritance at 2505 ± 7 Ma (Jagodzinski, Reid and Farrell 2011).

The outcropping extent of this Paleoarchean rock is uncertain, and it occurs within an area of largely

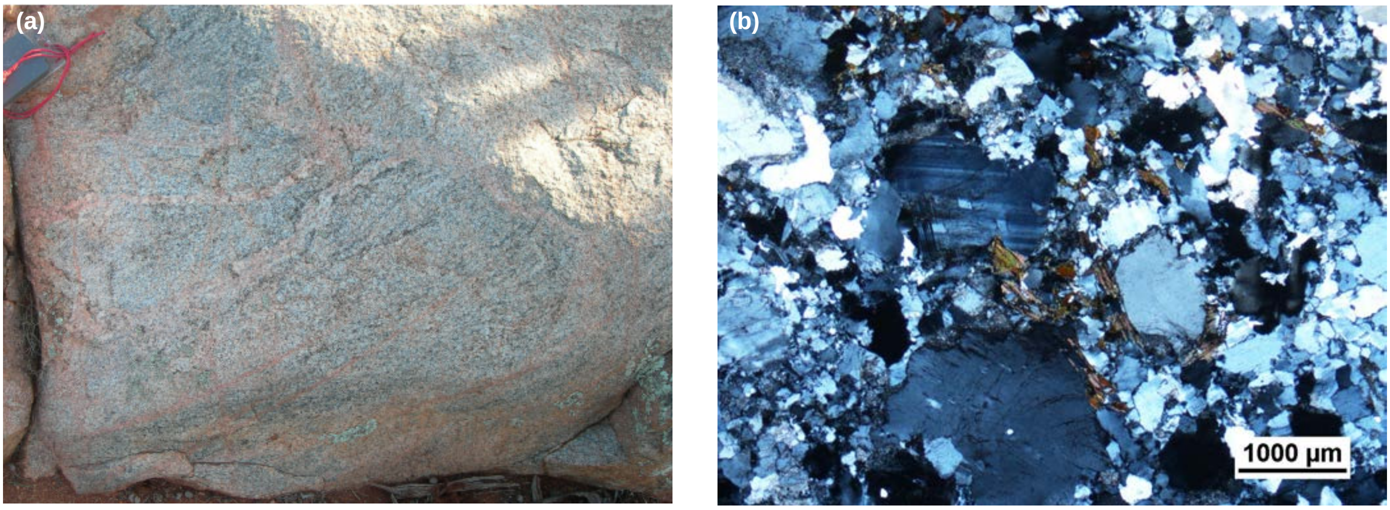


***Figure 12** c. 3250 Ma granitic gneiss west of the southern Middleback Range. **(a)** Outcrop. **(b)** Photomicrograph (crossed-polarised light) showing scattered pleochroic biotite, plagioclase (showing multiple twins), orthoclase and anhedral quartz grains. (Photos 410561, 410562)*

undifferentiated granite, granite gneiss, dolerite and amphibolite which includes Cooyerdoo Granite and Kimban intrusives.

The c. 3250 Ma granitic gneiss has a granitic to tonalitic composition on an Ab–An–Or normative diagram (Fig. 9; Goodwin 2010). It has a depleted REE signature, especially in the heavy REE, and a positive Eu anomaly. Its trace and REE signatures are similar to average Archean TTG (Fig. 10). The c. 3250 Ma granitic gneiss plots close to the depleted mantle curve on a neodymium evolution diagram, indicating that it formed from the fractionation of a mantle-derived magma source (Goodwin 2010).

## Subsurface extent of the Cooyerdoo Granite

Isotopic and inherited zircon data suggest that the Cooyerdoo Granite extends in the subsurface well beyond its known outcrop extent. The Kimban-aged Burkitt Granite, exposed directly to the west of the gneissic Cooyerdoo Granite (Fig. 3), has an evolved $\varepsilon_{Nd}$ signature which may suggest partial derivation or incorporation of the Cooyerdoo Granite or another Paleo-Mesoarchean granitoid (Fraser et al. 2010; Neumann 2001). The informally named Sleaford Complex aged Lake Gilles leucogranite, which is exposed ~15 km to the west of the outcropping Cooyerdoo Granite (Fig. 3), contained three inherited zircons aged c. 3150 Ma and yielded a $T_{DM}$ of 3250 Ma, also suggesting partial derivation from or incorporation of the Cooyerdoo Granite (Fraser et al. 2010). The Hiltaba-aged Charleston Granite cropping out to the south of the Iron Duke in the Middleback Range, just beyond the southernmost exposure of the Cooyerdoo Granite (Fig. 3), was found to contain an inherited zircon grain with an age in excess of c. 3150 Ma and yielded a $T_{DM}$ of 2840 Ma, suggesting it was partially derived from or incorporated Cooyerdoo Granite at depth (Creaser and Fanning 1993; Fraser et al. 2010). Farther south, igneous units of the Sleaford Complex (Coulta Granodiorite and Hall Bay Volcanics; Fig. 2) in the southern Eyre Peninsula have evolved $T_{DM}$ ages ranging from c. 2700 to c. 3200 Ma, (Cowley and Fanning 1992; Swain et al. 2005), also likely due to the incorporation of Mesoarchean or Paleoarchean crust.

Fraser et al. (2010) suggest that the Cooyerdoo Granite, or equivalent Mesoarchean crust, defines a wedge whose western boundary may extend to the Kalinjala Mylonite Zone (KMZ), a transpressional shear zone formed during the Kimban Orogeny which in the northern Eyre Peninsula is defined by a major magnetic boundary between the Spencer and Cleve domains (Reid, McAvaney and Fraser 2008; Fig. 3). The presence of Cooyerdoo Granite is less certain to the east, being obscured by Paleoproterozoic sediments, and to the north beneath the Mesoproterozoic Gawler Range Volcanics. The inferred extent of the Cooyerdoo Granite to the east of the KMZ correlates with the western boundary of the South Australian Heat Flow Anomaly (SAFHA) in the eastern Gawler Craton, and it may be that the Mesoarchean crust is the source of high heat-producing granites in the eastern Gawler Craton (Fraser et al. 2010).

## Conclusion

The Cooyerdoo Granite represents the first Mesoarchean crust outcropping in the Gawler Craton, and adds a further 600 million years to the geological history of South Australia. It also provides the first evidence of possible metamorphism in the northern Eyre Peninsula at c. 2500 Ma, although the structural nature of this deformation is uncertain due to likely rotation during the Kimban Orogeny. The Cooyerdoo Granite is a calcalkaline I-type granite and was derived from the melting of 3250 Ma granitic crust with TTG affinities. It underlies the Middleback Range, where it is basement to the Hutchison Group and extends westwards in the subsurface to the Kalinjala Mylonite Zone, and may underlie the SAHFA.

Further mapping in the region hopes to determine the outcropping extent of the 3250 Ma granitic gneiss from which the Cooyerdoo Granite is derived, and potentially uncover an older sedimentary unit into which these Mesoarchean granitoids intruded. Isotopic analysis is in progress on the younger crustally derived Kimban- and Hiltaba-aged granites to the east of the Cooyerdoo Granite, to determine whether it potentially extends in the subsurface beneath the cover of the

Paleo- and Mesoproterozoic sediments towards the eastern margin of the craton and the SAHFA.

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