# Technical papers

## A new lithostratigraphic scheme for the northeastern Murchison Domain, Yilgarn Craton

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### Abstract

A new lithostratigraphic scheme for the northeastern part of the Murchison Domain, Yilgarn Craton, is presented as a working model, based on recent mapping and geochronological results, and previously available geochronology. These data suggest that previously published schemes require revision. In the new scheme, greenstones are collectively referred to as the Murchison Supergroup and divided into three groups: i) the 2814 – 2800 Ma Norie Group of mafic volcanic rocks, felsic volcaniclastic sandstones and banded iron-formation; ii) the 2785 to 2734 Ma Polelle Group of mafic volcanic rocks, felsic volcanic and volcaniclastic sedimentary rocks and banded iron-formation; and iii) the 2724 – 2700 Ma Glen Group of coarse clastic sedimentary rocks and komatiitic basalt. A fourth, older (c. 2950 Ma) group is present in the Mount Gibson – Golden Grove area to the south, based on previous geochronological work. Evidence of a similar age event in the current mapping area is indicated by the widespread presence of xenocrystic and detrital zircons of this age in younger volcanics and granitic rocks; however, outcrops of rocks of this age have yet to be identified.

Deposition of the supracrustal rocks was followed by widespread and voluminous emplacement of granitic rocks from 2716 to 2592 Ma. The granitic rocks are divided into: the Big Bell Suite of 2716–2694 Ma tonalitic to monzogranitic rocks; the 2686–2665 Ma Tuckanarra Suite of granodioritic to monzogranitic rocks; and the 2660–2640 Ma Jungar Suite of dominantly K-feldspar-porphyritic monzogranites. Post-tectonic granites of the 2637–2602 Ma Bald Rock Supersuite are divided into the monzogranitic Walganna Suite and the Wogala Suite of fluorite-bearing alkaline granite.

**KEYWORDS:** Yilgarn Craton, Youanmi Terrane, Murchison Domain, Murchison Supergroup, Archean tectonics, lithostratigraphy, geochronology, structural geology

### Introduction

The northeastern Murchison Domain forms part of the Youanmi Terrane within the Archean Yilgarn Craton (Cassidy et al., 2006; see inset to Fig. 1). The domain has long been recognized as having had a long and complex history, as recorded by greenstone ages of up to c. 3034 Ma, xenocrystic zircons in granites with ages older than 4000 Ma, and granitic rocks that range in age from c. 3050 to c. 2919 Ma pegmatite-banded gneisses to c. 2630 Ma post-tectonic monzogranites (Pidgeon and Wilde, 1990; Watkins et al., 1991; Wiedenbeck and Watkins, 1993; Mueller et al., 1996; Schiøtte and Campbell, 1996; Yeats et al., 1996; Nelson et al., 2000; Pidgeon and Hallberg, 2000).

Previous studies produced conflicting litho-stratigraphic schemes for both greenstones and granitic rocks, based on regional mapping with only local and limited precise geochronology (e.g. Watkins and Hickman, 1990; Pidgeon and Wilde, 1990; Schiøtte and Campbell, 1996; Pidgeon and Hallberg, 2000). Wang (1998) provided a wealth of geochronological data, but within a limited mapping framework, and Champion and Cassidy (2002) provided geochemical data on granitic rocks at a reconnaissance scale with limited specific geochronology.

In 2005, the Geological Survey of Western Australia (GSWA) initiated a regional 1:100 000-scale mapping program, which has utilized orthorectified aerial photography, newly acquired aeromagnetic, radiometric, and gravity data, a variety of new remote-sensing data including ASTER and Landsat TM, and produced many new SHRIMP U–Pb zircon dates. This developing dataset has brought about a re-evaluation of the lithostratigraphy of the domain, as well as its crustal evolution (Spaggiari, 2006; Van Kranendonk, 2008). Based on these results, as well as on previous work (particularly that of Pidgeon and Hallberg, 2000, and Wang, 1998), this paper reviews previous lithostratigraphic schemes and presents a new lithostratigraphic scheme as a working model for the northeast Murchison Domain. All greenstones in the Murchison Domain have been metamorphosed but protoliths are readily identifiable in most instances, and protolith names are used in this paper to assist in the understanding of the stratigraphic framework.

### Previous lithostratigraphy

Supracrustal assemblages of the western Yilgarn Craton were initially subdivided into a four-part scheme for lithologies in the 'Murchison Province' and north 'Southern Cross Province' (Hallberg et al., 1976; Muhling and Low, 1977; Baxter, 1982; Elias, 1982; Baxter et al., 1983; Lipple et al., 1983; Baxter and Lipple, 1985). They comprise:

(a) an upper felsic–sedimentary association

(b) an upper mafic association

(c) a lower felsic–sedimentary association

(d) a lower mafic association.

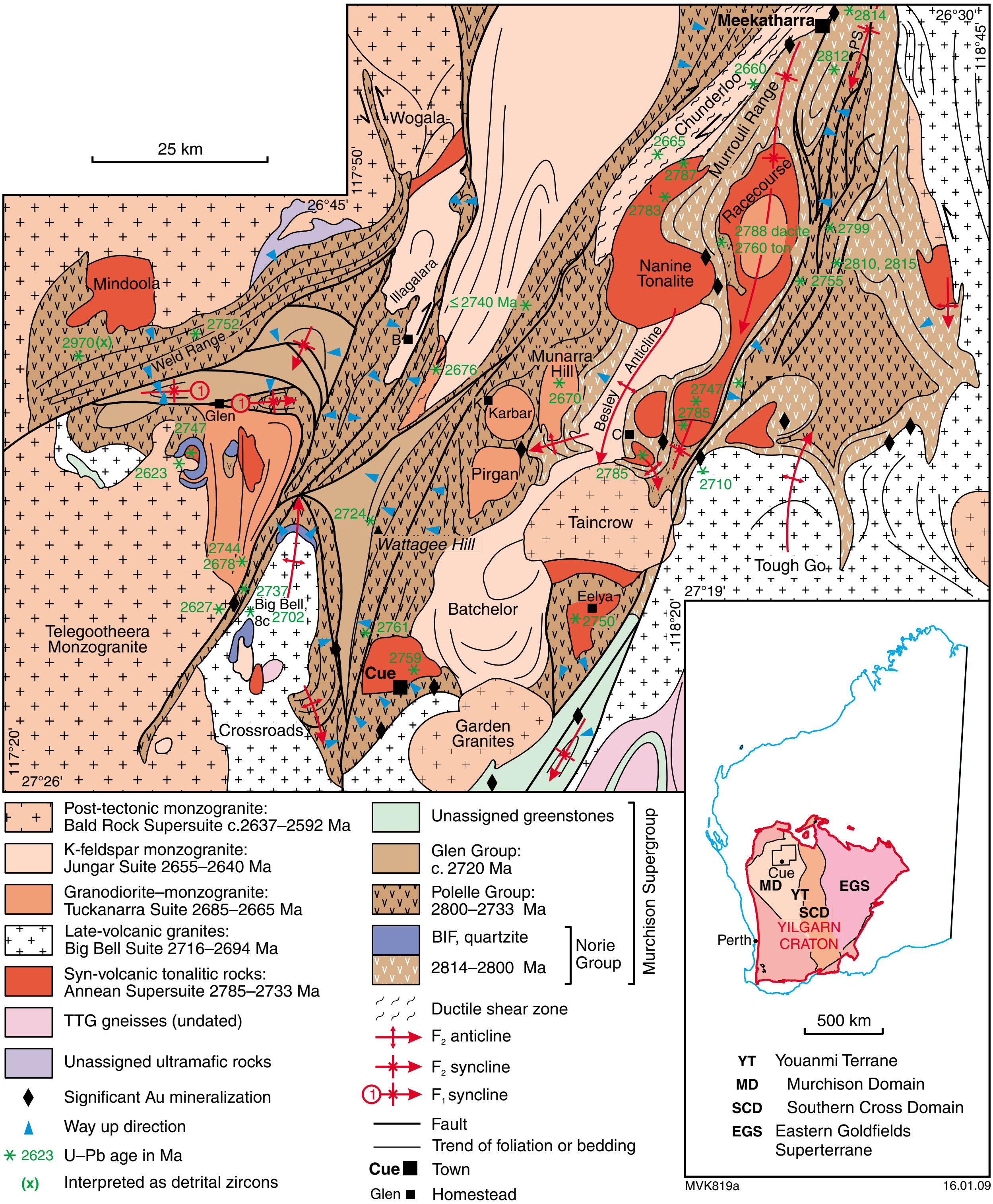



*Figure 1. Interpreted bedrock geology map of the Cue to Meekatharra area of the Murchison Domain, showing the distribution of inferred supracrustal groups and granitic suites and supersuites, available age data, and major structural features. Interpretation is based on 1:100 000 mapping of the CUE, MADOONGA, REEDY, and MEEKATHARRA map sheet areas, aeromagnetic data, and geochronology (cited in text). B = Beebyn Homestead; C = Culliculli Homestead; K = Karbar Homestead; Chunderloo = Chunderloo Shear Zone; PS = Polelle Syncline*

Subsequently Watkins and Hickman (1990) introduced a stratigraphic scheme for their 'Murchison Supergroup', which comprised the older Luke Creek Group and a younger Mount Farmer Group, based on regional mapping but very little radiometric dating. The Porlell and Yalgoo Subgroups, as well as seventeen formations, were also defined within the Mount Farmer Group.

Subsequent high-precision U–Pb zircon geochronology on rocks from the northeastern 'Murchison Terrane' by Pidgeon and Hallberg (2000) showed several inconsistencies with the lithostratigraphic scheme of Watkins and Hickman (1990). As a result, Pidgeon and Hallberg (2000) introduced an informal subdivision of supracrustal greenstone lithologies into five 'assemblages' and concluded that it was not possible to erect a formalized stratigraphic scheme for the greenstones of the Murchison region.

Gneissic and plutonic granitic rocks of the Murchison Domain were initially subdivided by Watkins and Hickman (1990) into three main types, based primarily upon chronology from field relations. The granitic rock types included pegmatite-banded gneiss, recrystallized monzogranite, and post-folding granites. Wang et al. (1993) used geochemistry and geochronology to divide the monzogranites into three suites: monzogranite–granodiorite, trondhjemite–tonalite, monzogranite–syenogranite. Champion and Cassidy (2002) modified the Watkins and Hickman (1990) scheme to define four suites in the northern Murchison, based on Yilgarn-wide geochemistry. These include high-Ca granites, low-Ca granites, mafic granites, high-HFSE (High Field Strength Element) granites, and syenite. Champion and Cassidy (2007) showed that a broad northeasterly trending corridor of rocks between Meekatharra and Mount Magnet had younger depleted mantle model ages ($T_{DM}$) to 2.95 Ga, compared with adjacent parts of the domain that have $T_{DM}$ ages to 3.3 Ga.

## Problems with previous lithostratigraphic schemes

### Watkins and Hickman

Many aspects of the lithostratigraphic scheme of Watkins and Hickman (1990) need to be revised in light of new geochronological and map data.

1. Rocks ascribed to different formations belong, in some places, to the same unit. For example, rocks mapped as the Golconda and Windaning Formations in the Meekatharra area are both c. 2814 Ma old and linked by a previously unrecognized major fold structure.

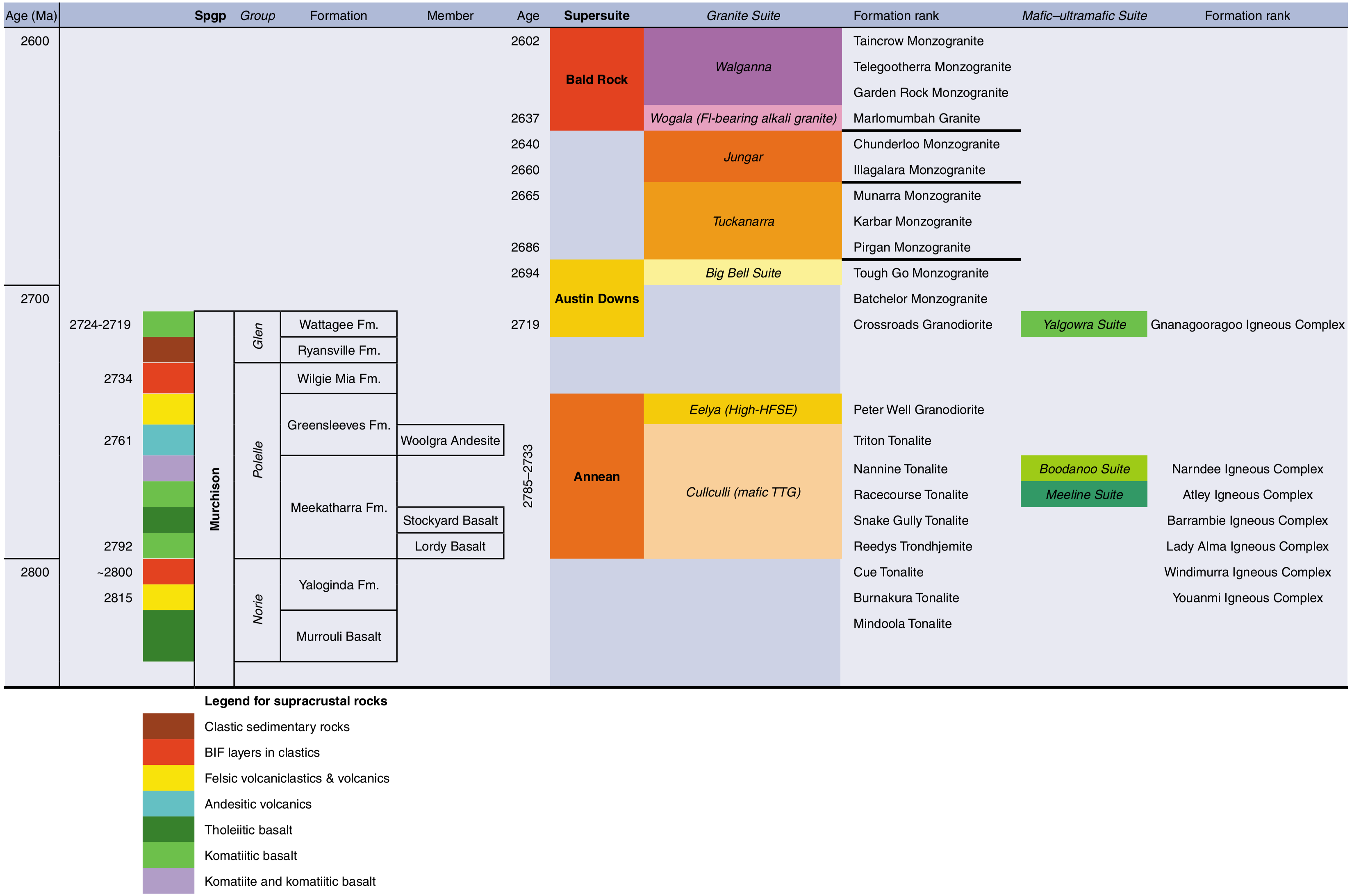
2. Some rocks that were ascribed to a single formation have been found to represent two discrete flow units with significantly different lithological characteristics and ages. For example, basaltic rocks mapped as the Gabanintha Formation in the area north of Cue include distinct basalt and komatiitic basalt flows separated by a thick unit of felsic volcaniclastic rocks. However, the new geochronology has shown that, in this area, two similar-looking sequences have distinctly different ages of >2761 Ma and c. 2724 Ma, respectively. In another example, felsic volcaniclastic rocks that were mapped as part of the Windaning Formation in different parts of the Meekatharra area include rocks of distinctly different age at c. 2814 Ma and c. 2756 Ma.

3. Some rocks that have been correlated between greenstone belts are very different in age. For example, the Luke Creek Group in the Mount Magnet greenstone belt is c. 2950 Ma, whereas rocks assigned to the Luke Creek Group in the Meekatharra greenstone belt are c. 2814 Ma, and in the Weld Range greenstone belt are c. 2752 Ma (Wang, 1998; Geological Survey of Western Australia, in prep.).

4. Some formations bracket together very different rock types (e.g. coarse clastic sedimentary rocks and komatiitic basalt within the Mougooderra Formation) that should each be given formation status.

5. The authors defined many separate formations, or groupings of formations, within the Mount Farmer Group, which were restricted to individual greenstone belts.

6. The division of granitic rocks based on structural complexity is inconsistent with




Notes:

Golconda Formation (Watkins and Hickman, 1990) abandoned because it is not the best type area, and renamed the Yaloginda Formation after Yaloginda Bore southwest of Meekatharra

Gabanintha Formation (Watkins and Hickman, 1990) abandoned because it is a mixture of many different, distinct basaltic units

Windaning Formation (Watkins and Hickman, 1990) abandoned because it is in large part equivalent to their Golconda Formation

Glen Group may be equivalent to Mougooderra Formation further to the south (Watkins and Hickman, 1990), whose lower contact is a marked unconformity on 2930–2810 Ma volcanic rocks

*Figure 2. Stratigraphic scheme for the northeastern Murchison Domain, divided into three main columns for supracrustal rocks, granitic suites and supersuites, and mafic–ultramafic suites*

new geochronological data, which show that many older granites have been little affected by penetrative strain and that many complexly folded gneisses contain abundant younger material.

### Pidgeon and Hallberg

Pidgeon and Hallberg's (2000) lithostratigraphic scheme of five informal volcanic assemblages is problematic for many of the same reasons as the Watkins and Hickman (1990) scheme. In addition, the distribution of Assemblages 4 and 5 are inconsistent with observed way-up criteria from recent mapping, and the relationship between Assemblages 3 and 5 is unclear. The scheme leaves a significant amount of mafic rocks, felsic volcanic rocks, and banded iron-formation (BIF) unassigned.

## New lithostratigraphic scheme

The formal lithostratigraphic scheme presented here (Fig. 2, Table 1) is a working model that updates and replaces the scheme presented informally by Van Kranendonk (2008). In the current scheme, the Murchison Supergroup is defined as comprising three groups of supracrustal rocks (Fig. 1), although it is recognized that a fourth, older (c. 2950 Ma), group from the Mount Gibson – Golden Grove mine area to the south will have to be included in the supergroup at a later date (Yeats et al., 1996; Wang et al., 1998) and that remnants of this group may occur in the current map area. Two supersuites of mixed granitic and mafic–ultramafic igneous rocks are also recognized, along with one other supersuite of granitic rocks and two other suites of granitic rocks that are not assigned to supersuites (Fig. 2).

### Greenstones

Three volcano-sedimentary groups have been defined in the map area, based on map data, geochronology, and the presence of (ultra-) mafic–felsic volcanic–sedimentary cycles (Table 1, Fig. 2; Van Kranendonk, 2008).

The basal Norie Group is best exposed in, and just east of, the Murrouli Range, southwest of Meekatharra in the northeastern part of the map area (Fig. 1). At the base of the group is the Murrouli Basalt (Watkins and Hickman, 1990), which consists of a thick succession of pillowed and massive tholeiitic basalt. These rocks are metamorphosed to amphibolite and upper greenschist facies, with lower grades away from the intrusive contact with the Nannine Tonalite (Cullculli Suite, Annean Supersuite) along the western margin of the Murrouli Range. Conformably overlying the Murrouli Basalt is the Yaloginda Formation, which consists of fine- to medium-grained felsic volcaniclastic sedimentary rocks and interbedded BIF (Fig. 3a). These rocks face to the east in the Murrouli Range and are folded around the south-plunging Belsey Anticline, whose hinge is transected by the undated Batchelor Monzogranite (Fig. 1). Rocks of the Norie Group are also folded around the hinge of the Polelle Syncline, just to the east of Meekatharra, and form the eastern limb of this large-scale structure (Fig. 1). Thin remnants of the upper Norie Group are preserved in the southwestern part of the study area, consisting of BIF and quartzite of the Yaloginda Formation. A remarkable feature of the Yaloginda Formation is the prevalence of sheeted sills of fine- to medium-grained peridotite and dolerite that split apart and inflate the original sedimentary layering of the formation (Figs 3b,c), which are interpreted to be subvolcanic sills associated with volcanism of the overlying Polelle Group.

The age of the Norie Group is constrained by seven precise SHRIMP U–Pb zircon dates. A minimum age for the Murrouli Basalt is 2792 ± 5 Ma, the age of a dolerite sill within the formation (sample 96-125 of Wang, 1998). A similar minimum age constraint is provided by the crosscutting, c. 2785 Ma Nannine Tonalite (Cullculli Suite, Annean Supersuite: samples GSWA 178102, 178104 in GSWA, 2008). Felsic volcaniclastic sedimentary rocks of the Yaloginda Formation have been dated just north of Meekatharra, where a sample returned a single population of zircons dated at 2814 ± 3 Ma (GSWA sample 183953, in GSWA, in prep.), which is interpreted as a maximum age of deposition. Along strike to the south, Wang (1998) obtained a nearly identical age of 2812 ± 7 Ma from felsic tuffaceous sandstone of this formation (sample 96-128). A sample of felsic volcaniclastic rock from the Yaloginda Formation on the southwestern limb of the Polelle Syncline returned a single population of zircons at 2806 ± 4 Ma (GSWA sample 178142, in GSWA, in prep.). Wang (1998; samples 93-975 and 93-976) also dated two samples of amygdaloidal andesite from this area, which returned ages of 2810 ± 5 Ma and 2815 ± 7 Ma. A 2821 ± 5 Ma date from zircons extracted from a gabbro from the lady Alma Igneous Complex near Gabanintha (Meeline Suite: sample 96-631 of Wang, 1998)





*Figure 3. Photographs of representative rock types in the Cue–Meekatharra area; a) View, looking north, of graded bedding between fine-grained felsic volcaniclastic sedimentary rocks and ferruginous shale or BIF, Yaloginda Formation; b) View northeast, of multiple screens of BIF separated by peridotite sills that have been bleached white by surficial weathering (Boomerang mine); c) Close-up view of screens of BIF encased within a sheeted sill of foliated peridotite (Thompsons mine). Notebook for scale; d) Bedded volcaniclastic siltstone in between basaltic flow units of the Meekatharra Formation, south of Karbar*

may represent the onset of Norie Group volcanism (but see below). We therefore interpret these age data to indicate deposition of the Norie Group from 2820 to 2800 Ma.

The 2800–2730 Ma Polelle Group conformably overlies the Norie Group and is best exposed in the hinge of the Polelle Syncline (Fig. 1). This group includes the lower Meekatharra Formation of tholeiitic basalt, komatiitic basalt, komatiite, and thin interflow felsic volcaniclastic sedimentary rocks. The conformably overlying Greensleeves Formation consists of andesitic to rhyolitic volcanic and volcaniclastic rocks, conformably overlain by BIF and felsic volcaniclastic rocks of the Wilgie Mia Formation. At the base of the Polelle Group in the Polelle Syncline, a komatiitic basalt unit is referred to as the Lordy Basalt Member (previously 'Lordy Basalt' of Watkins and Hickman, 1990). Overlying this is a unit of pillowed tholeiitic basalt, referred to as the Stockyard Basalt Member (previously 'Stockyard Basalt' of Watkins and Hickman, 1990). Just west of Karbar, these units are separated by a thin (30 cm) unit of fine-grained felsic volcaniclastic sedimentary rock (Fig. 3d). Southwest of Karbar and north of Cue, the Meekatharra Formation dominantly consists of tholeiitic basalt, although interbedded units of komatiitic basalt are also present.

In the Polelle Syncline, the Stockyard Basalt Member is overlain by komatiitic basalt and komatiite, which are overlain by andesitic volcanic and volcaniclastic rocks that are referred to as the Woolgra Andesite Member of the Greensleeves Formation (Fig. 2, Table 1). North of Cue, the Greensleeves Formation consists largely of well-bedded felsic volcaniclastic sedimentary rocks, grading from more andesitic compositions at the base, to rhyolitic compositions at the top. In the Weld Range, very fine grained felsic sedimentary rocks (cherty tuffaceous siltstones) grade up into, and are interbedded with, thick units of BIF of the Wilgie Mia Formation. This formation is interpreted to continue into the area south of Beebyn Homestead (Fig. 1), where it is deformed into a north-plunging synformal anticline.

The age of the lower, dominantly basaltic, Meekatharra Formation is poorly constrained. A dacite from near the base of the formation is dated at 2784 ± 22 Ma (Wiedenbeck and Watkins, 1993), which is within error of a maximum depositional age of 2799 ± 2 Ma determined from a thin unit of cross-bedded felsic volcaniclastic sandstone (GSWA sample 183921, in GSWA, 2008). A 2792 ± 5 Ma dolerite sill (Wang, 1998) in the underlying Norie Group may also reflect the age of basaltic volcanism in the Polelle Group, although the zircons in this gabbro may be xenocrysts. The age of the upper part of the Polelle Group is very well dated from several samples of intermediate to felsic volcanic and volcaniclastic rock. Two samples of rhyolitic vitric tuff from the Greensleeves Formation north of Cue have been dated at 2761 ± 4 Ma (samples W372 and W373, in Pidgeon and Hallberg, 2000) and three other dated samples from this area have a pooled mean age of 2741 ± 3 Ma (samples 93-986, 93-987, 96-632, in Wang, 1998). A feldspar-phyric andesite from the Woolgra Andesite Member in the Polelle Syncline is dated at 2755 ± 5 Ma (GSWA sample 178105, in GSWA, 2008), whereas a similar rock from the Abbotts greenstone belt is 2744 ± 4 Ma (GSWA sample 178106, in GSWA, 2008). Three other samples of clast-bearing felsic tuffs from the Abbotts greenstone belt are dated at 2734 ± 4 Ma, 2744 ± 8 Ma, and 2750 ± 9 Ma, and contain populations of c. 3.5 Ga and c. 2.9 Ga xenocrystic zircons (samples 93-970, 93-971, and 96-623, in Wang, 1998). Sheared felsic volcanic rocks from the Big Bell Mine are dated at 2737 ± 4 Ma (Mueller et al., 1996).

A sample of felsic crystal tuff interbedded with BIF in the Weld Range yielded a main population of zircons with an age of 2752 ± 9 Ma, as well as populations of inherited zircons at c. 2920 Ma and c. 3263 Ma (sample 96-120, in Wang, 1998). The main zircon population of 2752 ± 9 Ma is interpreted to represent the age of felsic volcanism and the depositional age of the BIF in this area. A maximum depositional age of 2969 ± 3 Ma from felsic volcaniclastic sandstone on the northern flank of the Weld Range (GSWA sample 184112, in GSWA, 2008) is identical to zircon ages obtained from a felsic porphyry along strike to the northeast (sample 96-633, in Wang, 1998). These ages, which are similar to those obtained from felsic rocks in the Mount Gibson – Golden Grove area to the south (Yeats et al., 1996; Wang et al., 1998), may indicate an older component to the belt, or they can be interpreted to represent populations of detrital and xenocrystic zircons, given the younger age of felsic volcanism indicated by the results from sample 96-120 in the Weld Range area (2752 ± 9 Ma; Wang, 1998).

Four samples of felsic tuff from the Dalgaranga greenstone belt to the southwest of the study area have ages of 2747 ± 5 Ma (samples W296, W297, W298, W308, in Pidgeon and Hallberg, 2000) and are thus interpreted to be part of the Greensleeves Formation. Three younger dates of c. 2700 Ma from this belt are described as crystal tuffs, but are unusual in that they have been described to contain amphibole phenocrysts and therefore may represent younger, high-level intrusions (samples 96-640, 97-125, and 97-126, in Wang, 1998), particularly as the c. 2719 Ma gabbro sills of the Yalgowra Suite intrude the volcanic rocks in this area, indicating a >2720 Ma age for the felsic volcanics (see below). A felsic porphyry interpretation for the younger, amphibole-bearing rocks in the Dalgaranga greenstone belt is consistent with dates of c. 2700 Ma from felsic porphyries near Meekatharra (Wang, 1998) and granites near the Big Bell Mine (Mueller et al., 1996).

Rocks of the c. 2720 Ma Glen Group conformably to ?disconformably overlie the Polelle Group between Cue and the Weld Range. North of Cue, felsic volcanic rocks of the Greensleeves Formation are conformably overlain by a thick unit of pyroxene spinifex-textured komatiitic basalt and pillowed komatiitic basalt, referred to here as the Wattagee Formation (Fig. 2, Table 1). Just north of Wattagee Hill, the komatiitic basalts of this formation are interbedded with more felsic volcanic units ranging from andesite to rhyolite. Komatiitic basaltic rocks of the Wattagee Formation are also present south of the Weld Range, where they conformably overlie a thick section of coarse clastic sedimentary rocks and finer grained, felsic volcaniclastic sedimentary rocks of the Ryansville Formation, and are deformed into a steeply plunging syncline (Van Kranendonk, 2008).

Associated with the komatiitic basalts of the Glen Group are thick differentiated mafic–ultramafic sills that were emplaced into the underlying Polelle Group, particularly within felsic volcaniclastic rocks of the Greensleeves Formation (Fig. 2; Van Kranendonk, 2008). These sills range from dunite and pyroxenite at their base to gabbro and leucogabbro with long feathery pyroxene crystals at their tops (Van Kranendonk, 2008) and are ascribed to the Yalgowra Suite (see below). Although they have not dated these in the study area, Pidgeon and Hallberg (2000) obtained an age of 2719 ± 6 Ma from similar thick gabbroic sills of the Yalgowra Suite in the Dalgaranga greenstone belt that were emplaced into c. 2745 Ma greenstones. This c. 2720 Ma age is used to estimate the time of emplacement of the gabbroic sills of the Yalgowra Suite in the map area, and also the time of eruption of the komatiitic basalts of the Glen Group in the Cue area. This interpretation has recently been confirmed by a 2724 ± 4 Ma date from a rhyolite layer within the Wattagee Formation (GSWA sample 183975, in GSWA, in prep.). Other samples from differentiated sills of the Yalgowra Suite have been collected from the Cue area for U–Pb dating, in order to confirm the age of this voluminous magmatic event.

## Granitic rocks

Van Kranendonk (2008) recognized five generations (?suites) of granitic rocks in the map area, based on composition, nature and degree of deformation, cross-cutting relationships, and age. Although this division is essentially maintained, the rocks have been further subdivided and formally ascribed to seven suites and three supersuites (Figs 1,2, Table 1).

The oldest generation of granitic rocks in the map area belongs to the Annean Supersuite and is composed principally of hornblende(–biotite) tonalite–trondhjemite–granodiorite (TTG) and quartz diorite rocks. Two geochemically distinct suites have been identified, based on work by Champion and Cassidy (2002). The Cullculli Suite consists of hornblende(–biotite) TTG (and quartz diorite) rocks, commonly as discrete subvolcanic plutons, but also as gneissic rocks invaded by younger granitic rocks and strongly deformed (so-called pegmatite-banded gneisses). The Eelya Suite includes granitic rocks with high-HFSE geochemical characteristics. In the map area, this latter suite consists solely of the Peter Well Granodiorite, a subvolcanic intrusion to Greensleeves Formation felsic volcanic and volcaniclastic rocks some 20 km east of Cue (Fig. 1).

In places, granitic rocks of the Cullculli Suite are sheeted at a few metres scale, with variations defined by mafic mineral content and the amount of quartz (see fig. 3a in Van Kranendonk, 2008). Elsewhere, Cullculli Suite TTGs are characterized by a distinctive mafic clotty texture that consists of elliptical (now strained, but originally spherical) hornblendite clots that range from 1 cm to 8 cm in size (see fig. 3b in Van Kranendonk, 2008). Because of the widespread and abundant nature of the clots, this texture is interpreted as evidence of mingling and mixing between granitic melts and mafic magmas. Further evidence for the comagmatic nature of mafic and granitic melts is present in the form of syn-plutonic mafic dykes in some granitic bodies (see fig. 3c in Van Kranendonk, 2008). Other plutons, such as the Nannine Tonalite, are characterized by a white-weathering appearance and an equigranular to weakly feldspar-porphyritic texture with 15–20% hornblende.

Granitic rocks of the Annean Supersuite locally display evidence of having been affected by two sets of structural fabric elements, which further differentiates them from younger granitic suites that are more potassic, lack mafic clots, and display evidence of only a single deformational event (Van Kranendonk, 2008). Granitic rocks of the Annean Supersuite range in age from 2787 to 2733 Ma and are coeval with volcanism of the Polelle Group. Local, 2–5 km-diameter plutons were emplaced as subvolcanic intrusions that fed felsic volcanic centres, such as are preserved at Eelya Hill and at Cue (Cue Tonalite). These centres are highly mineralized (Au) within the plutonic rocks themselves (e.g. Gem of Cue and Eelya North mines), as well as in their felsic volcanic envelope. Two mafic clotty-textured tonalites from southwest of Glen Homestead and south-southwest of Meekatharra are both 2747 ± 4 Ma (GSWA samples 178141 and 178196, GSWA, in prep.). Older components of this suite include the Cue Tonalite (2759 ± 4 Ma; sample W378, in Pidgeon and Hallberg, 2000), the 2760 ± 8 Ma Racecourse Tonalite south-southwest of Meekatharra (sample PFG-1, in Wiedenbeck and Watkins, 1993), and c. 2785 Ma ages from the Nannine Tonalite southwest of Meekatharra (GSWA samples 178102 and 178104, in GSWA, 2008). Wang et al. (1995) dated the Snake Gully Tonalite and Reedy Trondhjemite at 2751 ± 6 Ma and 2785 ± 8 Ma, respectively. Wang (1998) dated the Peter Well Granodiorite at 2747 ± 6 Ma, and two samples from just to the north of this pluton at 2752 ± 4 Ma and 2749 ± 6 Ma (samples 93-991, 93-989, and 93-990, in Wang, 1998). The youngest age for this supersuite comes from the Dalgaranga greenstone belt, where a sample of diorite returned an age of 2733 ± 7 Ma (sample 96-641, in Wang, 1998).

The Austin Downs Supersuite consists of the Big Bell Suite of foliated tonalitic to monzogranitic rocks and the Yalgowra Suite of layered mafic–ultramafic intrusions. The type area for the Big Bell Suite is along the eastern contact of greenstones near the Big Bell Mine, where interlayered and highly strained mafic and felsic volcanic rocks are cut by the 2702 ± 6 Ma (Mueller et al., 1996) Crossroads Granodiorite. Further east is the 2710 ± 10 Ma (Wang et al., 1995) Tough Go Monzogranite, which cuts across greenstones and is foliated. There are several other dates on granitic rocks in the range between 2716 and 2694 Ma, ranging from north of Meekatharra to south of Golden Grove that are included within the Big Bell Suite, including a foliated tonalite from the Abbotts greenstone belt (Schiøtte and Campbell, 1996; Wang, 1998).

The Tuckanarra Suite consists of strongly foliated and locally magmatically layered granodiorite to monzogranitic rocks in the age range from 2686 to 2666 Ma (see fig. 3d in Van Kranendonk, 2008; GSWA sample 178199, in GSWA, 2008), including felsic porphyries in greenstones near Meekatharra (Hollingsworth, D., 2007, written comm.). These granitic rocks split apart the greenstones, are locally cut by younger K-feldspar monzogranites, and have been affected by the late phase of shear-related deformation.

The Jungar Suite of foliated to strongly sheared K-feldspar-porphyritic monzogranites is dated from 2660 to 2640 Ma (GSWA samples 187651 and 187655, in GSWA, in prep.; GSWA samples 178101 and 178103, in GSWA, 2008). These rocks are characterized by strong shear fabrics that suggest they may have been emplaced during, or just before, shearing (see fig. 3e in Van Kranendonk, 2008).

The post-tectonic Bald Rock Supersuite of undeformed granitic rocks is subdivided into two suites: the Walganna Suite of biotite(–muscovite) monzogranites to syenogranites that range in texture from coarsely K-feldspar-porphyritic to coarse-grained, equigranular rocks (see fig. 3f in Van Kranendonk, 2008); and the Wogala Suite of fluorite-bearing alkali granites. Dated samples from the Walganna Suite fall in the range from 2637 to 2602 Ma (Wiedenbeck and Watkins, 1993; Yeats et al., 1996; Wang, 1998). Granite of the Walganna Suite that cuts across foliated and refolded mafic clotty-textured granite in the area just southwest of Glen Homestead has been dated at 2623 ± 9 Ma (GSWA sample 178197, in GSWA, in prep.).

## Mafic–ultramafic layered intrusions

Mafic–ultramafic layered intrusive rocks comprise approximately 40% by volume of the greenstones of the Murchison Domain (Fig. 4). Three suites are identified based upon lithological association, level of emplacement, and limited age relationships: the older Meeline and Boodanoo Suites of the Annean Supersuite (Fig. 2) are both interpreted to be c. 2780 Ma in age and contemporaneous with eruption of both the mafic–ultramafic volcanic rocks of the Meekatharra Formation of the Polelle Group, and also with emplacement of the granitic rocks of the Cullculli Suite of the Annean Supersuite (Fig. 2).

The larger mafic–ultramafic layered intrusions of the Meeline Suite, including the Windimurra, Atley, Lady Alma, Barrambie, and Youanmi Igneous Complexes, partially preserve original intrusion morphologies and comprise relatively shallowly inward-dipping, concentric layers. However, post-emplacement deformation has affected the majority of the bodies so that they are now typically steeply dipping and oriented parallel with major shear zones (Fig. 4). Outcrop patterns suggest that most of the intrusions were intruded as tabular bodies, i.e. sills, laccoliths, and lopoliths. Primary magmatic layering is well preserved in the larger complexes and comprises mega-cyclic units of up to 100 m-thick cycles of peridotite–gabbro–anorthosite, with horizons of vanadium-bearing magnetitite (Fig. 5). Smaller scale modal layering provides readily obtainable way-up information in both the large and the smaller intrusions. Gabbro is the dominant lithology. However, some intrusions contain a higher proportion of peridotite, pyroxenite, and olivine gabbro. Significant vanadium mineralization is present in several intrusions of the Meeline Suite, with a mine currently operating in the Windimurra Igneous Complex, and another proposed in the Barrambie Igneous Complex (Fig. 4). A maximum

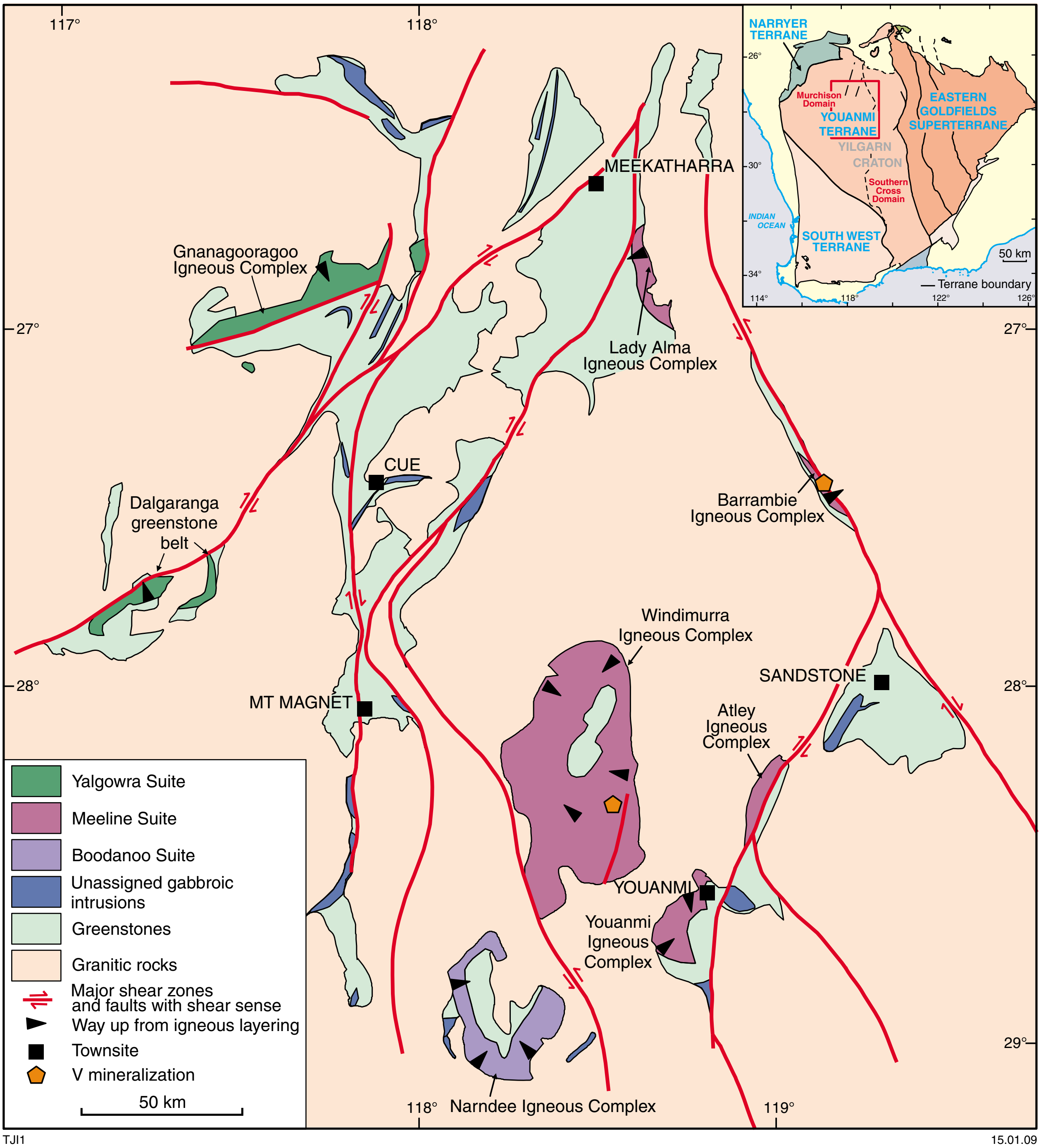



***Figure 4.   Simplified geological map of the northeastern Murchison Domain, highlighting the location of mafic–ultramafic intrusive suites relative to supracrustal greenstones and shear zones. Also shown are igneous differentiation way-up directions and the location of two vanadium projects***

age for the Windimurra Igneous Complex is provided by the 2813 ± 3 Ma age (GSWA 169003, in Nelson, 2001) of overlying rhyolites of the Kantie Murdanna Volcanics, which the complex intrudes. A 2821 ± 5 Ma date on zircons from gabbro of the Lady Alma Igneous Complex near Gabanintha (Wang, 1998) may represent the age of emplacement of the gabbro. However, given that this age is older than the interpreted age of the host rocks (c. 2814 Ma), that the intrusions are most likely contemporaneous with Meekatharra Formation volcanism at 2800 to 2760 Ma, and that the dated zircons have low Th/U ratios, we suggest that the age of c. 2821 Ma from the Lady Alma Igneous Complex represents a population of inherited zircons derived from the host rocks.

The mafic–ultramafic lithologies present in the Narndee Igneous Complex of the Boodanoo Suite differ from those in the Meeline Suite in several ways. The average composition of the Narndee Igneous Complex gabbros is more mafic and less Ca-rich than those of the Meeline Suite, and the volume of dunitic lithologies comprising the layered units is significantly higher. The Narndee Igneous Complex also lacks significant magnetite concentrations and hence has an uneconomic vanadium content. In addition, hornblende gabbros are a major component of the Narndee Igneous Complex, whereas such rocks are rarely observed in the Meeline Suite.

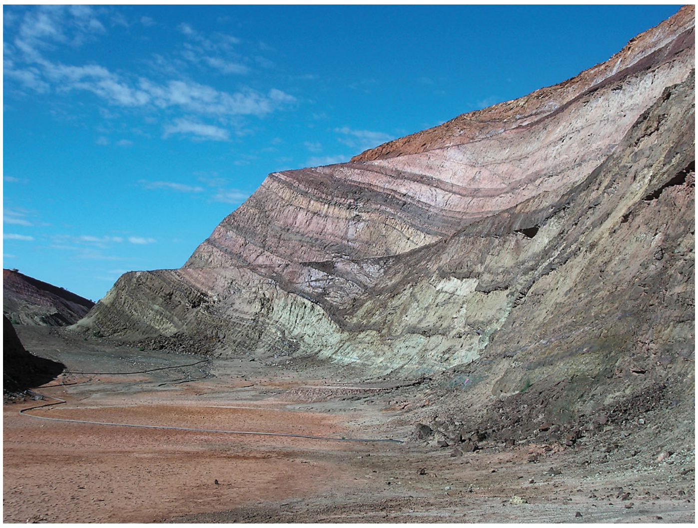


*Figure 5. Looking south in Windimurra Vanadium Ltd's pit, magnetitite layers in leucogabbro, Windimurra Igneous Complex*

The younger Yalgowra Suite (c. 2720 Ma) is interpreted as contemporaneous with the eruption of komatiitic basalts of the Glen Group and with granitic rocks of the Big Bell Suite, together comprising the Austin Downs Supersuite (Fig. 2). The Yalgowra Suite consists of thick, layered mafic–ultramafic sills, most of which are emplaced into felsic volcaniclastic rocks and BIF of the Greensleeves and Wilgie Mia Formations near the top of the Polelle Group. These sills have previously been described in Watkins and Hickman (1990) and Van Kranendonk (2008), but are characteristically thick gabbros, with bases of pyroxenite and cumulate peridotite, and tops of leucogabbro and local anorthosite. PGE mineralization occurs in the Gnanagooragoo Igneous Complex (Parks, 1998). A 2719 ± 6 Ma date from a gabbroic sill of the Yalgowra Suite in the Dalgaranga greenstone belt (Pidgeon and Hallberg, 2000) is consistent with a crosscutting relationship of these rocks with c. 2747 Ma felsic volcanic host rocks. This, together with the high U, Th, and Th/U ratios of the dated zircons in this gabbro, is used to suggest that c. 2720 Ma is representative of the age of the suite as a whole.

## Discussion

The new lithostratigraphic scheme presented herein is a working model, which in combination with a compilation of available geochronology, reveals that the development of the greenstone stratigraphy in the northeastern Murchison Domain was essentially continuous from 2820 to 2720 Ma. This involved two principal volcanic cycles in the lower part of the Murchison Supergroup, each of which consists of mafic–ultramafic volcanism and plutonism followed by felsic volcanism and plutonism, and then by deposition of BIF. The third cycle, at the top of the supergroup, commenced with deposition of coarse clastic sedimentary rocks after an approximately 10 Ma hiatus in volcanism, followed by the eruption of komatiitic basalts and minor felsic volcanic rocks. There is no outcrop from the top of this cycle to determine how it ended. Large volumes of mafic–ultramafic intrusive rocks appear to accompany the initial melting phases of these major events, and may be associated with komatiitic volcanism at the base of the Polelle and Glen Groups. These two major heat pulses caused crustal melting and formed the Culculli and Big Bell Suites of felsic intrusive rocks, respectively.

At c. 2750 Ma, felsic volcanism in the middle part of the Polelle Group was accompanied by the emplacement of granitic rocks. However, the bulk of granitic rocks in this part of the craton were emplaced later, from immediately after the end of volcanism (Glen Group) and then essentially continuously for 224 m.y., from 2716 to 2592 Ma, with magmatic peaks at c. 2678 Ma, 2665 Ma, and 2642 Ma.

Combined, these data record magmatism over 330 m.y., a period of time equivalent to the span from the modern day back to the early Carboniferous. If the Meeline Suite is coeval with Polelle Group volcanism, then this 2800 to 2730 Ma event represents a massive addition of magma both into and onto an older crust, whose presence is indicated by the widespread occurrence of detrital and inherited zircons in the range from 4.0 to 2.9 Ga across the whole of the domain. The presence of komatiitic basalt, komatiite, and thick ultramafic–mafic layered complexes suggests a major mantle plume event associated with significant crustal extension.

The latter part of this history, from 2720 to 2620 Ma, spans the main period of crustal development in the Eastern Goldfields Superterrane of the eastern part of the craton (Kositcin et al., 2008). This similar history across what have been interpreted as a series of accreted terranes (e.g. Myers, 1995; Swager, 1997) allows the question of whether terrane accretion models are applicable for the Yilgarn Craton, or if models of plume-related magmatism and resultant partial melting of older crust leading to partial convective overturn can be applied (Campbell and Hill, 1988; Nelson, 2008; Van Kranendonk, 2007, 2008).

## Conclusions

1. It is possible to construct a meaningful stratigraphic scheme for at least the northeastern Murchison Domain. This scheme may well be applicable to the rest of the Murchison and Southern Cross Domains of the Youanmi Terrane. The scheme is consistent with the existing large dataset of high-precision geochronology.

2. The Murchison Domain contains at least three main geological cycles over a total age range of at least 224 Ma. The cycles consist of mafic–ultramafic volcanism and plutonism, followed by intermediate to felsic volcanism and plutonism, and deposition of BIF. In the study area the third cycle appears incomplete.

3. Significant volumes of mafic–ultramafic intrusive rocks comprise up to 40% by volume of the greenstone belts. Three suites are apparent from field relations and mineralogy. However, better age constraints are required. These suites contain considerable vanadium and minor Cu–Ni–PGE mineralization.

4. Granitic magmatism continued from about 2785 to about 2600 Ma, and comprises seven identifiable suites based upon chronology and distinguishing petrographic features. The history of plutonism indicates continuous granite emplacement over this period.

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**Table 1. Stratigraphic definitions of the Murchison Domain**

| *Lithostratigraphic unit* | *Parent unit* | *Unit code* | *Lithology* | *Age (Ma)* | *Origin of name* |
|---|---|---|---|---|---|
| **Murchison Supergroup** | | A-MU-xb-f | Basalt, felsic volcanic and volcaniclastic rocks, and clastic and chemical metasedimentary rocks; metamorphosed | 2820–2700 | Murchison River, named in 1839 by George Grey, after Sir Roderick Murchison, an esteemed 19th century Scottish geologist |
| Norie Group | Murchison Supergroup | A-NO-xb-f | Basalt, felsic volcaniclastic rocks, and BIF; metamorphosed | 2820–2800 | Norie Homestead (abd; Meekatharra) |
| Murrouli Basalt | Norie Group | A-NOm-b | Basalt and komatiitic basalt; metamorphosed | 2820–2815[1,2] | Murrouli Range (Meekatharra) |
| Yaloginda Formation | Norie Group | A-NOy-xf-cib | Felsic volcaniclastic rocks and BIF; local quartzite; widely intruded by peridotite sills; metamorphosed | 2815–2800[1,2] | Yaloginda Mining Centre (Meekatharra) |
| Polelle Group | Murchison Supergroup | A-PO-xb-f | Basalt, komatiitic basalt, felsic volcanic and volcaniclastic rocks, and BIF; metamorphosed | 2800–2730[1,2,3] | Polelle Homestead (abd; Gabanintha) |
| Meekatharra Formation | Polelle Group | A-POm-b | Basalt and komatiitic basalt; metamorphosed | 2800–2760[1,2,3] | Meekatharra (Meeka-tharra/Gabanintha) |
| Lordy Basalt Member | Meekatharra Formation | A-POml-bk | Komatiitic basalt; metamorphosed | c. 2790 | |
| Stockyard Basalt Member | Meekatharra Formation | A-POms-b | Basalt and komatiitic basalt, minor felsic tuff; metamorphosed | c. 2780 | |
| Greensleeves Formation | Polelle Group | A-POg-f | Andesitic to rhyolitic volcanic and vol-caniclastic rocks; widely intruded by layered mafic–ultramafic sills; weakly metamorphosed | 2760–2730[1,2,4,6] | Greensleeves Bore (Cue) |
| Woolgra Andesite Member | Greensleeves Formation | A-POgw-fa | Andesitic volcanic and volcaniclastic rocks; weakly metamorphosed | c. 2755[1] | Woolgra Bore (Meekatharra) |
| Wilgie Mia Formation | Polelle Group | A-POw-xcib-f | BIF and felsic volcaniclastic rocks; weakly metamorphosed | c. 2750[2] | Wilgie Mia (topographic point) |
| Glen Group | Murchison Supergroup | A-GL-xbk-s | Komatiitic basalt, with underlying clastic sedimentary rocks; minor chert and rhyolite; weakly metamorphosed | 2725–2700[1] | Glen Homestead (Cue) |
| Ryansville Formation | Glen Group | A-GLr-xmh-b | Clastic sedimentary rocks, and minor chert; weakly metamorphosed | c. 2725 | Ryansville Mining Centre (Cue) |
| Wattagee Formation | Glen Group | A-GLw-bk | Komatiitic basalt and minor rhyolite; weakly metamorphosed | c. 2720[1] | Wattagee Hill (Cue) |
| **Annean Supersuite** | | A-AN-xg-o | Tonalite, trondhjemite, and granodiorite, and gabbro, peridotite, dolerite, pyroxenite, magnetitite, and anorthosite; metamorphosed | 2787–2744[1-5] | Annean (abd) |
| Eelya Suite (high-HFSE) | Annean Supersuite | A-EE-gg | Biotite granodiorite; weakly metamorphosed | 2747[2] | Eelya Hill (Reedy) |
| Peter Well Granodiorite | Eelya Suite | A-EEpw-gg | Biotite granodiorite; weakly metamorphosed | 2747[2] | Peter Well (Reedy) |
| Cullculli Suite | Annean Supersuite | A-CC-g | Tonalite, granodiorite, and trondhjemite; typically hornblende bearing, and with common mafic clots; metamorphosed | 2785–2744[1-5] | Cullculli Homestead (abd; Reedy) |

| | *Easting/Northing* | *Type area (1:000 000 map)* | *Area of occurrence* | *1:250 000 map sheet(s)* | *1:100 000 map sheet(s)* | *Previous use* |
|---|---|---|---|---|---|---|
| | | Composite of at least three sections used to define groups | Murchison Domain | Cue, Belele, Glengarry, Sandstone | Koonmarra, Tieraco, Glengarry, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyangoo | No |
| | 634813/7037665 | Murrouli Range, ~7.5 km southwest of Norie Homestead | NE Murchison Domain | Cue, Belele, Glengarry | Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna | No |
| | 629096/7032041 | Murrouli Range, ~7.5 km southwest of Norie Homestead | NE Murchison Domain | Cue, Belele, Glengarry | Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna | (Watkins and Hickman, 1990) |
| | 642005/7049025 | Yaloginda Mining Centre | NE Murchison Domain | Cue, Belele, Glengarry | Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna | No |
| | 653945/7022175 | Polelle Syncline, southeast of Meekatharra | NE Murchison Domain | Cue, Belele, Glengarry | Koonmarra, Tieraco, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyan-goo | No |
| | 649104/7057627 | Polelle Syncline, southeast of Meekatharra | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Tieraco, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyangoo | No |
| | | Polelle Syncline, ~26 km south-southeast of Meekatharra | NE Murchison Domain | Glengarry, Belele | Meekatharra, Gabanintha | Lordy Basalt (Watkins and Hickman, 1990) |
| | | Polelle Syncline, ~11 km southeast of Meekatharra | NE Murchison Domain | Glengarry, Belele | Meekatharra, Gabanintha | Stockyard Basalt (Watkins and Hickman, 1990) |
| | 583549/6968467 | 8.25 km northwest of Cue | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Koonmarra, Tieraco, Kalli, Madoonga, Meekatharra, Gabanintha, Cue, Reedy, Nowthanna, Dalgaranga | No |
| | 648182/7026463 | 5 km north of Woolgra Bore | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Meekatharra, Gabanintha | Woolgra Formation (Watkins and Hickman, 1990) |
| | 570000/7021000 | Weld Range | NE Murchison Domain | Cue, Belele | Kalli, Madoonga, Noondie, Cue | No |
| | 564647/7007469 | 12.5 km west-northwest of Glen Homestead | NE Murchison Domain | Cue, Belele | Madoonga, Cue | No |
| | 553583/7010235 | 1 km north of Ryansville Mining Centre | NE Murchison Domain | Cue, Belele | Madoonga, Cue | No |
| | 585393/6989582 | 1.5 km north of Wattagee Hill | NE Murchison Domain | Cue, Belele | Madoonga, Cue | No |
| | 616539/7026395 | 25 km southwest of Meeka-tharra, 5 km west of Norie (abd; Meekatharra) | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Koonmarra, Tieraco, Glengarry, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyangoo | No |
| | 615288/6972693 | Eelya Hill (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 615288/6972693 | Eelya Hill (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 621851/7001849 | 25 km southwest of Meeka-tharra, 5 km west of Norie (abd; Meekatharra) | NE Murchison Domain | Belele, Cue, Glengarry | Kalli, Madoonga, Meekatharra, Glengarry, Cue, Reedy | No |

**Table 1. Stratigraphic definitions of the Murchison Domain (continued)**

| *Lithostratigraphic unit* | *Parent unit* | *Unit code* | *Lithology* | *Age (Ma)* | *Origin of name* |
|---|---|---|---|---|---|
| Triton Tonalite | Cullculli Suite | A-CCtr-gt | Metatonalite | 2785 | Triton mine (Reedy) |
| Snake Gully Tonalite | Cullculli Suite | A-CCsg-gt | Tonalite and quartz diorite; metamorphosed | 2752[5] | Snake Gully mine (Reedy) |
| Nannine Tonalite | Cullculli Suite | A-CCna-gta | Hornblende metatonalite; metamorphosed | 2785[1] | Town of Nannine (abd; Meekatharra) |
| Racecourse Tonalite | Cullculli Suite | A-CCrc-gt | Tonalite; metamorphosed | 2760[3] | Racecourse Well (Meekatharra) |
| Reedy Trondhjemite | Cullculli Suite | A-CCrt-gt | Trondhjemite; metamorphosed | 2785[5] | Reedy (Reedy) |
| Cue Tonalite | Cullculli Suite | A-CCct-gt | Tonalite; metamorphosed | 2759[4] | Cue (Cue) |
| Burnakura Tonalite | Cullculli Suite | A-CCbk-gt | Tonalite; metamorphosed | ?2750 | Burnakura Mining Centre (Reedy) |
| Mindoolah Tonalite | Cullculli Suite | A-CCmd-gt | Tonalite; metamorphosed | ?2750 | Mindoolah Mining Centre (Kalli) |
| Boodanoo Suite | Annean Supersuite | A-BD-xony-any | Layered gabbro, with dunite, pyroxenite, anorthosite, and hornblende gabbro; includes younger leucogabbro; metamorphosed | c. 2780[8] | Boodanoo Homestead (Coolamaninu) |
| Narndee Igneous Complex | Boodanoo Suite | A-BDnr-xony-any | Layered gabbro, with dunite, pyroxenite, anorthosite, and hornblende gabbro; includes younger leucogabbro; metamorphosed | c. 2780[8] | Narndee Homestead (Coolamaninu) |
| Meeline Suite | Annean Supersuite | A-ML-oxny-amy | Layered mafic–ultramafic intrusive rocks; dominantly gabbros, with anorthosite, magnetitite, and ultramafic cumulate rocks; metamorphosed | c. 2780[9,10] | Meeline Homestead (Challa) |
| Windimurra Igneous Complex | Meeline Suite | A-MLwi-xony-am | Layered gabbro and anorthosite with magnetitite and pyroxenite layers; includes younger gabbro and pyroxenite intrusions; metamorphosed | c. 2780[9,10] | Windimurra Homestead (Windimurra) |
| Youanmi Igneous Complex | Meeline Suite | A-MLyo-xony-am | Layered gabbro and anorthosite with magnetitite and pyroxenitic layers; metamorphosed | c. 2780 | Youanmi Townsite (Youanmi) |
| Lady Alma Igneous Complex | Meeline Suite | A-MLla-xony-am | Layered gabbro and anorthosite, with magnetitite and pyroxenite layers, and thick ultramafic cumulates; metamorphosed | 2821 ± 5[2] | Lady Alma mine (Gabanintha) |
| Atley Igneous Complex | Meeline Suite | A-MLat-xony-am | Layered gabbro and anorthosite with magnetitite and pyroxenitic layers; metamorphosed | c. 2780 | Atley Homestead (Atley) |
| Barrambie Igneous Complex | Meeline Suite | A-MLbm-xony-am | Layered gabbro and anorthosite with magnetitite and pyroxenitic layers; metamorphosed | c. 2780 | Barrambie Homestead (Sandstone) |
| **Austin Downs Supersuite** | | A-AD-xmg-og | Monzogranite, layered gabbro sills, and dolerite; commonly foliated; metamorphosed | 2720–2700[2,6] | Austin Downs Homestead (Cue) |
| Big Bell Suite | Austin Downs Supersuite | A-BB-mgm | Monzogranite; commonly foliated; metamorphosed | 2720–2700[6] | Big Bell (Cue) |
| Tough Go Monzogranite | Big Bell Suite | A-BBth-mgm | Monzogranite; commonly foliated; metamorphosed | 2710[5] | Tough Go Well (Reedy) |
| Batchelor Monzogranite | Big Bell Suite | A-BBba-mgm | Monzogranite; commonly foliated; metamorphosed | ?2710 | Batchelor Well (Reedy) |
| Crossroads Granodiorite | Big Bell Suite | A-BBcr-mgm | Monzogranite; commonly foliated; metamorphosed | 2702[6] | Crossroads Bore (Cue) |

| | Easting/Northing | Type area (1:000 000 map) | Area of occurrence | 1:250 000 map sheet(s) | 1:100 000 map sheet(s) | Previous use |
|---|---|---|---|---|---|---|
| | 625401/6998299 | 3 km west of Reedy (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 630243/7003356 | 5 km northeast of Reedy (Reedy) | NE Murchison Domain | Cue | Reedy | after Wang et al. (1993, 1995) |
| | 633255/7024765 | 25 km southwest of Meeka-tharra, 5 km west of Norie (abd; Meekatharra) | NE Murchison Domain | Belele | Meekatharra | No |
| | 637595/7028273 | 1 km west of Racecourse Well (Meekatharra) | NE Murchison Domain | Belele | Meekatharra | No |
| | 626820/6999112 | 3.5 km northeast of Reedy (Reedy) | NE Murchison Domain | Cue | Reedy | after Wang et al. (1993, 1995) |
| | 588762/6966095 | 1 km north of Cue | NE Murchison Domain | Cue | Cue | No |
| | 643620/7005250 | 17.5 km east-northeast of Reedy (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 547541/7018783 | Mindoolah Mining Centre (Kalli) | NE Murchison Domain | Belele | Kalli, Madoonga | No |
| | 623783/6821576 | 11 km south-southwest of Narndee Homestead (Bungar) | S Murchison Domain and N Southern Cross Domain | Kirkalocka, Ninghan | Coolamaninu, Bungar | No |
| | 615328/6797463 | 11 km south-southwest of Narndee Homestead | S Murchison Domain and N Southern Cross Domain | Kirkalocka, Ninghan | Coolamaninu, Bungar | Narndee intrusion Scowen (1991) |
| | 624323/6854118 | Composite of at least six complexes | E Murchison Domain | Glengarry, Cue, Sandstone, Youanmi, Kirkalocka, Ninghan | Wynyangoo, Woodley, Challa, Windimurra, Coolamaninu, Youanmi, Bungar, Gabanintha, Nowthanna, Atley, Youno Downs, Sandstone | Windimurra complex Ahmat (1986) |
| | 651527/6866032 | Windimurra Hills | S Murchison Domain | Cue, Sandstone, Kirkalocka,Youanmi | Wynyangoo, Woodley, Challa, Windimurra, Coolamaninu, Youanmi | Yes |
| | 678771/6833764 | 4 km west of Youanmi Townsite | SE Murchison Domain | Youanmi | Youanmi | Youanmi intrusion Stewart, et al. (1983) |
| | 667000/7017250 | Gabanintha Mining Centre extending for 5 km southeast | NE Murchison Domain | Glengarry, Sandstone | Gabanintha, Nowthanna | Gabanintha Formation and Gabanintha Rhyolite Wang (1998) |
| | 702864/6876126 | 15 km northeast of Atley Homestead | SE Murchison Domain | Youanmi | Atley | No |
| | 715947/6954020 | 2 km north of Barrambie Homestead | E Murchison Domain | Sandstone | Youno Downs, Sandstone | Barrambie gabbro (informal) |
| | 573652/6970757 | 500 m east of Big Bell Mine (Cue) | NE Murchison Domain | Cue, Glengarry | Cue, Austin, Reedy, Nowthanna | No |
| | 565235/6975486 | 500 m east of Big Bell Mine (Cue) | NE Murchison Domain | Cue, Glengarry | Cue, Austin, Reedy, Nowthanna | No |
| | 635084/7001742 | 3.5 km southwest of Tough Go Well | NE Murchison Domain | Cue, Glengarry | Reedy, Nowthanna | No |
| | 611200/6998084 | 500 m east-southeast of Batchelor Well (Reedy) | NE Murchison Domain | Cue | Cue, Reedy | No |
| | 568918/6969358 | 500 m east of Big Bell Mine (Cue) | NE Murchison Domain | Cue | Cue, Austin | No |

Table 1. Stratigraphic definitions of the Murchison Domain (continued)

| *Lithostratigraphic unit* | *Parent unit* | *Unit code* | *Lithology* | *Age (Ma)* | *Origin of name* |
|---|---|---|---|---|---|
| **Yalgowra Suite** | Austin Downs Supersuite | A-YA-xony-any | Layered mafic–ultramafic intrusive rocks; dominantly gabbro, minor basal ultramafic rocks; metamorphosed, variably deformed | c. 2720[4] | Yalgowra area (Madoonga) |
| Gnanagooragoo Igneous Complex | Yalgowra Suite | A-YAgn-xony-any | Layered dolerite, gabbro, wehrlite, and olivine–chromite cumulate rocks; metamorphosed | c. 2730 | Gnanagooragoo Hill, Weld Range (Madoonga) |
| **Tuckanarra Suite** | Austin Downs Supersuite | A-TU-mg | Monzogranite to granodiorite; commonly foliated; metamorphosed | 2685–2670[1] | Tuckanarra Hill (Reedy) |
| Munarra Monzogranite | Tuckanarra Suite | A-TUmu-mgm | Monzogranite; metamorphosed | 2670[1] | Munarra Hill (Reedy) |
| Karbar Monzogranite | Tuckanarra Suite | A-TUkb-mgm | Monzogranite; metamorphosed | c. 2670 | Karbar Homestead (Reedy) |
| Pirgan Monzogranite | Tuckanarra Suite | A-TUpr-mgm | Monzogranite; metamorphosed | c. 2670 | Pirgan Hill (Reedy) |
| **Jungar Suite** | Austin Downs Supersuite | A-JU-mgm | Monzogranite; metamorphosed | 2665–2645[1] | Jungar Pool (Cue) |
| Chunderloo Monzogranite (Meekatharra) | Jungar Suite | A-JUcl-mgm | Monzogranite; metamorphosed | 2665–2660[1] | Chunderloo Bore |
| Illagalara Monzogranite | Jungar Suite | A-JUig-gmg | K-feldspar megacrystic monzogranite, occasionally laminated; metamorphosed | c. 2645 | Illigalara Pool (Madoonga) |
| **Bald Rock Supersuite** | | A-BR-g | Monzogranite, syenogranite, and alkali granite; post-tectonic | 2637–2602 | Bald Rock (Cue) |
| Walganna Suite | Bald Rock Supersuite | A-WG-g | Monzogranite to syenogranite; post-tectonic | 2637–2602[2,3,7] | Walganna Rock (Noondie) |
| Taincrow Monzogranite | Walganna Suite | A-WGtc-g | Monzogranite to syenogranite; post-tectonic | c. 2625 | Taincrow Homestead (abd; Cue) |
| Telegootherra Monzogranite | Walganna Suite | A-WGtg-g | Monzogranite to syenogranite; post-tectonic | c. 2625 | |
| Garden Rock Monzogranite | Walganna Suite | A-WGga-g | Monzogranite to syenogranite; post-tectonic | c. 2625 | Garden Granite Rock (Wynyangoo) |
| Wogala Suite | Bald Rock Supersuite | A-WO-gfv | Fluorite-bearing alkali granite; post-tectonic | c. 2625 | Wogala Bore (Madoonga) |
| Marlomumbah Granite | Wogala Suite | A-WOma-gfv | Fluorite-bearing alkali granite; post-tectonic | c. 2625 | Marlomumbah Well (Madoonga) |

NOTES: 1 Geological Survey of Western Australia (2008)
2 Wang (1998)
3 Wiedenbeck and Watkins (1993)
4 Pidgeon and Hallberg (2000)
5 Wang et al. (1995)
6 Mueller et al. (1996)
7 Yeats et al. (1996)
8 Scowen (1991)
9 Nelson (2001)
10 Ahmat (1986)
abd = abandoned

| | *Easting/Northing* | *Type area (1:000 000 map)* | *Area of occurrence* | *1:250 000 map sheet(s)* | *1:100 000 map sheet(s)* | *Previous use* |
|---|---|---|---|---|---|---|
| | 592161/7014960 | Composite of at least four complexes | NE Murchison Domain | Belele, Cue, Glengarry, Sandstone | Kalli, Noondi, Cue, Madoonga, Meekatharra, Reedy | No |
| | 567100/702400 | Weld Range (Madoonga) | NE Murchison Domain | Belele, Cue | Kalli, Noondi, Cue, Madoonga | Weld Range Complex Parks (1998) |
| | 608236/6997530 | 2.5 km southwest of Jungar Pool | NE Murchison Domain | Cue, Belele | Cue, Reedy, Meekatharra | No |
| | 615452/7012259 | 1 km west of Munarra Hill (Reedy) | NE Murchison Domain | Cue, Belele | Reedy, Meekatharra | No |
| | 599537/7002671 | 6 km south of Karbar Homestead (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 603096/6990710 | 5 km southwest of Tuckanarra (Reedy) | NE Murchison Domain | Cue | Reedy | No |
| | 595187/7011864 | 17.5 km southwest of Meekatharra (Meekatharra) | NE Murchison Domain | Cue, Belele, Glengarry | Madoonga, Meekatharra, Cue, Reedy | No |
| | 638188/7045770 | 17.5 km southwest of Meekatharra (Meekatharra) | NE Murchison Domain | Belele, Glengarry | Meekatharra, Gabanintha | No |
| | 598134/7032253 | 20 km west-northwest of Annean Homestead (Meekatharra) | NE Murchison Domain | Cue, Belele | Cue, Madoonga | No |
| | 553103/6981193 | Bald Rock (Cue) | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Koonmarra, Tieraco, Glengarry, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyangoo | No |
| | 547830/6967902 | Walganna Rock (Noondie) | NE Murchison Domain | Cue, Belele, Glengarry, Sandstone | Koonmarra, Tieraco, Glengarry, Kalli, Madoonga, Meekatharra, Gabanintha, Noondie, Cue, Reedy, Nowthanna, Dalgaranga, Austin, Wynyangoo | No |
| | 613997/6983882 | Taincrow Rockhole (Cue) | NE Murchison Domain | Cue | Reedy | No |
| | 553103/6981193 | Bald Rock (Cue) | NE Murchison Domain | Cue, Belele | Kalli, Madoonga, Noondie, Cue | No |
| | 603250/6957000 | Garden Granite Rock (Wynyangoo) | NE Murchison Domain | Cue | Cue, Reedy, Austin, Wynyan-goo | No |
| | 596245/7044131 | Wogala Bore (Madoonga) | NE Murchison Domain | Belele | Madoonga | No |
| | 596245/7044131 | Wogala Bore (Madoonga) | NE Murchison Domain | Belele | Madoonga | No |