New evidence on the evolution of the Cue–Meekatharra area of the Murchison Domain, Yilgarn Craton

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Abstract

This paper presents a preliminary compilation of recent mapping and geochronological results from the northeastern part of the Murchison Domain, Yilgarn Craton. The data suggest that there are four volcanic packages deposited as ultramafic, mafic, through to felsic volcanic cycles: i) at c. 2970 Ma; ii) 2814–2799 Ma; iii) ≥2785–2745 Ma; and iv) c. 2720–2704 Ma. Emplacement of clotty-textured hornblende tonalites accompanied eruption of volcanic package 3, whereas the eruption of pillowed, pyroxene spinifex-textured komatiitic basalts of package 4 was accompanied by the widespread emplacement of thick differentiated mafic–ultramafic subvolcanic sills.

Two deformational events are recognized. Early east-trending folding (D_1) accompanied emplacement of granitic rocks, probably at around c. 2676 Ma. Second-generation structures (D_2) formed at 2660–2637 Ma and include north to north-northeasterly trending foliations, north- to northeast-plunging folds and lineations, and north-northwesterly striking sinistral shear zones and northeast-striking dextral shear zones that collectively indicate east–west compression. Gold mineralization is found within D_2 shear zones. Post-tectonic granites are c. 2623 Ma.

The sequence of events represented by the deposition of volcanic package 4, D_1–D_2 deformation, and intrusion of pre- to syn-D_2 granitic rocks are temporally equivalent to those in the Eastern Goldfields Superterrane of the Yilgarn Craton and warrant a reconsideration of current geodynamic models of terrane accretion.

KEYWORDS: tectonics, geochronology, structural geology, Youanmi Terrane, Yilgarn Craton, Archean

Introduction

The northeastern part of the Murchison Domain (hereafter NE Murchison Domain) forms part of the Youanmi Terrane within the Archean Yilgarn Craton (Cassidy et al., 2006: see inset of Fig. 1). The domain has long been recognized as containing an older geological history than its counterparts of the Eastern Goldfields Superterrane (EGS) of the eastern Yilgarn Craton, as recorded by greenstone ages of up to 3034 Ma (Pidgeon and Wilde, 1990; Schiøtte and Campbell, 1996; Pidgeon and Hallberg, 2000), and by four generations of granites, including c. 3050–2919 Ma pegmatite-banded gneisses and c. 2780–2740 Ma syn-volcanic plutons (Watkins et al., 1991; Wiedenbeck and Watkins, 1993). The ancient history of the domain is further emphasized by the presence of xenocrystic zircons in granites with ages of up to 4.0 Ga (Nelson et al., 2000).

Watkins and Hickman (1990) identified two volcano-sedimentary groups, whereas Pidgeon and Hallberg (2000) identified five volcanic assemblages. Geochronology has shown that the greenstones range in age from 3034–2704 Ma (Pidgeon and Wilde, 1990; Schiøtte and Campbell, 1996; Pidgeon and Hallberg, 2000). Champion and Cassidy (2007) recognized three geochemically distinct types of granitic rocks across the Murchison Domain, as did Wang et al. (1993). Champion and Cassidy (2007) also showed that a broad northeast-striking corridor of rocks between Meekatharra and Mount Magnet has relatively juvenile Sm–Nd model ages (to 2.95 Ga) compared with adjacent parts of the domain that have Sm–Nd model ages to 3.3 Ga.

In addition to an older rock record, the Murchison Domain has experienced an older and more prolonged deformation history than the EGS. Watkins and Hickman (1990) identified an early phase of deformation in some pegmatite-banded gneisses and in the lower volcanic succession. Nelson et al. (2000) suggested that deformation in the northwestern part of the Murchison Domain was completed at between 2689–2680 Ma, which contrasts with the peak of deformation in the EGS at 2670–2630 Ma. However, it has been shown that the Murchison Domain also experienced widespread granitic magmatism, ductile shearing, and gold mineralization at between 2675–2630 Ma, which indicates a degree of contemporaneity with events in the EGS (Wang et al., 1993).

Previous studies suggested that large-scale — 150 km — fold interference patterns in the Murchison Domain evolved through either granitic diapirism (Gee et al., 1981), or two sets of orthogonal compressional deformation events (Myers and Watkins, 1985). Mapping by Foley (1997) in the Yalgoo area provided support for the former model. Spaggiari (2006) identified a northeast-striking corridor of ductile deformation through the Cue–Meekatharra area, called the Meekatharra Structural Zone, interpreted to result from predominantly dextral ductile-shear deformation.

What remains unresolved from these earlier studies is: i) the origin of the dome-and-keel geometry of granites and greenstones in the Murchison Domain; ii) the nature and driving force of the

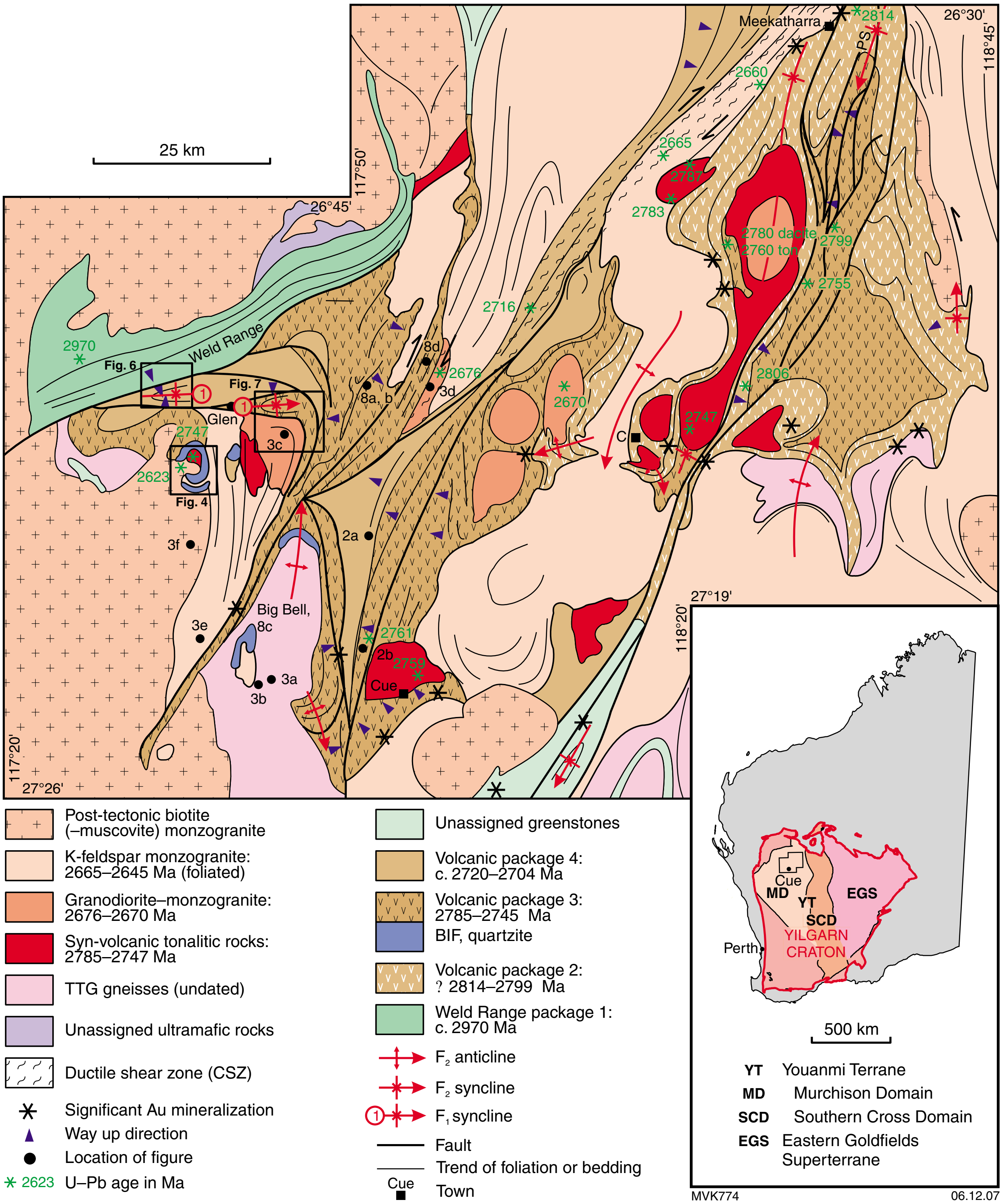


Figure 1. Interpreted bedrock geology map of the Cue to Meekatharra area of the Murchison Domain, showing the distribution of inferred volcanic packages and granitic suites, available age data, and major structural features. Interpretation is based on 1:100 000 mapping of the Cue and Meekatharra areas and on aeromagnetic data reinterpreted from Spaggiari (2006), GSWA (2007a,b), see text for references to non-GSWA geochronology. C = Culliculli; CSZ = Chunderloo Shear Zone; Glen = Glen Homestead; PS = Polelle Syncline, TTG = tonalite–trondhjemite–granodiorite. Locations of Figures 2, 3, 4, 6, 7, and 8 also shown. Inset shows location of figure within the tectonic framework of the Yilgarn Craton (after Cassidy et al., 2006)

pre-2660 Ma geotectonic history of the Murchison Domain; and iii) the processes that link c. 2660–2630 Ma events between the Murchison Domain and the EGS.

In this article, new lithological and structural map data are combined with recently acquired geochronological data and an interpretation of aeromagnetic images to suggest a four-fold division of volcanic rocks and a five-fold division of granitic rocks (Table 1; see also Spaggiari, 2006; Forbes et al, 2006; GSWA, 2007a,b). The data are used here to suggest that early deformation of the NE Murchison Domain was associated with greenstone sinking and emplacement of granites after 2720 Ma, probably at ~2680 Ma. This was followed by dextral north-northeasterly striking shear deformation and upright folding on northerly- to north-northeasterly trending axial planes at c. 2630 Ma, as part of Yilgarn-wide, east–west compressional deformation superimposed on a crust that had been thoroughly softened through partial melting and granite intrusion.

New map and structural data

Greenstone assemblage

Greenstones in the map area can be divided into four volcanic packages, based on age data and the concept of ultramafic to felsic volcanic cycles (Fig. 1). In, and to the north of, the Weld Range is a thick succession of felsic volcanic and volcaniclastic sandstones that overlies poorly exposed tholeiitic basalts. This package contains thick layers of banded iron-formation (BIF) that form the Weld Range. As with volcanic package 3 in the Cue–Glen Homestead area, felsic volcanic and sedimentary rocks of the Weld Range area have been intruded by thick, differentiated gabbroic sills and are overlain by low-grade komatiitic basalts. A 2970 ± 4 Ma date (GSWA, 2007; sample GSWA 184112*) from felsic volcanic rocks just north of the Weld Range indicates older felsic volcanism in this area than in the Cue–Meekatharra area to the south and east.

In the Meekatharra area (including greenstones to the east and south of the town), volcanic package 2 consists of tholeiitic basalts and an overlying unit of felsic volcaniclastic sedimentary rocks and BIF (Fig. 1; Table 1). The base of this succession is intruded by younger (c. 2780 and 2660 Ma) granitic rocks, so that the full range of lithologies in this package is unknown. A sample of felsic volcaniclastic sedimentary rock from this package has a maximum depositional age of 2814 ± 3 Ma (GSWA 183953). A 2806 ± 4 Ma rhyolite (GSWA 178142) in the far southern part of the belt confirms the antiquity of volcanism. A 2799 ± 2 Ma felsic volcaniclastic sandstone from near the core of the Polelle Syncline is also interpreted as part of this package, lying immediately beneath komatiitic basalts of package 3 (see below). These dates are consistent with a minimum age for this package as given by a cross-cutting, hornblende-bearing granite dated at c. 2785 Ma, located about 25 km southwest of Meekatharra (Fig. 1; GSWA 178102, 178104).

Volcanic package 3 in the Meekatharra area is broadly conformable on underlying rocks. It consists of an upward-younging succession of komatiitic basalt, tholeiitic basalt, andesite, and local dacite. An extrusive dacite from this package has been dated at 2784 ± 22 Ma (sample 87-322 in Wiedenbeck and Watkins, 1993), and an andesitic volcanic extrusive rock dated at c. 2755 Ma (GSWA 178105). This age range is similar to that for three dated syn-volcanic hornblende-bearing tonalite intrusions in the belt, which range from 2785 to 2745 Ma (GSWA 178102, 178104, 178141; sample PFG-1 in Wiedenbeck and Watkins, 1993).

In the Cue–Glen Homestead area the stratigraphically lowest volcanic package is correlated with volcanic package 3 from the Meekatharra area because of their similar age and the continuation of stratigraphy between the belts across the antiform located just west of Culliculli (C on Fig. 1). This package contains thin units of quartzite and BIF at, or very near, the base of the succession that are intruded by sheeted, foliated granitic rocks (Fig. 1). These sedimentary rocks are conformably overlain by a ~10 km-thick package of dominantly tholeiitic basalts that passes gradationally upwards into andesitic flows and thick dacitic to rhyolitic volcaniclastic rocks. Rhyolitic crystal tuffs from this package are 2761 ± 4 Ma (Pidgeon and Hallberg, 2000), the same age as hornblende-bearing tonalite at Cue (2759 ± 4 Ma), and close to the age of a mafic clotty-textured tonalite from west of Glen Homestead, which is c. 2747 Ma (GSWA 178196). A similar date of 2744 ± 5 Ma was obtained from an andesite in the Abbotts greenstone belt, just north of the study area on BELELE† (GSWA 178106), suggesting that this package extends outside the map area.

Volcanic package 3 in the Cue–Glen Homestead area is ?conformably overlain by a thick package of low-grade komatiitic basalts and minor interbedded felsic volcanic rocks that comprise volcanic package 4 (Table 1). Basal flow units

* Results of geochronology for GSWA sample numbers may be found in the reference Geological Survey of Western Australia (2007), shown in the text as GSWA and a six-figure number

† Capitalized names refer to 1:250 000 maps unless otherwise indicated

Table 1. Comparison between the timing of deposition/intrusion for the three areas of the NE Murchison Domain (see text for geochronology references)

Age (Ma)	Dalgaranga greenstone belt (southwest)	Cue–Glen Homestead area and Weld Range	Meekatharra area (northeast)	Volcanic package/ granite suite
2600				
		2623 Ma K-feldspar monzogranite		Post-tectonic granite 5
			2637 Ma shear Au	D_2
			2644, 2648 Ma granite	Pre- to syn-D_2 granite 4
2650				
			2665, 2660 Ma granite	Pre- to syn-D_2 granite 3
		2676 Ma layered granodiorite	2670 Ma granite	D_1
2700				
		2716 Ma rhyolite		
	2719 Ma gabbro	komatiitic basalt		Volcanic 4
2750	2747 Ma felsic volcanic rocks	2747 Glen tonalite	2755 Ma andesite	
		2759 Cue tonalite	2760 Ma tonalite	Syn-volcanic granite 2
		2761 Ma rhyolite tuffs		Volcanic 3
		Tholeiitic and komatiitic basalt	2784 Ma dacite 2785 Ma hornblende granite	
		BIF and quartzite	komatiite, komatiitic and tholeiitic basalt	
2800			2799 Ma volcaniclastic sandstone	
			2804 Ma rhyolite	Volcanic 2
			2814 Ma felsic sedimentary rocks	
			tholeiitic basalt	
2850				
≷				
		× 2920 Ma	× 2898 Ma	
	× 2970 Ma	2970 Ma Weld Range		Volcanic 1
3000	× 3034 Ma	× 2998, 3010 Ma	× 3027 Ma	Early TTG granite 1

NOTES: TTG = Tonalite–trondhjemite–granodiorite
× = xenocrystic zircons
Red lettering denotes granitic events
Darker blue shading denotes volcano-plutonic events
Dark blue lines denote base of volcanic packages
Dark yellow denotes gold mineralization

contain coarse pyroxene-spinifex texture (Fig. 2a). However, the majority of the unit consists of pillowed units with fine-grained pyroxene-spinifex texture. Associated with the komatiitic basalts are thick differentiated mafic–ultramafic sills that were emplaced into the underlying volcanic package 2, particularly within felsic volcaniclastic rocks. These sills range from dunite and pyroxenite at their base, to gabbro and leucogabbro with long feathery pyroxene crystals at their tops (Fig. 2b). Although the gabbroic sills have not been dated in the current map area, Pidgeon and Hallberg (2000) obtained an age of 2719 ± 6 Ma from similar thick gabbroic sills emplaced in c. 2747 ± 5 Ma greenstones in the Dalgaranga greenstone belt, located ~60 km southwest of Cue. The c. 2720 Ma date is used to estimate the time of eruption of the komatiitic basalts in the Cue area. A similar young age of volcanism is given by a 2716 ± 4 Ma age of a sheared fragmental rhyolite in volcanic package 3, located about halfway between Meekatharra and Glen Homestead (Pidgeon and Hallberg, 2000). The youngest date for this package is c. 2704 Ma (Schiøtte and Campbell, 1996).

Granitic rocks

Five generations (?suites) of granitic rocks have been identified in the map area, based on composition, the nature and degree of deformation, cross-cutting relationships, and age (Fig. 1).

The oldest generation is composed of bluish grey-weathering, hornblende(–biotite) tonalite–trondhjemite–granodiorite and quartz diorite rocks, which are typically sheeted at a scale of a few metres and are locally gneissic with veins of leucogranite (Fig. 3a). These rocks have not yet been dated.

The second generation of granitic rocks are syn-volcanic granites characterized by tonalitic compositions and mafic clotty textures consisting of 0.5 – 4 cm large hornblendite clots (Fig. 3b). Because of the widespread distribution and abundance of the clots, this texture is interpreted as evidence of 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 (Fig. 3c). These granitic rocks locally display evidence of having been affected by two sets of structures, which further differentiates them from younger granitic suites that are more potassic, lack mafic clots, and display evidence of only a single deformational event. The age of two mafic clotty-textured tonalites from southwest of Glen Homestead and east of

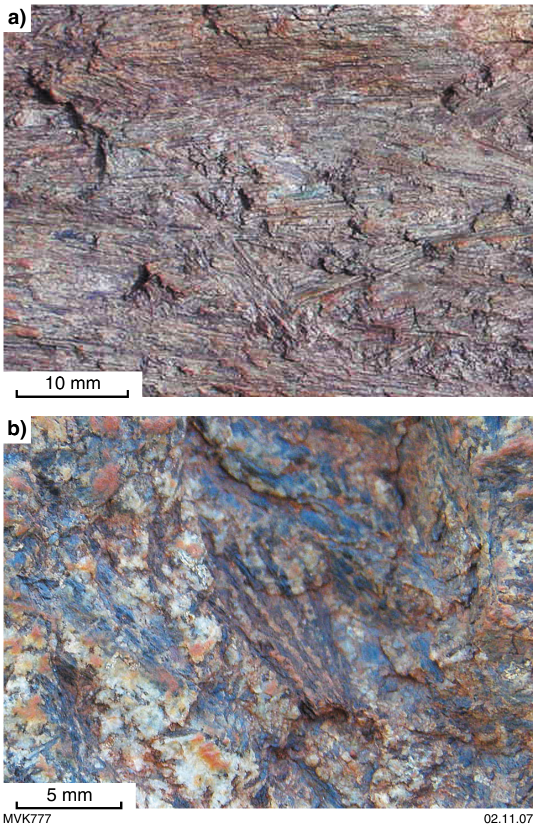


Figure 2. Pyroxene-spinifex textures from rocks belonging to volcanic package 3 in the Cue area: a) coarse pyroxene-spinifex texture in a flow unit near the base of the package; b) long feathery pyroxene crystals in leucogabbro near the top of a differentiated sill emplaced into the lower volcanic package

Culliculli are both 2747 ± 4 Ma (GSWA 178141, 178196). Older components of this suite include the Cue Tonalite (2759 ± 4 Ma; sample W378 in Pidgeon and Hallberg, 2000), a 2760 ± 8 Ma massive tonalite from the syncline south-southwest of Meekatharra (sample PFG-1 in Wiedenbeck and Watkins, 1993), and dates from a hornblende tonalite and a biotite granodiorite from southwest of Meekatharra, at c. 2785 Ma (GSWA 178102, 178104).

The third generation of granitic rocks includes compositionally layered granodiorites (Fig. 3d) and more homogeneous monzogranites. These granitic rocks split apart the greenstone assemblage and have been affected by only the late phase of shear-related deformation. They range in age from 2676 to 2670 Ma (GSWA 178190, 178199).

A fourth generation of granitic rocks consists dominantly of well-foliated K-feldspar porphyritic biotite monzogranites, dated in the range 2665–

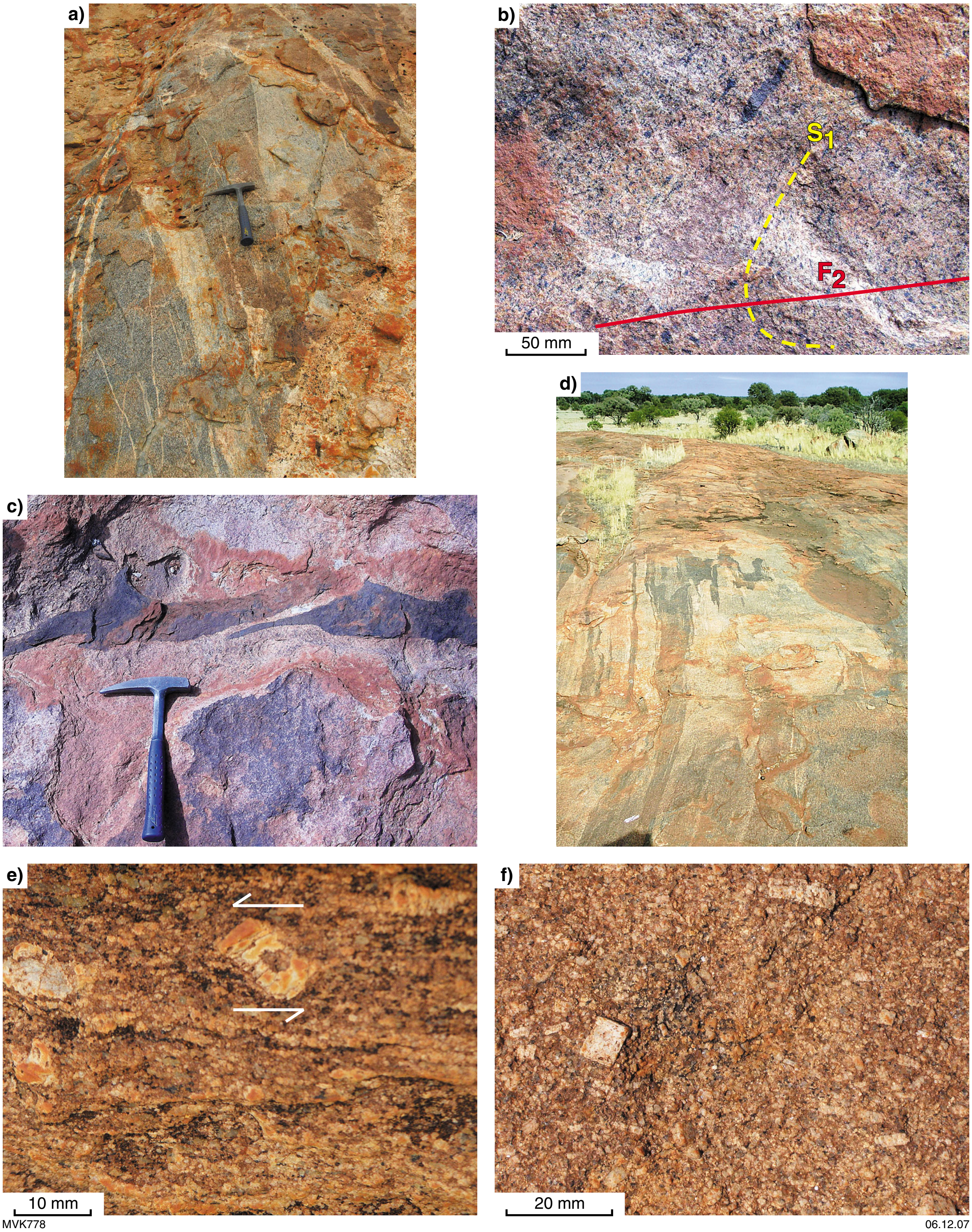


Figure 3. Granitic rock types of the Cue area: a) sheeted blue-grey tonalite–trondhjemite–granodiorite rocks of undated, but presumably oldest, generation; b) mafic clotty-textured metatonalite of the syn-volcanic suite, showing evidence of two deformational events in the form of flattened (S_1) and then folded (F_2) mafic clots; c) syn-plutonic mafic dyke in monzogranite from southeast of Glen Homestead (see Fig. 7 for location); d) compositionally layered granodiorite–monzogranite (c. 2676 Ma), showing primary igneous layering and overprinting S_2 foliation; e) sinistrally rotated K-feldspar phenocryst in c. 2660 Ma monzogranite; f) undeformed K-feldspar megacrystic monzogranite of the post-tectonic suite

2645 Ma (GSWA 187651, 187655, 178101, and 178103). These rocks are characterized by strong shear fabrics (Fig. 3e), and field relationships suggest emplacement during, or just before, shearing. This is consistent with the evidence from Wang et al. (1993) for gold-related shearing at 2637 ± 4 Ma.

A post-tectonic suite of undeformed granitic rocks comprises biotite(–muscovite) monzogranites to syenogranites that range in texture from coarsely K-feldspar porphyritic to coarse-grained, equigranular rocks (Fig. 3f). A sample of this unit 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 (Fig. 1; GSWA 178197).

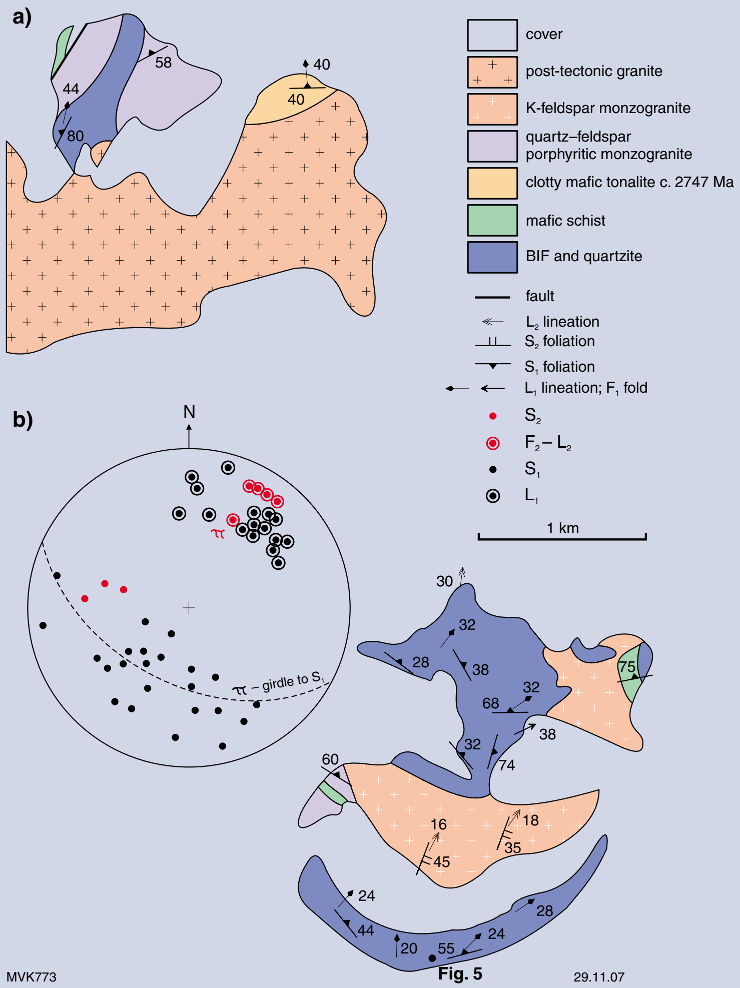


Figure 4. (a) Simplified geological map of part of the Cue area, showing structures in an area of tight folding of BIF and quartzite. Inset (b) shows equal area stereoplot of measured D_1 and D_2 fabric elements from this area, including π-girdle calculated from poles to S_1, and the resultant π-pole

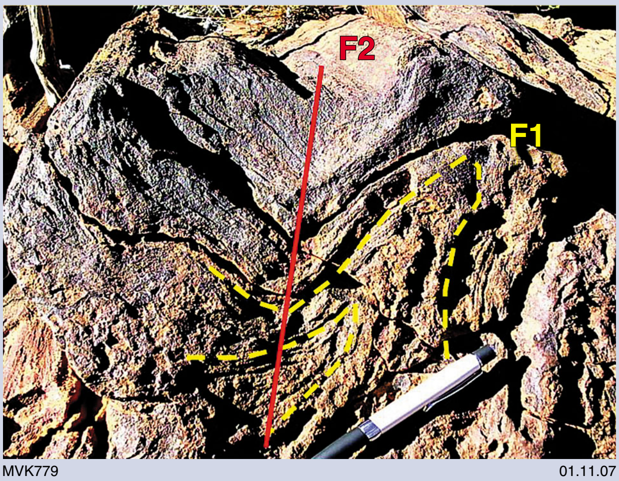


Figure 5. View, looking north, of a refolded tight F_1 fold and upright F_2 fold in BIF from the base of volcanic package 2 in the Cue area (see Figure 4 for location)

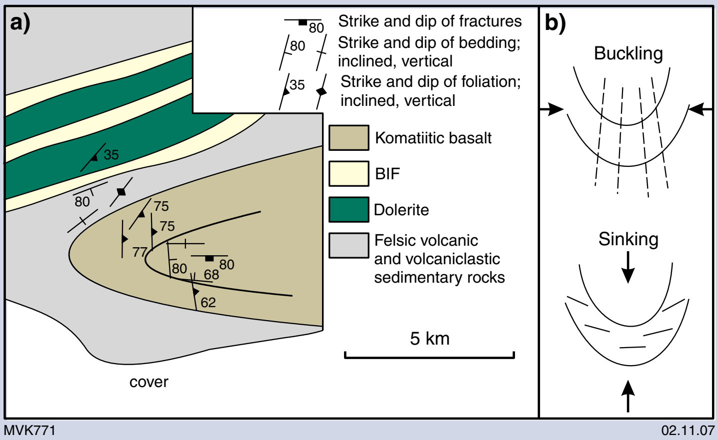
Structural geology

Three key observations can be made about the structural development of the map area. Firstly, overprinting relationships show that a set of north- to north-northeasterly striking folds, shear zones, and foliations represent D_2 structures that overprint easterly striking D_1 folds preserved just to the south of the Weld Range (Figs 4 and 5). As described in more detail below, the second observation is that D_1 structures resulted through greenstone sinking and granite emplacement. The third observation is that D_2 structures become increasingly more penetrative from west to east across the map area and include northerly plunging folds, northerly striking foliations, north-northwesterly striking sinistral high-strain zones and northeast-striking dextral shear zones (Fig 1).

Nature of D_1 deformation (post-2720 Ma, pre-2660 Ma)

The second key structural observation mentioned above relates to the geometry between foliations and bedding in one of the east-trending F_1 synclines south of the Weld Range (Fig. 6). In this fold, which has steeply dipping limbs and a fold axis that plunges steeply to the north, foliations are oblique to bedding in an anticlockwise direction on the northern limb of the fold and in a clockwise direction on the southern limb of the fold. There is no evidence of axial planar foliations except in the very innermost part of the hinge where a spaced fracture cleavage parallel to the axial plane is developed (Fig. 6a). This geometry of the foliations with respect to bedding on the limbs of the fold excludes buckling as the fold mechanism, but supports fold formation through sinking of greenstones into the surrounding granitic rocks (Fig. 6b; Dixon, 1975). The steep plunge of the fold axis suggests a significant degree of highly asymmetric greenstone sinking.

Figure 6. a) simplified map of structures in part of the tight east–west striking F_1 fold of the southwestern Weld Range area (see Fig. 1 for location), showing foliations at an oblique angle to bedding around the fold hinge; b) sketches of different fold models and related strain resulting from buckling (top) and vertical sinking of greenstones into soft granitic crust (bottom). Solid lines represent folded bedding, whereas dashed lines indicate trend of foliations



Observations from the isoclinal, east-trending syncline to the east of the fold described above support a cause-and-effect relationship between granite emplacement and at least partial F_1 fold development in greenstones. In this case, the domical granite body to the south of the fold is well-exposed and shows evidence for inflation through intrusion of pegmatitic granite sheets that are aligned parallel to the granite–greenstone contact (Fig. 7). Therefore, it appears that at least part of the amplitude of the folded greenstones is due to, or coincident with, doming of granitic rocks.

Dating of granites (GSWA, 2007) shows that D_1 structures formed after 2747 Ma, the age of a mafic clotty-textured tonalite that contains D_1 structures, and after the intrusion of a gabbroic sill of inferred c. 2720 Ma age that has been deformed into an F_1 fold. In contrast, 2676 Ma granites show only the D_2 fabric set, suggesting that D_1 formed prior to, or possibly at, this time.

D_2 deformation (2660–2630 Ma)

The third key structural observation mentioned above is that D_2 structures become progressively stronger and more pervasive from west to east across the map area (Fig. 1). In the far west of the map area, the east-trending F_1 fold displayed in Figure 6 is unaffected by D_2 deformation, whereas the F_1 fold to the east contains north-striking S_2 foliations and F_2 folds that overprint S_1–L_1 fabrics (Fig. 7b). To the south of this fold structure is a broad zone of strong north-trending foliations in granitic rocks that die out to the north along strike (Fig. 1). These foliations lack strong lineations and asymmetric kinematic indicators, suggesting deformation through flattening. The fact that these foliations die out into greenstones along strike to the north suggests that the fabric developed while the granites were being emplaced and still soft, whereas basaltic greenstones were competent and largely unaffected by the D_2 flattening. North-northeasterly trending ridges of BIF to the east of this F_1 fold are deformed into a large-scale,

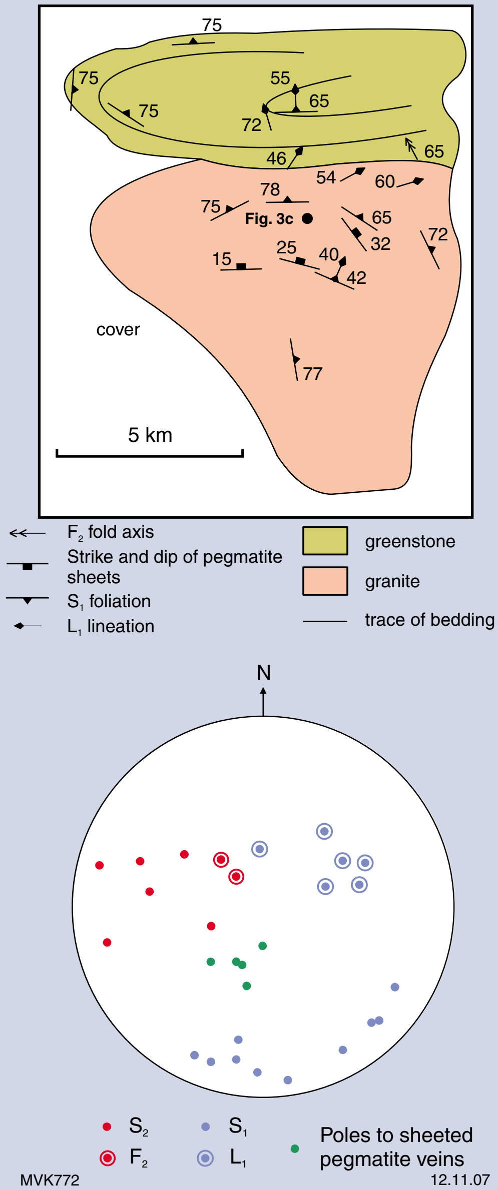


Figure 7. Simplified map of structures in part of the isoclinal east–west trending F_1 fold just east of Glen Homestead (see Fig. 1 for location), showing D_1 and D_2 structures and pegmatite sheeting in granitic rocks to south

north-northeasterly trending tight D_2 fold on a steeply plunging hinge. Minor D_2 folds show Z and S asymmetry on the east and west limbs of this fold, respectively, and have a spaced axial planar S_2 cleavage (Fig. 8a,b).

To the south and east of Glen Homestead, rocks become strongly deformed within a north-northeasterly striking corridor of anastomosing and domainal high shear-strain, the western boundary of which is marked by the high-strain shear zone that runs through the Big Bell mine (Figs 1, 8c). In the southern part of this shear zone, very strong subvertical foliations contain steeply north-plunging metamorphic mineral lineations. Further north along strike, lineations plunge shallowly to moderately to the south and are associated with dextral kinematic indicators recognizable both in sheared metavolcanic rocks (Fig. 8d) and granitic rocks within the Chunderloo Shear Zone (Fig. 1; Spaggiari, 2006). Interpretation of aeromagnetic data suggests this shearing was contemporaneous with the formation of upright, north- to north-northeasterly trending F_2 folds across the eastern part of the map area, including the Polelle Syncline east of Meekatharra (Fig. 1). D_2 structures formed during, or soon after, emplacement of 2660 Ma granites, and continued to form until c. 2630 Ma (Wang et al., 1993).

Summary and conclusions: implications for craton evolution

Generation of the large-scale dome-and-keel granite–greenstone geometry of the NE Murchison Domain appears related to a combination of vertical tectonics during D_1 as well as fold interference resulting from east–west D_2 compression. During D_1, structural data indicate that greenstones sank into thermally softened granitic middle crust, causing remobilized granitic material derived from partial melting of older granitic crust to rise into the upper crust as inflated domes, following a similar process to that invoked for the East Pilbara Terrane of the Pilbara Craton (Van Kranendonk et al., 2004). The D_1 event occurred some time after 2720 Ma, but before, or during, emplacement of c. 2676 Ma granites, and thus is likely to correspond to the deformational event recognized by Nelson et al. (2000) in rocks

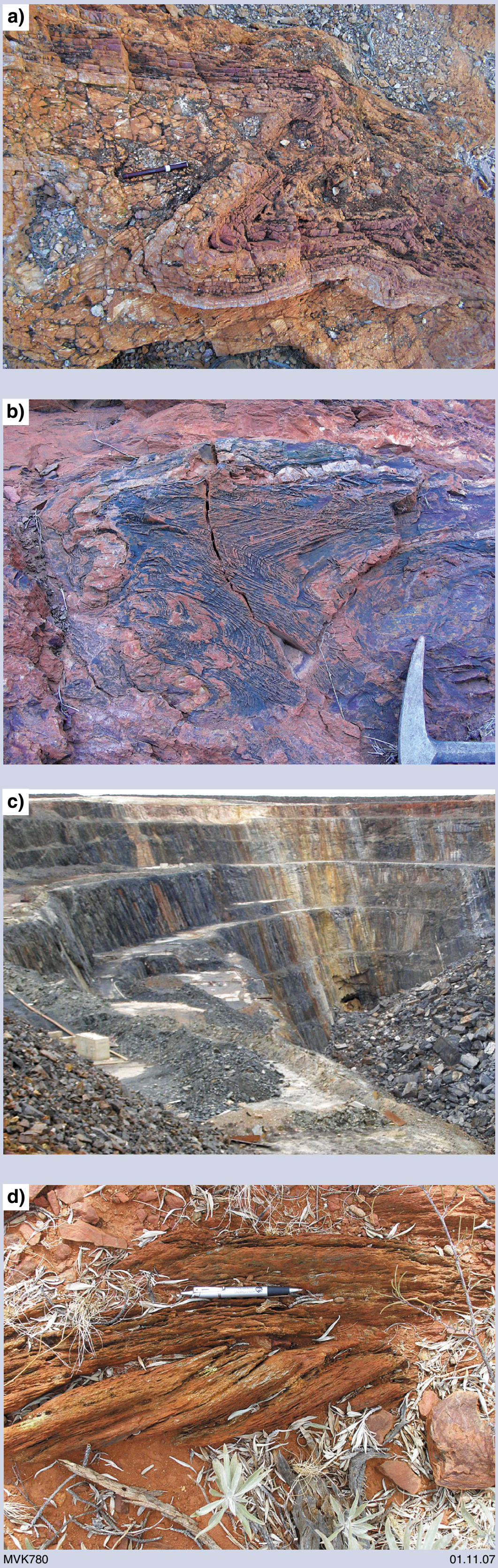


Figure 8. D_2 structural features of the study area: a) tight, steeply plunging Z-asymmetrical fold of BIF from east of Glen Homestead; b) axial planar cleavage in hinge of folded BIF from east of Glen Homestead; c) view north of the pit wall of the Big Bell mine, showing intense, steeply east-dipping D_2 shear fabric; d) view, looking down, facing northwest, of dextral S–C fabric relationship in strongly sheared metavolcanic rocks. See Figure 1 for image locations

further to the northwest. Subsequent regional east–west shortening during D_2 deformation was responsible for refolding of this earlier fold pattern (Figs 4, 5).

The driving forces for pre-2660 Ma events in the NE Murchison Domain are yet to be fully understood, but include 100 Ma of almost continuous volcanism (2814–2716 Ma; Table 1) and plutonic activity during crust formation. An interesting feature of this history is that the final stage of volcanism (2720–2704 Ma volcanic package 4), and emplacement of granitic rocks at 2676–2645 Ma in the NE Murchison Domain, overlap with the onset of volcanism and granite emplacement in the EGS of the Yilgarn Craton (Blewett and Czarnota, 2007). In the NE Murchison Domain, this event is instigated by the eruption of a thick sequence of pyroxene spinifex-textured komatiitic basalt, hinting at the arrival of a mantle plume at this time (Campbell et al., 1989). Emplacement of granitic rocks and associated greenstone sinking (D_1) is most likely to result from partial melting of older crust as a consequence of heat derived from the plume event, but following a time lag required for conductive heat transfer from the plume head through the crust (e.g. Campbell and Hill, 1988). The similarity of ages and events between the NE Murchison Domain and EGS warrants a re-examination of existing subduction–accretion geodynamic models for Yilgarn Craton evolution (Barley et al., 2007; Van Kranendonk, 2007).

D_2 deformation at 2660–2630 Ma in the NE Murchison Domain is contemporaneous with dominantly transpressional shear deformation and gold mineralization in the EGS (2655–2620 Ma: Weinberg et al., 2003; Blewett and Czarnota, 2007) and is contemporaneous with, to younger than, shear deformation in the Southern Cross Domain of the Youanmi Terrane (Chen et al., 2004). This deformation is younger than the timing of the end of deformation suggested by Nelson et al. (2000) and indicates its domainal nature in the Murchison Domain. Significantly, the geometry of D_2 structures is similar to the shear deformation in the Southern Cross Domain (sinistral north-northwest striking shear zones and dextral north-northeast striking shear zones connected by north–south zones of pure shear flattening; Chen et al., 2001a,b, 2004), and documents progressive development of east–west compression across the craton. In the NE Murchison Domain, the bulk of Au mineralization is associated with D_2 structures (Fig. 1), coincident with the more bountiful Au mineralization in the EGS.

References

Barley, ME, Brown, SJA, Krapez, B, Cassidy, KF, Champion, DJ, and Kositcin, N, 2007, Assembling the Eastern Yilgarn Craton: terranes and tectonostratigraphic components, *in* Proceedings of Geoconferences (WA) Inc, Kalgoorlie '07 Conference *edited by* FP Bierlein and CM Knox-Robinson: Geoscience Australia, Record 2007/14, p. 14–17.

Blewett, R, and Czarnota, K, 2007, A new integrated tectonic framework of the Eastern Goldfields Superterrane, *in* Proceedings of Geoconferences (WA) Inc, Kalgoorlie '07 Conference *edited by* FP Bierlein and CM Knox-Robinson: Geoscience Australia, Record 2007/14, p. 27–32.

Campbell, IH, and Hill, RI, 1988, A two-stage model for the formation of the granite–greenstone terrains of the Kalgoorlie–Norseman area, Western Australia: Earth and Planetary Science Letters, v. 90, p. 11–25.

Campbell, IH, Griffiths, RW, and Hill, RI, 1989, Melting in an Archean mantle plume: heads it's basalts, tails it's komatiites: Nature, v. 339, p. 697–699.

Cassidy, KC, Champion, DC, Krapez, B, Barley, ME, Brown, SJA, Blewett, RS, Groenewald, PB, and Tyler, IM, 2006, A revised geological framework for the Yilgarn Craton, Western Australia: Geological Survey of Western Australia, Record 2006/8, 8p.

Champion, DC, and Cassidy, KC, 2007, An overview of the Yilgarn Craton and its crustal evolution, *in* Proceedings of Geoconferences (WA) Inc, Kalgoorlie '07 Conference *edited by* FP Bierlein and CM Knox-Robinson: Geoscience Australia, Record 2007/14, p. 8–13.

Chen, SF, Libby, JW, Greenfield, JE, Wyche, S, and Riganti, A, 2001a, Geometry and kinematics of large arcuate structures formed by impingement of rigid granitoids into the greenstone belts during progressive shortening: Geology, v. 29, p. 283–286.

Chen, SF, Witt, WK, and Liu, S, 2001b, Transpression and restraining jogs in the northeastern Yilgarn Craton, Western Australia: Precambrian Research, v. 106, p. 309–328.

Chen, SF, Libby, JW, Wyche, S, and Riganti, A, 2004, Kinematic nature and origin of regional-scale ductile shear zones in the central Yilgarn Craton, Western Australia: Tectonophysics, v. 394, p. 139–153.

Dixon, JM, 1975, Finite strain and progressive deformation in models of diapiric structures: Tectonophysics, v. 28, p. 89–124.

Foley, BJ, 1997, Reassessment of Archaean tectonics in the Yalgoo District, Murchison Province, Western Australia: Melbourne, Victoria, Monash University, BSc thesis (unpublished).

Forbes, CJ, Chen, SF, Wyche, S, and Spaggiari, CV, 2006, Greenstones and structures of the Meekatharra area, Youanmi Terrane, western Yilgarn Craton: Geological Society of Australia, Abstracts 82, p. 180.

Gee, RD, Baxter, JL, Wilde, SA, and Williams, IR, 1981, Crustal development in the Archaean Yilgarn Block, Western Australia: Special Publication, Geological Society of Australia, v. 7, p. 43–56.

Geological Survey of Western Australia, 2007a, Compilation of geochronology data, June 2007 update: Geological Survey Western Australia.

Geological Survey of Western Australia, 2007b, Murchison: Geological Survey of Western Australia, 1:100 000 Geological Information Series.

Myers, JS, and Watkins, KP, 1985, Origin of granite–greenstone patterns, Yilgarn Block, Western Australia: Geology, v. 13, p. 778–780.

Nelson, DR, Robinson, BW, and Myers, JS, 2000, Complex geological histories extending for ≥4.0 Ga deciphered from xenocryst zircon microstructures: Earth and Planetary Science Letters, v. 181, p. 89–102.

Pidgeon, RT, and Hallberg, JA, 2000, Age relationships in supracrustal sequences of the northern part of the Murchison Terrane, Archaean Yilgarn Craton, Western Australia: a combined field and zircon U–Pb study: Australian Journal of Earth Sciences, v. 47, p. 153–165.

Pidgeon, RT, and Wilde, SA, 1990, The distribution of 3.0 Ga and 2.7 Ga volcanic episodes in the Yilgarn Craton of Western Australia: Precambrian Research, v. 48, p. 309–325.

Schiøtte, L, and Campbell, IH, 1996, Chronology of the Mount Magnet granite–greenstone terrain, Yilgarn Craton, Western Australia: implications for field based predictions of the relative timing of granitoid emplacement: Precambrian Research, v. 78, p. 237–260.

Spaggiari, CV, 2006, Interpreted bedrock geology of the northern Murchison Domain, Youanmi Terrane, Yilgarn Craton: Geological Survey of Western Australia, Record 2006/10, 19p.

Van Kranendonk, MJ, 2007, Litho-structural development of the northern Murchison domain within the context of Yilgarn Craton evolution, *in* Proceedings of Geoconferences (WA) Inc, Kalgoorlie '07 Conference *edited by* FP Bierlein and CM Knox-Robinson: Geoscience Australia, Record 2007/14, p. 23–26.

Van Kranendonk, MJ, Collins, WJ, Hickman, AH, and Pawley, MJ, 2004, Critical tests of vertical vs horizontal tectonic models for the Archaean East Pilbara Granite–Greenstone Terrane, Pilbara Craton, Western Australia: Precambrian Research, v. 131, p. 173–211.

Wang, LG, McNaughton, NJ, and Groves, DI, 1993, An overview of the relationship between granitoid intrusions and gold mineralisation in the Archean Murchison Province, Western Australia: Mineralium Deposita, v. 28, p. 482–494.

Watkins, KP, Fletcher, IR, and de Laeter, JR, 1991, Crustal evolution of Archaean granitoids in the Murchison Province, Western Australia: Precambrian Research, v. 50, p. 311–336.

Watkins, KP, and Hickman, AH, 1990, Geological evolution and mineralization of the Murchison Province, Western Australia: Geological Survey of Western Australia, Bulletin 137, 267p.

Weinberg, RF, Moresi, L, and van der Borgh, P, 2003, Timing of deformation in the Norseman–Wiluna Belt, Yilgarn Craton, Western Australia: Precambrian Research, v. 120, p. 219–239.

Wiedenbeck, M, and Watkins, KP, 1993, A timescale for granitoid emplacement in the Archean Murchison Province, Western Australia, by single zircon geochronology: Precambrian Research, v. 61, p. 1–26.