The Burtville Terrane, northeast Yilgarn Craton: does it really belong in the Eastern Goldfields Superterrane?

by

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The Burtville Terrane is located along the northeastern margin of the Yilgarn Craton, and is the easternmost terrane of the Eastern Goldfields Superterrane (Cassidy et al., 2006). The terrane is bounded to the west by the c. 2715–2685 Ma Kurnalpi Terrane, and is separated from it by the Hootanui Fault (Fig. 1). The Burtville Terrane comprises three domains: from west to east the Duketon, Merolia, and Yamarna Domains. The domain subdivision was based predominantly on major structural features, identified by aeromagnetic and seismic data, and includes the Yamarna Shear Zone, which separates the Merolia and Yamarna Domains (Fig. 1). The Duketon Domain, the best documented of the three domains, comprises a succession of felsic, mafic, and ultramafic volcanism older than that observed in either the Kurnalpi Terrane or Kalgoorlie Terrane to the east (e.g. Dunphy et al., 2003; Kositcin et al., 2008).

Recent 1:100 000-scale mapping in the Merolia and Yamarna Domains by the Geological Survey of Western Australia has delineated several felsic to mafic and ultramafic rock packages. New geochronological data obtained during the course of the mapping indicate the supracrustal sequences in the Merolia Domain are markedly older than those in the Yamarna Domain. In contrast, SHRIMP U–Pb zircon dating and mapping of the supracrustal rocks of the Yamarna Domain suggest that these rocks are contemporaneous with those in the Kalgoorlie and Kurnalpi Terranes. These findings suggest the need for a revision of the Eastern Goldfields Superterrane concept.

Merolia and Duketon Domains

A 440 m-thick felsic to mafic package at Ulrich Range (Fig. 1) in the northern Merolia Domain is dominated by amphibolite-facies metabasalts and pillowed basalts intercalated with minor metadacitic, meta-andestic and metasiliciclastic rocks. SHRIMP U–Pb zircon dating of a meta-andesite indicates a crystallization age of 2961 ± 5 Ma (GSWA sample 193363, Geological Survey of Western Australia, in prep.).

The Mount Venn greenstone belt (Fig. 1) comprises a mafic–ultramafic succession containing minor metasedimentary rocks and chert that is overlain by c. 2770 Ma felsic volcaniclastic and coherent rocks (GSWA samples 178122, 183118, Geological Survey of Western Australia, in prep.). At the northern end of this belt, the mafic–ultramafic rocks are intruded by a layered gabbro complex that contains a 30 cm-wide pegmatitic leucogabbro that has yielded a magmatic crystallization age of 2755 ± 5 Ma (GSWA sample 185976, Geological Survey of Western Australia, in prep.). This is the same age as a hornblende plagiogranite interpreted to be a fractionated felsic component of layered gabbro in the Duketon Domain (Fletcher et al., 2001). The Mount Venn layered intrusion at the southern end of the belt intrudes the upper part of the succession and is texturally different from the dated layered gabbro complex. Attempts to date the Mount Venn intrusion have been unsuccessful. The eastern margin of the Mount Venn greenstone belt is in sheared contact with schlieric monzogranite with a magmatic age of 2932 ± 3 Ma (GSWA sample 179448, Geological Survey of Western Australia, in prep.).

The occurrence of c. 2770 Ma felsic rocks is not limited to the Mount Venn area. New geochronological data on a volcaniclastic sandstone within a mafic–ultramafic sequence near Stella Range in the Irwin Hills greenstone belt (Fig. 1) have yielded an age of 2774 ± 5 Ma (GSWA sample 193362, Geological Survey of Western Australia, in prep.). In addition, a 2769 ± 8 Ma age of crystallization has been determined for a metagranite lying 7 km north of Stella Range (GSWA sample 193360, Geological Survey of Western Australia, in prep.). In the southern Duketon Domain, a biotite granite and the granite precursor to a biotite migmatite are dated, respectively, at c. 2765 Ma and 2770 ± 4 Ma (Fletcher et al., 2001; Dunphy et al., 2003).

In the northern Irwin Hills greenstone belt, a granite that has been dated at 2716 ± 5 Ma (GSWA sample 182603, Geological Survey of Western Australia, in prep.) has intruded a greenstone succession consisting of metabasalt with minor banded iron-formation, giving a minimum age for the sequence. In the Mount Sefton greenstone belt (Fig. 1), a similar sequence of metabasalt with minor chert, dolerite, and gabbro sheets, has been intruded by a concordant leucogabbro sill that yielded a magmatic age of 2812 ± 5 Ma (GSWA sample 185968, Geological Survey of Western Australia, in prep.), providing a minimum age for the greenstones of this belt.

The new geochronological data indicate a prolonged geological history across the Duketon and Merolia Domains

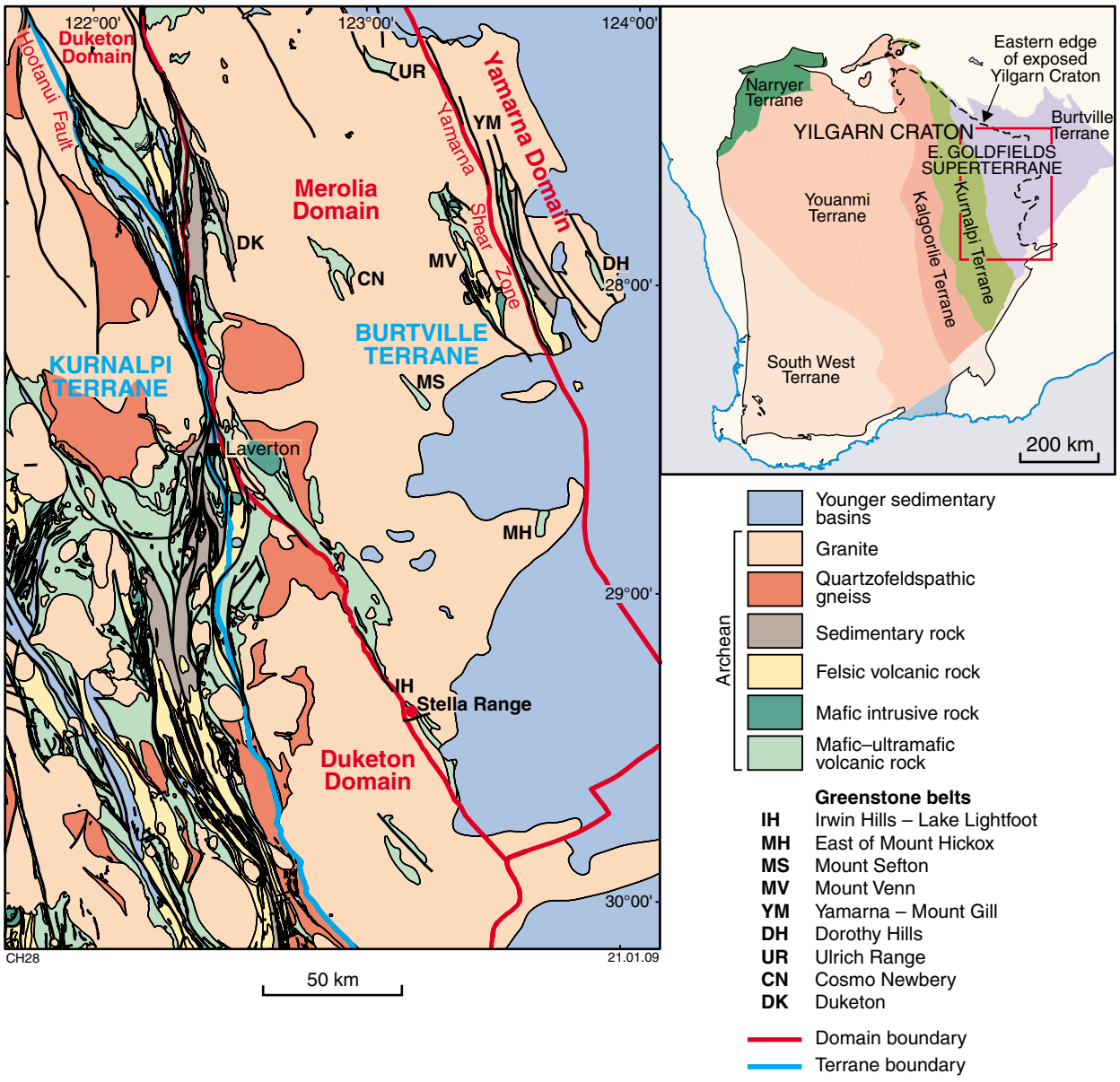

Figure 1. Geological map of the northeastern Yilgarn Craton showing the domains of the Burtville Terrane (after Cassidy et al., 2006) and the greenstone belts referred to in the text. The inset shows the tectonic divisions of the Yilgarn Craton (modified from Cassidy et al., 2006)

with at least two major magmatic events: an older pre-2900 Ma event and a younger regional-scale bimodal (mafic–felsic) volcanic cycle that may have lasted for more than 40 m.y., culminating at c. 2770 Ma. Younger dates obtained from layered gabbros suggest there was a widespread mafic intrusive event at c. 2755 Ma. Significantly, no greenstone rocks have been dated younger than c. 2755 Ma, although there are a considerable number of granites that have been dated at between 2670 and 2640 Ma.

Yamarna Shear Zone

The Yamarna Domain is separated from the Merolia Domain by the Yamarna Shear Zone. A seismic profile across the shear zone indicates an east-dipping, listric fault flooring into a detachment at 35 km depth, similar to the terrane-bounding Hootanui and Ockerburry Faults (Goleby et al., 2004). New mapping has shown that the Yamarna Shear Zone is >30 km wide and structurally complex, with folding and sinistral and dextral shearing discretely partitioned into three structural zones (Pawley et al., 2009). The deformation history of the Yamarna Shear Zone can be related to events recognized in structural syntheses proposed for other parts of the Eastern Goldfields Superterrane (e.g. Blewett and Czarnota, 2007).

Yamarna Domain

East of the Yamarna Shear Zone, Archean greenstone rocks of the Yamarna Domain form two main greenstone belts. The Yamarna – Mount Gill greenstone belt comprises a mafic succession with minor ultramafic rocks, intercalated with metamorphosed clastic sedimentary rocks, chert, and felsic volcanic rocks. The greenstones have been dated at 2683 ± 5 Ma (dacite; GSWA sample 183150, Geological Survey of Western Australia, in prep.), 2699 ± 5 Ma (metarhyolite sample with significant lead loss; Sircombe et al., 2007), and 2682 ± 5 Ma (maximum depositional age of a metasandstone; Sircombe et al., 2007). Farther east, the Dorothy Hills greenstone belt comprises a sequence of metabasalts with minor dolerite sills that has not yet been dated. No greenstone rocks in the Yamarna Domain have been dated at older the c. 2700 Ma.

Regional significance

SHRIMP U–Pb geochronology of the mafic to felsic sequences from the Merolia and Duketon Domains indicate the sequences are typically older (i.e. c. 2961 Ma, 2812–2770 Ma, and c. 2755 Ma) than those recognized in other parts of the Eastern Goldfields Superterrane. This indicates that the Merolia and Duketon Domains had a long history prior to the post-2720 Ma extension associated with the formation of the Kalgoorlie and Kurnalpi Terranes, and may have more in common with greenstones in the Youanmi Terrane in the western Yilgarn Craton (Van Kranendonk and Ivanic, 2009). In contrast, the greenstones in the Yamarna Domain are similar in age and character to those in the Kalgoorlie Terrane, where a mafic succession that has ultramafic rocks near the base is intercalated with, and overlain by, felsic volcanic and sedimentary rocks that are <2700 Ma (Kositcin et al., 2008, and references therein).

The geochronology also suggests that the greenstones of the Yamarna Domain may have been deposited during an extensional event contemporaneous with the development of the Kalgoorlie Terrane. Thus, it is likely the Yamarna Shear Zone represents a terrane boundary in the northeast Yilgarn Craton as it bounds a distinct lithostratigraphic package to the east.

As a consequence, the Eastern Goldfields Superterrane subdivision (Cassidy et al., 2006) should be re-evaluated, with the Burtville Terrane of Cassidy et al. (2006) to be divided into an older western terrane made up of the Duketon and Merolia Domains (Burtville Terrane), and a younger eastern terrane corresponding to the Yamarna Domain (Yamarna Terrane), as proposed in Pawley (2009).

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