The western Yilgarn: why the Youanmi Terrane?

by

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The earliest subdivision of the Yilgarn Craton (Gee et al., 1981) contained four components: the Eastern Goldfields, Southern Cross, and Murchison Provinces and the Western Gneiss Terrain. However, the relationship between these regions was enigmatic, with the boundaries not strictly based on observed geological features. Various authors (e.g. Myers, 1993) subsequently developed schemes in which the Yilgarn Craton was divided into superterranes and terranes based on greenstone belt shapes and trends, rock associations, and ages of greenstone deposition, granite intrusion, and deformation. Some of these schemes carried an implication of Yilgarn Craton-wide accretionary tectonics.

New regional mapping and precise sensitive high-resolution ion microprobe (SHRIMP) geochronology, and new geochemistry and isotope data obtained by the AMIRA International Limited regional granite study (Cassidy et al., 2002), suggest that in the central and western Yilgarn Craton, the Southern Cross and Murchison 'Provinces' of Gee et al. (1981), or 'Granite–Greenstone Terranes' of Tyler and Hocking (2001) do not represent allocthonous terranes that have come together during an accretionary event. Rather, they more likely formed part of the 3.0 – 2.7 Ga proto-Yilgarn Craton to which the elements of the Eastern Goldfields Superterrane accreted after 2.7 Ga. Because they are no longer considered to be terranes in the strict sense, they are now called domains within the Youanmi Terrane (Cassidy et al., 2006; Fig. 1).

The Youanmi Terrane is bound to the west by the Darling Fault system, to the north by the Capricorn Orogen, to the southeast by the Albany–Fraser Orogen, and to the southwest by the South West Terrane. The boundary with the Eastern Goldfields Superterrane is marked the Ida and Waroonga Faults. The boundary with the Narryer Terrane is taken to be Yalgar Fault (Myers, 1993), but the nature of this fault and the relationship between greenstones of the Narryer and Youanmi Terranes will be investigated during the current mapping program. The boundary with the South West Terrane is poorly defined, and will be investigated in future mapping programs.

Southern Cross Domain

The Southern Cross Domain contains at least two greenstone successions. The older (3.0 Ga) succession typically contains abundant banded iron-formation and chert interbedded with mafic and subordinate ultramafic rocks overlain by a mafic-dominated succession. Without more detailed geochronology it is difficult to demonstrate correlations of individual units between greenstone belts and, in some instances, within greenstone belts. In the centre and north, greenstone belts along the eastern and western sides of the domain commonly preserve a quartzite or quartz-rich metasedimentary unit with maximum depositional ages greater than 3.1 Ga at the base of the exposed succession that is either in faulted or intrusive contact with much younger granite. In the far south the Ravensthorpe greenstone belt contains 2.95 Ga calc-alkaline volcanic rocks that host copper–zinc–gold mineralization in an association that has more in common with the succession in the Golden Grove region in the Murchison Domain than with other greenstone belts in the Southern Cross Domain.

The younger succession in the Southern Cross Domain is best known in the Marda–Diemals greenstone belt where it consists of the 2.73 Ga calc-alkaline Marda Complex and clastic sedimentary Diemals Formation. However, other greenstone belts also contain felsic volcanic rocks. For example, 2.72 Ga dacite in the Gum Creek greenstone belt appears to be part of a widespread, but very poorly exposed, younger greenstone succession that also contains clastic sedimentary rocks, including abundant graphitic shale.

Murchison Domain

Greenstones in the Murchison Domain contain a similar mix, but broader range, of rock types than those in the Southern Cross Domain. Previously established stratigraphic schemes (e.g. Watkins and Hickman, 1990) have a lower greenstone succession similar in character to that in the Southern Cross Domain with a complex upper greenstone succession. However, new precise SHRIMP geochronology has demonstrated that simple stratigraphic correlations are difficult across such a broad area (e.g. Pidgeon and Hallberg, 2000). U–Pb zircon geochronology shows 2.95 Ga felsic rocks at Golden Grove and in the Weld Range. However, 2.8 Ga volcanic rocks have been identified at Golden Grove, in the Mount Magnet area, near Windimurra and Youanmi, and in the Pollele Syncline near Meekatharra. In the latter instance the 2.8 Ga age

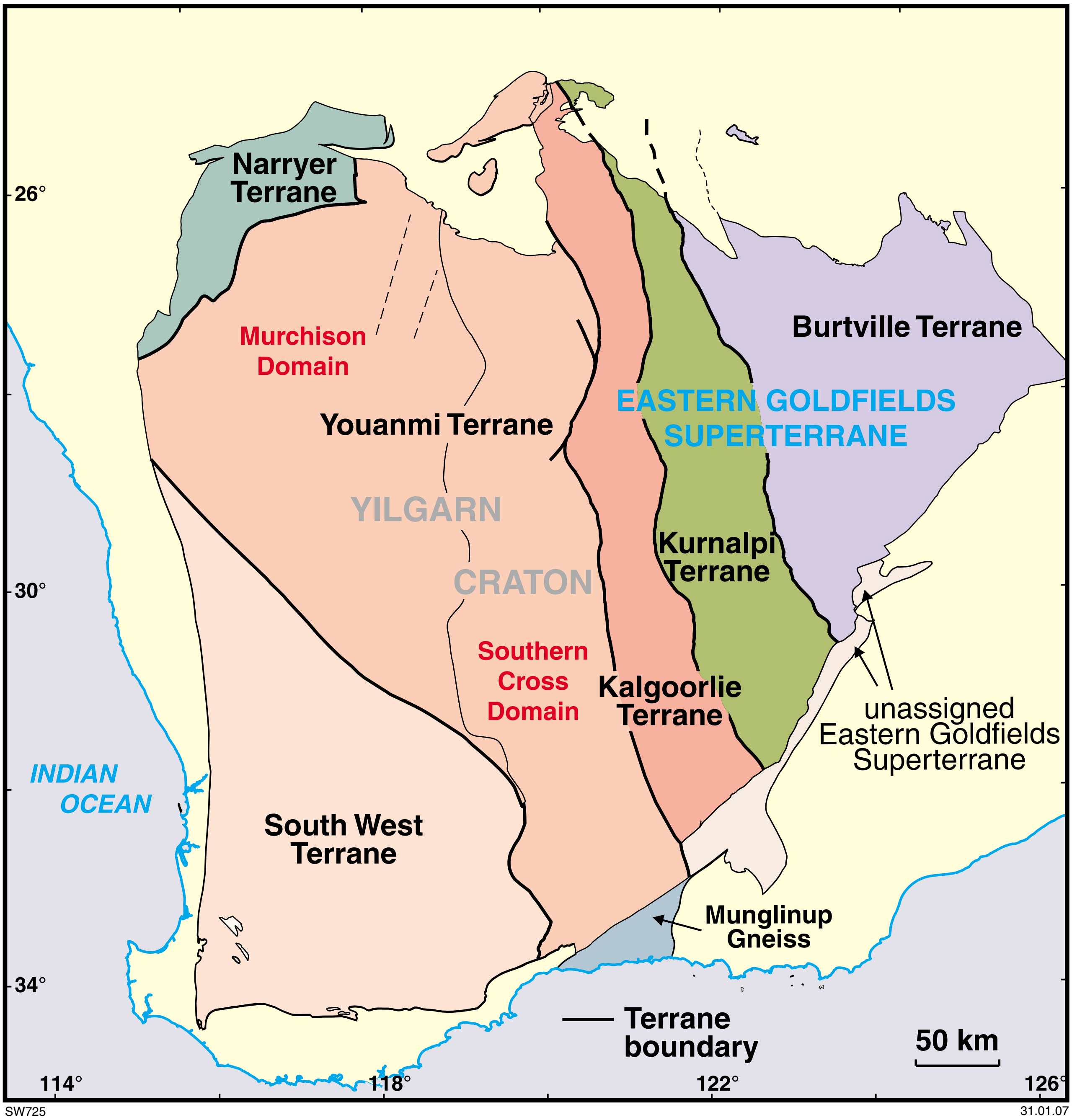

Figure 1. Tectonic division of the Yilgarn Craton, showing subdivisions into terranes and domains (modified from Cassidy et al., 2006)

was obtained on a tuff interbedded with a number of komatiite flows, clearly demonstrating the presence of some komatiite volcanism of this age. Widespread felsic rocks (andesite–rhyolite) range in age from 2.76 to 2.69 Ga. Clastic sedimentary rocks including graphitic shales like those found locally in the Southern Cross Domain are locally associated with the younger felsic volcanic rocks.

The extensive suite of layered mafic and ultramafic intrusions in the middle of the Youanmi Terrane may represent a mantle plume event to which the widespread 2.8 Ga magmatism in the Murchison Domain is related.

Other evidence

The Youanmi Terrane is isotopically distinct from other terranes. A pre-3.0 Ga age for the initial formation of the Youanmi Terrane is based on Sm–Nd and Hf isotope depleted-mantle model ages for granites and felsic volcanic rocks that indicate a 3.3 – 3.0 Ga felsic crustal component. Detrital and xenocrystic zircon ages suggest 4.3 – 3.1 Ga sources for some rocks in the Murchison and Southern Cross Domains. They also suggest that greenstones of the Narryer Terrane that also contain pre-4.0 Ga detrital zircons may have had a common history with some of those in the Youanmi Terrane.

The Murchison and Southern Cross Domains have comparable structural histories with early shallow to recumbent structures overprinted by upright folds, all overprinted by northwest to northeasterly trending shear zones. However, east–west folding that appears to have occurred early during the upright folding phase in the Murchison Domain has not been recognized in the Southern Cross Domain. It is also likely that the Murchison Domain shows evidence of Proterozoic deformation that is not so apparent in the Southern Cross Domain. Major movement on the regional-scale shear zones that have previously been suggested as granite–greenstone terrane boundaries post-dates all greenstone deposition and most granite intrusion.

Mineralization

Gold mineralization in the Youanmi Terrane is found in a variety of geological settings. Base metal deposits in the widely separated Ravensthorpe and Golden Grove areas are associated with 2.95 Ga calc-alkaline volcanic successions. Iron deposits are found throughout the Youanmi Terrane with economic deposits in both the Southern Cross and Murchison Domains. Economic nickel mineralization has only been identified in older-than 2.9 Ga komatiites in the southern part of the Southern Cross Domain. At least some of the komatiites in the Murchison Domain may be related to 2.8 Ga mantle plume activity that produced the vanadium-bearing layered intrusions in the north of the Youanmi Terrane.

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