Recent mapping in the Sandstone region: implications for gold mineralization

by

S. Wyche, S. F. Chen, and M. G. Doyle

During 2002 and 2003, field mapping in the northern part of the Yilgarn Craton focused on the Sandstone, Booylgoo Range, Gum Creek, Barrambie, and Poison Hills greenstone belts (Fig. 1). Outside these major belts, a number of small patches of greenstone lie within broad granite areas of dominantly monzogranitic composition. Much of the new work is currently being compiled, so this paper contains preliminary observations about the stratigraphy in the greenstone belts, the regional structure, and their relationship with known gold deposits. Most greenstone successions in the region outcrop poorly, with the best exposures in the Booylgoo Range belt, locally around the margins of the Sandstone belt, and on the eastern side of the Gum Creek belt.

The Sandstone, Booylgoo Range, Gum Creek, Barrambie, and Poison Hills greenstone belts have similar stratigraphic packages that contain many elements comparable with those described in the mafic-dominated lower greenstone succession elsewhere in the Southern Cross Granite–Greenstone Terrane, including the Marda–Diemals area. However, unlike the Marda–Diemals region (Chen et al., 2003) where felsic volcanic rocks of the Marda Complex and clastic sedimentary rocks of the Diemals Formation unconformably overlie the mafic-dominated succession, both the Sandstone and Gum Creek belts contain interleaved clastic sedimentary rocks and minor felsic volcanic facies. Distinctive quartzites and quartz-rich metasedimentary rocks like those in the Maynard Hills and Illaara greenstone belts to the southeast are absent from the Sandstone, Booylgoo Range, Gum Creek, Barrambie, and Poison Hills greenstone belts.

Structural complexity in the Sandstone greenstone belt and the lack of continuous greenstone sections in the Barrambie and Poison Hills greenstone belts makes it difficult to establish clear stratigraphic successions; however, in all the belts, prominent units of ferruginous chert and banded iron-formation with intercalated mafic and ultramafic rocks are low in the succession. The chert and banded iron-formation are overlain by a thick unit of mainly tholeiitic metabasalt that contains a substantial interval of komatiitic basalt in its lower part in the Booylgoo Range belt. The upper part of the succession in the Gum Creek and Sandstone belts contains clastic metasedimentary rocks. They are very poorly exposed in the north of the Sandstone greenstone belt where they consist of shale and siltstone. More widespread metasedimentary rocks in the Gum Creek belt include shale, carbonaceous shale, sandstone, local conglomerate, and intercalated coherent rhyolite and dacite. The poor exposure in the western part of the Gum Creek belt, combined with structural complications, makes it difficult to establish an unequivocal stratigraphic succession. Sensitive high-resolution ion microprobe (SHRIMP) U–Pb zircon dating by Wang et al. (1998) suggests that at least some of the felsic and metasedimentary rocks are c. 2700 Ma or younger. If these ages are correct, then it is likely that the felsic and sedimentary part of the succession is unconformable on, or tectonically interleaved with, a mafic-dominated succession that is probably older than 2900 Ma. Layered mafic–ultramafic sills intrude all the greenstone belts at various levels.

Eisenlohr et al. (1993) described some of the major regional shear zones, and Beeson et al. (1993) carried out more detailed structural studies in the Gum Creek greenstone belt. The overall deformation history, which is supported by our recent studies, is similar to that described elsewhere in the Southern Cross Granite–Greenstone Terrane (Chen et al., 2003). An early, poorly recognized episode of recumbent folding and possible thrust faulting (D_1) was followed by a protracted period of broadly east–west compressional deformation that produced northerly to north-northwesterly trending upright folds and reverse faults (D_2), which are overprinted by sinistral north-northwesterly trending shear zones and dextral north-northeasterly trending shear zones (D_3). Late kinks and northeasterly and northwesterly trending brittle faults (D_4) overprint all earlier structures. These late structures may pre-date easterly to southeasterly trending brittle fractures that are evident on aeromagnetic images in areas of granite (Fig. 1). Some late fractures have been intruded by Proterozoic mafic–ultramafic dykes. Greenstones are metamorphosed to greenschist and amphibolite facies. Peak metamorphism coincided with widespread granite intrusion after c. 2685 Ma, probably during late D_2 and early D_3.

There is little evidence of D_1 structures in most of the greenstone belts, with the best evidence being local intrafolial and refolded folds in banded iron-formation and

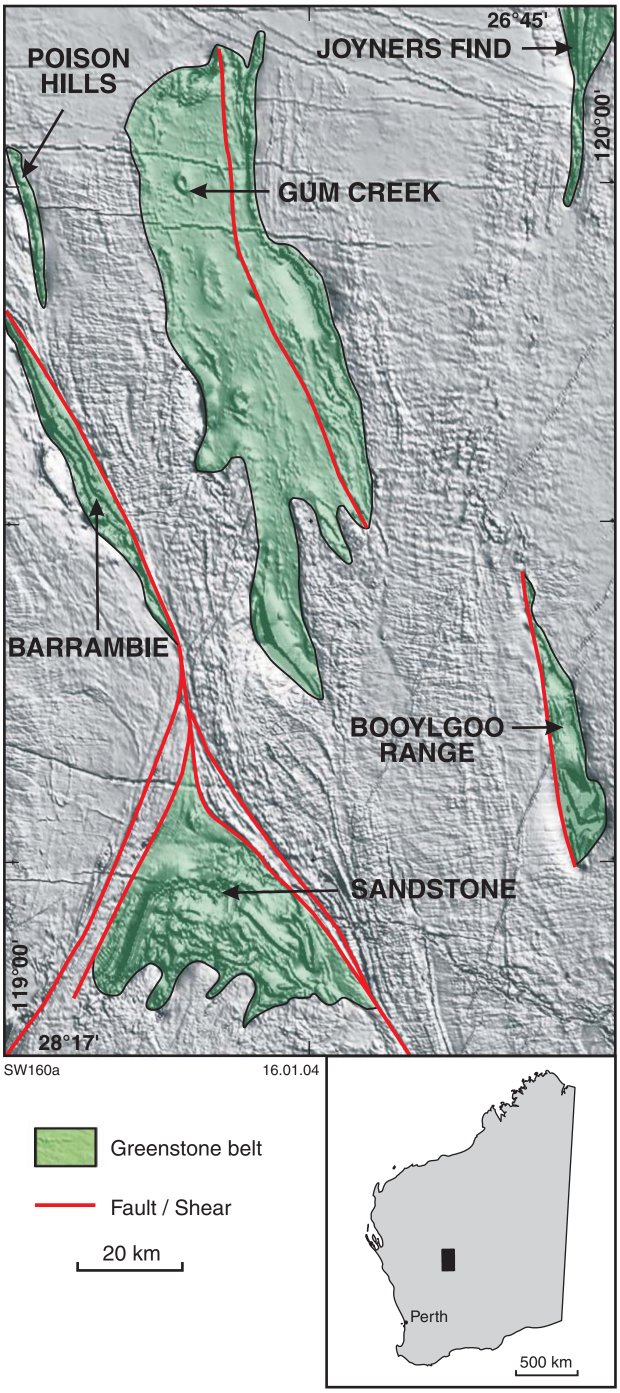

Figure 1. Aeromagnetic image showing the Sandstone, Booylgoo Range, Gum Creek, Barrambie, Joyners Find, and Poison Hills greenstone belts in the northern Yilgarn Craton

chert. In the Sandstone belt, the distribution of outcrops, and patterns on aeromagnetic images, suggest the presence of large-scale F_1 folds and possible thrust faults that have been refolded during D_2. The belt-scale F_2 fold has been variously interpreted as an antiform (Stewart et al., 1983) and a synform (Chen, 2003).

The overall form of the Gum Creek and Booylgoo Range greenstone belts has been shaped by synclinal structures formed during D_2. In the Gum Creek belt, Beeson et al. (1993) interpreted a synclinorium that has been disrupted by a major D_3 shear zone towards its eastern side. In the Booylgoo Range belt, a keel-shaped F_2 syncline outlined by banded iron-formation has been disrupted by the development of D_2 reverse faults.

The Sandstone and Gum Creek greenstone belts have the largest recorded historical gold production in the region with more than 28 t and 39 t respectively. Mining is still active in these belts with current production from Troy Resources' Bulchina operation in the Sandstone greenstone belt, and Legend Mining's Gidgee gold mine in the Gum Creek belt. Substantial historical gold production (695 kg) has also been recorded from the Barrambie greenstone belt, which lies to the west of the Gum Creek belt. There is no recorded production, and no evidence of any historical mining activity, in the Booylgoo Range greenstone belt in the east. This poor endowment appears to be typical of the belts in the eastern part of the Central Yilgarn region with most belts having no recorded gold production and only sparse and shallow workings. The exception is the Joyners Find greenstone belt to the northeast of the Gum Creek belt, which has a recorded historical production of about 374 kg.

There have been few detailed studies of gold mineralization, with the best documented deposits in the Gum Creek greenstone belt. Although some of the richest deposits in the region are hosted by mafic rocks, examples of deposits hosted by banded iron-formation, felsic porphyry, granite, and probable metasedimentary schist are also known. Whereas many deposits such as those at Omega (Beeson et al., 1993; Ross and Smith, 1998) and Kingfisher (Hazard, 1998) appear to have formed in favourable sites where competency contrasts or early deformation events have been overprinted by late (?D_4) structures, the origin of other deposits is more equivocal. Beeson et al. (1993) argued that a number of significant deposits such as those at Gidgee may have formed during D_3 shearing or earlier.

References

BEESON, J., GROVES, D. I., and RIDLEY, J. R., 1993, Controls on mineralization and tectonic development of the central part of the northern Yilgarn Craton: Minerals and Energy Research Institute of Western Australia, Report no. 109, 93p.

CHEN, S. F., 2003, Atley, W.A., Sheet 2741: Western Australia Geological Survey, 1:100 000 Geological Series.

CHEN, S. F., RIGANTI, A., WYCHE, S., GREENFIELD, J. E., and NELSON, D. R., 2003, Lithostratigraphy and tectonic evolution of contrasting greenstone successions in the central Yilgarn Craton, Western Australia: Precambrian Research, v. 127, p. 249–266.

EISENLOHR, B. N., GROVES, D. I., LIBBY, J., and VEARNCOMBE, J. R., 1993, The nature of large-scale shear zones and their relevance to gold mineralization, Yilgarn Block: Minerals and Energy Research Institute of Western Australia, Report no. 122, 161p.

HAZARD, N. J., 1998, Kingfisher gold deposit, Gidgee, *in* Geology of Australian and Papua New Guinean Mineral Deposits *edited by* D. A. BERKMAN and D. H. MacKENZIE: Australasian Institute of Mining and Metallurgy, Monograph 22, p. 123–126.

ROSS, D. I., and SMITH, D. W., 1998, Omega gold deposit, Gidgee, *in* Geology of Australian and Papua New Guinean Mineral Deposits *edited by* D. A. BERKMAN and D. H. MacKENZIE: Australasian Institute of Mining and Metallurgy, Monograph 22, p. 119–122.

STEWART, A. J., WILLIAMS, I. R., and ELIAS, M., 1983, Youanmi, W.A.: Australia BMR and Western Australia Geological Survey, 1:250 000 Geological Series Explanatory Notes, 58p.

WANG, Q., BEESON, J., and CAMPBELL, I. H., 1998, Granite–greenstone zircon U–Pb chronology of the Gum Creek greenstone belt, Southern Cross Province, Yilgarn Craton: Tectonic Implications, *in* Structure and evolution of the Australian continent *edited by* J. BRAUN, J. C. DOOLEY, B. R. GOLEBY, R. D. VAN DER HILST, and C. T. KLOOTWIJK: American Geophysical Union, Geodynamics Series, v. 26, p. 175–186.