pmd*CRC ARCHITECTURE (A1) PROJECT - "THE A-TEAM"

predictive mineral discovery
COOPERATIVE RESEARCH CENTRE

Why is the Menzies-Boorara Shear Zone not as well endowed as the Boulder-Lefroy Shear Zone?

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Watermark: Isoclinally folded and boudinaged sandstone lithology from Yunndaga gold mine, WA

Overview

This project investigates key structural features and gold-associated hydrothermal alteration events of the Menzies-Boorara Shear Zone (MBSZ) (figure 1). The MBSZ is a crustal-scaled fault and shear system that has thus far yielded significantly less gold deposits than the nearby Boulder-Lefroy Shear Zone (BLSZ), which hosts two world-class gold deposits (see Hagemann and Cassidy, 2001, for details).

There is a relative lack of geological information from the MBSZ. Hence this project has the potential to more comprehensively understand gold mineralisation within the MBSZ; with the aim of using these results to find out why there is a difference in gold endowment between these neighbouring shear zones. Figure 1 also shows the gold deposits this project is based on. From north to south these are: Yunndaga, New Boddington, South Talbot, Paddington and Golden Ridge.

The MBSZ is further segmented into the *Bardoc Tectonic Zone* (Witt, 1994) and the *Boorara Shear Zone* (figure 1). It is still in contention whether the Bardoc Tectonic Zone is instead connected to the Abattoir Fault, and not the Boorara Shear Zone as adhered to in this poster.

Summary

Based on field work from five key gold deposits within the MBSZ, the following results have been found:

(1) The major deformation event within the MBSZ was through the development of NNW-trending, upright, dip-slip reverse faults, folds and associated foliations. This has broadly been correlated with 'D_2-style' deformation. There have been limited sinistral 'D_3-style' strike-slip structures observed from the gold deposits.

(2) The MBSZ is made up of relatively narrow, fault-bounded stratigraphic units. Gold mineralisation has been observed to be associated with competency contrasts within these units. Since these competent units are narrow relative to the BLSZ (10's vs. 100's metres thick), there are volumetrically less favourable sites for gold mineralisation within the MBSZ.

(3) Given the limited sites for gold endowment within MBSZ, textural evidence still suggests that there have been multiple mineralisation events throughout the deformation history of the MBSZ.

(4) The apparent lack of telluride-bearing phases from the ore assemblages implies that mineralising hydrothermal fluids were dissimilar to those associated with the BLSZ. This further suggests that the mineral systems of these two shear zones are also genetically different.

Structural insights

The MBSZ is a curvilinear geological structure characterised by heightened deformation relative to its surrounding terranes. Across strike, this deformation zone extends for approximately five kilometres. Field work based largely on the five aforementioned gold deposits have revealed the following architectural and structural insights:

(1) All known occurrences of gold mineralisation occur completely within the confines of the MBSZ (figure 1). This is in contrast to the BLSZ, where gold deposits are associated with higher-order fault structures (Hagemann and Cassidy, 2001).

(2) The bulk of lithologies all have a NNW-trending strike and dip steeply/moderately to the west (figures 2 a & b). All lithologies observed are relatively narrow, and only extend across strike for 10's of metres. In contrast, Bateman et al. (2001) report that the major mineralised lithology at the Golden Mile (BLSZ) is 100's of metres thick. Furthermore, lithology contacts are invariably faulted and sheared, indicating the high degree of attenuation, juxtaposition and discontinuity of various units within the shear zone. Structural fabrics are not uniformly developed throughout the hosting lithologies; this is primarily due the competency contrasts of the differing rock units.

(3) Where developed, the deformation events have been preserved as (i) a NNW-trending pervasive fabric that records down-dip reverse movement and associated folding and faulting (figure 3a); (ii) overprinting sinistral shearing associated with this NNW-trending fabric (figure 3b) and (iii) Various brittle/ductile sinistral and dextral faulting events that overprint the NNW-trending pervasive fabric at a high angle (figure 4a). These three deformation events broadly confirm with the D_2, D_3 and D_4 events respectively, of other regional structural studies, e.g. Swager (1997). However, the 'D_3' sinistral shearing event has only observed at one locality, i.e. Yunndaga (figure 3c).

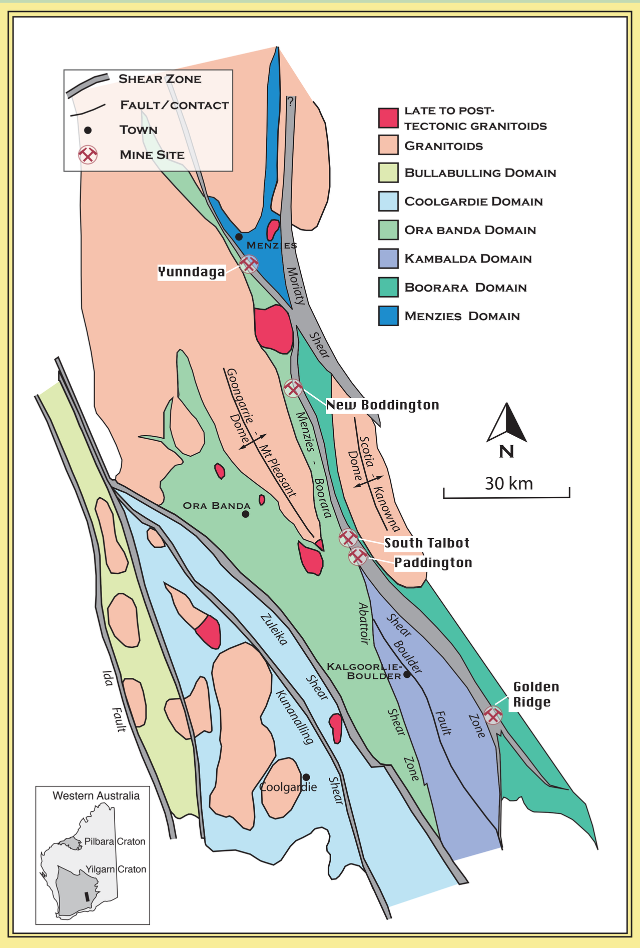

Figure 1: Part of the Archaean Kalgoorlie Terrane showing its various tectono-stratigraphic domains and major shear zones/ faults. Adapted from Witt (1993).

Figure 2(a): South Talbot, looking north. Westerly-dipping gabbro unit (G) flanked by less competent interbedded shales and sandstones.

Figure 2(b): Yunndaga, looking south. Westerly-dipping sandstones and shales (ss) in fault contact with a more competent para-amphibolite unit (pa). Lode-Au structures are observed along this contact.

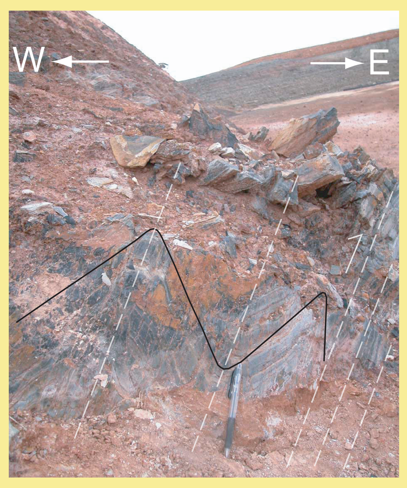

Figure 3(a): Upright, NNW-trending folded sedimentary unit and associated axial planar fabric.Talbot South gold mine.

Figure 3(b): Photograph taken from above of a steeply-plunging asymmetric fold within interbedded shales and sandstones suggesting sinistral ductile shearing. Yunndaga gold mine.

Controls on gold mineralisation

A vast range of structurally controlled, quartz-dominated veining events characterise gold mineralisation within the MBSZ.

(1) Lode-gold mineralisation is either cited within (i) more competent felsic to mafic igneous units (Golden Ridge, Paddington, South Talbot), within (ii) moderately foliated basalt (New Boddington) or at (iii) the contact between an ortho- and para-amphibolite (Yunndaga) (Beeson et al., 1996). A range of ductile (Yunndaga) and brittle-ductile (Paddington, Golden Ridge, New Boddington and Talbot South) lode structures characterise the mineralisation events. See examples in figures 4a, b & c.

(2) Relative to the D_2 and D_3 events of Swager (1997)), field-based overprinting relationships indicate that gold mineralisation is either: Pre- to syn-D_2 (New Boddington (figure 4a) and Golden Ridge); pre- to syn-D_3 (Yunndaga, figure 4b) or post D_3 (Paddington and South Talbot, figure 4c). Native gold has been observed to infill fractures within the arsenopyrite assemblages, and confirm the relatively late timing of mineralisation at Paddington and South Talbot (figures 5 a & b).

No singular style of structure characterises mineralisation within the MBSZ. Instead, hydrothermal fluids associated with gold mineralisation appear to have utilised a variety of structures that promoted gold deposition over a prolonged time scale. This in accordance with previous regionally-based studies such as Witt (1993).

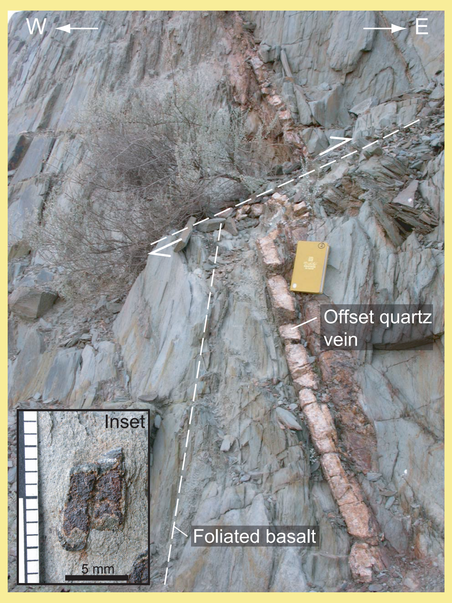

Figure 4(a): Mineralised quartz vein that has been offset by dextral faulting. Note the steep, westerley-dipping, NNW-trending foliation and associated pressure shadows on the long-axis of the oxidised pyrite (inset); indicating that mineralisation was pre- or syn deformation. New Boddington gold mine.

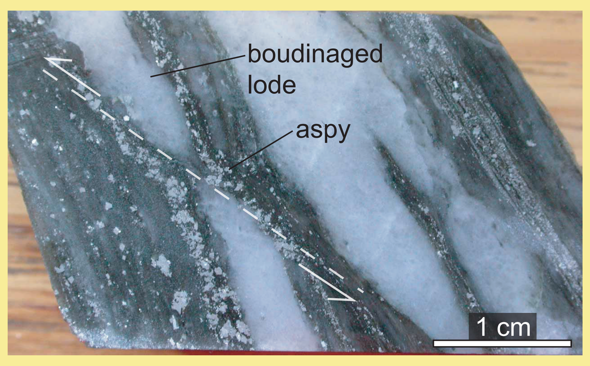

Figure 4(b): Boudinaged & mineralised quartz-carbonate vein from Yunndaga gold mine. Note the non-pristine, deformed arsenopyrite grains and the relatively later oblique offset structure. Wall rock alteration is characterised by quartz, carbonate, biotite and chlorite.

Figure 4(c): Mineralised quartz-carbonate vein from Paddington ('ladder lode'). This veining event cross-cuts observed fabrics within the host dolerite and is associated with an arsenopyrite-dominated sulphide assemblage.

Mineralogical insights

Lode gold mineralisation within the MBSZ is associated with arsenopyrite- and pyrite-dominated sulphide assemblages. Lesser amounts of sphalerite +/- pyrrhotite +/- chalcopyrite and +/- galena have also been observed. Silica + carbonate + white mica + chlorite +/- biotite all typify wall rock alteration assemblages associated with these Au + sulphide events. An example is displayed in figure 6. The most striking mineralogical difference of these lode-gold systems to the BLSZ, is that no telluride-bearing minerals have been observed from the gold deposits studied (cf. Clout et al. (1990)).

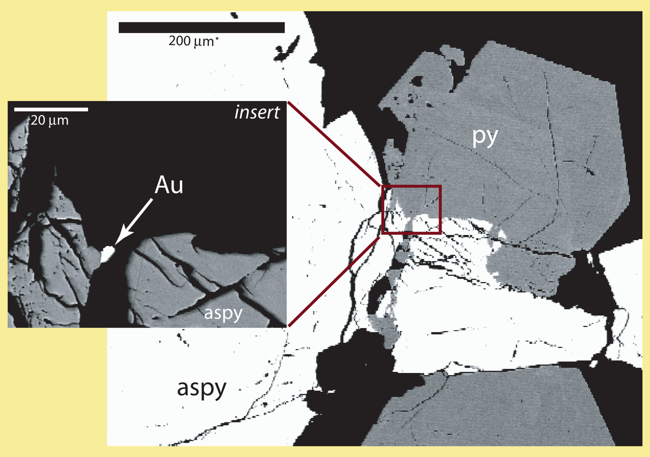

Figure 5(a): SEM secondary electron image of fractured, relatively earlier arsenopyrite that has been infilled with pyrite + native gold (gold is visible within the inset, as contrast has been adjusted). Paddington gold mine.

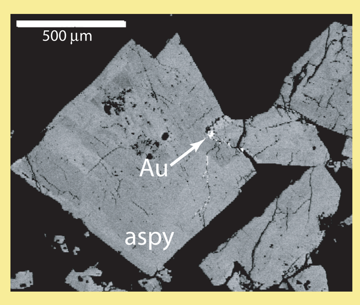

Figure 5(b): SEM secondary electron image From South Talbot. Relatively earlier, fractured arsenopyrite has been infilled with native gold.

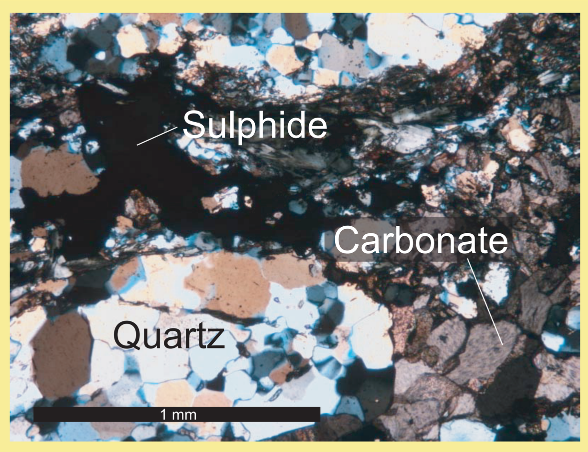

Figure 6: Cross-polarised photomicrograph of a typical gold-associated alteration assemblage. Yunndaga gold mine.

References

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Acknowledgements

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