The role of refolding on the localisation of gold mineralisation at Woolwonga

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The Woolwonga gold deposit is a structurally-controlled orogenic gold deposit that was discovered during the gold rush in the 1870s. Approximately 32 000 oz of gold was produced from Woolwonga between 1870 and 1908, and a further 130 000 oz was produced by Dominion Mining between 1991 and 1995 at an average grade of 2.8 g/t.

The Woolwonga deposit is located 50 km northwest of Pine Creek on the western margin of the Central Trough of the Pine Creek Orogen as defined by Ahmad and McCready (2001). It is hosted in the Mount Bonnie Formation, a sequence of shales, siltstones, greywackes, tuffs and rare ironstones and dolostones (Ahmad and Hollis 2013).

Gold deposits at Woolwonga are associated with so-called saddle reef and stockwork veins that are centred on the northwest–southeast-trending Woolwonga Anticline. The association of gold deposits with folds having northwest to north–northwest-trending axes is recognised throughout the Pine Creek Orogen; however, there are few detailed descriptions that explain the role of structures or include the history of deformation and kinematic or dynamic mechanisms of the localisation of gold mineralisation in these settings. Such models are critical to the design of exploration programs and provide a framework to increase the understanding of mineralisation processes.

The structural geology of the Woolwonga deposit was defined from mapping exposures in the walls of the pit. The enveloping and internal distribution of gold in the deposit was delineated in three dimensions using Leapfrog™. The integration of the structural geology and metal distribution led to the identification of the structural controls on gold mineralisation at Woolwonga and a new exploration strategy.

The deformation history at Woolwonga comprises a series of five dominantly ductile events that broadly correspond to D_3 of the regional deformation scheme described by Ahmed and Hollis (2013) but with a few significant differences.

The oldest recognisable cleavage, S_1, preserved at Woolwonga is parallel to bedding. The structural geology of the Woolwonga deposit is dominated by the northwest-striking Woolwonga Anticline and a series of high-strain zones that folded it from its originally east–west-striking orientation. Cleavage relationships on either side of the Woolwonga Anticline reveal this fold originally formed with a subvertical east-west striking axial plane and axial planar foliation, S_2, which crenulates the bedding parallel S_1 cleavage.

The Woolwonga Anticline was refolded into its present orientation by clockwise shearing in plan (dextral) along S_3, which is northwest-striking and subvertical. The S_3 crenulation is pervasive on the northeast limb of the anticline but highly localised on the southwest limb; it has the same shear sense either side of the hinge indicating it was not responsible for the initiation of the fold. East–west-striking bedding, mesoscopic F_2 axial planes and axial planar cleavage S_2 are well preserved between S_3 high-strain zones. S_3 is locally crenulated by a subhorizontal crenulation, S_4, but few recumbent folds have been observed, which most likely reflects preferential partitioning of D_4 deformation into finer grained sedimentary beds.

The youngest recognised deformation, D_5, formed a north–northwest-striking subvertical crenulation cleavage and mesoscopic high-strain zones. S_5 crenulated the wall rocks along the margins of veins and coincides with pinching of auriferous quartz veins but, critically, does not deform them internally.

The most visually striking feature of the metal distribution in longitudinal sections is shallow to moderately southeast-plunging shoots that correspond to fold-shaped veins centred on the hinge of the Woolwonga Anticline. However, these shoots disguise the more critical elements of the metal distribution, that being northwest-plunging tabular lodes hosted by D_3 high-strain zones on the northeast-limb of the anticline. These shoots plunge 75° to 310° parallel to the L_5^3 intersection lineation and are the highest tenor parts of the deposit (**Figure 1**).

Gold mineralisation occurred in D_5 as a response of the interaction of progressively forming S_5 high-strain zones with existing northwest-striking D_3 high-strain zones and fold hinges. The northwest-striking lodes formed

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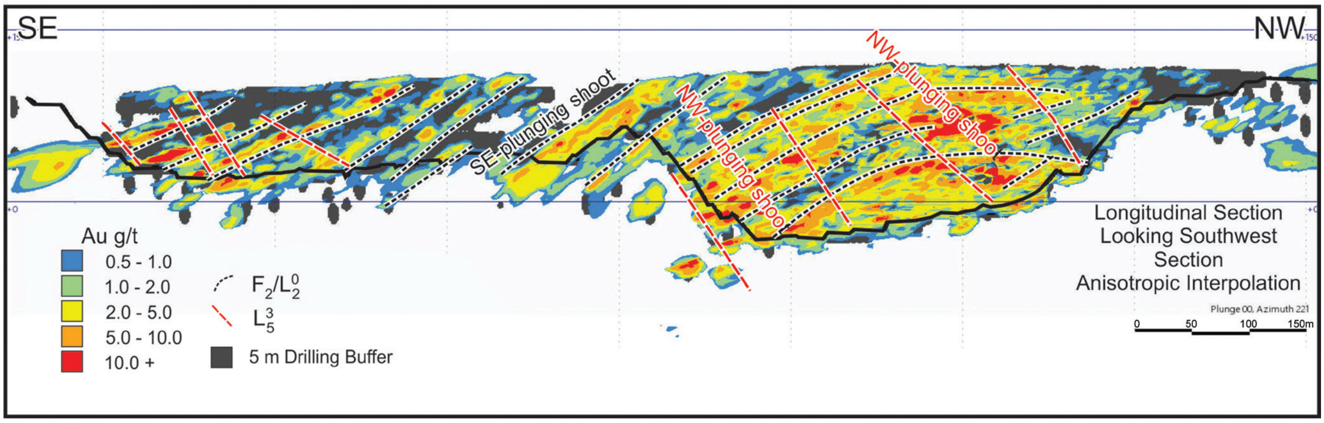

Figure 1. Woolwonga gold deposit. Longitudinal section looking southwest.

by inhomogeneous deformation across the S_3 high-strain zones, whereas reactivation of bedding around the fold axis southeast of the S_3-hosted lodes formed saddle reefs. In sections normal to the axis of the Woolwonga Anticline, lodes in the saddle reefs contain high-grade shoots centred on L_5^0 intersection lineation that cut the fold axis and attest to the D_5 timing for mineralisation.

The Woolwonga gold deposit is centred on a refolded anticline. Mineralisation occurred in D_5 as a result of the interaction of progressively forming high-strain zones with existing S_3 high-strain zones and the refolded F_2 anticline.

References

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