Volcanogenic massive sulfide mineralization at Weld Range: a comparison with Golden Grove

by

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The Archean Yilgarn Craton of Western Australia appears to be poorly endowed with volcanogenic massive sulfide (VMS) deposits when compared to the Archean cratons of Canada. Balancing this rather pessimistic perception, the presence of at least a few economic VMS deposits in the Yilgarn Craton suggests that rather than poor endowment there may be other factors such as weathering or lack of outcrop hindering the discovery of VMS, resulting in reduced exploration success.

Geology and geochemistry

Base metal mineralization was discovered at the Glenview prospect, by Hampton Hill Mining NL, in a felsic volcanic succession on the northern side of the Weld Range in the northern Murchison Domain of the Youanmi Terrane, Yilgarn Craton. The company considered the geology in this prospect to be similar to that at Golden Grove (Fig. 1), which is Western Australia's largest VMS deposit. The prospectivity of the Glenview area was evaluated by comparing it with Golden Grove, focusing particularly on some of the features that are deemed necessary for VMS formation and preservation, as well as some that are considered favourable for VMS mineralization in the Murchison Domain, i.e. characteristics that are similar to Golden Grove (Guilliamse, 2013; in prep.).

Golden Grove is situated within a felsic volcano-sedimentary sequence that shows good lateral continuity and has evidence for deep subaqueous emplacement of both host rocks and mineralization (Clifford, 1992). The sequence is dominated by felsic volcanic, volcaniclastic, and sedimentary rocks, with evidence of hydrothermal activity from chemical sediments interspersed with fine-grained, laminated volcaniclastic and sedimentary units. Sericite and chlorite alteration are associated with the massive sulfide and stringer mineralization.

Petrologic studies indicate that Glenview is also developed in a felsic volcano-sedimentary sequence, consisting of volcaniclastic rocks, hyaloclastites, coherent felsic lavas, clastic sedimentary rocks, chert, and banded iron-formation. There is extensive sericite and chlorite alteration, and the presence of sulfide veins and minor massive sulfide mineralization indicates percolation of metal-laden hydrothermal fluids. Although the sedimentary and volcanic units at Glenview show evidence for subaqueous emplacement, definitive evidence for depth of emplacement is lacking. However, the absence of welding in pyroclastic-rich volcaniclastic units suggests a minimum depth of 500 m, defined by Cas (1992) as the minimum depth needed to produce the confining pressures required to prevent boiling and facilitate massive sulfide formation on the sea floor.

In the fertility diagram of Lesher et al. (1986), felsic volcanic rocks from Golden Grove and Glenview both plot in the highly prospective FII and FIIIa fields (Fig. 2). The lithologic and geochemical similarities between Glenview and Golden Grove suggest that they formed in similar tectonic settings. Geochemical signatures for both areas are consistent with an active continental-margin setting based on Th and Ta ratios defined by Schandl and Gorton (2002) as shown on Figure 3. Although active continental margins are common settings for post-Archean deposits, most of the Archean deposits in Canada were noted by Schandl and Gordon (2002) to plot in the within-plate volcanic zone.

Isotopic dating and spectral scanning

Felsic volcanic rocks on the northern side of Weld Range, which host the Glenview prospect, were previously mapped as part of the c. 2752 Ma Wilgie Mia Formation on the MADOONGA 1:100 000 geological sheet (Ivanic, 2009). However, a SHRIMP U–Pb zircon age of 2977 ± 3 Ma for crystallization of rhyolite at Glenview (GSWA 155569, Wingate et al., 2013a) indicates that these rocks are significantly older. This age is consistent with results for other rocks east of Glenview on the northern side of the range, including 2979 ± 3 Ma for a metarhyolite clast in volcaniclastic breccia (GSWA 193972, Wingate et al., 2012), and a unimodal age component of 2969 ± 3 Ma for detrital zircons in a metasandstone (GSWA 184112, Wingate et al., 2008). A felsic metavolcaniclastic rock near the middle of the Weld Range yielded a maximum depositional age of 2752 ± 9 Ma (Wang, 1998). On the southern side of the Weld Range, felsic volcaniclastic metasandstone is dominated by a 2747 ± 3 Ma zircon age component (GSWA 155572, Wingate et al., 2013b). The age difference of about 230 Ma across the Weld Range indicates the presence of an unconformity, the exact location of which is not known but could be where a boulder conglomerate outcrops.

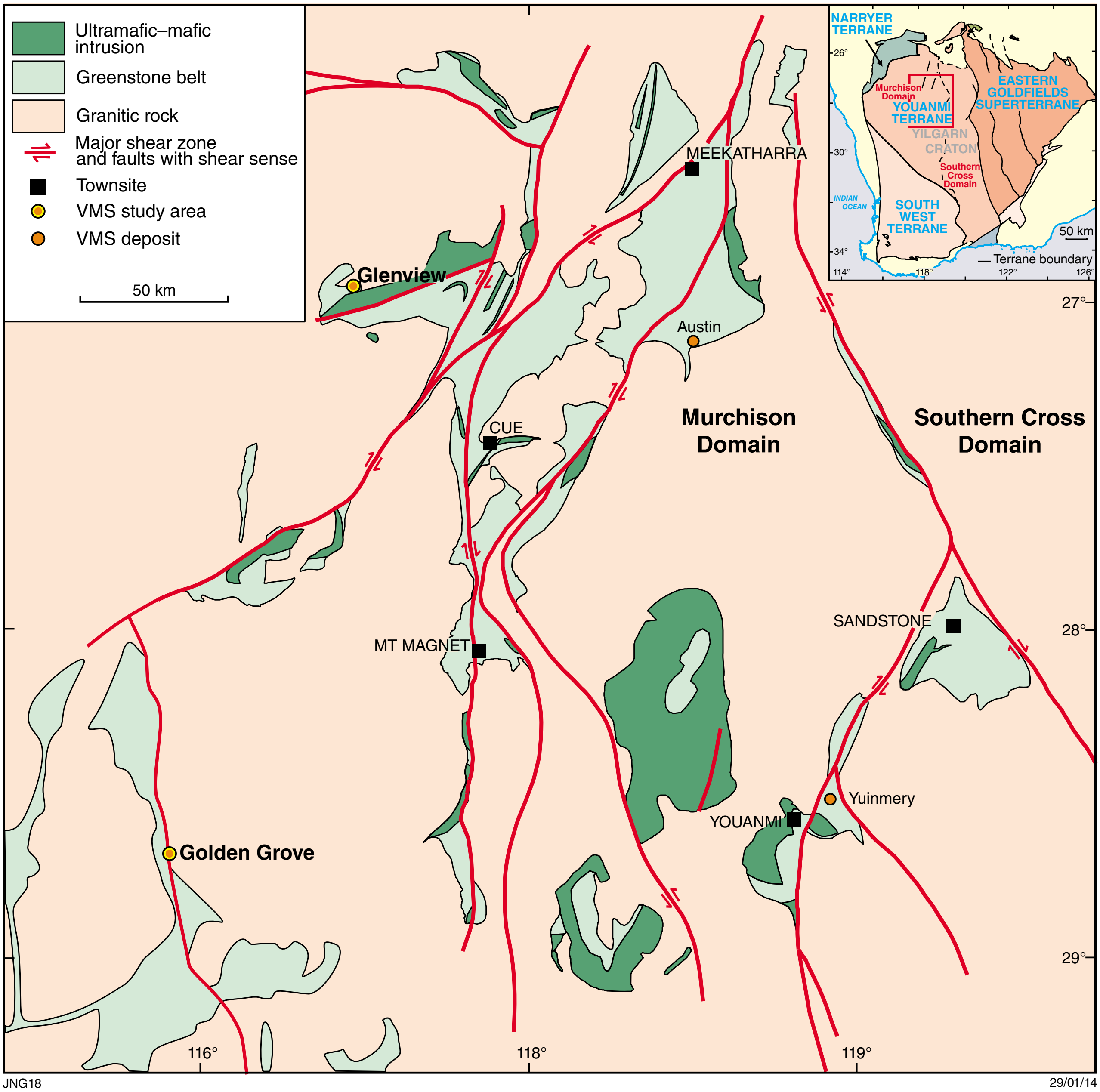

Figure 1. **Simplified geology of the northern Murchison Domain showing the location of Golden Grove and Glenview. Modified from Van Kranendonk et al. (2010)**

Crystallization ages of c. 2977 Ma for rhyolite at the base of the Weld Range are only slightly older than those of c. 2960 Ma for the entire dacitic succession at Golden Grove (GSWA, unpublished data). Also, galena samples from Glenview dated by CSIRO for MIM Exploration Pty Ltd indicated Pb-isotope dates of c. 3180 Ma, broadly similar to a Pb-isotope date of c. 3145 Ma for Golden Grove (Martin et al., 1997).

HyLogger spectral scanning of drillcore from Golden Grove indicated changes in the species of chlorite and white mica that provide measurable vectors towards sulfide mineralization. In relation to distance from sulfide mineralization, chlorite becomes Fe-rich over a metre scale, whereas paragonite becomes the dominant white mica over a decametre scale. Changes in the variability of specific absorption features related to white mica are also found to be effective vectors at indicating mineralization.

The wavelength at which the diagnostic AlOH absorption feature occurs is less variable in mineralized drillcore. Applied to Glenview, these vectors indicate favourable conditions for mineralization in the eastern portion of the Glenview prospect, where drillholes contain abundant paragonite and display markedly less variation in the wavelength of the AlOH absorption feature related to white mica (Fig. 4).

Conclusion

The present study indicates that the tectonic setting, environment of formation, and age of felsic volcanism at Glenview are similar to those at Golden Grove, and that the Weld Range is prospective for VMS deposits. Alteration patterns suggest that the most prospective area may be in the eastern part of the Glenview prospect.

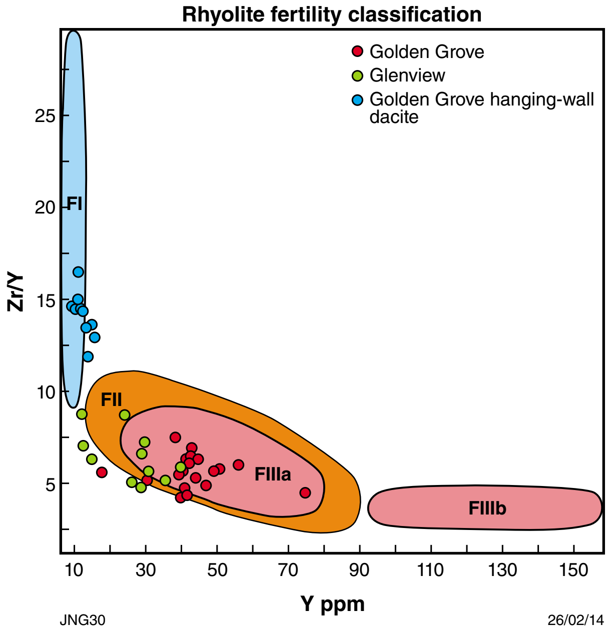

Figure 2. Felsic fertility plot of Lesher et al. (1986). Felsic volcanic rocks from Glenview and Golden Grove plot mainly in the FII and FIIIa fields, indicating that both are prospective for VMS mineralization

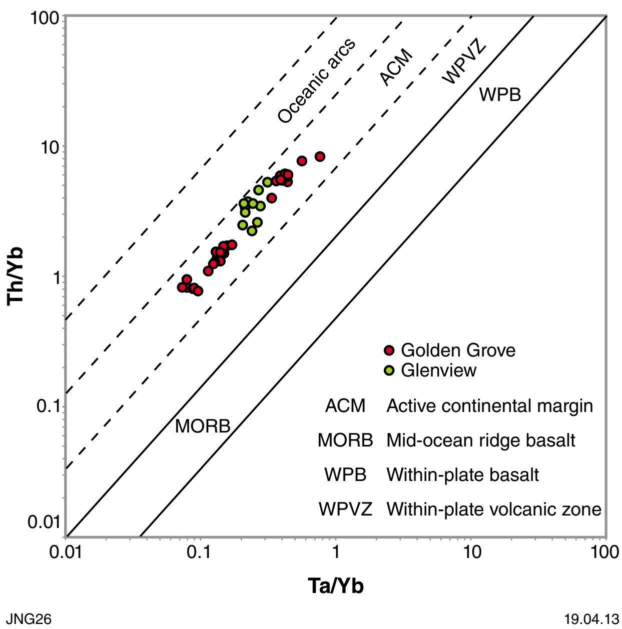

Figure 3. Tectonic setting discrimination diagram (modified from Schandl and Gorton, 2002), suggesting that felsic metavolcanic rocks from the Weld Range and Golden Grove both formed in an active continental margin setting

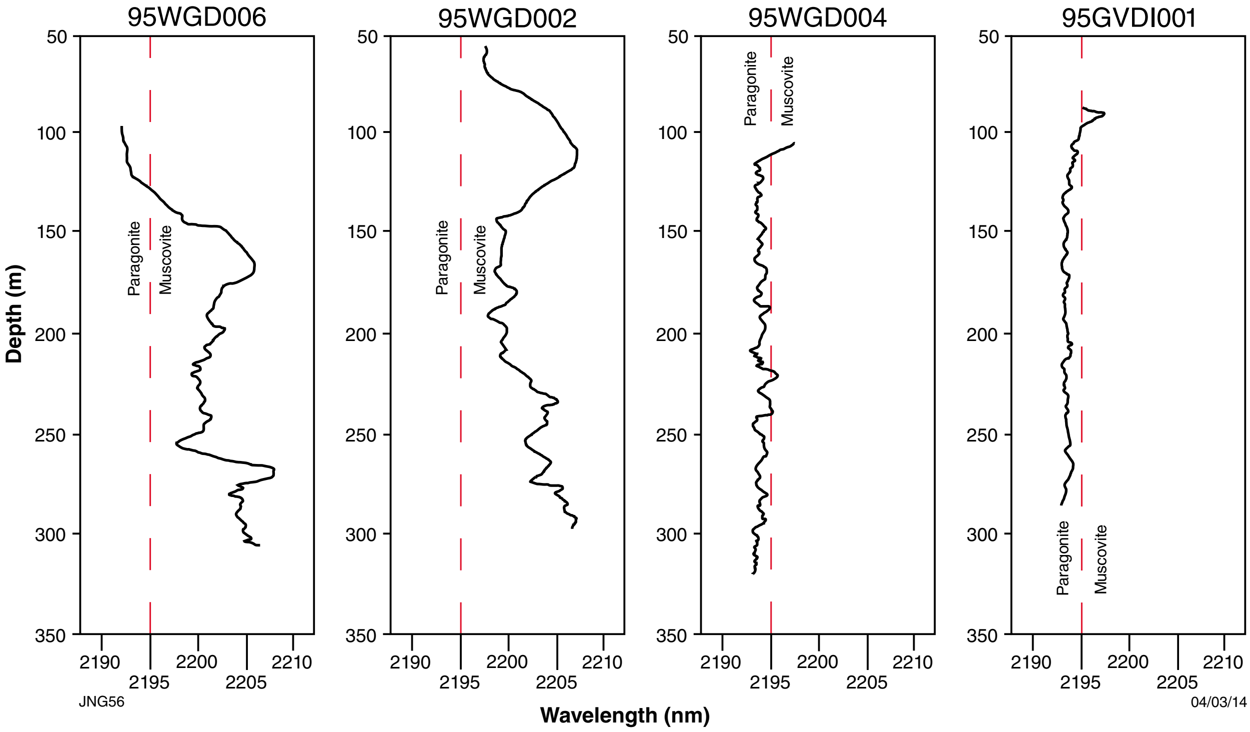

Figure 4. **Downhole variation in the wavelength intersection of the AlOH absorption feature related to white mica in drillholes from Glenview, illustrating the difference between western (95WGD006 and 95WGD002) and eastern (95WGD004 and 96GVDI001) drillholes**

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