2.7 Ga plume associated VMS mineralization in the Eastern Goldfields Superterrane: insights from the Ag-Zn-(Au) Nimbus deposit

Hollis, S.P.[1,2,3], Mole, D.[2], Gillespie, P.[4], Tessalina, S.[5], Caruso, S.[6], Barnes, S.J.[2], Pumphrey, A.[4], Cas, R.A.F[7], Hildrew, C.[8], Goodz, M.[9], Hancock, L[3], Yeats, C.J.[10], Verbeeten, A[11] and Wyche, S.[3]

[1]iCRAG (Irish Centre for Research in Applied Geosciences), University College Dublin, Ireland (steve.hollis@icrag-centre.org)
[2]Mineral Resources Flagship, CSIRO, Kensington, Perth, Australia
[3]Geological Survey of Western Australia, Perth, Australia
[4]MacPhersons Resources, Kalgoorlie, Australia
[5]John de Laeter Centre for Isotope Research, Curtin University, Perth, Australia
[6]Centre for Exploration Targeting, University of Western Australia, Perth, Australia
[7]School of Geosciences, Monash University, Victoria, Australia
[8]ARC Centre of Excellence in Ore Deposits (CODES), University of Tasmania, Hobart, Australia
[9]Goodz & Associates GMC Pty Ltd, Kalgoorlie, Australia
[10]Geological Survey of New South Wales, Maitland, Australia
[11]Minerex Petrographic Services, Kalgoorlie, Australia

Economic volcanic-hosted massive sulfide (VHMS) deposits of the Archean Yilgarn Craton, Western Australia, are restricted to zones of juvenile crust as revealed through regional Nd, Pb and Hf isotopic variations and the geochemistry of felsic volcanic rocks. Interpreted as Archean paleo-rift zones, one of these runs N-S through the Eastern Goldfields Superterrane (broadly coincident with the Kurnalpi Terrane) and is associated with the high grade ca. 2690 Ma Teutonic Bore, Jaguar and Bentley deposits, plus sub-economic VHMS mineralization further south. To date, only small, historic Cu deposits (e.g. Anaconda) and barren pyritic lenses have been recognised in the older 2.7 Ga plume-dominated lower stratigraphy of the Eastern Goldfields.

The Nimbus Ag-Zn-(Au) deposit (12.1 Mt at 52 g/t Ag, 0.9% Zn and 0.2g/t Au) is located approximately 10 km east of Kalgoorlie, near the margin of the Kurnalpi rift zone. Its origin has been contentious for a number of years with previous models favouring seafloor/sub-seafloor VHMS mineralization or a high sulfidation fault-hosted system. The local stratigraphy comprises a NW-trending and steeply-dipping bimodal-felsic package of volcanic rocks (i.e. quartz-feldspar porphyritic dacite and lesser basalt, plus their autoclastic equivalents) with subordinate carbonaceous mudstone, tuff, polymict conglomerates and volcanic breccias. Komatiite flows, volcanic sandstones/siltstones, carbonaceous mudstone, basalt and dolerite were intersected in a distal drillhole. Primary sulfide resources occur as a series of stacked plunging lenses, overlying mined supergene and oxide mineralization. In the primary sulfide zone, early well-developed massive pyrite is underlain by 1) semi-massive, stringer and breccia-type Ag-Zn±Pb(Cu-Au) sulfides (including: pyrite, low- and high-iron sphalerite, galena, pyrargyrite, marrite, boulangerite, arsenopyrite, chalcopyrite, Ag-bearing tetrahedrite) associated with the autoclastic facies of thick units of dacite; and 2) stringer and disseminated sulfides (dominated by pyrite and sphalerite) in coherent pseudo-brecciated dacite at depth. Hydrothermal alteration is characterized by intense and pervasive quartz-sericite-carbonate±fuschite, with chlorite predominantly associated with mafic units. Two new U-Pb zircon SHRIMP ages of 2703 ± 5 Ma and 2702 ± 4 Ma from the host dacite indicate the Nimbus deposit was coeval with plume magmatism in the Eastern Goldfields.

Compared to other VHMS occurrences in the Yilgarn Craton, the Nimbus deposit is unusual in terms of its tectono-stratigraphic position, the geochemistry of its host sequence (i.e. FI-affinity felsic volcanic rocks, ocean-plateau like low-Th basalts), mineralogy (e.g. abundance of Ag-Sb-Pb-As bearing sulfosalts, high Hg, low Cu) and carbonate-sericite-silica dominated alteration assemblages. Classification of Nimbus as a shallow water and low temperature VHMS deposit with epithermal characteristics (i.e. a hybrid bimodal-felsic deposit) is consistent with its position near the margin of this paleo-rift zone. The recognition that the Nimbus deposit is associated with 2.7 Ga plume magmatism opens up new areas for VHMS exploration in the Eastern Goldfields Superterrane over a strike length exceeding 500 km. The Palinuro Volcanic Complex of the northern Aeolian arc, Tyrrhenian Sea, Italy, represents a comparable modern shallow water and low temperature hydrothermal system.