Geological Evolution of the DeGrussa Cu-Au-Ag Volcanic-Hosted Massive Sulfide Deposit, Western Australia

Margaret L. Hawke,[1*] Garry Davidson,[1] Sebastien Meffre,[1] Paul Hilliard,[2] Ross R. Large,[1] and J. Bruce Gemmell[1]

[1]CODES, Centre of Excellence in Ore Deposits, University of Tasmania, Private Bag 79, Sandy Bay, Hobart, TAS 7001, Australia
[2]Sandfire Resources NL, PO Box 1495, West Perth WA 6872, Australia

*E-mail, mlhawke@utas.edu.au

The DeGrussa Cu-Au-Ag volcanic-hosted massive sulfide (VHMS) deposit is hosted in 2027 Ma turbiditic sedimentary rocks and mafic basalts of the DeGrussa Formation, the lowest stratigraphic unit of the Bryah Group, part of the palaeo-Proterozoic supracrustal sequence situated in the southern part of the Capricorn Orogen of central Western Australia. Stratigraphy is crosscut by intrusive dolerite units of ages 1991 ± 7, 1999 ± 7 and 2003 ± 7 Ma. The deposit consists of four ore lenses (DeGrussa, Conductor 1, Conductor 4, and Conductor 5), with an estimated total resource of 12.4 Mt @ 4.7% Cu and 1.8 g/t Au.

Geological observations support formation in a deep marine, oceanic rift setting. Massive sulfide lenses consist of fine-grained pyrite, chalcopyrite, and pyrrhotite with lesser sphalerite, galena, marcasite, magnetite, and molybdenite. Ore contacts are typically associated with chlorite schist and talc-carbonate alteration. Replacement textures indicate some parts of the deposit were formed in the subseafloor environment. The lack of sulfate minerals in the ore, but the presence of peripheral jasper, suggests that DeGrussa either formed in a silled reduced oceanic subbasin with an oxic top layer, or from low Ba, highly reduced, fluids that were emplaced into a suboxic-oxic water column. The latter scenario produces barite-poor Cu-Zn deposits in modern mid-ocean ridge basins.

A significant magmatic input or heat source to mineralizing fluids is suggested, given the 270˚ to 350˚C, high temperature, and reduced ore assemblage dominated by chalcopyrite-pyrite-pyrrhotite-magnetite. The $\delta^{34}S$ values of +0.25 to +6.31‰ are comparable to igneous values and could form from reduced magmatic-hydrothermal fluid or by leaching of volcanic S. Elevated gold and copper grades can also be explained by a magmatic-hydrothermal source. Lead isotopes, however, imply higher $^{238}U/^{204}Pb$ (μ) in the source of the mineralizing fluids, indicating an upper crustal source of lead. Higher $\delta^{34}S$ for pyrite up to +9.82‰ suggest possible mixing with a secondary sulfur source.