

Indicator minerals, interface sampling and sulfur isotopes for vectoring the Nova-Bollinger Ni-Cu-Co sulfides, Western Australia

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The Nova-Bollinger Ni-Cu-Co sulfide deposit is located approximately 200 km southeast of Kalgoorlie within the Albany-Fraser Orogen in Western Australia. The mineralization is associated with an eye-shaped, metamorphosed mafic-ultramafic sill complex and covers an area of 2.8 km² with a maximum depth of about 450 m. The surface regolith is characterized by saprolite with variable thicknesses (5-70 m), most likely related to bedrock lithology and structure variations. Saprolite is overlain by a thin transported cover (<5 m) of lacustrine clay and calcrete, except for areas of paleochannels east of Nova deposit, where it reaches up to 55 m of fluvial sand and clay. Sampling above and below the unconformity (interface) between the in-situ and transported regolith showed elevated Ni, Cu, Co, Cr and S over the massive Ni sulfides and in the paleochannel sediments. Indicator-heavy mineral (IHM) analysis was undertaken above the unconformity and shows fresh detrital sulfides (pyrrhotite, chalcopyrite, and pentlandite) and gossan fragments preserved during the mechanical weathering over the mineralization. Bulk chemical analyses of IHM showed elevated Ni, Cu, Co, Pb and S in the paleochannel sediments, only proximal to the sulfide mineralization. This is evidenced by elevated secondary diagenetic chalcopyrite, pyrite, marcasite, minor galena, and sphalerite. Weathering of the chalcopyrite in the shallower oxidized part of the paleochannel has formed covellite. There is the potential for the hydromorphic dispersion and physical transport of detrital sulfides and associated gossan fragments along the gently inclined interface, resulting in broader exploration targets. Sulfur isotope analysis of alunite, which is common in the Nova supergene profile, was undertaken to discriminate between alunite-related and unrelated to the weathering of hypogene massive sulfides. Little or no sulfur-isotope fractionation accompanies the oxidation of hypogene sulfides during weathering. The alunite in the Nova supergene profile has an average value of $\delta^{34}\text{S}_{\text{VCDT}}$ of 21 per mil, whereas all primary sulfides have an average value of $\delta^{34}\text{S}_{\text{VCDT}}$ of 2 per mil. Although alunite occurs mainly over the mineralization and along faults, the higher values of $\delta^{34}\text{S}$ indicate a marine source of sulfur and, thus, unrelated to the Nova sulfides.