

**Using Multi-Element Geochemistry to Map Multiple Components of a Mineral System. Case study from a sediment hosted Cu-Ni camp, NW Province, Zambia**

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The Trident project in the Domes region of NW Zambia comprises the Sentinel copper deposit (5 Mt contained Cu) and the Enterprise nickel deposit (480,000t contained Ni). The two ore bodies are 12 km apart and appear to represent discrete deposit styles of a mineralizing system that has a detectable footprint of at least 50 x 50 km. Ultra-trace, multi-element geochemistry of residual soils was used to define bedrock lithology and stratigraphy, define some aspects of the alteration signatures and map metal mobility at a district scale.

Multivariate analysis of immobile trace elements in the soils was used to characterize lithological signatures and help define stratigraphic boundaries in the Trident area. This approach greatly enhanced geologic understanding in a region that has subdued terrain, significant soil cover and vegetation, and less than 5% outcrop. Dense brines derived from the dissolution of evaporites have pervasively altered broad regions of the basal stratigraphy. Distinctive characteristics of this alteration such as hydrothermal monazite and nickeliferous talc are retained in saprolitic soils. There is a strong partitioning to this alteration; it is present throughout a lower red bed sequence, but absent from reduced facies higher in the sequence. The redox boundary across which the change occurs defines a gently dipping structure that is mostly parallel but locally discordant to stratigraphy. Rocks in the oxidized, lower part of the system are strongly affected by magnesium metasomatism, and preserve a diagnostic alteration assemblage of talc, phlogopite and kyanite. Rocks above the boundary, in the reduced part of the system, do not contain this mineral assemblage and lack significant mineralization. Rocks affected by the talc, phlogopite kyanite alteration have been totally stripped of Cu, U, Co and a broad suite of other metals. The mineralogical and metal distribution patterns defined from the soil geochemistry map fluid migration patterns through the sedimentary basin at a district scale. The two deposits represent the only currently known locations of reduced shale horizons within the oxidized hydrothermal system.

These observations are key to understanding the geology of the Domes region of the Central African Copperbelt. Previous interpretations of quartz-kyanite-talc ('whiteschist') assemblages in the Domes region have been used to interpret high pressure (HP) metamorphic conditions. However, there is no evidence of subduction during the Neoproterozoic-Cambrian in NW Zambia, and no evidence for a metamorphic pile or structures related to the level of thickening required to attain high-pressure conditions. On the basis of observations across all scales, we

interpret that the quartz-kyanite-talc (-phlogopite) bearing rocks are the result of magnesium metasomatism in the presence of hypersaline brines derived from evaporite dissolution. This hydrothermal process occurred at high crustal levels under an elevated geotherm related to *ca* 550-500Ma deformation and represents the transport pathway for the base metals ultimately concentrated in the Sentinel and Enterprise deposits.