Paper Number: 566

Multi-scale detection of buried mineralization and lithology through Kalahari transported cover in NW Botswana

Salama, W.[1], Anand, R.R.[1], and Kidder, J.[2], Pinchand, T.[1]

[1]CSIRO, Mineral Resources, 26 Dick Perry Avenue, Kensington WA 6151, Perth, Western Australia
[2]First Quantum Minerals, 1/24 Outram St, West Perth WA 6005, Western Australia

_____

Many prospective areas in NW Botswana are obscured by extensive Kalahari cover. This cover presents a critical challenge for mineral exploration, as the industry currently lacks the fundamental data, scientific knowledge and technological tools needed to discover new, buried, world-class ore deposits. With an average depth of 60m of Kalahari cover the effectiveness of traditional geochemical sampling techniques is greatly reduced. However, the cover itself presents a valuable opportunity for exploration and we present some results here. Exploration of the Katangan Supergroup of NW Botswana for Cu has been undertaken by First Quantum Minerals (FQM) from 2014-2015. The region is dominated by thick (25-90 m) Kalahari transported cover of organic soil, aeolian sand, calcrete and silcrete over slightly weathered bedrock. Goethite-hematite-rich redox fronts are commonly developed in aeolian sand, especially in the lower part. The Kalahari transported cover do not show significant development of soil horizons. Organic soil is underlain by massive undifferentiated sand which may contain charcoal fragments.

For geochemical detection of buried mineralization through cover at three prospects (Namasere, Laharpo East and Sepopa), in addition to a large geochemical data provided by FQM, we have employed a variety of geochemical techniques (total, partial extractions, soil size fractions and Laser Ablation ICPMS). Mineralogical methods including the detailed analysis (optical and scanning electron microscopy) of individual minerals within cover materials have been applied and provided important signals of metal dispersion not necessarily realized in bulk sample analyses.

At Namasere Cu prospect, there is evidence of multiple events of vertical and lateral migration of elements from source into the regolith profile that reflect the underlying mineralization and/or lithology at depth. At interface (unconformity; 2 km spaced sampling), mechanical dispersion is dominant as indicated by Mn-rich ilmenite, Ca- and Mn-rich garnet, sulphides, biotite, magnetite, kyanite, zircon, apatite, hornblende and epidote. Key indicator heavy minerals that are abundant in Namasere prospect and should be targeted are Mn-rich ilmenite and Mn-rich garnet (with sulphide inclusions). Weathering of these heavy minerals produced Fe and Mn oxides that are anomalous in Cu, Ni, Co, Zn and As. Hydromorphic dispersion of Cu, Ni, Co, Zn and As has been important in Fe oxide-rich palaeo-redox fronts formed in aeolian sand by groundwater processes when water tables were nearer to the surface. Metals from the underlying mineralization have been incorporated in poorly crystalline to well crystalline Fe oxides and anomalous concentrations were evident when extracted by 0.1M and 0.25M hydroxylamine hydrochloride and weak aqua regia. In overlying soils, the geochemical response is less convincing. Elements extracted by mild aqua regia leach of five soil size fractions (<2, 2-75, 75-250, 250-2000 and >2000 µm) of 2 m profile show that Cu, Mo and Co are concentrated in the Fe-rich 75-250 µm fraction, whereas many other elements (e.g. Pb, Zn, Ag, Se, Te) are concentrated in the clay size (<2 µm) fraction.

Elemental results from four partial extractions (water, sodium acetate, sodium pyrophosphate, hydroxylamine hydrochloride) performed on <250 µm soil fraction for samples collected at various depths show that many elements (Ag, Cu, Co, Zn, As, Bi, Cd, Se, Sb, W and Te) are associated with

organically-bound Fe extracted by sodium pyrophosphate. Significant increase in Mn concentrations in top 40 cm of profile produced false positives. Normalisation of data with Mn suggests that elevated concentrations in Cu, Co and Zn in soils are the product of scavenging by Mn oxides.

In conclusion, sampling of interface and redox samples is highly recommended in this environment. Soil sampling should be targeted between 50 and 80 cm to avoid false anomalies formed by scavenging of metals by Mn oxides in near-surface environments. Pyrophosphate extraction is recommended for ore and pathfinder elements. The 75-250 µm soil fraction should be analysed by mild aqua regia. Ultimately, more of such studies are needed to identify regolith materials and minerals that act as deep geochemical sensors to provide confidence for exploration in areas of deep cover.