Hydrothermal Mineralization and Alteration of the Sediment-Hosted Fe-Cu-Co Target H Prospect, Mumbwa Iron-Oxide Copper-Gold District, Zambia

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Abstract

The geology of the sediment-hosted Fe-Cu-Co Target H Prospect, Mumbwa Iron-Oxide Copper-Gold District, Zambia, is underlain by limestone, dolomitic siltstone, and breccia belonging to the Neoproterozoic Kundelungu Group of the Katanga Supergroup. Limestone consists of medium-grained calcite and minor dolomite, and quartz. Dolomitic siltstone which conformably overlies limestone is composed of fine-grained dolomite, quartz, illite, muscovite, K-feldspar, and chlorite. Breccia develops as a distinct lithology in extremely fractured zones of limestone and dolomitic siltstone. Mineralogy of the breccia varies depending on the composition of the cement. In the core of the breccia zone, siderite is the dominant mineral in the cement but the composition changes to dolomite-rich in the margin.

The primary mineralogy of the host rocks has been modified by three types of hydrothermal alteration. The earliest alteration occurs as overgrowths of muscovite and K-feldspar on fine-grained illite and chlorite. Muscovite and K-feldspar alteration is observed in the dolomitic siltstone and breccia clasts. The second alteration involved recrystallization of dolomite and calcite as a breccia cement and an infill in stockwork veins embedded in dolomitic siltstone and limestone. The last type of alteration is characterized by partial to complete replacement of dolomite and calcite by siderite and ankerite in the breccia cement and stockwork veins.

Mineralogical and geochemical studies of the sediment-hosted Fe-Cu-Co Target H Prospect show evidence of multistage epigenetic mineralization which is related to hydrothermal processes in an iron-oxide copper-gold system. Ore mineralization comprises primary and secondary ore stages. The primary ore stage is of two types: (1) hematite-rich ore which consists of crystalline hematite and pyrite overprinted by disseminated chalcopyrite in the breccia; and (2) chalcopyrite-rich ore comprising of chalcopyrite and minor bornite replacing disseminated pyrite in dolomitic siltstone, limestone, and stockwork veins. In the first stage primary ores, chalcopyrite occurs as intergrowths and inclusions in hematite and pyrite. Pyrite contains high concentrations of cobalt (up to 5 wt. %). Secondary ore stage comprises of chalcocite, covellite, goethite, malachite, and native copper.

Statistical interpretation of the whole-rock geochemical data using principal component analysis (PCA) reveals three distinct element groupings reflecting the three types of hydrothermal alteration. The first group constitutes the main elements in the muscovite and K-feldspar alteration minerals. These include Si, Al, Na, K, Ti, and P. Trace elements; Sc, Be, V, Cr, Ga, Ge, Rb, Zr, Nb, and Cs are included in the muscovite and K-feldspar alteration minerals. The second group consisting of Mg and Ca represents dolomite and calcite alteration. Trace elements; Zn, Sr, and Y, are included in dolomite and calcite. The last group consists of Fe, Mn, C, and S. This category comprises of the main elements in siderite and ankerite. Minor and trace elements; Co, Ni, Cu, As, Mo, In, Sn, Sb, W, Pb, and U cluster in this group. PCA results are consistent with petrographic evidence which indicates that the primary Fe, Cu, and Co

minerals at Target H Prospect are associated with siderite and ankerite alteration in the breccia.

Keywords: Mumbwa Iron-Oxide Copper-Gold District, Fe-Cu-Co Target H Prospect, Hydrothermal Mineralization and Alteration

