Hydrothermal Alteration and Cu-(Co) Mineralization of the Fishtie Deposit: Implication for Metal Source and Timing of Mineralization in the Zambian Copperbelt Deposits

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This study presents lithologic, petrographic, mineralogic, and sulfur isotopic data for the recently discovered Fishtie deposit to discuss controls of Cu-(Co) mineralization, and shed light on the contentious issues of metal sources and timing of mineralization in Zambian Copperbelt sediment-hosted deposits. Cu-(Co) mineralization occurs in stratified sandstone and conglomerate of the Grand Conglomerate formation, as well as the overlying folded dolomite and dolomitic siltstone of the Kakontwe Limestone Formation. The host rocks were affected by two hydrothermal events,resulting in the formation of; (i) magnesium (Mg-) alteration assemblage occurring as patchy to pervasive replacement of calcite and plagioclase in conglomerate matrix and clasts by dolomite and clinochlore, and (ii) iron (Fe-) alteration assemblage of chamosite, biotite and siderite that overprints the Mg-alteration assemblage. Cu mineralization occurs as chalcopyrite in host rock and veins, with minor bornite and chalcocite in Mg- and Fe-alteration assemblages, whereas Co mineralization occurs as cobaltite in chalcocite zones and is limited to Fe-alteration assemblages.

Sulfur isotopic results of sulfide minerals show strong lithologic control, as evidenced by the highest $\delta^{34}S$ values (from ~+15‰ to +27.2‰) recorded in sulfides disseminated in dolomitic siltstone, while the lowest $\delta^{34}S$ values (from ~-0.07‰ to +7‰) were recorded in vein-hosted hosted sulfides in dolomite and dolomitic siltstone. Intermediate $\delta^{34}S$ values (+9.2‰, +11.2‰, +13‰) are observed in sulfides disseminated in sandstone and conglomerate unit. Variations in $\delta^{34}S$ values suggests mixing of hydrothermal sulfur and reduced sulfur from evaporitic sulfate. Trapped hydrocarbons in dolomitic siltstone, sandstone and conglomerate acted as a reductant.

We propose a metamorphic model for Cu-(Co) mineralization of the Fishtie deposit that involves circulation of oxidizing hydrothermal fluids capable of remobilizing Cu and Co from basement mafic rocks. Reaction of metal-bearing hydrothermal fluids with reduced sulfur led to deposition of Cu-(Co) mineralization in fault-controlled veins and folded dolomite and dolomitic siltstone.