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Lithostratigraphic Distribution and Geochemistry of Carrollite in the World-Class Tenke-Fungurume Cu-Co Mining District, Democratic Republic of the Congo

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Improving our knowledge of cobalt (Co)-rich deposits is crucial to enhance exploration success for the Co needed for the green energy transition. The Tenke-Fungurume mining district (TFM) in the Central African Copperbelt with 3.5 Mt Co (CMOC, 2022) represents one of the largest Co reserves worldwide. This study investigated the lithostratigraphic distribution and geochemistry of carrollite ($CuCo_2S_4$), the primary hypogene Co ore mineral in TFM.

Twenty-four polished sections from mineralized samples of units in the R.A.T and Mines Subgroups of the Roan Group were examined. Carrollite is most abundant in the R.S.F., followed by the R.S.C. and S.D.B. Carrollite in these samples occurs as disseminations in dolomitic siltstone in R.A.T. Grise (n=2); as disseminations in dolomite horizons in D.Strat. (n=3); as disseminations, lenses, and bed-parallel layers in dolomite-quartz-rich horizons and in quartz-dolomite veins in R.S.F. (n=11); as disseminations in massive dolomite in R.S.C. (n=3); as disseminations in dolomitic shale in S.D. (n=4); and as disseminations and lenses in dolomitic shale and quartz veins cutting bedding at high angles in S.D.B. (n=1). The variety of Co mineralization styles appears to reflect both wall rock lithology and the previous occurrence of disseminated-to-nodular or lenticular evaporite minerals.

The Cu:Co of carrollite increases systematically with stratigraphic height in the local lithostratigraphic section. The Cu:Co value is 0.36±0.05 in R.A.T. Grise and 0.35±0.01 in D.Strat., progressing upsection to 0.52±0.01 in R.S.F., 0.51±0.01 in R.S.C., 0.48±0.02 in S.D.B., and 0.51±0.01 in S.D. Iron, Se, and Mo contents in R.A.T. Grise carrollite are, respectively, 156±377ppm, 170±168ppm and 280±251ppm. Moving into the overlying stratigraphic units, Fe content in carrollite increases, whereas the Mo and Se contents decrease, by one-to-two orders of magnitude. This element systematics are attributed to the influence of redox conditions on carrollite deposition and may serve as a vectoring tool for exploration.