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Fingerprinting Mineralization in the Sediment-Hosted Cu-Ag System: Constraints from the Khoemacau Zone 5 Cu-Ag Deposit in NE Botswana's Portion of the Kalahari Copper Belt

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The Ghanzi Group's Neoproterozoic sedimentary rocks are known to house the Khoemacau Zone 5 Cu-Ag deposit, located in the Ghanzi-Chobe Belt. Despite lacking visible signs of alteration, these host rocks may still display hydrothermal overprints that are difficult to detect, potentially impeding undercover exploration success. As mineral deposit exploration becomes more challenging, it becomes necessary to employ novel approaches that are reliable and cost-effective. One such approach is to use various geoscientific proxies as exploration tools to direct mineralization. We utilized a combination of alteration types, changes in mineralogy, and rock chemistry from barren to mineralized rocks to develop geochemical and mineralogical vectors for the Cu-Ag mineralized system. We employed inductively coupled plasma-optical emission spectrometry, X-ray fluorescence spectrometry, X-ray diffraction spectrometry, and multivariate statistical analyses (including PCA and AHC).

Copper is highly correlated with Mn and Mo and, in some cases, with Co and As. This suggests saturation in sulfide minerals such as molybdenite, cobaltite, and arsenopyrite. Copper, Mn, Sr, Mo, As, Li, and Y concentrations increase proximal to the mineralized zone. Within the mineralized zone, increased Cu content is associated with elevated As, Co, Li, Mn, Mo, and Sr concentrations. Beyond the mineralized zone, As, Cu, Mn, Mo, and Y concentrations decrease proportionately to their proximity to the mineralized zone, but Li and Sr content increases locally. The mineralized zone is characterized by high concentrations of calcite, chlorite, and mica, suggesting a possible correlation between high Cu concentrations and the processes of sericitization, carbonatization, and chloritization. Significant albitization occurs beyond the mineralized zone. As a result, higher Mn, Mo, Li, Sr, and local As and Co can be utilized as indicators of mineralized zones. Chloritization, sericitization, and carbonatization are examples of changes that can serve as mineralization vectors.