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Accurate Detection of Copper Sulfide Mineralization Beneath Cover Using Isotope Hydrogeochemistry

Adam Simon¹, Ryan Mathur¹, Karr McCurdy¹, Lee Ann Munk³

¹Vectores Science, Inc., Ann Arbor, United States, ²University of Michigan, Ann Arbor, United States,

³University of Alaska Fairbanks, Fairbanks, United States

Exploration for mineral deposits is increasingly more difficult because ore bodies are concealed beneath cover that does not contain a chemical signal for mineralization. Geophysical data can suggest the possible presence of sulfide mineralization, but verification requires drilling. Together, geophysics and drilling take substantial capital and time. We developed a novel exploration method that uses the copper isotope composition of ground and surface water as a subsurface probe for sulfide mineralization. Our method does not use copper concentration. We use multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) to measure the abundances of both isotopes of copper, Cu-65 and Cu-63, as low as parts per trillion levels, and use the ratio of Cu-65 to Cu-63 to accurately fingerprint the presence of, and distinguish among, chalcopyrite, hypogene vs. supergene chalcocite, and pyrite. We completed 50+ field studies globally that demonstrate the method is successful for the discovery of epithermal, porphyry, IOCG, VMS, magmatic Ni-Cu sulfide, and sediment-hosted copper deposits covered by caliche, sedimentary rocks and gravel, and glacial till. Field areas included Alaska, Arizona, Australia, Canada, Chile, Peru, and Zambia, where water was sampled from wells, springs, seeps, ponds, and/or effluent streams. The hydrogeochemical method has been successfully used for brownfield and greenfield exploration. For areas with existing geophysical data, our primary data and interpretation provide certainty for the presence or absence of concealed sulfide mineralization, allowing companies to focus capital and time on drilling targets that contain copper sulfide mineralization and not on drilling barren targets. For areas without geophysical data, we expedite exploration by quickly screening prospective terrane to identify mineralized areas deserving of geophysical data generation and drilling. This transformative hydrogeochemical method will expedite exploration by accurately identifying concealed prospects and locating drilling targets.