The Application of Radiogenic (Sr and Pb) and Stable Metal (Cu) Isotopes in Undercover Exploration, Northwest Queensland

Joseph Tang[1], Balz Kamber[2], David Murphy[2], Ryan Mathur[3], Brandon Mahan[4]
[1]Geological Survey Of Queensland, Brisbane, Australia, [2]Queensland University of Technology, Brisbane, Australia, [3]Juniata College, Pennsylvania, USA, [4]Melbourne Analytical Geochemistry, School of Geography Earth and Atmospheric Sciences, University of Melbourne, Melbourne, Australia

Ninety-five percent of mineral occurrences in northwest Queensland (NWQ) are discovered within the exposed Proterozoic rocks of the Mount Isa and Georgetown areas, with only a few, relatively recent finds (e.g., Ernest Henry, Cannington) concealed under Mesozoic cover rocks of the Carpentaria and Eromanga basins. Geophysics and geological mapping indicate prospective Proterozoic rocks extend under these Mesozoic basins, which hamper mineralisation signatures from reaching the surface.

Groundwater offers an effective alternative exploration methodology to costly geophysics and drilling. Pore waters inherit the chemical signatures of their host rock, and metal solutes can be transported up to 5 km from source. Solute concentrations are typically in parts-per-billion, are highly susceptible to dilution and evapotranspiration.

Metal isotopic ratios (206Pb/204Pb, 207Pb/204Pb, 65Cu/63Cu, 87Sr/86Sr) are largely unaffected by dilution or concentration factors and are robust geological tools for identifying source regions and sulphide weathering. By plotting Pb isotopes in groundwater against published Pb-Pb growth curves for the Mount Isa Inlier, potential Proterozoic source rocks can be identified, and hence, axiomatically enable informed decisions to be made regarding their mineral prospectivity. All major deposits in NWQ are Proterozoic and to be able to assign an anomalous water to the same mineralisation epoch will help explorers plan their undercover exploration programs. δ65Cu for chalcopyrite, pyrite and native Cu in the Swan, Eloise, Jericho, and Ernest Henry deposits, ranges from -1 to 2. Weathering of Cu ores preferentially concentrates heavy 65Cu relative to 63Cu and contouring the δ65Cu values will telescope them towards Cu-associated sources. The 87Sr/86Sr ratio has a strong relationship with source lithology. It clearly distinguishes Great Artesian Basin waters from waters of the Proterozoic Mount Isa and Georgetown Inliers.

Metal isotopes when used in conjunction with water chemistry, sound regional isotopic and geological knowledge, are therefore powerful tools for predicting mineral prospectivity.