Using Chemistry of REE-Bearing Phosphates for ISCG Exploration

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The challenge of cover has forced exploration into deeper search spaces, thereby limiting the successful discovery of new ore deposits. This difficulty is reflected in decreasing rates of successful deposit discovery, which is impacting the global supply of minerals. Among these impacted minerals are critical minerals, which include copper and the rare earth elements (REEs). Copper and REEs are essential in the construction of renewable energy technologies and clean energy solutions. To secure supply of these minerals, more deposits that contain critical minerals need to be discovered. New techniques are being developed to be added to the exploration toolkit to aid exploration for such deposits. Among these developing techniques are geochemical targeting tools that use mineral chemistry to understand proximity to ore deposits.

Here we present the results from an investigation into using REE-bearing phosphate minerals (monazite, rhabdophane) in exploration for iron sulfide-copper-gold (ISCG) deposits. The Jericho and Kulthor ISCG deposits in the Cloncurry District, Queensland, Australia are used as case study areas. At Kulthor, hydrothermal REE-bearing phosphates associated with mineralisation are characterised by elevated light REE (except Ce) and S concentrations and depleted Th concentrations compared to samples with no association with mineralisation. Hydrothermal samples associated with mineralisation at Jericho also preserve elevated S and depleted Th, with the addition of elevated Ca compared to metamorphic monazite. The hydrothermal phosphates at Jericho yield low analytical totals (93–97%), which is attributed to the phase being rhabdophane, a low-temperature mineral that has a similar chemistry to monazite but contains structurally bound water. Rhabdophane is not apparent at Kulthor. Overall, the REE-bearing phosphate minerals show distinctive chemistries depending on their proximity to mineralisation, indicating their potential to be used as an indicator for proximity to mineralisation.