METALLOGENETIC MODELS AS EXPLORATION TOOLS

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ABSTRACT

Mineral exploration is based on the systematic determination of various parameters which can be used to locate anomalies that reflect the presence of potential economic mineralization within the host environment. The search for these anomalies is a high-risk financial endeavour. To reduce the magnitude of this risk, the best technical tools must be utilized.

The nature of the tools to be used depends on the type of mineralization sought and on the metallogenetic model. A metallogenetic model is formulated by compiling and interpreting the essential characteristics of a group of similar deposits, assuming a fundamental unifying concept of genesis. The framework of this model is defined by deposit morphology and mineralization, structural/metamorphic relationships, host-rock mechanics, and lithogeochemical/mineralogical data. The most important aspect of the model for the exploration geologist is the description of the relationships between mineralization and the host rocks, in both time and space.

In the case of unconformity-type uranium deposits, the diagenetic-hydrothermal metallogenetic model relates uranium mineralization to diagenetic processes operating within the Athabasca Group sandstones. Use of this model suggests possible locations of the mineralization target, form(s) of mineralization, patterns of host-rock alteration and geochemical dispersion, and structural/metamorphic associations.

Mineralogical exploration targets suggested by the model are zones of bleaching with loss of coherence and residual clay mineral enrichment, and presence of characteristic clay and accessory minerals within the host-rock alteration halo. Lithogeochemical anomalies consist primarily of those major and minor elements that reflect the mineralogical alteration. The model also predicts deposit and alteration halo dimensions and topology which can dictate decisions concerning drill hole placement and length. Bedrock sampling and drift prospecting are suggested reconnaissance survey methods. Mineralogical analyses plus trace/minor element geochemical analyses are recommended for elucidating the dispersion halos caused by the mineralization process.

The model suggests that the primary structural target is the intersection of regional basement lineaments with the sub-Athabasca Group unconformity. Tectonic controls and lithological competency contrasts of basement rocks have focussed fracturing in the more massive, felsic units. This has promoted fluid movement within these units and permitted sandstone-basement fluid interaction. Field mapping and geophysical methods are powerful tools for use in delineating regional structural and lithological patterns.

While metallogenetic modelling is a valuable tool in mineral exploration, it must not be used blindly. A given model should not be used just as a rationalization of the available data, but should be revised or discarded on the basis of new data or interpretations.