The Lithogeochemistry of the Athabasca Group: Insights into Chemostratigraphy and Metal Mobility Learned from the Outer Ring and Halliday Lake Unconformity-Type Uranium Prospects

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Abstract

The Athabasca Basin is filled with sandstones and conglomerates of the Athabasca Group which are composed predominantly of detrital quartz while matrix components comprise resistant heavy mineral phases and clay and phosphate minerals related to diagenetic and hydrothermal alteration. Drill core samples were collected from nine holes at the Outer Ring and Halliday Lake unconformity-type uranium prospects located in the eastern portion of the Athabasca Basin. Samples were digested using a whole rock lithium borate fusion followed by a dilute nitric acid digestion, and a strong aqua-regia partial digest (HNO_3-HCL) before being analyzed using ICP-MS and ICP-ES. A subset of samples were digested using a 2% HNO_3 weak acid leach (WAL) and analyzed by HR-ICP-MS. Samples were analyzed for oxides (fusion), trace metals and REEs (all digests) and Pb isotopes (aqua-regia and WAL). Using this data major and trace metals were broken down into two groups based on their behaviour within the Manitou Falls Formation of the Athabasca Group. The first group is immobile elements whose concentrations vary with the stratigraphy and sedimentological properties such as maximum transported grain size and cumulative conglomerate thickness. This group of elements includes As, Si, Al, Ti, P, Fe, Mn, REEs, LILEs, HFSEs and may be mineralogically related to resistant heavy minerals, clay minerals and diagenetic phosphates. Immobile element concentrations are highest in the conglomeratic MFb and MFa Members of the Manitou Falls Formation. The second group is mobile elements whose concentrations do not vary with the stratigraphy or sedimentological properties. These mobile elements include Ag, Co, Cr, Cu, Li, Mo, Ni, Pb, and Zn. Subtle variations in their concentrations between drill holes may be used to infer the intensity of alteration, the presence of sandstone hosted fracturing and faulting and potentially the underlying basement lithologies.