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Recent advances about the unconformity-related U deposits

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Giant unconformity-related uranium deposits were formed during the Mesoproterozoic era, 1.6-1.0 Ga ago, in both Athabasca Basin (Canada) and Kombolgie Basin (Australia). They are precious witnesses of protracted large-scale fluid flows at the interface between sedimentary basins and their crystalline basement, at conditions close to peak diagenesis (130-220°C). Although the Athabasca Basin hosts the world's largest high-grade uranium deposits, metallogenic models still bear important uncertainties. The objective of this contribution is to present new insights about the genetic model of these exceptional deposits.
Origin of the metals
The origin of the metals concentrated in the deposits has been investigated based on a systematic study of Hudsonian uranium mineralization in the basement rocks near the Athabasca Basin. This study shows that pre-Athabasca mineralization, expressed as uranium oxides, potentially represents a major uranium source for the unconformity related deposits.
Origin of the mineralizing brines
The origin of the brines has been investigated based on coupled Cl/Br and δ37Cl composition of fluid inclusions trapped in quartz-dolomite veins and δ11B composition of Mg-tourmalines associated with U ores. These studies have shown that the brines initially derive from subaerial evaporation of seawater up to epsomite saturation (salt content of ca. 25-35 wt%) forming the Cl-Na-K-Mg-rich brines.
Fluid percolation in the basement rocks, metal uptake and brine modifications
The original Cl-Na-K-Mg brines have percolated through the sedimentary pile and in the underlying basement, during tectonic reactivation, thanks to major faults and dense network of microfractures, partly inherited from late-orogenic deformation related to Trans-Hudson Orogen. Intensive brine/basement interaction was responsible for major chemical and isotopic changes (O, H, C) of the initial brines to form two chemically distinct NaCl-rich and CaCl2-rich brines, both being highly enriched in metals. Their metal enrichment comparable with brines related to MVT Pb-Zn deposits supports the idea that the basement was the dominant source for metals, and especially for U.
Conditions for the transport and deposition of uranium
The mineralizing brines have U concentrations between 1x10-6 and 2.8x10-3 mol.l-1, making them the U richest crustal fluids so far. This exceptional U content is related to the oxidizing and acidic nature of the brines and to the high availability of U sources. Synchrotron analyses show that U is present at the hexavalent sate in these brines. The mixing of the NaCl-rich and CaCl2-rich brines is coeval with the UO2deposition but the reductant necessary for UO2 precipitation remains enigmatic.

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