

Origin of U-mineralizing brines in the Athabasca Basin, Canada

A. RICHARD^{1*}, M. CATHELINEAU¹, M.-C. BOIRON¹,
M. CUNNEY¹, D.A. BANKS², P. BOULVAIS³,
C. FRANCE-LANORD⁴ AND T. PETTKE⁵.

¹G2R, Nancy-Université, CNRS, BP 239, 54506 Vandoeuvre-lès-Nancy Cedex, France

(*correspondence: antonin.richard@g2r.uhp-nancy.fr)

²School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

³Université de Rennes 1, Géosciences Rennes, CNRS UMR 6118, 35042 Rennes Cedex, France

⁴CRPG, CNRS, BP 20, 54501 Vandoeuvre-lès-Nancy, Cedex, France

⁵Institute of Geological Sciences, University of Bern, Baltzerstrasse 1+3, CH-3012 Bern, Switzerland

High salinity brines are commonly sampled as fluid inclusions in close paragenetic relationship with unconformity-related U mineralizations in the Proterozoic Athabasca Basin. The large range of brine composition results from the mixing of two end-members (NaCl-rich and CaCl₂-rich) during or after maximum burial (T from 120 to 180°C) [1]. Here, we address the question of the origin of these brines and their possible interactions with basin and basement lithologies.

Chorinities of 5-7 molal, coupled with Cl/Br ratios of 100-400 and negative $\delta^{37}\text{Cl}$ values, are unambiguously in favour of a common dominant evaporated seawater origin for both brines, typical of primary brines having past the point of halite precipitation. Such brines either have immediately percolated through the sedimentary pile, or alternatively have been trapped in the evaporitic formation and were expelled afterwards during compaction events. $\delta^{18}\text{O}$ values of inclusions-hosting quartz and dolomites are compatible with evolved deep basinal brines.

The CaCl₂-rich brines are thought to result from strong interactions with basement lithologies where they have up-taken uranium, as shown by the very high content detected by LA-ICP-MS. The range of $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of inclusions-hosting dolomite veins suggests a mixed origin, between a marine origin and a more radiogenic component typical of basement lithologies. D/H values of brines, coupled with $\delta^{13}\text{C}$ values of dissolved CO₂ argue for interactions with organic matter and D-depleted materials. The isotopic trends may indicate the involvement of C-rich components in the water-rock processes in relation with the U mineralization.

[1] Derome *et al.* (2005) *Econ. Geol.* **100**(8), 1529-1545.

Post-subduction porphyry and epithermal Au deposits

JEREMY P. RICHARDS

Dept. Earth and Atmospheric Sciences, University of Alberta,
Edmonton, Alberta, Canada, T6G 2E3
(Jeremy.Richards@ualberta.ca)

An increasing number of porphyry and epithermal deposits, commonly rich in Au (and in some cases also PGE), are being recognized in post-subduction tectonic settings ranging from collisional to arc-rifting, as well as arc migration or reversal. Examples include deposits such as Porgera, Ok Tedi, and Lihir in Papua New Guinea, Grasberg in Indonesia, Emperor in Fiji, Sari Gunay in Iran, Çöpler in Turkey, and porphyry Cu-Au deposits in Tibet. The magmas associated with these deposits are commonly weakly alkaline in character (shoshonitic or hawaiitic, and their derivatives), and are emplaced in relatively small volumes distal to any contemporaneous volcanic arc.

Studies of paleo-arc sections suggest that during arc magmatism, large volumes of mafic cumulates, including hydrous minerals such as amphibole, are left at the base of the crust from fractionating primitive arc magmas. These magmas are S-rich but oxidized, meaning that the bulk of the S is present as SO₂. Under such conditions, trace amounts of magmatic sulfides left as residual phases in these cumulate sequences will be enriched in highly siderophile elements such as Au and PGE, having strongly partitioned these elements from a much larger volume of mafic silicate melt.

If these amphibolites are subjected to later dehydration melting, they will yield a felsic melt and garnet residue, and any sulfides will likely be resorbed into the relatively S-poor melt. Such melting may be triggered, after subduction-related magmatism has ceased, by crustal thickening during arc collision, delamination of sub-continental mantle lithosphere, or arc rifting, the latter two processes permitting invasion of hot, mafic asthenospheric partial melts that may also carry a subduction-modified geochemical signature. Common elements of these processes will be a relatively small volume and degree of partial melting (leading to mildly alkaline magmas), and a range of magma compositions from mafic to intermediate with trace element signatures reflecting the presence of amphibole and garnet in the deep crustal source. Such rocks have been identified as adakites by some authors, but no link to slab melting is here suggested.

Key to the potential Au-(PGE)-rich metallogeny of these magmas (vs. the Cu-rich nature of normal arc magmas) is the opportunity to remelt small amounts of siderophile element-rich residual sulfide left behind in the deep lithosphere by the prior passage of oxidized, S-rich arc magmas.