

Advancing studies of the origin and role of hydrocarbons in ore-forming systems

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We have advanced an in-line rock crushing, gas chromatographic (GC) technique that can detect and quantify hydrocarbons present within fluid inclusions to a lower limit of 1 ppm. This technique has been adapted from developments by Bray *et al.* [2] and Salvi and Williams-Jones [1] in order to comprehensively analyze a much wider range of hydrocarbons (C1-C9 olefins and paraffins). The system is comprised of four stainless steel rock crushers that crush rock fragments in a sealed and sterile environment, passing the released volatiles into the GC to be separated and analyzed.

Rock types associated with various ore-forming systems, as well as a number of others are being investigated. These include: mantle-derived xenoliths, hydrothermal veins from major ore deposit types including MVT, VMS and magmatic sulfide deposits, porphyry systems, IOCG deposits, and epithermal/geothermal deposits. With this work, we are: (1) constraining the importance of hydrocarbons in transporting ore metals via olefins, alcohols and/or carboxylic acids that may facilitate metal complexation and transportation; (2) determining hydrocarbon origin (e.g. mantle-derived, remobilized from associated hydrocarbon deposits, *in situ* formation by metal catalyzed Fischer-Tropsch reactions [3]).

We suspect that the presence of particular metals (i.e. group VIII elements [3]) may effectively catalyze the respeciation/polymerization of light hydrocarbons into higher order compounds via the interaction between oxidized and/or reduced carbonic fluids within hydrothermal systems with various ore metal-bearing systems. Tentative results collected from analyzing hydrothermal quartz veins associated with base metal sulfide deposits in the Canadian Shield illustrate a high level of hydrocarbon speciation, including compounds such as butane, pentane, hexane and various saturated and unsaturated isomers thereof. Trace quantities of higher order compounds within the C6-C8 region were also found (possibly toluene, xylene, octane, etc.).

[1] Salvi & Williams-Jones (2003) *Min. Assoc. of Canada* **32**, 247–278. [2] Bray *et al.* (1991) *J. of Geochem. Exploration* **42**, 167–193. [3] Potter & Konnerup-Madsen (2003) *The Geol. Soc. of London, Spec. Pub.* **214**, 151–173.

Metallogenic provinces: Products of asthenosphere-thermal boundary layer-lithosphere interactions

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Continental lithospheric mantle (CLM) was extensively modified by subduction-derived fluids especially at craton margins, and melts, from ~ 3 Ga as preserved in xenoliths of CLM. As well, melt-related metasomatism of CLM can be proxied by alkali basalts in ocean basins, by Dupal-type anomalies where a continental low-velocity zone is rafted into ocean basins as continents rift, and by continental alkali basalts all with high-LREE budgets.

Orogenic gold deposits, dominantly associated with accretionary-type orogens, are generated at terrane boundaries where an accretionary wedge, and LVZ, are subcreted between the over-riding and subducting plates. Dehydration at low-water-rock ratios, during thermal rebound following cessation of subduction, generates low-salinity aqueous fluids enriched in Au, Ag, As, Sb, Hg and lithophile elements which advect along terrane boundaries where the deposits form. This element budget is a proxy for subduction-fluid induced metasomatism of the mantle wedge and sub-arc lithosphere during normal convergent margin magmatism.

During rifting of such metasomatized mantle in continental and oceanic settings, Au-rich fluids, and alkaline magmas, are generated as expressed in Au-porphyry deposits and epithermal systems. During plume impingement at craton margins ultramafic liquids interact with noritic melts generated from metasomatized CLM raising Si- and H₂O-activities that trigger sulphide saturation for Ni-Cu-PGE deposits. At intracontinental rifts where plumes are focussed, the bimodal A-type granite and gabbro-anorthosite association is best expressed in the Proterozoic as controlled by the depth of the CLM. Fe-oxide, Cu, Au, REE deposits form by plume and decompressional melting and dehydration of metasomatized CLM with REE-contributed from entrained LVZ.