Depleted Mantle as the Source of Gold in Archean Alkaline Magmatic-Hydrothermal Systems

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Field relations, trace element and isotopic compositions and isotope dating suggest that 2.6 to 2.7 Ga. old gold-bearing syenites, lamprophyres (sensu stricto) and carbonatites of the Abitibi greenstone belt are genetically related. Their chondrite-normalized REE signatures are very similar and a survey of isotope data in the literature reveals ε_{Nd} and $^{87}Sr/^{86}Sr$ values that are consistent with a depleted mantle source. Preliminary results from syenites and lamprophyres of the Duquesne gold mine indicate that they have similar REE patterns in addition to both mantle and crustal isotopic compositions.

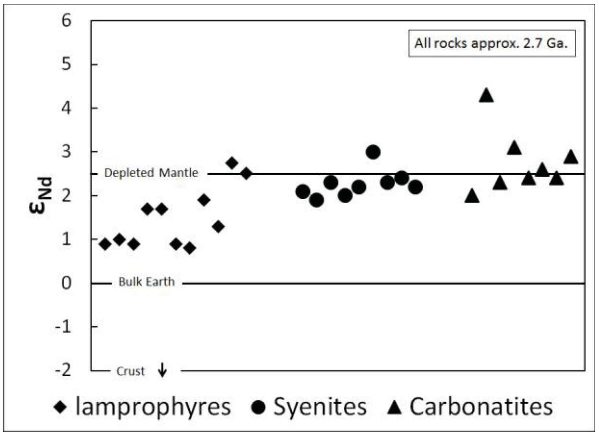

Figure 1: ε_{Nd} values for 2.6 to 2.7 Ga. lamprophyres, syenites and carbonatites of the Abitibi greenstone belt. The three lithologies display similar, mantle values, although the lamprophyres show some crustal alteration.

These results allow us to shed light on the petrogenesis of these rocks and their relationship to the gold deposits. Lamprophyres are quenched, volatile-rich, mafic porphyric rocks that interact very little with the crust as they rise from the mantle. Syenites also appear to be derived from a depleted mantle source that has interacted very little with the crust during their evolution. We propose that the syenites were produced by fractional crystallization of lamprophyre magmas in the crust. In this model, gold could have been carried from the mantle to its site of deposition in shallow level syenitic porphyries via a mantle-derived, carbothermal fluid. This model also finds support in the coexistence of carbonic-fluid-saturated, hybrid silicocarbonatites of Abitibi and most late-Archean gold deposits.

SO_2 emissions and their role in eruptive activity at Fuego Volcano, Guatemala

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Magmatic volatiles have an important role in many aspects of volcanism, from magma generation to initiation of seismic phenomena to influence on eruption style. It follows that many models of volcanism and volcanogenic phenomena rely on behavior of such volatiles. UV cameras offer enhanced temporal resolution over previous SO_2 emission rate measurement techniques and also offer a synoptic view of plumes and degassing behavior. Integrated UV camera and seismic measurements recorded in January 2008 and January 2009 at Fuego volcano, Guatemala, provide new insight into the system's shallow conduit processes.

In 2008, an inter-explosion period was marked by pseudo-cyclic patterns of SO_2 emission rate. Comparison of the data with band-pass-filtered seismic data indicates that the onsets of increases in SO_2 emission rate are accompanied by very long period (VLP) seismic events. Larger amplitude VLPs are associated with larger pulses of SO_2 and shorter preceding inter-event times. Other VLPs associated with explosions at Fuego have been linked to pressurization at the intersection of two cracks [1], but the non-explosive nature of these VLPs may indicate a different source process.

UV camera data in 2009 reveal patterns of SO_2 emission rate relative to explosions and low-frequency seismic tremor that indicate tremor and degassing share a common source process. Progressive decreases in emission rate appear to represent inhibition of gas loss from magma as a result of rheological stiffening in the upper conduit. Measurements of emission rate from two closely-spaced vents, made possible by 2-dimension nature of camera data, help constrain this model.

Eruptive activity at Fuego appeared superficially similar in January 2008 and 2009, with a passive gas plume and sporadic, ash-rich explosions. Gas emission data obtained via UV camera, in combination with seismic data, enabled elucidation of different eruptive processes driven by the movement and escape of volatiles.

[1] Lyons and Waite (2011) *Journal of Geophysical Research* **116**, B09303.