A model for the genesis of metasomatic fluids associated with orogenic gold deposition

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Orogenic gold deposits occur in Cretaceous to Archean age accretionary margins and greenstone belts, predominantly in association with quartz + carbonate vein mineralisation and hostrock replacement [1]. Uncertainty about the origin of the gold and the ore-forming fluids of these deposits has made the relationship between their petrogenesis and geotectonic setting ambiguous. In particular, published O and H stable isotope compositions of ore-forming fluids, interpreted from fluid inclusions in quartz or from micaceous accessory minerals such as sericite, muscovite or fuchsite have large ranges (0 to +17‰ and -170 to +4‰, respectively, relative to VSMOW). As a result, orogenic Au-forming fluids have been interpreted to be of magmatic, metamorphic, meteoric or mixed origin, or to vary across deposits [2] [3].

We propose that orogenic ore-forming fluids are derived from prograde devolatization of ultramafic rocks that were metasomatized to talc-serpentine-magnesite schists during seawater alteration of oceanic crust and the mantle wedge. Such a source predicts CO_2 concentrations of ≤50%, as observed in ore-forming fluids, and a large range in $\delta^{18}O_{FLUID}$ that is positively correlated with increasing metamorphic grade of the deposit, as is also observed.

$\delta D_{SEAWATER}$ has likely increased by ~25‰ over geologic time as predicted by models of gradual continental growth and periodic global glaciations, and observed in hydrogen isotope compositions of well-preserved antigorites since the Eoarchean [4]. Incorporating the effect of variable $\delta D_{SEAWATER}$ and the likely increase in the subaerial exposure of continental rocks with time, the petrogenetic model described here explains the isotopic variability of orogenic ore-forming fluids while still establishing a common origin for such fluids over Earth history.

[1] Goldfarb *et al.* (2005) *Soc. Econ. Geologists,* 100th Anniversary Vol, 1-46. [2] Groves *et al.* (2003) *Econ. Geol.* **98**, 1-29. [3] Ridley and Diamond (2000) *Rev. Econ. Geo.* **13**, 141-162. [4] Pope *et al.* (2012) *PNAS* **109**, 4371-4376.