High-resolution, ultra-trace and major element chemical stratigraphy of a new Paleoproterozoic weathering profile

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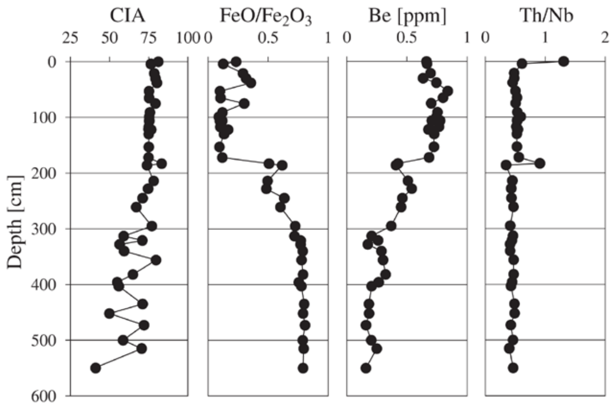
Paleosols contain information about ancient atmospheric and climate conditions, as well as the secular change in supply of nutrients to the ocean. A newly exposed, ~5 meters deep 1.85 Ga weathering profile is described. It developed on pillowed metabasalt (Flin Flon, Manitoba, Canada) and was sampled (~120 samples) and analyzed at much higher spatial resolution (>50 samples) than previous such profiles for ultra-trace, major element, and ferrous iron.

Consistent with previous studies on nearby paleosol exposures [1,2], the examined weathering profile is characterized by a spectacularly preserved, coherent upward Fe enrichment, accompanied by loss of Fe^{2+} and the development of a positive Ce anomaly, implying weathering in an oxic atmsophere. The new, high-precision trace element data collected reveal enrichment of several alkali (Cs, Rb, in addition to K, Na) and alkaline earth (Be, Sr, Ba) elements upward towards the paleosol contact with overlying sandstone. By contrast, the HFSE remained largely immobile in the profile which is evident through the highly consistent Zr/Hf, Th/Nb, and Nb/Ta ratios.

This presentation will discuss the distinction of original chemical features preserved in the profile, for example those inherited from the separate pillow basalt flows, versus those superimposed by weathering, water table fluctuation and possible extraneous sediment input.



[1] Holland *et al*. (1989) *Am. J. Sci*. **289**, 362-389. [2] Pan & Stauffer (2000) *Am. Mineral*. **85**, 898-911.

The volcanic-plutonic connection

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The broad similarities in age and compositonal range found in plutonic and volcanic exposures from a given magmatic province clearly indicate that these rocks types are closely related genetically. However, to which extent plutons (particularly the ones with intermediate to silicic compositions) are former magma reservoirs that have lost melt remains controversial. Recent work using both geochemical and physical modeling provides new avenues to explore these issues that are fundamental to our understanding of crustal evolution. First, mechanical constraints on rates of crystal-liquid separation indicate that most chemical differentiation is likely to occur within an melt extraction window located between 50 and 80 vol% crystals across the whole range of magma composition (from mafic to silicic). This extraction window will lead to compositional gaps in extracted liquids, as observed in numerous volcanic series around the world. In contrast, plutonic exposures will span a range of compositions that will vary continously as a function of how much melt was lost at a given location. Trace element modelling suggest that variable degrees of crystal accumulations are common in all plutonic sequences, including in intermediate to silicic compositions (tonalites - granodiorites). We also report erupted crystal cumulates, excavated from shallow magma chambers during large explosive eruptions. Such findings, alongside with thermal models of magma-crust interaction, suggest that crystal fractionation occurring by melt extraction in mush zones, and accompanied by a limited amount of crustal assimilation, is the dominant differentiation process in the Earth's crust. In this framework, volcanic rocks mostly represent liquids extracted from different reservoirs while plutons typically correspond to the left-overs crystal mushes that have been periodically stripped from a fraction of their interstitial melts.