Evolution of soil Iron mineral composition as a function of climate-driven Fe loss

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We measured soil iron mineral composition as a function of pedogenic Fe loss in surface (10 – 20 cm) and subsurface (50 – 70 cm) basaltic soil horizons from the Island of Maui along a climate gradient (MCG) ranging from 2.2 – 4.2 m mean annual precipitation (MAP). All soil forming factors except climate were conserved. Solid phase Fe mineralogical composition was assessed using room temperature (RT, 22°C) and liquid helium temperature (LHeT, 4.2 K) ^{57}Fe Mössbauer spectroscopy (MBS). Analysis of the MBS spectra resolved four main mineral components: hematite, ferric-organic complexes, ferrous iron, and a goethite component that could be further sub-divided into three approximate size components (< 3 nm, 3 -12 nm, and > 12 nm). Increasing MAP from 2.8 to 4.2 m resulted in a decrease of ^{57}Fe Mössbauer-assigned soil goethite fraction coincident with an increase in ferrous and organically bound-Fe components, while the hematite fraction showed little climatic effect. The MCG has a documented decrease in both mean annual Eh values and Fe with increasing rainfall, thus yielding an upland soil gradient where progressive Fe removal is very likely dominated by reductive dissolution. Despite this, ferric oxides persist even at 4.2 m MAP, suggesting re-oxidation events are a common feature of these ecosystems. Interestingly, the total goethite fraction exhibits a strong inverse-correlation (R^2=0.88) with Fe isotope values (δ^{56}Fe, measured previously [1]) for both surface and sub-surface horizons. This suggests the mechanisms governing Fe loss and Fe retention are linked to a greater degree than often appreciated.

[1] Thompson *et al*. (2007) *Chem. Geol.* **238**(1-2), 72-83.

Dykes and slabs in the mantle: Model sources for the adakite clan

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Melting of mafic rock in the mantle environment to produce melts of intermediate composition are explored with two hypotheses: (1) melting of young subducted oceanic crust, and (2) melting of arc-generated dykes in the lithospheric mantle. The melting of subducted crust is evaluated by examining conditions of dehydration and partial melting of mafic rock, and transferring key reaction curves onto gridded maps of the down-going slab. Petrologic zones on the slab range from broad regions of prograde metamorphism to more restricted areas involving partial melting and restite formation. Melting will be concentrated in areas of extremely young crust adjacent to slab windows, where the slab is thinnest and hottest. Nearest the slab window and closest to the trench, melts will have the composition of non-adakitic dacite, and the restite will be garnet-free. Farther from the slab window, and at greater depths, melting of the subducted crust will produce adakitic magma, leaving a garnetiferous restite. Reaction of slab-derived melts with overlying mantle of the asthenosphere or lithosphere will modify the magma, resulting in liquid compositions with more magnesia and less silica. Although this model is feasible, the second hypothesis, involving melting of dykes in the lithospheric mantle, provides an attractive alternative. This hypothesis requires a previous event of magmatism and emplacement of mafic dykes into the mantle lithosphere. Where such lithosphere is reheated, the dykes undergo partial fusion and leave behind garntiferous restite. The resulting felsic melts react with the ambient lithospheric peridotite to produce more magnesian magmas. Dykes of subduction-generated basalt, with enrichments in hydrous magmatophile elements relative to those in typical ocean floor basalt, may be preferable sources for the generation of the adakite and magnesian andesite. Heating of the lithosphere could involve upwelling asthenosphere in a range of tectonic environments including plumes, slab windows and extending crust.