

Organic matter and Fe oxide coatings reduce the relevance of laboratory rates to mineral dissolution in soil

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The minerals present in a soil and the reactive surface area of those minerals are key factors in determining element release rates from soils due to mineral dissolution. This study examines the contribution and influence of the relatively un-reactive soil organic matter (SOM) and amorphous and free Fe oxide phases to soil surface area and element release from the dissolution of primary silicate minerals within two podzol soil profiles. Soils were sampled systematically with depth (using a coarse-stepped continuous strategy) from granitic podzols directly overlying bedrock in Dartmoor and Glen Dye, UK. The geometric and BET specific surface area and porosity of bulk soil samples were calculated and measured prior to and following the removal of SOM and amorphous and free Fe oxide phases. Batch and flow through dissolution experiments were then performed on the different sample sets.

Bulk soil surface area and porosity decreased overall from the base of the soil profiles to the soil surface, largely due to the loss of relatively reactive primary minerals up the soil profiles and an associated increase in the proportion of residual quartz, the quartz dilution effect [1]. Superimposed over these variations were the contributions and influences of the SOM and amorphous and free Fe oxide phases on soil surface area. SOM aggregated and coated soil mineral grains, increasing the effective diameter of the mineral grains and occluding underlying mineral surfaces and porosity, thus reducing bulk soil surface area. Amorphous and free Fe oxide phases contributed to soil surface area as discrete fine particles and architecturally elaborate and porous surface coatings. They were also present as aggregate binding agents and smooth surface coatings (amorphous only) that occluded mineral surfaces and reduced soil surface area. Podzolisation translocated the SOM, amorphous and free Fe oxide phases down the soil profile and in doing so redistributed un-reactive mineral surface area and porosity between the eluvial and illuvial horizons. This exacerbated the quartz dilution effect between these horizons and resulted in a relative peak in bulk soil surface area in the illuvial horizon.

The presence of SOM, amorphous and free Fe oxide phases typically reduced bulk soil Si release rates through the contribution of unreactive surface area and/or the occlusion of underlying reactive mineral surface area. The exception was the contribution of biogenic silica to reactive soil surface area and Si release rates in the upper soil profile. As a result, pristine mineral laboratory dissolution studies do not account for the influence of SOM, amorphous and free Fe oxide phases reactive surface area in the field environment and thus the derived dissolution rates are not representative of aggregated and coated field grains.

[1] Bern (2009) *Applied Geochemistry* **24**, 1429-1437.

Geochemical Zonation of Mantle Plumes: Lower Mantle Chemical Heterogeneity and Plume Splitting

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The geochemistry of basalts from single hotspot tracks contains important clues about the compositional heterogeneity of the Earth's mantle. Increasingly spatial chemical zoning has been recognized as a long-term feature (up to 80 Ma) of hotspot tracks, including the Galapagos [1,2], Hawaii [3,4], Marquesas, Somoa [5] and Tristan-Gough [6] hotspot tracks. It is argued that geochemical zonation of hotspot tracks reflect lateral zonation in the plume stem in the form of stripes or filaments that ultimately reflect tapping of different geochemical reservoirs in the plume source [1,4-9]. An important question is what plume zonation tells us about the plume source in the lower mantle. Seismic tomographic studies show the existence of two large seismic low-velocity anomalies in the lower mantle beneath the southern Pacific and beneath southern and western Africa [e.g.10]. It has been proposed that the zoned plumes are related to the margins of these large-scale low-velocity anomalies and that the orientation of the zoning can provide information about the chemical composition of these lower mantle seismic anomalies [4,5,6]. The talk will discuss problems with this model and how these problems might be resolved. The talk will also explore other implications of zoned plumes, for example, if plume zonation can led to the breakup/splitting of the plume conduit or alternatively if plume-splitting allows us to identify chemical zonation in plumes.

[1] Hoernle et al. (2000) *Geology* **28**: 435-438. [2] Werner et al. (2003) *G³* **4**(12), 1108. [3] Abouchami et al. *Nature* **434**: 851-856 (2005). [4] Weis et al. (2011) *NGS* **4**(12): 831-838. [5] Huang et al. (2011) *NGS* **4**(12): 874-878. [6] Deppe et al. (in revision) *NGS*. [7] Farnetani & Samuel (2005) *GRL* **32**, L07311. [8] Lohmann et al. (2009) *EPSL* **284**: 553-563. [9] Farnetani & Hofmann (2009) *EPSL* **282**: 314-322. [10] Ritsema et al. (2011) *GJI* **184**: 1223-1236.