Comparison of laboratory and whole-ecosystem weathering in early post-glacial environments

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To quantify the contribution of continental deglaciation to local and global chemical fluxes, we compared the weathering record derived from a 13,500 year, 5.3 m lake sediment core in the Cadillac Granite of coastal Maine, exposed immediately after deglaciation, with semi-batch dissolution experiments of the same bulk rock composition.

A 5-step sequential extraction of sediment [1] indicates that weathering products of Al and Fe are virtually zero for the first 3,500 years, while P is associated with apatite ($Ca_5(PO_4)_3(OH,F,Cl)$). Vegetation became established about 10,000 years BP, by which time calcite ($CaCO_3$) and apatite had been depleted in the soil and are absent from the sediment. Concurrently, Al, Fe, Mn, and P in fractions (2) and (3) increased dramatically as a consequence of production of DOC in the watershed and accelerated export of organically-bound Al, Fe, and Mn, and POC to the lake. There, photodegradation released inorganic Al, Fe, and Mn which precipitated and sorbed dissolved P from the water column [2]. Thus, the lake transitioned from high pH, P, and Ca, and low DOC, Al, Fe, and Mn to lower pH and Ca, very low P, and elevated organically-bound Al, Fe, and Mn.

Crushed Stonington Granite (molar ratios Ca/Na = 0.21; Mg/Na = 0.085; P/Ca = 0.035) was chemically weathered in laboratory batch reactors for 11 weeks. Batches were replenished with acid after one, two, four, and seven weeks of reaction. We investigated effects of pH, grain size, acid type, and DOC on trace mineral depletion and P availability. Early dissolution was strongly non-congruent (Ca/Na ~16-24; Mg/Na ~4.5-7; P/Ca~0.1-0.5), indicating preferential dissolution of calcic minerals (apatite, fluorite, and calcite) and biotite or hornblende, the source of Mg. Calcite became depleted before fluorite. Later, Ca/Na declined to ~1 as P/Ca decreased to 0.1. Mg/Na ratios remained elevated (~6.4-7.4). After 1 week of weathering, Al and P concentrations declined, suggesting scavenging of P as a result of $Al(OH)_3$ precipitation at higher pH.

The batch experiments yield weathering trajectories. Combining them with the dated changes in sediment chemistry, we are able to link specific weathering reactions to field scale kinetics.

[1] Psenner *et al.* (1988) *Arch. Hydrobiol. Beih. Ergebn. Limnol.* **30**, 98-103. [2] Kopáček *et al.* (2005) *Envir. Sci. Technol.* **39,** 8784–8789.

Petrology of new Martian meteorite LAR06319, an olivine-pheric Basaltic Shergottite

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Meteorite LAR06319 is thought to come from Mars based on oxygen isotope data (A.M.N. 2007). The basaltic texture with abundant pyroxenes (PX) and large olivines (OL) interspersed with shocked plagioclase glass (maskelynite, MA) suggests that it is related to shergottites. Large OL (0.5-2.5 mm) are subhedral and more Mg-rich in their core compared to their rims (see Fig.). Smaller OL are more Fe–rich and not zoned. Pyroxenes are mostly elongate subhedral pigeonite laths (up to 1 mm long). Their zoning is complex with the most common type showing large Mg-rich cores, surrounded by a more calcic rim, in turn mantled by a thin (<20 μm) Fe-rich rim (see Fig.). Occasional small (<200 μm) PX have an augite core surrounded by a Fe-rich rim. Maskelynite is homogeneous in composition ($An_{60}Ab_{35}Or_5$). Phosphates (Phos) as well as Si-rich phases are present in the MA. Accessory phases include homogeneous chromite (Chr), ilmenite and sulfides which are often closely associated.

The large OL represent either xenocrysts or first crystallized phenocrysts. The zoning of the PX suggests continuous crystallization of a melt becoming more and more Ca-rich until the onset of plagioclase crystallization, similar to what has been observed in QUE94201 & EETA79001B (McSween & Treiman 1998 R.M. 36). The Si-rich phases and phosphates may be late-stage mesostasis. The large OL and PX cores may have crystallized during the slow ascent of the melt in the lithosphere while the smaller phases and PX rims may have crystallized faster at crustal levels.

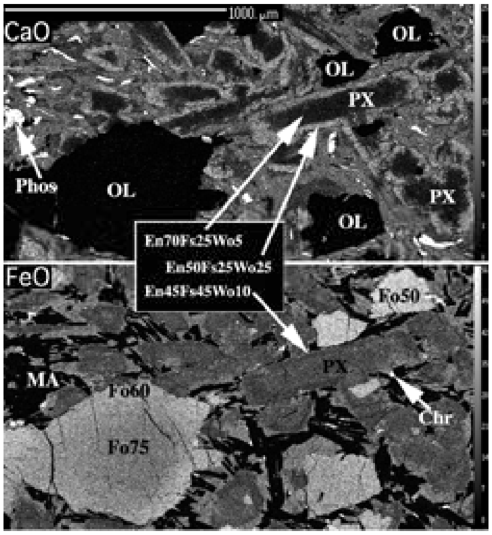

Figure 1: Weight % CaO & FeO maps of LAR06319, ZAF corrected.