Beaker to Boreal: linking mineral dissolution to fungal bio-weathering

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Multiple studies have reported large discrepancies between experimental, laboratory derived, weathering rates, and those measured in the field [1]. Much of the difference is due to physical, chemical, biological or temporal effects. Here we present a series of experiments linking mineral surface properties, element release in the presence and absence of organic ligands, and complex plant-fungi symbiosis driven weathering. We refine our understanding of fungal mineral weathering [2] by quantifying these processes in systems where biotite is the sole nutrient source. We measured the properties of biotite and its dissolution in complex fluids, and evaluated fungal growth rates and growth modes over its surface.

The chemical characteristics of the biotite surface in contact with fluids (pH 1–12), determined through potentiometric titration and electrokinetic measurements, [3] indicate the formation of a dissolution front in the acidic and neutral regions after 20 minutes. Longer timescale, closed– and open–system, dissolution experiments (pH 2-6) revealed the progression of this dissolution front to be both diffusion and surface reaction controlled. Microbially secreted organic ligands, when present, likely enhance nutrient release through chelation, rather than through surface complex formation.

Finally, the growth rates and modes of the ectomycorrhizal *Paxillus involutus*, in symbiosis with *Pinus sylvestris*, growing over the biotite flake surface were measured *in situ* by time resolved light microscopy and characterized by synchrotron-based μ-FTIR. These results allowed us to refine our previous calculations of fungal mineral weathering rates [2], and provided us with a greater understanding of a significant portion of bio-weathering in natural settings, such as the Boreal forest.

[1] Brantley *et al* (2011) *Geobiology*. **9**, 140-165 [2] Bonneville *et al* (2011) *GCA*. **75**, 6988-7005 [3] Bray *et al* (2014) *GCA*. **128**, 58-70