

## Do organic acids contribute to bio-weathering rates?

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As part of the physical and chemical ‘bio-fracking’ that occurs at the interface between fungi and mineral surfaces [1], organic acids are known to be secreted at concentrations from  $10^{-5}$  to  $10^{-3}$  moles  $L^{-1}$  [2]. However, solution based experimental studies of some silicate minerals describe the need for  $10^{-2}$  to  $10^{-1}$  moles  $L^{-1}$  of organic acids to observe appreciable effects on dissolution rate (doubling), compared to abiotic dissolution [3]. The effect of organic acids at lower concentrations, and their contribution to biological weathering, and in turn the global C cycle, is currently unclear. Here we present two experimental examples of how the typically low concentrations of organic acids found around fungal hyphae influence mineral weathering.

Firstly, solution based biotite dissolution experiments (pH 2 to 6) revealed a change in the stoichiometry of element release in the presence of organic ligands, preferentially liberating Al, Fe and Mg from the solid phase via the formation of metal-organic complexes [4]. Secondly, organic ligand exudation at the interface between symbiotic fungal hyphae and minerals in a plant-fungi monoxenic microcosm led to the formation of secondary Ca-oxalate minerals [5].

The formation of metal-organic complexes in solution and of secondary precipitates enhances microorganism driven mineral weathering rates. Organic acids preferentially liberate divalent cations important in carbon drawdown in the longterm C cycle.

[1] Bonneville et al (2011) *GCA* **75**:6988-7005 [2] Adeyemi & Gadd (2005) *Bio Metals* **18**:269-281 [3] Golubev et al (2006) *GCA* **70**:4436-4451 [4] Bray et al (2015) *GCA* in press [5] Schmalenberger et al *Sci Reports* (in review)