Structural Fe(II) oxidation in biotite by an ectomyrrizal fungi drives mechanical forcing

S. BONNEVILLE[1], A.W. BRAY[2] AND L.G. BENNING[2,3]

[1]Biogéochimie et Modélisation du Système Terre, Département Géosciences, Environnement et Société, Université Libre de Bruxelles, 50 av. F. D. Roosevelt, 1050 Brussels, Belgium, (steeve.bonneville@ulb.ac.be)

[2]Cohen Geochemistry, School of Earth and Environment, University of Leeds, LS2 9JT, United Kingdom.

[3]GFZ, German Research Centre for Geosciences, Telegrafenberg, Potsdam 14473, Germany.

Microorganisms are essential agents of Earth's soil *weathering engine* who help transform primary rock-forming minerals into soils. Mycorrhizal fungi, with their vast filamentous networks in symbiosis with the roots of most plants can alter a large number of minerals via local acidification, targeted excretion of ligands, submicron-scale biomechanical forcing and mobilization of Mg, Fe, Al and K at the hypha-biotite interface (Bonneville *et al*. 2009 and 2011).

Here, we present experimental evidence that *Paxillus involutus* –a basidiomycete fungus- in ectomycorrhizal symbiosis with Scots pine (*Pinus sylvestris*), is able to oxidize a substantial amount of structural Fe(II) in biotite. Iron redox chemistry, quantified by X-ray Absorption Near Edge Spectra on 13 fungi-biotite sections along three distinct hypha colonizing the [001] basal plane of biotite, revealed variable but extensive Fe(II) oxidation up to ~ 2μm in depth and a Fe(III)/Fe_{total} ratio of up to ~0.8. We calculated that the growth of Fe(III) hydroxide implies a volumetric change and a strain within the biotite lattice potentially large enough to induce micro-crack formation which are abundant below the hypha-biotite interface. Although difficult to quantify, the formation of such network of crack beneath the hypha resulting from extensive Fe(II) oxidation will likely weaken the overall cohesion of the biotite and favor the exfoliation and the formation of channels beneath hypha. Alternatively, the formation of a crack network could facilitate the penetration of hypha within pre-existing fracture of the biotite surface. This Fe(II) oxidation also leads to the formation of a large pool of Fe(III) (i.e., structural Fe(III) and Fe(III) oxyhydroxides) within biotite that could participate in the Fe redox cycling in soils.

[1] Bonneville S. *et al*. (2009) *Geology* **37**, 615-618.
[2] Bonneville S. *et al*. (2011) *Geochimica et Cosmochimica Acta*, **75**, 6988-7005.