Geophysical Research Abstracts
Vol. 14, EGU2012-10520, 2012
EGU General Assembly 2012

Mechanisms of primary mineral weathering inferred from B isotopes

A. Voinot (1,2), M-P. Turpault (2), F. Chabaux (1), and D. Lemarchand (1)

(1) Université de Strasbourg, EOST, LHyGeS, Strasbourg Cedex, France (alexandre.voinot@etu.unistra.fr), (2) Lab. Biogéochimie des Ecosystèmes Forestiers, INRA, Champenoux, France

Silicate weathered minerals result from a combination of dissolution/precipitation or transformation reactions. Despite their chemical and isotopic compositions as well as their mineralogy record the physico-chemical conditions of their formation and history, the determination of the current state of weathering in soils still remains very challenging. The main difficulties come from a difficult access to the mineral sites actually active during primary mineral transformation and from non-stoichiometric release of site-forming cations.

To better characterize how minerals record the conditions of their formation, we coupled analyses of mineralogy with major elements and boron isotopes in a series of primary minerals (biotite, muscovite, K-feldspar and plagioclase) associated in varying amount with their replacement phases (vermiculite, kaolinite, illite…). The minerals are sampled along an acid Alocrisoil profile developed on granitic bedrock from the Breuil-Chenue forest (France). Previous studies have demonstrated that boron occupies different minerals sites (tetrahedron in substitution of Si, or interfoliar sites possibly in direct contact with the surrounding fluid, Williams et al. 2001, Muttik et al. 2011, Voinot et al., in prep.). Voinot et al. (in prep.) have also demonstrated that boron isotopes are very sensitive to silicate transformation or dissolution reactions.

In deeper soil layers (100 to 130 cm), kaolinite is found in biotite mineral habitus. Examination of the boron isotopes distribution in those weathered agglomerates points to a boron depletion and a rapid isotopic equilibration with the surrounding soil solution as kaolinite fraction increases. The same – but magnified – trend is observed during shallow weathering mechanisms (20 to 30 cm) of fine particles of biotite ($< 200\ \mu$m). By contrast, coarse biotite minerals ($> 200\ \mu$m) evolve to a vermiculite-like product that tends to be enriched in boron (up to three times the initial biotite concentration) but share a common isotopic composition with kaolinite revealing an equilibrium with the solution. Plagioclases dissolve very early in the deepest horizon with a high degree of in-situ kaolinite reprecipitation in their mineral habitus. Here again, the isotopic composition reflect exchange with the soil solution. Muscovite shows no particular weathering mechanism other than dissolution, but isotope shift toward the soil solution value tends to indicate that the reacting boron is mainly located in easy accessible mineral interlayer sites. K-feldspar samples remained unchanged either mineralogically or isotopically.

These results suggest an apparent duality between phyllosilicates which are mainly involved in transformation reactions with rapid isotopic equilibration with the surrounding soil solution, whilst tectosilicates show mainly dissolution reactions without evidence of isotopic exchange with the fluid. Depending on their nature, the secondary phases that replace the weathered primary minerals will also play a major role in the boron cycle in soils.