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The behavior of stable isotopes in soils: from the laboratory to the field

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The potential of stable isotopes, in particular that of " new " isotopes to trace weathering processes is getting more and more attention. Numerous recent studies have investigated the potential of Si, Mg, Ca, Li in soils and rivers to In order to interpret correctly field data and distinguish between source and fractionation effects, experiments conducted in laboratory conditions are necessary. We illustrate this idea here by using boron isotopes. Boron isotopes in rivers and soils show important variations mostly derived from silicate weathering processes. The general behavior is the enrichment of the heavy isotope in the fluid phase. In solution, boron has a remarkably simple speciation: boric acid and conjugate borate ion (pK =9,2). In order to constrain the behavior of boron in soils and rivers, we have conducted adsorption experiments onto organic molecules and oxides-hydroxides. The main result from these experiments is that the light isotope is preferentially adsorbed to the solid phase, leaving a solution enriched in heavy isotope. The adsorption coefficient curves show a typical bell-shaped curve, with maximum values at pH about 8. Modeling of the adsorption curves show that, in contrast to what generally thought, the borate ion form is not the only phase to be adsorbed. Although pH-dependent, the fractionation measured between the solution and the solid is not the fractionation that exists in solution between the borate and boric acid form. The fractionation between the solution and the solid phases can be modeled by a surface complexation model implying different surface complexes, depending on pH range. The net fractionation between solution and solid is therefore controlled by the competition between surface B speciation and solution of boron in solution. The different substrate used in the experiments (humic acid, goethite, birnessite) display different isotopic fractionation curves with pH, illustrating the variety of boron surface complexes. The fractionation coefficient and partition coefficient used in the experiments permit us to speculate on the behavior of boron

in soils. Boron sorption is expected to have an important effect in organic rich soils and Fe-oxides soils. This conclusion is supported by data on a soil profile in Central Africa.