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How can B isotopes distinguish lithogenic from biogenic fluxes in a forested watershed?

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On continents, inputs of elements are sustained by atmospheric deposits and mineral weathering. Before being exported by surface or ground waters, most of the major and some trace elements are stored by vegetation and later released by the decomposition of the dead biomass. The timescales at which elements are cycled by the biomass differ from those of their release by mineral dissolution that leads to systems being frequently out of steady state. This feature makes difficult instantaneous mass balance calculation as well as estimation of the rock weathering rate. The understanding of the relative role played by the vegetal cover in regulating transportation of some elements is crucial because it may also control many aspects of our environment, from the distribution and biodisponibility of elements in soil to the propagation of a pollutant through the food chain. This will also help to quantify in what extent the geochemical cycles in a given ecosystem are dependent of the inputs or are controlled by the vegetation recycling. At the soil or watershed scale it is therefore crucial to be able to assess whether the reactions are limited by the soil mineralogy or by the biological activity.

In this aim, we chose to focus on boron because its isotopic system (^{11}B and ^{10}B) is highly sensitive to water/rock interactions and is also concentrated in vegetation. Moreover, analyses of vegetation samples (δ^{11}B = +20 to +30 ‰) have revealed an important isotopic shift from those of minerals in the soil (δ^{11}B = -10 to -20 ‰) making therefore the fluxes related to the biological activity easy-to-follow when B is back to the soil solution after the litter has decomposed. We then sampled every 6 weeks from 2003 to 2006, rain, throughfalls, soil solutions at 5, 10, 30 and 60 cm depth as well as brooks. These samples allowed us to develop a 1D model of reactive

transport in the soil/plant system and to make some mass balance calculations on the B geochemical cycles. The results point out the control of the vegetation cycle on the top meter in soil and then an increased contribution of the mineral dissolution with depth. Comparison with the mineralogy and analyses of B isotopes in bulk soil layers as well as handpicked minerals helped us 1) to better identify where the reactive zones in soil are, 2) to extrapolate from B fluxes to those of major cations and then 3) to better quantify in our system how the origin of elements splits between reactions involving the lithology and the biology.