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Vegetation cycling regulates dissolved B in forested watershed

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The aim of this work is to test the potential of B isotopes to trace and monitor the control by the vegetation of the geochemical fluxes at the catchment scale. Because boron has two light stable isotopes, ^{10}B and ^{11}B, it is sensitive to water-rock interactions and fractionates during chemical reactions (adsorption/desorption, precipitation, dissolution). In natural environments, its concentration can vary from several ppt in rainwater to hundreds of ppm in clays and its isotopic composition from -30 ‰ in evaporites to 60 ‰ in salt lakes. Moreover, boron is a nutrient for vegetation.

The Strengbach catchment (Vosges Mountains, France) is an instrumented site allowing to monitor water and soil chemistry as well as vegetation since 1986. Because the soils of the Strengbach catchment are acidic, and hence poor in bio-available cations, it is a good opportunity to better understand the impact of the vegetation cycling on geochemical cycles that should take here a particular importance.

We conducted a comprehensive spatial and temporal study of the B concentration and B isotopes in water samples from the catchment covering more than two seasonal cycles (May 2004 – August 2006) and most,if not all, spring waters. As a complement, we performed a more detailed analysis of the B behavior at the soil/plant scale.

The B concentrations vary from 0.2 to 25 ppb, with throughfalls being the most concentrated solutions analyzed on site. Water samples are rather poor in B (about 4 ppb) compared to mean river waters (about 10 ppb).

The B isotopic compositions range from 14‰ to 46‰. Compared to the isotopic composition of minerals in soil, it appears that soil solutions, springs and the Strengbach river are all enriched in ^{11}B. We observed a noteworthy consistence of δ^{11}B val-

ues of waters sampled through the various stages of the hydrological cycle. The most intriguing feature of our observations is the surprising high isotopic composition of the vegetal cover (up to +46 ‰) as revealed by throughfall analyses and preliminary results on beech and spruce samples.

In soil solutions, there is an exponential-like decrease of the [B] indicating that B mostly originates from throughfalls. However, B isotopes clearly show two distinct behaviors of B with a gradual decrease with depth of the $\delta^{11}B$ values indicating a preferential removal of ^{11}B (most likely by vegetation) and a massive uptake of B at about -10cm characterized this time by a preferential removal of ^{10}B. This latter behavior is interpreted by interactions between soil solutions and clay minerals.

Relationships with major elements indicate that dissolved B in the Strengbach river reflects a mixture of subsurface waters greatly affected by the vegetal cycling and deeper waters that have isotopic compositions closer to those of silicate minerals.

This study demonstrates that B is greatly affected by the vegetal cycling in sub-surface environment that drives the B isotopic compositions of solutions towards high values and by mixing with deeper waters that more closely reflect water/rock interactions. This double feature of the B geochemical cycle in a forested catchment makes B an interesting tool for deciphering the relative parts of mineral and vegetal in the regulation of geochemical cycles.