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Fractionation of lithium isotopes during granite weathering revealed in waters, saprolites, soils and sediments (Massif Central, France)

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This study presents the results of Li and its isotopes in all reservoirs of a small river catchment draining granite including surface water, primary minerals and accessory phases of the granites, the whole rock, the soil and sediment samples developed on the catchment with data for mineral water and rainwater, in order to evaluate the potential of Li isotopes to be an effective tracers of water/rock interaction processes in a granitic environment. The $\delta^7\text{Li}$ ratios and Li concentrations were measured on the sediment and soil samples following standard acid-dissolution procedures and chemical purification of Li using cationic exchange resin protocole in a clean lab. Lithium isotopic

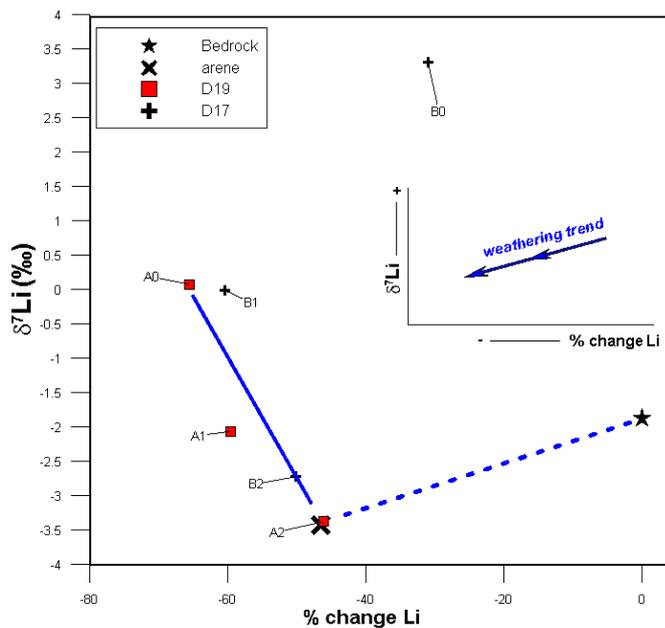


Figure 1. Plot of the percentage change for Li (%) relative to Ti vs. the $\delta^7\text{Li}$ ratios in the granite bedrock, the arene, the soils and sediments. The % change is calculated according to the equation: $100 \times ((\text{element}/\text{Ti})_{\text{sample}}/(\text{element}/\text{Ti})_{\text{granite}} - 1)$.

compositions were measured by using a Neptune MC-ICP-MS and Li concentrations by ICP-MS. The granite-gneiss Margeride massif is located in the French Massif Central and consists of light and dark granite facies (10 to 19% biotite, respectively). Different samples were selected to represent the granite weathering process, starting from the fresh granite sample (bedrock), in near surface condition and in two sites on the catchment. We selected a sample of the weathered-rock (arene), taken from the top of the granite outcrop where the original granitic structure and skeletal fabric were retained. A second set of samples were collected from the surface saprolite and sand-silt are the main grain size fractions (A0, B0). A third set of samples corresponding to sediments collected on river banks were classified as sandy-silt (A1, B1). The last set of samples was collected in fields bordering the streams and was classified as silty-sand (A2, B2). In order to evaluate the extent of chemical mobility during weathering of the granite, the percentage change relative to Ti was applied to Li (Figure 1). Percentage change ranges from -31 to -66% for Li in the samples collected from the surface saprolite (A0, B0). The arene being depleted around -47% for Li with a decrease of the $\delta^7\text{Li}$ ratio from -1.9 to -3.4 ‰. Samples D19 show more depleted values from the soil A2 to river bank sediments A1 and finally for surface saprolite A0, excepted the sample D17-B0. This variation is accompanied by less negative $\delta^7\text{Li}$ ratios, meaning that Li is enriched in soil with fractionation of Li isotopes and changes in the mineral abundance in the samples (apatite and biotite have close to 0 or slightly positive $\delta^7\text{Li}$).

To complement this first view, we have i) modelled the theoretical Li isotopic signature of water interacting with granite by a dissolution model; ii) applied atmospheric input correction to surface water; iii) applied Raleigh equation in order to model the Li isotopic fractionation and compared with corrected surface water and mineral water and iv) replaced Li isotope with Sr isotopes in a larger weathering frame.