Water/rock interactions: clues from experiments and Pb-Li isotopes tracing

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Weathering reactions, e.g. breakdown and alteration of rocks and minerals at the Earth's surface, supply solutes to both surface and ground waters. In a recent study (Négrel et al. 2010, Chem. Geol. Vol. 274) focusing on the lead geochemistry and Pb-isotope ratios of groundwaters along a small (53 km^2) endoreic granitic catchment in India (Masheshwaram, Andhra Pradesh), we have shown that most of the lead in the groundwaters is of geogenic origin. Combining a weathering model and field observations, we were able to define a two step weathering process that includes a control on the Pb-isotope ratios by accessory phases and by the main minerals from the granite in a second step of weathering.

In order to go further and to better characterize water/rock interactions, we performed laboratory experiments with granite rock samples from this field site. The aim of the present work is to better constrain the processes of water/rock interactions both in terms of (i) source (dissolution of different primary minerals) and (ii) extent of weathering, by measuring Pb and Li isotope signatures. This is because lithium is a fluid-mobile element and, due to the large relative mass difference between its two stable isotopes, it is subject to significant low temperature mass fractionation which provides key information on the nature and extent of weathering processes.

Laboratory experiments consisted in measuring the evolution through time of major and trace elements, as well as Pb and Li isotopic compositions of a rainwater solution in equilibrium with a granite powder. Experiments were carried out at 25°C with a solution/powder mass ratio of 10. 15 mL of reference solution TMRAIN-95 and 1.5 g of powdered granite were placed in screw-top Teflon® PFA beakers. The beakers were kept in a temperature-controlled oven, which temperature was maintained within 5% of target temperature over the total duration of the experiments. Aliquots of the solution (after filtration at 0.20 µm) in contact with the granite powder were periodically sampled (from weeks up to one year) and analyzed for lead and lithium isotopic compositions.

Preliminary data show that a radiogenic contribution of lead is observed during the experiments, in agreement with the field observations, and that the light lithium isotope (^6Li) is preferentially retained during uptake of Li into secondary minerals. The results of these experiments will be discussed in the frame of the relative proportion of granite weathering (dissolution of primary minerals) to secondary mineral formation.