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Behavior of Sr and Nd isotopes during granite weathering: the Margeride massif (France)

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Weathering is the breakdown and alteration of rocks and minerals at or near the Earth's surface into products that are more in equilibrium with the conditions found in this environment. Weathering reactions supply solutes to surface- and groundwaters, and promote or inhibit development of pathways for groundwater flows. Water resources in hard-rocks (granite, gneiss) commonly involve different hydrogeological compartments such as overlying sediments, weathered rock, the weathered-fissured zone, and fractured bedrock.

Sr- and Nd-isotope data as well as rare earth elements, from rocks, arenes and regoliths, sediments and soils, shallow and deep groundwater (e.g. mineral water springs), surface waters in the Margeride massif located in the French Massif Central are presented. Granitoids and gneiss are the main lithologies encountered in the Margeride massif, which correspond to a large and 5 km depth laccolith (Négrel, 1999).

Comparing to the bedrock, the Sr isotopes in arenes and regoliths, sediments and soils diverge largely with a linear increase in the $^{87}Sr/^{86}Sr$ and Rb/Sr ratios. The Nd isotopes fluctuate least between the bedrock and the weathering products.

In order to characterise the theoretical Sr isotopic signature, e.g. IRf(Sr), of a water interacting with a granite, we applied a dissolution model (Négrel et al., 2001) based on the hypothesis that most of the Sr comes from the dissolution of plagioclase, potassium feldspar and biotite. Moreover, the newly formed phases being in equilibrium with their parent solution, only the Sr content of fluid is modified; the $^{87}Sr/^{86}Sr$ ratio remains constant. Similarly to the model applied for Sr, we have developed an approach to model the theoretical Nd isotopic signature, e.g. IRf(Nd), of a water interacting with a granite assuming that Nd originates from the same minerals than Sr,

plus apatite.

The IRf(Sr) ratio of water after equilibration with the Sr derived from minerals was calculated for the Margeride granite and compared to values measured in surface- and groundwaters. The comparison of the results shows agreement between the calculated IRf(Sr) and the observed $^{87}Sr/^{86}Sr$ ratios. On the other hand, the IRf(Nd) ratio of water after equilibration with the Nd derived from minerals was calculated for the Margeride granite. The results indicate good agreement with the surface waters values whereas deep groundwaters analysed within the Margeride hydrosystem cannot be directly linked with the weathering of the granite alone. Because the recharge area of deep groundwaters is located on the Margeride massif, very deep circulation, involving interaction with another rocks (e.g. schists, depth > 5 km) must be considered.

These results highlight the complexity of deep groundwaters circulation in the French Massif Central that has long been recognised as an area with numerous mineral water springs, many of which are used for health cures or for bottled mineral water. Knowledge of water circulation and interactions with the surrounding rocks is an important parameter to ensure economic use of deep groundwaters in terms of drinkable mineral waters as well as in terms of geothermal developments.

Négrel, Ph. 1999. Geochemical study in a granitic area, the Margeride, France: chemical element behavior and $^{87}Sr/^{86}Sr$ constraints. Aquatic Geochemistry, 5, 125-165.

Négrel, Ph., Casanova, J., Aranyossy, J.F. 2001. Strontium isotope systematics used to decipher the origin of groundwaters sampled from granitoids: the Vienne case (France). Chemical Geology, 177, 287-308.