

Insight into biotite weathering rate using U-series isotopes

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While the chemical weathering rate of silicates is a key parameter for several geochemical processes, field measurement of these rates remains challenging. Uranium- and Th-series nuclides were used to investigate biotite weathering in a soil profile. Some crystal-habits of biotites (including the alteration products) were hand-picked from five horizons (20 to 140 cm) of a soil profile from the experimental Breuil-Chenu site (France). Additionally, biotites from a seemingly 'fresh' block of the granitic bedrock were also recovered. Chemical analyses and XRD data allow quantifying the fraction of biotite remaining in these crystal-habits (91% to 9%). The extraction of the 'fresh' biotite interlayer demonstrates the lack of U and Th in this interlayer.

Unexpected behaviour of U and Th nuclides was recorded in these biotites. An unambiguous loss of ²³²Th occurs during the transformation of the biotite to its alteration products, whereas little U loss (similar to Fe) was observed, implying an efficient redistribution of U between the primary mineral and the alteration products (mainly kaolinite and vermiculite) within the crystal-habit. The measured U-series activity ratios show an ordered evolution, consistent with an increased weathered stage in these samples. However, this "U-series-derived-weathered-stage" is not always coherent with the location of the sample within the soil profile, i.e.: the 'fresh' biotite from the granite bedrock actually displays some U-series activity ratios typical of significantly weathered samples, suggesting an incongruent leaching of U and Th isotopes. These results highlight that the U- and Th-series nuclides are probing some water-mineral interactions occurring before macroscopic mineral transformation.

Using an open-system leaching model, the coupled (²³⁴U/²³⁸U), (²³⁴U/²³⁰Th), and (²²⁶Ra/²³⁰Th) disequilibria measured in the samples permit to calculate a weathering duration ranging from 12 to 50 ka for the most altered biotite of this soil profile. The biotite weathering rates deduced from these data are consistent with the range of field rates previously reported [1], suggesting a valuable use of U-series isotopes for mineral-weathering field rate determination.

[1] White A. (2002) *Chem. Geol.* **190**; 69-89.

Dissolved Mo, W, V in Atlantic surface water

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Molar ratio of Mo/W is about 1800:1 in the Pacific Ocean water, while in the Earth's crust Mo/W ratio is close to 1. Tungsten was preferentially scavenged by hydrogenic Fe-Mn oxyhydroxides in oceans relative to Mo, that enriches ocean water. In sediments of South Atlantic one can see gradual decrease of Mo/W ratio in the past. It is not clear what drives the directional changes of Mo/W ratio. To investigate the factors controlling the behavior of these elements in the Earth's history (a record in the sediments), their variations should be studied in the modern ocean water.

The concentration of W in open ocean water is extremely low (about 50 pmol/L). So we developed the technique for solid phase extraction preconcentration of dissolved W together with Mo and V from ocean water with ICP-MS detection. The concentration factor is 50; the detection limits are 0.31 nmol/kg for Mo, 6 pmol/kg for W and 40 pmol/kg for V. The precision of the determination is 2.7% for Mo, 3.4% for W and 3.5% for V in seawater (n=6).

The concentrations of the above mentioned elements in 16 surface water samples of submeridional profile (from 36°N to 36°S) across the Atlantic Ocean have been determined using the developed technique. The ranges of studied elements concentrations were: Mo – 90-110 nmol/kg, W – 54-93 pmol/kg and V – 28-35 nmol/kg along the profile. Concentrations of studied elements are not clearly correlate with salinity. Mo content shows strong correlation with V content. Distribution of W differs from that of Mo and V. The Mo/W ratio in the surface water changes from ca. 1100 to 1800 along the profile in Atlantic Ocean.