

## Rates of weathering rind formation from $^{238}\text{U}$ - $^{234}\text{U}$ - $^{230}\text{Th}$ chronometry: Application to basalt weathering

E. PELT<sup>1</sup>, F. CHABAUX<sup>1</sup>, C. INNOCENT<sup>2</sup>, A. NAVARRE-SITCHLER<sup>3</sup>, P. SAK<sup>4</sup> AND S. BRANTLEY<sup>3</sup>

<sup>1</sup>EOST-CGS Strasbourg France (fchabaux@illite.u-strasbg.fr)

<sup>2</sup>BRGM Orléans France (c.innocent@brgm.fr)

<sup>3</sup>Earth and Environmental Sciences institute, Penn State University, Univ Pk, PA, USA (brantley@eesi.psu.edu)

<sup>4</sup>Department of Geology, Dickinson College, Carlisle, PA, USA (sakp@dickinson.edu)

Weathering rinds developed on fresh rocks provide an opportunity to constrain the processes and rates of weathering as a function of parameters such as lithology and climate [1]. Such information requires first to develop reliable dating methods for such materials, which have been rarely studied, up to now, by radiochronometric techniques.

In this study we propose to evaluate the potential of  $^{238}\text{U}$ - $^{234}\text{U}$ - $^{230}\text{Th}$  chronometry to constrain the age and the formation rate of weathering rinds. We worked on a rind developed on a basaltic clast from a Costa Rican alluvial terrace, which has been extensively studied for mineralogy, geochemistry and petrology [1]. Nine subsamples of this clast were collected along a 2 cm transect, from the center of the fresh basalt core to the outer rind boundary, by drilling samples (2.5mm in diameter and 5mm depth) on one section of the split clast. Major and trace element concentrations, as well as Sr isotope ratios and  $^{238}\text{U}$ - $^{234}\text{U}$ - $^{230}\text{Th}$  disequilibria have been analysed in each subsample.

The data are consistent with immobility of Th and removal of mobile elements such as Ca, Mg, and Sr during weathering. Additionally, the increase of  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope ratios, ( $^{234}\text{U}/^{238}\text{U}$ ) activity ratio and U/Th ratios from the fresh core to the outer rind boundary implies an input of U, with ( $^{234}\text{U}/^{238}\text{U}$ )>1, and an input of radiogenic Sr into the rind. These U and Sr inputs could both be ascribed to an external flux of dissolved U and Sr transported by the upper soil waters and adsorbed on or incorporated into Fe-Al oxy-hydroxydes. Modelling  $^{238}\text{U}$ - $^{234}\text{U}$ - $^{230}\text{Th}$  disequilibria in the rind by using an U gain-and-loss model classically applied for the interpretation of U-Th data in weathering profiles [2] give an advance rate of 4mm/10ka for this 1.5cm-thick rind. This age is in close agreement with other independent methods [1]. This study highlights the potential of the U-series dating method to constrain the timescale of weathering rind formation and therefore to provide new information about the rate of bedrock conversion to saprolite.

### References

- [1] Sak *et al.* (2004), *Geochim. Cosmochim. Acta* **68** 1453-1472.
- [2] Chabaux *et al.* (2003), *Reviews in Mineralogy and Geochemistry* **52**, 533-576.

## Tracking mobile niobium in the boreal environment with a “multi-survey” approach

P. PELTOLA<sup>1</sup>, M. E. ÅSTRÖM<sup>1</sup>, J.J. VIRTASALO<sup>2</sup>, A.T. KOTILAINEN<sup>3</sup> AND R. SALMINEN<sup>3</sup>

<sup>1</sup>Kalmar University, School of Pure and Applied Natural Sciences, S-39182 Kalmar, Sweden (pasi.peltola@hik.se, mats.astrom@hik.se)

<sup>2</sup>University of Turku, Department of Geology, FIN-20014 Turku, Finland (jojovi@utu.fi)

<sup>3</sup>Geological Survey of Finland, FIN-02151 ESPOO, Finland (aarno.kotilainen@gsf.fi, reijo.salminen@gsf.fi)

Niobium is mainly found in weathering-resistant minerals and generally considered as an immobile element and a recent soil (Echevarria *et al* 2005) and hydrochemical (Lutfi *et al* 2007) study has not changed this view. Still very little is known about the behaviour of Nb in various soils or in continental surface- and ground water environments. Nb has one stable ( $^{93}\text{Nb}$ ) and several unstable isotopes found in radioactive wastes, e.g.  $^{95}\text{Nb}$  and  $^{94}\text{Nb}$  ( $t_{1/2}=35\text{d}$  and 2400a).

We examined dissolved and acid-available particulate fractions of Nb in boreal stream and ground waters and “non-detrital” Nb in sediments. The data consists of both speciation experiments and time-series of a small stream, large scale regional geochemical data sets and brackish/lacustrine environment sediments.

In streams spatial patterns, temporal trends and speciation experiments all point to dissolved humic substances and colloidal Fe as the main carriers and controls of Nb. Clay-silt and ore deposits may be responsible for producing local stream-water Nb anomalies. In groundwater in glacial till overlying Proterozoic granitoids, dissolved (0.45  $\mu\text{m}$ ) Nb concentrations were about an order of magnitude higher than in stream water and strongly correlated with dissolved Fe. In the brackish-water sediments, the Nb concentrations (1.3-4.2 ppm) were clearly higher than in the lacustrine ones (0.25-0.53 ppm). To explain this, we assessed the potential role of organic material, biological processes, mineralogy and input factors. However, no satisfactory explanation for the change was found.

The use of multiple surveys was a successful approach for studying the behaviour of Nb. Although this metal is relatively immobile our results show that certain conditions favour Nb enrichment in the aquatic environment which also has implications for the behaviour of radionioium.

### References

- Echevarria G., Morel J. L. and Leclerc-Cessac E. (2005), *J. Env. Rad.* **78**, 343-352.
- Firdaus L., Norisuye K., Sato T., Urushihara S, Nakagawa Y., Umetani S. and Sohrin Y. (2007), *Anal. Chim. Acta* **583**, 296-302.