Mobility of rare earth elements during igneous rocks weathering and associated stream water transport (Malaval catchment, Massif Central, France)

L. CHAUX[1], T. ROUTIER[1], O. POURRET[1], M. STEINMANN[2] AND S. BONTEMPS[2]

[1]HydrISE, LaSalle Beauvais, 60026 Beauvais cedex, France (olivier.pourret@lasalle-beauvais.fr)
[2] UMR 6249 Chrono-Environnement, Univ. Franche-Comté, 25030 Besançon cedex, France

Rock alteration occurs within the critical zone at the interface between atmosphere, biosphere, hydrosphere and lithosphere. It is a major process within the global biogeochemical cycle and contributes also to the evolution of landscapes. Chemical weathering dissolves partially or completely bedrock minerals to form weathering profiles, and dissolved ions are transported by surface and underground runoff to the oceans. In order to establish a link between the distribution patterns of the rare earth elements (REE) in stream water and bedrock, a detailed alteration study of the granitic, gneissic and basaltic bedrocks of a small mountain catchment was realized (Malaval catchment, Massif Central, France).

The mineralogy of fresh and weathered samples was determined by microscopy and XRD. Major and trace elements were determined by ICP-AES and ICP-MS. A comparison between the REE patterns of the more altered horizons of each profile and the $< 0.22\ \mu$m water fraction of the Malaval stream has been realized in order to determine the influence of the different bedrocks on stream water chemistry [1]. Results suggest similar alteration mechanisms for granite and gneiss, which is mainly controlled by the dissolution of plagioclase leading to losses of Na_2O, CaO, SiO_2 and Al_2O_3. Mobilization of K_2O can be related to fracturing of K-feldpar, whereas the evolution of the REE patterns is mainly controlled by the distribution of zircon. In the alteration profiles on basalt, olivine is the first mineral to be altered into orange oxides leading to a mobilization of MgO. The transformation of plagioclase into clays is accompanied by losses of Na_2O and CaO. Lowered iron concentrations can be related to fracturing of pyroxene. A comparison between the REE patterns of the most altered horizons of the different weathering profiles suggests that water chemistry of the adjacent Malaval stream is mainly controlled by basalt weathering. In order to confirm this finding, sequential leachings have been performed on basalt samples and compared with stream water.

[1] Steinmann & Stille (2008) *Chem. Geol.* **254**, 1-18.

Spatial and temporal variability of fluid and gas chemical composition at the Lucky Strike hydrothermal vent site (Mid-Atlantic Ridge)

V. CHAVAGNAC, C. BOULART, C. MONNIN AND A. CASTILLO

Geosciences Environement Toulouse, 14 Avenue Edouard Belin, 31400 Toulouse, FRANCE (valerie.chavagnac@get.obs-mip.fr)

Numerous acidic submarine hydrothermal sites have been discovered, sampled and studied along the Mid-Atlantic ridge between 14ºN and 38ºN near the Azores hot spot. Most hydrothermal systems lie on basaltic substratum and only a few of them on ultramafic rock substratum. The Lucky Strike hydrothermal field was discovered in 1992 during the joint US-French FAZAR expedition on a volcanic segment at 37º50’N at 1700m water depth. The high-temperature hydrothermal fluids (up to 328ºC) have been collected in 1993 and 1994. The chemical composition of fluid and gas emitted at this site indicate variable chlorinities lower than seawater, low hydrogen sulfide, low metal concentrations and high gas contents. The distinct chemical end-members argue for a significant geographic control of the venting system and fluid chemistry is strongly affected by phase separation at depth.

The Lucky Strike hydrothermal field was visited during the BATHYLUCK and MOMARSAT cruises in 2009 and 2010, respectively, in order to assess the spatial and temporal variability of the hydrothermal fluid and gas chemical composition. Numerous fluid discharges on the western side the lava lake were collected as limited chemical were acquired thus far. A maximum temperature of 340ºC was measured at South Crystal. Based on the distribution of element concentrations, fluid chemistry is strongly affected by phase separation at depth as well as the geographic control of fluid plumbing system. Our results indicate that 3 different fluids are feeding the Lucky Strike field (1: Eiffel Tower, Montségur; 2: White Castle, Isabel, Cypress; 3: Y3, Nuno, Crystal, South Crystal, Sintra). The concentrations of CH_4 and CO_2 have increased since 1994 at Eiffel Tower, Sintra, Montségur and Y3, while the N_2 concentrations have all decreased significantly. The H_2 concentrations have stayed stable at Eiffel tower while increasing at Y3 but decreasing at Montségur. CH_4 is generated by water-rock interaction by Fischer-Tropsch caalysis of CO_2 reduction.