

Evidence for stable strontium isotope fractionation during chemical weathering

G.F. DE SOUZA, B.C. REYNOLDS AND B. BOURDON

ETH Zurich, Institute of Isotope Geology and Mineral Resources, Switzerland (gdesouza@student.ethz.ch; reynolds@erdw.ethz.ch; bernard.bourdon@erdw.ethz.ch)

The use of a sample–standard bracketing protocol during multicollector inductively-coupled mass spectrometry (MC-ICPMS) enables us to determine the stable isotopic composition of Sr in a variety of materials (rocks & minerals, soils, and water). These variations are reported relative to the standard NBS 987 in the standard delta notation ($\delta^{88/86}\text{Sr}$) with an external reproducibility of $\pm 0.06\%$.

We have measured $\delta^{88/86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ of soil parent material (rock, mineral separates) and soils forming a ~150yr chronosequence in the forefield of the Damma Glacier in Central Switzerland. Minerals in the Hercynian granitoid rocks analysed show significant differences (0.3%) in $\delta^{88/86}\text{Sr}$, leading to whole-rock $\delta^{88/86}\text{Sr}$ variations. Such differences are most likely due to postmagmatic events such as the subsolidus unmixing of alkali feldspar, or element remobilisation during a hydrothermal event or during Alpine metamorphism in the presence of fluids.

The $\delta^{88/86}\text{Sr}$ of surface water tends toward lower values than average watershed lithology and is lower than that of seawater (Fietzke and Eisenhauer, 2006). Temporal variations of ~0.1% are observed and are most likely related to changes in discharge, either due to variations in subglacial water-rock interaction time or in the relative contribution of deep flowpaths to discharge.

The $\delta^{88/86}\text{Sr}$ values of total soil digestions show a systematic trend from rock-like values (~0.2%) in the youngest soils to higher values (~0.5%) in the oldest. Unlike total soil $^{87}\text{Sr}/^{86}\text{Sr}$, these values cannot be explained by mixing between lithological endmembers, and thus require a preferential loss of isotopically light Sr during weathering, also indicated by the lower $\delta^{88/86}\text{Sr}$ values observed in surface water. We propose that fractionation during dissolution of feldspars, during precipitation of secondary weathering phases and during biological utilisation are three possible mechanisms for the loss of isotopically light Sr.

This variation in total soil $\delta^{88/86}\text{Sr}$, together with heterogeneity in $\delta^{88/86}\text{Sr}$ of the three main Sr-bearing minerals (plagioclase, K-feldspar, biotite) in granitoid rocks, has implications for studies of relative mineral weathering rates in granitic catchments. The combination of $\delta^{88/86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ data provides a unique solution for three-component mixing, thus obviating the need for simplifying assumptions that are necessary when only radiogenic Sr isotope variations are discussed.

References

Fietzke, J. and Eisenhauer, A. (2006), *Geochem. Geophys. Geosys.* **7** doi:10.1029/2006GC001243

Modeling the effect of aging on Deccan Traps weathering and CO₂ consumption

CELINE DESSERT¹, YVES GODDERIS² JACQUES SCHOTT² AND BERNARD DUPRE²

¹IPGP, Paris, France, (dessert@ipgp.jussieu.fr)

²LMTG, CNRS, Observatoire Midi-Pyrénées, Toulouse, France, (godderis@lmtg.obs-mip.fr)

Basalts weathering account for 30 % of the CO₂ consumption through continental silicate weathering, and may have played a major role in past climatic crises. Since basalts weather rapidly with the subsequent formation of thick soils, the question of the effect aging on weathering rate is crucial. Indeed, in the absence of efficient physical erosion, it can be expected that basalt weathering slows down rapidly with time, thus reducing its impact on the climatic evolution.

Here we present the results of a numerical model describing the effect of aging of the rate of weathering of Deccan Traps. The model design is a 20 box-model, based on the structure of the WITCH model. Fresh primary minerals are supplied to the bottom layer through bedrock dissolution, and to top layers as the “numerical” column goes down into the bedrock following chemical ablation. At each time step, the chemical composition of the downward water flux is calculated within each box, as well as the dissolution of primary minerals and the accumulation of secondary minerals representing the « soil » formation. Both precipitation and dissolution rates are calculated within the framework of Transition State Theory using the best available data issued from laboratory experiments. The model is run for 1 million years until a steady-state is achieved, corresponding to a constant mineralogical composition in each layer and to a constant chemical composition of the percolating waters. Calculated elemental ratios in solution are compared to the field measurements, as well as absolute concentrations.

Perturbations are then applied to the model, through the prescribed removal of several boxes at the top of the soil pile, in order to simulate enhanced physical erosion due to external factors, such as anthropic activities. The response of the CO₂ consumption rate to these perturbations is quantified.