

Linking soil chemistry, treeline shifts and climate change: a scenario

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Global warming can destabilize our fragile ecosystems. As cold areas become warmer, both flora and fauna must adapt to new conditions [1]. It is widely accepted that climate changes deeply influence the treeline shifts. But there is little knowledge about what happens to the soil chemistry when ecosystems tend to replace each other. Will elemental availability become a crucial factor in progressively warming conditions?

The Sinks Canyon and Stough Basin - SE flank of the Wind River Range, Wyoming, USA - offer a case study to answer these questions. Conceptually, the areas were divided into three main subsets: tundra, forest and subarid environment, all with soils developed on granitoid moraines. From each subset, a liquid topsoil extract was produced and mixed with the solid subsoil samples in batch reactors at 50 °C. The batch experiment was performed over 1800 h, and the progress of the dissolution was regularly monitored by analysing liquid aliquots with IC and ICP-OES.

The nutrients are released within the first hours of the experiment. Si and Al are continuously released into the solution, while some alkali elements – i.e. Na - show a more complex trend. Organic acids (acetic, citric) and other ligands produced during biodegradation play an active role in mineral dissolution and nutrient release. Furthermore, the mineral colloids detected in the extract (X-ray diffraction) can significantly control surface reactions (adsorption/desorption) and contribute to specific cationic concentrations. The experimental set up is then compared to a computed dissolution model using SerialSteadyQL and PHREEQC software.

Decoding the mechanisms driving mineral weathering is the key to understand the main geochemical aspects of landscape adaptation during climate changing conditions.

[1] Burga *et al.* (2010) *Flora* **205**, 561-576

Mg isotope fractionation during hydrothermal carbonation of serpentine

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As (i) the Mg isotope composition of seawater is lighter than that of the mantle and (ii) Mg isotopic composition of the mantle is considered homogeneous [1], significant fractionation processes must be occurring during the alteration of the continental crust [2,3]. This study has been initiated to explore possible processes accounting for this fractionation.

Here we present new observations of Mg isotope fractionation during the carbonation of the Linnajavri Ultramafic Complex, N-Norway. Carbonation of the serpentinite in this complex occurred at closed system conditions (except for the volatiles) at ~275 °C resulting in the formation of mainly magnesite and talc [4]. Textural observations and reaction path considerations indicate that mineral replacement began with magnesite precipitation resulting in an increasing Si activity in the alteration fluid eventually saturating talc. The original serpentine has an isotopic composition of $\delta^{26}\text{Mg}$ (DSM3) = -0.11±0.05, whereas talc is enriched in ²⁶Mg with average $\delta^{26}\text{Mg}$ = 0.17±0.08 and magnesite is depleted in ²⁶Mg with average $\delta^{26}\text{Mg}$ = -0.95±0.15. These observations indicate that Mg isotopes are efficiently fractionated at mid-crustal PT conditions.

The observed fractionation has significant implications for the Mg isotope distribution in natural waters due to the large difference of the dissolution rates of Mg bearing silicates relative to Mg-bearing carbonates – the dissolution rates of magnesite are ~3 orders of magnitude faster than that of talc at 25 °C and pH=8 [5,6]. Our observations suggest that Mg isotope fractionation during carbonate formation and their faster erosion rates at Earth's surface conditions may explain the enrichment of seawater in ²⁴Mg compared to that of fresh mantle Mg and that Mg-bearing hydrous silicates may represent the missing sink for residual the ²⁶Mg.

[1] Teng *et al.*, (2007) *EPSL* **26**, 84-92. [2] Tipper *et al.*, (2006) *EPSL* **247**, 267-279. [3] Wimpenny *et al.*, (2010) *GCA* **74**, 5259-5279. [4] Beinlich *et al.* (2012) *Terra Nova* **24**, 446-455. [5] Saldi *et al.* (2007) *GCA* **71**, 3446-3457. [6] Pokrovsky *et al.*, (2005) *Chem. Geol.* **217**, 239-255.