

Experimental studies on CO₂ sequestration in basaltic rocks with a plug flow reactor

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Mineral trapping in silicate rocks is considered the most stable strategy of CO₂ storage. Conceptual model of CO₂ mineral fixation in Iceland assumes that acidic carbonated waters injected into basaltic rocks will initially cause rock dissolution and release of divalent cations such as Ca²⁺, Mg²⁺ and Fe²⁺. As reactions progress, these elements will combine with CO₃²⁻ and precipitate as carbonates due to increasing pH [1]. A large scale experiment with a plug flow reactor imitating chemical and physical conditions within the basaltic rocks after CO₂ injection, gives an opportunity to study the rate of basaltic rock dissolution and solid replacement reactions under controlled CO₂ conditions. The experimental set-up makes it possible to follow changes in pH, Eh and chemical composition of the fluid on different levels along the flow path within the column. Characterization and quantification of secondary minerals (carbonates and clays) enables determination of molar volume and porosity changes with time. Data obtained from experiment will be used in reactive transport models to elucidate the advance of reaction fronts, forecast porosity changes followed by estimation of upper limit CO₂ injected into a given geological formation.

Experimental set-up consists of 7 titanium compartments assembled into a 2.5 m long pipe (5.4 cm OD x 5 cm ID), corresponding to a volume of ~ 5 dm³. The column is filled with basaltic glass grains, of known chemical composition and surface characteristic (45-100 μm size fraction). CO₂ saturated water will be pumped under 75 bar pressure through the column. This contribution will present first preliminary results from this column experiment.

[1] Gislason *et al.* (2010) *JGGC*, **4**, 537-545

Stable Sr isotopes in seawater

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Early work on dissolved Sr in GEOSECS ocean profiles from the Atlantic and Pacific showed Sr/salt variations with depth, providing evidence for depletion of dissolved Sr in surface waters [1]. This depletion was attributed to uptake of Sr from surface waters by acantharians, whose skeleton is made of celestite (SrSO₄), which subsequently dissolves at depth, thus exerting a control on strontium cycling in the water column [2].

We explore the potential of stable Sr isotopes as a tracer of such nutrient-like behaviour in seawater. We have analysed surface seawater samples and a depth profile collected in the Southern Ocean during GEOTRACES cruise ANT-XXIV-3 along the Greenwich Meridian, as well as the NASS-4 standard and a deep-water North Atlantic sample. The Sr isotope data were obtained using a ⁸⁴Sr-⁸⁷Sr double spike by TIMS at MPI. Measured δ^{44/42}Ca obtained on the same samples are effectively homogeneous with an average value of 0.83 ± 0.04‰ (total range) relative to SRM 915a.

The ⁸⁷Sr/⁸⁶Sr of both surface water and depth profile samples gave a consistent value of 0.709176±8 (range) relative to 0.710250±7 (2SD) for SRM 987. The ⁸⁸Sr/⁸⁶Sr ratios, expressed as δ^{88/86}Sr, show little variation in the deep waters, averaging 0.35±0.02‰. In contrast, surface waters show subtle variations along the transect (0.33±0.02‰) just within error of that in deep waters. The Southern Ocean compositions tend to be isotopically slightly lighter, overall, than those of the Atlantic further north (0.36±0.02‰), and as measured for IAPSO seawater [3, 4].

These preliminary data suggest that constancy of δ^{88/86}Sr in seawater cannot be assumed a priori. Any variations thus far appear to lie on the edge of the analytical precision. Nevertheless, mapping the ocean δ^{88/86}Sr distribution appears to be an important task, and may help elucidate the internal biological cycling of strontium in the water column.

[1] Brass & Turekian (1974) *EPSL* **23**, 141-148. [2] Bernstein *et al.* (1987) *Science* **237**, 1490-1494. [3] Fietzke & Eisenhauer (2006) *G³* **7**, DOI: 10.1029/2006GC001243. [4] Krabbenhöft *et al.* (2009) *JAAS* **29**, 1267-1271.