

Field evidence of Sr exchange between particulate material and seawater in estuaries

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The reactivity of riverine particulate material upon arrival in the oceans is an important consideration for global element cycles, as this flux dominates for the majority of elements [1]. A small amount of particulate dissolution in saline water would have a noticeable impact on land-to-ocean fluxes of key elements such as Ca, Mg and Sr. A recent study showed significant dissolution and/or exchange of strontium between riverine particulate material and seawater in laboratory conditions [2]. If replicated in the natural environment, the calculated Sr release upon arrival in estuarine waters would be of a similar order of magnitude to hydrothermal exchange at mid-ocean ridges. To date, no study has found evidence of Sr exchange in field studies, potentially because the concentrations of Sr in seawater are high and there is experimental evidence for contemporaneous precipitation of Sr-bearing phases [2].

This study focuses on the Borgarfjörður estuary in western Iceland. The basaltic lithology of the catchment and the shallow depth of the fjord make this site ideal for detecting any interaction between solid and liquid phases, as this should equate the most easily weathered material and the highest sediment to water ratio in the natural environment. Two independent field trips collected water, suspended material and bedload samples in transects along the fjord, and subsequently analyzed for major element concentrations and ⁸⁷Sr/⁸⁶Sr values. While dissolved Sr concentrations are controlled by the extent of mixing with saline water, the ⁸⁷Sr/⁸⁶Sr values of both the dissolved and suspended load display evidence that unradiogenic Sr is liberated from solid particles upon first contact with saline water. Bedload samples show a systematic increase in ⁸⁷Sr/⁸⁶Sr values along the length of the estuary. These analyses represent the first *in situ* evidence of considerable Sr exchange between riverine particulate material and seawater, and demonstrate that particulate material can play an important role in defining the chemistry of coastal waters. These findings have important consequences for global Sr budget calculations and the general use of isotopes as tracers of biogeochemical processes.

[1] Oelkers et al. (2011) *Appl. Geochem.* **26**, S365-S369.

[2] Jones et al. (2012) *Geochim. Cosmochim. Acta* **77**, 108-120.

Subduction erosion, magmatism and continental crust formation in the southern Central Andes

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Subduction zones, such as the Andean convergent margin, form large recycling systems and are the main producers of new continental crust. The subduction of continental material through either tectonic subduction erosion or sediment cycling is an important component when estimating the mass flux through an active margin over time. Subduction erosion in particular has been highlighted as an important process along certain parts of the Andean continental margin, especially to the west of the Central Andes [1, 2].

It has been suggested that the rate of subduction erosion along the north-central Andean margin has varied over time with constant, fast rates between 150 and 20 Ma and slower rates during the Neogene [3]. A near constant rate of subduction erosion between 150 and 20 Ma suggests a continuous supply of continental material into the subduction zone, during this time.

We have combined high resolution, U-Pb dating, isotope geochemistry, and major and trace element analyses, from a suite of magmatic rocks sampled from the southern Central Andes (28° to 32°S), in order to investigate source contamination by subducted continental material between the late Cretaceous and the late Miocene.

The results of new, in-situ U-Pb dating of magmatic zircons by SIMS place further constraints on the presence of a widespread period of reduced arc magmatism in the southern Central Andes during the late Eocene to late Oligocene (35 - 26 Ma). Oxygen and hafnium isotopic analysis, of the same magmatic zircons (by SIMS and LA-ICPMS respectively), reveal variations in $\delta^{18}\text{O}_{\text{(VSMOW)}}$ of between $9.78 \pm 0.21\%$ and $3.59 \pm 0.21\%$ and in ϵHf of between 10.4 ± 1.3 and -4.4 ± 0.8 . This new data, when combined with the results of whole rock, major and trace element analysis, provides increased constraint on the amount of continental material being subducted to depth and recycled to the continental crust via arc magmatism during this key time in the evolution of the Andes.

[1] Stern (1991) *Geology*, **19**, 78-81.

[2] Stern (2004) *Rev. geol. Chile*, **31**, 161-206.

[3] Clift and Hartley (2007) *Geology*, **35**, 503-506.