Heavy isotope fractionation in magmatic systems: The example Tl

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Variations in the isotopic composition of heavy isotopes are not expected to occur by mass-dependent fractionation in high-temperature systems, since relative mass differences are very small (e.g. < 1% for Tl) and the fractionation scales with $1/T^2$ [1]. In contrast, the mass-independent fractionation due to differences in the nuclear volume between isotopes generally increases with atomic number and scales with 1/T [2].

In this study we show that isotopic fractionation of Tl occurs in the peralklaline Ilimaussaq intrusion, southwest Greenland. We studied magmatic and hydrothermal amphiboles and astrophyllite, which is a rare amphibole-related mineral. The isotopic compostion of Tl varies systematically with increasing magmatic differentiation. The most differentiated rocks show the largest variations, which are most probably related to fluid unmixing from the late-stage magma, as shown in previous studies [3]. Late-stage magmatic and hydrothermal minerals exhibit contrasting isotopic compositions, with isotopically light Tl in the magmatic samples and heavier Tl in the hydrothermal rocks. Post-magmatic hydrothermal alteration affected a single sample and produced the heaviest observed Tl isotope composition. Overall, the rocks of the Ilimaussaq intrusion thus display a variability of 1‰ in the $^{203}Tl/^{205}Tl$ isotope ratio as a results of fractionation that occurred at temperatures of between 250 and >1000°C [4].

In addition to this study of natural samples, we will carry out ab-initio modelling of the isotopic fractionation of Tl due to mass-dependent and –independent effects to enhance the existing knowledge [5] of the importance of non-classical fractionation processes in high-temperature systems.

[1] Bigeleisen & Mayer (1947) *J. Chem. Phys.* **15**, 261. [2] Bigeleisen (1996) J. Am. Chem. Soc. **118**, 3676–3680. [3] Pfaff *et al.* (2008) *Lithos* **106**, 280-296. [4] *Markl et al.* (2001) *J. Petrol.* **42**, 2231-2257. [5] Schauble (2007) *Geochim. Cosmochim. Acta* **71**, 2170-2189.

Tracing water masses with radiogenic isotopes: Water column and Fe-Mn crust records from the eastern equatorial Pacific Ocean

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The radiogenic isotope compositions of neodymium (Nd) and lead (Pb) have been shown to be effective tracers for continental weathering inputs and in the case of Nd, due to its quasi-conservative behavior, also for present and past ocean circulation.

We present the first full water depth profiles of dissolved Nd isotopes and concentrations from the eastern equatorial Pacific. Time series of past deep water Nd and Pb isotope compositions were obtained from a Mn nodule, as well as from two Fe-Mn crusts that grew on the flank of a seamount at different water depths (4000-3500 m; 3500-3000 m). We also present a comparison of vertical and horizontal time series obtained from a discoidal Mn nodule. The ages of the crusts and the nodule were derived from $^{10}Be/^{9}Be$ chronology. Growth rates are on the order of 3-6 mm/Myr for the crusts and much higher at 24-46 mm/Myr for most of the nodule.

Nd concentrations of the unfiltered water samples range from 8 to 58 pmol/kg and show a systematic increase with water depth caused by scavenging processes. Compared with previous data the deep water concentrations at around 4000 m yield exceptionally high values greater than 50 pmol/kg.

The seawater Nd isotope compositions (εNd) vary between -5 at depth and +1 near the surface. While surface waters are primarily influenced by the weathering inputs from young volcanic rocks (radiogenic εNd signatures) the deep water signatures are influenced by admixture of Circumpolar Deep Water (unradiogenic εNd signatures), which spreads northwards into the Pacific Ocean. The deep water Nd isotope signatures at 4000 m water depth (εNd = -3.5) corresponds well to the signatures measured for surface layers on a Fe-Mn crust and a nodule from the study area. This demonstrates that the present day bottom water at this site has been dominated by modified North Pacific Deep Water rather than of less radiogenic Antarctic Bottom Water (εNd=-8).