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Mg isotopic compositions of Pacific and Arctic seawater

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Magnesium is second to sodium in concentration among the cation elements of seawater. The relatively large mass difference between its three isotopes, ²⁴Mg, ²⁵Mg, and ²⁶Mg, makes the mass dependent isotope fractionation of magnesium a potential tool to trace physico-chemical processes in the biogeochemical cycle. In this study, we measured seawater from the Pacific Ocean and Canadian Basin of the Arctic Ocean. Seawater from six different depths, ranging from the surface to the bottom, were sampled at each locality. The major purpose of this study was to test whether seawater is homogeneous and could potentially serve as standard in magnesium isotope geochemistry or whether the isotopic composition changes with physico-chemical conditions, i.e. salinity and temperature.

Analytical method. Two separate stages of ion exchange chromatography were used in this study to separate Ca and Na [1]. The purified Mg chloride salts were redissolved in 0.1M HNO₃ and this Mg solution was introduced into MC-ICP-MS (Nu 1700, Nu Instruments, Wrexham, Wales) via a DSN-100 dissolver. The Nu 1700 was tuned to high mass resolution of $m/\Delta m \approx 2500$ in order to resolve C₂⁺ and CN⁺ interferences on masses 24 and 26. All samples were measured with a sample-standard bracketing method using DSM3 as reference [2].

Results. The average $\delta^{26}\text{Mg}$ and $\delta^{25}\text{Mg}$ of Pacific sea water samples are -0.83 ± 0.09 (2 σ SD) and -0.46 ± 0.07 (2 σ SD), respectively. Whilst $\delta^{26}\text{Mg}$ and $\delta^{25}\text{Mg}$ of seawater samples from the Canadian Basin average at -0.94 ± 0.10 (2 σ SD) and -0.51 ± 0.06 (2 σ SD), respectively. Based on these results, the seawater from the Canadian Basin may be slightly lighter than Pacific seawater. However, seawater samples from the Canadian Basin are characterised by low salinity indicating an influence from the polar ice shield and perhaps the riverine discharge from the Canadian shield. Seawater samples with high salinity have a homogeneous magnesium isotope compositions and are identical, within error, with Northern Atlantic seawater [1].

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References

- [1] Chang et al. (2003) *JAAS* **18**, 296-301.
[2] Galy et al. (2003) *JAAS* **18**, 1352-1356.

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Hf and Nd isotopes in ferromanganese crusts and seawater: An alternative view

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Hydrogenetic ferromanganese (Fe-Mn) crusts are commonly believed to reflect the isotopic compositions of dissolved Hf and dissolved Nd in seawater. The variations of Hf and Nd isotopic ratios along profiles through Fe-Mn crusts are utilized as proxies for the evolution of Hf and Nd isotopes in seawater through time. Comparing Hf and Nd isotopes in Fe-Mn crusts, two observations have been made: (i) at a given Nd isotopic composition, seawater Hf is more radiogenic than Hf in the Earth's mantle and crust, (ii) despite an apparently coupled evolution of Hf and Nd isotopes in seawater, both systems occasionally decouple and follow different trends. The first observation is currently explained by input of unradiogenic riverine Hf into seawater due to the preferential retention of unradiogenic Hf in weathering-resistant zircon, while for the second observation no explanation has been widely accepted yet.

We will discuss evidence from speciation calculations, sequential leaching, REE geochemistry and Fe isotope studies, and present an alternative explanation for the observed behaviour of Hf and Nd isotopes. The Nd isotopic composition of a Fe-Mn crust correctly reflects that of ambient local seawater at the Fe-Mn crust's depositional site because of continuous re-equilibration of scavenged Nd with dissolved seawater Nd. In marked contrast, the isotopic composition of Hf in a hydrogenetic Fe-Mn crust does not reflect that of dissolved Hf in ambient seawater at the depositional site. Rather, it reflects the isotopic composition of Hf associated with colloidal Fe oxyhydroxide particles. The actual isotopic composition of this "colloidal" Hf is the average of the Hf the Fe colloids encountered and depends on their origin and migration pathway. Thus, there is no true (de)coupling between Hf and Nd isotopes in hydrogenetic Fe-Mn crusts: Nd isotopes provide information on local ambient seawater, Hf isotopes on the origin and fate of colloidal Fe oxide particles. Combined with evidence from Fe isotopes this suggests that although significant input of truly dissolved hydrothermal Hf into seawater is usually small, the dissolved (i.e., truly dissolved plus colloidal) Hf budget of seawater is strongly affected by hydrothermal Hf.