

Mg isotope ratios of chlorophylls of marine phytoplankton species

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Magnesium has three stable isotopes (²⁴Mg, ²⁵Mg and ²⁶Mg) and is essential for chlorophylls in all photoautotrophs. The chlorophyll concentrations of marine phytoplankton in seawater are controlled by nutrients, light intensity, temperature or species of phytoplankton. The magnesium isotope ratios in chlorophylls of marine phytoplankton may be affected by these parameters (temperature, species of phytoplankton or nutrient conditions) but it is not clear.

We developed an analytical scheme of magnesium isotope ratio measurements for chlorophylls of marine phytoplankton samples. All phytopigments were extracted from phytoplankton samples with 90% acetone and a small portion from the extracted sample was measured with an analytical column by HPCL to determine the phytopigment composition. After that, each chlorophyll pigment of residue was separated and purified with a preparative column by HPLC. Each chlorophyll was extracted into the organic phase from each eluent fraction by using ether and Milli-Q water to remove sea salts which affect magnesium isotope measurements (Galy *et al.*, 2001). The organic phase was evaporated to dryness and decomposed with H₂O₂, and finally pure magnesium solution in 2% HNO₃ was obtained. The magnesium isotope ratios of ²⁵Mg/²⁴Mg ($\delta^{25}\text{Mg}$) and ²⁶Mg/²⁴Mg ($\delta^{26}\text{Mg}$) were measured relative to NIST SRM 980 by the standard-sample bracketing method using a MC-ICP-MS, IsoProbe (Micromass, UK) via a microflow nebuliser. The $\delta^{26}\text{Mg}$ values were 0.00±0.04‰ (n=36, NIST SRM980) and 3.60±0.07‰ (n=26, WAKO standard solution). Large differences in $\delta^{26}\text{Mg}$ values were found for commercially available chlorophylls (WAKO and Sigma) between different plant species and between chlorophylls a and b.

By applying this method, the magnesium isotope ratios of cultured phytoplankton species (*Emiliania huxleyi* and *Gephyrocapsa oceanica*) at different temperatures of logarithm and stationary stages, and marine phytoplankton samples collected from the eutrophic northern and oligotrophic southern oceans around Japan were determined. These data will be discussed in relation to temperature, growth stage, species dependency, or nutrient conditions.

Reference

Galy *et al.*, (2001), *Int. J. Mass Spectrom.* **208**, 89-98.

Spatial and temporal relationships between hydrothermal alteration assemblages at the Palinpinon geothermal field, Philippines

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Hydrothermal alteration at Palinpinon geothermal field, associated with the Nasuji pluton, includes K-silicate (biotite, magnetite), calc-silicate (garnet, clinopyroxene), hypogene advanced argillic (zunyite, alunite), propylitic (tremolite-actinolite, epidote), illite (smectite, illite) and steam-heated advanced argillic (amorphous silica, kaolinite) assemblages. Quartz veins (K-silicate alteration) formed from magmatic-hydrothermal fluids (267° to >600°C, 26 to 56 eq.wt.% NaCl, <0.2 wt.% Cu). Radiogenic dating implies a genetic link between intrusion emplacement (Nasuji pluton: ⁴⁰Ar/³⁹Ar=0.7-0.3 Ma) and alteration assemblages (biotite: ⁴⁰Ar/³⁹Ar=0.7-0.6 Ma; alunite: K-Ar=0.9-0.8 Ma). Calc-silicate, biotite and propylitic alteration zones have developed above a 'blind' intrusion (>2.5 km depth), east of the Nasuji pluton. Parts of the biotite and propylitic alteration zones are in thermal equilibrium with the present geothermal system. The lack of hypogene advanced argillic alteration in this area is interpreted to indicate that magma degassing has been hindered or prevented, possibly due to high lithostatic confining pressures. At <2 km, illite and steam-heated advanced argillic alteration assemblages are in thermal equilibrium with the present geothermal system. The intimate spatial and temporal relationships between intrusion emplacement and alteration at Palinpinon are characteristic of mineral deposits such as, porphyry, skarn, high and low sulfidation epithermal. At Palinpinon a coupled porphyry-high sulfidation epithermal alteration system formed at 0.9-0.8 Ma, with a coupled porphyry-low sulfidation epithermal system forming today; demonstrating that these alteration systems can form simultaneously in a single mineral district. However, assays (<0.02 wt.% Cu, <0.03 wt.% Pb, <0.01 wt.% Zn, <0.01 wt.% Mo, <8 g/t Ag, <0.05 g/t Au) show that the alteration zones at Palinpinon are barren. This could be due to an insufficient supply of metals in the magmatic-hydrothermal fluids, or a lack of fracture permeability, resulting in an inadequate focus for high volume fluid flux.