4.1.24

The magnesium isotopic composition of oceanic water masses

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Quantifying the isotope budget of magnesium is an important step in understanding the evolution of ocean chemistry. Past work supports an oceanic residence time on the order of ~11 Ma. This relatively long residence time implies that different water masses should have a constant [Mg] and a common isotopic composition, yet a recent study has found evidence for [Mg] variations in seawater and concluded that low temperature hydrothermal activity influences the oceanic Mg cycle [1].

Using seawater Mg isotope data, we present evidence for a well-mixed ocean with respect to Mg and conclude that spatial variations in seawater [Mg] are unlikely. 14 seawater samples from the Atlantic, Pacific and Indian Oceans and the Mediterranean, Red and Dead Seas were investigated. We find the magnesium isotope composition of seawater to be constant, with a δ^{26}Mg = -0.82 (+/- 0.10) ‰ relative to the DSM3 standard. This value is consistent with previous reports of the Mg isotopic composition of seawater [2, 3]

We also document the Mg-isotope signature of samples proximal to low-temperature hydrothermal plumes, and find that these plumes do not exert a strong control on oceanic [Mg]. Previous work has identified Mg-depleted, Ca-enriched low-temperature hydrothermal plumes [1]. We measured samples from depth transects including a number of samples from areas proximal to the TAG hydrothermal field that contain the trace-metal signature of hydrothermal activity. We observe no variation in the Mg isotope composition with depth, and find the Mg isotopic value of these samples to be identical to ocean water. These findings either strengthen previous concern [4] about Mg-depleted hydrothermal plumes [1] or imply that no isotopic fractionation of Mg occurs during its consumption by the weathering of the oceanic crust.

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4.1.31

Validity of obducted umbers as a recorder of Os isotopic composition of ancient seawater

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The secular change of Os isotopic composition of Cenozoic seawater has been well reconstructed by the Os isotopes of submarine metalliferous sediments. The umbers exposed on land have been used as a potential recorder of Os isotopic composition of pre-Cenozoic seawater [1]. The Cyprus umbers are considered to record the ^{187}Os/^{188}Os ratio of ~90 Ma seawater, based on the compositional similarities to modern hydrothermal plume fall-out materials [1]. In order to check the validity of obducted umbers as a recorder of marine Os isotopes, however, the direct comparison between uplifted umbers and seafloor metalliferous sediments of the same depositional age is truly needed.

The Mineoka umbers overlying ~52.8 Ma MORB-type greenstones occur in the Cenozoic accretionary complex in Japan. Major, trace and rare earth element chemistry of the Mineoka umbers is indistinguishable from that of the East Pacific Rise plume particulates and metalliferous sediments [2, 3], indicating that the Mineoka umbers preserve primary geochemical signatures at the time of precipitation. The Mineoka umbers are characterized by enrichment of Os and depletion of Re relative to upper continental crust. Their ^{187}Os/^{188}Os ratios vary from 0.456 to 0.549, exhibiting a relatively wide range which may be due to the longer duration of the Mineoka umber deposition than the residence time of Os in seawater. The ^{187}Os/^{188}Os ratio of ~53 Ma submarine metalliferous sediment has been estimated as 0.484 [4], which agree well with that of the Mineoka umbers. Our present measurements assure that umbers uplifted onto land can be used as a recorder of Os isotopic composition of ancient seawater.

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