Mg isotope fractionation during hydrothermal ultramafic rock alteration – Implications for the global Mg-cycle

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Riverine and ocean waters are enriched in ^{24}Mg compared to the homogenous chondritic Mg isotopic composition of the Earth's mantle [1] requiring a fractionation step that is generally attributed to continental crust weathering [2,3]. Here we present new observations indicating that this enrichment may originate from Mg isotope fractionation during the hydrothermal alteration of primary silicates. Hydrothermally altered ultramafic rock samples were collected from three different localities in Norway. Coexisting olivine and serpentine exhibit invariant Mg isotope ratios suggesting that serpentinization does not fractionate Mg isotopes. In contrast, carbonation results in significant inter-mineral Mg isotope fractionation between antigorite, magnesite, and talc. The carbonation of constrained by O isotope thermometry at ~275 ˚C [4] and closes the temperature gap between previous investigations of the natural distribution of Mg isotopes during weathering and magmatic processes. The precursor antigorite has $\delta^{26}Mg$ (DSM3)=-0.11±0.05‰, whereas the talc is enriched in ^{26}Mg with mean $\delta^{26}Mg$=0.17±0.08‰ and the magnesite is depleted in ^{26}Mg with mean $\delta^{26}Mg$=-0.95±0.15‰. Our data suggest that hydrothermal ocean floor alteration may result in the formation of a ^{24}Mg enriched sink. Fast dissolution of carbonate minerals during chemical weathering of altered ultramafic and mafic rocks on the continents will yield isotopically lighter Mg to continental runoff.

[1] Teng *et al* (2007) *EPSL* **26**, 84-92 [2] Tipper *et al* (2006) *EPSL* **247**, 267-279 [3] Wimpenny *et al* (2010) *GCA* **74**, 5259-5279 [4] Beinlich *et al* (2012) *Terra Nova* **24**, 446-455