Magnesium isotope fractionation during epigenetic dolomitization of carbonate rocks

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Dolomites were important Mg sinks in the Phanerozoic cycle of carbonate rocks either as early diagenetic or epigenetic products. Determining the Mg isotope fractionation during both dolomitization types may provide an important input for models reconstructing the evolution of brines and the secular variations in the global marine δ^{26}Mg record. Here we present a study on the fractionation of Mg isotopes during epigenetic dolomitization of carbonate country rocks by interaction with marine derived hypersaline brines.

We measured the δ^{26}Mg of natural Mg-depleted deep brines from Northern Negev, Israel, and discordant dolostones from the Dead Sea Rift Valley margins. These brines, which belong to the much studied Dead Sea Rift Valley brines, evolved through evaporation of seawater in the Sedom Lagoon during the Neogene and consequently percolated to the subsurface, dolomitizing the Cretaceous limestones through which they flowed. While some of these brines were flushed back to the Dead Sea Rift valley to form the Dead Sea and its precursors, the rest of the brines remained trapped at great depths. The discordant dolostones in the vicinity of Dead Sea Rift valley are the product of this epigenetic dolomitization.

The results show that the deep brines are enriched in ^{26}Mg ($-0.6‰<\delta^{26}Mg<0‰$) relative to present-day seawater ($\delta^{26}Mg=-0.83‰$) and most probably also to that of Pliocene seawater from which they evolved, given the long residence time of Mg in the oceans. This observation is compatible with the depleted isotopic composition of the discordant dolostones ($\delta^{26}Mg\approx-2‰$). Given these isotopic compositions, and based on the remaining fraction of Mg in the brines, which was found to be ~0.3, we calculated the fractionation factor during dolomitization ($\Delta^{26}Mg_{dolomite\text{-}brine}$) to be between -0.7‰ and -0.4‰. These values are lower than previously published fractionation factors and may result from the high temperatures under which this dolomitization took place.