Mg Isotope Variation of Dolomitization of Limestone: A Case study of the Carbonate Profile of Middle Triassic Age, South Eastern China

WENXUAN HU, WEIQIANG LI, ZHONGYA HU, XIAOMIN WANG

School of Earth Sciences and Engineering, Nanjing University, 163, Xianlin Ave., China. huwx@nju.edu.cn

Magnesium isotopes are an emerging tool to study the geological processes recorded in carbonates. However, the fidelity of Mg isotopes in geological records of carbonate minerals (e.g., calcite and dolomite) against burial metamorphism remains poorly constrained. Additionally, magnesium as one of the most important elements in dolomite, Mg isotope ratios may provide specific information on the fluid–rock interaction. Here we report our investigation on the Mg isotope systematics of a dolomitized Middle Triassic Geshan carbonate section in eastern China, complemented by analyses of Sr-C-O isotopic compositions, major and trace element concentrations, and petrographic and mineralogical features.

Multiple lines of evidence consistently indicated that post-depositional diagenesis of carbonate minerals occurred to the carbonate rocks, and $\delta^{26}Mg$ values of carbonates increased significantly with the increase of Mg content during the dolomitization. Magnesium isotope compositions of the carbonate rocks closely follow a mixing trend between a high $\delta^{26}Mg$ dolomite end member and a low $\delta^{26}Mg$ calcite end member, irrespective of sample positions in the section and calcite/dolomite ratio in the samples. By fitting of the measured Mg isotope data using a two-end member mixing model, an inter-mineral $\Delta^{26}Mg_{dolomite\text{-}calcite}$ fractionation of 0.72‰ was obtained. Based on the experimentally derived Mg isotope fractionation factors for dolomite and calcite, a temperature of 150-190ºC was calculated to correspond to the 0.72‰ $\Delta^{26}Mg_{dolomite\text{-}calcite}$ fractionation.

Our results indicate that both calcite and dolomite had been re-equilibrated during burial metamorphism, and based on isotope mass balance, the system was buffered by dolomite in the section. Therefore, burial metamorphism may reset Mg isotope signature of calcite, and Mg isotope compositions in calcite should be dealt with caution in studies of carbonate rocks with thermal history. By contrast, Mg isotopes of dolomite are less prone to post-depositional resetting due to a number of properties including high Mg abundance and high thermodynamic stability, and Mg isotopes in dolomite may be a more robust recorder for original carbonate precipitates.

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