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Magnesium isotopic composition of the deep continental crust

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Abstract

To constrain the behavior of Mg isotopes during deep crustal processes and the Mg isotopic composition of the middle and lower continental crust, 30 composite samples from high-grade metamorphic terranes and 18 granulite xenoliths were investigated. The composites derive from eight different high-grade metamorphic terranes in the two largest Archean cratons of China, including 13 TTG gneisses, 5 amphibolites, 4 felsic, 4 intermediate, and 4 mafic granulites. They have variable bulk compositions with SiO_2 ranging from 45.7 to 72.5%, representative of the middle crust beneath eastern China. The $\delta^{26}Mg$ values of these samples vary from –0.40 to +0.12‰, reflecting heterogeneity of their protoliths, which could involve upper crustal sediments. The granulite xenoliths from the Cenozoic Hannuoba basalts also have a diversity of compositions with MgO ranging from 2.95 to 20.2%. These xenoliths equilibrated under high temperatures of 800–950 ºC, corresponding to depths of the lower continental crust (>30 km). They yield a large $\delta^{26}Mg$ variation of –0.76 to –0.24‰. The light Mg isotopic compositions likely result from interactions with isotopically light metamorphic fluids, probably carbonate fluids. Together with previously reported data, the average $\delta^{26}Mg$ values of the middle and lower continental crusts are estimated to be –0.21 ±0.07‰ and –0.26 ±0.06‰, respectively. The bulk continental crust is estimated to have an average $\delta^{26}Mg$ of –0.24 ±0.07‰, which is similar to the average of the mantle. The large Mg isotopic variation in the continental crust reflects the combination of several processes, such as continental weathering, involvement of supracrustal materials in the deep crust, and fluid metasomatism.

Keywords: Magnesium isotope, deep continental crust, high-grade metamorphic terrane, granulite xenolith, Invited Centennial article