

## Highlights and Breakthroughs

### The deep continental crust has a larger Mg isotopic variation than previously thought

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**Abstract:** Magnesium isotope compositions of the bulk continental crust is a key to understand Mg isotope behaviors during crustal processes, and is the prerequisite to study mantle-crust material exchange/reaction by Mg isotopes. However, thus far, little is known about Mg isotopic compositions of the middle and lower continental crust. In the article by Yang et al. in this issue entitled “Magnesium isotopic composition of the deep continental crust”, the authors present high precision Mg isotopic analyses of high-grade metamorphic terrane samples and granulite xenoliths from China, which represent the middle and lower continental crust, respectively. Large Mg isotopic variation is observed in the deep continental crust, reflecting the combination of several processes, such as continental weathering, involvement of supracrustal materials, and fluid metasomatism. In addition, this article also provides an average Mg isotope composition of the bulk continental crust, which is crucial to future applications of Mg isotopes.

**Keywords:** magnesium isotope, deep continental crust, high-grade metamorphic terrane, granulite xenolith

It is well known that the variation of Mg isotope compositions is limited during high-temperature geological processes (Teng et al., 2007; 2010a; Handler et al., 2009; Yang et al., 2009; Bourdon et al., 2010; Dauphas et al., 2010; Li et al., 2010; Liu et al., 2010; Pogge von Strandmann et al., 2011; Xiao et al., 2013), but is quite large during low-temperature processes (Pogge von Strandmann et al., 2008; Teng et al., 2010b; Tipper et al., 2010; Huang et al., 2012; Liu et al., 2014). Just like other fluid-mobile elements, Mg displays a highly variable and remarkably discrepant isotope composition in the upper continental crust (Shen et al., 2009; Li et al., 2010; Liu et al., 2010; Huang et al., 2013) and the hydrosphere (Tipper et al., 2006; Foster et al., 2010; Ling et al., 2011) when compared with the relatively homogeneous mantle ( $\delta^{26}\text{Mg} = -0.25 \pm 0.07\text{‰}$ , Teng et al., 2010a). The main processes responsible for such large isotopic variation are continental weathering and/or carbonate deposition that occurred among sedimentary systems/upper continental crust and hydrosphere (Pogge von Strandmann et al., 2008; Teng et al., 2010b; Tipper et al., 2010; Huang et al., 2012; Liu et al., 2014). During continental weathering, light Mg isotopes favor the hydrosphere to weathered residue, whereas during carbonate deposition, light Mg isotopes prefer carbonate minerals to the hydrosphere.

The distinct Mg isotopic behaviors during these different processes provide the potential to use Mg isotopes to study mantle-crust material exchange/reaction. Although Mg isotope compositions of most reservoirs have been well studied, the continental crust, especially of the lower crust, remains poorly constrained. Teng et al. (2013) reported Mg isotopic data for some lower crustal xenoliths, but this study didn't involve any middle crustal samples. Furthermore, whether or not such a large Mg isotopic variation represents a global signature of the lower crust or just is a local arbitrary case, needs further investigation.

Yang et al. (2015) provides inseparable continuity to obtain new data to better understand the Mg isotope compositions of the middle and lower crust. In this study, they chose a series of typical middle and lower crustal rocks from eastern China, did careful analyses and calculations, and placed strong constraints to understand the isotope compositions of the middle and lower crust. They found large Mg isotopic variations ( $\delta^{26}\text{Mg} = -0.76$  to

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+0.12‰) in both the middle and lower crustal rocks, which may reflect the combination of several processes, such as continental weathering, involvement of supracrustal materials, and fluid metasomatism. This study thus confirms the deep crust is indeed globally heterogeneous in terms of Mg isotopes.

It is surprising that the deep continental crust beneath eastern China displays such a large Mg isotopic variation, which was previously considered to be homogeneous because granites derived from this region have a small Mg isotopic variation ( $\delta^{26}\text{Mg} = -0.35$  to  $-0.14\%$ ) (Li et al., 2010; Liu et al., 2010). Therefore, the new results are very helpful in understanding the deep crustal processes, suggesting that partial melting and granite differentiation may homogenize Mg isotope composition of the deep crustal source rocks, and erase the detailed information of the deep continental crust.

Yang et al. (2015) also provided an average Mg isotope composition of the bulk continental crust. Although there are large Mg isotopic variations in both the middle and lower crust, the bulk continental crust as indicated by Yang et al. (2015) remains a mantle-like Mg isotopic composition ( $\delta^{26}\text{Mg} = -0.24 \pm 0.07\%$ ).

To summarize, Yang et al. (2015) present a new dataset of Mg isotope compositions of the deep continental crust, which reveal a larger variation than previously indicated by granites. This study is very helpful in understanding the Mg isotopic behavior during deep crustal processes, and constraints average Mg isotope composition of the bulk continental crust.

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