Earth Science

Abnormal Lithium Isotope Composition from Ancient Lithospheric Mantle

Lithium has proven to be an important geochemical tracer for fluid-related processes on the Earth's surface as well as crust-mantle recycling because of its moderate incompatibility during mantle melting, strong fluid mobility, and the large mass fractionation, with up to 80‰ variation of $^{7}Li/^{6}Li$ in terrestrial samples. The Li isotopic heterogeneity in the mantle caused by fluid/melt-rock interaction can be rehomogenized over geologically short time periods due to the fast diffusion of Li, and thus the mantle is broadly characterized by homogeneous Li isotope composition. However, several studies have suggested the existence of abnormal $\delta^{7}Li$ in the mantle, such as high $\delta^{7}Li$ (up to +7.9) of HIMU lavas and low $\delta^{7}Li$ (lower than -7.0) of mantle-derived minerals and lavas, which are considered to have resulted from isotope fractionation during the dehydration of subducted oceanic crust. To date, the data on abnormal $\delta^{7}Li$ are mainly recorded from indirect samples of the mantle or directly on clinopyroxene separates in peridotites, although the latter are susceptible to recent diffusive fractionation of Li isotopes during the entrainment and transportation of the xenoliths by host magma due to the much faster diffusion of Li in pyroxene than in olivine. In contrast, the Li isotope compositions in the cores of large olivine grains from peridotite xenoliths, which represent direct samples of the upper mantle, provide more robust signature of the lithospheric mantle.

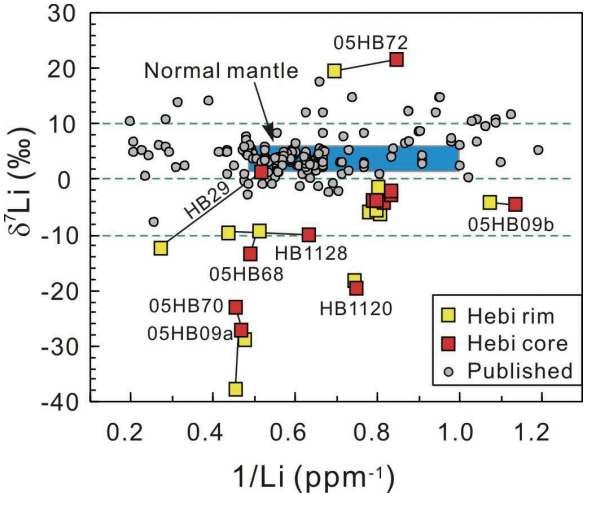

Figure 1: Variation of $\delta^{7}Li$ with Li abundances of olivines in the Hebi xenoliths compared to the published data for olivines from worldwide peridotites. The field for normal mantle is based on the compositions of relatively pristine olivines and fresh MORB.

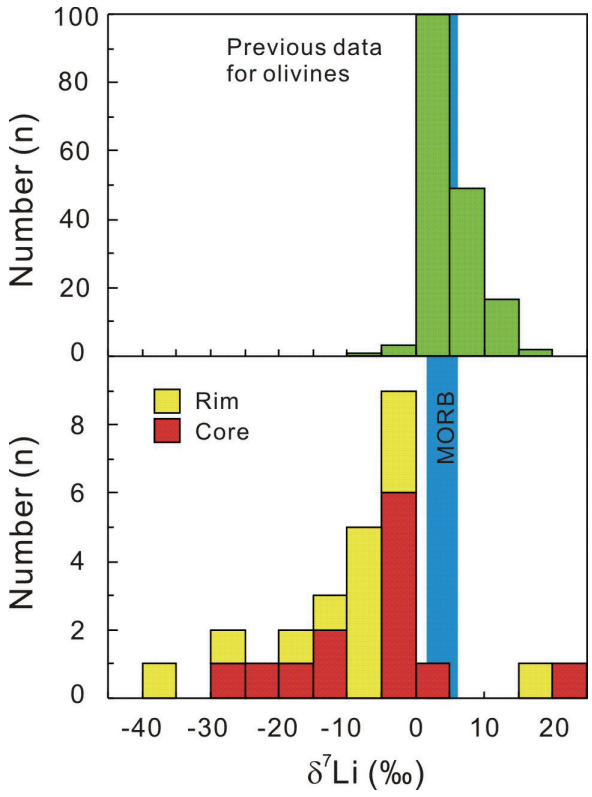

Figure 2: Histograms of $\delta^{7}Li$ for olivines in the Hebi xenoliths and those from worldwide peridotites.

In their study, TANG and colleagues at the CAS Institute of Geology and Geophysics reported the anomalous Li isotope compositions of olivines in a suite

of peridotite xenoliths from the Hebi locality in the central North China Craton, one of the world's oldest continental nuclei. The δ^7Li in the cores of olivines from the Hebi high-Mg# peridotites (Fo>91) show an extreme variation from -27 to +21, in a marked deviation from the δ^7Li range of fresh MORB although the Li abundances of the olivines are within the range of normal mantle (1-2 ppm). The Li abundances and δ^7Li characteristics of the Hebi olivines could not have been produced by recent diffusive-driven isotopic fractionation of Li and therefore the δ^7Li in the cores of these olivines might have recorded the isotopic signature of the subcontinental lithospheric mantle. These data demonstrate that abnormal δ^7Li may be preserved in the ancient lithospheric mantle as observed in this study, which suggests that the subcontinental lithospheric mantle has experienced modifications of fluid/melt derived from recycled oceanic crust.

The above results were published by *Scientific Reports*, an open access publication from the publishers of *Nature*. (Tang *et al*. Abnormal lithium isotope composition from the ancient lithospheric mantle beneath the North China Craton. *Scientific Reports*, 2014, 4: 4274. Doi: 10.1038/srep04274).