Uniform silicon isotopes in the depleted mantle and no melt-induced fractionation

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The degree of homogeneity and potential for Si isotopic fractionation in the mantle have been unclear. Intuitively, it seems unlikely that such a large reservoir of silicon would be affected by isotopic heterogeneity introduced by recycling. Nevertheless, if certain seismic reflectors in the deep mantle represent subducted banded iron formations [1] and such reservoirs have significantly fractionated δ^{30}Si [2], this leaves the question of whether subtle isotopic variability may trace such material.

Douthitt [3] gives a value of $\delta^{30}\text{Si} = -0.4 \pm 0.3‰$ for the mantle but the uncertainties are too large to resolve any small isotopic effects. A recent higher precision study revealed a scatter in the Si isotope data for mantle samples [4] with a range of values between $\delta^{30}\text{Si} = -0.51$ and -0.35‰ (2σ reproducibility = ± ~0.1‰). Our study was undertaken to investigate if this apparent variability within the depleted mantle is real and, if so, what it is related to.

We analysed seventeen samples of MORB using the method described in [5], utilising a Nu Plasma HR MC-ICP-MS. The samples, chosen for their freshness and background information, are from the Mid-Atlantic ridge, East Pacific Rise, Indian Ocean and Australian-Antarctic discontinuity. The data all fall between $\delta^{30}\text{Si} = -0.35$ and $-0.22 \pm 0.04‰$, defining a smaller range than previously observed [4]. There are no systematic differences between ocean basins, nor any relationship between δ^{30}Si and chemical composition (e.g. SiO_2, $(La/Sm)_n$) or other isotopes (e.g. Pb). The average global depleted mantle value is $\delta^{30}\text{Si} = -0.27 \pm 0.07‰$ (2 s.d.), slightly heavier than the value given in [4].

Further work on a number of well-characterised peridotites yield δ^{30}Si that is within error of the MORB values. Therefore, there is no evidence of isotopic fractionation during partial melting. However, preliminary data for arc basalts show more variation, suggesting that sub-arc processing affects the silicon isotope signature of the materials involved.

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The evolution of mantle sources of Mesozoic intra-plate volcanism in the Southern Mongolia: Implication from Sr-Nd-Pb isotopic and geochemical data

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We present a new geochemical and Sr-Nd-Pb isotopic data for Southern Mongolian intra-plate basalts.

The Lower Cretaceous (LC) basalts are depleted in Nb, Ta and Ti and are enriched in Pb relative to primitive mantle. Their Ce/Pb and Ti/(Yb*100) ratios are 3-16 and 28-79 respectively. In ε_{Nd} vs. ε_{Sr} space, the LC basalts form trend from PREMA-like mantle to EMII source. In $^{206}\text{Pb}/^{204}\text{Pb}$ vs. $^{207}\text{Pb}/^{204}\text{Pb}$ space, investigated basalts form trend toward field of sources with elevated U/Pb ratios.

In contrast, the Upper Cretaceous to Oligocene (UCO) basalts has OIB-like trace element distribution on the primitive-mantle-normalized diagram. The Ce/Pb and Ti/(Yb*100) are higher in these basalts (12-38 and 79-172 respectively) compared to with the LC basalts. Furthermore, in ε_{Nd} vs. ε_{Sr} space, the UCO basalts form trend from PREMA-like mantle to EMI source. In $^{206}\text{Pb}/^{204}\text{Pb}$ vs. $^{207}\text{Pb}/^{204}\text{Pb}$ space, the UCO basalts form array shifted to field of less-radiogenic Pb compared to LC basalts.

Thus, we conclude that source of the LC basalts correspond to ancient buried oceanic crust and terrigeneous material which were subducted at the active continental margin environment during Paleozoic period. Enriched source of the UCO basalts corresponds to buried ancient (Precambrian-aged) lower continental or oceanic crust. So the change of sources characteristics of intra-plate magmatism indicates the change of dynamic of mantle convection occurred at boundary of Lower and Upper Cretaceous.

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