Correspondences of helium isotope compositions between gabbros or abyssal peridotites with basalts: A view for heterogeneity inferred from the volcanics in uppermost mantle

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The heterogeneity of helium isotope compositions in uppermost mantle has been predicted from the extrusive volcanic facies, e.g. glassy chilled margin of basalts, or phenocrysts of the phylic basalts, in oceanic environment.

Correspondences of helium isotope compositions between gabbros or clinopyroxene separates from abyssal peridotites and near-site basalts has been reported [1, 2]. Even in the unusual area where basalts show low $^3He/^4He$ down to 6.3 Ra [3], clinopyroxene separates and a pyroxenite chunk also showed similar $^3He/^4He$: 6.2 or 6.3 Ra [4].

Here we report two supporting observations. A laser probe helium isotope measurement applied to a single olivine grain of 8.0mg in weight. It was separated from a highly olivine-phyric alkaline basalt dredged at 10°53.5'E in the Joseph Mayes segment of Southwest Indian Ridge. It also showed ~6Ra of $^3He/^4He$ under 10% contribution of blank correction. Thus, such low $^3He/^4He$ has been confirmed as a certain isotope signature reflecting mantle heterogeneity; it comes from the mantle source via magma chamber throughout the basaltic lava erupting in the area.

As another example, two aliquots of gabbro section of drill cores have also been selected. The drill core obtained in IODP Exp.304/305 on Atlantis Massif. The conventional step-heating method were applied them. They showed 8.2 and 8.8Ra of $^3He/^4He$, respectively, which is well within the range of $^3He/^4He$ variation of the ridge-axis samples.

[1] Kumagai *et al.* (2003a) *G-cubed* **4**, paper #9107, doi: 10.1029/2003GC000540. [2] Kumagai *et al.* (2003b) *Eos Trans. AGU* **84**(46) Fall Meet. Suppl., Abstract V11E-0540. [3] Georgen *et al.* (2003) *Earth Planet. Sci. Lett.* **206**, 509-520. [4] Kumagai *et al.* (2006) *Eos Trans. AGU* **87**(52) Fall Meet. Suppl., Abstract V23E-0692.

Interpreting $\Delta^{17}O$ of nitrate in ice cores at high accumulation sites

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Because atmospheric oxidants determine the lifetimes of reduced trace gases that act as greenhouse gases and pollutants, there has been great interest in deducing variability in oxidant concentrations from the ice core record. Ice core measurements of $\Delta^{17}O$ of nitrate ($\Delta^{17}O(NO_3^-)$)($\Delta^{17}O \approx \delta^{17}O - 0.52\times(\delta^{18}O)$) provide a means to diagnose paleoatmospheric changes in the oxidation chemistry of nitrate production, but cannot yet be used to quantify atmospheric oxidant concentrations.

We present advances in the interpretation of ice core $\Delta^{17}O(NO_3^-)$ at sites with high snow accumulation (~20 cm/yr water equivalent) by comparing measurements of $\Delta^{17}O(NO_3^-)$ from two snowpits at Summit, Greenland to calculations of an atmospheric chemical box model (see Figure; points represent measurements, solid line represents model results). Measured values of $\Delta^{17}O(NO_3^-)$ covering three seasonal cycles (Jan-Dec 2000, Jul 2003–Mar 2006) range from 22.4‰ in summertime to 33.7‰ in wintertime, while model results show a larger range (18.9-31.5‰). Agreement between observed and modeled results is excellent for winter, when O_3 oxidation of nitrogen oxides dominates nitrate production. The 2-7‰ discrepancy between summertime box model results and measurements of $\Delta^{17}O(NO_3^-)$ is best explained by transport of nitrate with higher $\Delta^{17}O(NO_3^-)$ from neighboring oceanic regions. This suggests that $\Delta^{17}O(NO_3^-)$ preserved in Greenland ice is representative of atmospheric chemistry on a regional scale and is not dominated by local oxidation chemistry or post-depositional processing.

We also present preliminary results of $\Delta^{17}O(NO_3^-)$ measurements from a 70 meter ice core from the West Antarctic Ice Sheet (WAIS). Because snow accumulation rates at WAIS are similar to those at Summit, similar processes are expected to control $\Delta^{17}O(NO_3^-)$ at these sites.