

The origin of fluid in mantle

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To reveal the volatile cycle between the Earth's surface and deep, I have tried to investigate the origin of fluids in mantle.

In the far eastern Siberia area, there are mantle-derived ultramafic xenoliths. Spectroscopical and petrographical observation suggest that there are at least two compositionally distinct fluids in these xenoliths. One consists predominantly of liquid CO₂. The other is melt inclusion involving blebs. To reveal the origin, I have analyzed noble gases in the fluid inclusions by applying a method of vacuum crushing for extraction of noble gases. I have revealed the occurrence of ³He/⁴He ratios extremely lower than those of MORB in olivine separates for some of subcontinental mantle-derived xenoliths from far eastern Siberia. While, MORB-like high ³He/⁴He ratios have also been observed for some samples in gases extracted by the crushing method. Hence, at least two kinds of fluid sources with the low ³He/⁴He ratio and the MORB-like value might exist in the upper mantle underneath the far eastern Siberia area. There is a point should be clarified whether the crushing method can extract gases included in the fluid inclusions.

I have tried to extract noble gases in fluid inclusions one-by-one by laser beam focused on a spot of approximately 20 microns in diameter using a Mitsutoyo x50 objective lens with long working distance (17.0 mm). For the experiment, I used mantle-derived olivine separates in alkali pillow basalts collected from the toe of the oceanward slope of the northern Japan Trench. Comparing the Ar isotopic compositions to those obtained by the crushing method, three kinds of fluid inclusions have different isotopic compositions from each other. Furthermore, the result of the crushing experiment can be explained by sum of gases from these inclusions. It is indicative of that noble gases extracted by the crushing method are mostly located in fluid inclusions of minerals.

Although the melt inclusions were observed throughout the mantle-derived xenoliths from far eastern Siberia, the inclusions of liquid CO₂ were rarely seen in the samples showing the low ³He/⁴He ratios. Therefore it is speculated that the inclusions of liquid CO₂ has a high ³He/⁴He ratio similar to that of MORB, and the component with the low ³He/⁴He ratio is derived from blebs in melt inclusions. Since the low ⁴⁰Ar/³⁶Ar ratios indicating occurrence of atmospheric component were observed irrespective of the occurrence of CO₂ inclusions, it is likely that the atmospheric component would exist in melt inclusions.

The far eastern Siberia area had been located at the subduction zone. The melt inclusion showing atmospheric property and significantly low ³He/⁴He ratio may have been derived from a component related to the old subducted slab. On the other hand, the ³He/⁴He ratios observed in the CO₂ inclusion are assumed to be similar to the MORB-like value, which might reflect more ubiquitous character of the upper mantle as a whole. Hence, the far eastern Siberian mantle with the initially MORB-like source might have been infiltrated by subduction-related fluids at least partly.

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