

Deep mantle origin of kimberlite magmas revealed by neon isotopes

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Kimberlites are well known as a carrier of diamonds. Based on pressure and temperature stability of diamonds in the Earth, kimberlite magma might be derived from a depth at least more than 150 km. However, we cannot identify the initial depth where a kimberlite magma is formed in spite of a number of studies. Noble gas isotopes have a potential to constrain the origin of kimberlite magmas because they show completely different values between the more primitive source (represented by OIBs) and the depleted source (MORBs). We report the first neon data indicating the deep mantle origin of kimberlites from Udachnaya-East pipe, eastern Siberia.

Noble gases in olivine separates from alteration-free kimberlites collected from the deep levels (~500 m) of Udachnaya-East pipe (e.g., [1]) were extracted by in vacuo sequential dynamic crushing. $^3\text{He}/^4\text{He}$ ratios decrease from 5.7 to 1.2 R_A with progress of crushing, indicating that the original $^3\text{He}/^4\text{He}$ ratio of the magma is similar to typical one of subcontinental lithospheric mantle (SCLM) and that in-situ produced ^4He after eruption of the pipe was released from olivine lattice and/or solid phase of inclusions, as olivine particle size is getting smaller with progress of crushing. Neon isotope ratios indicate less nucleogenic feature of the kimberlite magma than the MORB source. Based on He-Ne systematics, it is revealed that helium and neon in the Udachnaya kimberlite magma can be explained by a mixing between plume-like component, which would be the original characteristic of the source of kimberlite magma, and SCLM-like one, which would be acquired from the surrounding materials in the SCLM and/or crust during magma ascent. A rough correlation between $^{20}\text{Ne}/^{22}\text{Ne}$ and $^{40}\text{Ar}/^{36}\text{Ar}$ ratios constrain $^{40}\text{Ar}/^{36}\text{Ar}$ ratio of the magma to be less than 13000, suggesting less radiogenic feature of the source of kimberlite than the MORB source. Our results indicate that the source of the Udachnaya kimberlite have similar noble gas characteristics to those of OIBs, and constrain a depth of its origin to be deeper than the upper mantle.

References

[1] Kamenetsky, M.B., Sobolev, A.V., Kamenetsky, V.S., Maas, R., Danyushevsky, L.V., Thomas, R., Pokhilenko, N.P., and Sobolev, N.V. (2004) *Geology*, **32**, 845-848.