Geophysical Research Abstracts
Vol. 14, EGU2012-2234, 2012
EGU General Assembly 2012

Toward a general view of mantle peridotite beneath the volcanic front: petrology of peridotite xenoliths from Bezymyanny volcano (central Kamchatka)

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We have a large amount of data about petrological and geochemical features of upper mantle peridotites based on researches of mantle xenoliths, ophiolites or solid intrusions. But the nature of sub-arc mantle, especially beneath a volcanic front, has not been fully understood due to the scarcity of occurrences of mantle-derived materials there. Kamchatka Peninsula is one of the active volcanic arcs, having 29 active volcanoes, and 13 volcanoes of them contain cognate or mantle peridotite xenoliths (Erlich et al., 1979). Peridotite xenoliths derived from the upper mantle beneath the volcanic front are expected from 9 of them (Erlich et al., 1979). Avachinsky (Avacha) volcano is the most famous of them because of its easy accessibility and high xenolith production. Peridotite xenoliths from Avacha record high degree of melting and multiple stages of metasomatism (e.g., Ishimaru et al., 2007; Ionov, 2010). Formation of secondary orthopyroxenes replacing olivine is one of characteristics of arc-derived peridotite xenoliths (e.g., Arai & Kida, 2000; McInnes et al., 2001). In addition, we found peculiar metasomatisms, e.g., Ni enrichment (e.g., Ishimaru and Arai, 2008), in the Avacha peridotite xenolith suite. Here, we show petrological and geochemical features of ultramafic xenoliths from Bezymyanny volcano, central Kamchatka, to obtain a more generalized view of the sub-front mantle.

We examined 2 harzburgite xenoliths from Bezymyanny. They are composed of fine-grained minerals (cf. Arai and Kida, 2000), and occasionally contain hornblende and/or phlogopite. Almost all orthopyroxenes show irregular shapes and replace olivine, indicating a secondary origin. At the boundary between the harzburgite and host andesite, we observed hornblende and secondary orthopyroxenes. At the xenoliths' interior, Fo content of olivine and Cr# (= Cr/(Cr + Al) atomic ratio) of chromian spinel are high, 91-92 and 0.43-0.69, respectively, and the Fo content decreases to 76 at the boundary with the host andesite although the Cr# is almost constant. These features indicate the Bezymyanny harzburgites are residual mantle peridotite although modified by reaction with the host andesite. Mg# (= Mg/(Mg + Fe total) ratio) of orthopyroxene is almost the same as those of olivine (0.90-0.92). Calculated oxygen fugacity, at P = 1.5 GPa, is 1.5-3.0 log unit relative to FMQ-buffer. These geochemical features are consistent with the report by Shcherbakov and Plechov (2010). Orthopyroxenes do not show simple residual feature in REE pattern, and are LREE-enriched and MREE-depleted: chondrite-normalized La/Dy and Dy/Yb ratio is 1.1-9.1 and 0.1-0.3, respectively. Absence of Eu depletion in REE patterns denies the host andesite or its evolved melt as a metasomatic agent although orthopyroxenes in contact with the host andesite have Eu depletion. This means that these harzburgite were metasomatized by LREE-enriched and SiO_2-oversaturated melts or fluids at a mantle condition. We found fluid inclusions of CO_2 and CO_2-H_2O in primary olivines by Raman spectroscopy. Additional Raman spectroscopic observation yields geobarometric information of their derived depth and/or metasomatism.