Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SCG63-15 Room:104 Time:May 23 11:45-12:00

Sedimentary pore fluid-like halogens and noble gases in mantle peridotites from the Western-Pacific subduction zones

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Halogen and noble gas compositions can provide complementary information as tracers on origins and behaviors of H_2O in the mantle. This is because both groups of elements are strongly partitioned into fluids and have distinct elemental and/or isotopic compositions depending on their origins. Elementally fractionated atmospheric noble gases in the convecting mantle can be explained by subduction of seawater or sedimentary pore fluids [1]. A pioneer work suggests that halogens in a mantle wedge peridotite just above a subducting slab show a signature suggesting its origin involving sedimentary pore fluids [2]. Halogens and noble gases in pore fluids may be incorporated into serpentine minerals in oceanic plates, and then carried into the deeper mantle through the subduction [2,3]. Here, we present halogen and noble gas compositions of mantle peridotites from the Western-Pacific subduction zones to put a better constraint on how far the influence of subducted pore fluids extends in the mantle.

We apply the ”noble gas method” to samples, in which halogens (Cl, Br and I) and other elements (K, Ca, Se, Te, Ba and U) are converted to isotopes of Ar, Kr and Xe by neutron irradiation in a nuclear reactor [4]. This method has superior detection limits, two to five orders of magnitude lower than those by other methods, and can determine low halogen concentrations in mantle peridotites.

Samples studied in the present work are harzburgitic xenoliths from the Avacha volcano in Kamchatka, Russia and the Pinatubo volcano in the Philippines, and alpine-type peridotites from the Horoman massif in Hokkaido, Japan. H_2O-rich fluid inclusions have been described in minerals of those peridotites [5,6,7]. The Br/Cl and I/Cl values show heavy enrichments in I, suggesting a contribution of subducted fluids [2] to halogens in a mantle-like component [7] with various proportions, which have unique values in each locality. Slab-derived atmospheric noble gases are also dominated in these samples as previously reported [9,10].

The features of subducted halogens and noble gases in the mantle peridotites demonstrate that sedimentary pore fluids are carried beneath the island arcs through subduction and survive in the mantle wedge.

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Keywords: halogen, noble gas, peridotite, mantle, subduction zone, pore fluid