SGC51-06 Room:A04 Time:May 24 16:45-17:00

Across-arc variation in noble gas and halogen compositions of volcanic rocks from the Izu-Ogasawara subduction zone

SUMINO, Hirochika[1*] ; BURGESS, Ray[2] ; JEPSON, Lisa[2] ; CAVRIT, Deborah[2] ; SHIMIZU, Aya[4] ; MACHIDA, Shiki[3] ; BALLENTINE, Chris[5]

[1]GCRC, Grad. Sch. Sci., Univ. Tokyo, [2]SEAES, Univ. Manchester, [3]Sch. Creative Science and Engineering, Waseda Univ., [4]Tokyo Metropolitan Industrial Technology Research Institute, [5]Dept. Earth Sciences, Univ. Oxford

Recently, subducted halogens and noble gases with seawater and sedimentary pore-fluid signatures were discovered in exhumed mantle wedge peridotites and eclogites from the Sanbagawa-metamorphic belt, southwest Japan [1,2]. These findings along with seawater-derived heavy noble gases (Ar, Kr, and Xe) in the convecting mantle [3] provide observations that allow us to investigate the processes that control the return of volatile and highly incompatible elements into the mantle. Serpentinized lithosphere of subducting oceanic plates can transport noble gases and halogens acquired from pore water in the overlying sediment [1,2,4]. To verify whether and how such subduction fluids modify the composition of the mantle beneath subduction zones, we determined the noble gas and halogen compositions of olivines in arc lavas of the northern Izu-Ogasawara subduction zone and IODP sediments and basalts recovered from the northwestern margin of the Pacific plate. Trace amounts of halogens (Cl, Br, and I) in the olivine samples were measured by a combination of neutron irradiation and noble gas mass spectrometry [5].

The $^{3}He/^{4}He$ ratios of samples from the volcanic front (Izu-Oshima, Miyakejima, Mikurajima, Hachijojima, and Aogashima) and rear-arc (Niijima, Higashi-Izu monogenetic volcanoes, Nanzaki, and en-echelon seamount chains) regions are in the range of the mid-ocean ridge basalt (MORB) value, without systematic differences among the regions. This indicates a considerably low contribution to the mantle wedge beneath the arc of radiogenic ^{4}He in the subduction fluids observed in the Sanbagawa samples exhumed from a depth ranging from 30 to 100 km [1,2].

In contrast, the $^{40}Ar/^{36}Ar$ ratios for each volcano (299-620) are significantly lower than the MORB source (up to 32,000 [3]), indicating significant involvement of atmospheric Ar ($^{40}Ar/^{36}Ar$ = 296) in the magmas. Systematically higher $^{40}Ar/^{36}Ar$ ratios in the rear arc than in the volcanic front, and a comparison with those of subducting materials, suggest that subduction of seawater-derived Ar significantly affects the noble gas composition of the magma-generation region. A simple mass balance calculation of subducted and mantle-derived Ar isotopes reveals that higher subduction flux than that of seawater-derived Ar in the pore fluids in the subducting sediment/crust is required. The serpentinized lithosphere in the subducting slab is the best possible carrier of seawater-derived Ar with high subduction flux.

Although the halogen compositions of most of the olivines are close to that of MORB-source mantle, some samples from the en-echelon seamount chains show a significant contribution from pore-fluid-derived halogens. Combined with the noble gas results, halogen-poor fluid associated with atmospheric noble gases may be dominantly released from the subducting slab beneath the Izu-Ogasawara arc, while halogen-rich fluid significantly contributes to the magma generation region beneath some volcanoes in the rear arc.

It remains unclear whether noble gases and halogens in the subducting materials are completely released beneath the rear arc. However, the presence of seawater-like noble gases in the convecting mantle [3] implies that a small portion of seawater-dissolved atmospheric noble gases, carried in the serpentine, might be transported to greater depths in the deeper mantle.

[1] Sumino et al. (2010) Earth Planet. Sci. Lett. 294, 163-172. [2] Sumino et al. (2011) Mineral. Mag. 75, 1963. [3] Holland & Ballentine (2006) Nature 441, 186-191. [4] Kendrick et al. (2011) Nature Geosci. 4, 807-812. [5] Turner (1965) J. Geophys. Res. 70, 5433-5445.

Keywords: Noble gas, Halogen, Subduction zone, Izu-Ogasawara arc, Pore fluid