# Volatile element transport within a closed system constrained by halogens and noble gases in mantle wedge peridotites

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Halogen and noble gas systematics are powerful tracers of volatile recycling in subduction zones. The presence of noble gases and halogens with seawater and sedimentary pore-fluid signatures in exhumed mantle wedge peridotites and eclogites from the Sanbagawa-metamorphic belt, southwest Japan [1,2], and in seafloor and forearc serpentinites [3] along with seawater-like heavy noble gases (Ar, Kr, and Xe) in the convecting mantle [4] strongly suggest the subduction of sedimentary-pore-fluid-like noble gases and halogens.

In order to determine how volatiles are carried into the mantle wedge and how the subducted fluids modify halogen and noble gas compositions in the mantle, we analyzed halogen and noble gas compositions of mantle peridotites containing $H_2O$-rich fluid inclusions collected at volcanic fronts from two contrasting subduction zones (the Avacha volcano of Kamchatka arc and the Pinatubo volcano of Luzon arcs) and orogenic peridotites from a peridotite massif (the Horoman massif, Hokkaido, Japan) which represents an exhumed portion of the mantle wedge [5].

The halogen and noble gas signatures in the $H_2O$-rich fluids are similar to those of marine sedimentary pore fluids and forearc and seafloor serpentinites. This suggests that marine pore fluids in deep-sea sediments are carried by serpentine and supplied to the mantle wedge, preserving their original halogen and noble gas compositions.

On the other hand, the measured $Cl/H_2O$ and $^{36}Ar/H_2O$ in the peridotites are higher than those in sedimentary pore fluids and serpentine in oceanic plates. The halogen/noble gas/$H_2O$ systematics are interpreted within a model where water is incorporated into serpentine in a closed system formed along fracture zones developed at the outer rise, where oceanic plates bend prior to entering subduction zones,

 

preserving $Cl/H_2O$ and $^{36}Ar/H_2O$ values of sedimentary pore fluids. Dehydration–hydration process within the oceanic lithospheric mantle maintains the closed system until the final stage of serpentine dehydration. The sedimentary pore fluid-like halogen and noble gas signatures in fluids released at the final stage of serpentine dehydration are preserved due to highly channelized flow, whereas the original $Cl/H_2O$ and $^{36}Ar/H_2O$ ratios are fractionated by the higher incompatibility of halogens and noble gases in hydrous minerals. The fluids are supplied to the mantle wedge beneath volcanic fronts and trapped as fluid inclusions in mantle wedge peridotites.

Some studies have argued that the sources of trace elements and water are decoupled in subduction zone magmas and that the major source of water is serpentine. Halogen and noble gas signatures found in the peridotites investigated here reveal that serpentine supplies a significant amount of water to the mantle wedge beneath volcanic fronts, and that this water is not strongly decoupled from these two groups of elements. The seawater-like noble gases in the convecting mantle [4] can be also explained by deeper subduction and/or involvement of the noble gas signatures observed in this study, to the convecting mantle.

[1] Sumino *et al.* *EPSL* 2010. [2] Sumino *et al.* *Mineral. Mag.* 2011. [3] Kendrick *et al.* *Nature Geosci.* 2011. [4] Holland & Ballentine *Nature* 2006. [5] Kobayashi *et al.* *EPSL* 2017.

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