Spatial distribution of halogen compositions near the paleo slab-mantle wedge boundary, example from the Sanbagawa metamorphic belt

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The heavy halogens (Cl, Br, I) are highly soluble in fluids, and highly incompatible during partial melting of peridotite. Furthermore, in subduction zones their ratios, especially I/Cl ratios, vary over several orders of magnitude depending on the source (e.g. mantle, subducting slab, sediments, and sedimentary pore fluids), making them good tracers for fluid sources in subduction systems. To constrain how slab-derived fluids modify halogen compositions in the mantle wedge and how volatiles are cycled in subduction zones, we analyzed and observed the spatial distribution of halogen compositions across a paleo slab-wedge mantle boundary *(Kawahara et al, 2016)* in the Shiraga metaserpentinite body of the Sanbagawa belt.
To analyze halogens contained in rocks with low concentrations, samples were neutron irradiated at the Kyoto University Research Reactor to convert halogens (^{37}Cl, ^{79}Br and ^{127}I) into noble gas isotopes (^{38}Ar, ^{80}Kr,^{128}Xe), which have lower detection limit. The extraction (crushing and heating) and measurement were conducted by magnetic sector mass spectrometer at the University of Tokyo.
The halogen data of fluids derived from crush extraction (thought to be fluid inclusions) show relatively high I/Cl ratios with stable Br/Cl ratios. These features are distinct from the fluid of normal mantle and altered ocean crust but are similar with data for mantle wedge peridotites exhumed from ~100 km depth *(Sumino et al, 2010)*, which are considered to partially preserve the signals of sedimentary pore fluids.
In addition, for the crush extraction, the serpentinite body shows overall decreasing I/Cl ratios with increasing distance from the slab-wedge mantle boundary, and this trend is discontinuous at the boundary. The halogen data derived from heat extraction show a similar spatial distribution but with lower I/Cl ratios for all samples.
The high I/Cl values in the mantle wedge are not explicable by the adjacent slab data. Alternatively, it can be explained by progressive dilution of an original fluid with high I/Cl, as it was transported through the slab-wedge mantle interface, and penetrated upward into the mantle wedge, where it was mixed with mantle-derived fluid with low I/Cl. This model implies that the original fluid was derived from the deeper part of subduction zone rather than the immediately adjacent and structurally underlying sediment, which is in good agreement with some previous studies on dehydration processes and fluid flow in subduction zones.

Keywords: Subduction zone, Halogen, Sanbagawa metamorphic belt

