Importance of being salty: Salinity of fluid inclusions in subduction channels and mantle wedges

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High-pressure and high-temperature experiments suggest that saline fluids can effectively transport large-ion-lithophile elements such as Pb, Rb, and Sr (Kawamoto et al., 2014, Earth Planets and Space) and carbonate (Newton and Manning, 2002, Am Mineral). In order to understand chlorine and fluid-mobile elements recycling in subduction zones, we determine the salinity of natural fluid inclusions in mantle xenoliths and jadeitites from serpentine mélanges of Southwest Japan and Dominican Republic. The salinity of aqueous fluids in the mantle wedge seems to decrease from trench side to back-arc side: from 5.1 ± 1.0 wt% NaCl equivalent in harzburgite xenoliths of the Pinatubo, a frontal volcano of the Luzon arc, the Philippines, to 3.7 ± 0.8 wt% NaCl equivalent in lherzolite xenoliths of the Ichinomegeta, a rear-arc volcano of the Northeast Japan arc (Kawamoto et al., 2013, Proc Natl Acad Sci USA, Kumagai et al., 2014, Contrib Mineral Petrol). Abundances of chlorine and H_2O in olivine-hosted melt inclusions also suggest that frontal basalts have higher Cl/H_2O ratios than rear-arc basalts in the Guatemala arc (Walker et al., 2003, Contrib Mineral Petrol).

In addition to these data, fluid inclusions in quartz-free jadeitites contain aqueous fluids having 7 ± 0.3 wt% NaCl equivalent and those in quartz-bearing jadeitites contain aqueous fluids having 4.6 ± 1.2 wt% NaCl equivalent in supra-subduction zones in the Southwest Japan arc (Mori et al., 2015, International Eclogite Conference). Quartz-bearing jadeitites contain fluid inclusions of aqueous fluids having 4.3 ± 1.3 wt% NaCl equivalent in Rio San Juan Complex, Dominica Republic (Kawamoto et al., 2015, Goldschmidt Conference). These data indicate that aqueous fluids with higher salinity are found at shallower than the reaction of albite = jadeite + quartz occurring at 1.5 GPa, 500 °C. All of these salinity data in natural fluid inclusions have values similar to or slightly greater than the value of salinity of seawater (3.5 wt% NaCl equivalent) and show decreasing salinity from trench to back-arc side in the mantle wedge and subduction channels. This can suggest that aqueous fluids dehydrated from the subducting hydrous minerals “wash out” salt components during dehydration reactions due to the preference of halogen to fluids (Scambelluri, et al., 2004, Earth Planet Sci Lett, Bernini et al., 2013, Contrib Mineral Petrol, Debret et al., 2013, Terra Nova).