

Halogen Chemistry and Stable Cl Isotope Composition of Thermal Springs in the Cascade Arc

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The Cascade volcanic arc is located above a young (~6Ma) and slowly subducting (~4 cm/y) Juan de Fuca plate. Because of the high temperatures in the subduction slab, dehydration reactions are thought to occur at shallow depth to the west of the Cascade volcanic front. Spatial devolatilization trends may be observed at the surface by examining geochemical trends from along and across the volcanic front. We have measured the concentration of halogens (F, Cl, Br, I) and the stable Cl isotope compositions of thermal spring waters and primitive basalts along and across the Cascade arc in order to further quantify the extent of halogen cycling through the Cascadia subduction system.

Thermal springs from 35 localities, between north-central Washington to Lassen, Northern California with Cl concentrations ranging from 250 to 14,000 ppm (Bergfeld et al., 2008, Hurwitz et al., 2005) were analyzed for their Cl isotope composition. The $\delta^{37}\text{Cl}$ values range from -2.0 to +1.9 ‰ (n=35), and show no correlation with Cl concentrations and sample location along the arc. The majority of samples are characterized by slightly negative values, whereas only five have positive values (0.6‰, 0.8‰, 1.1‰, 1.2‰, 1.9‰). Given the upper mantle has a $\delta^{37}\text{Cl}$ value near 0‰, the variation in the Cl isotope data suggests either that the chloride isotope compositions of these spring waters were modified upon ascent to the surface by the interaction of underlying sediment and/or contain a subducted slab derived component.

Nine well characterized basalt samples from across the southern Washington Cascades, (Leeman et al., 2005) were analyzed for their bulk halogen concentrations and $\delta^{37}\text{Cl}$ value. $\delta^{37}\text{Cl}$ values range from -0.1‰ to 0.7‰ (n=7). Cl concentrations are highest at the volcanic front (140-157 ppm Mt. St. Helens and Mt. Adams) compared to the forearc (17-82 ppm) and in the backarc (19-65 ppm). Br shows a similar trend to Cl with the highest concentrations at the volcanic front (0.22-0.31 ppm) compared to the forearc (0.08-0.13 ppm) and in the backarc (<0.06 ppm). In contrast, F and I show decreasing concentrations from the forearc to the backarc. F concentrations are highest in the forearc (144-600 ppm) decreasing to 120-197 ppm at the volcanic front and 75-164 ppm in the backarc. Iodine concentrations are highest in the forearc (0.09 to 0.10 ppm) to <0.03 ppm in the volcanic front and backarc. Like F and I, B concentrations decrease steadily toward the backarc (Leeman et al., 2004).

Bergfeld et al., 2008, USGS Prof. Paper 1750, chap. 25, 523-542.

Hurwitz et al., 2005, EPSL., 235, 700-71.

Leeman et al., 2004, ChemGeol. 212, 101-124.

Leeman et al., 2005, JVGR. 140, 67-105.

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