Thermal implications of Pb isotope and volatile systematics in the western Aleutian arc

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Lead isotopes of arc magmas constrain mixing relationships between sediment and mantle components in subduction zones and may provide insight for the source of H_2O entering the arc source region [1]. Here, we investigate the relationship between Pb isotopes, volatiles, and thermal structure in the western Aleutians.

We measured H_2O contents of olivine-hosted melt inclusions using FTIR and Pb isotopes in their parent tephras using MC-ICP-MS for 5 volcanoes in the western Aleutians. All inclusions from one volcano, Semisopochnoi, were found to be degassed and are ommitted here. Our results show a negative correlation (R^2=0.91, p-value=0.05, n=4) between Pb isotopic ratios and maximum H_2O indicating mixing between two main sources: (1) a water-rich source of unradiogenic Pb and (2) a lower-water source with more radiogenic Pb. We interpret these sources to be a hydrated, altered MORB or serpentinized oceanic lithosphere component and a sediment component, respectively, with the former increasing westward from Tanaga. The Pb and H_2O systematics in this section of the arc may result from increased dehydration of sediments and altered oceanic crust beneath the forearc, in tandem with a progressive increase in H_2O derived from the serpentinized oceanic lithosphere entering the arc source region towards the west. The thermal implications of this model require the slab Moho in the far western Aleutians (Segula and west) to be at least 680ºC, where breakdown of serpentinite occurs (assuming 4GPa) [2]. At these temperatures, slab melting is likely to occur thus supporting the hypothesis that slab melting is involved in the formation of high-Mg andesites in the western Aleutians. [3,4,5]

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