Geochemical and Isotopic Evidence for Differentiation and Assimilation of in the Origin of Mount Rainier’s Calc-Alkaline Andesitic Suite


Introduction
Petrogenetic processes and sources have been difficult to infer in the Cascades because much of the arc is built atop relatively young mafic-to-intermediate crust similar chemically and isotopically to magmas arising from ongoing subduction. However, improvements in the precision of radiogenic and stable isotope measurements allow crustal contributions to be recognized and quantified for Mt. Rainier. A suite of ~50 basaltic andesites through dacites, and regional basement rocks, were analyzed for high-precision Sr, Nd, and Pb isotopes, and δ¹⁸O (plag or whole rock).

Results and Discussion
Results are simple: isotope-ratio pairs (Pb-Nd, -Sr, etc.) define arrays that overlap local subduction-zone basalts and extend toward isotopic compositions of Eocene Puget Group (PG) continentally-derived sandstones (see figure). Mt. Rainier sits atop a synclinorium of Oligocene and Miocene arc rocks underlain to the west and east by PG sediments. Projection of steep dips places the sandstones in the mid-lower crust beneath the volcano where assimilation probably takes place. Shallow Tertiary arc rocks (e.g., Miocene Tatoosh pluton) are slightly isotopically and need not be major contributors to the magmatic system. Isotopic results also rule out contributions from Mesozoic rocks exposed to the east. A third source is signaled by rare low-K Mt. Rainier eruptives that isotopically and chemically resemble magmas of Mt. St. Helens, 80 km SSW. Geophysical surveys show that Mt. St. Helens straddles the boundary between the Paleocene-Eocene Siletzia seamount province (W) and probable Cretaceous-Paleogene basement (E). The buried terrane boundary passes ~15 km west of Mt. Rainier, and the low-K source might be deep Siletzia basement.

Amounts of PG sediment assimilation range from zero to possibly 25% in Mt. Rainier magmas but are only weakly correlated with differentiation. Instead, parental basalts and basaltic andesites mainly evolve by crystal fractionation, but they also assimilate readily fused deep sediments by irregular, generally low, amounts. In contrast, sediment assimilation is absent at Mt. Adams (Jicha et al., 2009), 75 km SSE, because it sits atop an anticlinorium where sediments have either been eroded away entirely or are at high crustal levels where they are too cold to be assimilated readily.

Conclusions
High precision isotope studies allow identification of the exact crustal rocks that were assimilated by the more mafic basalts that are feeding the Mt. Rainier volcano. The magma chamber beneath the volcano is most likely housed in the PG sandstones that were assimilated. This would place the magma chamber at mid crustal levels at approximately 20 km deep.