

Petrogenesis of the South Sister, OR cone building eruptions

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We conducted a petrologic study on two andesites (56-59 wt% SiO₂) and seven dacites (61-65.3 wt% SiO₂) to understand the conditions that gave rise to the pulse of intermediate volcanism that constructed the South Sister stratovolcano in light of the recent (~20y) crustal deformation adjacent to the volcano. All samples erupted from the main edifice, except for two dacites that erupted in the peripheral field within ~5kya of the cone building event. The andesites and dacites range in crystallinity ($\leq 15\%$ and $\leq 5\%$, respectively), and all are multiply saturated in six mineral phases (plg + cpx + opx + ilm + tmt + ap). No hydrous phases were observed. We incorporated Fe-Ti oxide compositions into a geo-thermometer [1] to derive pre-eruptive temperatures ($910 \pm 12^\circ\text{C}$ to $981 \pm 24^\circ\text{C}$) and oxygen fugacities ($\Delta\text{NNO}-0.1$ to $+0.4$) for all samples. Application of a hygrometer [2] to plagioclase (~An₃₅₋₇₀) in these samples yields maximum pre-eruptive H₂O contents of 3.0-4.8 wt%. Orthopyroxene spans a range in composition (~En₅₀₋₇₀) despite relatively low modal abundances ($\leq 3\%$). Comparison of experimentally [3] documented effects of H₂O on Fe-MgK_D values for opx-melt with natural opx compositions also supports crystallization at low H₂O contents (≤ 3.5 wt%). Major, trace and REE analyses do not support mixing of magmatic end-members as an essential component for the South Sister intermediate melts, but they do suggest that the intermediate melts segregated from a crystalline residue containing: ol + opx/cpx + plag + hbl. The phenocryst assemblage suggests that crystallization occurred at low H₂O contents in the shallow crust ($\leq 1.5\text{kb}$), at temperatures above hornblende stability. Because sample geochemistry (i.e., Dy*) requires hornblende to be present in the source of the intermediate magmas, we infer that the magmatic source of the intermediate melts is deeper than the depth of phenocryst crystallization. Comparison of major element patterns with experiments show that the South Sister geochemistry can be produced from a mafic source at depths as shallow as ~2kb (~6km), given H₂O-saturated conditions.

[1] Ghiorso and Evans (2008) *AJS* **308**, 957-1039. [2] Waters and Lange (2015) *AmMin* **100**, 2172-2184. [3] Waters and Lange (2017) *CMP* **172**.