Changes in andesite-dacite genesis over the 3-Myr lifespan of the Goat Rocks volcanic complex, central Cascade arc

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At the Goat Rocks volcanic complex in the central Cascade arc, ~3 million years of andesite-dacite magmatism exemplify the temporal variability of eruptive products at arc volcanoes, and provide a perspective for evaluating arc-wide variation and evolution. For example, while distinct compositions at nearby Mounts Adams and St. Helens might be interpreted to reflect spatially-restricted magmatic sources or crustal components, both Adams and St. Helens-like compositions were produced by the Goat Rocks system at different times.

Active between ~3 Ma and 115 ka, Goat Rocks was for much of its lifespan the main eruptive center on the arc north of Mount Hood, preceding and overlapping the onset of Mounts Rainier, Adams, and St. Helens. Based on mapping, $^{40}Ar/^{39}Ar$ ages of lava flows, and U-Pb ages of zircons, we divide the volcanic history of Goat Rocks into four stages. Here we focus on the youngest two, the Lake Creek stage (LC, 1.1 Ma to 600 ka) and Old Snowy Mountain stage (OSM, 440 to 115 ka), which record a major compositional shift. Bulk compositions from OSM stage are dominantly med-K andesite (more St. Helens or Rainier-like) and distinct from the med- to high-K andesites and dacites (more Adams-like) that erupted during LC stage. With respect to trace elements, the two suites commonly exhibit opposite differentiation trends; for example, Y increases and Dy/Yb decreases with increasing silica during LC stage, while the opposite is true for OSM stage magmas. Amphibole thermobarometry indicates hotter, deeper crystallization of amphibole within OSM stage magmas, compared to cooler, shallower amphibole crystallization at the end of the LC stage. In general, we infer that hotter, more hydrous magma rejuvenated the system at the onset of OSM stage. In detail, lava flows from flank vents of OSM stage, like the Goat Ridge volcano (~440 ka), exhibit differences from the main compositional suite such as higher P_2O_5 concentrations and La/Yb or Dy/Yb ratios at a given silica content—making them more LC-like in character. This suggests that in early OSM stage, new magmas were assimilating cumulate material or stalled magmas from the Lake Creek system; but by ~200 ka, focused magmatism had diluted the compositional influence of older intrusions.

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