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# Attaining high-resolution eruptive histories for active arc volcanoes with argon geochronology

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Geochronology of active arc volcanoes commonly illuminates eruptive behavior over tens to hundreds of thousands of years, lengthy periods of repose punctuated by short eruptive episodes, and spatial and compositional changes with time. Despite the >1 Gyr half-life of $^{40}$K, argon geochronology is an exceptional tool for characterizing Pleistocene to Holocene eruptive histories and for placing constraints on models of eruptive behavior. Reliable $^{40}$Ar/$^{39}$Ar ages of calc-alkaline arc rocks with rigorously derived errors small enough ($\pm$ 500 to 3,000 years) to constrain eruptive histories are attainable using careful procedures. Sample selection and analytical work in concert with geologic mapping and stratigraphic studies are essential for determining reliable eruptive histories. Preparation, irradiation and spectrometric techniques have all been optimized to produce reliable, high-precision results.

Examples of Cascade and Alaska/Aleutian eruptive histories illustrating duration of activity from single centers, eruptive episodicity, and spatial and compositional changes with time will be presented:

(1) Mt. Shasta, the largest Cascade stratovolcano, has a 700,000-year history (Calvert and Christiansen, 2011 *Fall AGU*). A similar sized and composition volcano (Rainbow Mountain) on the Cascade axis was active 1200-950 ka. The eruptive center then jumped west 15 km to the south flank of the present Mt. Shasta and produced a stratovolcano from 700-450 ka likely rivaling today's Mt. Shasta. The NW portion of that edifice failed in an enormous (>30 km$^3$) debris avalanche. Vents near today's active summit erupted 300-135 ka, then 60-15 ka. A voluminous, but short-lived eruptive sequence occurred at 11 ka, including a summit explosion producing a subplinian plume, followed by >60 km$^3$ andesite-dacite Shastina domes and flows, then by the flank dacite Black Butte dome. Holocene domes and flows subsequently rebuilt the summit and flowed to the north and east.

(2) Mt. Veniaminof on the Alaska Peninsula is a $\sim$350 km$^3$ tholeiitic arc volcano with basalt early in its history ($\sim$250 ka) and basaltic andesite to dacite currently. Chemical variation is due principally to crystallization differentiation with little or no evidence for crustal contamination. The smooth increase with time of Veniaminof's most silicic products chronicles the development of an intrusive complex, also reflected in granitoid blocks expelled during Holocene explosive eruptions (Bacon et al., 2007 *Geology*).

(3) The Three Sisters in the central Oregon Cascades are a cluster of small volcanoes with remarkable chemical diversity (basalt to high silica rhyolite) that mainly erupted in a short interval between 40-15 ka. This eruptive interval was unusual in its chemical diversity beginning bimodal (basaltic andesite and rhyolite), progressing to dacite then andesite, and back to basaltic andesite. Over eighty percent of mapped units are dated, enabling time-series displays of the chemical and spatial evolution of the volcanic field (Calvert et al., *2010 Fall AGU*).