Pushing the limits of $^{40}Ar/^{39}Ar$ precision: Constraining the eruptive history of the La Garita Caldera

LEAH E. MORGAN[1], MICHAEL A. COSCA[1], AMY GILMER[1], SAMUEL A. JOHNSTONE[1], REN THOMPSON[1]

[1]U.S. Geological Survey, Denver, CO 80225, USA

Recent advances in $^{40}Ar/^{39}Ar$ geochronology have yielded significant improvements in precision and accuracy. Here, we assess the analytical precision and geological implications of a major eruptive center by $^{40}Ar/^{39}Ar$ experiments that avoid internal uncertainties on J (measure of neturon fluence during irradiation) by only comparing sample ages relative to others within the same annular position of an irradiation disc during a single irradiation.

We use the rotation capabilities of the U.S. Geological Survey TRIGA reactor to avoid uncertainties in the J value inherent in the $^{40}Ar/^{39}Ar$ method. This reactor rotates sample canisters about a vertical axis at 1 rpm, theoretically smoothing out any horizontal flux gradients, which is confirmed by remarkably consistent and precise single-crystal standard data from fixed annular positions of an irradiation disc. The placement of all unknowns of interest within this same annular position removes the typical requirement that J value uncertainties be incorporated in age uncertainties and thus allows us to compare relative ages within this position with higher precision. Ages and uncertainties reported here are thus applied only with respect to other samples in the same annular irradiation position.

We assess the likelihood of age differences between samples and units with a Bayesian, Markov Chain Monte Carlo method. Unlike standard null-hypothesis significance testing, the Bayesian approach allows for the direct assessment of the likelihood of age differences, is less sensitive to outliers, and does not require normality.

We apply the neutron fluence gradient minimization and Bayesian approach to sanidines from three mapped eruptive units of the ca. 28 Ma La Garita Caldera in the Central San Juan Mountains of Colorado: Pagosa Peak Dacite (ca. 200 km^3); Fish Canyon Tuff, (ca. 5,000 km^3); and Nutras Creek Dacite, (<1 km^3). This approach allows us to differentiate timescales on the order of 20 ka between the ages of these closely-spaced eruptions and establish a ca. 50 ka timescale of pre-collapse activity in the La Garita Caldera system.