



First-principles calibration of $^{40}\text{Ar}/^{39}\text{Ar}$ mineral standards and complete extraction of $^{40}\text{Ar}^*$ from sanidine

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$^{40}\text{Ar}/^{39}\text{Ar}$ geochronology relies on comparing argon isotopic data for unknowns to those for knowns. Mineral standards used as neutron fluence monitors must be dated by the K-Ar method (or at least referenced to a mineral of known K-Ar age). The commonly used age of 28.02 ± 0.28 Ma for the Fish Canyon sanidine (FCs) (Renne et al., 1998) is based upon measurements of radiogenic ^{40}Ar in GA1550 biotite (McDougall and Roksandic, 1974), but underlying full data were not published (these measurements were never intended for use as an international standard), so uncertainties are difficult to assess. Recent developments by Kuiper et al. (2008) and Renne et al. (2010) are limited by their reliance on the accuracy of other systems. Modern technology should allow for more precise and accurate calibration of primary K-Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ standards. From the ideal gas law, the number of moles of ^{40}Ar in a system can be calculated from measurements of pressure, volume, and temperature. Thus we have designed and are proceeding to build a pipette system to introduce well-determined amounts of ^{40}Ar into noble gas extraction lines and mass spectrometers. This system relies on components with calibrations traceable to international standards, including a diaphragm pressure gauge (MKS Instruments), thermocouples, and a “slug” of an accurately determined volume to be inserted into the reservoir for volume determinations of the reservoir and pipette. The system will be renewable, with a lifetime of ca. 1 month for gas in the reservoir, and portable, to permit interlaboratory calibrations. The quantitative extraction of $^{40}\text{Ar}^*$ from the mineral standard is of highest importance; for sanidine standards this is complicated by high melt viscosity during heating. Experiments adding basaltic “zero age glass” (ZAG) to decrease melt viscosity are underway. This has previously been explored by McDowell (1983) with a resistance furnace, but has not been quantitatively addressed with laser heating. The sensitivity of each participating mass spectrometer will be calibrated by the bracketing standards approach, alternating measurements of pipette gas and mineral standards. This will convert relative abundances into absolute molar quantities and allow for quantification of interlaboratory systematic bias. Uncertainty propagation indicates uncertainties of the molar quantity of ^{40}Ar in mineral standards will be $< 0.25\%$ (2σ), a considerable improvement of one component of the uncertainties involved in $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology.

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