**40Ar/39Ar Analytical Background**

The separates were treated with 1) 5% hydrochloric acid for 10 minutes in an ultrasonic bath and rinsed with distilled water, and 2) 5% hydrofluoric acid for 10 minutes, rinsed with distilled water, cleaned with distilled water for 4 minutes using an ultrasonic stick, and dried overnight in a 50°C oven. ~15-27 mg of the unknown samples were loaded into appropriately sized holes in 20 mm diameter 99.999% aluminium disks, which were stacked and bolted together, and then sealed within a 99.9% Al canister to make up the irradiation package. Grains of Taylor Creek sanidine (TCR-2) age standard (27.87 ± 0.04 Ma, 1σ error; M.A. Lanphere, pers. comm., calibrated to SB–3 biotite (Lanphere and Dalrymple, 2000)) were regularly interspersed in the aluminium disks with the unknown samples to monitor the fast neutron gradient.

The irradiation packages were irradiated with fast neutrons in the Cadmium-Lined In-Core Irradiation Tube (CLICIT) reactor core position at the Oregon State University nuclear reactor, Corvallis, USA. All the plagioclase samples were doubly irradiated, initially for 4 hours (Can #43), followed by re-irradiation for 1 hour (Can #45). Double irradiation of the samples was necessary due to a series of laser and mass spectrometer breakdowns, plus reconstruction work in the GEOMAR laboratory in 2017, which resulted in > 6 months elapsing since irradiation of the Can #42 Ca-bearing samples, thus allowing the majority of the 37ArCa to decay away. The larger errors associated with the J values reflects the combined J values of two TCR-2 age standards from the Cans #43 and #45 irradiations, and the J values and 1σ errors for each sample are noted in Supplementary Files 3-1 to 3-4. All the basaltic groundmass samples were single irradiated for 4 hours (Can #47).

Upon return of the irradiation canister, single age standard grains and unknown sample separates were loaded into variously sized holes aluminium laser palettes. A laser palette and glass coverslips were loaded into an ultra-high vacuum 4.5” laser chamber fitted with a Kovar viewport that was baked at 230°C, and the whole extraction line was baked in an oven at 195°C for 8 hours, and then pumped for 2 days to remove adsorbed atmospheric argon from the samples and chamber walls.

A 25 W Coherent Sabre 25TSM argon ion laser (λ = 455-515 nm) argon ion laser, with a computer-controlled isel X-Y stage, was used to incrementally heat the unknown samples or totally fuse the age standard single grains for 45 seconds, with a 0.25-1.0 mm diameter laser beam. The laser system was fitted with a binocular microscope and light source for sample illumination and X-Y stage calibration, and a camera for video recording of the laser heating of each sample.

The gases released by laser heating were cleaned for a total of 3 minutes using an automatically-refilling liquid nitrogen Dewar attached to a glass finger, and two SAES AP10 getter pumps (one at 400°C and one at room temperature) to remove all active gases. The remaining noble gases were equilibrated into a high sensitivity Mass Analyser Products (MAP) 216 mass spectrometer with a mass resolution of 236, fitted with a Bauer-Signer-type source, operated at an emission current of 240 uA, with a Becton Dickinson MM-1 Mesh electron multiplier, and a mass spectrometer sensitivity of 2.718 x 10-10 cm3/V (1.211 x 10-14 moles/V).

The five Ar isotopes (36Ar to 40Ar) and 6 baselines (masses 35.5 to 40.5) were measured over for blanks, age standards, air and unknown samples were measured via peak-hoping using the single electron multiplier. The extraction line to mass spectrometer equilibration time was 30 seconds, which was followed by peak centring routine(s) that took 15-22 seconds. The 11 cycles of raw intensity data was extrapolated back to *time-zero* (i.e., when the inlet valve between the extraction line and the mass spectrometer opened). The fully automated laser heating, X-Y stage movement, automated valves operation, and data acquisition were computer controlled using a Turbo Pascal program. System blank Ar isotope measurements were obtained during the unknown sample analyses, after every 5 unknown analyses, and are shown in the Supplementary Files.

Unknown analyses were corrected for (1) peak tails from adjoining Ar peaks, (2) baselines, (3) blanks, (4) mass spectrometer discrimination using a power law mass discrimination factor of 1.0098 ± 0.21% (1σ) per atomic mass unit, measured from air pipette shots and modern glasses, and nuclear interference correction factors (listed in Supplementary Files 3-1 to 3-4) obtained from Renne et al. (2013; 2015). Errors are quoted at 1σ and 2σ levels, and the 40Ar/39Ar ages were calculated using the 40K decay constants, 40K/K ratio, and 40Ar/36Ar atmospheric ratio of Steiger and Jäger (1977). Other decay constants used include 39Ar = 2.941 x 10-7 hours (± 0.558% 1σ; Stoenner et al., 1965), 37Ar = 8.262 x 10-4 hours (± 0.229% 1σ; Renne and Norman, 2001), and 36Cl = 2.257 x 10-6 years (± 0.65% 1σ; Renne et al., 2008). The ingrowth of 36Ar from the decay of 36Cl was corrected using the 36Cl/38Cl production ratio of 262.8 ± 1.7 (1σ; Renne et al., 2008).

The corrections and age determinations, and plateau and inverse isochron plots were all made using the *ArArCALC* Excel macro program (v. 2.5.2) developed by Koppers (2002). Plateau ages were determined using the criteria of Lanphere and Dalrymple (1978), where the plateau is comprised of at least 3 consecutive heating steps that are within 2σ errors of each other, and where a significant proportion of the 39Ar release (> 50%) is represented in the plateau steps. 36Ar/37Ar alteration index (AI) values were used as a guide to gauge the alteration/freshness of a sample, and were calculated for the plagioclase and basaltic groundmass samples using the criteria of Baksi (2007), with a cut-off value of 36Ar/37Ar AI < 0.00006 for plagioclase, and 36Ar/39Ar AI < 0.0006 for groundmass.

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