

Appendix 1. Summary of $^{40}\text{Ar}/^{39}\text{Ar}$ results and analytical methods

Sample	Lab #	Irradiation	mineral	age analysis	steps/analyses	Age	$\pm 2\sigma$	MSWD	comments
J54E	57455	212	groundmass concentrate	bulk step-heat	3	4.43	0.17	0.83	weighted mean
GTM-260805-djk	57183	208	groundmass concentrate	bulk step-heat	4	4.50	0.07	0.56	weighted mean
J54B	57452	212	groundmass concentrate	bulk step-heat	8	4.82	0.20	1.86	weighted mean
J54C	57457	212	groundmass concentrate	bulk step-heat	9	5.54	0.38	1.06	weighted mean

Sample preparation and irradiation:

Minerals separated with standard heavy liquid, Franz Magnetic and hand-picking techniques.

NM-208 irradiated for 7 hours at the Nuclear Science Center reactor at Texas A&M university.

NM-212 irradiated for 10 hours in the C.T. position at USGS TRIGA, Denver Colorado.

Neutron flux monitor Fish Canyon Tuff sanidine (FC-2). Assigned age = 28.201 Ma (Kuiper et al., 2008).

Instrumentation:

Analyses performed on a Mass Analyzer Products 215-50 mass spectrometer on line with automated all-metal extraction system.

J54E, J54B, and J54C were step-heated using a Mo double-vacuum resistance furnace. GTM-260805-djk was step heated using a defocused CO_2 laser.

Flux monitors fused by a 50 watt Synrad CO_2 laser.

Analytical parameters:

Electron multiplier averaged $4.58\text{e-}17$ moles/pA for laser analyses for irradiation NM-208.

Electron multiplier sensitivity averaged $1.00\text{e-}16$ moles/pA for furnace analyses for irradiation NM-212.

Typical system blank and background was 126.3, 38.3, 1.19, 1.91, 0.84×10^{-18} moles at masses 40, 39, 38, 37 and 36, respectively for the laser analyses.

Typical system blank and background was 2874.0, 1.47, 0.53, 1.29, 7.1×10^{-18} moles at masses 40, 39, 38, 37 and 36, respectively for the furnace analyses.

J-factors determined by CO_2 laser-fusion of 6 single crystals from each of 8 radial positions around the irradiation tray.

Decay constants and isotopic abundances after Min et al., (2000).

Correction factors for interfering nuclear reactions were determined using K-glass and CaF_2 and are as follows:

NM-208 $(^{40}\text{Ar}/^{39}\text{Ar})_{\text{K}} = 0.0 \pm 0.0004$; $(^{36}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.00028 \pm 0.00002$; and $(^{39}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.00068 \pm 0.00005$.

NM-212 $(^{40}\text{Ar}/^{39}\text{Ar})_{\text{K}} = 0.01 \pm 0.002$; $(^{36}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.00028 \pm 0.00002$; and $(^{39}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.0007 \pm 0.00002$.

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