$^{40}Ar/^{39}Ar$ Geochronology Results from the Black Mountains and Iron Mountain, Arizona

By

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Introduction

One basalt sample was submitted for dating by Sue Beard of the USGS. The basalt (B14-087) is a sample of the lowest basalt flow at Iron Mountain, south of the mouth of the Grand Canyon.

$^{40}Ar/^{39}Ar$ Analytical Methods and Results

The groundmass concentrate prepared with dilute HCl treatment, removal of phenocrysts using a franz magnetic separator and/or hand picking. The groundmass concentrates and monitors (Fish Canyon tuff sanidine, 28.201 Ma, Kuiper et al., 2008) were loaded into aluminum discs and irradiated for 16 hours at the USGS TRIGA reactor in Denver Colorado.

The samples were step-heated with a Photon Machines Diode laser and analyzed with a Thermo Argus VI mass spectrometer. Abbreviated analytical methods for the dated samples are given in Table 1. The age results are summarized in Table 1 and the argon isotopic data are given in Table 2.

Sample B14-087 yielded a disturbed age spectrum but this sample yielded a hump-shaped age spectrum with initially increasing and then decreasing apparent ages (15.14±0.14 Ma to 18.32±0.01 Ma and back down to 17.87±0.13 Ma) correlating with a rise and fall in radiogenic yield and K/Ca values (27.8% to 97.1% back to 67% radiogenic and 0.31 to 0.50 to 0.4) . We have not assigned a weighted mean age to the age spectra as there is not a concordant portion. The data was evaluated with the inverse isochron technique and was found to be non-isochronous. The integrated age for this sample is 18.00±0.02 Ma.

Discussion

The hump-backed shape of the age spectrum for B14-087 is strongly suggestive of ^{39}Ar recoil. In samples suspected of having undergone recoil, the integrated age is assigned as our best estimate of the samples age. We have therefore, assigned 18.00 ±0.02 Ma as preferred age for this sample but caution that our confidence in this age is not as high as that for the other two samples.

References Cited

Kuiper, K. F., Deino, A., Hilgen, F. J., Krijgsman, W., Renne, P. R., and Wijbrans, J. R., 2008, Synchronizing rock clocks of earth history: Science, v. 320, p. 500-504.

Min, K., Mundil, R., Renne, P. L., and Ludwig, K.R., 2000, A test for systematic errors in $^{40}Ar/^{39}Ar$ geochronology through comparison with U/Pb analysis of a 1.1-Ga rhyolite: Geochimica et Cosmochimica Acta, v. 64, p. 73-98.

Taylor, J.R., 1982. An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements,. Univ. Sci. Books, Mill Valley, Calif., 270 p.

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

Sample	Lab #	Irradiation	Rock Type	mineral	age analysis	steps/analyses	Age	±2σ	MSWD	comment
B14-087	63754	277	basalt	groundmass concentrate	laser step-heat	11	18.00	0.02	-	integrated age

Sample preparation and irradiation:
Minerals separated with standard heavy liquid, Franz Magnetic and hand-picking techniques.
Samples in NM-277 irradiated in a machined Aluminum tray for 16 hours in C.T. position, USGS TRIGA, Denver, Colorado.
Neutron flux monitor Fish Canyon Tuff sanidine (FC-2). Assigned age = 28.201 Ma (Kuiper et al., 2008).

Instrumentation:
Total fusion monitor analyses performed on a Argus VI mass spectrometer on line with automated all-metal extraction system. System = Jan
Step-heat analyses performed on a Argus VI mass spectrometer on line with automated all-metal extraction system. System = Obama
Multi-collector configuration: 40Ar-H1, 39Ar-Ax, 38Ar-L1, 37Ar-L2, 36Ar-CDD
Flux monitors fused with a Photon Machines Inc. CO_2 laser. Groundmass concentrate step-heated with a Photon Machine Inc. Diode laser.

Analytical parameters:
Sensitivity for the Argus VI with the Diode laser (step-heated samples) is 9.84e-17 moles/fA.
Sensitivty for the Argus VI with the CO2 laser (fused monitors)is 4.62 e-17 moles/fA.
Typical system blank and background was 44.7, 0.25, 0.89, 0.66, 0.17 x 10^{-18} moles at masses 40, 39, 38, 37 and 36, respectively for the laser analyses.
J-factors determined by CO_2 laser-fusion of 6 single crystals from each of 13 radial positions around the irradiation tray.
Decay constants and isotopic abundances after Minn et al., (2000).

Table 2. $^{40}Ar/^{39}Ar$ analytical data.

	ID	Power (Watts)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)
	B14-087, gm, 9.97 mg, J=0.0037187±0.02%, IC=1.0315±0.0017, NM-277B, Lab#=63754-01										
X	A	1	8.051	1.046	19.95	1.728	0.49	27.8	1.4	15.14	0.14
X	B	1	3.330	1.625	3.269	6.85	0.31	74.9	7.0	16.87	0.03
X	C	1	2.874	1.526	0.9722	21.7	0.33	94.3	24.6	18.32	0.01
X	D	2	2.782	1.168	0.5940	19.40	0.44	97.1	40.4	18.25	0.01
X	E	2	2.769	1.054	0.5601	17.55	0.48	97.1	54.6	18.17	0.01
X	F	2	2.801	1.025	0.6952	13.88	0.50	95.6	65.9	18.10	0.01
X	G	3	2.945	1.096	1.251	18.46	0.47	90.4	80.9	18.00	0.01
X	H	5	3.565	5.755	4.755	16.33	0.089	73.6	94.2	17.80	0.03
X	I	7	3.911	11.70	7.550	5.13	0.044	67.0	98.3	17.87	0.05
X	J	10	3.845	5.520	5.562	1.368	0.092	68.8	99.4	17.95	0.08
X	K	15	3.825	4.815	5.337	0.683	0.11	68.9	100.0	17.87	0.13
	Integrated age ± 2σ		**n=11**			**123.1**	**0.22**		**K2O=1.28**	**18.00**	**0.02**

Notes:

Isotopic ratios corrected for blank, radioactive decay, and mass discrimination, not corrected for interfering reactions.
Errors quoted for individual analyses include analytical error only, without interfering reaction or J uncertainties.
Integrated age calculated by summing isotopic measurements of all steps.
Integrated age error calculated by quadratically combining errors of isotopic measurements of all steps.
Plateau age is inverse-variance-weighted mean of selected steps.
Plateau age error is inverse-variance-weighted mean error (Taylor, 1982) times root MSWD where MSWD>1.
Plateau error is weighted error of Taylor (1982).
Decay constants and isotopic abundances after Minn et al., (2000).
symbol preceding sample ID denotes analyses excluded from plateau age calculations.
Weight percent K_2O calculated from ^{39}Ar signal, sample weight, and instrument sensitivity.
Ages calculated relative to FC-2 Fish Canyon Tuff sanidine interlaboratory standard at 28.201 Ma
Decay Constant (LambdaK (total)) = 5.463e-10/a
Correction factors:
$(^{39}Ar/^{37}Ar)_{Ca}$ = 0.0007064 ± 4e-06
$(^{36}Ar/^{37}Ar)_{Ca}$ = 0.0002731 ± 0
$(^{38}Ar/^{39}Ar)_K$ = 0.01261
$(^{40}Ar/^{39}Ar)_K$ = 0.00808 ± 0.00041

B14-087 Groundmass Concentrate