

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

Sample	Lab #	Irradiation	Rock Type	mineral	age analysis	N	Age	$\pm 1\sigma$ MSWD
LM-43-djk	63713	276	grey clast from gravel	sanidine	laser fusion	10	28.76	0.03 11.5
LM-43-djk	63715	276	red clast from gravel	sanidine	laser fusion	16	28.96	0.02 19.7
BR-345-djk	63718	276	red clast from gravel	sanidine	laser fusion	13	29.00	0.03 16.0
LM-40-djk	63720	276	red clast from gravel	sanidine	laser fusion	14	29.06	0.03 45.1

#### Sample preparation and irradiation:

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

Samples in NM-276 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

Multi-collector configuration: 40Ar-H1, 39Ar-Ax, 38Ar-L1, 37Ar-L2, 36Ar-CDD

Flux monitors and unknowns fused with a Photon Machines Inc. CO<sub>2</sub> laser.

#### Analytical parameters:

Sensitivity for the Argus VI with the CO<sub>2</sub> laser 5 e-17 moles/fA.

Typical system blank and background was 35, 0.7, 0.2, 1.0, and 0.13 x 10<sup>18</sup> moles at masses 40, 39, 38, 37 and 36, respectively.

J-factors determined by CO<sub>2</sub> laser-fusion of 6 single crystals from each of 13 radial positions around the irradiation tray.

Decay constant (5.463e-10 /a) after Min et al. (2000).

Argon isotopic data.

ID	Power (watts)	<sup>40</sup> Ar/ <sup>39</sup> Ar	<sup>37</sup> Ar/ <sup>39</sup> Ar	<sup>36</sup> Ar/ <sup>39</sup> Ar (x 10 <sup>-3</sup> )	<sup>39</sup> Ar <sub>K</sub> (x 10 <sup>-15</sup> mol)	K/Ca	<sup>40</sup> Ar* (%)	Age (Ma)	±1σ (Ma)
<b>LM-43-djk grey</b> , sanidine, J=0.0038592±0.03%, IC=1.039051±0.0042157, NM-276J, Lab#=63713, Argus VI									
11	3	5.882	0.0083	6.136	3.619	61.2	69.1	28.471	0.063
13	3	6.012	0.0078	6.484	2.441	65.6	68.1	28.656	0.071
08	3	5.973	0.0072	6.349	3.098	70.7	68.6	28.661	0.067
12	3	4.648	0.0100	1.862	3.926	51.0	88.2	28.668	0.026
14	3	4.286	0.0098	0.6199	2.792	52.0	95.7	28.707	0.018
02	3	4.770	0.0100	2.247	4.443	50.9	86.1	28.726	0.029
05	3	4.294	0.0051	0.6158	2.675	100.8	95.8	28.767	0.019
01	3	4.284	0.0050	0.5810	3.151	101.5	96.0	28.769	0.017
03	3	5.095	0.0167	3.324	2.389	30.5	80.7	28.777	0.044
04	3	4.516	0.0090	1.304	5.213	56.6	91.5	28.897	0.019
<b>Mean age ± 1σ</b>			n=10	MSWD=11.51		64.1 ±22.3		28.760	0.028
<b>LM-43-djk red clast</b> , sanidine, J=0.0038571±0.03%, IC=1.039051±0.0042157, NM-276J, Lab#=63715, Argus VI									
x 18	3	4.544	0.1774	1.620	1.233	2.9	89.8	28.542	0.040
04	3	4.240	0.0225	0.3816	8.502	22.7	97.4	28.865	0.008
19	3	5.726	0.0356	5.411	2.889	14.3	72.1	28.889	0.061
12	3	4.349	0.0240	0.7269	7.257	21.2	95.1	28.919	0.016
09	3	4.310	0.0180	0.5901	2.400	28.3	96.0	28.920	0.021
13	3	4.293	0.0357	0.5321	3.867	14.3	96.4	28.936	0.015
08	3	4.215	0.0243	0.2582	4.429	21.0	98.2	28.949	0.013
10	3	4.342	0.0307	0.6845	2.085	16.6	95.4	28.960	0.023
11	3	4.322	0.0240	0.6142	4.299	21.3	95.8	28.963	0.015
14	3	4.346	0.0350	0.6936	2.328	14.6	95.3	28.973	0.020
05	3	4.364	0.0276	0.7428	1.003	18.5	95.0	28.990	0.039
15	3	4.222	0.0227	0.2591	4.887	22.5	98.2	28.995	0.011
02	3	4.233	0.0228	0.2881	7.260	22.4	98.0	29.010	0.011
03	3	4.245	0.0407	0.3315	3.183	12.5	97.8	29.015	0.014
17	3	6.631	0.0496	8.411	3.409	10.3	62.5	29.025	0.084
01	3	4.251	0.0400	0.3357	7.181	12.7	97.7	29.046	0.010
06	3	4.804	0.0480	2.154	1.958	10.6	86.8	29.162	0.036
x 16	3	11.15	0.0230	19.63	0.179	22.2	47.9	37.35	0.35
<b>Mean age ± 1σ</b>			n=16	MSWD=19.67		17.7 ±5.2		28.962	0.019
<b>LM-40-djk</b> , sanidine, J=0.0038426±0.02%, IC=1.039051±0.0042157, NM-276J, Lab#=63720, Argus VI									
11	3	4.327	0.0258	0.5944	1.398	19.8	96.0	28.927	0.028
06	3	4.311	0.0290	0.5415	2.300	17.6	96.3	28.931	0.019
01	3	4.806	0.0416	2.219	4.491	12.3	86.4	28.934	0.028
05	3	4.406	0.0282	0.8548	2.642	18.1	94.3	28.947	0.022
09	3	4.308	0.1012	0.5364	1.491	5.0	96.5	28.957	0.025
14	3	4.405	0.0659	0.8496	2.950	7.7	94.4	28.971	0.020
07	3	4.320	0.0361	0.5413	3.355	14.1	96.4	28.997	0.015
08	3	4.354	0.0295	0.6529	5.339	17.3	95.6	29.000	0.013
10	3	4.269	0.0225	0.3433	1.983	22.7	97.7	29.041	0.020
13	3	4.189	0.0233	0.0720	8.327	21.9	99.5	29.043	0.006
15	3	4.401	0.0270	0.7866	1.023	18.9	94.8	29.047	0.037
12	3	5.184	0.0455	3.441	0.796	11.2	80.4	29.049	0.072
03	3	4.299	0.0405	0.4078	4.913	12.6	97.3	29.125	0.011
02	3	4.252	0.0553	0.2096	6.380	9.2	98.6	29.215	0.008
x 04	3	7.198	0.0451	0.7387	5.943	11.3	97.0	48.417	0.014
<b>Mean age ± 1σ</b>			n=14	MSWD=45.13		14.9 ±5.4		29.064	0.025

Argon isotopic data.

ID	Power (watts)	<sup>40</sup> Ar/ <sup>39</sup> Ar	<sup>37</sup> Ar/ <sup>39</sup> Ar	<sup>36</sup> Ar/ <sup>39</sup> Ar (x 10 <sup>-3</sup> )	<sup>39</sup> Ar <sub>K</sub> (x 10 <sup>-15</sup> mol)	K/Ca	<sup>40</sup> Ar* (%)	Age (Ma)	±1σ (Ma)
<b>BR-345-djk</b> , sanidine, J=0.0038498±0.02%, IC=1.039051±0.0042157, NM-276J, Lab#=63718, Argus VI									
03	3	4.395	0.0438	0.8532	3.754	11.6	94.3	28.932	0.017
06	3	4.475	0.0249	1.118	2.772	20.5	92.6	28.934	0.021
07	3	4.192	0.0383	0.1506	4.186	13.3	99.0	28.963	0.010
08	3	4.364	0.0274	0.7235	3.268	18.6	95.1	28.976	0.017
11	3	4.346	0.0224	0.6589	6.774	22.8	95.6	28.979	0.011
01	3	4.521	0.0533	1.259	4.674	9.6	91.9	28.979	0.018
13	3	4.246	0.0390	0.3238	3.529	13.1	97.8	28.980	0.013
12	3	4.283	0.0265	0.4416	10.170	19.3	97.0	28.987	0.008
15	3	4.296	0.0298	0.4840	1.813	17.1	96.7	28.992	0.022
14	3	4.274	0.0242	0.3988	1.967	21.1	97.3	29.017	0.019
10	3	4.320	0.0310	0.5460	6.270	16.5	96.3	29.038	0.011
05	3	4.310	0.2299	0.5325	3.096	2.2	96.8	29.107	0.015
04	3	4.329	0.0417	0.5105	2.061	12.2	96.6	29.178	0.020
x 02	3	4.650	0.0708	1.045	1.151	7.2	93.5	30.321	0.036
<b>Mean age ± 2σ</b>			n=13	MSWD=15.95		15.2 ±5.6		28.999	0.033

**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.

Mean age is weighted mean age of Taylor (1982). Mean age error is weighted error

of the mean (Taylor, 1982), multiplied by the root of the MSWD where MSWD>1, and also incorporates uncertainty in J factors and irradiation correction uncertainties.

Isotopic abundances after Steiger and Jäger (1977).

x preceding sample ID denotes analyses excluded from mean age calculations.

Ages calculated relative to FC-2 Fish Canyon Tuff sanidine interlaboratory standard at 28.201 Ma (Kuiper et al., 2008)

Decay Constant (LambdaK (total)) = 5.463e-10/a (Min et al., 2000)

Correction factors:

$$(^{39}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.0007064 \pm 0.000004$$

$$(^{36}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = 0.0002731 \pm 0.0000005$$

$$(^{38}\text{Ar}/^{39}\text{Ar})_{\text{K}} = 0.01261 \pm 0.00002$$

$$(^{40}\text{Ar}/^{39}\text{Ar})_{\text{K}} = 0.00808 \pm 0.00041$$