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Timing, magnitude, and style of Miocene deformation, west-central Walker Lane belt, Nevada

R. Ernest Anderson, U.S. Geological Survey, Kernville, CA 93238

Byron R. Berger, U.S. Geological Survey, MS 964, Denver, CO 80225

Dan Miggins, U.S. Geological Survey, MS 963, Denver, CO 80225

Sample and analytical information:

A total of 12 out of 20 samples collected in the field were selected for $^{40}Ar/^{39}Ar$ dating from the Coal Valley area and southern Singatse Range, Nevada. General locations and all geochronological data are shown in Table 1. Samples were prepared and analyzed at the Denver Argon Geochronology Laboratory in Denver, Colorado. The least altered samples were collected in the field, but does not guarantee absence of alteration. The furnace step-heating technique was used on all samples at the Denver laboratory using a Mass Analyzer Products Limited MAP 215 series rare-gas mass spectrometer.

Incremental heating results can be found in data repository file 1 and all corresponding age-spectra can be found in Figure 4. As used herein, the term "plateau" refers to two or more contiguous temperature steps with apparent dates that are indistinguishable at the 95% confidence interval and represent ≥ 50% of the total $^{39}Ar_K$ released (Fleck et al., 1977); $^{39}Ar_K$ is defined in supplementary file 2. An "average date" represents what we infer to be the best estimate of the apparent age for a sample that contains no plateau. Generally we restrict this term to a portion of the age spectrum that shows near concordancy but comprises < 50% of the released argon, or the included argon fractions have dates that overlap within three standard deviations of the weighted mean. Isochron analysis (York, 1969) was used to assess if extraneous radiogenic argon components were trapped in any samples. A total gas date, analogous to a conventional K–Ar date, is calculated for each sample by taking the weighted mean of the dates for all gas fractions of the sample.

All step-heating samples show varying degrees of excess argon, ^{39}Ar recoil (Hess and Lippolt, 1986), with gas fractions at lower temperatures yielding older ages and gas fractions at higher temperatures yielding younger ages, as well as minor argon loss. Several samples contained significant excess ^{40}Ar, generally showing a saddle-shaped age-spectrum, a decrease in age from low temperature to high temperature heating steps, or a climbing age spectrum. Initial $^{40}Ar/^{36}Ar$ ratios calculated from isochrons for the various samples analyzed show various degrees of extraneous argon, but most are higher than or within error of the atmospheric value of 295.5, suggesting that extraneous radiogenic argon is present in varying amounts, depending on the mineral and/or groundmass concentrates analyzed.

Sample Preparation

Both groundmass concentrations of basalts and andesites, as well as mineral separates of sanidine, plagioclase and hornblende were used in this study. High-purity mineral separates (>99.9 % pure) of sanidine, plagioclase and hornblende, as well as basalt and andesite groundmass concentrates were concentrated and cleaned to a purity of >97%. Mineral concentrates were selected by choosing the largest size range free of composite grains and were purified using magnetic, heavy liquid and paper-shaking techniques. Various heavy liquids were used to concentrate alkali feldspars, biotite, pyroxene and amphibole. Lithium Heteropoly Tungstate (LST) with a density of 2.852 was used for the feldspar separations. A combination of Methylene Iodide (MEI) and Bromoform (Bromo) were used to separate biotite (density of ~3.1) and amphibole and pyroxene (densities of ~3.1 to 3.3), respectively. Final mineral separates were hand picked under a binocular microscope to a purity of >99% with particular attention to excluding grains with abundant inclusions, adhering material, carbonate, or alteration. All biotite and hornblende separates were treated in a dilute bath of HCl (<10%) for 15-30 minutes to dissolve any primary and secondary calcite present. Sanidine separates were treated in a dilute bath of HF (~15%) for approximately 5-15 minutes, depending on the purity of the crystals, to remove glass and other material adhering to the crystals.

All groundmass concentrates range in size between 80–100 mesh (180-150 μm). Common sources of inaccuracy in groundmass dating of basaltic rocks are xenoliths and phenocrysts, and special care was taken to remove any such impurities from the concentrates using a magnetic separator and/or hand picking samples clean. Material containing xenoliths was excluded from concentrates by cutting thin slabs of the rock and carefully plucking out the xenoliths. Groundmass concentrates were evaluated for phenocryst size and content, glass content, xenoliths, carbonate content, and the degree of alteration. Most lavas and tuff samples contained either primary or secondary calcite, which was dissolved using a dilute bath of HCl (<10%) for a minimum of 30 minutes. In some rocks, several mineral and groundmass splits were obtained for $^{40}Ar/^{39}Ar$ dating. Both mineral and groundmass concentrates were washed in acetone, alcohol, and deionized water (2X) to dissolve any organics and remove dust.

$^{40}Ar/^{39}Ar$ Step-heating method

Mineral separates were analyzed using the $^{40}Ar/^{39}Ar$ age-spectrum technique, a variant of the conventional K/Ar method. A mineral separate of unknown age and a mineral standard of known age were irradiated at the USGS TRIGA reactor in Denver, Colorado, following techniques described by Dalrymple et al. (1981) to produce ^{39}Ar from ^{39}K by neutron bombardment. After irradiation, the ^{40}Ar (radiogenic)/^{39}Ar (from potassium) ratios of sample and standard were determined. Standard techniques were employed to produce $^{40}Ar/^{39}Ar$ spectra.

The isotopic composition of argon was measured at the USGS in Denver, Colorado using a MAP 215 series rare-gas mass spectrometer made by Mass Analyzer Products Limited. Abundances of five argon isotopes (^{40}Ar, ^{39}Ar, ^{38}Ar, ^{37}Ar, and ^{36}Ar) were measured in each sample. Argon was released from the samples in 7-15

temperature steps. Radiogenic ^{40}Ar ($^{40}Ar_R$) is the total ^{40}Ar derived from natural radioactive decay of ^{40}K after all corrections from non-decay-derived ^{40}Ar, including atmospheric ^{40}Ar and reactor-produced ^{40}Ar, have been made. K-derived ^{39}Ar (^{39}ArK) is the total ^{39}Ar derived from the epithermal neutron-induced $^{39}K(n,p)^{39}Ar$ after corrections for non-^{39}K-derived ^{39}Ar, including ^{42}Ca-derived ^{39}Ar, are made. The value of F ($^{40}Ar_R/^{39}Ar_K$) is the quantity resulting from the division of radiogenic ^{40}Ar and K-derived ^{39}Ar. Quantities for radiogenic ^{40}Ar and K-derived ^{39}Ar are given in volts of signal measured on a Faraday detector by a digital voltmeter. These quantities can be converted to moles, using the mass spectrometer sensitivity at time of measurement of $9.736x10^{-13}$ moles of argon per volt of signal. The measured $^{40}Ar/^{39}Ar$ ratio used for mass discrimination correction is 298.9.

Samples were irradiated in three irradiation packages (DD71, DD72, and DD90) for times ranging from 15 to 40 hours at 1 megawatt in the USGS TRIGA reactor in Denver. The J-value for each sample was determined from adjacent standards; errors in the calculated J-value were determined experimentally by calculating the reproducibility of multiple monitors. Corrections for the irradiation-produced, interfering isotopes of argon were made by measuring the production ratios for the interfering isotopes of argon produced in pure K_2SO_4 and CaF_2 irradiated simultaneously with most of the samples for this study. Fish Canyon Tuff sanidine (FCT-2) was used as our monitor mineral with an internally calibrated age of 28.03 Ma calibrated against MMhb-1 with an inter laboratory calibrated age of 523.1 Ma.

Corrections were made for additional interfering isotopes of argon produced from irradiation of chlorine using the method described by Roddick (1983). Measured quantities of ^{37}Ar and ^{39}Ar were corrected for radioactive decay, and the $^{39}Ar/^{37}Ar$ ratios were corrected for this decay as well as for interfering argon isotopes. By multiplying the $^{39}Ar/^{37}Ar$ ratios by 0.5, the relative approximate K/Ca distribution of the samples may be obtained. Error estimates for apparent ages of individual temperature steps were assigned by using the equations of Dalrymple et al. (1981); however, the equations were modified to allow the option of choosing the larger of separately derived errors in the F-value- either a calculated error or an experimental error determined from the reproducibility of identical samples. Age plateaus were determined by comparing contiguous gas fractions using the critical value test of Dalrymple and Lanphere (1969), and McIntyre (1963), and the error was determined using the equations of Dalrymple et al. (1981).

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Repository argon data for Anderson et al.

Temp (^{o}C)	$^{40}Ar_R$[1]	$^{39}Ar_K$[1]	$^{40}Ar_R/^{39}Ar_K$[1,2]	$^{39}Ar/^{37}Ar$[3]	$\%^{40}Ar_R$	$\%^{39}Ar$	Apparent Age[4] (Ma at ± 2 sigma
5-209-15/#10/DD71							
Plagioclase; 248.1 mg; J-value=.00505±0.1%							
650	0.01636	0.00856	1.911	0.14	14.9	1.2	17.32 ± 8.66
750	0.08893	0.05010	1.775	0.10	55.3	7.0	16.10 ± 0.03
850	0.18063	0.10717	1.686	0.09	77.9	14.9	15.29 ± 0.30
950	0.34411	0.20541	1.675	0.09	87.2	28.5	15.20 ± 0.09
1050	0.24545	0.14675	1.673	0.08	85.1	20.4	15.17 ± 0.11
1150	0.17085	0.09188	1.859	0.08	79.0	12.8	16.86 ± 0.13
1250	0.14872	0.06137	2.423	0.08	72.4	8.5	21.94 ± 0.14
1350	0.07095	0.02421	2.930	0.09	66.5	3.4	26.50 ± 1.05
1450	0.04772	0.02412	1.978	0.09	54.0	3.4	17.93 ± 1.17

Total gas age: 16.56 ± 0.29 Ma
Plateau age (steps 3-5): 15.21 ± 0.17 Ma
Isochron age (steps 1-5): 15.23 ± 0.15 Ma; $(^{40}Ar/^{36}Ar)_I$= 304 ± 4

5-209-15/#14/DD71							
Groundmass concentrate; 249.7 mg; J-value=.004964±0.1%							
650	0.49923	0.40149	1.243	8.52	22.6	5.8	11.10 ± 0.05
750	2.34626	1.45926	1.608	3.01	75.7	21.1	14.34 ± 0.03
850	2.65476	1.63018	1.629	2.30	96.0	23.6	14.52 ± 0.04
950	4.08591	2.52597	1.618	2.31	97.7	36.6	14.43 ± 0.03
1000	1.16264	0.73487	1.582	1.60	94.5	10.6	14.11 ± 0.05
1350	0.23459	0.15453	1.518	0.19	80.9	2.2	13.54 ± 0.44

Total gas age: 14.19 ± 0.04 Ma
Plateau age (steps 3-4): 14.47 ± 0.04 Ma
Isochron age (steps 1-6): 14.48 ± 0.07 Ma; $(^{40}Ar/^{36}Ar)_I$= 246 ± 39

5-156-1/#41/DD72							
Hornblende; 245.8 mg; J-value=.003696±0.1%							
800	0.01333	0.00161	8.256	0.55	11.2	0.2	54.22 ±6.20
950	0.01750	0.00305	5.746	0.69	62.7	0.4	37.91 ± 15.23
1050	0.02269	0.00431	5.264	0.20	68.7	0.6	34.76 ± 2.70
1085	0.06172	0.02460	2.509	0.16	70.1	3.2	16.65 ± 0.50
1120	0.10957	0.04543	2.412	0.16	78.2	5.9	16.01 ± 0.35
1150	0.34345	0.14453	2.376	0.10	83.3	18.8	15.78 ± 0.16
1180	0.82146	0.35037	2.345	0.15	91.4	45.6	15.57 ± 0.04
1225	0.32891	0.14095	2.334	0.15	93.2	18.4	15.49 ± 0.14
1275	0.09613	0.04110	2.339	0.15	88.9	5.4	15.53 ± 0.40
1350	0.02779	0.01187	2.341	0.18	76.0	1.5	15.54 ± 0.84

Total gas age: 15.93 ± 0.10 Ma
Plateau age (steps 7-8): 15.54 ± 0.09 Ma
Isochron age (steps): ± Ma; $(^{40}Ar/^{36}Ar)_I$:

5-159-23/#123/DD72							
Hornblende; 249.1 mg; J-value=.003690±0.1%							
750	0.39010	0.01671	23.351	0.62	64.1	1.7	149.11 ± 0.99
900	0.49039	0.02947	16.641	1.59	88.6	2.9	107.51 ± 0.25
1000	0.39435	0.02564	15.382	0.65	93.2	2.5	99.60 ± 0.20
1050	0.46331	0.02433	19.042	0.24	94.0	2.4	122.51 ± 0.46
1100	0.81060	0.03605	22.482	0.26	95.9	3.6	143.78 ± 0.52
1125	2.44028	0.09684	25.199	0.22	97.9	9.6	160.40 ± 0.24
1150	4.21384	0.16440	25.631	0.21	98.6	16.3	163.03 ± 0.24
1175	5.90695	0.23063	25.612	0.21	98.9	22.9	162.91 ± 0.24
1225	6.71384	0.25989	25.834	0.21	99.3	25.8	164.26 ± 0.25
1275	2.06834	0.07992	25.880	0.21	98.6	7.9	164.54 ± 0.25
1400	1.08523	0.04210	25.781	0.21	98.6	4.2	163.94 ± 0.24

Total gas age: 158.14 ± 0.27 Ma
Weighted mean age (steps): ± Ma
Weighted mean age (steps 9-11): 164.28 ± 0.25 Ma
Isochron age (steps): ± Ma; $(^{40}Ar/^{36}Ar)_I$=

5-212-4A/#9/DD71

Groundmass Concentrate; 260.6 mg; J-value=.005035±0.1%

650	0.02294	0.01341	1.711	0.46	5.1	0.6	15.47 ± 1.90
750	0.32244	0.15109	2.134	0.56	70.7	6.5	19.28 ± 0.32
850	0.69263	0.35582	1.947	0.71	91.3	15.2	17.59 ± 0.15
950	1.40066	0.74914	1.870	0.80	96.9	32.1	16.90 ± 0.03
1050	1.15949	0.62949	1.842	0.78	97.1	26.9	16.65 ± 0.03
1200	0.62463	0.34928	1.788	0.54	91.3	14.9	16.17 ± 0.07
1400	0.16208	0.08844	1.833	0.06	78.7	3.8	16.57 ± 0.03

Total gas age: 16.96 ± 0.08 Ma
Weighted mean age (steps 4-7): ± Ma
Isochron age (steps 1-7): 17.04 ± 0.41 Ma; ($^{40}Ar/^{36}Ar)_I$= 298 ± 12

1-212-5/#51/DD72
Sanidine; 45.9 mg; J-value=.003740±0.1%

800	0.11273	0.03818	2.952	34.86	48.4	2.0	19.81 ± 1.08
1000	0.41925	0.16308	2.571	63.79	97.3	8.6	17.26 ± 0.28
1100	0.67117	0.26434	2.539	111.70	97.1	14.0	17.05 ± 0.06
1200	0.96560	0.37908	2.547	147.80	97.5	20.1	17.10 ± 0.19
1250	0.86607	0.33907	2.554	161.93	98.7	17.9	17.15 ± 0.17
1300	1.26049	0.49424	2.550	180.62	99.1	26.2	17.13 ± 0.11
1350	0.47331	0.18424	2.569	150.32	99.0	9.7	17.25 ± 0.12
1450	0.07283	0.02773	2.626	98.86	88.3	1.5	17.63 ± 0.36

Total gas age: 17.20 ± 0.17 Ma
Plateau age (steps 2-7): 17.14 ± 0.16 Ma
Isochron age (steps): ± Ma; ($^{40}Ar/^{36}Ar)_I$=

5-212-14/#40/DD72
Sanidine; 56.7 mg; J-value=.003744±0.1%

800	0.21050	0.08306	2.534	71.22	65.2	3.0	17.04± 0.10
1000	0.84531	0.33453	2.527	143.26	97.6	12.0	16.99 ± 0.03
1100	1.11507	0.43916	2.539	181.33	98.6	15.7	17.07 ± 0.03
1200	2.02040	0.79697	2.535	167.56	98.9	28.5	17.04 ± 0.03
1250	1.36364	0.53681	2.540	154.76	98.4	19.2	17.08 ± 0.03
1300	1.42072	0.55934	2.540	148.13	98.1	20.0	17.07 ± 0.03
1350	0.09714	0.03832	2.535	5.77	57.4	1.4	17.04 ±0.03
1450	0.01638	0.00585	2.799	0.76	26.9	0.2	18.81 ± 2.84

Total gas age: 17.06 ± 0.04 Ma
Plateau age (steps 3-7): 17.06 ± 0.03 Ma
Isochron age (steps): ± Ma; ($^{40}Ar/^{36}Ar)_I$=

5-214-6/#43/DD72
Hornblende; 246.6 mg; J-value=.003574±0.1%

750	0.02051	0.00187	10.979	0.11	8.6	0.3
900	0.01267	0.00201	6.292	0.37	7.5	0.3
1025	0.01355	0.00314	4.316	0.20	24.1	0.4
1075	0.05206	0.01987	2.620	0.16	56.9	2.7
1125	0.14156	0.05504	2.575	0.16	55.8	7.4
1150	0.40976	0.15989	2.563	0.15	65.5	21.6
1175	0.83171	0.32585	2.552	0.15	88.7	44.0
1225	0.39906	0.15649	2.550	0.16	94.6	21.1
1275	0.03611	0.01402	2.576	0.15	75.3	1.9
1350	0.00828	0.00311	2.662	0.17	45.1	0.4

Total gas age: 16.67 ± 0.16 Ma
Plateau age (steps 5-8): ± Ma
Plateau age (steps 3-7): 17.06 ± 0.03 Ma
Isochron age (steps 4-9): 16.82 ± 0.07 Ma; ($^{40}Ar/^{36}Ar)_I$= 302 ± 3

5-214-20/#12/DD71
Plagioclase; 248.3 mg; J-value=.005044±0.1%

700	0.06259	0.03269	1.915	0.17	42.9	6.5	17.34 ± 0.84
800	0.07519	0.04338	1.733	0.10	72.9	8.7	15.70 ± 0.26
900	0.14123	0.08067	1.751	0.08	92.0	16.1	15.86 ± 0.08
1000	0.12405	0.07268	1.707	0.08	89.9	14.5	15.47 ± 0.34
1100	0.15441	0.08928	1.730	0.08	89.9	17.9	15.67 ± 0.14
1200	0.08779	0.05127	1.712	0.08	77.9	10.3	15.51 ± 0.78

1300	0.09882	0.05527	1.788	0.08	86.2	11.1	16.20 ± 0.04
1450	0.12686	0.07452	1.702	0.08	74.4	14.9	15.42 ± 0.49

Total gas age: 15.79 ± 0.32 Ma
Plateau age (steps 2-6): 15.65 ± 0.32 Ma
Isochron age (steps 1-8): 15.53 ± 0.17 Ma; ($^{40}Ar/^{36}Ar)_I$= 314 ± 8

5-97-5/#45/DD72
Groundmass Concentrate; 245.5 mg; J-value=.003815±0.1%

650	0.09983	0.03763	2.653	0.96	24.1	2.7	18.17 ± 0.11
750	0.70053	0.25614	2.735	1.24	80.9	18.2	18.73 ± 0.18
850	0.72595	0.28397	2.556	0.86	91.5	20.2	17.51 ± 0.10
950	1.18639	0.48204	2.461	0.57	95.5	34.3	16.86 ± 0.03
1050	0.40093	0.16443	2.438	0.52	93.7	11.7	16.70 ± 0.12
1150	0.20691	0.09182	2.253	0.61	85.5	6.5	15.44 ± 0.19
1350	0.19664	0.08752	2.247	0.08	78.7	6.2	15.40 ± 0.19

Total gas age: 17.16 ± 0.10 Ma
Isochron age (steps 1-7): 16.68 ± 0.53 Ma; ($^{40}Ar/^{36}Ar)_I$= 303 ± 20

5-97-5/#49/DD72
Groundmass Concentrate; 248.0 mg; J-value=.003819±0.1%

600	0.26178	0.09222	2.839	0.95	41.9	6.6	19.45 ± 0.10
700	0.36494	0.13453	2.713	1.35	84.4	9.6	18.59 ± 0.24
800	0.64917	0.24984	2.598	1.12	87.9	17.8	17.81 ± 0.10
900	0.95544	0.38681	2.470	0.62	92.3	27.5	16.94 ± 0.07
1000	0.66575	0.27336	2.435	0.52	93.2	19.5	16.70 ± 0.06
1100	0.31292	0.13381	2.339	0.66	88.3	9.5	16.04 ± 0.26
1200	0.18305	0.07985	2.292	0.29	82.9	5.7	15.72 ± 0.19
1300	0.11631	0.05441	2.138	0.06	84.1	3.9	14.67 ± 0.35

Total gas age: 17.13 ± 0.13 Ma
Isochron age (steps 1-8): 16.35 ± 0.58 Ma; ($^{40}Ar/^{36}Ar)_I$= 328 ± 31

5-160-5/#8/DD71
Groundmass Concentrate; 255.3 mg; J-value=.004990±0.1%

650	0.15724	0.08863	1.774	1.68	23.5	2.7	15.90 ± 1.11
750	1.19468	0.55330	2.159	1.48	81.5	16.8	19.33 ± 0.04
850	1.97003	0.99663	1.977	1.10	92.0	30.3	17.71 ± 0.05
950	1.35497	0.72735	1.863	0.58	93.9	22.1	16.69 ± 0.04
1100	1.26167	0.68465	1.843	0.51	93.5	20.8	16.51 ± 0.05
1350	0.42108	0.24103	1.747	0.18	90.4	7.3	15.66 ± 0.13

Total gas age: 17.31 ± 0.08 Ma
Isochron age (steps 1-6): 16.47 ± 0.63 Ma; ($^{40}Ar/^{36}Ar)_I$= 359 ± 129

5-160-5/#42/DD72
Hornblende; 145.4 mg; J-value=.003748±0.1%

800	0.01094	0.00319	3.432	0.54	11.5	0.7	23.06 ± 0.60
1000	0.01176	0.00290	4.056	0.31	43.4	0.6	27.22 ± 1.93
1075	0.05749	0.02343	2.454	0.15	67.0	5.2	16.51 ± 0.25
1125	0.13997	0.06148	2.277	0.15	79.1	13.6	15.33 ± 0.21
1175	0.39507	0.17503	2.257	0.15	85.4	38.8	15.20 ± 0.12
1225	0.26204	0.11620	2.255	0.15	88.2	25.8	15.18 ± 0.05
1350	0.15437	0.06866	2.248	0.15	86.2	15.2	15.14 ± 0.10

Total gas age: 15.40 ± 0.12 Ma
Plateau age (steps 5-7): 15.18 ± 0.09 Ma
Isochron age (steps 1-7): 15.15 ± 0.74 Ma; ($^{40}Ar/^{36}Ar)_I$= 333 ± 19

5-160-5/#13/DD71
Plagioclase; 199.7 mg; J-value=.005015±0.1%

700	0.05683	0.03350	1.696	0.79	21.1	11.8	15.28 ± 0.51
800	0.08784	0.05796	1.515	0.09	37.4	20.4	13.66 ± 0.40
900	0.12683	0.07388	1.717	0.04	67.9	26.0	15.47 ± 0.54
1000	0.11915	0.06863	1.736	0.03	62.5	24.2	15.64 ± 0.19
1150	0.05216	0.02791	1.869	0.03	31.1	9.8	16.83 ± 0.67
1300	0.04171	0.01414	2.950	0.04	26.6	5.0	26.49 ± 0.69
1450	0.04672	0.00783	5.968	0.05	23.0	2.8	53.20 ± 2.07

Total gas age: 16.85 ± 0.47 Ma

Plateau age (steps 3-4): 15.56 ± 0.31 Ma
Weighted mean age (steps 1-4): 15.04 ± 0.41 Ma
Isochron age (steps): ± Ma; ($^{40}Ar/^{36}Ar)_I$=

GR-S-6 /#44/DD90
Groundmass Concentrate; 230.1 mg; J-value=.008137±0.1%

650	0.05941	0.15121	0.393	2.44	9.8	5.5	5.76 ± 0.33
750	0.52543	0.56946	0.923	2.75	54.0	20.6	13.49 ± 0.09
850	0.60683	0.61177	0.992	2.12	81.3	22.1	14.50 ± 0.14
950	0.46604	0.48135	0.968	1.81	82.2	17.4	14.16 ± 0.07
1050	0.31746	0.33606	0.945	1.58	80.2	12.2	13.81 ± 0.10
1150	0.29585	0.32209	0.919	1.01	81.7	11.6	13.43 ± 0.21
1250	0.15835	0.16977	0.933	0.40	68.5	6.1	13.64 ± 0.44
1400	0.11887	0.12356	0.962	0.09	69.7	4.5	14.07 ± 0.52

Total gas age: 13.48 ± 0.19 Ma
Weighted mean age (steps 2-8): 13.92 ± 0.23 Ma
Maximum age (steps #3): 14.50 ± 0.14 Ma
Isochron age (steps 2-8): 14.17 ± 0.32 Ma; ($^{40}Ar/^{36}Ar)_I$= 280 ± 18

GR-S-4 /#46/DD90
Hornblende; 250.9 mg; J-value=.007703±0.1%

750	0.00558	0.00274	2.039	289.04	2.1	0.4	28.12 ± 6.30
900	0.00459	0.00301	1.527	0.66	6.6	0.4	21.10 ± 16.80
1000	0.00433	0.00184	2.354	0.54	10.6	0.2	32.42 ± 11.23
1050	0.00464	0.00327	1.419	0.11	17.3	0.4	19.62 ± 16.98
1100	0.06108	0.05560	1.099	0.15	47.7	7.5	15.20 ± 0.29
1150	0.31729	0.28678	1.106	0.14	67.6	38.7	15.31 ± 0.09
1175	0.25757	0.23245	1.108	0.14	77.1	31.4	15.33 ± 0.18
1225	0.12890	0.11592	1.112	0.14	75.6	15.6	15.39 ± 0.50
1300	0.03725	0.03164	1.177	0.13	54.4	4.3	16.29 ± 1.60
1450	0.01237	0.00763	1.622	0.10	24.3	1.0	22.39 ± 5.18

Total gas age: 15.57 ± 0.43 Ma
Plateau age (steps 5-8): 15.32 ± 0.27 Ma
Isochron age (steps 4-9): 15.14 ± 0.22 Ma; ($^{40}Ar/^{36}Ar)_I$= 309 ± 5

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1. Abundance of $^{40}Ar_R$ (radiogenic ^{40}Ar) and $^{39}Ar_K$ (K-derived ^{39}Ar) is measured in volts and calculated to five decimal places. Voltage may be converted to moles using 1.160×10^{-12} moles argon per volt signal. $^{40}Ar_R/^{39}Ar_K$ is calculated to three decimal places. All three are rounded to significant figures using analytical precision.

2. Corrected for mass discrimination. Mass discrimination was determined by calculating the $^{40}Ar/^{36}Ar$ ratio of aliquots of atmospheric argon pipetted from a fixed pipette on the extraction line; the ratio during these experiments was between 298.5 and 299.1, which was corrected to 295.5 to account for mass discrimination. $^{40}Ar_R/^{39}Ar_K$ was also corrected for all interfering isotopes of argon including atmospheric argon. ^{37}Ar and ^{39}Ar, which are produced during irradiation, are radioactive, and their abundances were corrected for radioactive decay. Abundances of interfering isotopes from K and Ca were calculated from reactor production ratios determined by irradiating and analyzing pure CaF_2 and K_2SO_4; the K_2SO_4 was degassed in a vacuum furnace prior to irradiation to release extraneous argon. Corrections for Cl-derived ^{36}Ar were determined using the method of Roddick (1987). Production ratios for this experiment were determined for $(^{40}Ar/^{39}Ar)_K$, $(^{38}Ar/^{39}Ar)_K$, $(^{37}Ar/^{39}Ar)_K$, $(^{36}Ar/^{37}Ar)_{Ca}$, $(^{39}Ar/^{37}Ar)_{Ca}$, and $(^{38}Ar/^{37}Ar)_{Ca}$; measured values are available upon request.

3. To calculate apparent K/Ca ratios, divide the $^{39}Ar_K/^{37}Ar_{Ca}$ by 2. The accuracy of apparent K/Ca ratios is dependent upon fast to thermal neutron ratios in the particular reactor. In the U.S. Geological Survey TRIGA reactor the correction factor has not been determined since Dalrymple et al. (1981). Because reactor fuel in the USGS TRIGA has been changed since 1981, this ratio must be viewed as approximate but is internally consistent for each sample and reveals within-sample variability.

4. Apparent ages and associated errors were calculated from raw analytical data and then rounded using associated analytical errors. Apparent ages of each fraction include the error in J value (0.11%), which was calculated from the reproducibility of splits of the argon from several standards. Apparent ages were calculated using decay constants of Steiger and Jäger (1977). All apparent age errors are cited at 1σ. Uncertainties in the calculations for apparent age of individual fractions were calculated using equations of Dalrymple et al. (1981) and the critical value test of McIntyre (1963).