Appendix 1. $^{40}Ar/^{39}Ar$ supporting data for:

$^{40}Ar/^{39}Ar$ AGES OF SELECTED BASALTS IN THE SIERRA CUCHILLO AND MUD SPRINGS MOUNTAINS, SIERRA AND SOCORRO COUNTIES, NEW MEXICO

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Ten basalts were dated by the incremental heating method and all data are reported relative to Fish Canyon Tuff sanidine with an assigned age of 28.02 Ma. Isochron data are calculated for each sample and data are analyzed using the method of York (1969) and presented in Figure 1. Samples were irradiated at the USGS reactor in Denver, CO for 10 hours in the central thimble. Correction factors for interfering isotope reactions were determined from measurement of K-glass and CaF_2. Abbreviated methods are given in Table 1 and complete isotope data are given in Table 2.

References cited:

Renne, P.R., Swisher, C.C., Deino, A.L., Karner, D.B., Owens, T.L., and DePaolo, D.J., 1998. Intercalibration of standards, absolute ages and uncertainties in $^{40}Ar/^{39}Ar$ dating. Chemical Geology, 145, 117-152.

Steiger, R.H., and Jäger, E., 1977. Subcommission on geochronology: Convention on the use of decay constants in geo- and cosmochronology. Earth and Planet. Sci. Lett., 36, 359-362.

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

York, D., 1969. Least squares fitting of a straight line with correlated errors, Earth and Planet. Sci. Lett., 5, 320-324.

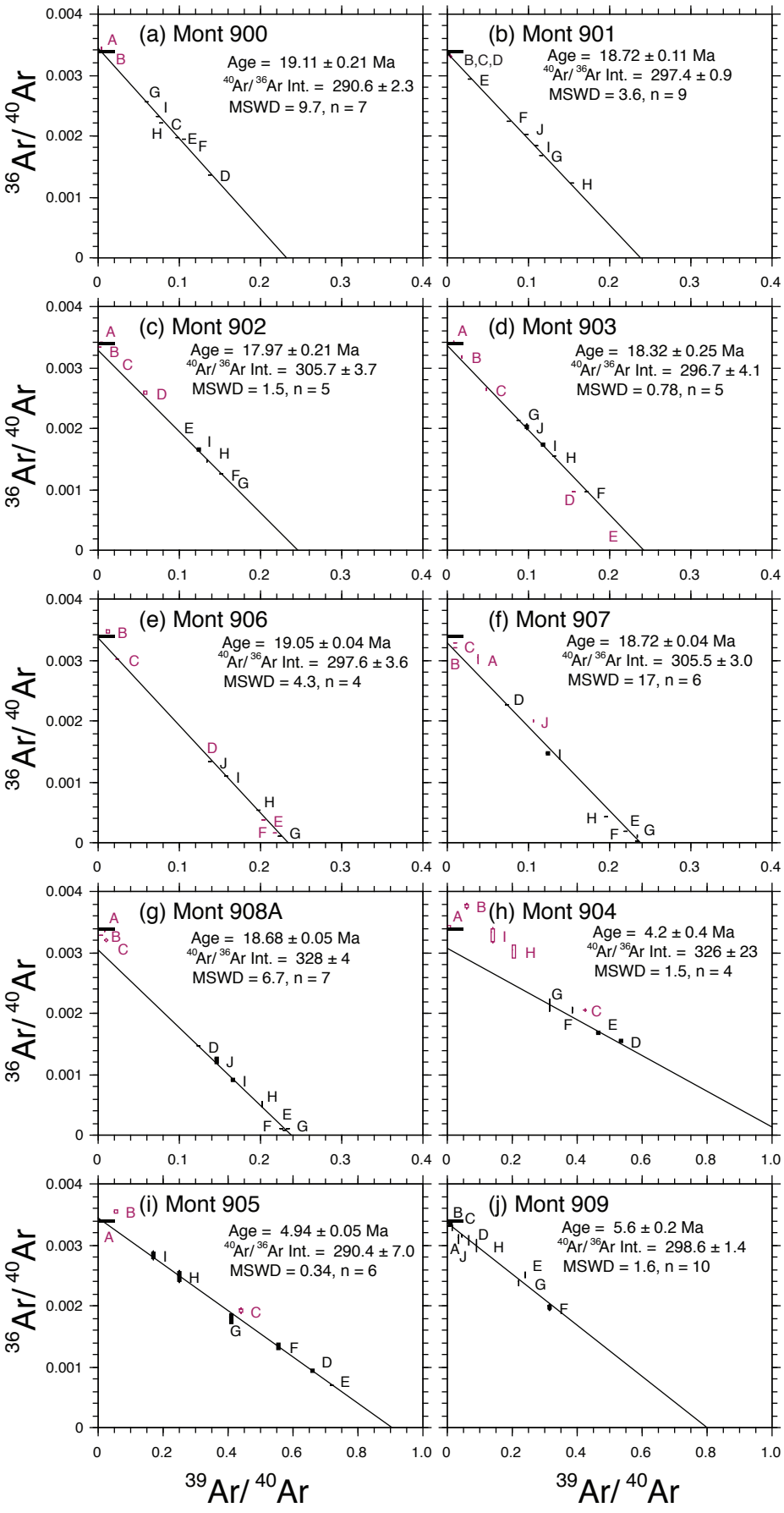

Figure 1. Isochron diagrams for basalt data. Date shown in black are used for linerar regression using the metohd of York (1969). Asll data are report at 1 sigma error.

Table 1. Age summary and analytical methods.

Methods

Sample preparation and irradiation:

Groundmass concentrated by coarse crushing and picking fragments visible free of phenocrysts.
Separates were loaded into machined Al discs and irradiated for 10 hours (NM-246)
in central thimble, USGS TRIGA reactor, Denver, CO.
Neutron flux monitor Fish Canyon Tuff sanidine (FC-2). Assigned age = 28.02 Ma (Renne et al., 1998).

Instrumentation:

Mass Analyzer Products 215-50 mass spectrometer on line with automated all-metal extraction system.
All samples were step-heated using a 50 W CO_2 laser.
Samples heated for 45 seconds
Reactive gases removed by 6 minute exposure to two SAES GP-50 getters. One operated at ~450°C and one at 20°C.
Gas also exposed to a W filament operated at ~2000°C and a cold finger operated at -140°C.

Analytical parameters:

Electron multiplier sensitivity averaged 6 x 10^{-17} moles/pA.
Total system blank and background: Step-heating = 170 3, 1, 2, 1.1 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
J-factors determined to a precision of ~± 0.1% by CO_2 laser-fusion of 6 single crystals
from 6 radial positions around the irradiation tray.
Correction factors for interfering nuclear reactions were determined using K-glass and CaF_2 and are as follows:
$(^{40}Ar/^{39}Ar)_K = 0.007 \pm 0.00005$; $(^{36}Ar/^{37}Ar)_{Ca} = 0.00028 \pm 0.00002$; and $(^{39}Ar/^{37}Ar)_{Ca} = 0.00070 \pm 0.00005$.

Table 2. Argon isotopic 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)
	Mont 900, Groundmass Concentrate, 8.88 mg, J=0.0024722±0.09%, D=1.002±0.001, NM-246G, Lab#=60910-01										
Xi	A	2	232.0	3.374	798.9	0.199	0.15	-1.6	0.6	-16.8	6.3
Xi	B	3	92.29	2.135	301.9	0.724	0.24	3.5	2.9	14.5	2.6
	C	4	12.60	1.587	28.13	2.39	0.32	35.0	10.6	19.59	0.33
	D	5	7.197	1.598	10.15	3.37	0.32	60.1	21.3	19.20	0.16
	E	8	10.03	1.534	20.06	9.65	0.33	42.1	52.1	18.75	0.18
	F	12	9.290	2.258	18.61	4.59	0.23	42.8	66.7	17.66	0.20
	G	18	16.23	5.642	43.08	6.83	0.090	24.4	88.5	17.65	0.34
	H	25	13.28	5.538	32.00	2.08	0.092	32.2	95.2	19.02	0.43
	I	30	13.42	6.074	32.53	1.52	0.084	32.1	100.0	19.16	0.45
	Integrated age ± 1σ			n=9		31.4		K2O=0.55%		18.18	0.24
	Plateau ± 1σ	steps C-I		n=7	MSWD=9.10	30.4			97.1	18.69	0.27
	Isochron±1σ	steps C-I		n=7	MSWD=9.73		$^{40}Ar/^{36}Ar$=	290.6±2.3		19.11	0.21
	Mont 901, Groundmass Concentrate, 12.96 mg, J=0.0024827±0.09%, D=1.002±0.001, NM-246F, Lab#=60905-01										
X	B	2	297.5	2.598	997.6	0.122	0.20	1.0	0.3	13.1	9.3
X	C	3	265.8	2.214	883.3	0.211	0.23	1.9	0.8	22.4	7.4
X	D	3	200.2	2.007	661.6	0.505	0.25	2.4	2.1	21.5	4.7
X	E	4	33.37	1.521	97.71	2.04	0.34	13.8	7.1	20.56	0.75
X	F	5	12.93	1.215	29.22	3.38	0.42	34.0	15.5	19.58	0.29
	G	8	8.507	1.456	14.65	16.0	0.35	50.5	54.9	19.13	0.13
	H	12	6.446	3.928	8.943	7.48	0.13	64.0	73.4	18.42	0.16
	I	25	8.952	5.868	17.96	8.63	0.087	46.1	94.7	18.46	0.22
	J	30	10.07	6.282	21.92	2.14	0.081	40.8	100.0	18.36	0.34
	Integrated age ± 1σ			n=9		40.5		K2O=0.48%		18.95	0.23
	Plateau ± 1σ	steps G-J		n=4	MSWD=5.48	34.2			84.5	18.77	0.21
	Isochron±1σ	steps B-J		n=9	MSWD=3.57		$^{40}Ar/^{36}Ar$=	297.4±0.9		18.72	0.11
	Mont 902, Groundmass Concentrate, 10.21 mg, J=0.0024609±0.07%, D=1.002±0.001, NM-246G, Lab#=60906-01										
Xi	A	2	200.0	3.354	680.0	0.153	0.15	-0.3	0.6	-2.7	6.1
Xi	B	3	312.7	2.111	1037.8	0.355	0.24	2.0	1.9	27.4	6.5
Xi	C	4	52.93	1.776	164.6	0.823	0.29	8.4	4.9	19.6	1.3
Xi	D	5	16.75	1.481	43.72	1.59	0.34	23.6	10.7	17.47	0.45
	E	8	10.57	1.497	21.67	11.2	0.34	40.6	51.7	18.96	0.18
	F	12	6.514	1.732	8.562	6.31	0.29	63.3	74.8	18.22	0.13
	G	18	6.222	6.878	8.764	3.51	0.074	67.5	87.6	18.62	0.23
	H	25	7.403	6.461	12.64	2.08	0.079	56.7	95.2	18.61	0.30
	I	30	7.916	6.439	14.77	1.32	0.079	51.5	100.0	18.09	0.36
	Integrated age ± 1σ			n=9		27.4		K2O=0.42%		18.60	0.25
	Plateau ± 1σ	steps E-I		n=5	MSWD=3.19	24.4			89.3	18.48	0.16
	Isochron±1σ	steps E-I		n=5	MSWD=1.52		$^{40}Ar/^{36}Ar$=	305.7±3.7		17.97	0.21

Table 2. Argon isotopic 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)
	Mont 903, Groundmass Concentrate, 9.03 mg, J=0.0024703±0.08%, D=1.002±0.001, NM-246F, Lab#=60902-01										
Xi	A	2	123.8	1.592	422.2	0.133	0.32	-0.7	0.5	-3.8	4.9
Xi	B	2	53.91	1.127	171.1	0.393	0.45	6.4	2.1	15.3	1.9
Xi	C	3	20.80	1.071	55.04	0.794	0.48	22.2	5.2	20.50	0.82
Xi	D	3	6.378	1.220	6.368	2.29	0.42	72.1	14.3	20.37	0.20
Xi	E	4	4.855	1.472	2.014	3.77	0.35	90.3	29.2	19.41	0.13
	F	5	5.791	1.978	6.027	2.26	0.26	72.0	38.1	18.50	0.20
	G	8	11.17	2.668	24.34	4.37	0.19	37.6	55.4	18.64	0.27
	H	12	7.446	5.959	13.00	7.28	0.086	55.0	84.2	18.22	0.20
	I	25	8.327	7.412	16.43	3.36	0.069	49.0	97.4	18.19	0.29
	J	30	10.06	9.245	22.87	0.650	0.055	40.4	100.0	18.12	0.73
	Integrated age ± 1σ			n=10		25.3	0.13	K2O=0.44%		18.60	0.17
	Plateau ± 1σ	steps F-J		n=5	MSWD=0.61	17.9			70.8	18.38	0.12
	Isochron±1σ	steps F-J		n=5	MSWD=0.78		$^{40}Ar/^{36}Ar$=	296.7±4.1		18.32	0.25
	Mont 904, Groundmass Concentrate, 9.24 mg, J=0.002461±0.07%, D=1.002±0.001, NM-246G, Lab#=60907-01										
Xi	A	2	114.4	4.792	390.8	0.118	0.11	-0.6	0.7	-2.9	5.2
Xi	B	3	15.51	2.810	58.82	0.383	0.18	-10.5	2.8	-7.3	1.2
Xi	C	4	2.347	1.853	5.287	2.72	0.28	39.9	18.2	4.15	0.14
	D	5	1.862	1.458	3.247	3.35	0.35	54.8	37.1	4.52	0.12
	E	8	2.138	2.019	4.103	5.62	0.25	51.0	68.8	4.82	0.11
	F	12	2.587	7.991	7.477	3.24	0.064	40.0	87.2	4.61	0.26
	G	18	3.138	15.95	11.09	1.52	0.032	37.6	95.7	5.27	0.49
Xi	H	25	4.734	13.78	18.04	0.476	0.037	11.4	98.4	2.41	0.76
Xi	I	30	6.917	12.56	26.15	0.282	0.041	3.2	100.0	1.0	1.3
	Integrated age ± 1σ			n=9		17.7		K2O=0.30%		4.22	0.15
	Plateau ± 1σ	steps D-G		n=4	MSWD=1.67	13.7			77.5	4.70	0.10
	Isochron±1σ	steps D-G		n=4	MSWD=1.45		$^{40}Ar/^{36}Ar$=	325.7±23.0		4.23	0.36
	Mont 905, Groundmass Concentrate, 9.28 mg, J=0.0024724±0.07%, D=1.002±0.001, NM-246G, Lab#=60909-01										
Xi	A	2	268.3	2.777	915.9	0.123	0.18	-0.8	0.4	-9.2	9.0
Xi	B	3	17.31	1.157	61.63	0.627	0.44	-4.7	2.3	-3.63	0.91
Xi	C	4	2.263	0.8791	4.584	3.15	0.58	43.3	12.2	4.35	0.13
	D	5	1.511	0.6817	1.570	4.91	0.75	73.0	27.5	4.889	0.077
	E	8	1.390	0.7421	1.154	13.7	0.69	79.8	70.4	4.919	0.038
	F	12	1.789	3.150	3.258	5.57	0.16	60.6	87.8	4.82	0.11
	G	18	2.403	9.175	6.821	2.83	0.056	47.6	96.7	5.11	0.29
	H	25	3.943	7.034	11.68	0.588	0.073	27.1	98.5	4.78	0.57
	I	30	5.767	6.830	18.09	0.476	0.075	17.0	100.0	4.39	0.67
	Integrated age ± 1σ			n=9		32.0		K2O=0.54%		4.627	0.084
	Plateau ± 1σ	steps D-I		n=6	MSWD=0.37	28.1			87.8	4.907	0.032
	Isochron±1σ	steps D-I		n=6	MSWD=0.34		$^{40}Ar/^{36}Ar$=	290.4±7.0		4.935	0.050

Table 2. Argon isotopic 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)
	Mont 906, Groundmass Concentrate, 12 mg, J=0.0024759±0.08%, D=1.002±0.001, NM-246F, Lab#=60900-01										
Xi	B	2	76.21	1.542	264.0	0.136	0.33	-2.2	0.1	-7.4	4.9
Xi	C	3	39.08	1.059	117.1	0.419	0.48	11.7	0.6	20.2	1.6
Xi	D	3	8.196	0.6585	12.99	2.88	0.77	53.8	3.7	19.58	0.21
Xi	E	4	4.862	0.5955	1.907	12.3	0.86	89.4	17.1	19.294	0.057
Xi	F	5	4.576	0.5712	0.8397	16.8	0.89	95.6	35.2	19.412	0.045
	G	8	4.433	0.5389	0.6032	41.9	0.95	97.0	80.7	19.079	0.032
	H	12	5.004	2.047	3.145	7.94	0.25	84.8	89.3	18.855	0.093
	I	25	6.293	2.996	7.641	6.48	0.17	68.0	96.3	19.04	0.15
	J	30	7.183	2.239	10.13	3.44	0.23	60.9	100.0	19.44	0.19
	Integrated age ± 1σ			n=9		92.3		K2O=1.19%		19.142	0.049
	Plateau ± 1σ	steps G-J		n=4	MSWD=3.02	59.8			64.8	19.063	0.053
	Isochron±1σ	steps G-J		n=4	MSWD=4.28		$^{40}Ar/^{36}Ar$=	297.6±3.6		19.054	0.037
	Mont 907, Groundmass Concentrate, 8.36 mg, J=0.002477±0.08%, D=1.002±0.001, NM-246F, Lab#=60903-01										
Xi	A	2	25.97	8.888	80.37	0.138	0.057	11.5	0.4	13.4	3.5
Xi	B	2	88.29	4.039	288.7	0.176	0.13	3.8	1.0	14.9	4.2
Xi	C	3	85.69	2.933	273.4	0.387	0.17	6.0	2.3	22.9	2.7
	D	3	14.11	1.704	33.58	1.58	0.30	30.7	7.4	19.24	0.44
	E	4	4.511	1.154	1.070	5.26	0.44	95.1	24.5	19.056	0.098
	F	5	4.251	0.9645	0.3009	5.99	0.53	99.8	44.0	18.839	0.077
	G	8	4.274	0.8947	0.6131	11.5	0.57	97.5	81.6	18.503	0.054
	H	12	5.075	3.948	3.190	2.76	0.13	87.8	90.6	19.84	0.19
	I	25	7.932	13.60	15.35	2.04	0.038	57.0	97.2	20.26	0.45
Xi	J	30	9.346	10.49	21.37	0.849	0.049	41.7	100.0	17.43	0.64
	Integrated age ± 1σ			n=10		30.7	0.21	K2O=0.57%		18.92	0.11
	Plateau ± 1σ	steps D-I		n=6	MSWD=15.83	29.158			95.0	18.76	0.156
	Isochron±1σ	steps D-I		n=6	MSWD=16.77		$^{40}Ar/^{36}Ar$=	305.5±3.0		18.724	0.044
	Mont 908A, Groundmass Concentrate, 7.34 mg, J=0.0024828±0.08%, D=1.002±0.001, NM-246F, Lab#=60904-01										
Xi	A	2	118.3	3.718	397.7	0.091	0.14	1.0	0.3	5.2	6.7
Xi	B	2	187.5	2.505	611.7	0.239	0.20	3.7	1.2	31.1	5.1
Xi	C	3	86.00	1.912	275.4	0.479	0.27	5.5	3.0	21.2	2.4
Xi	D	3	7.995	1.407	11.99	2.49	0.36	57.1	12.0	20.34	0.20
	E	4	4.392	1.009	0.7100	7.74	0.51	97.1	40.3	18.987	0.067
	F	5	4.322	0.9225	0.5809	4.64	0.55	97.8	57.3	18.81	0.10
	G	8	4.248	1.316	0.7822	7.02	0.39	97.1	82.9	18.373	0.076
	H	12	4.910	11.99	5.754	1.72	0.043	85.6	89.2	18.85	0.41
	I	25	5.950	9.099	7.838	1.88	0.056	73.7	96.1	19.64	0.34
	J	30	6.723	9.636	10.88	1.06	0.053	64.0	100.0	19.28	0.50
	Integrated age ± 1σ			n=10		27.4		K2O=0.58%		19.07	0.14
	Plateau ± 1σ	steps E-J		n=6	MSWD=9.08	24.1			88.0	18.76	0.13
	Isochron±1σ	steps E-J		n=6	MSWD=8.29		$^{40}Ar/^{36}Ar$=	332.9±11.9		18.67	0.06

Table 2. Argon isotopic 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)
	Mont 909, Groundmass Concentrate, 8.27 mg, J=0.0024701±0.07%, D=1.002±0.001, NM-246F, Lab#=60901-01										
X	A	2	157.7	3.107	528.5	0.134	0.16	1.1	2.0	7.9	5.4
	B	2	129.1	2.986	424.8	0.220	0.17	2.9	5.4	16.9	4.5
	C	3	70.48	3.225	235.6	0.242	0.16	1.6	9.0	5.0	2.9
	D	3	21.87	3.808	69.51	0.541	0.13	7.5	17.2	7.3	1.2
	E	4	4.147	4.625	11.59	1.54	0.11	26.5	40.6	4.91	0.36
	F	5	3.151	4.427	7.398	1.19	0.12	42.1	58.6	5.91	0.32
	G	8	4.536	4.628	12.03	1.57	0.11	30.0	82.5	6.06	0.35
	H	12	10.43	61.02	47.93	0.674	0.008	12.5	92.7	6.1	1.9
	I	25	26.29	92.70	107.1	0.370	0.006	8.8	98.3	11.0	3.1
	J	30	57.42	112.8	218.7	0.114	0.005	3.7	100.0	10.3	5.5
	Integrated age ± 1σ			n=10		6.61		K2O=0.12%		6.57	0.63
	Plateau ± 1σ	steps B-J		n=9	MSWD=2.27	6.47			98.0	5.74	0.29
	Isochron±1σ	steps A-J		n=10	MSWD=1.61		$^{40}Ar/^{36}Ar$=	298.6±1.4		5.55	0.21

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 Steiger and Jäger (1977).
X preceding sample ID denotes analyses excluded from plateau age calculations.
i preceding sample ID denotes analyses excluded from isochron 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 28.02 Ma
Decay Constant (LambdaK (total)) = 5.543e-10/a
Correction factors:
$(^{39}Ar/^{37}Ar)_{Ca}$ = 0.0007 ± 5e-05
$(^{36}Ar/^{37}Ar)_{Ca}$ = 0.00028 ± 2e-05
$(^{38}Ar/^{39}Ar)_{K}$ = 0.013
$(^{40}Ar/^{39}Ar)_{K}$ = 0.0072 ± 0.00016