$^{40}Ar/^{39}Ar$ Geochronology Results for the Allens Ranch and Boulter Peak Quadrangles, Utah

by

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INTRODUCTION

This open-file report makes available raw analytical data from laboratory procedures completed to determine the age of rock samples collected during geologic mapping funded or supported by Brigham Young University (BYU), the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program, and the Utah Geological Survey (UGS). The references listed in table 1 report the age of the samples and generally provide additional information such as sample location, geologic setting, and significance or interpretation of the samples in the context of the area where they were collected. This open-file release includes two separate reports from the New Mexico Geochronological Laboratory. One is dated Oct. 13, 2012 and the other Nov. 21, 2012. Additional information about these samples and rock units is available in Christiansen and others (2007), McKean (2011), Allen (2012), McKean and others (2013), and McKean and others (in preparation). The analyses were performed by the New Mexico Geochronology Research Laboratory (NMGRL) under contract to Eric H. Christiansen (BYU). These data are highly technical in nature and proper interpretation requires considerable training in the applicable geochronologic techniques.

DISCLAIMER

This open-file release is intended as a data repository for information gathered in support of various UGS projects. The data are presented as received from the NMGRL and do not necessarily conform to UGS technical, editorial, or policy standards; this should be considered by an individual or group planning to take action based on the contents of this report. The Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding the suitability of this product for a particular use. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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Table 1. Sample numbers, rock type, and locations

Sample	Map Unit	Unit Name	Rock Type	Rock Name	Latitude (N)	Longitude (W)	7.5' Quadrangle	Reference
AR-608	Tb	Mosida Basalt	lava flow	trachybasalt	40.10982	112.02232	Allens Ranch	McKean, 2011
AR-1608	Tlsl	lava of Laguna Springs Volcanic Group	lava flow	andesite	40.00682	112.02439	Allens Ranch	McKean, 2011
AR-1108	Tc	Chimney Rock Pass tuff Member of the Soldiers Pass Formation	ash-flow tuff	rhyolite	40.06179	112.03631	Allens Ranch	McKean, 2011
BYU-REF (duplicate of AR-1108)	Tc	Chimney Rock Pass tuff Member of the Soldiers Pass Formation	ash-flow tuff	rhyolite	40.06179	112.03631	Allens Ranch	McKean, 2011
AR-2606	Ttp	tuff of Twelvemile Pass member of the Soldiers Pass Formation	ash-flow tuff	dacite	40.06342	112.04957	Allens Ranch	McKean, 2011
AR-908	Tp	tuff of Rattlesnake Pass member of the Packard Quartz Latite	ash-flow tuff	latite	40.10956	112.00527	Allens Ranch	McKean, 2011
AR-1708	Tptd	tuff of Tintic Davis Canyon member of the Packard Quartz Latite	vitrophyre of ash-flow tuff	rhyolite	40.00962	112.09603	Allens Ranch	McKean, 2011
BOULTPK-309	Tr	lava member of the Packard Quartz Latite	lava flow breccia	rhyolite	40.00193	112.12743	Boulter Peak	Allen, 2012
BOULTPK-1509	Tbc	shoshonite of Broad Canyon	lava flow	shoshonite	40.04174	112.15889	Boulter Peak	Allen, 2012
BOULTPK-209	Tbr	minette of Black Rock Canyon	minette sill	shoshonite	40.03381	112.22701	Boulter Peak	Allen, 2012
BOULTPK-409	Tbp	Gardison Ridge dike	dike	basalt	40.05033	112.13450	Boulter Peak	Allen, 2012

Notes:

Location data based on NAD83
Rock name using total alkali-silica diagram of LeBas and others (1986), for values normalized to 100% on a volatile free basis (data not shown here)
Sample Pierson-7 is from the Pierson Summit quadrangle of Nevada and was analyzed with the Boulter Peak samples (see NMGRL reports in this Open-File Report) but is not a part of this Utah dataset.

$^{40}Ar/^{39}Ar$ Geochronology Results for Samples from western Utah

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Internal Report # : NMGRL-IR-700

Introduction

Dr. Eric Christiansen from BYU submitted 6 samples for $^{40}Ar/^{39}Ar$ dating. These western Utah samples are volcanic and range between 15 and 35 Ma. The samples were prepared at BYU and are groundmass chips from a basalt, 4 sanidine separates from rhyolites and one plagioclase from a latite.

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

The provided samples were irradiated for 7 hours at the USGS TRIGA reactor in Denver, CO along with the standard Fish Canyon tuff sanidine as a neutron flux monitor. Plagioclase and groundmass were analyzed by the step-heating method using a defocused CO_2 laser to heat the samples whereas the sanidine were analyzed by the single crystal laser fusion (SCLF) method (Tables 1, 2, 3). A summary of the preferred eruption ages along with a listing of the analytical methods is provided in Table 1 and the general operational details for the NMGRL can be found at internet site http://geoinfo.nmt.edu/publications/openfile/argon/home/html.

The groundmass concentrate and plagioclase have age spectra defined by 10 heating steps and each sample displays some minor complexity (Fig. 1). AR-2606 plagioclase yields age disturbance for initial and late heating steps, but has a well-defined plateau (MSWD = 1.66) for intermediate steps with a weighted mean age of 34.62±0.17 Ma (Fig. 1a). AR-608 groundmass provides high precision individual steps, however the weighted mean age of 19.74±0.05 Ma for steps C-J are associated with a slightly elevated MSWD value of 4.5 (Fig. 1b).

The SCLF data are displayed on a probability diagram (Fig. 2) and tabulated in Table 3. Thirteen to 17 individual grains were fused and each sample yields a normal distribution of ages with weighted mean values between 32.6 and 35.2 Ma (Fig. 3; Table 1). Samples AR-908 and AR-1708 cluster at 35.08±0.03 and 35.21±0.03 Ma, respectively, whereas AR-1108 is 34.61±0.02 Ma and AR-1608 is 32.66±0.03 Ma. Most crystals are highly radiogenic (~99%) and also have K/Ca ratios between ~40 and 80. Based on a K/Ca of 2.1 there appears to be a single plagioclase in AR-1708 (run ID 59114-24).

Discussion

All weighted mean ages are considered to be accurate eruption ages for the provided samples. The samples fall within 4 distinct age bins at ~35.1, 34.6, 32.7 and 19.7 Ma. At the two sigma error level AR-908 and AR-1708 are distinct in apparent age, however it would be best to have stratigraphic data to confirm the accuracy of the age distribution.

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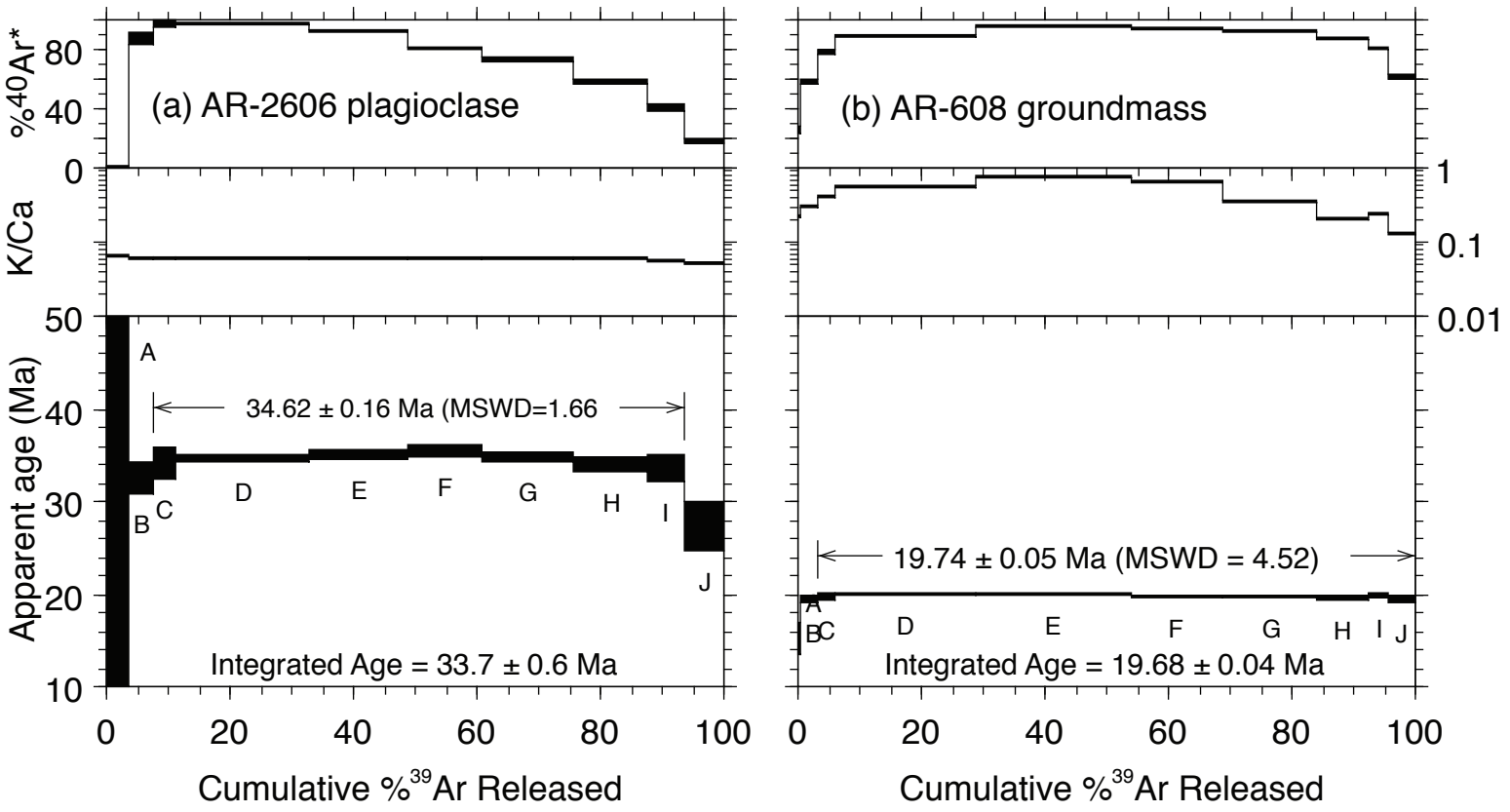

Figure 1. Age spectra, K/Ca and radiogenic diagrams for plagioclase (a) and groundmass (b) samples. Overall data are well behaved and are interpreted to yield accurate eruption ages.

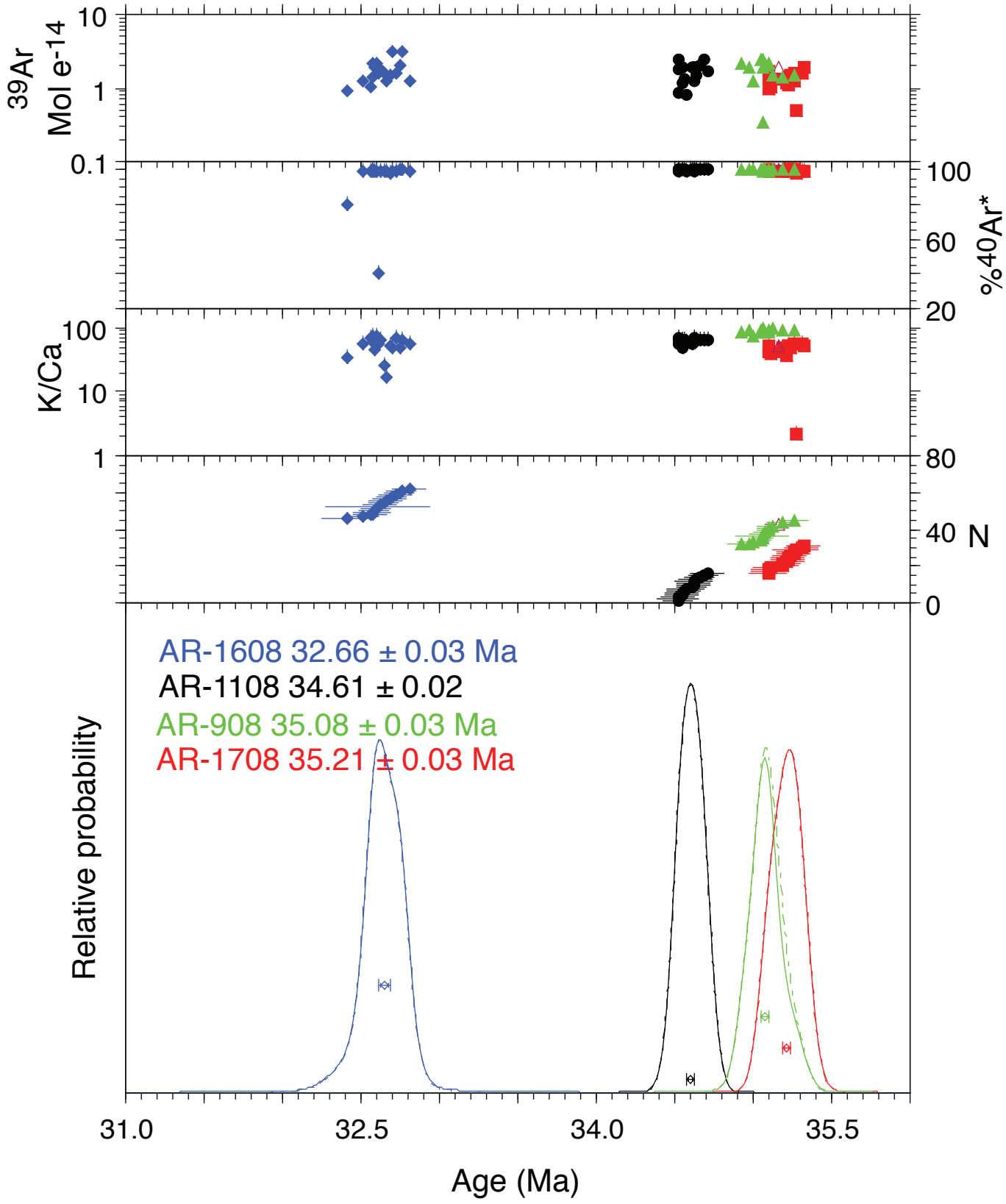

Figure 2. Probability, K/Ca, mole ^{39}Ar and $\%^{40}Ar^*$ diagrams for sanidine single crystal laser fusion data. Each sample yields a normal distribution of data with precise eruption ages.

Table 1. Age summary and analytical methods.

Summary

Sample	L#	min	Weighted mean ages				
			Age	±	MSWD	$\%^{39}Ar$	n
AR-608	59118	gm	19.74	0.05	4.53	96.5	8
AR-2606	59117	P	34.62	0.17	1.66	85.9	7
AR-908	59115	S	35.08	0.03	1.96	na	14
AR-1108	59113	S	34.61	0.02	1.01	na	15
AR-1608	59116	S	32.66	0.03	2.11	na	17
AR-1708	59114	S	35.21	0.03	1.33	na	15

L# = Lab number
min = material dated. gm = groundmass concentrate, S = sanidine, P = plagioclase
n = number of steps for plateau or crystals used for age calculation.
$\%^{39}Ar$ = percentage of total ^{39}Ar comprising the plateau.
All errors at 1σ

Methods

Sample preparation and irradiation:
Samples prepared with standard heavy liquid, magnetic and hand-picking methods.
Separates were loaded into machined Al discs and irradiated for 7 hours 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 or fused using a 50 W CO_2 laser.
Groundmass and plagioclase step-heated for 60 seconds.
Reactive gases removed by 8 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.
Sanidine laser fusion:
Reactive gases removed during a 3 minute reaction with 2 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 5 x 10^{-17} moles/pA.
Total system blank and background: Step-heating = 130, 0.6, 0.1, 2, 0.9 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
Total system blank and background laser fusion: 60, 0.8, 0.1, 1.3, 0.28 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
J-factors determined to a precision of ~± 0.06% by CO_2 laser-fusion of 6 single crystals
from 6 or 10 radial positions around the irradiation tray.
Correction factors for interfering nuclear reactions were determined using K-glass and CaF_2 and are as follows:
$(^{40}Ar/^{39}Ar)_K = 0.010\pm0.002$; $(^{36}Ar/^{37}Ar)_{Ca} = 0.00028\pm0.00002$; and $(^{39}Ar/^{37}Ar)_{Ca} = 0.00070\pm0.00005$.

Table 2. Argon isotopic data for step-heated samples.

	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)
	AR-2606, Plagioclase, 7.79 mg, J=0.0015725±0.06%, D=1.005±0.001, NM-225M, Lab#=59117-01										
X	A	3	1066	7.784	3576	0.582	0.066	0.9	3.7	27	13
X	B	4	13.26	8.571	8.522	0.649	0.060	86.3	7.7	32.36	0.87
	C	5	12.20	8.560	2.888	0.579	0.060	98.8	11.4	34.05	0.83
	D	6	12.64	8.562	3.829	3.44	0.060	96.7	33.1	34.50	0.22
	E	8	13.44	8.546	6.132	2.50	0.060	91.8	48.8	34.84	0.27
	F	10	15.63	8.283	12.99	1.96	0.062	79.8	61.1	35.24	0.34
	G	13	16.97	8.627	18.32	2.34	0.059	72.3	75.9	34.67	0.32
	H	16	20.85	8.628	32.44	1.91	0.059	57.4	87.9	33.85	0.45
	I	18	29.67	9.103	62.86	0.903	0.056	39.9	93.6	33.48	0.78
X	J	30	54.27	10.09	154.0	1.01	0.051	17.7	100.0	27.2	1.3
	Integrated age ± 1σ			n=10		15.9	0.059	K2O=0.50%		33.68	0.60
	Plateau ± 1σ	steps C-I		n=7	MSWD=1.66	13.6	0.060±0.002		85.9	34.62	0.17
	AR608, wr, 14.81 mg, J=0.0015726±0.06%, D=1.005±0.001, NM-225M, Lab#=59118-01										
X	A	3	21.49	2.370	55.43	0.720	0.22	24.7	0.6	15.00	0.90
X	B	4	11.95	1.699	17.70	3.23	0.30	57.4	3.5	19.35	0.20
	C	5	8.968	1.210	7.252	3.24	0.42	77.2	6.4	19.53	0.18
	D	6	7.961	0.8823	3.335	25.3	0.58	88.5	28.8	19.872	0.051
	E	8	7.327	0.6931	1.190	28.7	0.74	96.0	54.3	19.825	0.039
	F	10	7.415	0.7662	1.616	16.7	0.67	94.4	69.1	19.736	0.049
	G	13	7.521	1.493	2.378	17.1	0.34	92.3	84.3	19.582	0.057
	H	16	7.995	2.405	4.379	9.53	0.21	86.3	92.8	19.475	0.089
	I	18	8.798	2.177	6.717	3.52	0.23	79.5	95.9	19.74	0.15
	J	30	11.33	3.893	16.15	4.61	0.13	60.7	100.0	19.44	0.20
	Integrated age ± 1σ			n=10		112.6	0.41	K2O=1.86%		19.684	0.045
	Plateau ± 1σ	steps C-J		n=8	MSWD=4.53	108.7	0.53 ±0.22		96.5	19.745	0.049

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.
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

Table 3. Argon isotopic data for sanidine samples.

ID	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	Age (Ma)	±1σ (Ma)
AR-1108, Sanidine, J=0.0015681±0.05%, D=1.005±0.001, NM-225M, Lab#=59113								
21	12.37	0.0080	0.1410	22.295	63.8	99.7	34.530	0.049
23	12.46	0.0078	0.4197	7.896	65.4	99.0	34.531	0.083
19	12.40	0.0092	0.2189	16.934	55.5	99.5	34.534	0.060
28	12.37	0.0110	0.1112	10.624	46.3	99.7	34.554	0.067
20	12.37	0.0079	0.0840	17.715	64.6	99.8	34.559	0.059
27	12.41	0.0080	0.2133	12.139	64.1	99.5	34.564	0.066
22	12.47	0.0089	0.4117	7.647	57.6	99.0	34.576	0.078
24	12.40	0.0092	0.1264	18.075	55.5	99.7	34.614	0.056
29	12.52	0.0090	0.5266	11.737	56.4	98.8	34.627	0.071
26	12.40	0.0075	0.0910	17.188	67.9	99.8	34.632	0.056
17	12.41	0.0082	0.1267	17.878	62.2	99.7	34.635	0.067
30	12.44	0.0084	0.2338	14.073	60.8	99.4	34.639	0.064
16	12.42	0.0079	0.1246	18.812	64.3	99.7	34.667	0.056
25	12.46	0.0081	0.2427	22.534	63.0	99.4	34.692	0.054
18	12.44	0.0082	0.1503	15.579	62.2	99.6	34.718	0.061
Mean age ± 1σ	n=15	MSWD=1.01					34.608	0.022
AR-1708, Sanidine, J=0.0015688±0.05%, D=1.005±0.001, NM-225M, Lab#=59114								
25	12.64	0.0124	0.3656	8.679	41.3	99.2	35.103	0.072
19	12.61	0.0100	0.2537	15.132	51.2	99.4	35.103	0.062
28	12.63	0.0123	0.3336	12.275	41.4	99.2	35.107	0.068
21	12.63	0.0137	0.3107	9.257	37.2	99.3	35.113	0.072
17	12.73	0.0111	0.5519	11.821	45.9	98.7	35.188	0.071
16	12.66	0.0121	0.3121	11.862	42.1	99.3	35.196	0.071
20	12.68	0.0142	0.3703	10.412	36.0	99.1	35.216	0.075
29	12.64	0.0098	0.2161	10.234	51.9	99.5	35.225	0.074
22	12.63	0.0100	0.1853	13.021	51.1	99.6	35.226	0.065
27	12.62	0.0112	0.1247	14.102	45.5	99.7	35.247	0.064
26	12.63	0.0093	0.1172	14.252	54.7	99.7	35.267	0.066
30	12.65	0.0096	0.1759	11.385	52.9	99.6	35.269	0.067
24	12.90	0.2411	1.106	4.653	2.1	97.6	35.28	0.11
23	12.70	0.0093	0.3115	14.821	54.7	99.3	35.318	0.063
18	12.72	0.0103	0.3615	17.067	49.6	99.2	35.330	0.060
Mean age ± 1σ	n=15	MSWD=1.33					35.214	0.027
AR-908, Sanidine, J=0.0015702±0.05%, D=1.005±0.001, NM-225M, Lab#=59115								
21	12.51	0.0063	0.1619	19.466	80.6	99.6	34.936	0.057
19	12.55	0.0059	0.2287	17.455	86.9	99.5	34.986	0.056
26	12.56	0.0072	0.2566	11.493	71.1	99.4	35.010	0.068
24	12.52	0.0058	0.0484	22.697	88.3	99.9	35.053	0.055
20	12.52	0.0059	0.0496	22.170	87.0	99.9	35.063	0.059
29	12.62	0.0054	0.3693	3.211	94.0	99.1	35.07	0.15
25	12.55	0.0060	0.1366	17.775	84.6	99.7	35.072	0.059
17	12.55	0.0063	0.1154	18.318	81.4	99.7	35.079	0.058
18	12.56	0.0062	0.1094	19.912	81.8	99.7	35.104	0.058
28	12.63	0.0056	0.3736	19.502	91.2	99.1	35.105	0.058
22	12.59	0.0054	0.1940	13.309	94.4	99.5	35.132	0.070
16	12.63	0.0104	0.2663	17.203	49.2	99.4	35.170	0.056
23	12.60	0.0059	0.1348	12.517	86.5	99.7	35.197	0.067
27	12.61	0.0057	0.0936	13.323	89.1	99.8	35.275	0.068
Mean age ± 1σ	n=14	MSWD=1.96					35.076	0.030
AR-1608, Sanidine, J=0.0015717±0.06%, D=1.005±0.001, NM-225M, Lab#=59116								
27	14.43	0.0153	9.758	8.594	33.3	80.0	32.42	0.12
17	11.76	0.0094	0.6111	11.098	54.3	98.5	32.514	0.066
22	11.72	0.0077	0.4168	9.674	66.1	99.0	32.565	0.067
26	11.68	0.0073	0.2581	19.714	70.3	99.4	32.579	0.054
16	11.69	0.0089	0.2766	12.525	57.6	99.3	32.585	0.068
23	11.72	0.0115	0.3854	17.052	44.3	99.0	32.595	0.053
25	11.74	0.0071	0.4258	19.222	71.5	98.9	32.603	0.057
20	28.97	0.0093	58.74	14.874	54.6	40.1	32.62	0.29
18	11.80	0.0084	0.5951	16.665	60.6	98.5	32.637	0.060
28	11.83	0.0204	0.6673	14.630	25.0	98.3	32.651	0.061
29	11.81	0.0309	0.6168	11.500	16.5	98.5	32.666	0.068
32	11.88	0.0099	0.7889	13.828	51.7	98.0	32.688	0.063
31	11.77	0.0110	0.4080	28.324	46.5	99.0	32.708	0.051
30	11.80	0.0076	0.4936	14.429	67.4	98.8	32.726	0.064
21	11.73	0.0107	0.2092	19.200	47.5	99.5	32.753	0.052
24	11.73	0.0079	0.1902	28.012	64.3	99.5	32.773	0.047
19	11.77	0.0095	0.2681	11.333	53.9	99.3	32.819	0.068
Mean age ± 1σ	n=17	MSWD=2.11					32.659	0.030

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.
Decay constants and isotopic abundances after Steiger and Jäger (1977).
Ages calculated relative to FC-2 Fish Canyon Tuff sanidine interlaboratory standard at 28.02 Ma
Decay Constant (LambdaK (total)) = 5.543e-10/a

$^{40}Ar/^{39}Ar$ Geochronology Results for Samples from western Utah

By

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Table 1. Age summary and analytical methods.

Summary

Sample	L#	min	Weighted mean ages					Comment
			Age	±	MSWD	$\%^{39}Ar$	n	
BYU-REF	59833	S	34.76	0.08	2.81	na	11	SCLF (11 of 11)
BOULTPK309	59832	S	35.25	0.04	1.06	na	27	SCLF (27 of 27)
BOULTPK1509	59835	An	25.33	0.03	1.69	na	26	Wm of age spectrum steps (26 of 28)
Pierson-7	59836	S	22.23	0.08	1.18	na	40	Wm of age spectrum steps (40 of 40)
BOULTPK209	59834	Bi	28.72	0.06	0.94	na	6	Wm of age spectrum steps (6 of 24)
BOULTPK409	59830	gm	25.40	0.20	0.76	77.3	4	Plateau of age spectrum

L# = Lab number
min = material dated. gm = groundmass concentrate, S = sanidine, An = anorthoclase, Bi = biotite.
n = number of steps for plateau or crystals used for age calculation.
$\%^{39}Ar$ = percentage of total ^{39}Ar comprising the plateau.
All errors at 1σ

Methods

Sample preparation and irradiation:
Mineral separations provided by BYU.
Separates were loaded into machined Al discs and irradiated for 10 hours 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 or fused using a 50 W CO_2 laser.
Groundmass, bulk sanidine and anorthoclase step-heated for 30-45 seconds per step.
Reactive gases removed by 3-6 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.
Sanidine laser fusion:
Reactive gases removed during a 2.5 minute reaction with 2 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 5×10^{-17} moles/pA.
Total system blank and background: Step-heating = 75, 0.1, 0.02, 1.1, 0.4 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
Total system blank and background laser fusion: 35, 0.5, 0.1, 1.6, 0.17 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
J-factors determined to a precision of ~± 0.08% by CO_2 laser-fusion of 6 single crystals
from 6 or 10 radial positions around the irradiation tray.
Correction factors for interfering nuclear reactions were determined using K-glass and CaF_2 and are as follows:
$(^{40}Ar/^{39}Ar)_K = 0.010 \pm 0.002$; $(^{36}Ar/^{37}Ar)_{Ca} = 0.00028 \pm 0.00002$; and $(^{39}Ar/^{37}Ar)_{Ca} = 0.00070 \pm 0.00005$.

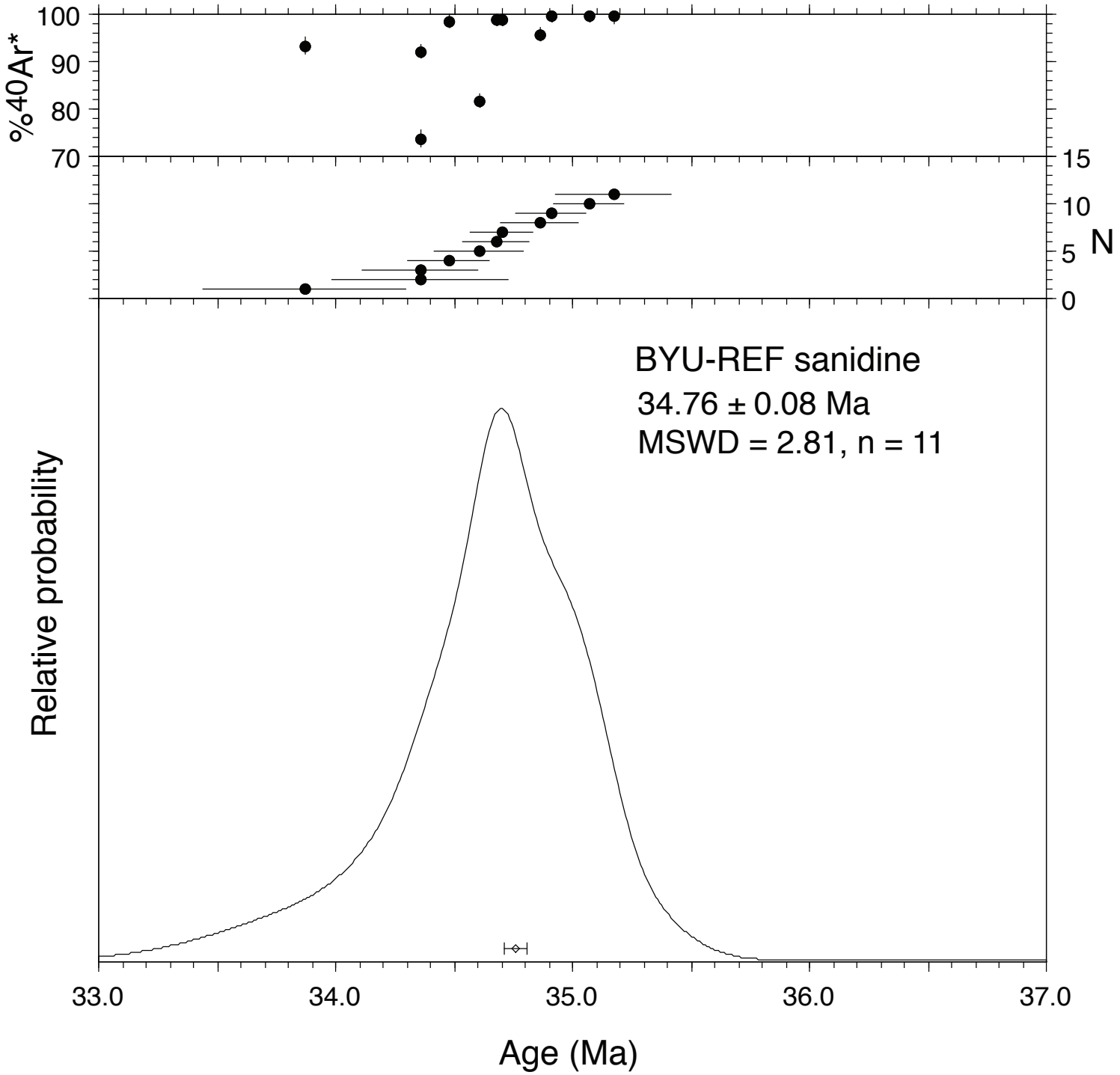

Figure 1. Age distribution of single crystal laser fusion analysis of BYU-REF sanidine.

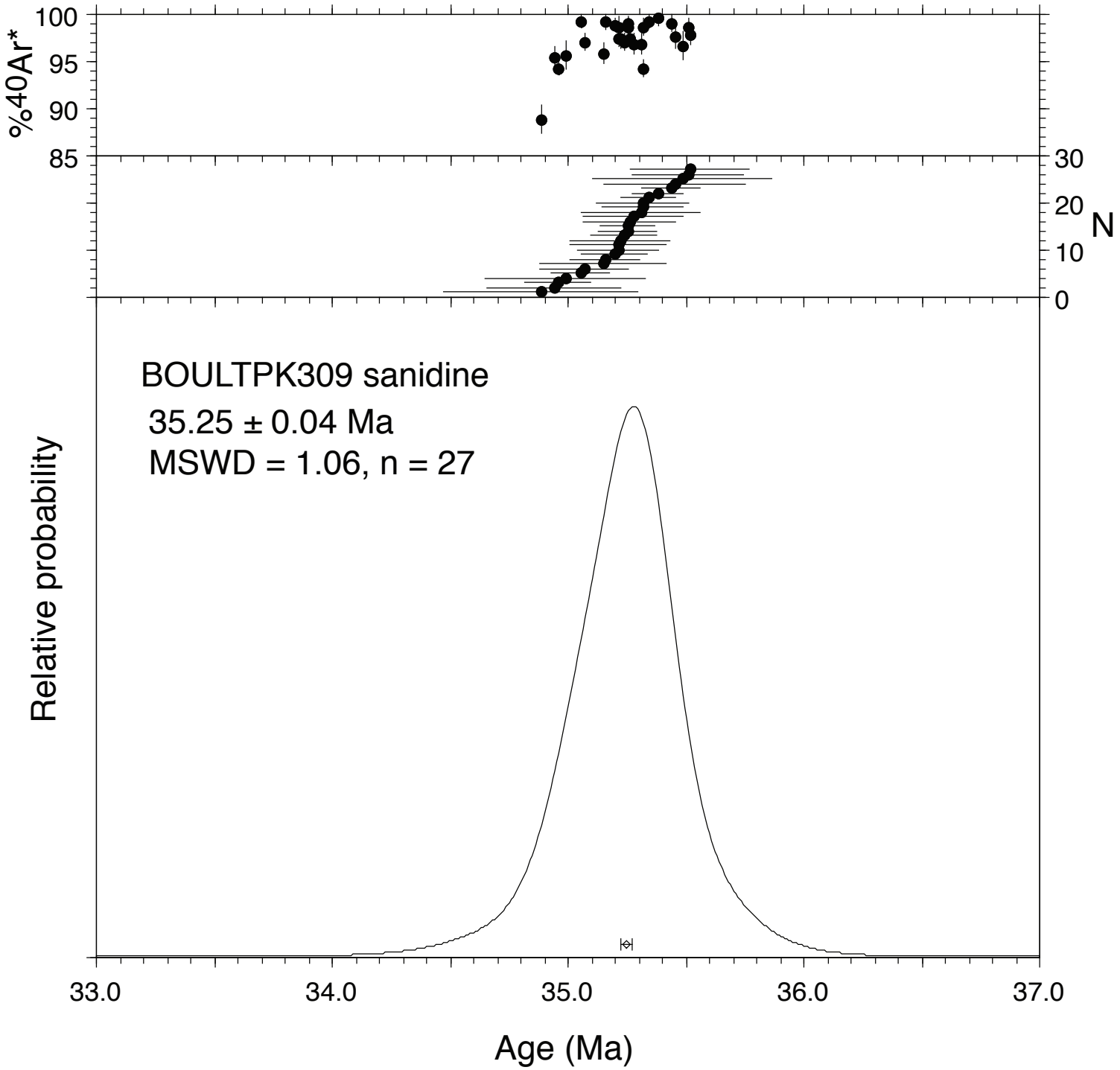

Figure 2. Age distribution of single crystal laser fusion analysis of BOULTK309 sanidine.

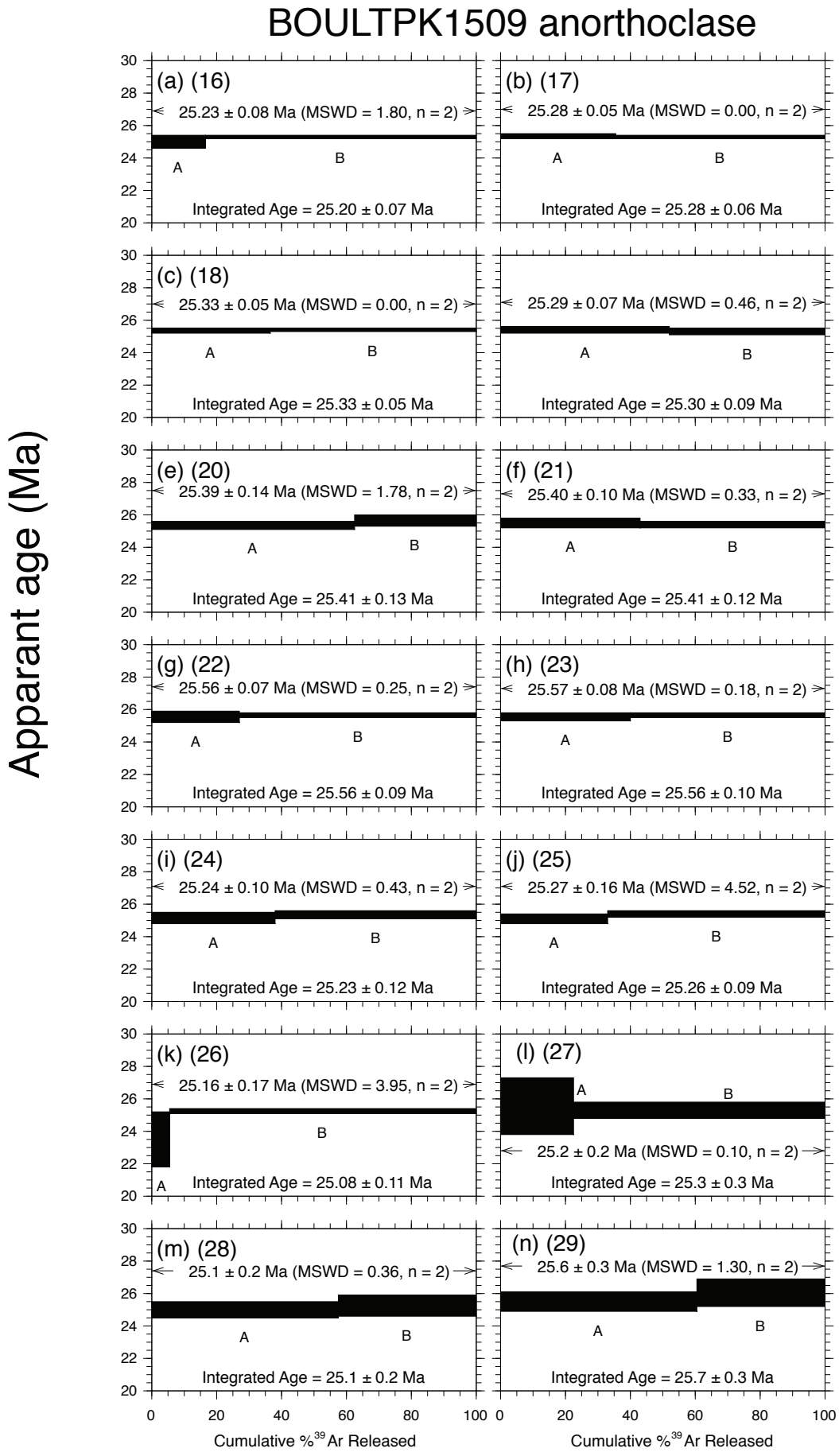

Figure 3. Two-step age spectra for individual anorthoclase crystals from BOULKTP 1509. All steps are concordant at the 2 sigma error level. Number in () is the run aliquot.

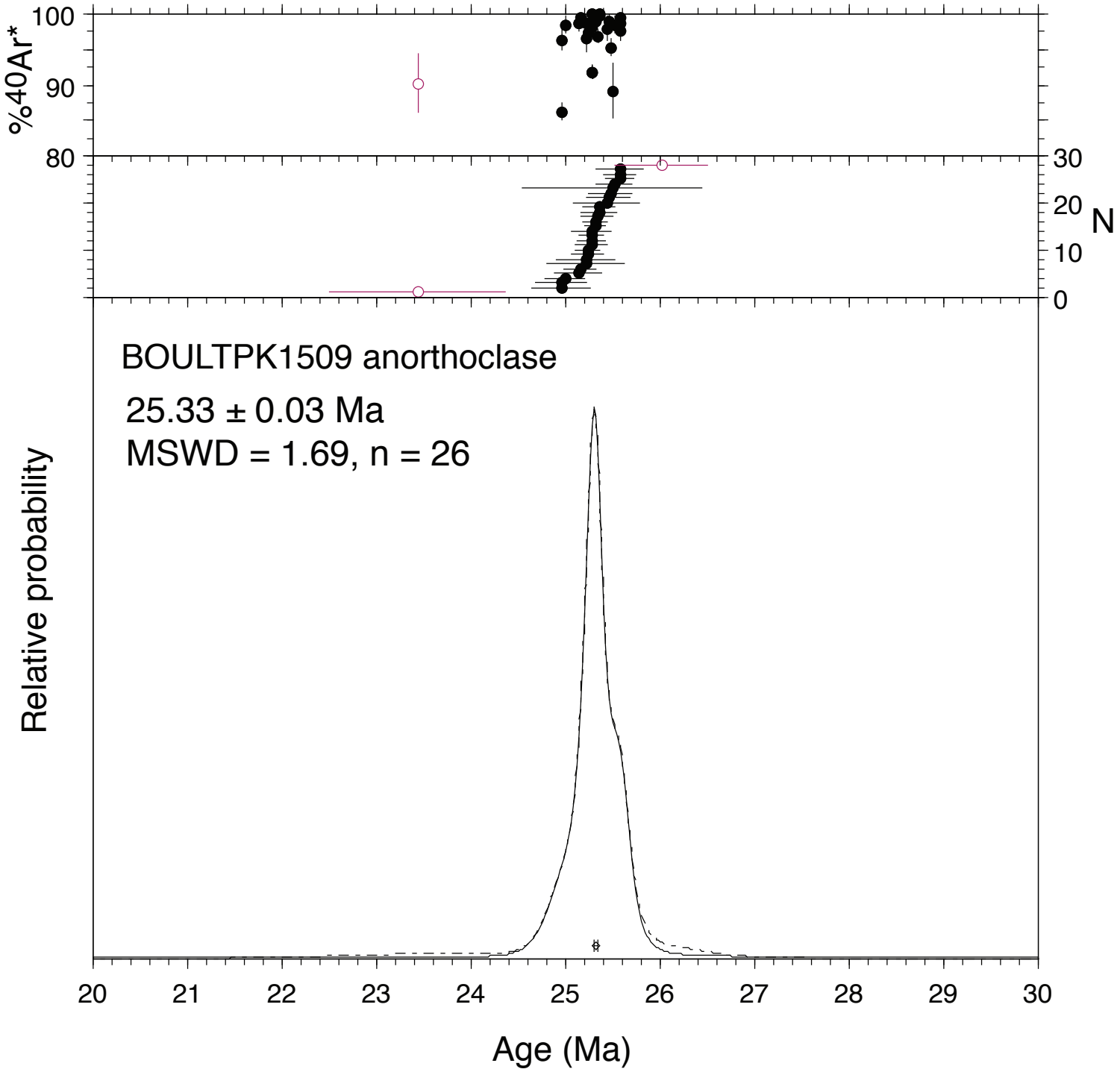

Figure 4. Age distribution of selected steps given by the age spectrum analyses of 14 single crystal splits of BOULTPK anorthoclase.

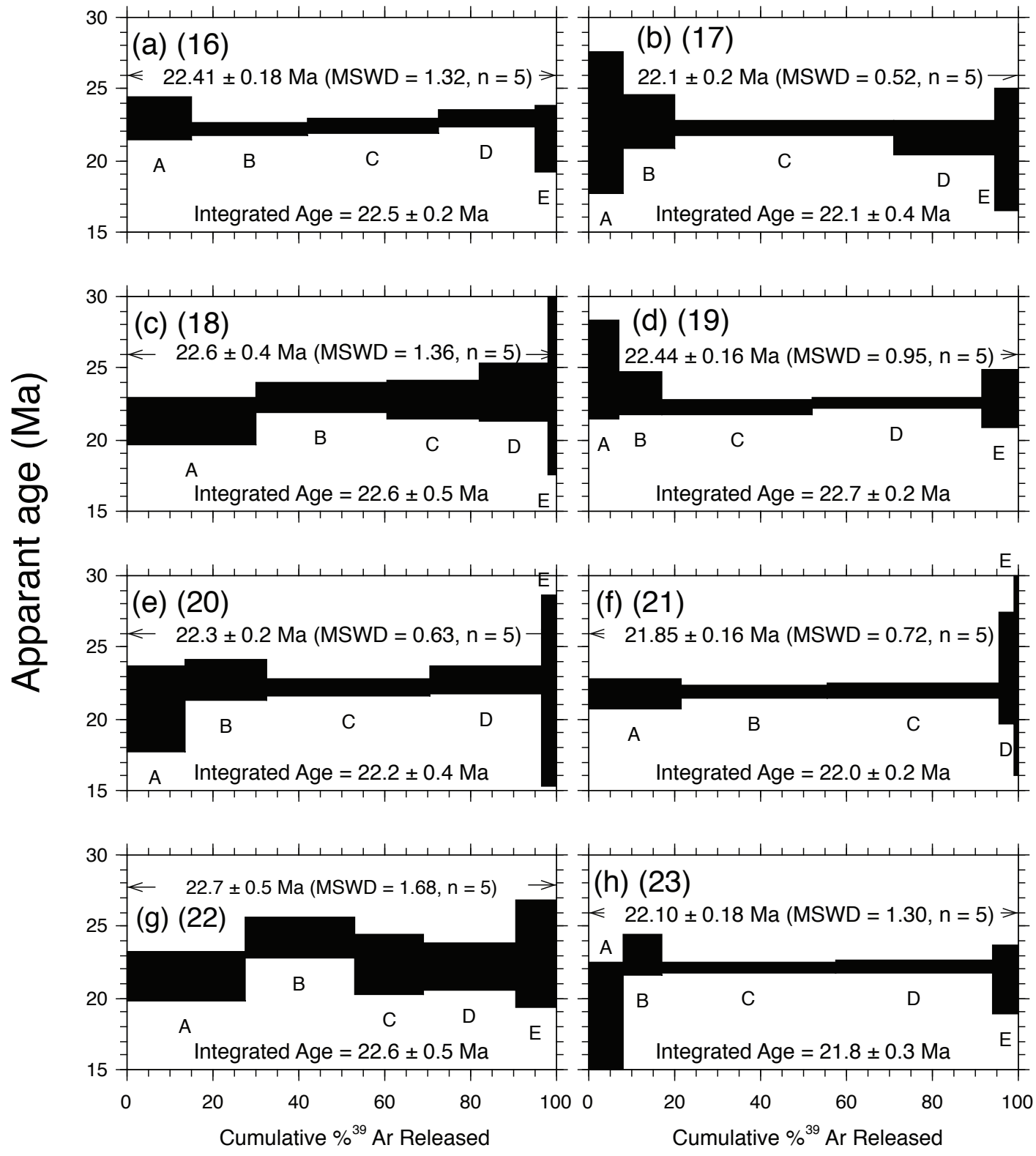

Figure 5. Five-step age spectra for bulk (5-10 grain each) sanidine samples from Pierson. All steps are concordant at the 2 sigma error level. Number in () is the run aliquot.

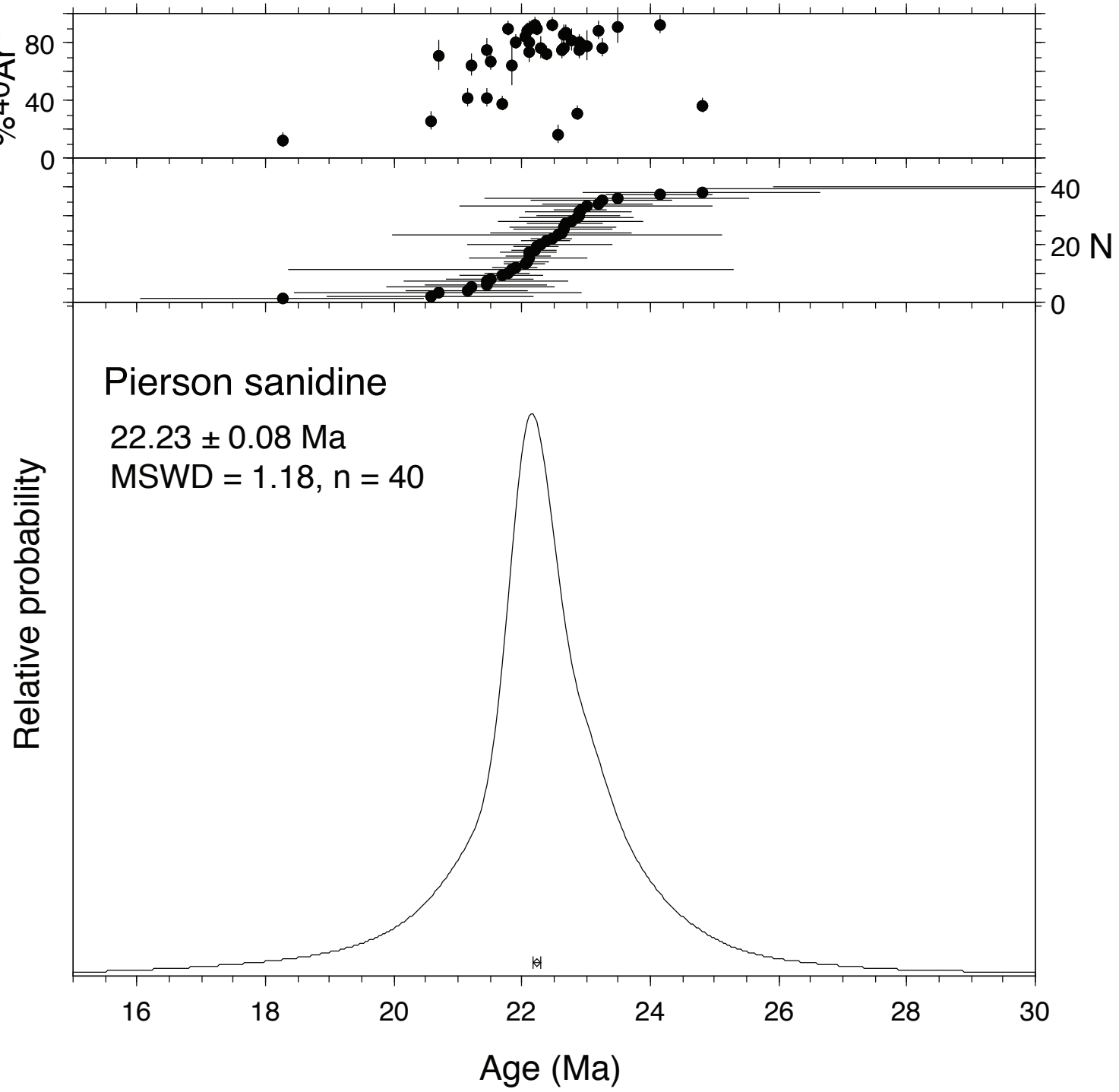

Figure 6. Age distribution of selected steps given by the age spectrum analyses of 8 (5-10 crystal) splits of Pierson sanidine.

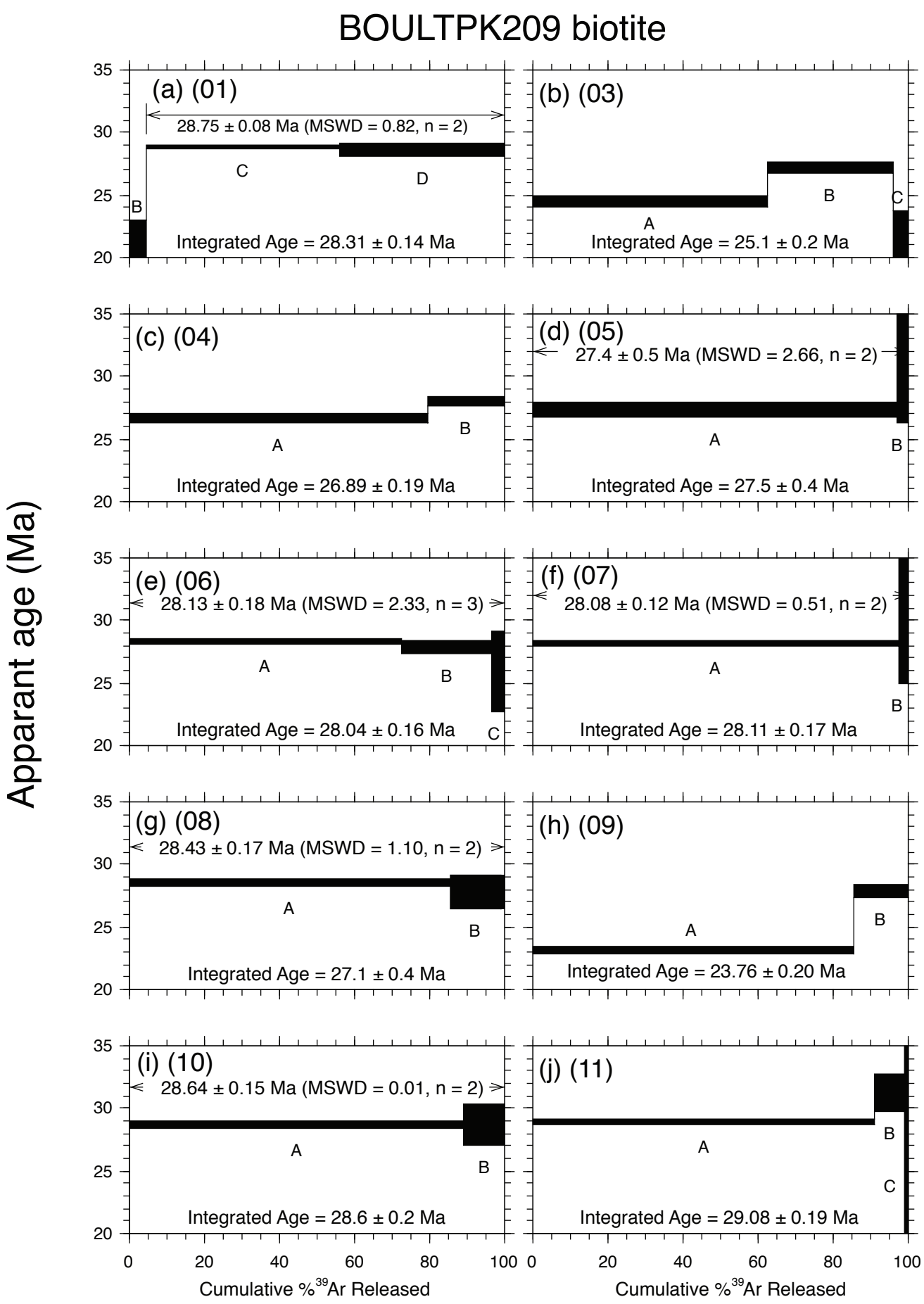

Figure 7. Two or three-step age spectra for single crystals of BOULTPK209 biotite. Spectra a variably disturbed and yield variable plateau and integrated ages. Overall, ages younger than ~28.5±0.5 Ma are considered inaccurate due to alteration and argon loss. Number in () is the run aliquot.

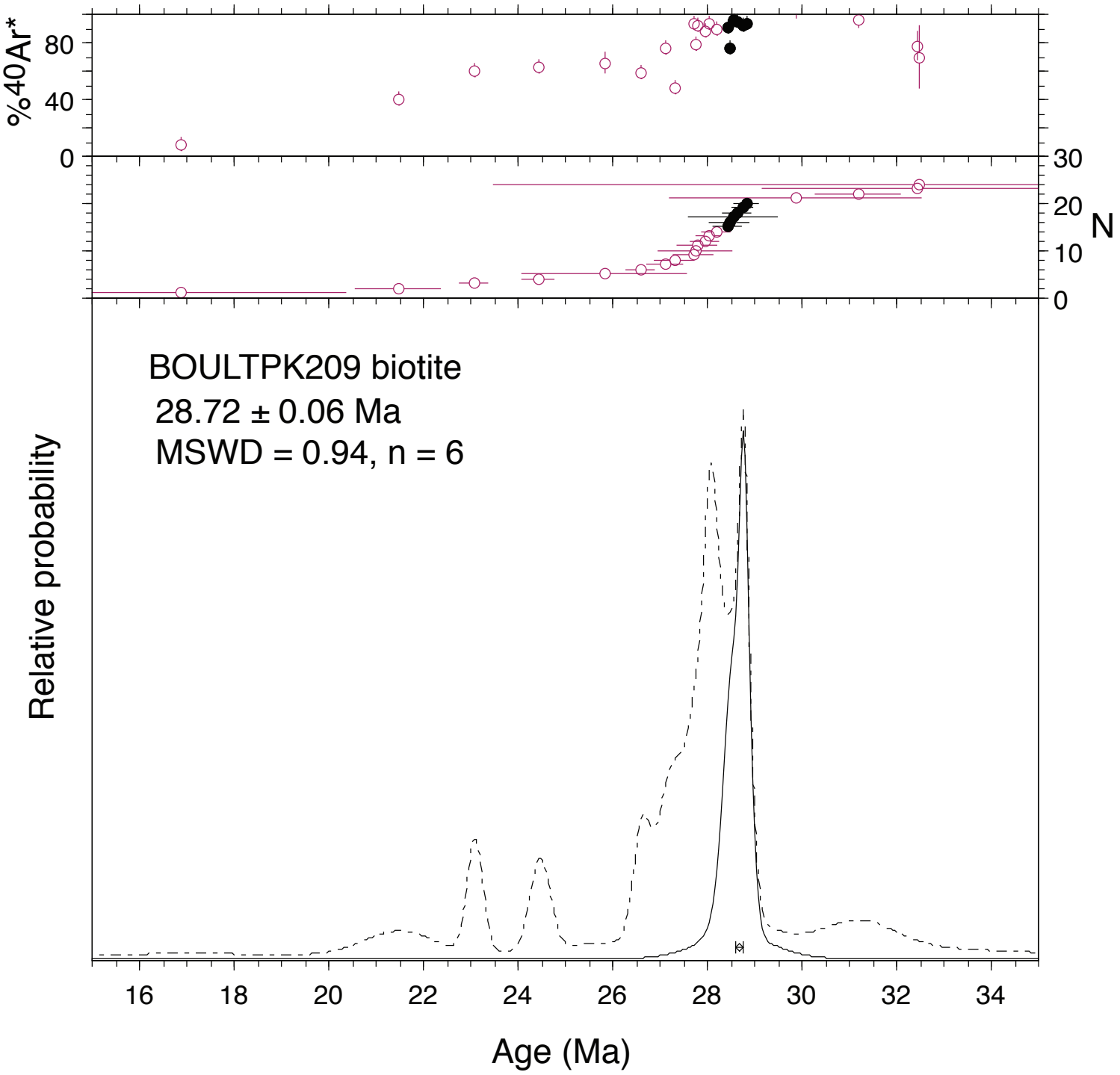

Figure 8. Age distribution of selected steps given by the age spectrum analyses of 10 single grains of BOULTPK209 biotite. High degree of scatter to young ages is related to argon loss caused by alteration.

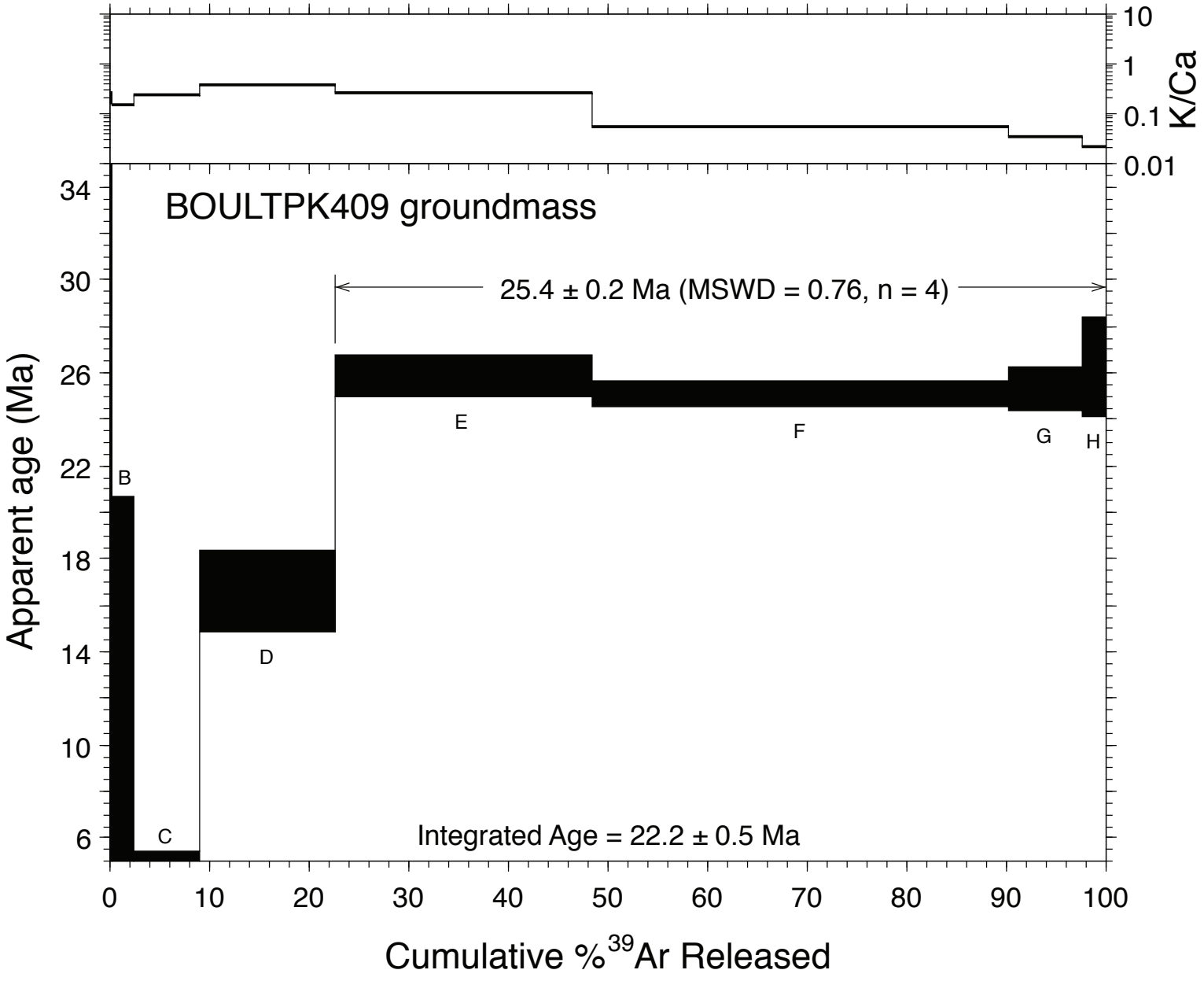

Figure 9. Age and K/Ca spectra for BoultPk groundmass concentrate.

Table 2. Argon data for total fusion analysis.

ID	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	Age (Ma)	±1σ (Ma)
BOULTPK309, sanidine, , J=0.0021191±0.08%, D=1.002±0.001, NM-237G, Lab#=59832								
06	10.39	0.0093	3.812	1.474	54.6	88.8	34.89	0.39
03	9.702	0.0085	1.512	2.103	59.9	95.2	34.94	0.26
17	9.821	0.0205	1.886	6.447	24.9	94.1	34.96	0.12
15	9.681	0.0111	1.399	1.630	45.8	95.6	35.00	0.31
25	9.359	0.0135	0.2939	6.471	37.9	99.0	35.058	0.096
01	9.563	0.0105	0.9425	3.865	48.5	97.0	35.08	0.16
09	9.722	0.0178	1.396	2.384	28.7	95.6	35.15	0.24
16	9.381	0.0059	0.2716	4.752	85.9	99.1	35.16	0.12
29	9.437	0.0116	0.4244	5.541	44.1	98.6	35.20	0.11
28	9.563	0.0097	0.8224	3.773	52.4	97.4	35.22	0.15
22	9.449	0.0071	0.4477	2.849	72.1	98.6	35.22	0.18
10	9.568	0.0092	0.8298	3.133	55.4	97.3	35.23	0.18
20	9.611	0.0111	0.9548	5.624	45.9	97.0	35.24	0.11
19	9.456	0.0117	0.4353	7.028	43.5	98.6	35.261	0.093
21	9.421	0.0064	0.3167	10.662	79.2	99.0	35.262	0.083
11	9.575	0.0093	0.8194	3.627	54.6	97.4	35.26	0.17
04	9.640	0.0103	1.017	3.879	49.7	96.8	35.28	0.19
13	9.662	0.0152	1.061	2.624	33.5	96.6	35.31	0.22
27	9.491	0.0081	0.4905	3.855	63.1	98.4	35.33	0.14
02	9.934	0.0086	1.935	4.636	59.6	94.0	35.33	0.16
18	9.430	0.0123	0.2737	8.806	41.4	99.1	35.349	0.085
24	9.395	0.0035	0.1265	6.582	144.9	99.6	35.384	0.086
26	9.468	0.0105	0.3163	5.871	48.7	99.0	35.44	0.10
14	9.612	0.0099	0.7701	2.090	51.6	97.6	35.46	0.27
07	9.721	0.0087	1.094	1.335	58.8	96.6	35.49	0.35
12	9.542	0.0165	0.4946	2.934	30.8	98.4	35.51	0.21
05	9.612	0.0118	0.7107	2.238	43.1	97.7	35.53	0.22
Mean age ± 1σ	n=27	MSWD=1.06			54.0 ±46.1		35.254	0.040
BYU-REF, sanidine, J=0.0021189±0.08%, D=1.002±0.001, NM-237G, Lab#=59833								
07	9.649	0.0297	2.273	1.331	17.2	92.8	33.87	0.40
05	12.37	0.0103	10.71	3.027	49.6	73.5	34.36	0.35
13	9.914	0.0202	2.710	2.408	25.3	91.6	34.36	0.22
21	9.302	0.0100	0.6020	5.491	51.0	98.0	34.49	0.15
22	11.22	0.0198	6.756	9.163	25.7	81.5	34.61	0.16
26	9.295	0.0430	0.4152	6.974	11.9	98.7	34.69	0.11
24	9.315	0.0079	0.4509	11.026	64.3	98.5	34.71	0.11
11	9.667	0.0141	1.464	6.329	36.2	95.4	34.87	0.14
30	9.305	0.0092	0.2368	6.798	55.5	99.2	34.92	0.12
20	9.336	0.0113	0.1996	7.029	45.0	99.4	35.08	0.12
19	9.353	0.0118	0.1664	2.968	43.4	99.5	35.18	0.21
Mean age ± 1σ	n=11	MSWD=2.81			38.6 ±33.5		34.76	0.08

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.
Decay constants and isotopic abundances after Steiger and Jäger (1977).
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 ± 2e-06
$(^{36}Ar/^{37}Ar)_{Ca}$ = 0.00028 ± 2e-05
$(^{38}Ar/^{39}Ar)_{K}$ = 0.013
$(^{40}Ar/^{39}Ar)_{K}$ = 0.01 ± 0.002

Table 3. Argon data for step-heated samples.

	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)
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-01										
X	B	3.0	14.43	0.5420	28.76	1.30	0.94	39.2	4.7	21.50	0.75
	C	6.0	8.327	0.0091	2.403	14.1	56.1	91.2	56.3	28.769	0.084
	D	8.0	10.07	0.0255	8.323	12.0	20.0	74.7	100.0	28.51	0.27
	Integrated age ± 1σ			n=3		27.4	12.3			28.57	0.14
	Plateau ± 1σ	steps C-D		n=2	MSWD=0.82	26.147			95.3	28.75	0.084
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-03										
X	A	3.0	10.39	0.0754	12.89	8.33	6.8	62.0	62.7	24.47	0.21
X	B	6.0	9.520	0.0273	7.708	4.48	18.7	75.2	96.3	27.14	0.24
X	C	15.0	66.54	0.0157	202.6	0.490	32.5	6.7	100.0	16.9	3.4
	Integrated age ± 1σ			n=3		13.3	8.9			25.84	0.21
	Plateau ± 1σ	no plateau									
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-04										
X	A	3.0	12.11	0.0274	16.62	16.2	18.6	57.9	79.8	26.62	0.18
X	B	6.0	8.454	0.0486	3.526	4.09	10.5	87.3	100.0	27.97	0.17
	Integrated age ± 1σ			n=2		20.2	16.1			27.47	0.15
	Plateau ± 1σ	no plateau									
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-05										
	A	3.0	15.41	0.1520	26.80	7.70	3.4	46.8	97.2	27.33	0.30
	B	6.0	11.24	0.1796	8.767	0.224	2.8	76.2	100.0	32.5	3.1
	Integrated age ± 1σ			n=2		7.93	3.3			28.56	0.30
	Plateau ± 1σ	steps A-B		n=2	MSWD=2.66	7.930			95.3	27.4	0.5
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-06										
	A	3.0	8.386	0.1261	3.092	6.61	4.0	88.8	73.0	28.24	0.13
	B	6.0	7.853	0.3302	1.838	2.14	1.5	93.2	96.6	27.75	0.27
	C	15.0	10.50	0.8926	12.29	0.304	0.57	64.8	100.0	25.8	1.6
	Integrated age ± 1σ			n=3		9.06	2.5			28.17	0.13
	Plateau ± 1σ	steps A-C		n=3	MSWD=2.32	9.06			100.0	28.13	0.18
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-07										
	A	3.0	7.968	0.0257	1.840	7.62	19.8	92.9	97.7	28.07	0.11
	B	6.0	7.527	0.0413	-1.1680	0.180	12.4	104.8	100.0	29.9	2.5
	Integrated age ± 1σ			n=2		7.80	19.6			28.19	0.13
	Plateau ± 1σ	steps A-B		n=2	MSWD=0.51	7.797			100.0	28.08	0.117
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-08										
	A	3.0	8.335	0.0303	2.697	5.45	16.8	90.1	85.8	28.47	0.16
	B	6.0	9.414	0.0414	6.832	0.864	12.3	77.8	100.0	27.76	0.66
	Integrated age ± 1σ			n=3		6.36	15.7			28.41	0.39
	Plateau ± 1σ	steps A-B		n=2	MSWD=1.10	6.360			100.0	28.43	0.166

Table 3. Argon data for step-heated samples.

	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)
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-09										
X	A	3.0	10.31	0.0571	13.79	14.6	8.9	59.0	85.8	23.09	0.17
X	B	6.0	8.006	0.0161	2.173	2.41	31.7	91.7	100.0	27.83	0.25
	Integrated age ± 1σ		n=2			17.0	9.9			24.27	0.15
	Plateau ± 1σ no plateau										
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-10										
	A	3.0	8.086	0.0866	1.747	4.79	5.9	93.5	89.3	28.65	0.16
	B	6.0	7.933	0.9644	1.566	0.571	0.53	95.0	100.0	28.58	0.82
	Integrated age ± 1σ		n=2			5.36	2.8			28.71	0.16
	Plateau ± 1σ	steps A-B	n=2	MSWD=0.01		5.359			100.0	28.64	0.155
	BOULTPK209, bi, J=0.0021203±0.09%, D=1.002±0.001, NM-237G, Lab#=59834-11										
X	A	3.0	8.167	0.0228	1.811	6.86	22.4	93.2	91.0	28.86	0.13
X	B	15.0	8.629	0.0080	1.272	0.624	63.8	95.5	99.3	31.21	0.75
X	C	15.0	12.59	0.0065	13.08	0.053	79.0	68.1	100.0	32.5	8.8
	Integrated age ± 1σ		n=3			7.54	23.8			29.15	0.15
	Plateau ± 1σ no plateau										
	BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-16										
	A	1.5	7.653	0.0254	3.520	4.37	20.1	85.9	16.7	24.97	0.20
	B	5.0	6.850	0.0166	0.6572	21.8	30.8	97.1	100.0	25.250	0.062
	Integrated age ± 1σ		n=2			26.2	28.3			25.251	0.066
	Plateau ± 1σ	steps A-B	n=2	MSWD=1.79		26.170			100.0	25.23	0.082
	BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-17										
	A	1.5	7.261	0.0348	1.974	14.9	14.7	91.7	35.8	25.284	0.083
	B	5.0	6.792	0.0249	0.4411	26.8	20.4	98.0	100.0	25.285	0.056
	Integrated age ± 1σ		n=2			41.7	17.9			25.326	0.056
	Plateau ± 1σ	steps A-B	n=2	MSWD=0.00		41.741			100.0	25.28	0.052
	BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-18										
	A	1.5	6.750	0.0142	0.2614	16.8	35.9	98.8	36.7	25.330	0.066
	B	5.0	6.694	0.0159	0.0844	29.0	32.1	99.6	100.0	25.325	0.050
	Integrated age ± 1σ		n=2			45.7	33.4			25.333	0.049
	Plateau ± 1σ	steps A-B	n=2	MSWD=0.00		45.743			100.0	25.33	0.045
	BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-19										
	A	1.5	6.912	0.0354	0.7833	8.21	14.4	96.6	52.3	25.35	0.11
	B	5.0	6.758	0.0237	0.3585	7.49	21.5	98.4	100.0	25.249	0.097
	Integrated age ± 1σ		n=2			15.7	17.1			25.323	0.076
	Plateau ± 1σ	steps A-B	n=2	MSWD=0.45		15.697			100.0	25.29	0.075
	BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-20										
	A	1.5	7.280	0.1032	2.044	5.91	4.9	91.5	62.8	25.30	0.13
	B	5.0	6.914	0.0508	0.5796	3.50	10.0	97.5	100.0	25.59	0.18
	Integrated age ± 1σ		n=2			9.41	6.1			25.47	0.11
	Plateau ± 1σ	steps A-B	n=2	MSWD=1.77		9.413			100.0	25.39	0.140

Table 3. Argon data for step-heated samples.

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)
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-21										
A	1.5	6.789	0.0152	0.2603	4.21	33.6	98.8	43.1	25.48	0.16
B	5.0	6.683	0.0197	0.0145	5.57	25.9	100.0	100.0	25.37	0.12
Integrated age ± 1σ			n=2		9.78	28.7			25.418	0.097
Plateau ± 1σ	steps A-B		n=2	MSWD=0.33	9.776			100.0	25.40	0.096
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-22										
A	1.5	7.072	0.0348	1.174	4.13	14.7	94.9	27.4	25.50	0.15
B	5.0	6.847	0.0227	0.3621	10.94	22.5	98.4	100.0	25.581	0.081
Integrated age ± 1σ			n=2		15.1	19.6			25.581	0.077
Plateau ± 1σ	steps A-B		n=2	MSWD=0.25	15.077			100.0	25.56	0.075
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-23										
A	1.5	6.840	0.0172	0.3906	4.85	29.7	98.3	40.0	25.52	0.13
B	5.0	6.781	0.0217	0.1375	7.27	23.6	99.4	100.0	25.591	0.095
Integrated age ± 1σ			n=2		12.1	25.7			25.573	0.082
Plateau ± 1σ	steps A-B		n=2	MSWD=0.18	12.124			100.0	25.57	0.081
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-24										
A	1.5	6.725	0.0242	0.3421	3.75	21.1	98.5	38.3	25.14	0.18
B	5.0	6.671	0.0153	0.0443	6.04	33.4	99.8	100.0	25.28	0.12
Integrated age ± 1σ			n=2		9.80	27.3			25.24	0.10
Plateau ± 1σ	steps A-B		n=2	MSWD=0.42	9.796			100.0	25.24	0.099
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-25										
A	1.5	6.712	0.0217	0.4097	4.76	23.5	98.2	33.0	25.02	0.14
B	5.0	6.715	0.0254	0.1129	9.67	20.1	99.5	100.0	25.374	0.090
Integrated age ± 1σ			n=2		14.4	21.1			25.265	0.080
Plateau ± 1σ	steps A-B		n=2	MSWD=4.51	14.429			100.0	25.27	0.163
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-26										
A	1.5	6.856	-0.0542	2.212	0.665	-	90.0	5.7	23.45	0.87
B	5.0	6.675	0.0149	0.1472	10.95	34.3	99.3	100.0	25.178	0.085
Integrated age ± 1σ			n=2		11.61	46.7			25.089	0.095
Plateau ± 1σ	steps A-B		n=2	MSWD=3.95	11.612			100.0	25.16	0.169
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-27										
A	1.5	7.550	0.1380	2.744	0.684	3.7	89.0	23.0	25.52	0.88
B	5.0	6.746	0.0223	0.3403	2.29	22.9	98.5	100.0	25.23	0.25
Integrated age ± 1σ			n=2		2.97	10.4			25.33	0.27
Plateau ± 1σ	steps A-B		n=2	MSWD=0.10	2.975			100.0	25.25	0.239
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-28										
A	1.5	6.844	0.0313	0.8818	2.43	16.3	96.1	58.0	24.97	0.25
B	5.0	6.893	0.0338	0.8232	1.76	15.1	96.4	100.0	25.22	0.34
Integrated age ± 1σ			n=2		4.19	15.8			25.11	0.20
Plateau ± 1σ	steps A-B		n=2	MSWD=0.36	4.194			100.0	25.06	0.201

Table 3. Argon data for step-heated samples.

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)
BOULTPK1509, Anorthoclase, J=0.0021226±0.09%, D=1.001±0.001, NM-237G, Lab#=59835-29										
A	1.5	6.853	0.0423	0.5005	2.04	12.1	97.8	61.0	25.45	0.29
B	5.0	6.743	0.0046	-0.3722	1.31	110.9	101.7	100.0	26.03	0.42
Integrated age ± 1σ			n=2		3.35	18.5			25.68	0.24
Plateau ± 1σ	steps A-B		n=2	MSWD=1.30	3.348			100.0	25.64	0.271
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-16										
A	1.5	20.37	0.3054	46.93	2.01	1.7	29.5	15.4	22.88	0.78
B	2.0	6.641	0.1636	2.750	3.48	3.1	87.5	42.0	22.11	0.24
C	3.0	8.210	0.5713	7.737	4.02	0.89	71.7	72.8	22.40	0.27
D	4.0	7.720	0.2414	5.590	2.94	2.1	78.0	95.3	22.92	0.31
E	5.0	7.682	0.4562	6.790	0.613	1.1	73.4	100.0	21.5	1.2
Integrated age ± 1σ			n=5		13.1	1.5			22.96	0.19
Plateau ± 1σ	steps A-E		n=5	MSWD=1.32	13.1			100.0	22.41	0.18
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-17										
A	1.5	37.37	0.3465	102.7	0.543	1.5	15.9	8.2	22.6	2.4
B	2.0	8.044	0.5716	6.985	0.792	0.89	74.0	20.2	22.64	0.97
C	3.0	6.598	0.1499	2.495	3.38	3.4	88.6	71.2	22.24	0.25
D	4.0	8.493	0.5436	9.413	1.55	0.94	66.5	94.6	21.52	0.57
E	5.0	7.792	0.5267	7.806	0.358	0.97	69.8	100.0	20.7	2.1
Integrated age ± 1σ			n=5		6.62	1.6			22.61	0.31
Plateau ± 1σ	steps A-E		n=5	MSWD=0.52	6.62			100.0	22.14	0.22
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-18										
A	1.5	13.52	0.4928	26.09	1.44	1.0	41.1	30.0	21.16	0.83
B	2.0	7.621	0.3644	5.322	1.48	1.4	79.0	61.0	22.90	0.54
C	3.0	7.840	0.8269	6.380	1.022	0.62	75.9	82.3	22.66	0.68
D	4.0	8.158	0.8819	6.918	0.758	0.58	74.9	98.2	23.26	1.00
E	5.0	9.503	1.168	3.714	0.087	0.44	89.1	100.0	32.1	7.3
Integrated age ± 1σ			n=5		4.79	0.85			23.05	0.38
Plateau ± 1σ	steps A-E		n=5	MSWD=1.36	4.79			100.0	22.59	0.41
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-19										
A	1.5	18.74	0.3813	39.96	0.574	1.3	34.8	7.0	24.8	1.7
B	2.0	6.981	0.2404	2.949	0.844	2.1	87.3	17.4	23.19	0.77
C	3.0	6.366	0.0527	1.739	2.84	9.7	91.7	52.2	22.20	0.26
D	4.0	6.496	0.0819	1.920	3.23	6.2	91.0	91.8	22.49	0.22
E	5.0	7.424	0.3502	4.781	0.666	1.5	80.6	100.0	22.8	1.0
Integrated age ± 1σ			n=5		8.15	3.9			22.85	0.21
Plateau ± 1σ	steps A-E		n=5	MSWD=0.95	8.15			100.0	22.44	0.16
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-20										
A	1.5	21.66	0.3282	53.12	0.815	1.6	24.9	13.8	20.6	1.5
B	2.0	7.000	0.1967	3.448	1.134	2.6	85.1	33.0	22.67	0.70
C	3.0	6.574	0.2396	2.529	2.23	2.1	88.5	70.8	22.13	0.31
D	4.0	6.945	0.2622	3.271	1.54	1.9	85.9	96.8	22.69	0.48
E	5.0	9.023	0.4263	10.81	0.188	1.2	63.7	100.0	21.9	3.4
Integrated age ± 1σ			n=5		5.91	2.0			22.58	0.31
Plateau ± 1σ	steps A-E		n=5	MSWD=0.63	5.91			100.0	22.30	0.24

Table 3. Argon data for step-heated samples.

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)
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-21										
A	1.5	15.56	0.2567	32.21	2.17	2.0	36.6	21.7	21.71	0.53
B	2.0	6.452	0.1269	2.388	3.43	4.0	88.8	55.9	21.80	0.22
C	3.0	7.291	0.2198	5.059	4.01	2.3	79.0	95.9	21.91	0.26
D	4.0	6.887	0.2773	2.382	0.346	1.8	89.7	99.3	23.5	2.0
E	5.0	8.946	0.2863	-1.6299	0.068	1.8	105.9	100.0	35.9	10.0
Integrated age ± 1σ			n=5		10.03	2.6			22.39	0.20
Plateau ± 1σ	steps A-E		n=5	MSWD=0.72	10.03			100.0	21.85	0.16
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-22										
A	1.5	13.71	0.1998	26.37	1.127	2.6	41.1	27.6	21.45	0.86
B	2.0	6.961	0.3338	2.076	1.039	1.5	91.3	53.1	24.16	0.73
C	3.0	7.773	0.6963	6.437	0.659	0.73	75.4	69.2	22.3	1.0
D	4.0	7.925	0.5071	7.031	0.888	1.0	73.3	91.0	22.11	0.81
E	5.0	7.905	0.4032	6.150	0.370	1.3	76.6	100.0	23.0	1.8
Integrated age ± 1σ			n=5		4.08	1.3			23.02	0.41
Plateau ± 1σ	steps A-E		n=5	MSWD=1.68	4.08			100.0	22.68	0.53
Pierson, san, J=0.0021246±0.08%, D=1.001±0.001, NM-237G, Lab#=59836-23										
A	1.5	40.44	0.4746	116.4	0.868	1.1	11.9	8.1	18.3	2.1
B	2.0	8.083	0.4842	6.858	0.978	1.1	74.5	17.1	22.91	0.70
C	3.0	6.976	0.2008	3.888	4.39	2.5	83.1	57.9	22.07	0.21
D	4.0	7.318	0.3535	4.994	3.95	1.4	79.5	94.5	22.13	0.24
E	5.0	8.718	0.5283	10.39	0.598	0.97	63.9	100.0	21.2	1.2
Integrated age ± 1σ			n=5		10.78	1.6			22.40	0.23
Plateau ± 1σ	steps A-E		n=5	MSWD=1.30	10.78			100.0	22.10	0.18

Table 3. Argon data for step-heated samples.

	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)
	BoultPK409, Groundmass Concentrate, 4.84 mg, J=0.0020704±0.07%, D=1.001±0.001, NM-237F, Lab#=59830-01										
X	A	1.0	381.0	2.504	1236.2	0.058	0.20	0.6	0.3	8.5	14.6
X	B	1.5	299.5	3.405	970.4	0.478	0.15	0.8	2.5	8.9	5.9
X	C	2.0	113.6	2.132	370.4	1.43	0.24	0.2	9.0	0.8	2.3
X	D	2.5	50.32	1.428	150.0	2.98	0.36	8.9	22.7	16.61	0.88
	E	3.0	23.41	1.911	54.18	5.65	0.27	29.7	48.5	25.82	0.44
	F	4.0	16.74	9.087	35.22	9.13	0.056	40.1	90.4	25.08	0.35
	G	5.0	12.70	14.21	23.35	1.61	0.036	53.2	97.8	25.30	0.57
	H	6.0	16.68	24.18	38.47	0.485	0.021	41.7	100.0	26.2	1.2
	Integrated age ± 1σ			n=8		21.8	0.081	K2O=0.84%		26.20	0.52
	Plateau ± 1σ	steps E-H		n=4	MSWD=0.76	16.9			77.3	25.39	0.24

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.
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 ± 2e-06
$(^{36}Ar/^{37}Ar)_{Ca}$ = 0.00028 ± 2e-05
$(^{38}Ar/^{39}Ar)_K$ = 0.013
$(^{40}Ar/^{39}Ar)_K$ = 0.01 ± 0.002