$^{40}Ar/^{39}Ar$ Geochronology Results for the Lofgreen, Vernon, and White Tower Quadrangles, Utah

by

Utah Geological Survey and
Nevada Isotope Geochronology Laboratory

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OPEN-FILE REPORT 588
UTAH GEOLOGICAL SURVEY
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2012

INTRODUCTION

This open-file report makes available raw analytical data from laboratory procedures completed to determine the age of rock samples collected during geologic investigations funded or partially supported by the Utah Geological Survey (UGS). The references listed in table 1 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 report was prepared by the Nevada Isotope Geochronology Laboratory (NIGL) under contract to the UGS. These data are highly technical in nature and proper interpretation requires considerable training in the applicable geochronologic techniques.

Table 1. Sample numbers and locations.

Sample #	**7.5' quadrangle**	**UTM Easting NAD83**	**UTM Northing NAD83**	**Reference**
KC-USU-1	White Tower	0363327	4116936	Summa, 2009
KC-USU-2	White Tower	0363420	4120091	Summa, 2009
		UTM Easting NAD27	**UTM Northing NAD27**	
879	Lofgreen	0380034	4434853	Kirby, 2010a
920	Lofgreen	0382814	4437572	Kirby, 2010a
873	Vernon	0381537	4430359	Kirby, 2010b

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 NIGL 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.

REFERENCES

Kirby, S.M., 2010a, Interim geologic map of the Lofgreen quadrangle, Tooele County, Utah: Utah Geological Survey Open-File Report 563, 17 p., 2 plates, scale 1:24,000, CD.

Kirby, S.M., 2010b, Interim geologic map of the Vernon quadrangle, Tooele County, Utah: Utah Geological Survey Open-File Report 564, 18 p., 2 plates, scale 1:24,000, CD.

Summa, M.C., 2009, Geologic mapping, alluvial stratigraphy, and Optically Stimulated Luminescence dating of the Kanab Creek area, southern Utah: Logan, Utah State University, M.S. thesis, 170 p.

The Nevada Isotope Geochronology Laboratory

University of Nevada, Las Vegas
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Project No. 312

LABORATORY DESCRIPTION AND PROCEDURES

Samples analyzed by the $^{40}Ar/^{39}Ar$ method at the University of Nevada Las Vegas were wrapped in Al foil and stacked in 6 mm inside diameter sealed fused silica tubes. Individual packets averaged 3 mm thick and neutron fluence monitors (FC-2, Fish Canyon Tuff sanidine) were placed every 5-10 mm along the tube. Synthetic K-glass and optical grade CaF_2 were included in the irradiation packages to monitor neutron induced argon interferences from K and Ca. Loaded tubes were packed in an Al container for irradiation. Samples irradiated at the U. S. Geological Survey TRIGA Reactor, Denver, CO were in-core for 7 hours in the In-Core Irradiation Tube (ICIT) of the 1 MW TRIGA type reactor. Correction factors for interfering neutron reactions on K and Ca were determined by repeated analysis of K-glass and CaF_2 fragments. Measured $(^{40}Ar/^{39}Ar)_K$ values were 2.05 (± 33.35%) x 10^{-2}. Ca correction factors were $(^{36}Ar/^{37}Ar)_{Ca}$ = 2.67 (± 1.87%) x 10^{-4} and $(^{39}Ar/^{37}Ar)_{Ca}$ = 6.91 (± 1.19%) x 10^{-4}. J factors were determined by fusion of 4-8 individual crystals of neutron fluence monitors which gave reproducibility's of 0.22% to 0.58% at each standard position. Variation in neutron fluence along the 100 mm length of the irradiation tubes was <4%. Matlab curve fit was used to determine J and uncertainty in J at each standard position. No significant neutron fluence gradients were present within individual packets of crystals as indicated by the excellent reproducibility of the single crystal fluence monitor fusions.

Irradiated FC-2 sanidine standards together with CaF_2 and K-glass fragments were placed in a Cu sample tray in a high vacuum extraction line and were fused using a 20 W CO_2 laser. Sample viewing during laser fusion was by a video camera system and positioning was via a motorized sample stage. Samples analyzed by the furnace step heating method utilized a double vacuum resistance furnace similar to the Staudacher et al. (1978) design. Reactive gases were removed by three GP-50 SAES getters prior to being admitted to a MAP 215-50 mass spectrometer by expansion. The relative volumes of the extraction line and mass spectrometer allow 80% of the gas to be admitted to the mass spectrometer for laser fusion analyses and 76% for furnace heating analyses. Peak intensities were measured using a Balzers electron multiplier by peak hopping through 7 cycles; initial peak heights were determined by linear regression to the time of gas admission. Mass spectrometer discrimination and sensitivity was monitored by repeated analysis of atmospheric argon aliquots from an on-line pipette system. Measured $^{40}Ar/^{36}Ar$ ratios were 278.50 ± 0.63% during this work, thus a discrimination correction of 1.0611 (4 AMU) was applied to measured isotope ratios. The sensitivity of the mass spectrometer was ~6 x 10^{-17} mol mV^{-1} with the multiplier operated at a gain of 36 over the Faraday. Line blanks averaged 27.18 mV for mass 40 and 0.01 mV for mass 36 for laser fusion analyses and 30.04 mV for mass 40 and 0.11 mV for mass 36 for furnace heating analyses. Discrimination, sensitivity, and blanks were relatively constant over the period of data collection. Computer automated operation of the sample stage, laser, extraction line and mass spectrometer as well as final data reduction and age calculations were done using LabSPEC software written by B. Idleman (Lehigh University). An age of 28.02 Ma (Renne et al., 1988) was used for the Fish Canyon Tuff sanidine fluence monitor in calculating ages for samples.

For $^{40}Ar/^{39}Ar$ analyses a plateau segment consists of 3 or more contiguous gas fractions having analytically indistinguishable ages (i.e. all plateau steps overlap in age at

$\pm$ 2σ analytical error) and comprising a significant portion of the total gas released (typically >50%). Total gas (integrated) ages are calculated by weighting by the amount of ^{39}Ar released, whereas plateau ages are weighted by the inverse of the variance. For each sample inverse isochron diagrams are examined to check for the effects of excess argon. Reliable isochrons are based on the MSWD criteria of Wendt and Carl (1991) and, as for plateaus, must comprise contiguous steps and a significant fraction of the total gas released. All analytical data are reported at the confidence level of 1σ (standard deviation).

Note: Check your samples data sheets for the discrimination, and fluence monitor values used for each sample.

RESULTS

General Comments

Your samples were run as conventional furnace step heating analyses on bulk groundmass or plagioclase separates, as well as single crystal laser fusion analyses on sanidine. All data are reported at the 1σ uncertainty level, unless noted otherwise.

Furnace step heating analyses produce what is referred to as an apparent age spectrum. The "apparent" derives from the fact that ages on an age spectrum plot are calculated assuming that the non-radiogenic argon (often referred to as trapped, or initial argon) is atmospheric in isotopic composition ($^{40}Ar/^{36}Ar = 295.5$). If there is excess argon in the sample ($^{40}Ar/^{36}Ar > 295.5$) then these apparent ages will be older than the actual age of the sample. U-shaped age spectra are commonly associated with excess argon (the first few and final few steps often have lower radiogenic yields, thus apparent ages calculated for these steps are effected more by any excess argon present). Excess argon can also produce generally discordant age spectra. This is often verified by isochron analysis, which utilizes the analytical data generated during the step heating run, but makes no assumption regarding the composition of the non-radiogenic argon. Thus, isochrons can verify (or rule out) excess argon, and isochron ages are usually preferred if a statistically valid regression is obtained (as evidenced by the MSWD, mean square of weighted deviates, a measure of the coherence of the population). If such a sample yields no reliable isochron, the best estimate of the age is that the minimum on the age spectrum is a maximum age for the sample (it could be affected by excess argon, the extent depending on the radiogenic yield). $^{40}Ar/^{39}Ar$ total gas ages are equivalent to K/Ar ages. Plateau ages are sometimes found, these are simply a segment of the age spectrum which consists of 3 or more steps, comprising >50% of the total gas released, which overlap in age at the $\pm$2σ analytical error level (not including the J-factor error, which is common to all steps). However, in general an isochron age is the best estimate of the age of a sample, even if a plateau age is obtained.

Laser fusion analyses allow the identification of juvenile phenocryst populations (which should yield the eruption age) as well as any older contaminating xenocrysts, or younger altered crystals. Data sets are screened for anomalous older (or younger) outliers by standard statistical methods. A weighted mean is calculated, and the MSWD is checked. Outliers in the data set which contribute to the MSWD are identified and eliminated sequentially until the MSWD falls below the cutoff value, based on the criteria of Wendt and Carl (1991). Data are also regressed on an isochron plot. As for step heating data, isochrons are generally preferred for age calculation.

KC-USU-1 Basalt Groundmass

This sample produced a discordant age spectrum with ages of generally low precision. Individual step ages decrease from a first step of ~550 ka to 211 ka for step 5, followed by increasing ages to a final step age of ~7 Ma. Overall, the age spectrum has a U-shape, which as discussed above may indicate excess argon is present. The total gas age (equivalent to a K-Ar age) for this sample is 1.12 ± 0.04 Ma. No plateau or isochron ages were defined by these data.

Radiogenic yields (%^{40}Ar*) are fairly low, as would be expected for a low-K material of young age. Although no isochron was obtained to verify, or rule out, the presence of excess argon, the U-shaped age spectrum and the known association of basaltic magmas with excess argon suggests a conservative interpretation of these data. Accordingly, the total gas age is likely to be anomalously old. The youngest age on the age spectrum may represent a maximum age for this sample (it could also be affected by excess argon). Thus, the most reasonable interpretation is that this sample is <211 ka.

KC-USU-2 Basalt Groundmass

This sample produced data similar to that of KC-USU-1 described above, and similar interpretations apply. The age spectrum is distinctly U-shaped, with high initial ages, falling to a minimum age at step 3 (276 ka), followed by increasing ages with the final steps. The total gas age is 856 ± 37 ka. No plateau is defined by these data, however, an isochron is defined by steps 4-9 (45% of the ^{39}Ar released). Note that this is referred to as a "pseudo isochron" because it is constrained by less than 50% of the gas released. Also, the data have low radiogenic yields, and cluster near the y-axis. Accordingly, the initial ^{40}Ar/^{36}Ar ratio is well constrained, but the age (x-axis intercept) is relatively poorly constrained. The isochron does indicate excess argon, with ^{40}Ar/^{36}Ar = 312 ± 5, and yields an age of 220 ± 110 ka. The age spectrum shape alone would suggest the sample is <276 ka, for reasons discussed above for KC-USU-01. The isochron confirms both excess argon, and a younger age that the minimum on the age spectrum. Although very imprecise, the isochron age is the most accurate and reliable for this sample.

879 Sanidine

This sample yielded a set of 16 indistinguishable laser fusion ages on single crystals. There is no statistical evidence of outliers. The mean age of this population is 35.35± 0.20 Ma (n=16) and the corresponding weighted mean on these same analyses is indistinguishable at 35.33± 0.05 Ma. Note that all of these analyses have consistent Ca/K ratios and high radiogenic yields, indicating a chemically homogeneous population of crystals that are unaltered. Fifteen of these analyses define an isochron age of 35.37± 0.10 Ma, and do not indicate the presence of excess argon as the ^{40}Ar/^{36}Ar intercept is indistinguishable from atmospheric argon. Since all ages are identical within uncertainties, and the isochron does not indicate excess argon is present, the weighted mean age may be used for this sample.

920 Plagioclase

This sample produced a nearly ideal, easily interpretable data set. With the exception of slightly older initial steps (only ~3% of the ^{39}Ar released), the age spectrum is flat, yielding reproducible ages. The total gas age is 37.32 ± 0.22 Ma. Steps 3-11 (75% of the ^{39}Ar released) define a younger plateau age of 36.78 ± 0.24 Ma, although these ages overlap at the 2σ uncertainty level. Steps 1-11 (78% of the ^{39}Ar released) define a valid isochron age of 36.63 ± 0.16 Ma, and indicate that some excess argon is present, as the initial ^{40}Ar/^{36}Ar = 312 ± 3. Although all of these ages overlap at the 2σ uncertainty level, the isochron age should be considered the most accurate and reliable.

873 Plagioclase

This sample produced an age spectrum with an initial high-age step (~39 Ma, but very imprecise) followed by ages which generally increase from step 2 (34.4 Ma) to the final step (36.9 Ma). The total gas age is 35.94 ± 0.17 Ma. Steps 4-10 (64% of the ^{39}Ar released) define an indistinguishable plateau age of 35.58 ± 0.19 Ma. Steps 3-8 (48% of the ^{39}Ar released) yield an isochron age of 35.87 ± 0.29 Ma, and an initial ^{40}Ar/^{36}Ar ratio of 201 ± 42. Note that although statistically valid, the isochron data cluster near the x-axis and the initial ratio is significantly lower than the atmospheric value of 295.5. There are no known geologic processes which could produce such an initial argon isotopic ratio, thus this isochron line fit is considered spurious and unreliable. Thus, the plateau age should be considered the most reliable for this sample.

The interpretations given above are based simply on inspection of the laboratory data. Geologic relationships, which are unknown to us, are not considered.

REFERENCES

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

Staudacher, T.H., Jessberger, E.K., Dorflinger, D., and Kiko, J., A refined ultrahigh-vacuum furnace for rare gas analysis, *J. Phys. E: Sci. Instrum.*, *11*, 781-784, 1978.

Wendt, I., and Carl, C., 1991, The statistical distribution of the mean squared weighted deviation, *Chemical Geology*, v. 86, p. 275-285.

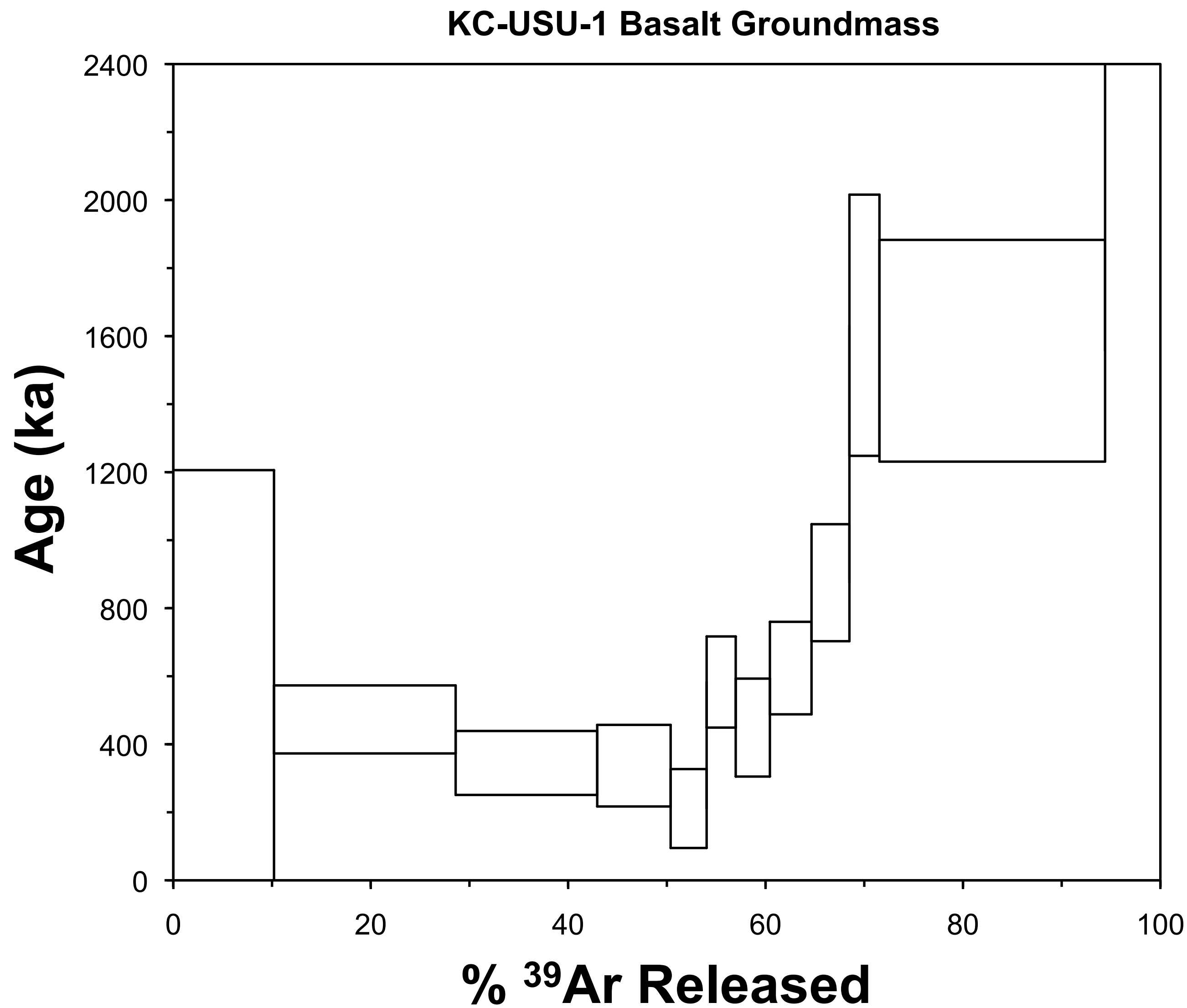
APPENDIX

Analytical data for samples KC-USU-1 basalt groundmass, KC-USU-2 basalt groundmass, 879 sanidine, 920 plagioclase, 873 plagioclase.

Clark-UT DNR, KC-USU-1, Basalt Groundmass, 26.30 mg, J = 0.001690 ± 0.19%
4 amu discrimination = 1.0501 ± 0.64%, 40/39K = 0.0205 ± 33.35%, 36/37Ca = 0.000267 ± 1.87%, 39/37Ca = 0.000691 ± 1.19%

step	T (C)	t (min.)	36Ar	37Ar	38Ar	39Ar	40Ar	%40Ar*	% 39Ar rlsd	Ca/K	40Ar*/39ArK	Age (ka)	1s.d.
1	650	12	3.471	2.647	1.987	60.400	983.88	1.1	10.2	2.49005948	209.134734	546.00	330.00
2	740	12	0.759	2.660	1.788	108.991	227.229	7.6	18.4	1.386244318	177.376064	473.00	50.00
3	800	12	0.482	1.999	1.334	84.946	142.831	7.0	14.3	1.336632972	124.699484	345.00	47.00
4	850	12	0.277	1.412	0.711	44.056	80.740	6.5	7.4	1.820686074	121.529644	337.00	60.00
5	900	12	0.189	0.921	0.366	21.594	53.121	3.2	3.6	2.423318791	73.415048	211.00	58.00
6	950	12	0.208	0.763	0.328	17.454	61.394	6.4	2.9	2.483827736	225.729046	583.00	67.00
7	1000	12	0.226	0.914	0.371	20.506	65.030	3.8	3.5	2.532581938	167.212433	449.00	72.00
8	1050	12	0.285	1.178	0.475	24.977	84.164	6.8	4.2	2.679924067	244.519254	624.00	68.00
9	1100	12	0.305	1.304	0.460	22.743	90.907	7.9	3.8	3.258537632	369.346338	875.00	86.00
10	1150	12	0.435	2.486	0.442	18.023	128.866	8.8	3.0	7.849916094	870.406412	1632.00	192.00
11	1220	12	3.756	31.259	3.413	135.375	1069.00	6.5	22.9	13.16189723	810.868474	1557.00	163.00
12	1400	12	2.668	7.164	1.154	33.182	812.689	10.2	5.6	12.30334802	28545.04006	7030.00	556.00
							Cumulative %39Ar rlsd =		100.0		Total gas age =	1117.05	41.96
											No plateau		
											No isochron		

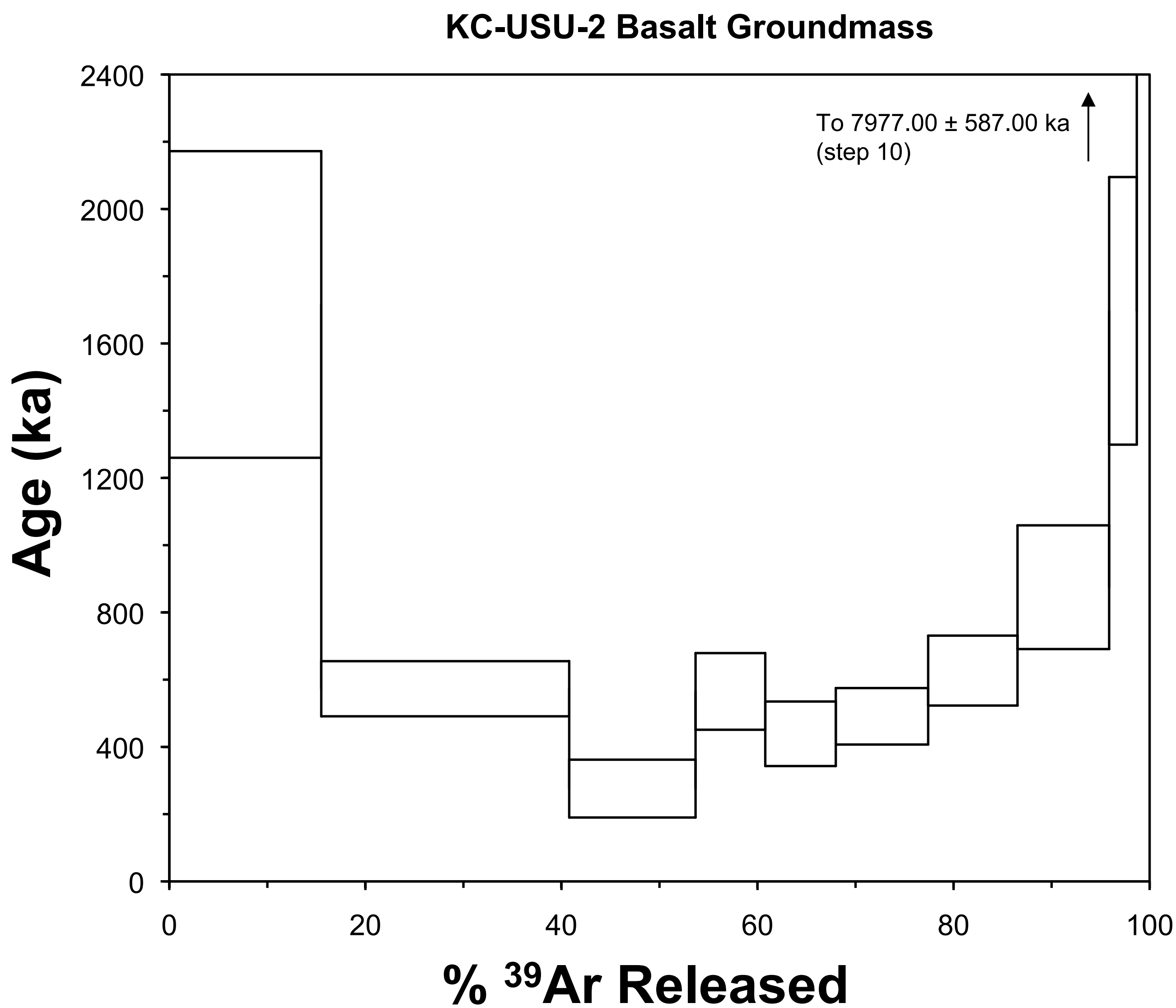
note: isotope beams in mV, rlsd = released, error in age includes J error, all errors 1 sigma
(36Ar through 40Ar are measured beam intensities, corrected for decay for the age calculations)

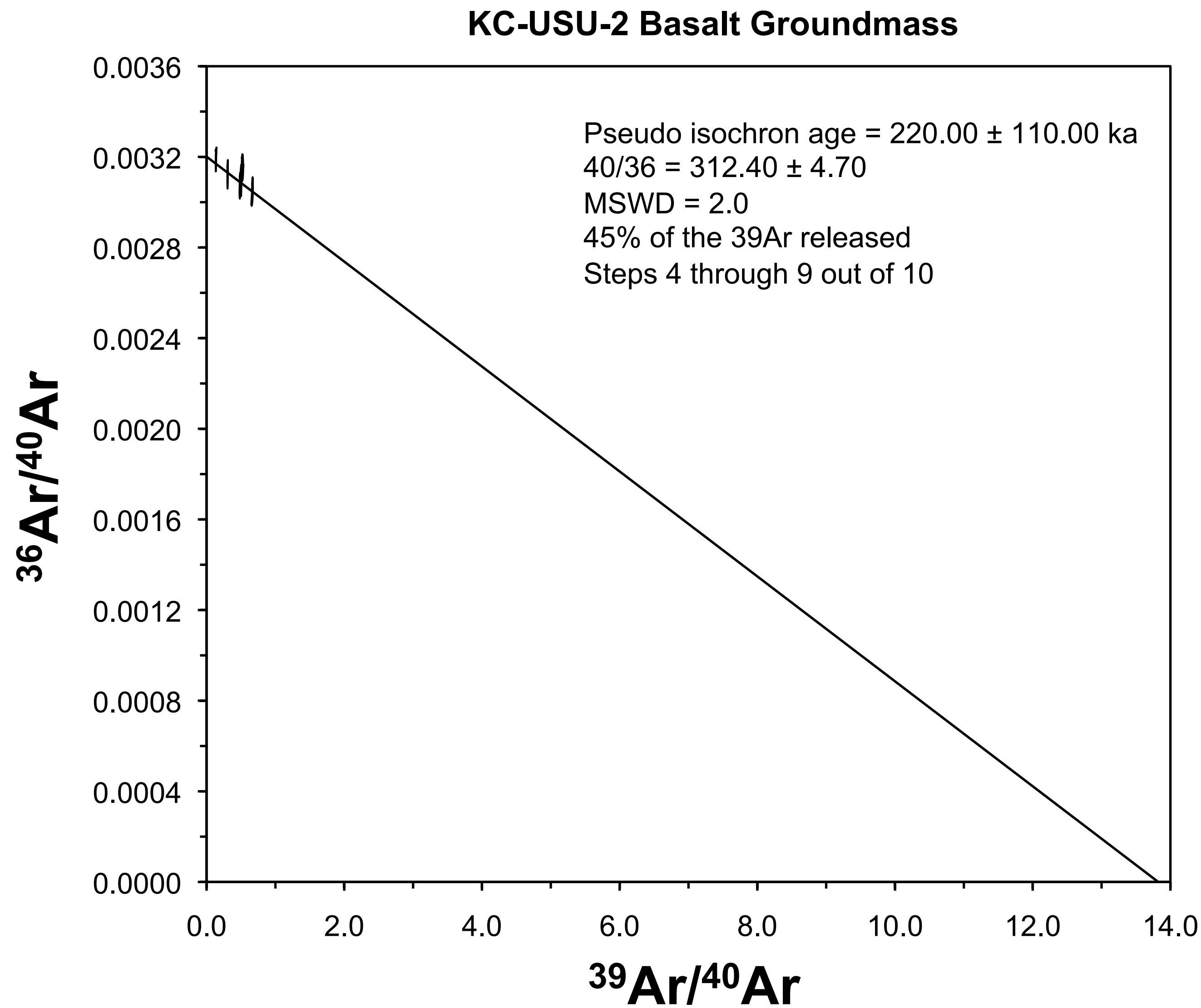

KC-USU-1 Basalt Groundmass
Age (ka)
0
400
800
1200
1600
2000
2400
0
20
40
60
80
100
% ^{39}Ar Released

Clark-UT DNR, KC-USU-2, Basalt Groundmass, 19.90 mg, J = 0.001676 ± 0.22%
4 amu discrimination = 1.0501 ± 0.64%, 40/39K = 0.0205 ± 33.35%, 36/37Ca = 0.000267 ± 1.87%, 39/37Ca = 0.000691 ± 1.19%

step	T (C)	t (min.)	36Ar	37Ar	38Ar	39Ar	40Ar	%40Ar*	% 39Ar rlsd	Ca/K	40Ar*/39ArK	Age (ka)	1s.d.
1	650	12	3.063	3.661	1.926	93.306	909.43	5.8	15.5	2.240350417	947.947190	1716.00	228.00
2	740	12	0.884	3.564	2.190	152.268	273.304	10.7	25.3	1.336093729	223.058304	573.00	41.00
3	800	12	0.472	1.815	1.149	77.593	137.683	5.3	12.9	1.335247733	98.633411	276.00	43.00
4	860	12	0.328	1.341	0.662	42.813	98.288	8.6	7.1	1.788215911	219.431398	565.00	57.00
5	940	12	0.334	1.805	0.684	43.313	98.266	7.0	7.2	2.379594144	164.379050	439.00	48.00
6	1020	12	0.336	2.719	0.931	56.731	100.219	10.1	9.4	2.737028506	186.634092	491.00	42.00
7	1100	12	0.441	3.391	1.024	54.856	130.570	9.3	9.1	3.530999881	247.965136	627.00	52.00
8	1170	12	0.799	11.695	1.267	56.289	220.751	8.0	9.3	11.8976139	372.431570	875.00	92.00
9	1220	12	0.644	9.660	0.557	16.982	173.547	6.1	2.8	32.77764008	931.765226	1697.00	199.00
10	1400	12	0.984	3.131	0.347	7.876	290.909	9.4	1.3	22.83919303	49065.39318	7977.00	587.00
							Cumulative %39Ar rlsd =		100.0		Total gas age =	855.65	36.65
											No plateau		
											Pseudo isochron age =	220.00	110.00
											(steps 4-9)		

note: isotope beams in mV, rlsd = released, error in age includes J error, all errors 1 sigma
(36Ar through 40Ar are measured beam intensities, corrected for decay for the age calculations)

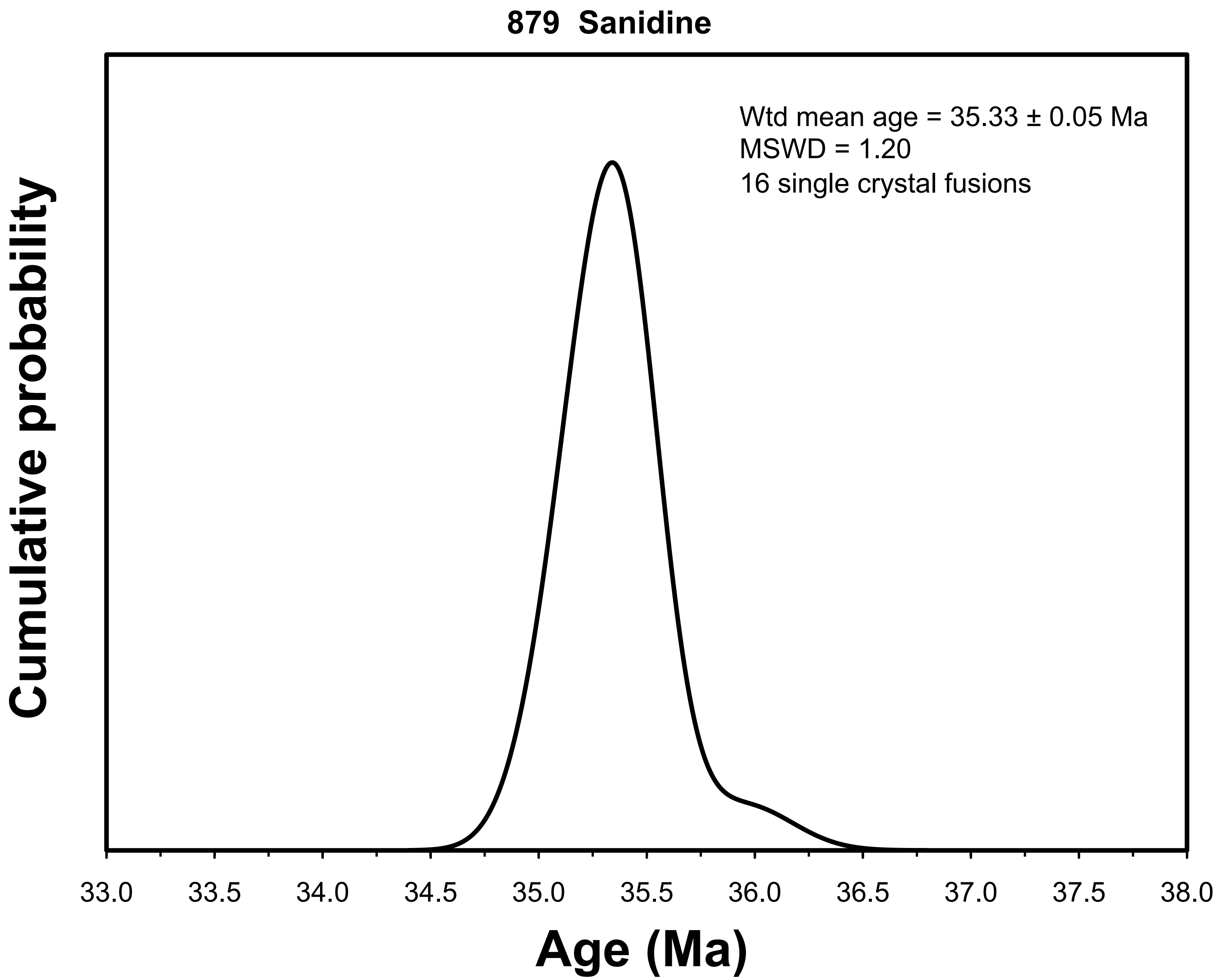

KC-USU-2 Basalt Groundmass
To 7977.00 ± 587.00 ka
(step 10)
Age (ka)
% 39Ar Released
0
400
800
1200
1600
2000
2400
0
20
40
60
80
100

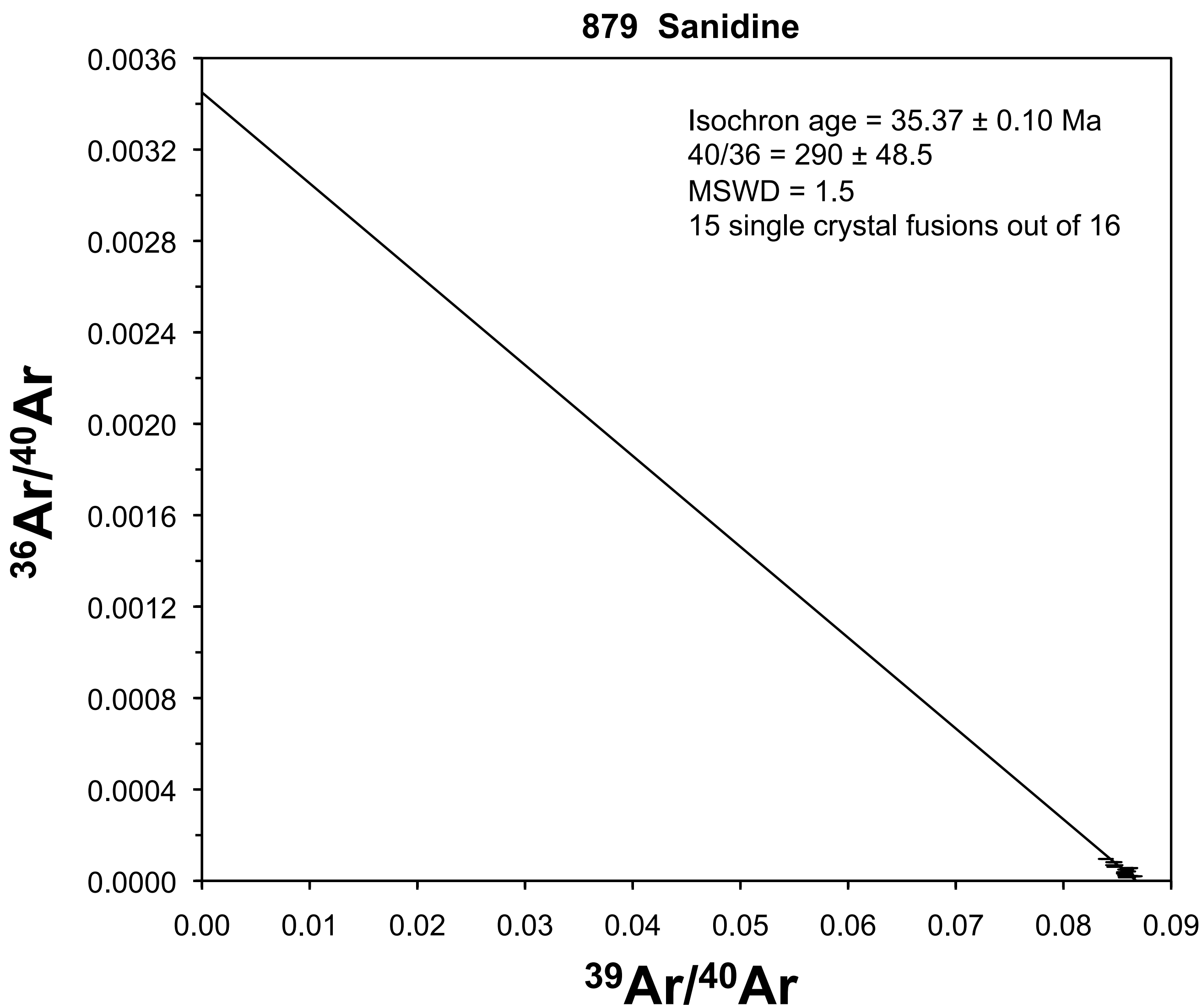

KC-USU-2 Basalt Groundmass
Pseudo isochron age = 220.00 ± 110.00 ka
40/36 = 312.40 ± 4.70
MSWD = 2.0
45% of the 39Ar released
Steps 4 through 9 out of 10
0.0036
0.0032
0.0028
0.0024
0.0020
0.0016
0.0012
0.0008
0.0004
0.0000
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
36Ar/40Ar
39Ar/40Ar

Clark-UT DNR, 879, Single Crystal Sanidine, J = 0.001718 ± 0.20%
4 amu discrimination = 1.0583 ± 0.33%, 40/39K = 0.0205 ± 33.35%, 36/37Ca = 0.000267 ± 1.87%, 39/37Ca = 0.000691 ± 1.19%

Crystal	T (C)	t (min.)	36Ar	37Ar	38Ar	39Ar	40Ar	%40Ar*	Ca/K	40Ar*/39ArK	Age (Ma)	1s.d.
1	1600	1	0.242	0.094	1.464	105.589	1264.25	97.3	0.01883769	11.4942	35.28	0.17
2	1600	1	0.384	0.188	3.775	274.701	3234.42	97.6	0.014481568	11.5255	35.37	0.17
3	1600	1	0.326	0.191	3.233	235.732	2780.57	97.9	0.017144827	11.5531	35.46	0.17
4	1600	1	0.206	0.135	2.200	159.456	1870.69	98.7	0.017914772	11.5215	35.36	0.16
5	1600	1	0.189	0.066	1.108	80.111	952.477	98.1	0.017432919	11.4004	34.99	0.17
6	1600	1	0.247	0.163	2.440	178.598	2089.95	98.3	0.019312102	11.4633	35.18	0.17
7	1600	1	0.199	0.140	1.837	133.782	1574.92	98.6	0.022143649	11.5113	35.33	0.17
8	1600	1	0.181	0.123	2.080	153.106	1795.95	99.1	0.016999305	11.5518	35.45	0.17
9	1600	1	0.182	0.107	1.858	133.140	1565.73	98.9	0.01700566	11.5330	35.40	0.17
10	1600	1	0.187	0.185	3.173	233.151	2712.38	99.3	0.016790077	11.5538	35.46	0.17
11	1600	1	0.167	0.102	1.725	122.541	1441.16	98.5	0.017613152	11.4679	35.20	0.17
12	1600	1	0.188	0.136	2.561	185.996	2155.78	99.1	0.015472248	11.4547	35.16	0.16
13	1600	1	0.355	0.139	2.457	179.063	2140.34	96.9	0.016425823	11.5478	35.44	0.17
14	1600	1	0.207	0.104	1.838	134.897	1583.06	98.5	0.016313579	11.4603	35.18	0.17
15	1600	1	0.194	0.101	1.909	139.959	1646.82	98.8	0.015269985	11.5327	35.40	0.17
16	1600	1	0.205	0.093	1.461	105.506	1276.21	98.2	0.01865195	11.7173	35.96	0.22
										Mean ± s.d. =	35.35	0.20
										Wtd mean age = (16 crystals)	35.33	0.05
										Isochron age = (15 crystals)	35.37	0.10

note: isotope beams in mV rlsd = released, error in age includes J error, all errors 1 sigma
(36Ar through 40Ar are measured beam intensities, corrected for decay in age calculations)

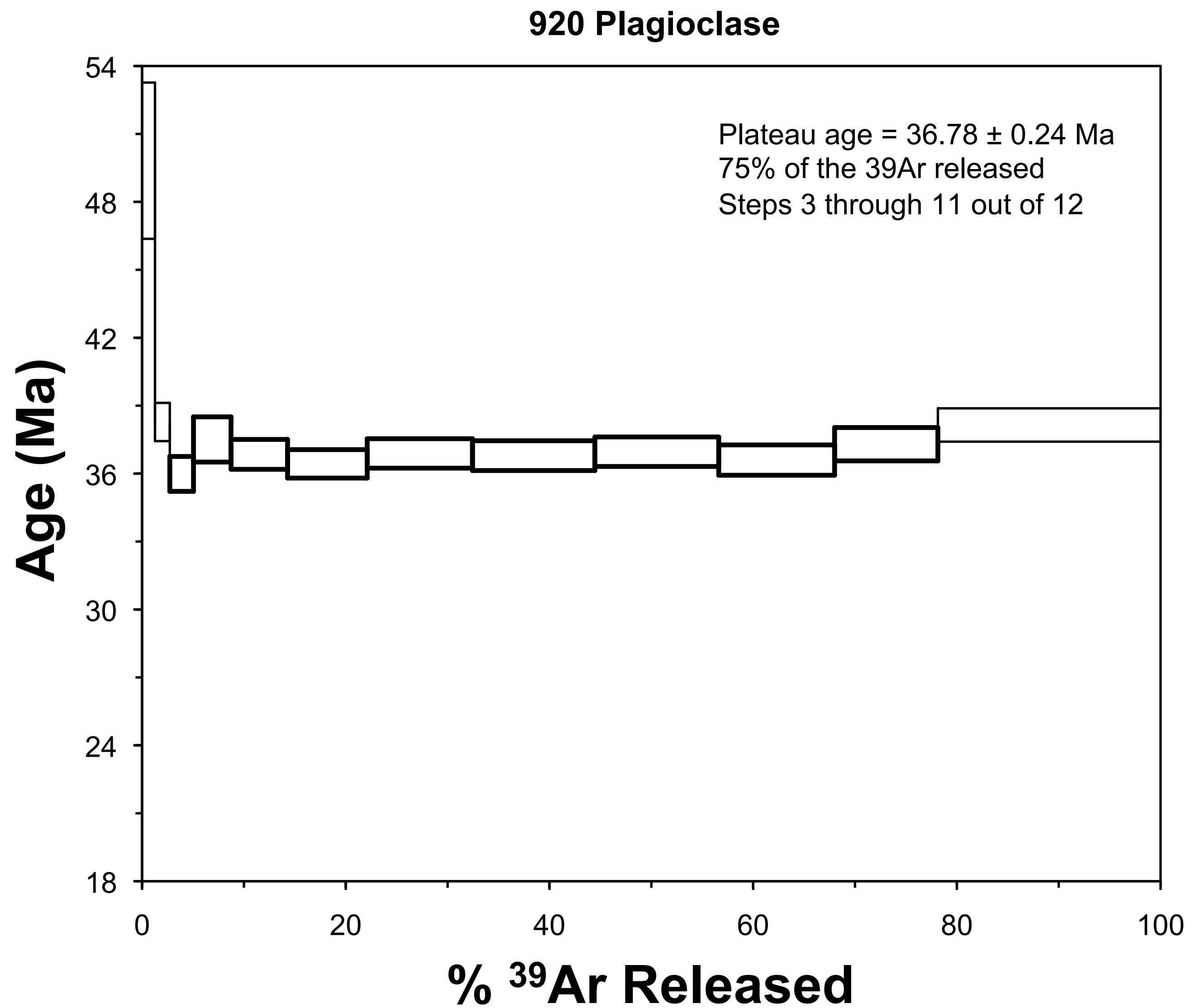

879 Sanidine
Wtd mean age = 35.33 ± 0.05 Ma
MSWD = 1.20
16 single crystal fusions
Cumulative probability
33.0
33.5
34.0
34.5
35.0
35.5
36.0
36.5
37.0
37.5
38.0
Age (Ma)


879 Sanidine
Isochron age = 35.37 ± 0.10 Ma
40/36 = 290 ± 48.5
MSWD = 1.5
15 single crystal fusions out of 16
0.0036
0.0032
0.0028
0.0024
0.0020
0.0016
0.0012
0.0008
0.0004
0.0000
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
36Ar/40Ar
39Ar/40Ar

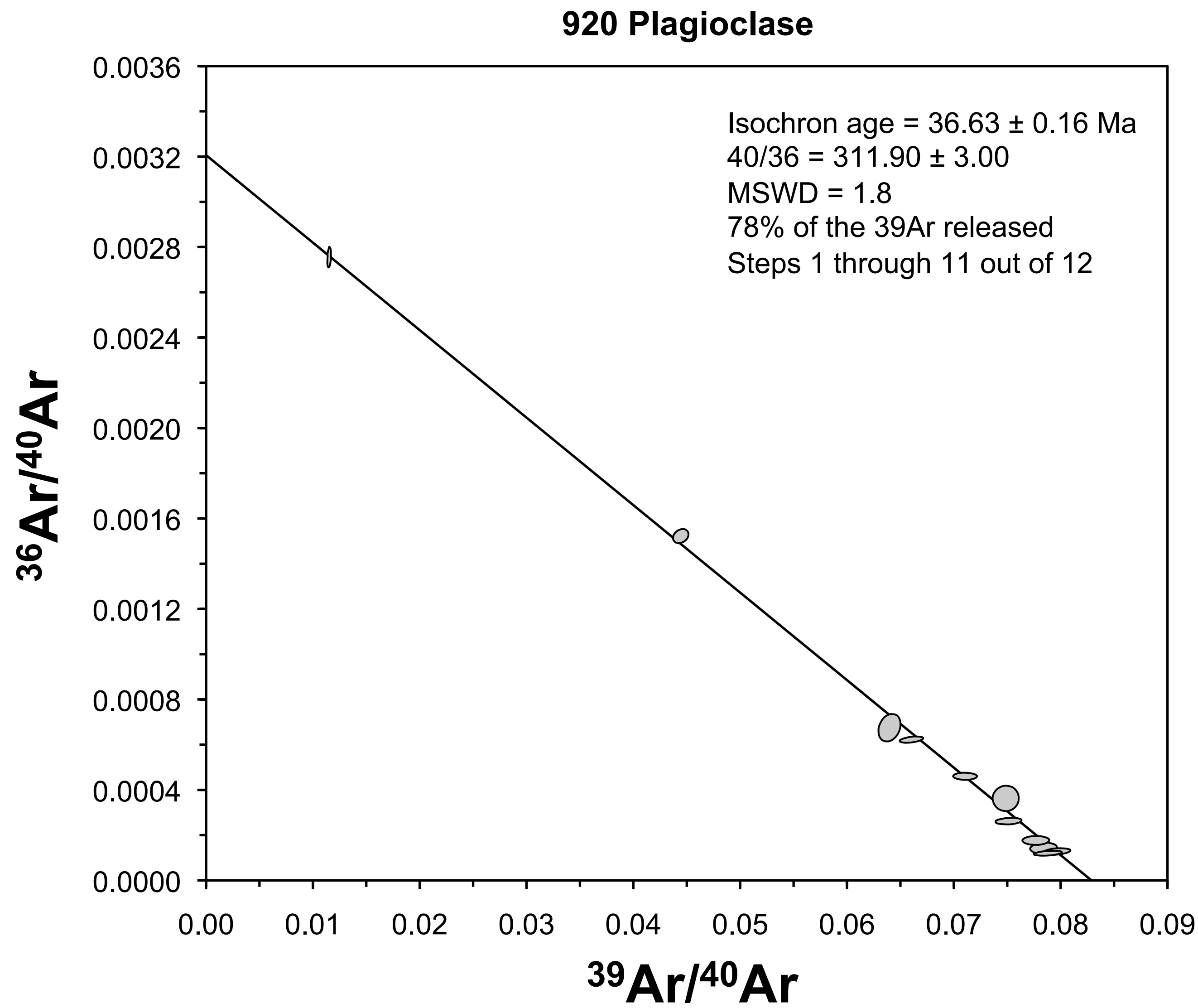
Clark-UT DNR, 920, Plagioclase, 26.80 mg, J = 0.001700 ± 0.19%
4 amu discrimination = 1.0501 ± 0.64%, 40/39K = 0.0205 ± 33.35%, 36/37Ca = 0.000267 ± 1.87%, 39/37Ca = 0.000691 ± 1.19%

step	T (C)	t (min.)	36Ar	37Ar	38Ar	39Ar	40Ar	%40Ar*	% 39Ar rlsd	Ca/K	40Ar*/39ArK	Age (Ma)	1s.d.
1	660	12	0.604	1.166	0.243	2.308	205.27	18.6	1.3	28.56544611	16.469954	49.82	1.73
2	720	12	0.057	1.284	0.044	2.647	46.212	82.6	1.5	27.41832516	12.614561	38.28	0.42
3	780	12	0.054	1.159	0.069	4.229	62.226	88.6	2.3	15.43555008	11.851360	35.99	0.39
4	840	12	0.274	1.575	0.137	6.707	155.718	54.7	3.7	13.21722893	12.357833	37.51	0.50
5	900	12	0.062	2.382	0.149	10.101	133.732	95.0	5.6	13.27311353	12.138486	36.85	0.33
6	960	12	0.082	3.362	0.209	14.227	185.858	95.5	7.8	13.30097329	11.999397	36.43	0.31
7	1025	12	0.097	4.474	0.266	18.803	245.024	95.7	10.3	13.39306094	12.152464	36.89	0.33
8	1090	12	0.124	5.126	0.320	21.874	287.492	94.0	12.0	13.1897018	12.119851	36.79	0.33
9	1150	12	0.153	5.254	0.335	22.113	300.185	94.9	12.2	13.373679	12.177756	36.97	0.33
10	1210	12	0.209	4.957	0.326	20.698	296.984	88.9	11.4	13.48071535	12.054630	36.60	0.34
11	1270	12	0.282	4.366	0.319	18.451	296.168	81.0	10.1	13.31880264	12.287926	37.30	0.37
12	1400	12	0.707	8.692	0.774	39.781	675.506	81.9	21.9	12.29453908	12.570600	38.15	0.37
							Cumulative %39Ar rlsd =		100.0		Total gas age =	37.32	0.22
											Plateau age = (steps 3-11)	36.78	0.24
											Isochron age = (steps 1-11)	36.63	0.16

note: isotope beams in mV, rlsd = released, error in age includes J error, all errors 1 sigma
(36Ar through 40Ar are measured beam intensities, corrected for decay for the age calculations)



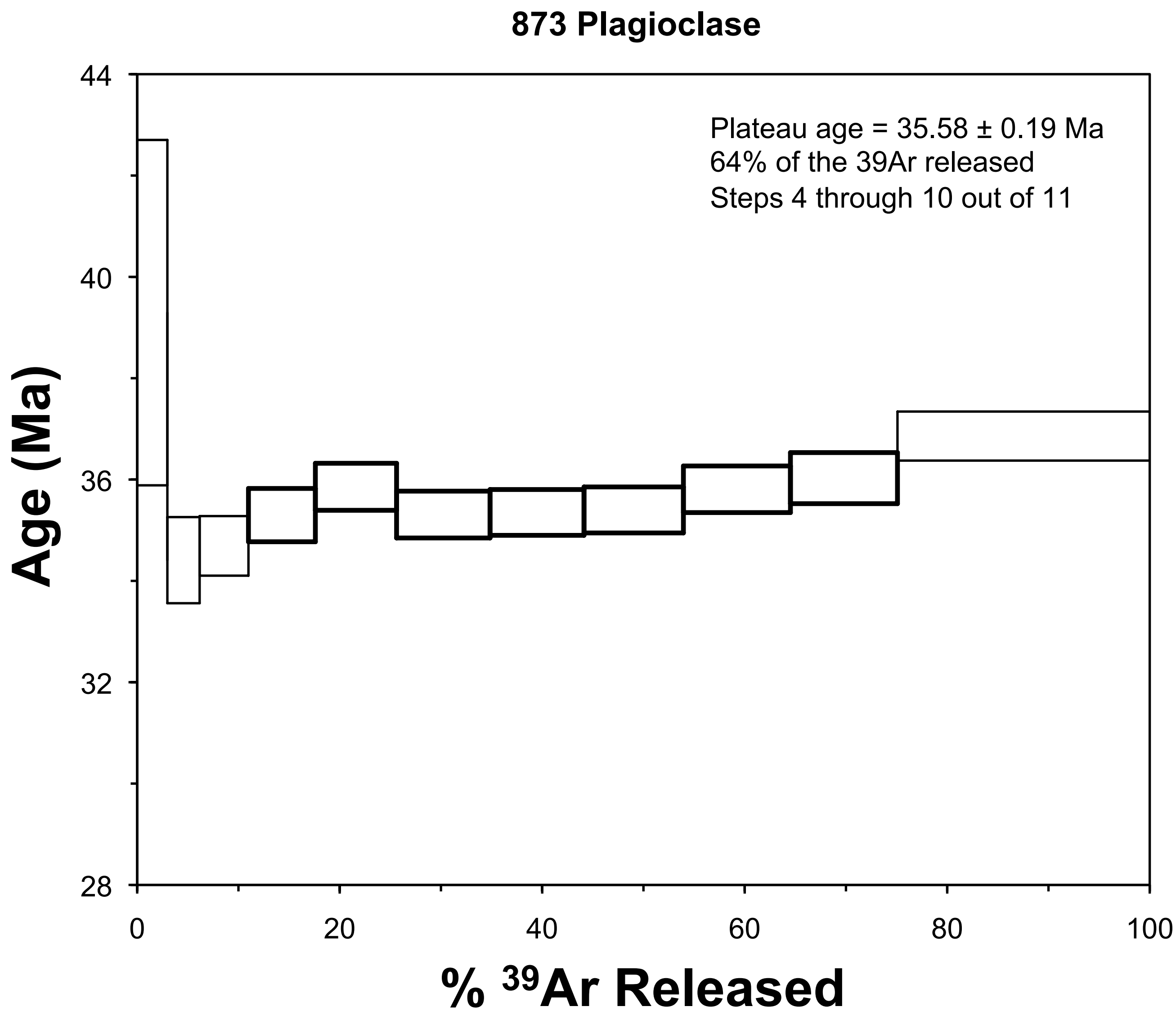
920 Plagioclase
Plateau age = 36.78 ± 0.24 Ma
75% of the 39Ar released
Steps 3 through 11 out of 12
54
48
42
36
30
24
18
Age (Ma)
0
20
40
60
80
100
% 39Ar Released


920 Plagioclase
Isochron age = 36.63 ± 0.16 Ma
40/36 = 311.90 ± 3.00
MSWD = 1.8
78% of the 39Ar released
Steps 1 through 11 out of 12
0.0036
0.0032
0.0028
0.0024
0.0020
0.0016
0.0012
0.0008
0.0004
0.0000
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
$^{36}Ar/^{40}Ar$
$^{39}Ar/^{40}Ar$

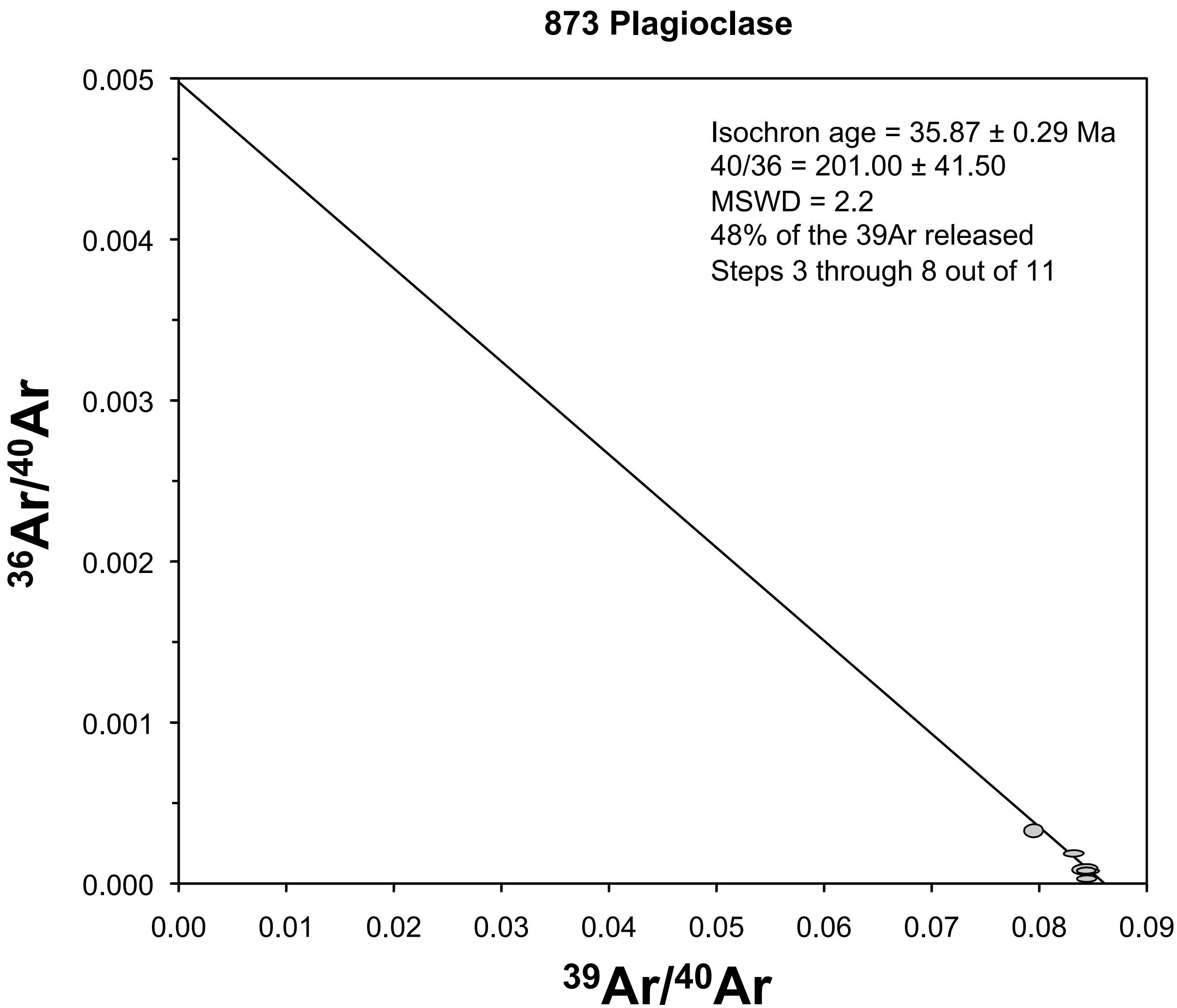
Clark-UT DNR, 873, Plagioclase, 22.20 mg, J = 0.001729 ± 0.21%
4 amu discrimination = 1.0565 ± 0.43%, 40/39K = 0.0205 ± 33.35%, 36/37Ca = 0.000267 ± 1.87%, 39/37Ca = 0.000691 ± 1.19%

step	T (C)	t (min.)	36Ar	37Ar	38Ar	39Ar	40Ar	%40Ar*	% 39Ar rlsd	Ca/K	40Ar*/39ArK	Age (Ma)	1s.d.
1	720	12	1.684	0.203	0.383	5.329	537.25	12.7	3.0	8.453768463	12.735451	39.29	1.70
2	780	12	0.087	0.230	0.091	5.698	85.805	83.3	3.2	8.959240666	11.137049	34.41	0.43
3	840	12	0.087	0.364	0.139	8.620	117.712	89.2	4.8	9.373760789	11.229204	34.69	0.29
4	900	12	0.068	0.503	0.168	11.818	149.118	96.2	6.6	9.448295023	11.427614	35.30	0.26
5	960	12	0.064	0.612	0.205	14.337	178.185	98.0	8.0	9.476024851	11.610393	35.86	0.23
6	1025	12	0.077	0.706	0.229	16.505	203.052	96.7	9.2	9.495651782	11.431210	35.31	0.23
7	1090	12	0.078	0.693	0.231	16.594	204.670	96.5	9.3	9.270185423	11.444941	35.35	0.23
8	1150	12	0.112	0.223	0.269	17.555	223.415	95.1	9.8	2.814294106	11.460961	35.40	0.23
9	1210	12	0.172	0.757	0.285	18.900	257.672	89.0	10.6	8.889776612	11.594368	35.81	0.23
10	1270	12	0.209	0.747	0.309	18.899	269.434	85.4	10.6	8.772498198	11.666317	36.03	0.25
11	1400	12	0.439	1.684	0.735	44.543	635.064	86.1	24.9	8.389852704	11.937836	36.86	0.24
							Cumulative %39Ar rlsd =		100.0		Total gas age =	35.94	0.17
											Plateau age = (steps 4-10)	35.58	0.19
											Isochron age = (steps 3-8)	35.87	0.29

note: isotope beams in mV, rlsd = released, error in age includes J error, all errors 1 sigma
(36Ar through 40Ar are measured beam intensities, corrected for decay for the age calculations)



873 Plagioclase
Plateau age = 35.58 ± 0.19 Ma
64% of the 39Ar released
Steps 4 through 10 out of 11
Age (Ma)
44
40
36
32
28
0
20
40
60
80
100
% 39Ar Released


873 Plagioclase
Isochron age = 35.87 ± 0.29 Ma
40/36 = 201.00 ± 41.50
MSWD = 2.2
48% of the 39Ar released
Steps 3 through 8 out of 11
0.005
0.004
0.003
0.002
0.001
0.000
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
$^{36}Ar/^{40}Ar$
$^{39}Ar/^{40}Ar$