2010210

Ar/Ar Biotite Step Heating Data, All Samples, Philipsburg Batholith

	ID	Temp (°C)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)
	PB4, Biotite, 5.61 mg, J=0.0023019±0.22%, D=1.0006±0.001, NM-212D, Lab#=57424-01										
x	A	625	84.68	0.1545	257.1	0.40	3.3	10.3	0.1	35.8	3.6
x	B	700	31.45	0.0765	62.79	1.35	6.7	41.0	0.6	52.8	1.1
x	C	750	25.88	0.0297	27.37	2.47	17.2	68.8	1.5	72.40	0.56
x	D	800	21.80	0.0229	12.32	3.41	22.3	83.3	2.6	73.86	0.33
x	E	875	18.74	0.0088	2.185	29.0	58.0	96.6	12.7	73.57	0.12
	F	975	18.39	0.0067	0.7874	53.2	76.6	98.7	31.2	73.842	0.095
	G	1075	18.43	0.0085	0.7546	47.1	59.8	98.8	47.6	74.030	0.099
	H	1250	18.38	0.0364	0.6191	103.6	14.0	99.0	83.6	74.010	0.097
	I	1700	18.57	0.1248	1.329	47.3	4.1	97.9	100.0	73.95	0.13
	Integrated age ± 1σ			n=9		287.9	13.4	K2O=8.56%		73.76	0.18
	Plateau ± 1σ		steps F-I	n=4	MSWD=0.78	251.3	34.0	±35.1	87.3	73.96	0.17
	PB17, Biotite, 5.25 mg, J=0.0023021±0.19%, D=1.0006±0.001, NM-212D, Lab#=57427-01										
x	A	625	92.36	0.1166	296.1	0.55	4.4	5.3	0.2	20.0	3.9
x	B	700	25.42	0.0451	38.10	3.26	11.3	55.7	1.5	57.86	0.53
x	C	750	18.82	0.0111	10.41	7.2	46.1	83.7	4.3	64.19	0.24
x	D	800	17.08	0.0099	3.896	7.8	51.6	93.3	7.4	64.94	0.19
x	E	875	16.30	0.0068	1.236	37.3	74.8	97.8	22.0	64.960	0.098
	F	975	16.27	0.0077	0.7188	48.4	66.2	98.7	41.0	65.436	0.088
	G	1075	16.27	0.0100	0.6426	48.8	51.0	98.8	60.2	65.554	0.085
	H	1250	16.15	0.0658	0.4208	89.0	7.8	99.3	95.2	65.350	0.080
	I	1700	17.03	0.4379	3.661	12.3	1.2	93.9	100.0	65.17	0.21
	Integrated age ± 1σ			n=9		254.6	10.2	K2O=8.09%		65.10	0.15
	Plateau ± 1σ		steps F-I	n=4	MSWD=1.56	198.5	32.2	±32.0	78.0	65.43	0.14
	PB19, Biotite, 5.48 mg, J=0.0023022±0.23%, D=1.0006±0.001, NM-212D, Lab#=57426-01										
X	A	625	67.80	0.0662	211.7	0.89	7.7	7.7	0.4	21.6	2.6
X	B	700	25.50	0.0424	38.42	2.38	12.0	55.5	1.6	57.78	0.65
X	C	750	23.76	0.0135	18.44	3.76	37.9	77.1	3.4	74.47	0.42
X	D	800	20.60	0.0091	6.419	4.8	56.3	90.8	5.7	76.01	0.28
X	E	875	18.95	0.0057	1.061	32.7	89.9	98.3	21.4	75.74	0.11
X	F	975	18.70	0.0052	0.2756	47.7	97.7	99.6	44.3	75.673	0.096
X	G	1075	19.24	0.0103	0.5679	36.1	49.3	99.1	61.6	77.48	0.11
X	H	1250	18.78	0.0448	0.3717	65.0	11.4	99.4	92.8	75.914	0.095
X	I	1700	19.44	0.2512	3.588	15.0	2.0	94.7	100.0	74.82	0.42
	Integrated age ± 1σ			n=9		208.3	13.7	K2O=6.34%		75.56	0.20
			no plateau								
	PB30, Biotite, 5.9 mg, J=0.0023015±0.16%, D=1.0006±0.001, NM-212D, Lab#=57431-01										
x	A	625	125.0	0.1285	369.1	0.373	4.0	12.7	0.1	64.9	4.4
x	B	700	41.31	0.0381	80.06	1.80	13.4	42.7	0.7	71.8	1.0
x	C	750	26.88	0.0160	28.71	4.6	32.0	68.4	2.3	74.77	0.44
x	D	800	21.54	0.0115	10.00	5.4	44.5	86.3	4.1	75.52	0.27
x	E	875	18.78	0.0069	2.093	45.7	74.5	96.7	19.7	73.83	0.10
	F	975	18.25	0.0075	0.6558	56.9	67.7	98.9	39.0	73.424	0.096
	G	1075	18.41	0.0137	1.236	42.1	37.3	98.0	53.3	73.39	0.11
	H	1250	18.31	0.0484	0.7068	96.5	10.6	98.9	86.1	73.607	0.094
	I	1700	18.40	0.1742	0.9722	40.8	2.9	98.5	100.0	73.70	0.11
	Integrated age ± 1σ			n=9		294.3	11.2	K2O=8.32%		73.62	0.14
	Plateau ± 1σ		steps F-I	n=4	MSWD=1.94	236.4			80.3	73.53	0.13

	ID	Temp (°C)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)
	PB42, Biotite, 6.07 mg, J=0.0023018±0.19%, D=1.0006±0.001, NM-212D, Lab#=57423-01										
x	A	625	101.6	0.0944	320.0	1.31	5.4	7.0	0.4	29.3	2.5
x	B	700	53.50	0.0545	133.0	3.80	9.4	26.5	1.7	57.9	1.1
x	C	750	31.91	0.0216	51.41	6.4	23.7	52.4	3.9	68.09	0.51
x	D	800	22.43	0.0147	16.02	11.4	34.6	78.9	7.7	72.00	0.22
x	E	875	19.46	0.0105	4.364	31.3	48.6	93.4	18.2	73.88	0.12
	F	975	18.89	0.0080	1.876	48.3	63.8	97.1	34.5	74.54	0.10
	G	1075	19.18	0.0133	2.997	43.1	38.5	95.4	49.0	74.37	0.11
	H	1250	19.36	0.0508	3.439	95.5	10.0	94.8	81.2	74.61	0.11
	I	1700	18.99	0.0697	2.061	55.8	7.3	96.8	100.0	74.76	0.11
	Integrated age ± 1σ			n=9		296.9	14.2	K2O=8.16%		73.86	0.18
	Plateau ± 1σ		steps F-I	n=4	MSWD=2.05	242.8			81.8	74.57	0.16
	PB50, Biotite, 4.65 mg, J=0.0023014±0.13%, D=1.0006±0.001, NM-212D, Lab#=57433-02										
x	A	625	135.6	0.1669	462.0	0.305	3.1	-0.7	0.1	-3.9	6.7
x	B	700	34.20	0.0889	69.22	0.89	5.7	40.2	0.6	56.2	1.4
x	C	750	32.55	0.0306	47.71	1.74	16.7	56.7	1.4	75.02	0.83
x	D	800	23.68	0.0107	18.47	2.01	47.7	77.0	2.3	74.10	0.65
x	E	875	18.88	0.0064	3.396	20.4	79.5	94.7	12.0	72.72	0.32
	F	975	18.55	0.0066	0.5120	32.7	76.9	99.2	27.4	74.77	0.10
	G	1075	18.63	0.0085	0.5194	38.9	59.8	99.2	45.8	75.09	0.10
	H	1250	18.54	0.0215	0.5556	74.4	23.7	99.1	81.0	74.715	0.094
	I	1700	18.64	0.0581	0.8975	40.2	8.8	98.6	100.0	74.70	0.12
	Integrated age ± 1σ			n=9		211.5	22.4	K2O=7.59%		74.40	0.13
	Plateau ± 1σ		steps F-I	n=4	MSWD=3.11	186.2			88.0	74.82	0.13
	PB73, Biotite, 5.95 mg, J=0.0023017±0.14%, D=1.0006±0.001, NM-212D, Lab#=57430-01										
x	A	625	98.06	0.1078	317.0	0.44	4.7	4.5	0.1	18.2	4.0
x	B	700	44.99	0.0639	102.7	0.94	8.0	32.6	0.5	59.8	1.8
x	C	750	29.69	0.0323	40.14	2.17	15.8	60.1	1.2	72.55	0.67
x	D	800	22.90	0.0190	16.73	2.95	26.8	78.4	2.2	73.05	0.46
x	E	875	19.36	0.0134	3.471	23.9	38.0	94.7	10.3	74.55	0.13
	F	975	18.63	0.0147	0.6198	45.0	34.7	99.0	25.5	74.987	0.098
	G	1075	18.65	0.0095	0.6557	55.9	53.7	99.0	44.3	75.030	0.096
	H	1250	18.68	0.0288	0.6041	129.4	17.7	99.1	88.0	75.23	0.10
	I	1700	18.77	0.1441	1.308	35.5	3.5	98.0	100.0	74.77	0.12
	Integrated age ± 1σ			n=9		296.1	14.3	K2O=8.31%		74.87	0.14
	Plateau ± 1σ		steps F-I	n=4	MSWD=2.84	265.7			89.7	75.02	0.14
	PB76, Biotite, 6.14 mg, J=0.0023021±0.17%, D=1.0006±0.001, NM-212D, Lab#=57428-01										
x	A	625	136.4	0.1690	424.1	0.300	3.0	8.1	0.1	45.6	5.9
x	B	700	36.83	0.1982	76.72	0.59	2.6	38.5	0.3	57.9	2.0
x	C	750	29.08	0.1184	37.77	1.16	4.3	61.6	0.6	72.94	0.97
x	D	800	23.45	0.0607	17.41	1.74	8.4	78.1	1.2	74.43	0.64
x	E	875	19.98	0.0147	6.003	14.7	34.8	91.1	5.8	74.06	0.19
x	F	975	18.64	0.0104	1.090	38.9	49.2	98.3	18.0	74.47	0.11
	G	1075	18.52	0.0100	0.4586	61.4	50.9	99.3	37.2	74.766	0.094
	H	1250	18.60	0.0317	0.5571	103.4	16.1	99.1	69.5	74.98	0.10
	I	1700	18.60	0.0574	0.6925	97.4	8.9	98.9	100.0	74.824	0.095
	Integrated age ± 1σ			n=9		319.6	15.5	K2O=8.68%		74.72	0.15
	Plateau ± 1σ		steps G-I	n=3	MSWD=1.27	262.1			82.0	74.85	0.14

	ID	Temp (°C)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)
	PB81, Biotite, 4.85 mg, J=0.0023021±0.23%, D=1.0006±0.001, NM-212D, Lab#=57425-01										
x	A	625	136.8	0.2195	448.1	0.365	2.3	3.2	0.2	18.0	5.1
x	B	700	34.97	0.1869	79.48	1.00	2.7	32.9	0.6	47.1	1.5
x	C	750	32.79	0.0294	49.05	2.01	17.3	55.8	1.6	74.39	0.86
x	D	800	23.44	0.0099	17.08	3.33	51.7	78.5	3.1	74.77	0.45
x	E	875	19.41	0.0062	3.901	28.7	82.7	94.1	16.4	74.22	0.12
	F	975	18.65	0.0064	0.8973	38.7	80.1	98.6	34.2	74.76	0.10
	G	1075	18.83	0.0286	1.158	31.8	17.9	98.2	49.0	75.15	0.11
	H	1250	18.62	0.0739	0.7738	72.9	6.9	98.8	82.6	74.794	0.094
	I	1700	18.81	0.0744	1.763	37.6	6.9	97.3	100.0	74.41	0.14
	Integrated age ± 1σ			n=9		216.4	11.2	K2O=7.44%		74.47	0.19
	Plateau ± 1σ		steps F-I	n=4	MSWD=6.14	181.0			83.6	74.82	0.21
	PB97, Biotite, 5.1 mg, J=0.0023014±0.15%, D=1.0006±0.001, NM-212D, Lab#=57432-02										
x	A	625	152.7	0.2325	478.0	0.161	2.2	7.5	0.1	46.9	7.8
x	B	700	41.43	0.1070	93.98	0.67	4.8	33.0	0.5	55.8	2.0
x	C	750	31.99	0.0246	46.20	1.33	20.7	57.3	1.4	74.56	0.98
	D	800	28.93	0.0133	32.93	1.10	38.3	66.4	2.1	78.0	1.0
	E	875	19.41	0.0046	3.889	20.0	110.9	94.1	14.9	74.24	0.34
	F	975	18.48	0.0030	0.4734	36.7	167.7	99.2	38.3	74.54	0.10
	G	1075	18.71	0.0070	0.6914	26.4	73.2	98.9	55.2	75.21	0.12
	H	1250	18.55	0.0274	0.6543	51.8	18.6	99.0	88.3	74.61	0.11
	I	1700	18.92	0.1115	1.871	18.2	4.6	97.1	100.0	74.68	0.15
	Integrated age ± 1σ			n=9		156.4	20.0	K2O=5.12%		74.57	0.15
	Plateau ± 1σ		steps D-I	n=6	MSWD=6.58	154.2			98.6	74.74	0.18
	PB105, Biotite, 5.98 mg, J=0.0023015±0.14%, D=1.0006±0.001, NM-212D, Lab#=57435-01										
x	A	625	51.71	0.2288	152.6	1.10	2.2	12.8	0.3	27.3	2.0
x	B	700	31.01	0.1135	52.86	3.24	4.5	49.6	1.3	62.80	0.67
x	C	750	22.53	0.0110	16.34	6.8	46.5	78.6	3.5	72.02	0.31
x	D	800	19.77	0.0076	6.009	12.4	67.1	91.0	7.3	73.17	0.18
x	E	875	18.68	0.0152	1.727	39.5	33.5	97.3	19.6	73.89	0.11
	F	975	18.58	0.0099	1.005	52.1	51.5	98.4	35.7	74.308	0.096
	G	1075	18.95	0.0226	2.013	50.2	22.6	96.9	51.3	74.60	0.11
	H	1250	18.61	0.0548	0.8166	122.5	9.3	98.7	89.3	74.67	0.10
	I	1700	18.57	0.0761	1.052	34.6	6.7	98.4	100.0	74.24	0.13
	Integrated age ± 1σ			n=9		322.4	13.3	K2O=9.00%		74.07	0.14
	Plateau ± 1σ		steps F-I	n=4	MSWD=3.73	259.3			80.4	74.47	0.15

	ID	Temp (°C)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)
	PB111, Biotite, 5.71 mg, J=0.0023014±0.12%, D=1.0006±0.001, NM-212D, Lab#=57434-01										
x	A	625	41.76	0.0739	106.8	1.04	6.9	24.4	0.5	41.8	1.7
x	B	700	23.01	0.0190	24.03	4.6	26.9	69.1	2.6	64.86	0.43
x	C	750	17.73	0.0103	4.960	10.3	49.6	91.7	7.2	66.24	0.17
x	D	800	16.88	0.0076	1.701	14.7	67.4	97.0	13.9	66.70	0.14
	E	875	16.74	0.0062	0.6625	31.8	82.6	98.8	28.2	67.383	0.098
	F	975	16.78	0.0088	0.7833	30.5	58.1	98.6	42.0	67.41	0.10
	G	1075	16.76	0.0103	0.9717	37.9	49.4	98.3	59.2	67.075	0.095
	H	1250	16.67	0.0649	0.3985	79.1	7.9	99.3	94.9	67.419	0.084
x	I	1700	17.59	0.1752	2.706	11.2	2.9	95.5	100.0	68.42	0.19
	Integrated age ± 1σ			n=9		221.2	13.5	K2O=6.47%		67.13	0.12
	Plateau ± 1σ	steps E-H		n=4	MSWD=3.07	179.4			81.1	67.32	0.12
	PB122, Biotite, 5.05 mg, J=0.0023019±0.15%, D=1.0006±0.001, NM-212D, Lab#=57429-01										
x	A	625	141.5	0.1807	432.9	0.894	2.8	9.6	0.2	55.5	5.6
x	B	700	29.48	0.0731	39.63	2.66	7.0	60.3	1.0	72.3	1.2
x	C	750	26.85	0.0222	27.74	6.68	23.0	69.5	2.8	75.83	0.48
x	E	875	23.56	0.0152	18.39	7.33	33.6	76.9	4.8	73.72	0.45
	G	975	18.58	0.0110	0.5027	14.0	46.3	99.2	8.6	74.93	0.22
	H	1075	18.67	0.0166	0.7807	44.3	30.6	98.8	20.6	74.97	0.13
	I	1250	18.63	0.0420	0.7695	177.6	12.1	98.8	69.0	74.840	0.094
	J	1700	18.69	0.1028	1.212	113.8	5.0	98.1	100.0	74.56	0.13
	Integrated age ± 2σ			n=8		367.2	9.1	K2O=8.63%		74.70	0.29
	Plateau ± 2σ	steps G-J		n=4	MSWD=1.85	349.6			95.2	74.81	0.14

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 ± 5e-05
$(^{36}Ar/^{37}Ar)_{Ca}$ = 0.00028 ± 2e-05
$(^{38}Ar/^{39}Ar)_{K}$ = 0.013
$(^{40}Ar/^{39}Ar)_{K}$ = 0.01 ± 0.002

ID	Temp (°C)	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$^{40}Ar^*$ (%)	^{39}Ar (%)	Age (Ma)	±1σ (Ma)

Methods:

Sample preparation and irradiation:
Mineral separates by standard magnetic, heavy liquid and hand-picking techniques.
Separates were loaded into machined Al discs and irradiated for 10 hours, USGS TRIGA Reactor, Denver
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.
Samples step-heated in Mo double vacuum resistance furnace.
Reactive gases removed during a 9 minute heating with a SAES GP-50 getter operated at ~450°C.
Additional cleanup (5 minutes) following heating with 2 SAES GP-50 getters, 1 operated at ~450°C and 1 at 20°C.
Gas also exposed to cold finger held at -140°C during heating.

Analytical parameters:
Electron multiplier sensitivity about $5x10^{-17}$ moles/pA
Total system blank and background: 100 1.4, 0.9, 2.5, 1.1 x 10^{-17} moles for masses 40, 39, 38, 37, 36, respectively.
J-factors determined to a precision of ~± 0.15% by CO_2 laser-fusion of 6 single crystals from each of 7 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±0.002; $(^{36}Ar/^{37}Ar)_{Ca}$ = 0.00028±0.00002; and $(^{39}Ar/^{37}Ar)_{Ca}$ = 0.00070±0.00005.