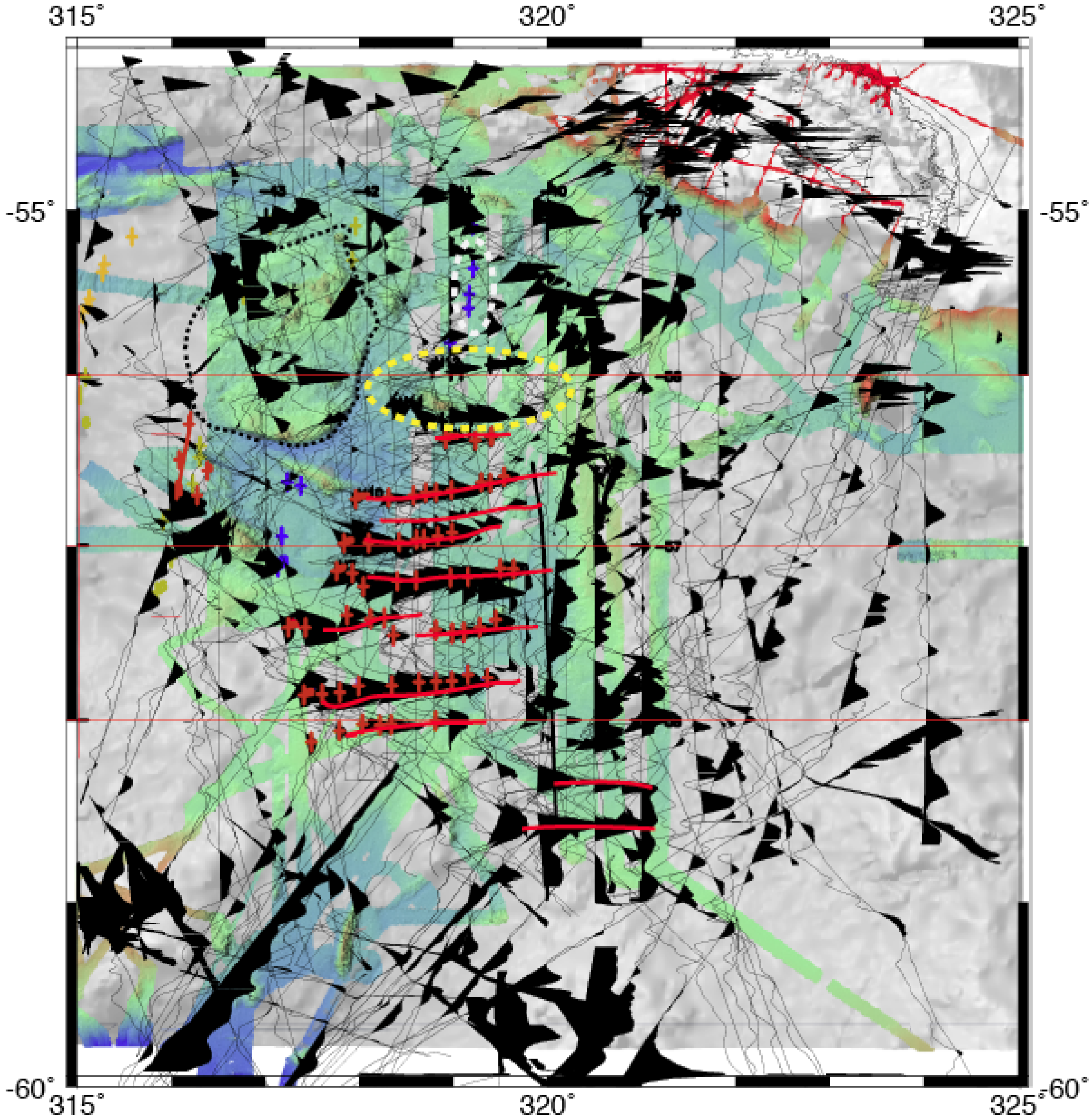
Appendix DR1. Magnetic Anomalies in the Central Scotia Sea



Methodologies

Magnetic 'wiggles' along track were compiled from all available shipboard data, acquired on various cruises of British Antarctic Survey [BAS] vessels, RVIB *N.B.Palmer* cruises and from the National Geophysical Data Center. Positive magnetic anomalies are shown in black. Yellow dashed oval indicates two apparently lineated positive anomalies that may have been created by lava flows or dikes originating from the ‘Starfish’ volcanic construct to the west (black dotted outline). These are not deemed to be anomalies produced by seafloor spreading that generated ocean crust, nor are those on the ‘Starfish’itself. Blue crosses represent magnetic anomaly picks shown by Eagles et al. (2005), those outlined in the white oval are clearly on a volcanic construct. Red crosses indicate magnetic anomaly picks shown in Figure 4. Red lines are the lineated magnetic anomalies shown on Figure 2.

Appendix DR2. Geochemistry

1. Geochemical Data: Dredged Lavas

Sample	2--1	3--1	3--2	5--2	5--4	5--5	5--6	7--2
Rock type	Basalt	Basalt	Basalt	Basaltic andesite	Basalt	Basalt	Basaltic andesite	Basaltic andesite
SiO2	51.11	47.49	48.20	53.48	51.66	51.66	54.10	54.03
TiO2	0.96	0.80	0.84	0.68	0.65	0.70	0.66	0.66
Al2O3	17.84	17.17	17.56	14.96	15.58	15.07	15.33	17.86
Fe2O3	9.67	10.19	10.48	8.51	8.88	7.88	8.31	7.27
MnO	0.27	0.14	0.13	0.11	0.10	0.18	0.12	0.14
MgO	4.41	7.96	6.92	7.85	6.64	7.02	7.84	2.78
CaO	4.98	6.73	8.92	1.82	0.28	4.40	1.33	6.25
Na2O	4.44	3.32	3.46	3.33	1.29	3.79	3.53	4.74
K2O	1.56	1.22	0.76	1.68	7.61	1.70	1.74	2.38
P2O5	0.25	0.07	0.09	0.09	0.10	0.16	0.09	0.55
LOI	3.41	4.36	2.99	6.42	5.77	8.04	6.24	3.94
Total	98.90	99.45	100.35	98.94	98.56	100.59	99.29	100.60
Rb	38.6	11.5	8.9	21.2	110.6	21.5	23.6	46
Sr	481	158	147	94	21	93	96	701
Y	19.8	13.7	16.0	22.0	20.1	26.4	22.2	24.4
Zr	106.9	41.5	41.6	85.0	77.9	88.7	86.5	107.9
Nb	2.97	0.94	0.90	3.46	3.26	3.78	3.65	4.68
Cs	0.65	0.26	0.30	0.52	0.44	0.27	0.65	1.02
Ba	255	294	190	272	770	341	289	597
La	12.89	2.11	2.27	9.01	7.57	10.44	9.19	22.64
Ce	28.43	5.41	5.87	19.58	17.18	21.31	19.65	47.51
Pr	4.05	0.93	1.01	2.71	2.37	2.92	2.70	6.71
Nd	17.25	4.60	4.95	11.72	10.30	12.62	11.76	27.02
Sm	3.93	1.58	1.71	3.10	2.69	3.38	3.10	5.77
Eu	1.24	0.66	0.68	0.96	0.80	1.04	0.98	1.69
Gd	3.70	1.93	2.16	3.31	2.86	3.72	3.36	4.85
Tb	0.53	0.34	0.38	0.54	0.48	0.62	0.55	0.66
Dy	3.23	2.35	2.60	3.56	3.23	4.11	3.65	3.82
Ho	0.59	0.45	0.51	0.67	0.63	0.79	0.69	0.71
Er	1.80	1.36	1.50	2.05	1.96	2.41	2.12	2.16
Tm	0.28	0.22	0.24	0.33	0.32	0.39	0.35	0.35
Yb	1.90	1.44	1.54	2.18	2.16	2.55	2.28	2.19
Lu	0.30	0.23	0.25	0.33	0.34	0.40	0.36	0.36
Hf	2.52	1.03	1.06	2.22	2.05	2.39	2.30	2.55
Ta	0.17	0.06	0.07	0.23	0.22	0.25	0.25	0.26
Pb	10.42	0.38	1.83	3.99	5.04	5.89	5.02	4.23
Th	2.12	0.30	0.33	2.36	2.25	2.47	2.45	4.41
U	0.60	0.19	0.19	0.99	0.96	1.03	1.04	1.06

2. Geochemical Data: Representative Dredged Pyroclastic and Volcaniclastic Rocks

Sample	7--1	11--4	3--10	5--1	5--3
Rock type	Ignimbrite	Ignimbrire	Sandstone	Sandstone	Sandstone
SiO2	69.45	65.74	67.58	69.11	68.76
TiO2	0.66	0.56	0.64	0.66	0.67
Al2O3	14.05	15.03	14.36	13.23	13.03
Fe2O3	3.94	4.49	4.81	5.85	5.57
MnO	0.10	0.10	0.09	0.08	0.08
MgO	0.55	1.42	1.92	2.47	2.46
CaO	1.61	5.01	2.09	0.18	0.18
Na2O	5.17	3.51	3.88	3.72	4.87
K2O	2.90	2.07	2.08	1.53	1.46
P2O5	0.19	0.18	0.12	0.28	0.54
LOI	0.96	0.78	2.12	3.20	2.87
Total	99.58	98.89	99.69	100.30	100.48
Rb	76.6	53.2	54.6	46.9	46.2
Sr	245	465	258	102	96
Y	46.3	26.4	22.5	14.6	12.7
Zr	294.6	211.3	203.9	206.8	220.5
Nb	10.94	10.87	8.30	6.32	6.36
Cs	0.75	1.24	1.26	1.66	1.69
Ba	632	587	585	237	229
La	27.36	29.70	27.08	10.32	10.81
Ce	57.66	59.25	52.71	27.29	25.48
Pr	7.69	7.45	6.58	3.80	3.46
Nd	31.04	28.29	24.57	15.40	13.48
Sm	7.20	5.79	4.87	3.44	2.88
Eu	1.72	1.40	1.17	0.65	0.66
Gd	6.96	4.97	4.24	2.93	2.52
Tb	1.10	0.71	0.59	0.42	0.35
Dy	7.06	4.19	3.59	2.50	2.09
Ho	1.36	0.77	0.66	0.45	0.39
Er	4.21	2.33	2.04	1.43	1.23
Tm	0.69	0.38	0.33	0.24	0.21
Yb	4.55	2.47	2.17	1.62	1.48
Lu	0.72	0.38	0.34	0.27	0.26
Hf	6.96	5.04	4.81	4.99	5.19
Ta	0.73	0.72	0.53	0.47	0.47
Pb	10.49	13.54	13.26	7.29	8.39
Th	8.14	8.59	7.57	6.19	6.75
U	2.02	2.18	1.69	2.28	2.16

3. Methodologies

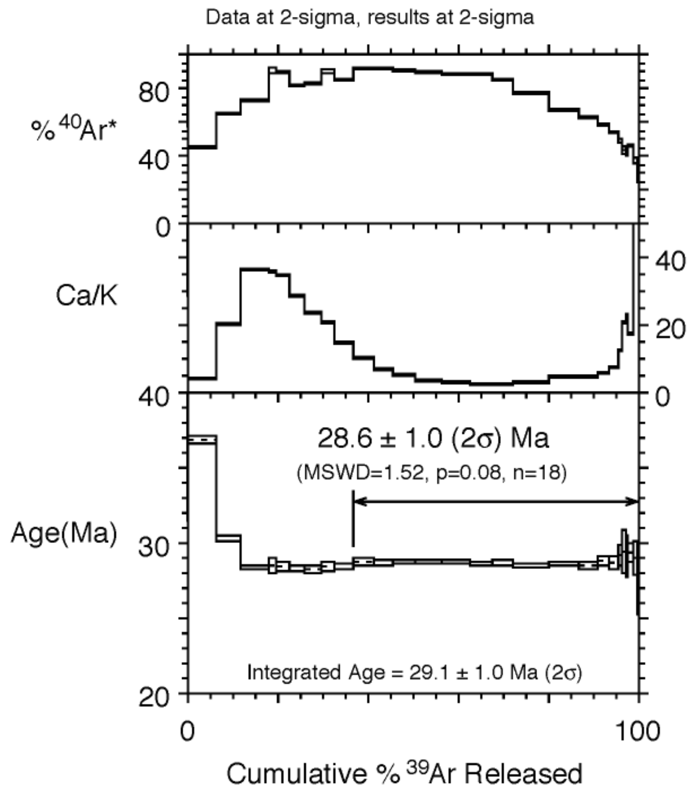
Our cruise did obtain the first in situ dredge samples from the CSS, but with considerable difficulty given the extensive sedimentary cover and high density of ice-rafted debris on the sea floor. We recovered samples from 12 dredge localities. Preconditions for *in situ* character were a significant increase in tension during dredging followed by abrupt relaxation, an absence of smoothed edges or striations, sea-floor characteristics such as pillow structures, a rock type of oceanic rather than continental (Antarctic) provenance, and a coating of manganese. This gave a small subset of samples which was further examined down the microscope and analysed first for major elements, trace elements and then for Pb-Sr-Nd-Hf isotopes, allowing samples to be grouped geochemically and petrographically, and those with implausible compositions and textures to be rejected. Ar-Ar dating was a final check and two samples were rejected at this stage. Importantly, the key samples for this paper, gave Ar-Ar ages which support an in situ origin. Note that alkali basalt tephra were also recovered but these have no bearing on this study. Analytical methods are as in other cited works on the Scotia arc-basin system.

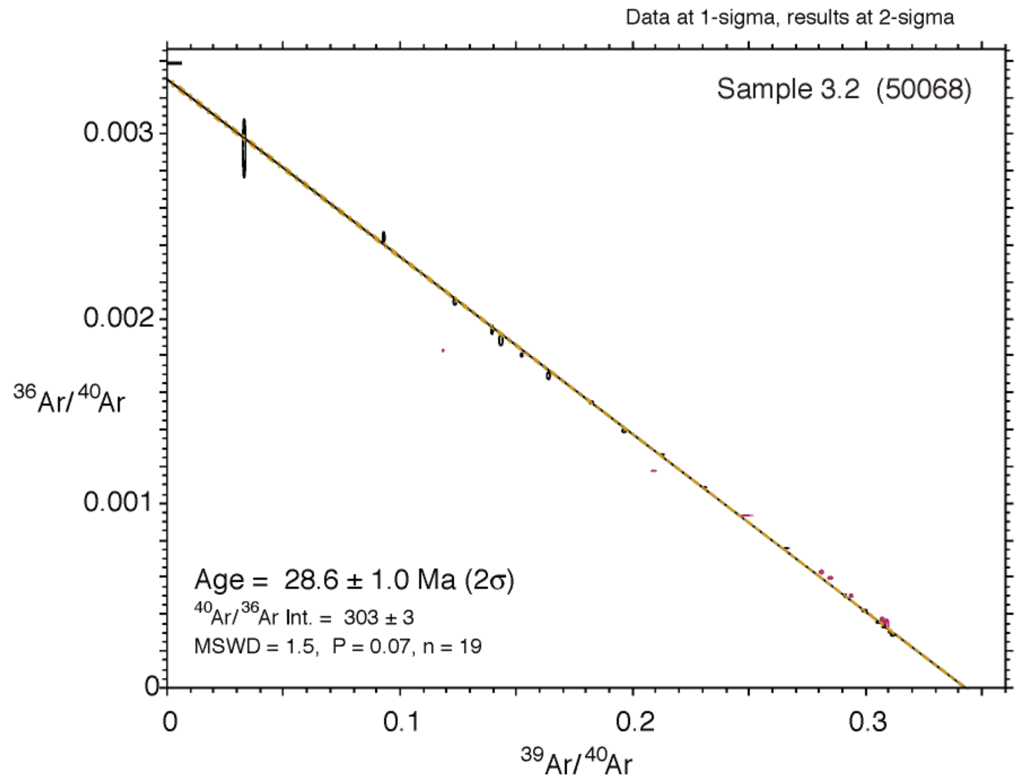
Appendix DR3: Ar-Ar Dating

1. Methodology

Analyses were carried out at the Scottish Universities Environmental Research Centre (SUERC). Samples and neutron flux monitors were placed in copper or aluminium foil packets and stacked in quartz tubes. The relative positions of the packets were carefully measured for later reconstruction of neutron flux gradients. The sample package was irradiated in the McMaster reactor, Cd-shielded facility for 14.22 hours. Fish Canyon Sanidine (28.201 Ma, Kuiper et al. 2008) was used to monitor ^{39}Ar production and establish neutron flux values (J) for the samples. Estimated errors in the neutron flux measurements are 0.5%. Gas was extracted from samples using an all-metal resistively-heated furnace with multi-step heating schedules ranging from ~700 to 1500°C. Liberated argon was then purified of active gases (e.g, CO_2, H_2O, H_2, N_2, CH_4) using three Zr-Ti-Al getters; one at 25°C and two at 400°C. Data were collected on a GVi instruments ARGUS 5-collector mass spectrometer using a variable sensitivity faraday collector array in static collection (non-peak hopping) mode. Time-intensity data were regressed to t_0 with second-order polynomial fits to the data. Mass discrimination was monitored by comparison to running-average values of an air standard. The average total system blank for furnace extractions, measured between each sample run, was $2x10^{-16}$ mol ^{40}Ar, $1x10^{-17}$mol ^{39}Ar, $2x10^{-17}$ mol ^{36}Ar over the temperature range where age information is extracted. All data are blank and mass discrimination corrected. Isochron calculated with contiguous steps (minimum 5 steps and 40% gas), MSWD best-fit selection criteria. Plateau calculated with trapped component from isochron (minimum 5 steps and 40% gas). Trapped components are very close to or indistinguishable from the composition of modern air.

2. Sample 3.2 (Lab ID: 50068; Plagioclase)

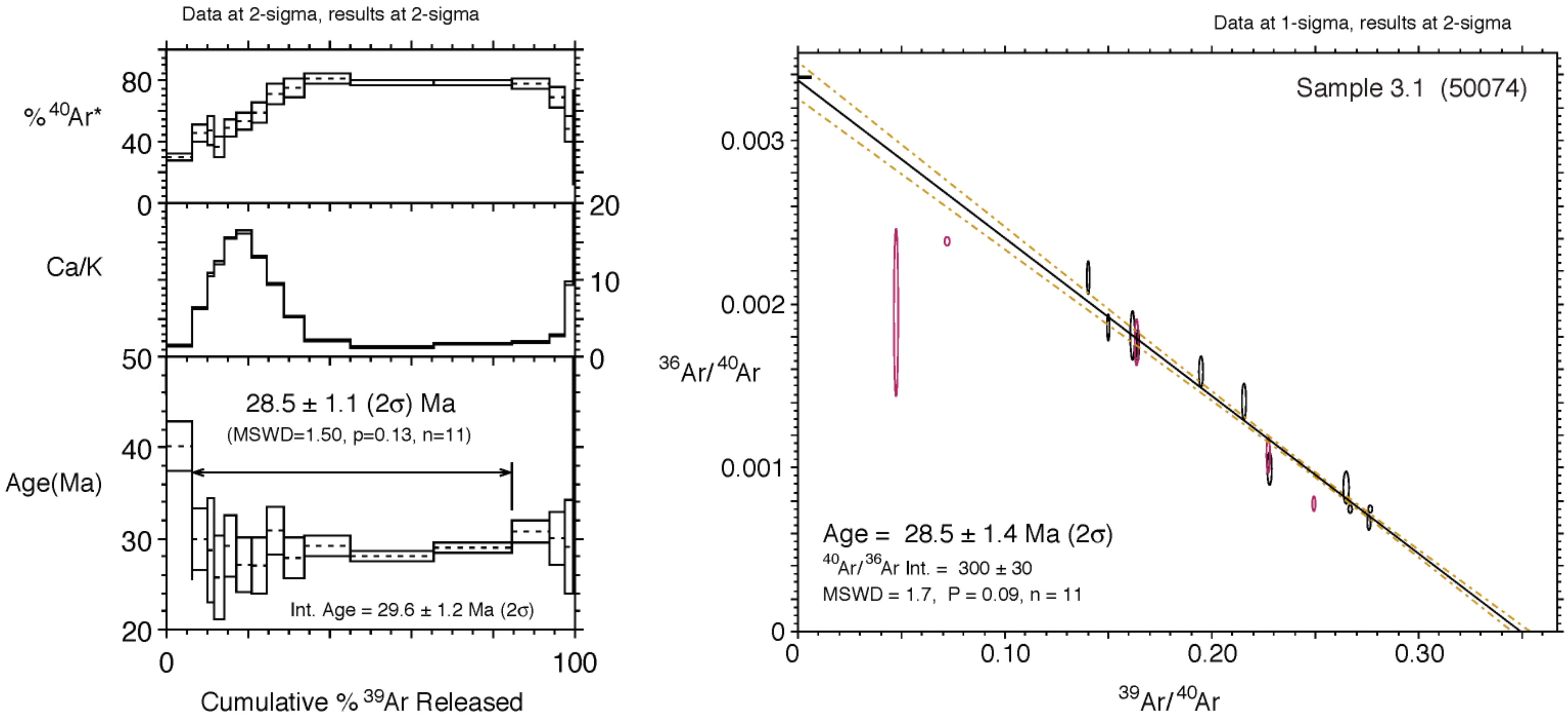




J=0.005481±0.000099 **;** 63.0% ^{39}Ar in plateau (steps 10-27; n=18 of 27 total steps)

%furnace power	^{40}Ar	±1s	^{39}Ar	±1s	^{38}Ar	±1s	^{37}Ar	±1s	^{36}Ar	±1s	^{39}Ar (mol)	% ^{39}Ar of total	% $^{36}Ar_{Ca}$	Ca/K	±1s	% ^{40}Ar*	Age (Ma)	±1s	w/±J ±1s
6.5	816.892	0.56721	205.4943	0.17022	2.66142	0.00358	3822.799	3.02308	1.76803	0.00359	1.44E-13	7.4	57.1	36.46177	0.0420942	72.5	28.55548	0.0725331	0.52
7	152.6039	0.23898	47.64456	0.04214	0.59202	0.0027	866.8392	0.73359	0.28308	0.00323	3.34E-14	1.7	80.8	35.66	0.0439157	89.5	28.3756	0.2063219	0.55
7.6	302.3499	0.28765	93.80723	0.08014	1.16518	0.00251	1646.992	1.31221	0.54734	0.00322	6.57E-14	3.4	79.4	34.41211	0.0404944	89	28.38331	0.1098615	0.52
8.2	390.5097	0.34268	110.6946	0.09615	1.39843	0.00265	1610.14	1.36301	0.67083	0.0031	7.75E-14	4	63.4	28.50974	0.034799	81.4	28.35875	0.0945902	0.52
8.8	424.1624	0.34962	121.7178	0.10015	1.52914	0.00324	1475.998	1.23756	0.64245	0.00288	8.52E-14	4.4	60.7	23.76774	0.0281317	82.3	28.30751	0.081921	0.51
9.4	296.5126	0.28505	91.87438	0.07514	1.14293	0.0027	961.9859	0.75997	0.36021	0.00299	6.43E-14	3.3	70.5	20.5225	0.0235311	89.4	28.41942	0.1037347	0.52
10	452.2796	0.38011	133.2969	0.12017	1.67915	0.00183	1007.796	0.83567	0.4922	0.00334	9.33E-14	4.8	54.1	14.81865	0.0182569	85.2	28.42506	0.0846704	0.52
10.6	428.3188	0.32486	133.7842	0.11016	1.66143	0.00321	695.5546	0.55934	0.30867	0.00322	9.36E-14	4.8	59.5	10.19019	0.0118225	91.4	28.71039	0.0789624	0.52
11.2	439.5518	0.36277	136.4511	0.12017	1.68896	0.0025	495.664	0.40931	0.26574	0.00295	9.55E-14	4.9	49.2	7.119779	0.0085955	90.9	28.71848	0.0721743	0.52
11.8	524.6409	0.38662	161.496	0.14019	2.00204	0.00329	424.4771	0.35955	0.28463	0.00282	1.13E-13	5.8	39.4	5.151675	0.0062482	90.3	28.73568	0.0608542	0.52
12.4	598.0659	0.40283	182.4903	0.1502	2.27047	0.00366	331.0648	0.30999	0.29884	0.00278	1.28E-13	6.5	29.2	3.555734	0.0044328	89.5	28.74003	0.0542442	0.52
13	647.3189	0.46301	195.2731	0.16021	2.43243	0.00293	279.456	0.25584	0.32549	0.00297	1.37E-13	7	22.7	2.804963	0.0034482	88.5	28.72463	0.054784	0.52
13.6	542.317	0.42756	162.5023	0.14019	2.03077	0.00249	206.1832	0.20724	0.28156	0.00301	1.14E-13	5.8	19.3	2.486852	0.003294	87.6	28.62661	0.0640491	0.52
14.2	478.048	0.36816	139.0462	0.12017	1.75283	0.00284	171.6537	0.14138	0.28409	0.00286	9.73E-14	5	16	2.419636	0.0028887	85.2	28.68785	0.0691611	0.52
14.8	937.1941	0.6649	249.1835	0.22027	3.24171	0.00338	418.63	0.36001	0.8153	0.00294	1.74E-13	8.9	13.6	3.292814	0.0040609	77.7	28.64423	0.0496909	0.52
15.4	924.7391	0.62687	213.7196	0.18023	2.92902	0.00293	483.8435	0.3902	1.12692	0.00284	1.50E-13	7.7	11.3	4.437279	0.0051776	68	28.85109	0.0536236	0.52
16	584.3721	0.43469	124.494	0.11016	1.74753	0.00203	308.3005	0.25201	0.81803	0.00293	8.71E-14	4.5	9.9	4.853799	0.0058471	62.7	28.85652	0.0799384	0.52
16.6	437.5922	0.31914	86.17385	0.06913	1.23247	0.00339	255.5502	0.21253	0.67713	0.00297	6.03E-14	3.1	10	5.812418	0.0067164	58.8	29.27417	0.1081359	0.54
17.2	305.1752	0.28296	55.85117	0.04813	0.81945	0.00278	214.0576	0.18099	0.52695	0.00324	3.91E-14	2	10.7	7.51198	0.009069	54.4	29.17043	0.1762829	0.55
18	218.4832	0.24599	35.9782	0.03115	0.55526	0.00237	226.4993	0.18339	0.43008	0.0029	2.52E-14	1.3	13.9	12.3391	0.0146266	49.9	29.7681	0.2435452	0.59
19	118.8849	0.2169	17.20482	0.01525	0.27792	0.00207	181.0411	0.19065	0.27221	0.00305	1.20E-14	0.6	17.6	20.62449	0.0283869	44.2	30.08635	0.5279842	0.75
21	127.8234	0.21975	17.97914	0.01623	0.29439	0.00184	210.7884	0.18818	0.30369	0.00287	1.26E-14	0.6	18.3	22.97915	0.0291762	42.6	29.88714	0.4789516	0.72
25	254.4926	0.25931	38.99249	0.03314	0.60614	0.00221	343.9248	0.31499	0.5486	0.00272	2.73E-14	1.4	16.6	17.28776	0.0216007	46.8	30.07003	0.2132141	0.58
30	178.3479	0.23642	22.51751	0.0192	0.39637	0.00199	621.8232	0.46752	0.53699	0.00306	1.58E-14	0.8	30.6	54.12559	0.0615324	38.2	30.15018	0.4126176	0.68
40	103.8663	0.21766	10.15855	0.00884	0.21194	0.00236	742.7616	0.57018	0.44871	0.00279	7.11E-15	0.4	43.7	143.3091	0.1662477	28.1	29.5332	0.8586766	1.01
Omitted, 2.5 nMADs from median age:																			
5.5	1691.22	1.00631	200.6491	0.20025	3.04886	0.00614	433.7337	0.45787	3.20351	0.00487	1.40E-13		3.6	4.236839	0.0061685	46	37.92889	0.1291871	0.69
6	797.7805	0.53121	167.8551	0.1502	2.24336	0.00333	1751.963	1.36121	1.39661	0.00342	1.17E-13		33.1	20.45722	0.0244028	65.3	30.60035	0.0837255	0.55
50	25.24266	0.22693	0.92106	0.00364	0.03207	0.00251	119.7993	0.1157	0.10497	0.00309	6.45E-16		30.1	254.9307	1.037769	14.1	41.32409	10.80052	10.83

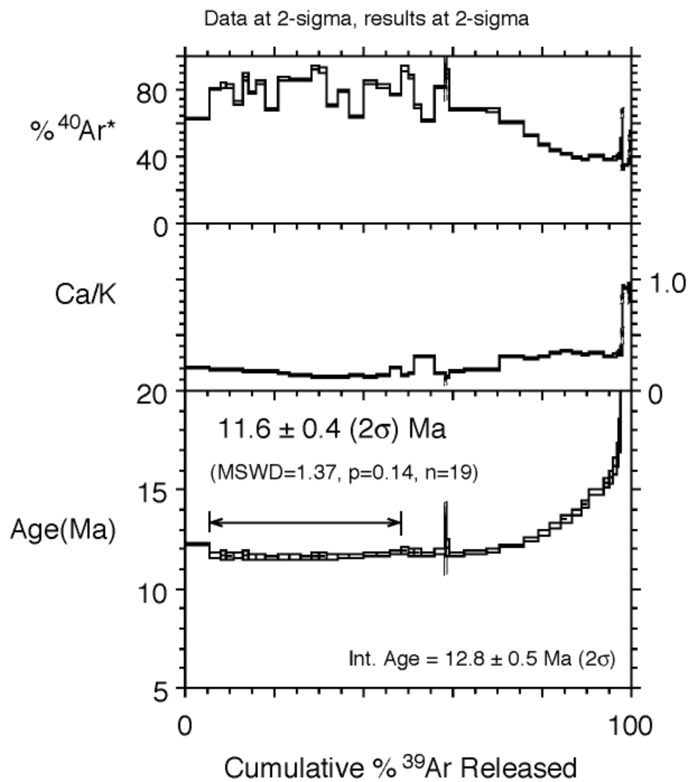
3. Sample 3.1 (Lab ID 50074: Plagioclase)

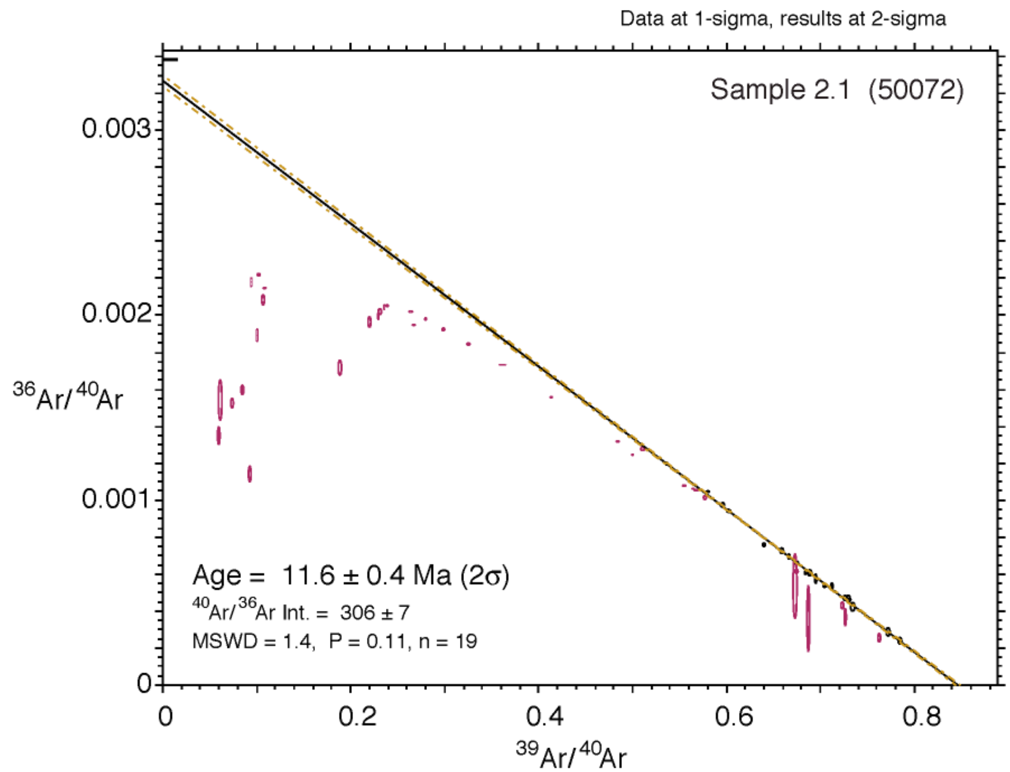


J=0.005567±0.000100**;** 78.5% ^{39}Ar in plateau (steps 2-12; n=11 of 16 total steps)

% furnace power	^{40}Ar	±1σ	^{39}Ar	±1σ	^{38}Ar	±1σ	^{37}Ar	±1σ	^{36}Ar	±1σ	^{39}Ar (mol)	% ^{39}Ar of total	% $^{36}Ar_{Ca}$	Ca/K	±1σ	% ^{40}Ar*	Age (Ma)	±1σ	w/±J ±1σ
5.1	31.28836	0.09698	4.69755	0.01241	0.06356	0.00319	14.79267	0.14988	0.06175	0.00269	3.29E-15	4	6.3	6.172077	0.0643298	45.3	30.07239	1.68867	1.77
5.3	14.84578	0.07821	2.40735	0.00515	0.03356	0.00283	12.87776	0.14994	0.0301	0.0023	1.69E-15	2	11.3	10.48474	0.1235745	46.8	28.80311	2.822825	2.87
5.8	20.75675	0.07841	2.9221	0.00476	0.04734	0.00292	18.11654	0.14806	0.04942	0.00225	2.05E-15	2.5	9.7	12.1517	0.1008325	36.4	25.84066	2.276731	2.32
6.5	23.63852	0.07911	3.8977	0.00589	0.05329	0.00336	30.45827	0.15639	0.04933	0.00225	2.73E-15	3.3	16.3	15.31625	0.0816368	48.3	29.29627	1.705934	1.78
7.2	22.59106	0.07831	4.42302	0.00572	0.06068	0.00309	36.39695	0.1611	0.0453	0.0022	3.10E-15	3.7	21.2	16.1288	0.0740878	53.2	27.20383	1.470864	1.55
8	21.59463	0.07759	4.67039	0.00623	0.0644	0.00319	30.6363	0.15217	0.03831	0.00242	3.27E-15	4	21.1	12.85697	0.0658618	58.6	27.06006	1.531853	1.61
9	23.92626	0.07708	5.46601	0.00676	0.06725	0.00304	26.19288	0.15884	0.03056	0.00248	3.83E-15	4.6	22.6	9.392231	0.0578944	70.7	30.86897	1.338271	1.45
10	23.26159	0.07704	6.16923	0.00641	0.07942	0.00314	15.96567	0.14834	0.02454	0.00236	4.32E-15	5.2	17.2	5.072383	0.047226	74.1	27.83702	1.127376	1.23
12	52.54788	0.07947	14.49407	0.01241	0.18185	0.00336	14.75327	0.15895	0.0384	0.00276	1.01E-14	12.3	10.1	1.995052	0.0214734	80.6	29.04482	0.5598993	0.76
14	91.81142	0.09211	25.40175	0.02324	0.3243	0.003	16.6707	0.14178	0.07264	0.0023	1.78E-14	21.5	6.1	1.286312	0.0109578	78	28.0349	0.2696812	0.57
16	92.19668	0.09239	24.61237	0.02027	0.32009	0.00314	21.26234	0.15456	0.0744	0.00225	1.72E-14	20.9	7.5	1.693221	0.0123377	77.9	29.02345	0.27162	0.58
18	46.00739	0.0794	11.46633	0.00906	0.14717	0.00342	10.1667	0.14853	0.0382	0.00236	8.03E-15	9.7	7	1.737847	0.0253202	77.1	30.77323	0.6058703	0.82
20	21.63724	0.0754	4.91215	0.00676	0.06399	0.00304	6.84671	0.15051	0.02495	0.00242	3.44E-15	4.2	7.2	2.73191	0.0599183	68.3	29.94853	1.44878	1.54
25	14.77147	0.07484	2.42127	0.00515	0.03016	0.0033	11.6069	0.1666	0.02908	0.00211	1.69E-15	2.1	10.5	9.395698	0.1357395	47.9	29.14791	2.573994	2.63
Omitted, 2.5 nMADs from median age:																			
5	111.6038	0.72419	8.10491	0.05616	0.15057	0.00604	5.36823	0.29007	0.26695	0.00276	5.67E-15		0.5	1.298192	0.070411	29.7	40.53737	1.352302	1.53
30	4.98458	0.07463	0.24705	0.00381	0.0044	0.003	16.62275	0.16151	0.01409	0.00255	1.73E-16		31.1	131.8787	2.377577	42.5	87.77075	30.68915	30.73

4. Sample 2.1 (Lab ID 50072: Sanidine)

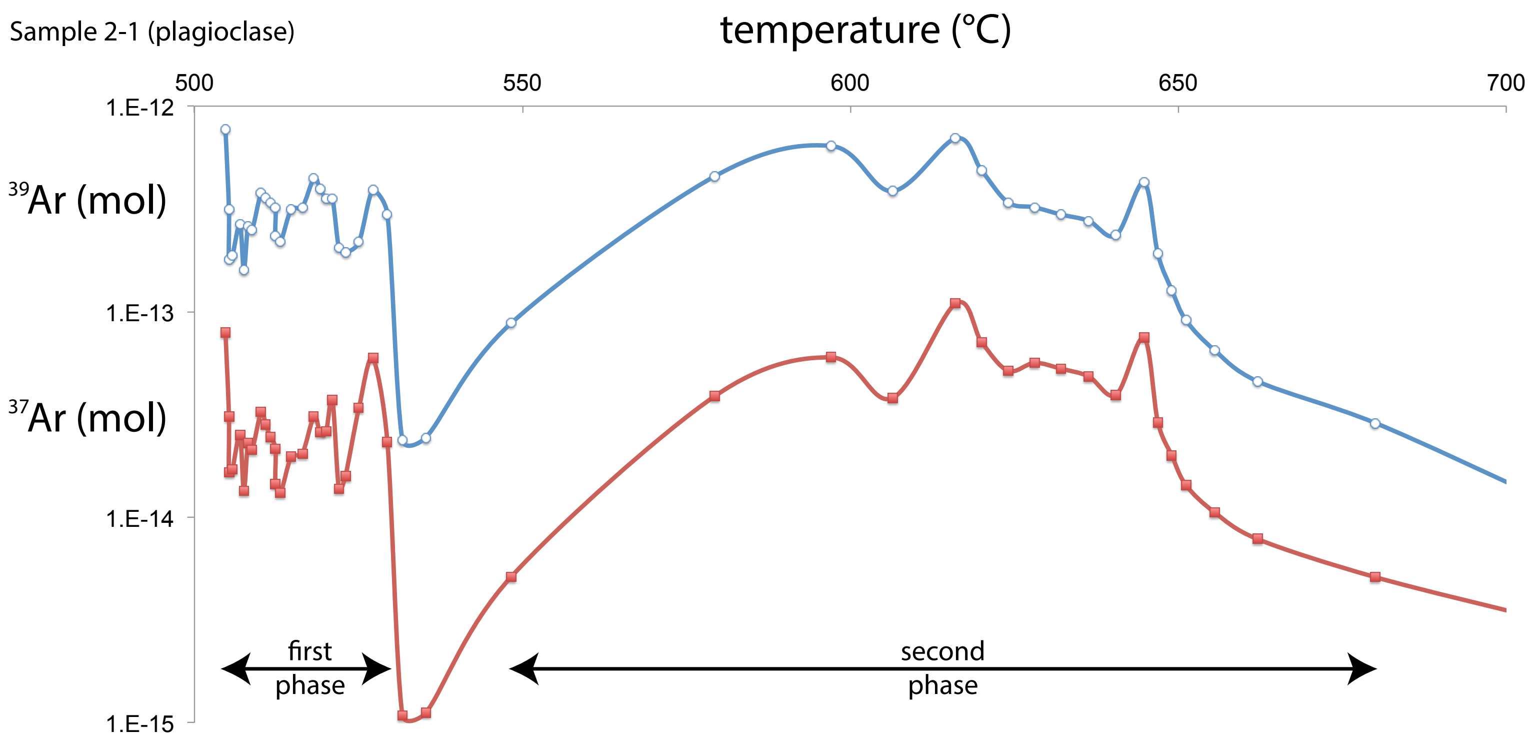




J=0.005465±0.000098; 42.7% ^{39}Ar in plateau (steps 2-20; n=19 of 52 total steps)

% furnace power	^{40}Ar	±1σ	^{39}Ar	±1σ	^{38}Ar	±1σ	^{37}Ar	±1σ	^{36}Ar	±1σ	^{39}Ar (mol)	% ^{39}Ar of total	39% Ar_{Ca}	Ca/K	±1σ	% ^{40}Ar*	Age (Ma)	±1σ	w/±J ±1σ
5.5	2214.822	0.32712	1103.109	1.20171	14.30166	0.01698	112.7597	0.37687	2.76171	0.00936	7.72E-13	6.9	1.1	0.200351	0.000702	63.4	12.4544	0.0330353	0.23
5.6	670.9263	0.36633	450.7376	0.37117	5.56552	0.01106	44.27653	0.36232	0.44933	0.00903	3.16E-13	2.8	2.6	0.1925333	0.0015771	80.6	11.72558	0.0600616	0.22
5.6	372.3893	0.23979	257.3836	0.22147	3.16041	0.0104	23.70322	0.35885	0.21897	0.00899	1.80E-13	1.6	2.9	0.1805022	0.0027256	83	11.73547	0.1024541	0.23
5.7	390.0987	0.20172	267.5472	0.21152	3.28561	0.01065	24.4211	0.35461	0.23883	0.00906	1.87E-13	1.7	2.7	0.1789043	0.0025907	82.3	11.72352	0.0991695	0.23
5.9	634.1005	0.37614	380.7552	0.32122	4.72767	0.01065	35.81737	0.35783	0.599	0.00899	2.67E-13	2.4	1.6	0.1843758	0.0018409	72.4	11.78666	0.0708599	0.22
6	311.0067	0.19228	227.4278	0.20157	2.7659	0.01009	19.25804	0.35577	0.13394	0.00897	1.59E-13	1.4	3.8	0.1659681	0.0030566	87.7	11.71046	0.1151666	0.24
6.1	568.4539	0.35646	373.0787	0.33121	4.58527	0.01036	32.893	0.35748	0.41838	0.00901	2.61E-13	2.3	2.1	0.1728061	0.0018765	78.6	11.70178	0.0720043	0.22
6.2	505.1424	0.3075	357.7721	0.30125	4.36586	0.01048	30.41205	0.35654	0.27608	0.00898	2.50E-13	2.2	2.9	0.1666077	0.0019501	84.2	11.61685	0.0742794	0.22
6.4	937.2239	0.55412	541.9512	0.45115	6.72954	0.01182	46.41982	0.35773	0.98191	0.00901	3.79E-13	3.4	1.2	0.1678801	0.0012961	69.3	11.7161	0.051896	0.22
6.5	705.3137	0.38593	512.7169	0.41115	6.26488	0.01122	40.23901	0.35785	0.33107	0.00898	3.59E-13	3.2	3.2	0.1538246	0.001368	86.5	11.62112	0.0526585	0.21
6.6	671.8525	0.36624	485.94	0.40116	5.96038	0.01092	35.0457	0.35689	0.32329	0.00899	3.40E-13	3	2.9	0.141354	0.0014383	86.1	11.62762	0.0554975	0.22
6.7	633.238	0.36623	459.7867	0.38117	5.6492	0.01137	30.86452	0.35994	0.30416	0.00896	3.22E-13	2.9	2.7	0.1315707	0.0015319	86.1	11.58238	0.0582619	0.22
6.7	428.706	0.23006	334.5855	0.27131	4.08568	0.01056	20.77222	0.35713	0.10561	0.00906	2.34E-13	2.1	5.2	0.1216836	0.0020855	93.1	11.63989	0.0794938	0.22
6.8	405.8223	0.24924	311.7348	0.27131	3.81869	0.0106	18.81466	0.35958	0.12048	0.00901	2.18E-13	1.9	4.1	0.1182952	0.0022536	91.5	11.63448	0.084891	0.22
7	756.1664	0.46487	449.3208	0.38117	5.63036	0.01032	28.08936	0.35555	0.73995	0.00895	3.15E-13	2.8	1	0.1225297	0.0015479	71.2	11.72102	0.0607038	0.22
7.2	694.2623	0.34655	460.5817	0.35119	5.72154	0.01097	29.13225	0.35865	0.48696	0.00904	3.22E-13	2.9	1.6	0.1239719	0.0015228	79.5	11.70849	0.0588358	0.22
7.4	1192.01	0.61366	636.87	0.49115	8.06583	0.01243	44.23126	0.36198	1.43144	0.00899	4.46E-13	4	0.8	0.136124	0.0011144	64.6	11.83636	0.0457188	0.22
7.5	806.6445	0.47474	565.4076	0.47115	7.00001	0.01127	37.05171	0.35555	0.43449	0.00904	3.96E-13	3.5	2.3	0.1284407	0.0012321	84.3	11.75578	0.048762	0.22
7.6	746.923	0.38584	508.1557	0.39116	6.30762	0.01065	37.54219	0.35791	0.45696	0.00899	3.56E-13	3.2	2.2	0.1448035	0.0013793	82.2	11.80689	0.0533494	0.22
7.7	796.6394	0.48463	507.6312	0.42115	6.31704	0.01111	52.98714	0.36437	0.61287	0.00898	3.55E-13	3.2	2.3	0.2045871	0.0014115	77.7	11.91293	0.0540317	0.22
7.8	385.4694	0.23949	292.284	0.25137	3.59362	0.01065	19.69851	0.36227	0.10254	0.00899	2.05E-13	1.8	5.1	0.1320944	0.0024217	92.5	11.9097	0.0902488	0.23
7.9	385.8938	0.2491	277.7018	0.2414	3.42763	0.00997	22.66738	0.36063	0.16896	0.00899	1.94E-13	1.7	3.5	0.1599848	0.0025384	87.4	11.86837	0.0950381	0.23
8.1	540.9632	0.29755	311.1632	0.25137	3.90918	0.01048	48.48333	0.37139	0.55466	0.0091	2.18E-13	1.9	2.3	0.3053938	0.0023429	70.3	11.94494	0.0867628	0.23
8.3	1093.704	0.62356	558.254	0.44115	7.11116	0.01176	84.7198	0.37326	1.41322	0.00906	3.91E-13	3.5	1.6	0.2974467	0.0013269	62.3	11.93512	0.0520171	0.22
8.5	635.0397	0.37592	426.5062	0.35119	5.30347	0.01111	33.17466	0.3623	0.39452	0.00899	2.99E-13	2.7	2.2	0.1524534	0.0016628	81.9	11.92212	0.0631068	0.22
8.7	50.75218	0.07023	34.00671	0.04193	0.42113	0.00992	1.5577	0.36078	0.02712	0.00898	2.38E-14	0.2	1.5	0.0897789	0.0207053	84.4	12.30054	0.7647279	0.8
9	51.01174	0.07079	34.85919	0.03865	0.42483	0.00985	1.59577	0.36259	0.01847	0.00906	2.44E-14	0.2	2.3	0.0897238	0.0203004	89.5	12.7903	0.752473	0.79
10	174.0461	0.10671	125.6971	0.10274	1.54904	0.01003	7.33529	0.3627	0.06417	0.00908	8.80E-14	0.8	3	0.1143794	0.0056322	89.4	12.08529	0.2096134	0.3
12	1149.513	0.70301	650.685	0.54116	8.2386	0.01111	55.39761	0.36237	1.21424	0.00903	4.55E-13	4.1	1.2	0.1668692	0.001096	69	11.92386	0.0448686	0.22
13	1627.669	1.00209	914.7889	0.7613	11.61589	0.0146	85.60129	0.36629	1.7354	0.00906	6.40E-13	5.7	1.3	0.1834068	0.0007968	68.8	11.96485	0.0350903	0.22
13.5	996.6053	0.55377	551.5347	0.44115	7.00255	0.01159	54.27306	0.36845	1.07704	0.0091	3.86E-13	3.4	1.3	0.1928713	0.0013133	68.3	12.07834	0.051728	0.22
14	2059.268	0.32641	995.5863	0.14205	12.80449	0.0146	156.5435	0.40786	2.73842	0.00908	6.97E-13	6.2	1.5	0.3081855	0.0008033	61.1	12.37541	0.0323849	0.22
14.2	1678.664	0.18175	692.8104	0.06527	9.06767	0.012	101.2303	0.37021	2.62472	0.0091	4.85E-13	4.3	1	0.2863864	0.0010449	54.1	12.83553	0.0448518	0.23
14.4	1341.884	0.17241	485.6556	0.0462	6.46082	0.01116	73.73505	0.36301	2.3264	0.00908	3.40E-13	3	0.8	0.2975786	0.0014604	49	13.2712	0.0613284	0.24
14.6	1410.577	0.21958	459.8035	0.02987	6.21074	0.01148	80.47524	0.36312	2.61231	0.00922	3.22E-13	2.9	0.8	0.343041	0.0015431	45.6	13.69449	0.0669547	0.25
Omitted, 2.5 nMADs from median age:																			
14.8	1415.37	0.18169	423.4846	0.03052	5.79846	0.01132	75.30906	0.3691	2.73504	0.00939	2.96E-13		0.7	0.3485505	0.0017027	43.2	14.13503	0.0742069	0.26
15	1411.576	0.27749	395.0799	0.05239	5.46197	0.01127	69.17012	0.36996	2.80442	0.00922	2.77E-13		0.7	0.3431544	0.0018295	41.5	14.5397	0.078918	0.27
15.2	1269.841	0.20049	336.5582	0.03706	4.70214	0.01018	56.35821	0.36236	2.56683	0.0091	2.36E-13		0.6	0.328211	0.0021027	40.5	14.96425	0.0894471	0.28
15.4	2265.692	0.36563	606.5876	0.04533	8.42183	0.01231	106.4606	0.38108	4.426	0.00976	4.25E-13		0.6	0.3439945	0.0012285	42.5	15.554	0.0627416	0.28
15.5	1139.563	0.14486	272.9388	0.03257	3.84856	0.01006	41.48822	0.37053	2.33986	0.00912	1.91E-13		0.5	0.2979309	0.0026504	39.5	16.15035	0.1080174	0.31
15.6	771.2335	0.1272	181.6124	0.02645	2.56273	0.00987	28.44463	0.37314	1.58012	0.00904	1.27E-13		0.5	0.3069805	0.0040106	39.6	16.48324	0.1520395	0.33
15.7	558.1475	0.08234	129.6502	0.02749	1.81584	0.00981	20.45524	0.3697	1.12941	0.00908	9.08E-14		0.5	0.3092342	0.0055659	40.4	17.024	0.2081919	0.37
15.9	404.5617	0.07375	92.85844	0.02553	1.30637	0.0097	15.10218	0.36731	0.80729	0.00904	6.50E-14		0.5	0.3187677	0.0077207	41.2	17.58336	0.2854622	0.42
16.2	295.8835	0.0692	65.44462	0.02396	0.9188	0.0097	11.17831	0.36857	0.58181	0.00904	4.58E-14		0.5	0.3347789	0.010992	42.1	18.6278	0.4019078	0.52
17	216.0772	0.07252	41.04534	0.02553	0.57598	0.00975	7.30083	0.36835	0.37181	0.00901	2.87E-14		0.5	0.3486298	0.017516	49.3	25.38812	0.6334445	0.78
18	202.1304	0.06841	18.98567	0.02373	0.28003	0.0097	4.74967	0.36983	0.23123	0.00898	1.33E-14		0.5	0.4903353	0.0380215	66.4	68.29463	1.333028	1.79
19.5	188.9357	0.06705	11.48774	0.0232	0.18808	0.00972	4.35872	0.36863	0.25568	0.00899	8.04E-15		0.5	0.7436701	0.0626443	60.2	94.99622	2.178059	2.74
22	367.9945	0.0754	34.73377	0.02401	0.58833	0.00995	14.37148	0.3696	0.80387	0.00893	2.43E-14		0.5	0.8109716	0.0207753	35.7	36.89363	0.745706	0.99
25	774.7041	0.08725	79.99738	0.02553	1.34569	0.00973	37.79223	0.37359	1.72309	0.00906	5.60E-14		0.6	0.9259399	0.009121	34.6	32.71726	0.3448521	0.68
28	1375.772	0.09911	150.7973	0.02805	2.47336	0.00981	70.05559	0.37508	2.96263	0.00927	1.06E-13		0.6	0.9105531	0.004861	36.7	32.69709	0.2064345	0.62
31	319.9584	0.07832	34.63885	0.02438	0.56336	0.00972	16.07465	0.37202	0.6699	0.00906	2.42E-14		0.6	0.9095658	0.0209706	38.5	34.6746	0.7561823	0.98
35	262.1927	0.07336	26.44351	0.02511	0.42505	0.00969	11.86195	0.37277	0.49825	0.00903	1.85E-14		0.6	0.8792112	0.0275244	44.2	42.62853	0.9786364	1.24
40	296.5872	0.06841	25.55142	0.02355	0.40715	0.00983	10.92103	0.36904	0.47435	0.00903	1.79E-14		0.6	0.8377312	0.0281982	53	59.621	1.004082	1.45
45	298.5269	0.07032	22.43499	0.02413	0.35752	0.00973	9.72461	0.36885	0.45595	0.00903	1.57E-14		0.6	0.849576	0.0320993	55.1	70.84142	1.137008	1.69
50	79.09863	0.07861	4.97218	0.02348	0.08194	0.00987	2.09399	0.36968	0.1219	0.00903	3.48E-15		0.5	0.8254347	0.1451542	54.6	83.7081	5.069434	5.28

Notes: The age interpretation of the high-resolution (n_{STEPS}>25) step-heating experiment on feldspar sample 2-1 presents three complications. Firstly, it yields a plateau with less than the widely accepted 50% ^{39}Ar yield cut-off. Second it shows a steadily increasing 'age' in the latter half of the extraction associated with a more calcic phase. Third, the steps used for the plateau and isochron are strictly non-atmospheric. Nevertheless, there is strong evidence to suggest that the plateau, as presented, yields a robust age. An explanation of the high-temperature end of the spectrum is that this sample represents two phases. A plot of ^{39}Ar and ^{37}Ar release versus temperature indicates two separate pulses of ^{39}Ar and ^{37}Ar implying two distinct phases, the first yielding a plateau age of 11.6, the second, more calcic phase showing progressively older age steps. The first phase has K/Ca of ca. 5-8 consistent with sanidine; sanidine is consistent with the whole rock geochemistry of the sample. The second phase, plagioclase, may be influenced by recoil, excess argon or a combination of the two. One of the phases is recording cooling of the rock (11.6 Ma) and the other is disturbed and cannot be interpreted in terms of a cooling age. Hypothetically if you could physically separate these two phases, then the first phase would yield a completely robust plateau; in reality the high-resolution step heating has done this for us and this was the reason we chose this approach for analysing these samples. Although ≥50% ^{39}Ar gas yield is widely accepted as a 'minimum cutoff', this number is effectively arbitrary. For example, some workers will choose ≥60% for yield, but with no statistical justification for the cut-off value. What is more informative is the fact that our sample yielded 19 indistinguishable age steps representing $1x10^{-11}$ mol of ^{39}Ar. Also note that the normally used statistical criteria (MSWD and P) take no account of the %^{39}Ar yield. The data points used in the plateau, plotted on the inverse isochron diagram, intercept at a value that is *very nearly* indistinguishable from air, i.e., 306±7 versus 298.56±0.31. Furthermore, the plateau calculation method takes into account the composition of the trapped component effectively removing any bias on the calculated age caused by the slight amount of excess argon.


Sample 2-1 (plagioclase)
temperature (°C)
500
550
600
650
700
1.E-12
1.E-13
1.E-14
1.E-15
39Ar (mol)
37Ar (mol)
first
phase
second
phase

Appendix DR4. Palaeogeographic Reconstructions

1. **Methodology**

Palaeogeographic reconstructions were made using the PLATES™ software utilizing published or interpolated poles of rotations for the major continents, South America [SAM], Africa [AFR] and Antarctica [ANT] to a global reference frame [000]. The South Georgia microcontinent on the North Scotia Ridge and the continental Terror, Pirie and Bruce Banks of the southern Scotia Sea (see text and Figs. 1 and 2, but only Pirie labelled in Fig. 4 due to lack of space) are shown at 25 Ma following some seafloor spreading in the West Scotia Sea.

25 Ma	Latitude +°N	Longitude +°E	Angle Degree		Reference
AFR	45.498	-44.843	-5.6639	000	*Duncan & Richards, 1991
SAM	57.692	36.358	9.6191	AFR	*Müller et al., 1999
ANT	11.391	-48.165	3.7617	AFR	*Royer & Chang, 1991
SGI	22.864	-30.450	-5.8416	SAM	* Eagles et al., 2005

10 Ma	Latitude +°N	Longitude +E	Angle Degree		Reference
AFR	9.645	-30.824	-1.8483	000	*Duncan & Richards, 1991
SAM	61.827	-40.343	3.3044	AFR	*Müller et al., 1999
ANT	8.244	-49.374	1.5421	AFR	*Royer & Chang., 1991
SGI	6.210	-21.890	-0.6690	SAM	*Eagles et al., 2005

SGI – South Georgia microcontinent * interpolated between published poles

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