VESPA Dating Study Supplemental File 4.

Petrographic observations, photomicrographs, K and Ca element maps, mineral and K reservoir modes, argon spectra and interpretive comments for eight VESPA samples*.

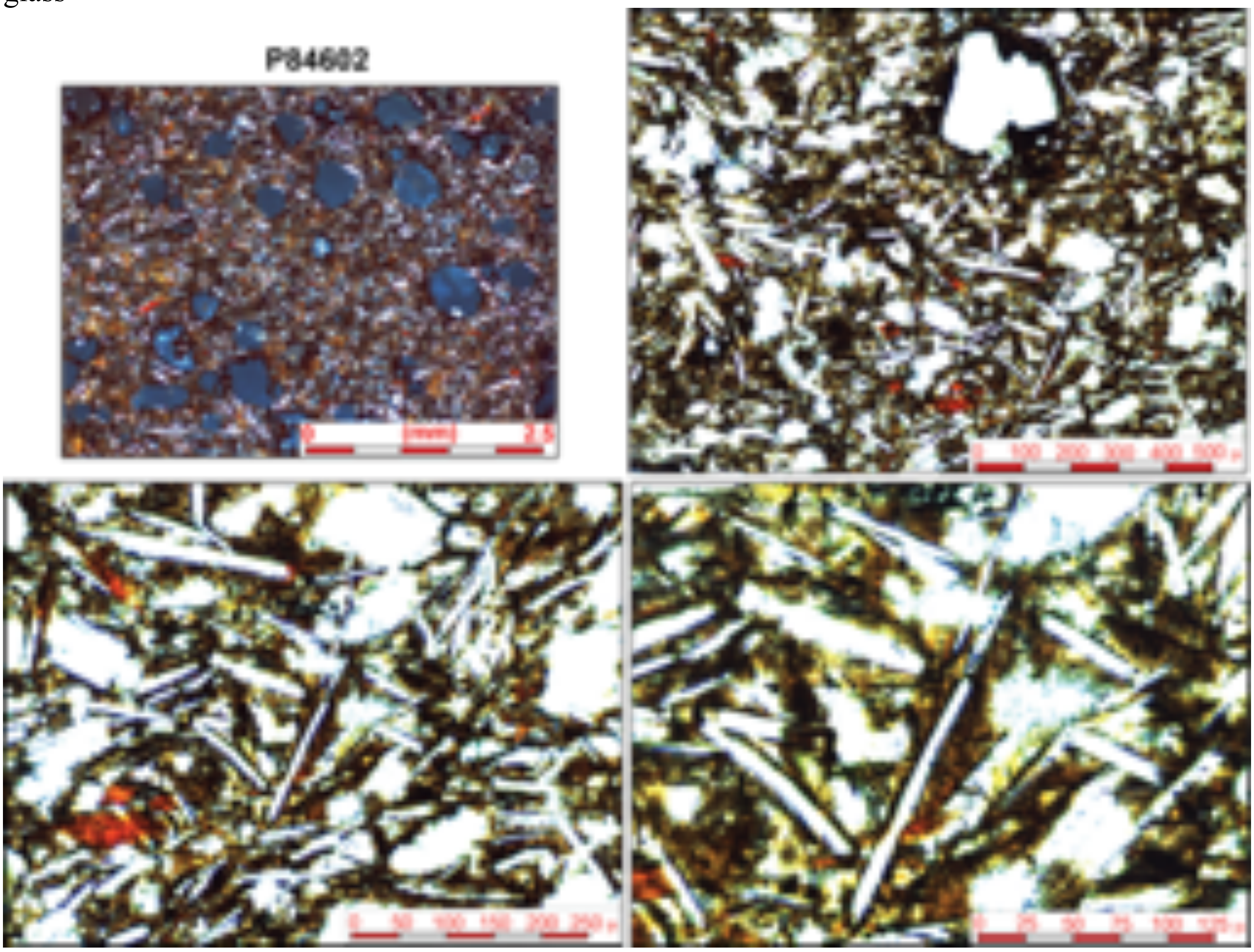
***** Note that the WMPA and isochron ages indicated on the spectra and captions below them assume all steps used in age calculations lie within analytical error of each other and assign a weighted mean uncertainty(1 sigma) accordingly. In many cases, these samples yielded disturbed spectra and steps used in the age calculation do not represent a statistically meaningful plateau, but are nonetheless interpretable. Ages and estimated errors (2 sigma) in the accompanying analysis of the argon data for each sample may not match exactly what is on the argon spectra, but reflect our best estimate of the age and uncertainty as reported in the main manuscript. See the manuscript for discussion.

P84602

P84602 Type 2 Spectrum: low T plateau

<u>*Petrographic observations*</u>

Highly vesicular aphyric basalt with ~20% large (200-500μ) vesicles, and some smaller ones. The quenched matrix is a very fine-grained somewhat altered looking groundmass with ~ 40% plag needles, 40-125μm long x 3-12μm wide, and a few % iddingitized olivines set in a dark brown matrix of carbonate, clays, and needles of secondary oxides. Element mapping refines these estimates, yielding ~50% fresh plag crystals, 2% iddingsite after olivine, and a mixture of an Fe-rich calcite (40%), Fe-Ti oxides (6%), and Fe-rich clays (~ 2%) that replace the original basaltic glass



Microprobe observations and analysis of K budget

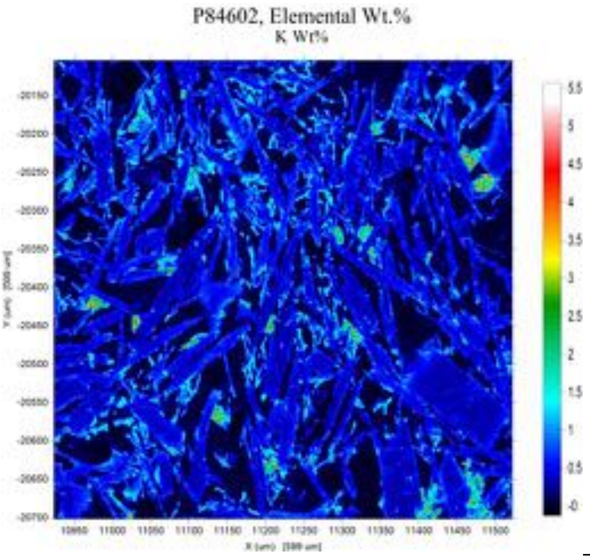
Most of the original potassium in this sample was likely held in groundmass glass and was subsequently lost during alteration. The remaining K is held mostly in plagioclase, roughly equally distributed between the sodic andesine rims (44%, K/Ca = 0.15) and calcic andesine cores (37%, K/Ca of 0.05), with an additional 13% in the clays (K/Ca ~ 0.15 and ~6% in the secondary carbonate (K/Ca ~.001)

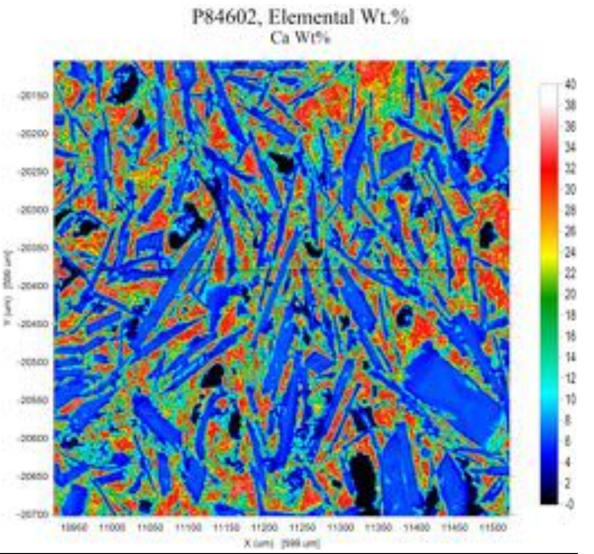
Sample P84602

Phases present and their criteria

Phase	***Criteria***	***pixels***	***raw vol %***	***norm vol%***	***Avg K (wt %)***	***fract K***	***% of total K***	***avg K/Ca***	***An content***
voids	0-25% tot	10448	7.3%	**0.0%**			**0.0%**		
Fe-ti oxides	4.2-16 Ti	8336	5.8%	**6.3%**		0	**0.0%**		
cpx			0.0%	**0.0%**		0	**0.0%**		
olv-iddg	34-53% Fe	2,569	1.8%	**1.9%**		0	**0.0%**		
plag cores	3.8-4.8% Na	42000	29.3%	**31.6%**	0.36	0.11389	**36.6%**	0.05	42-47
plag- rims	4.8-5.5% Na	24000	16.8%	**18.1%**	0.75	0.13558	**43.6%**	0.15	30-39
calcite/sid?	20-36% Ca	52800	36.9%	**39.8%**	0.05	0.01989	**6.4%**	0.001	
sanidine		0	0.0%	**0.0%**		0.00000	**0.0%**		
Fe-rich clays	1.3-4.5% K	3058	2.1%	**2.3%**	1.8	0.04146	**13.3%**	0.15	
hi K phase			0.0%	**0.0%**		0.00000	**0.0%**		
Totals		**143211**	**100.0%**	**100.0%**		**0.31081**	**100.0%**		

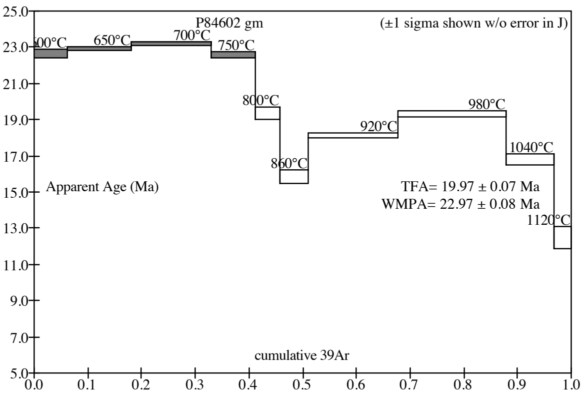
Total pixels	165242
Meas %	86.67%
Missing %	13.33%

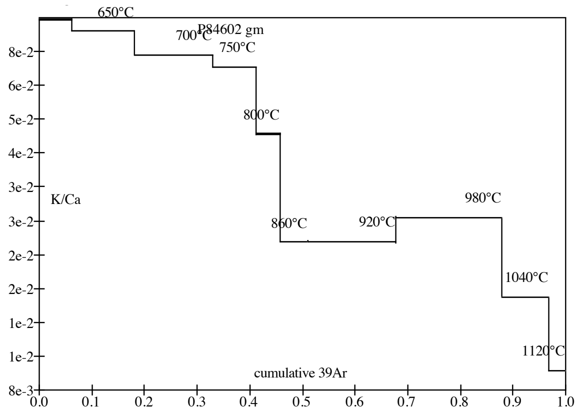




Analysis of Spectrum

This is a fairly unusual age spectrum, with a reasonably flat segment at ~23 Ma for the first 40% of the gas released, followed by an abrupt step downward to much younger and more erratic ages of 15-19 Ma over the latter part of the spectrum. This step downward is associated with a similar drop in apparent K/Ca ratios, from 0.07-0.10 initial values, to much lower values of ~0.02 or less over the last 50%. The early mini-plateau is considered a reliable estimate of the age and, given the apparent K/Ca ratios, reflects degassing of both plagioclase rims and cores. The younger ages during the latter part of the spectrum likely reflects extensive recoil (excess ^{39}Ar and ^{37}Ar) during degassing from the somewhat more retentive plag cores and adjacent carbonate. Overall, it is remarkable that any meaningful age information was obtained from such an altered and quenched sample.





Sample: SB69-16 P84602 gm J=0.0041184 FINAL J (28.1 FCT)

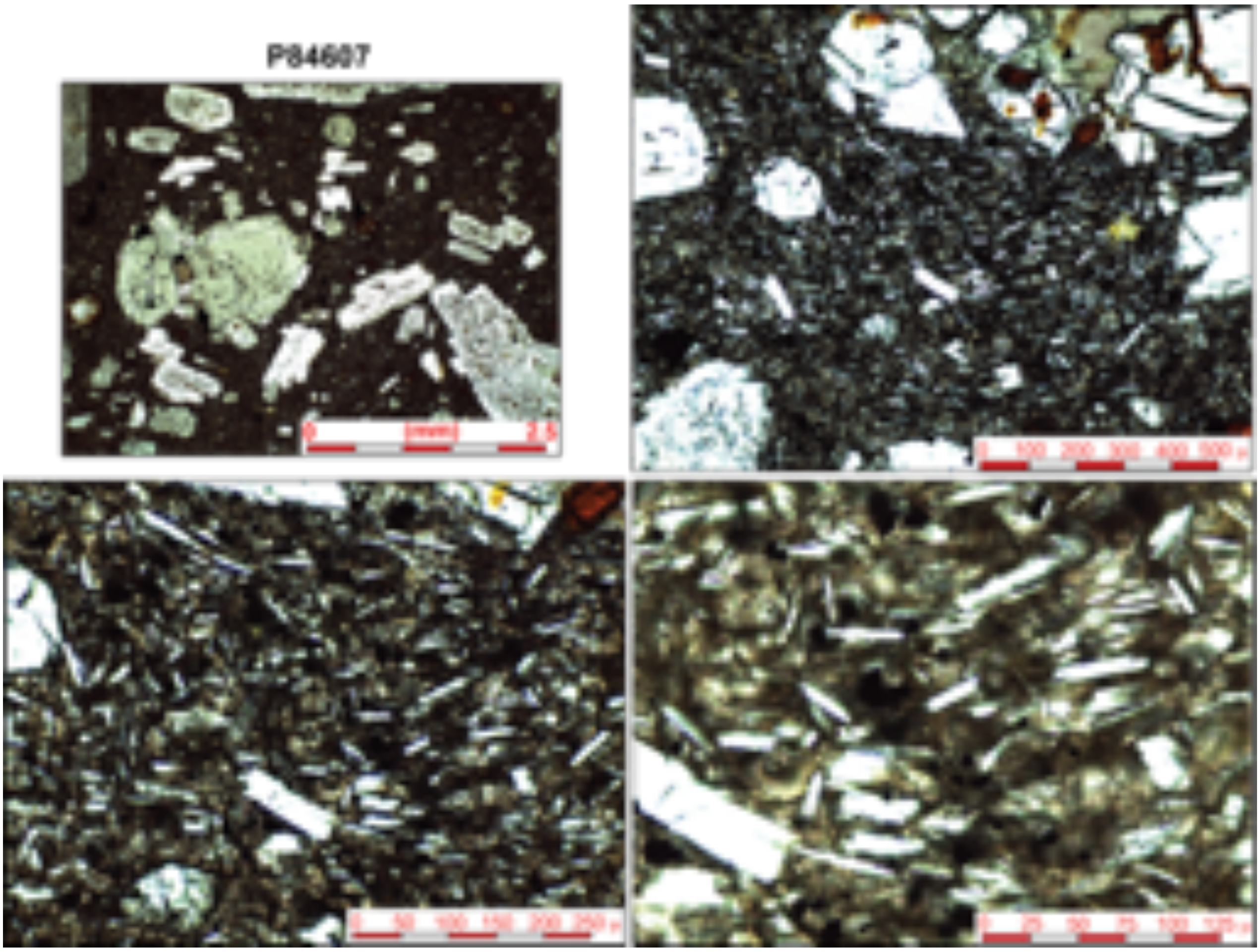
T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	6.1e-15	3.6507	0.0e+0	4.9794	0.0020	0.098	0.06160	0.841	22.7 ± 0.2
650	14	1.1e-14	3.3764	0.0e+0	5.3984	0.0009	0.091	0.18142	0.920	22.9 ± 0.1
700	14	1.3e-14	3.3174	0.0e+0	6.3245	0.0006	0.077	0.32890	0.947	23.2 ± 0.1
750	14	7.6e-15	3.4043	0.0e+0	6.8840	0.0012	0.071	0.41220	0.899	22.6 ± 0.2
800	14	6.9e-15	5.7882	1.2e-3	10.8599	0.0107	0.045	0.45692	0.453	19.4 ± 0.4
860	14	1.1e-14	7.3227	2.8e-3	22.6527	0.0175	0.022	0.51117	0.293	15.8 ± 0.4
920	14	2.0e-14	4.5627	2.1e-3	22.5502	0.0071	0.022	0.67690	0.538	18.1 ± 0.2
980	14	2.3e-14	4.2152	2.5e-3	19.1193	0.0054	0.026	0.87964	0.620	19.3 ± 0.1
1040	14	1.2e-14	5.2457	5.0e-3	32.8265	0.0101	0.015	0.96684	0.433	16.8 ± 0.3
1120	14	4.8e-15	5.5579	9.8e-3	54.3462	0.0131	0.009	1.00000	0.303	12.5 ± 0.6

Total fusion age, TFA= 19.97 ± 0.07 Ma (including J). All errors ±1 sigma.

P84607

P84607 Type 2 Spectrum: descending staircase

Petrographic observations
This is a representative sample of a groundmass that yields a descending staircase type spectrum. It is a porphyritic basalt containing ~25% phenocrysts (.05-2.0 mm) of plagioclase, clinopyroxene and iddingsitized olivine. The groundmass consists of fresh flow-aligned plagioclase crystals and a few % each of cpx, olivine, and Fe-Ti oxide crystals in a glassy matrix. Analysis of X-ray element concentration maps discussed below provides a more quantitative groundmass modal composition of 63% glass, 28% plagioclase, and 1-2 % each of cpx, olv, and Fe-Ti oxides. In addition, there is ~ 4.2% of an unidentified late stage high K phase- either sanidine or K-rich secondary clay/zeolite that occurs as tiny interstitial blebs only a few microns in diameter. Most groundmass plagioclase laths are 25-75μ long but only 5-20μ wide and are zoned from Ca cores to sodic rims, but a few are up to 100 x 20μ.

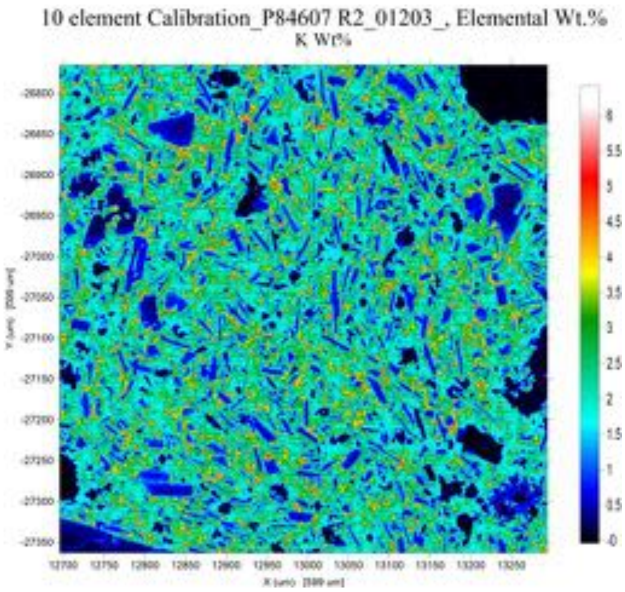


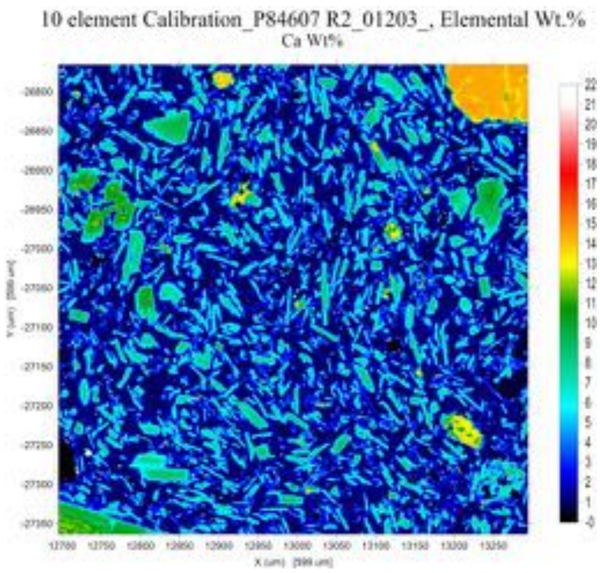
Microprobe observations and analysis of K budget
The majority (63%) of the total K in the groundmass resides in glass which has a highly variable measured K/Ca of 0.25 to 1.0, with the rest distributed between plagioclase calcic cores (2.7% with K/Ca ~0.06), plagioclase sodic rims (13.5% with K/Ca of 0.15), and in late blebs of sanidine(?) (14% with K/Ca > 3.0).

Sample P84607

Phases present and their criteria

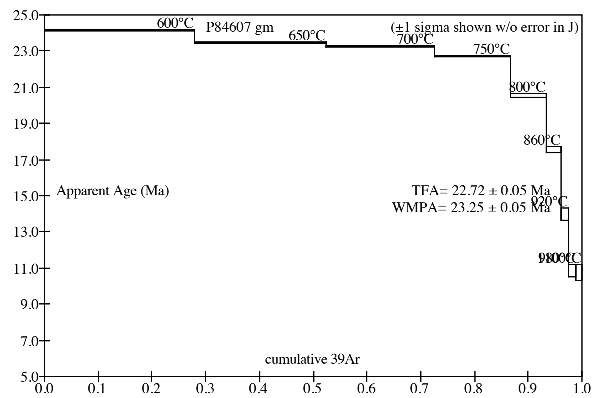
Phase	***Criteria***	***pixels***	***vol %***	***norm vol%***	***K (wt %)***	***fract K***	***% of K***	***avg K/Ca***	***An%***
voids	<75% tot	890	0.5%	**0.0%**	0		**0.0%**		
Fe-ti oxides	8.8-13% Ti	1780	1.1%	**1.1%**	0	0	**0.0%**		
cpx	12.8-15.5 Ca	3694	2.2%	**2.4%**	0.05	0.001190	**0.1%**	0.001	
olv	11.5 -18.5 Mg	2091	1.3%	**1.3%**	0.01	0.000135	**0.0%**		
plag cores	8.0 to 11.8% Ca	12028	7.3%	**7.7%**	0.47	0.036417	**2.7%**	0.06	An60-72
plag- rims	1.9-2.9 Na	31698	19.2%	**20.4%**	0.9	0.183774	**13.6%**	0.15	An48-54
glass	2-3% Fe	97395	59.1%	**62.7%**	1.5	0.941105	**69.6%**	0.25–1.0	
sanidine		0	0.0%	**0.0%**	0.5	0	**0.0%**		
K-rich phase	3.5-6% K	6549	4.0%	**4.2%**	4.5	0.189844429	**14.0%**	> 3.0	
other		0	0.0%	**0.0%**		0			
Totals		**156125**	**94.7 %**	**100.0%**		**1.3525**	**100.0 %**		
Total pixels		164836							
Meas %		94.72 %							
Missing %		5.28%							

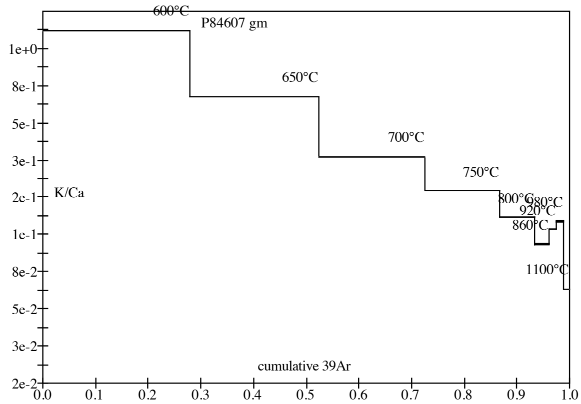




<u>*Analysis of Groundmass Spectrum*</u>

This sample yields a disturbed spectrum of monotonically decreasing ages with increasing temperatures, starting at 24 Ma and initially decreasing gradually, but then dropping abruptly at higher temperatures to ages as young as 10 Ma. This decreasing age pattern is mimicked by decreasing apparent K/Ca ratios from 1.6 to 0.06. The relatively flat early to central part of the spectrum yields a weighted mean age of 23.2 ± ~0.5 that is within error of the much better defined WMPA of 23.6 ± 0.24 Ma obtained from phenocrystic plagioclase in the same sample. In detail, it is likely that any argon associated with the K-rich interstitial sanidine or clay was pumped away during initial heating, the early analytical steps (600° to 750°) represent mainly degassing of fresh glass (K/Ca of 0.2-1.5), and the highest temperature steps reflect degassing of the acicular plagioclase (K/Ca of 0.06-.2) whose apparent ages are significantly decreased by the presence of excess ^{39}Ar due to reactor induced recoil from adjacent high K glass sites.

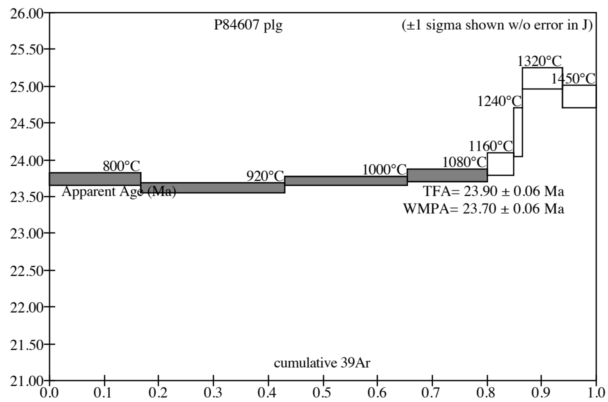


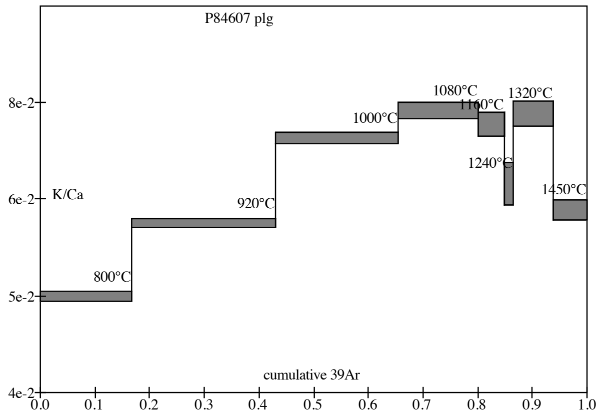


Sample: SB69-19 P84607 gm J=0.0040967 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	6.7e-14	3.4451	1.1e-3	0.3140	0.0005	1.6	0.27984	0.955	24.2 ± 0.1
650	14	5.8e-14	3.4125	8.0e-4	0.7128	0.0007	0.69	0.52423	0.938	23.5 ± 0.1
700	14	4.8e-14	3.4163	0.0e+0	1.4907	0.0008	0.33	0.72647	0.927	23.2 ± 0.1
750	14	3.3e-14	3.3571	0.0e+0	2.2829	0.0009	0.21	0.86722	0.921	22.7 ± 0.1
800	14	1.5e-14	3.2732	0.0e+0	3.1746	0.0016	0.15	0.93415	0.854	20.5 ± 0.1
860	14	5.1e-15	2.8099	9.3e-4	4.4241	0.0014	0.11	0.96062	0.850	17.6 ± 0.2
920	14	2.5e-15	2.4887	2.6e-3	3.6751	0.0020	0.13	0.97530	0.764	14.0 ± 0.3
980	14	1.7e-15	1.8786	7.9e-3	3.3298	0.0014	0.15	0.98833	0.785	10.8 ± 0.4
1100	14	1.9e-15	2.3576	1.2e-2	7.7152	0.0030	0.064	1.00000	0.621	10.8 ± 0.4

Total fusion age, TFA= 22.72 ± 0.05 Ma (including J)
Weighted mean age, WMPA= 23.25 ± 0.06 Ma (including J). All errors ±1 sigma.





Sample: SB69-177 P84607 plg J=0.0038937 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
800	14	4.2e-14	3.6069	0.0e+0	9.8045	0.0007	0.050	0.16685	0.943	23.7 ± 0.1
920	14	6.4e-14	3.4812	0.0e+0	8.2385	0.0003	0.059	0.43002	0.972	23.6 ± 0.1
1000	14	5.5e-14	3.4835	0.0e+0	6.7213	0.0003	0.073	0.65506	0.976	23.7 ± 0.1
1080	14	3.7e-14	3.6546	0.0e+0	6.2969	0.0008	0.078	0.80075	0.933	23.8 ± 0.1
1160	14	1.2e-14	3.6876	0.0e+0	6.5049	0.0009	0.075	0.84810	0.930	23.9 ± 0.2
1240	14	5.0e-15	4.0053	0.0e+0	7.4772	0.0017	0.066	0.86589	0.872	24.4 ± 0.3
1320	14	2.2e-14	4.3386	0.0e+0	6.3362	0.0025	0.077	0.93765	0.830	25.1 ± 0.2
1450	14	1.9e-14	4.3065	0.0e+0	7.9752	0.0025	0.061	1.00000	0.828	24.9 ± 0.2

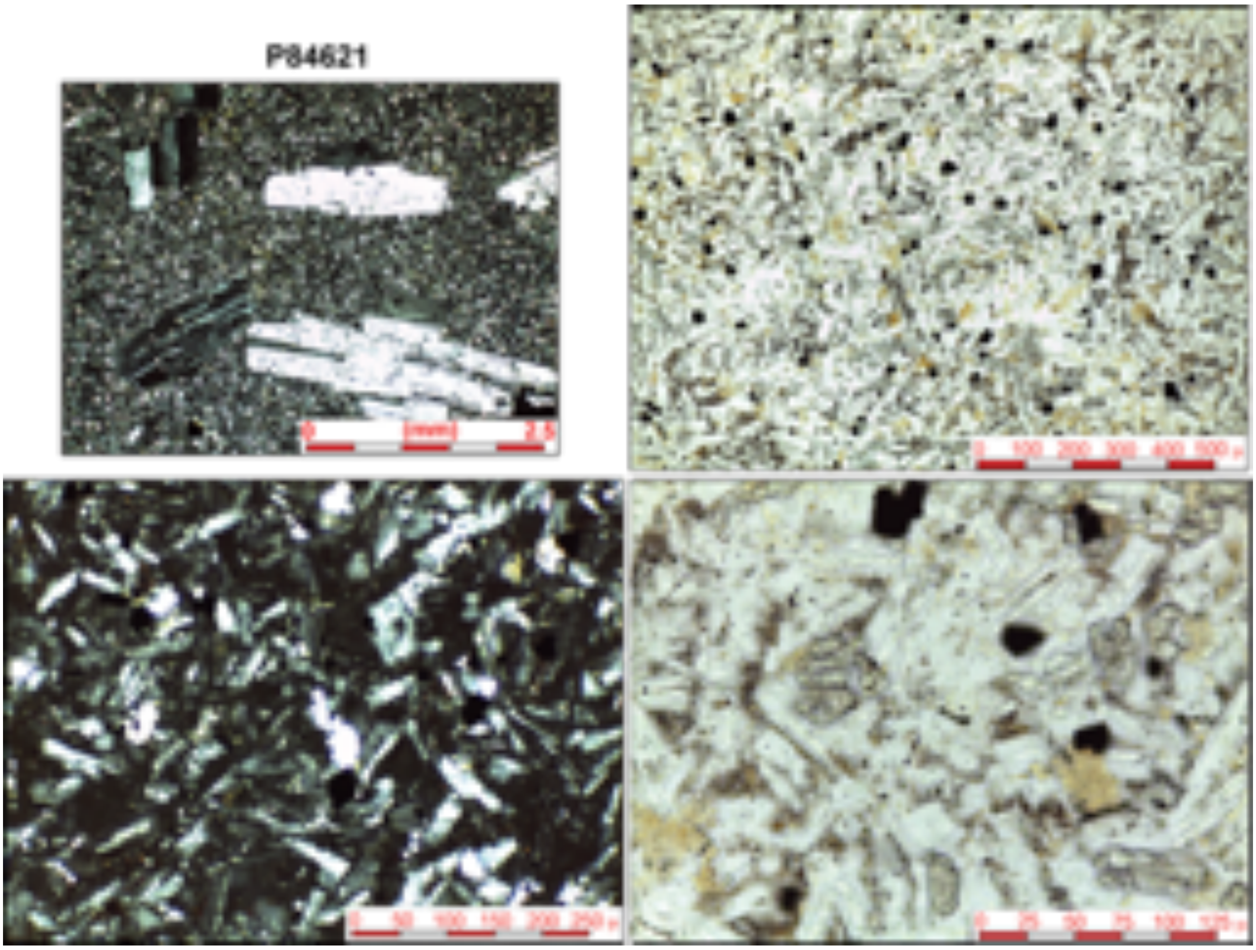
Total fusion age, TFA= 23.90 ± 0.06 Ma (including J)
Weighted mean plateau age, WMPA= 23.70 ± 0.06 Ma (including J). All errors ±1 sigma.

P84621

P84621 Type 1 (flat) groundmass spectrum

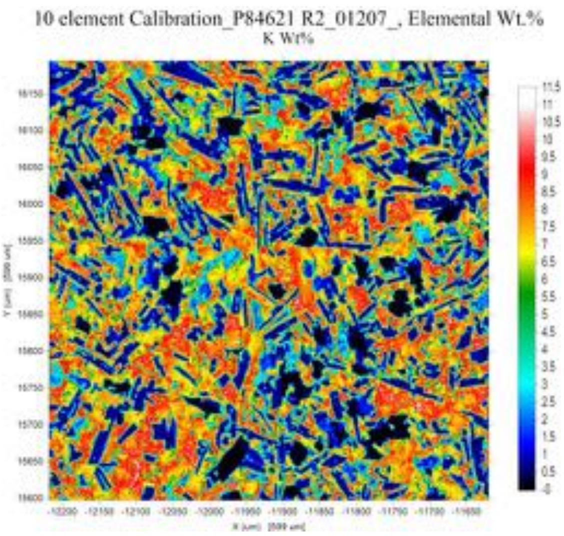
Petrographic observations:

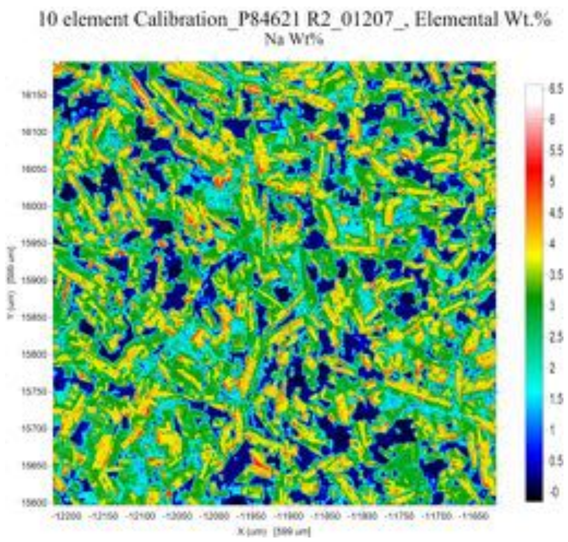
This sample of porphyritic basaltic andesite contains abundant phenocrysts of plagioclase (1-3 mm) in a very fresh, mostly crystalline groundmass composed of interlocking 25-75µ crystals of plagioclase (30%- An_{47-52}), 10-30µ granular crystals of clinopyroxene (7%), and Fe-Ti oxide (4%) in a pale low relief matrix of interstitial sanidine(47%) in patches up to 40µ across. Minor phases include pale brown glass (10%) and trace biotite and apatite (<2%).



Microprobe observations and analysis of K budget

Of the total potassium present, 88% is held in sanidine with average K/Ca ratios of 12, the remainder is in groundmass plagioclase (5%) with average K/Ca of ~0.1, and glass (8%) with K/Ca ratios of 3-5.





Sample P84621

Phases present and their criteria

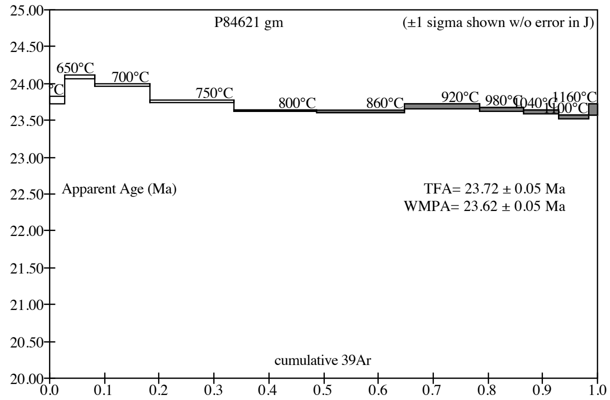
Phase	Criteria	pixels	raw vol %	Norm %	K (wt %)	fract K	% of K	K/Ca	An%
voids	< 40% tot	2316	1.4%	**0.0%**	0		**0.0%**		
Fe-ti oxides	> 7% Ti	3982	2.4%	**2.9%**	0	0	**0.0%**		
cpx	11-20% Ca	9604	5.9%	**6.9%**	0.1	0.006911	**0.2%**		
opx	20-28% Fe	1232	0.8%	**0.9%**	0.1	0.000887	**0.0%**		
plag	11-15.5% Al	42891	26.3%	**30.9%**	0.65	0.200631	**4.7%**	0.1	
plag		0	0.0%	**0.0%**		0.000000	**0.0%**		
glass	10-20% Fe, 2.3-4.5% K	15,600	9.6%	**11.2%**	2.9	0.325568	**7.7%**	4	
sanidine	7-12% K	64638	39.7%	**46.5%**	8	3.721324	**87.5%**	13	
K-rich clays	34-53 Fe	0	0.0%	**0.0%**	0	0.000000	**0.0%**		
apatitie	>21% Ca	1010	0.6%	**0.7%**		0.000000			
other						0.000000			
Totals		**141273**	**86.8%**	**100.0%**		**4.255322**	**100.0%**		

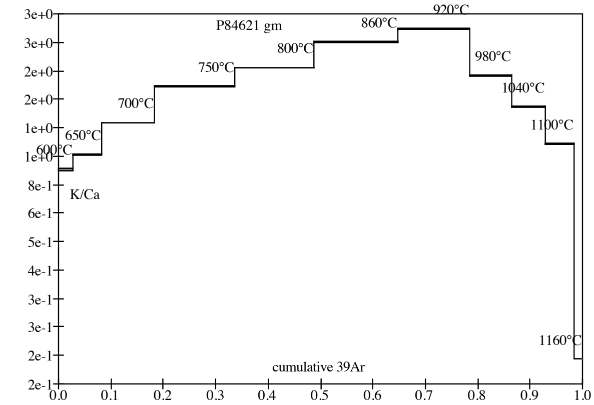
Total pixels	162812
Meas %	86.77%
Missing %	13.23%

Analysis of Spectrum

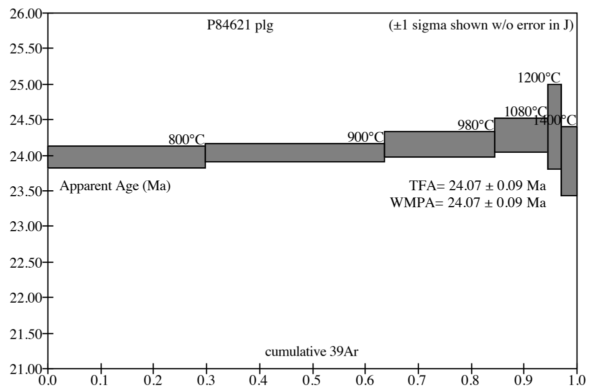
The groundmass argon spectrum (Fig. 3) yields slightly older ages in the lowest temperature steps, likely reflecting the recoil loss of ^{39}Ar from small non-retentive glass domains and plagioclase rims, a broad central to high temperature plateau associated with high K/Ca ratios during the release of argon from interstitial sanidine plus plagioclase cores, and a slight dip in ages associated with lower K/Ca ratios at the highest temperatures due to minor addition of ^{39}Ar by recoil to the more retentive groundmass plagioclase cores. The straightforward WMPA age calculated from the majority of the argon released reflects the crystallization age of the groundmass - in particular, the age of the fresh sanidine and plagioclase that holds most of the K in this shoshonitic lava. Note that in this case, the groundmass yields a more precise estimate of the age (23.62 ± 0.1 Ma) than the phenocrystic plagioclase (24.07 ± 0.18 Ma – isochron age) because of the inherently higher precision associated with the higher K content and much lower Ca correction for the groundmass crystal aggregates.

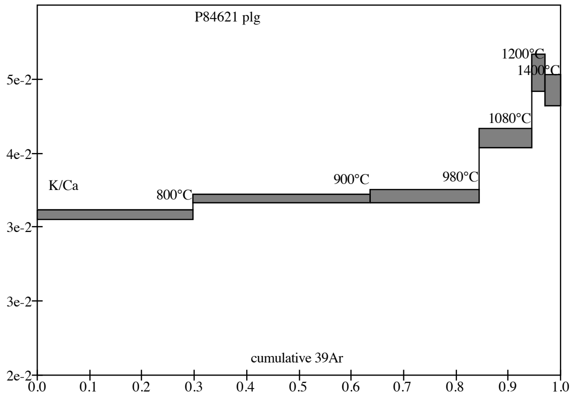
Groundmass





Plagioclase





Sample: SB69-4 P84621 gm J=0.0041663 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	2.5e-14	3.6179	0.0e+0	0.5482	0.0015	0.89	0.02798	0.880	23.8 ± 0.1
650	14	4.5e-14	3.3572	0.0e+0	0.4875	0.0004	1.0	0.08202	0.961	24.1 ± 0.1
700	14	8.2e-14	3.2552	0.0e+0	0.3752	0.0001	1.3	0.18266	0.987	24.0 ± 0.0
750	14	1.2e-13	3.2024	0.0e+0	0.2801	0.0001	1.7	0.33558	0.994	23.8 ± 0.0
800	14	1.2e-13	3.1820	0.0e+0	0.2400	0.0001	2.0	0.48797	0.995	23.6 ± 0.0
860	14	1.3e-13	3.1781	0.0e+0	0.1951	0.0001	2.5	0.64833	0.995	23.6 ± 0.0
920	14	1.1e-13	3.1893	0.0e+0	0.1753	0.0001	2.8	0.78385	0.995	23.7 ± 0.1
980	14	6.5e-14	3.1875	0.0e+0	0.2554	0.0001	1.9	0.86472	0.994	23.6 ± 0.0
1040	14	5.1e-14	3.1961	0.0e+0	0.3312	0.0001	1.5	0.92867	0.989	23.6 ± 0.0
1100	14	4.5e-14	3.2287	0.0e+0	0.4462	0.0003	1.1	0.98441	0.977	23.5 ± 0.1
1160	14	1.3e-14	3.3248	3.7e-4	2.5360	0.0005	0.19	1.00000	0.952	23.6 ± 0.1

Total fusion age, TFA= 23.72 ± 0.05 Ma (including J)
Weighted mean plateau age, WMPA= 23.62 ± 0.05 Ma (including J)
Inverse isochron age =23.64 ± 0.05 Ma. (MSWD =0.87; 40Ar/36Ar=276.9 ± 19.3)
Steps used: 800, 860, 920, 980, 1040, 1100, 1160, (5–11/11 or 66% ∑ 39Ar

Sample: SB69-178, 179 P84621 plg J=0.0038618 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
800	14	4.8e-14	3.9149	0.0e+0	14.9205	0.0015	0.033	0.29679	0.885	24.0 ± 0.2
900	14	5.0e-14	3.5798	0.0e+0	14.1986	0.0004	0.035	0.63531	0.970	24.0 ± 0.1
980	14	3.1e-14	3.5841	0.0e+0	14.0843	0.0003	0.035	0.84544	0.974	24.2 ± 0.2
1080	14	1.9e-14	4.6972	0.0e+0	11.7606	0.0040	0.042	0.94561	0.747	24.3 ± 0.2
1200	14	6.3e-15	6.1493	0.0e+0	9.5987	0.0089	0.051	0.97042	0.573	24.4 ± 0.6
1400	14	6.5e-15	5.2927	0.0e+0	10.1252	0.0062	0.048	1.00000	0.653	23.9 ± 0.5

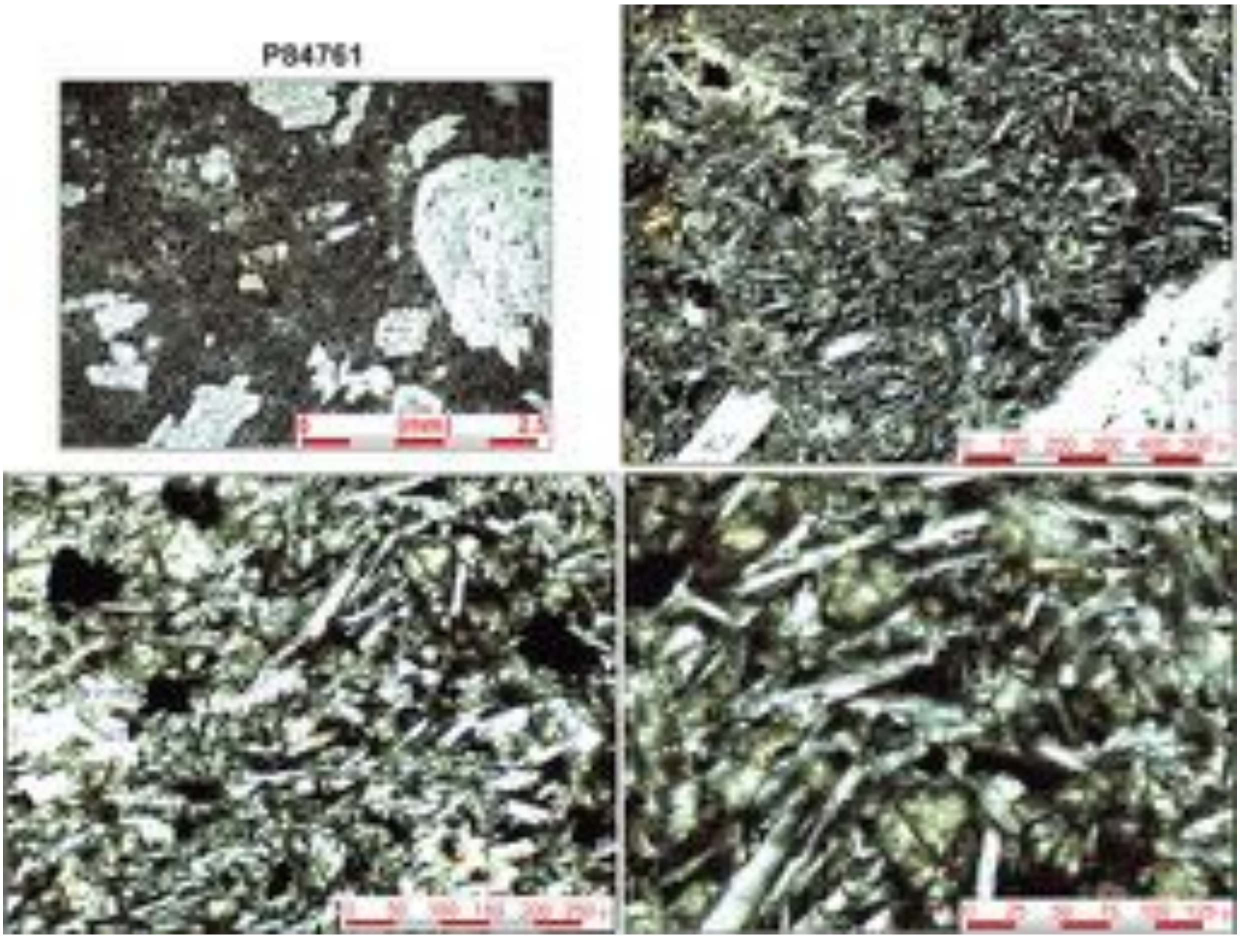
Total fusion age, TFA= 24.07 ± 0.09 Ma (including J)
Weighted mean plateau age, WMPA= 24.07 ± 0.09 Ma (including J)

P84761

P84761 Type 2 Spectrum:

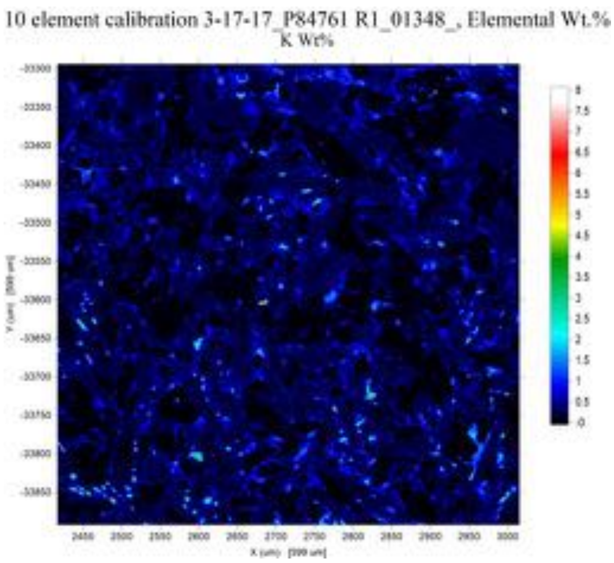
Petrographic observations

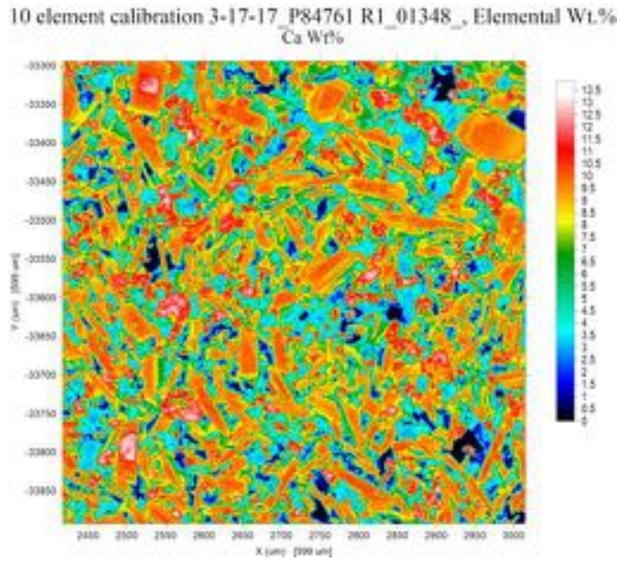
This fresh, porphyritic basaltic andesite has abundant large (0.5-2.5 mm) sieve-textured plagioclase and minor pyroxene phenocrysts in a nearly holocrystalline groundmass of interlocking plagioclase laths (50-100µm long by 5-15µm wide), granular 25-50µm pyroxene, a few % Fe-Ti oxides and minor interstitial glass. Element concentration maps provide a quantitative groundmass modal composition of 59% plagioclase, 36% pyroxene (with subequal amounts of cpx and opx), 1.5% Fe-Ti oxides, ~ 3% glass, and a trace amount of a late high K interstitial phase (sanidine?). The rock is very fresh, with little or no secondary clay.



Microprobe observations and analysis of K budget

In this sample, a large majority of the K is situated in the plagioclase, with ~33% in the An65-75 cores (average 0.18 wt% K, 0.012 K/Ca) and 46% in the An45-50 rims (averaging 0.45 wt% K, .06 K/Ca). The remaining 21% of the K is distributed between glass (16%, averaging 1.0 wt% K, K/Ca ~ 0.3), sanidine (4%) and other phases.





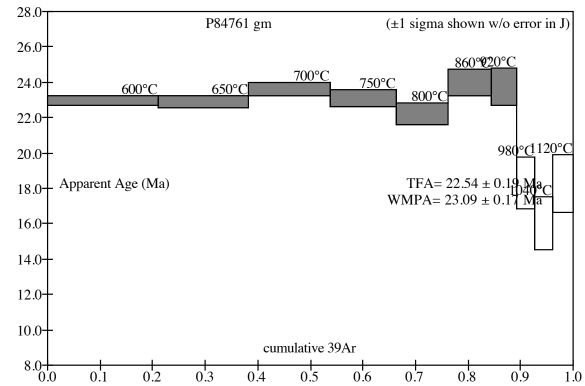
Sample P84761

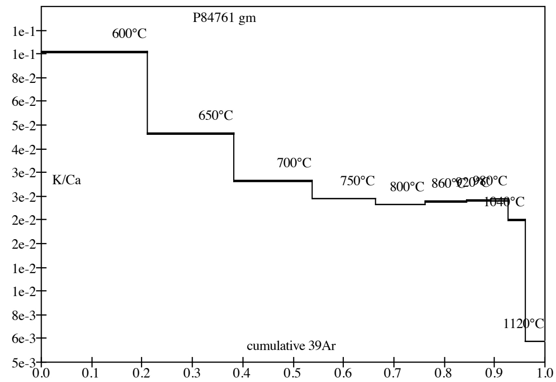
Phases present and their criteria

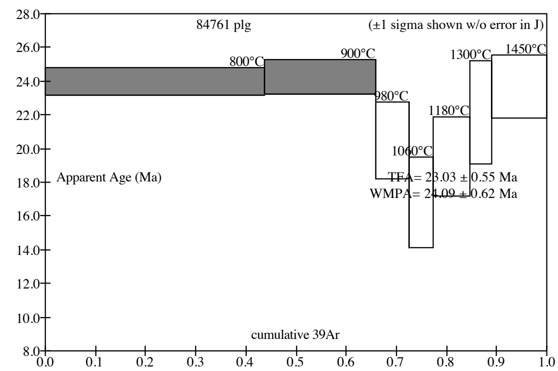
Phase	*Criteria*	*pixels*	*raw vol %*	*norm vol%*	*K (wt %)*	*fract K*	*% of K*	*K/Ca*	*An%*
voids	0-25% tot	1967	1.3%	**0.0%**			**0.0%**		
Fe-ti oxides	6.8-10.5% Ti	2149	1.5%	**1.5%**		0	**0.0%**		
cpx	12-18.5% Mg	25,600	17.6%	**17.8%**	0.01	0.00178	**0.9%**		
opx	16-29%Fe	26,200	18.0%	**18.2%**	0.01	0.00182	**0.9%**		
plag cores	1.9-2.75% Na	54314	37.3%	**37.8%**	0.18	0.06799	**32.8%**	0.02	65-75
plag- rims	2.7-5.2% Na	30382	20.8%	**21.1%**	0.45	0.09508	**45.9%**	0.06	45-50
glass	0.9-1.9% K	4686	3.2%	**3.3%**	1	0.03259	**15.7%**	0.3	
sanidine			0.0%	**0.0%**		0.00000	**0.0%**		
Fe-rich clays			0.0%	**0.0%**		0.00000	**0.0%**		
hi K phase	1.9-3.3 K	460	0.3%	**0.3%**	2.5	0.00800	**3.9%**		
Totals		**145758**	**100.0%**	**100.0%**		**0.20726**	**100.0%**		
Total pixels		152490							
Meas %		95.59%							
Missing %		4.41%							

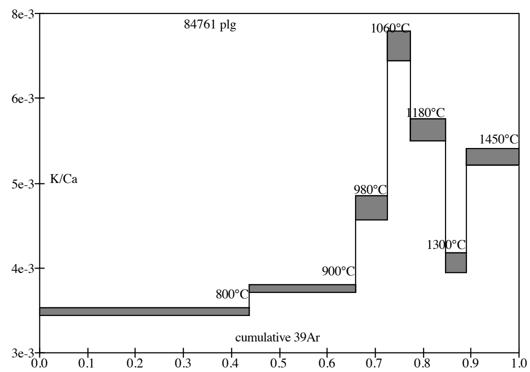
Analysis of Spectrum

This sample yields a straightforward flat age spectrum with a well-defined WMPA for the first 90% of the gas released, followed by a modest dip in ages at the highest temperature steps. The apparent K/Ca ratios drop rapidly from 1.0 on the initial step and then gradually flatten out at ~ 0.03 to 0.02 over most of the remaining spectrum, and then drop abruptly to 0.006 at the highest temperature. In light of the apparent K/Ca ratios, the flat initial 90% of the spectrum is attributed to the successive but overlapping degassing of glass (especially on the initial step), plagioclase rims, and finally plagioclase cores. The final high temperature steps that yield younger ages and lower K/Ca ratios are attributed to the presence of recoil induced excess ^{39}Ar coming from the most refractory plagioclase cores and pyroxene. In this sample, the groundmass provides a more precise estimate of the age (23.09 ± 0.38 Ma) then the associated plagioclase phenocrysts (24.1 ± 1.2 Ma) because of its inherently higher K/Ca ratio (~0.03 vs 0.004) and consequently much lower uncertainties associated with Ca corrections.









Sample: SB69-80 P84761 gm J=0.0039532 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	1.5e-14	7.7182	5.0e-3	4.8166	0.0152	0.10	0.20949	0.420	23.0 ± 0.3
650	14	1.2e-14	7.1205	3.7e-3	10.6987	0.0132	0.046	0.38292	0.454	22.9 ± 0.4
700	14	1.0e-14	6.9296	1.9e-3	16.9150	0.0122	0.029	0.53728	0.481	23.6 ± 0.4
750	14	9.0e-15	7.6970	2.1e-3	20.1879	0.0150	0.024	0.66323	0.424	23.1 ± 0.5
800	14	9.5e-15	10.4067	2.3e-3	21.3332	0.0246	0.023	0.76190	0.301	22.2 ± 0.6
860	14	1.0e-14	13.6523	3.4e-3	20.6656	0.0347	0.024	0.84396	0.248	24.0 ± 0.7
920	14	6.2e-15	13.5256	1.0e-2	20.4382	0.0344	0.024	0.89337	0.248	23.7 ± 1.1
980	14	3.8e-15	12.2886	7.9e-3	20.3200	0.0329	0.024	0.92649	0.210	18.3 ± 1.4
1040	14	3.8e-15	12.0631	9.4e-3	24.7206	0.0332	0.020	0.96031	0.187	16.0 ± 1.5
1120	14	6.3e-15	17.6527	8.6e-3	80.6518	0.0510	0.006	1.00000	0.146	18.3 ± 1.6

Total fusion age, TFA= 22.54 ± 0.19 Ma (including J)
Weighted mean plateau age, WMPA= 23.09 ± 0.17 Ma (including J)
Inverse isochron age =22.88 ± 0.53 Ma. (MSWD =1.18; 40Ar/36Ar=297.3 ± 4.3)
Steps used: 600, 650, 700, 750, 800, 860, 920, (1–7/10 or 89% ∑ 39Ar

Sample: SB69-211, 212 84761 plg J=0.0040685 FINAL J (28.1 FCT)

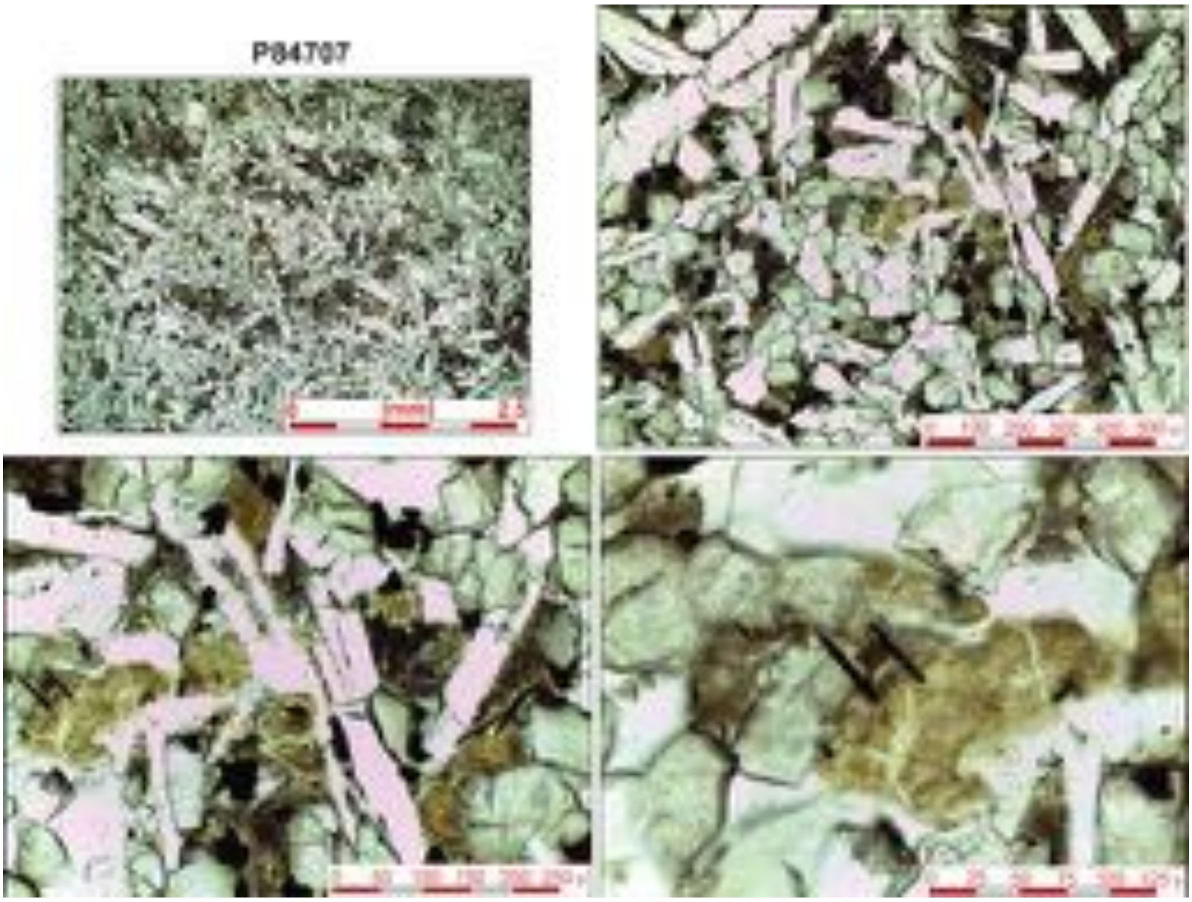
T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
800	14	1.2e-14	5.1829	0.0e+0	138.9058	0.0064	0.004	0.43805	0.635	24.0 ± 0.8
900	14	6.8e-15	5.9622	0.0e+0	130.4218	0.0089	0.004	0.65940	0.558	24.3 ± 1.0
980	14	2.9e-15	8.4432	8.1e-4	104.7006	0.0191	0.005	0.72555	0.333	20.5 ± 2.3
1060	14	6.5e-15	25.6309	2.5e-3	67.4654	0.0789	0.007	0.77280	0.090	16.8 ± 2.7
1180	14	1.5e-14	38.5162	2.9e-3	84.8723	0.1213	0.006	0.84562	0.069	19.5 ± 2.4
1300	14	5.9e-15	25.8307	2.3e-4	121.4547	0.0771	0.004	0.88981	0.118	22.2 ± 3.1
1450	14	2.1e-14	35.6277	2.5e-3	91.2119	0.1096	0.005	1.00000	0.091	23.7 ± 1.9

Total fusion age, TFA= 23.03 ± 0.55 Ma (including J)
Weighted mean plateau age, WMPA= 24.09 ± 0.62 Ma (including J)

P84707

P84707 Type 5 Spectrum: Strongly hump-shaped

Petrographic observations
The groundmass in this sample is quite coarse-grained compared to most other VESPA samples, with a diabasic-like texture of interlocking plagioclase laths, granular pyroxene, iddingsitized olivine, and minor intersertal glass now largely altered to fibrous brown mats of smectite. Primary crystals mostly range from 50-200μ in diameter and are all quite fresh. Element concentration maps yield refined estimates of ~45% plagioclase, 33% clinopyroxene, 2.5% Fe-Ti oxides and ~16% Fe-rich clays (smectite) with minor relict glass. The clays appear to be replacing both intersertal glass and small crystals of granular olivine.



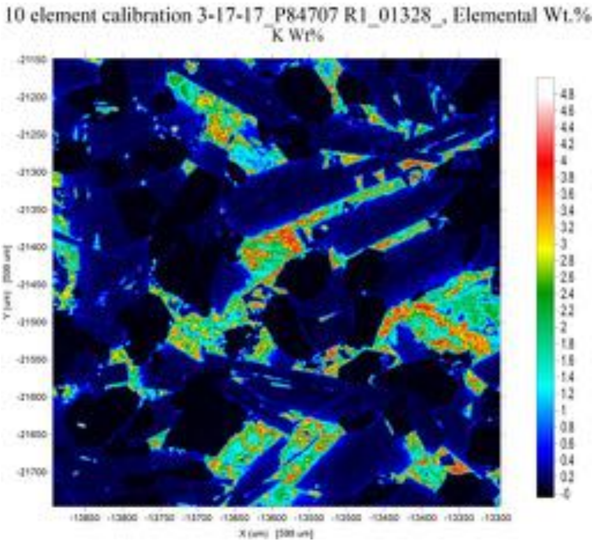
Microprobe observations and analysis of K budget
The potassium in this sample is held in 4 distinct reservoirs: The clays account for 75% of the total K, averaging 2.5-4.0 wt% K and K/Ca ratios of 2-6. The calcic cores of plagioclase account for an additional 10% of the K, but have very low K concentrations (~0.15 wt%) and very low K/Ca ratios of ≤ 0.02. The somewhat more sodic rims on plagioclase have somewhat higher K contents (0.5 wt%, K/Ca -0.15) and account for an additional 9% of the total K. Finally, the ~2% of preserved glass holds 3% of the K with typically ~ 0.8% K and K/Ca of 1.5. Given the coarse-grained character, it is likely that a majority of the K (held in the patches of clay) was removed during ultrasonic cleaning, so what was effectively dated was primarily plagioclase, with trace amounts of a much higher K but less retentive clay and glass

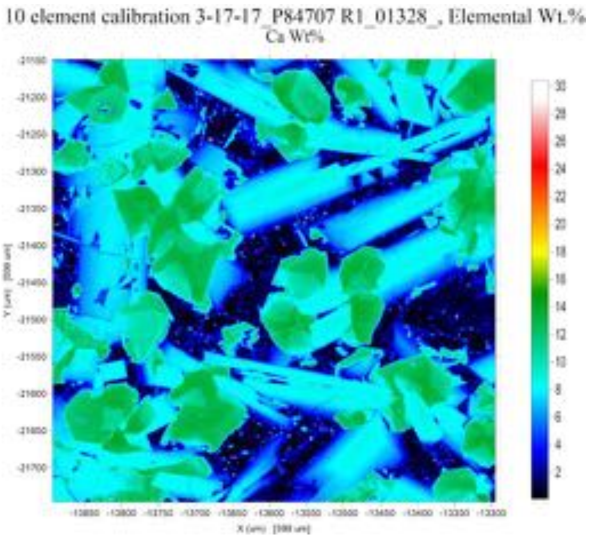
Sample P84707

Phases present and their criteria

Phase	Criteria	pixels	vol %	norm vol%	K (wt %)	fract K	% of K	avg K/Ca	An%
voids			0.0%	**0.0%**			**0.0%**		
Fe-ti oxides	10-28% Ti	3567	2.4%	**2.4%**	0	0	**0.0%**		
cpx	6-13% Mg	47999	31.8%	**32.3%**	0.05	0.01617	**3.0%**		
olv		0	0.0%	**0.0%**		0.00000	**0.0%**		
plag cores	2.6-4.6 Na	59978	39.7%	**40.4%**	0.14	0.05658	**10.6%**	0.02	
plag- rims	4.7-7.5 Na	12811	8.5%	**8.6%**	0.5	0.04316	**8.1%**	0.15	
glass	30.8-34.2 Si	2854	1.9%	**1.9%**	0.8	0.01538	**2.9%**	1.5	
sanidine		0	0.0%	**0.0%**		0.00000	**0.0%**		
K-rich clays	16-28 Fe	21208	14.1%	**14.3%**	2.8	0.40011	**75.3%**	3.5	
other		0	0.0%	**0.0%**		0.00000	**0.0%**		
Totals		**148417**	**98.3%**	**100.0%**		**0.53139**	**100.0%**		

Total pixels	150932
Meas %	98.33%
Missing %	1.67%

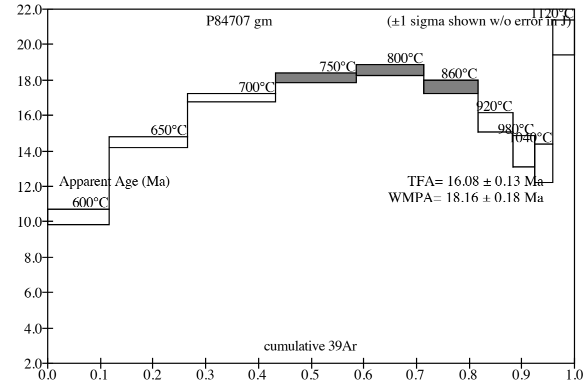


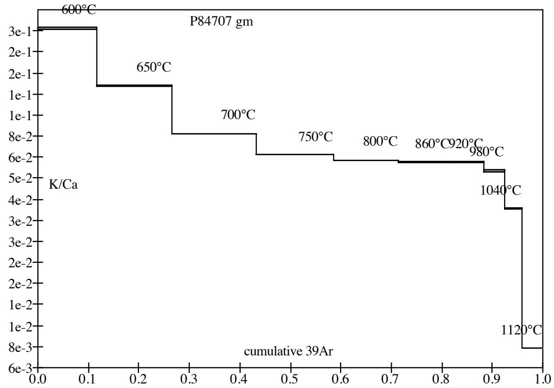


<u>Analysis of Spectrum</u>
This sample yielded a very strongly hump-shaped spectrum that climbs from 10 Ma to a maximum of 18.6 Ma and then descends again at higher temperatures. Virtually no two contiguous steps yielded concordant ages. A low precision, but reasonably well-behaved separate of plagioclase phenocrysts from the same sample yielded a WMPA of 22.2 ± 0.5 Ma, which we take as the best estimate of the age for this sample. The overall shape of the groundmass spectrum in concert with its K/Ca spectrum suggests that the early climbing part of the spectrum reflects the simultaneous degassing of residual clay and glass (both of which apparently experienced significant argon loss in nature) with an ever increasing contribution from the rims of groundmass plagioclase. The oldest ages obtained were from the gas released in the central part of the spectrum (43 to 81% of the cumulative ^{39}Ar released, at Ts of 750-850° C) and is likely coming from both plag cores and rims given the fairly uniform K/Ca values of ~0.06, but are still too young, because of the continued contribution from the very K-rich non-retentive phases that had experienced argon loss. Finally at the highest temperatures, ages drop precipitously as does the apparent K/Ca ratios, presumably reflecting the degassing of the refractory and very low K plagioclase cores and cpx, with their attendant excess ^{39}Ar induced by recoil. This is a classic example of a sample that seems like it would be an excellent candidate for dating (coarse-grained, fresh primary igneous phases) but is actually quite

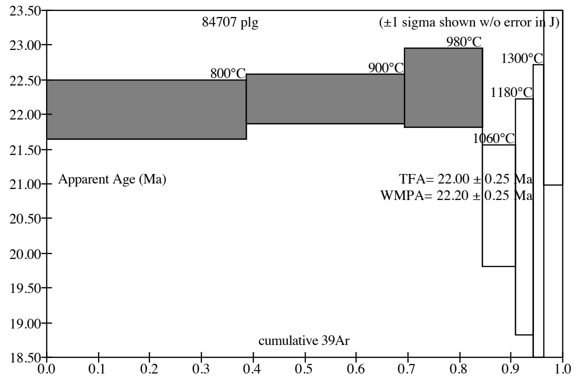
problematic because: (a) It has a very low overall K content to begin with, and (b) The vast majority of the K that is present is held in very non retentive fine-grained clays and glass –phases that are either younger than the crystallization age or highly vulnerable to argon loss in nature and recoil effects during irradiation.

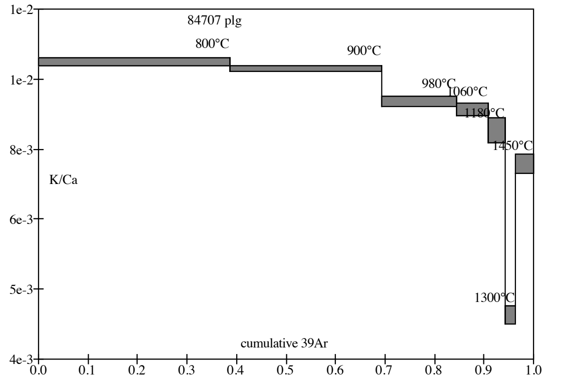
Groundmass





Plagioclase





Sample: SB69-75 P84707 gm J=0.0040137 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	1.2e-14	7.7962	7.1e-3	1.9048	0.0216	0.26	0.11683	0.183	10.3 ± 0.4
650	14	1.1e-14	5.3360	3.7e-3	3.5820	0.0113	0.14	0.26625	0.376	14.5 ± 0.3
700	14	1.0e-14	4.5380	3.7e-3	6.0458	0.0074	0.081	0.43313	0.520	17.0 ± 0.3
750	14	9.1e-15	4.3455	2.7e-3	7.6062	0.0062	0.064	0.58608	0.579	18.1 ± 0.3
800	14	7.6e-15	4.3334	3.8e-3	8.0846	0.0059	0.061	0.71395	0.596	18.6 ± 0.3
860	14	6.2e-15	4.3758	4.8e-3	8.2856	0.0065	0.059	0.81806	0.559	17.6 ± 0.4
920	14	3.8e-15	4.2606	8.3e-3	8.2259	0.0071	0.060	0.88268	0.509	15.6 ± 0.6
980	14	2.2e-15	4.0454	1.0e-2	9.0561	0.0071	0.054	0.92342	0.480	14.0 ± 0.9
1040	14	1.8e-15	3.8445	9.4e-3	13.6500	0.0068	0.036	0.95807	0.480	13.3 ± 1.1
1120	14	2.9e-15	5.2737	4.9e-3	63.1663	0.0083	0.008	1.00000	0.537	20.4 ± 1.0

Total fusion age, TFA= 16.08 ± 0.13 Ma (including J)
Weighted mean plateau age, WMPA= 18.16 ± 0.18 Ma (including J)

Sample: SB69-204, 205 84707 plg J=0.0041260 FINAL J (28.1 FCT)

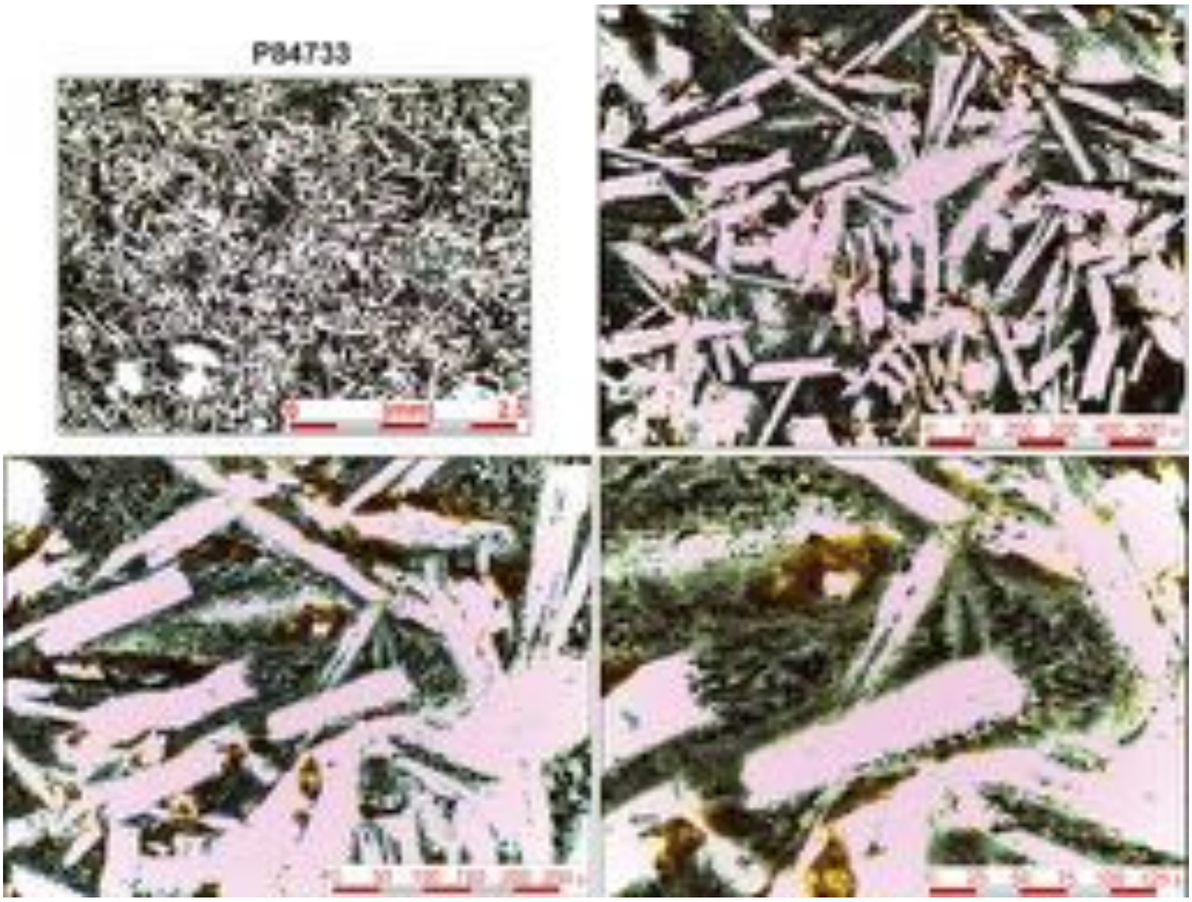
T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
800	14	1.7e-14	3.4893	0.0e+0	46.4135	0.0017	0.011	0.38647	0.855	22.1 ± 0.4
900	14	1.3e-14	3.2585	0.0e+0	47.4506	0.0009	0.010	0.69386	0.922	22.2 ± 0.4
980	14	6.6e-15	3.4782	0.0e+0	52.8579	0.0015	0.009	0.84442	0.870	22.4 ± 0.6
1060	14	3.2e-15	3.9605	0.0e+0	54.1876	0.0039	0.009	0.90904	0.706	20.7 ± 0.9
1180	14	2.8e-15	6.8207	0.0e+0	58.1681	0.0137	0.008	0.94190	0.407	20.5 ± 1.7
1300	14	3.0e-15	11.3924	0.0e+0	106.7539	0.0293	0.005	0.96367	0.241	20.3 ± 2.4
1450	14	3.5e-15	7.7339	0.0e+0	64.8640	0.0159	0.008	1.00000	0.394	22.5 ± 1.6

Total fusion age, TFA= 22.00 ± 0.25 Ma (including J)
Weighted mean plateau age, WMPA= 22.20 ± 0.25 Ma (including J)
Inverse isochron age =22.28 ± 0.99 Ma. (MSWD =0.15; 40Ar/36Ar=286.9 ± 38.4)

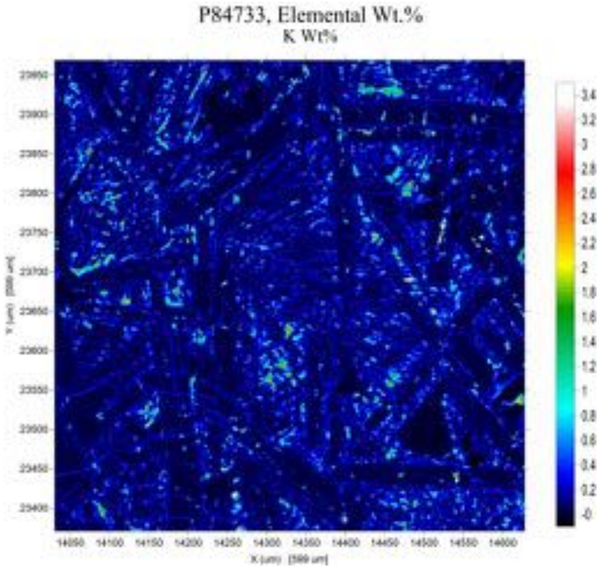
P84733

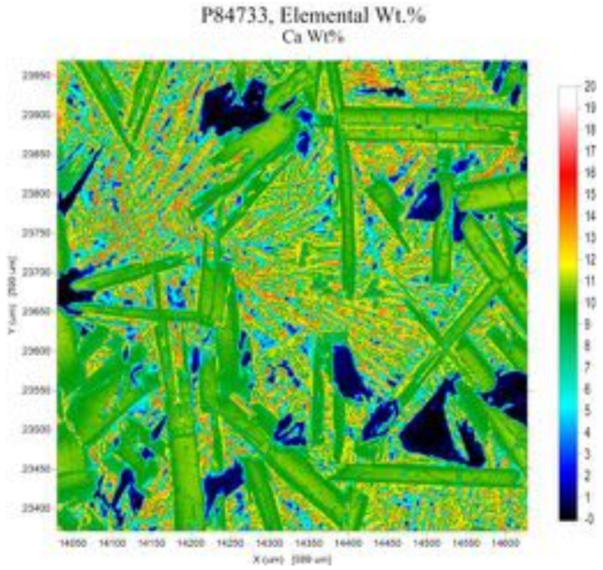
P84733 Type 5 Spectrum: Strongly hump-shaped

Petrographic observations
This sample is a nearly aphyric basalt or basaltic andesite with a hypocrystalline groundmass composed of a network of acicular plagioclase laths and irregular small patches of reddish brown iddingsite after olivine with intersertal brown patches of glass(?) that appears to be partly devitrified to dendritic and fibrous intergrowths of Fe-oxides and pyroxenes with the remainder largely altered to fibrous secondary clay minerals. The plagioclase laths are very fresh, commonly skeletal or swallow-tailed, mostly 100-220μm long x 20-40μm wide, and are zoned from bytownite (An71-78) cores to labradorite (An55-68) rims. Analysis of elemental concentration maps indicates that the groundmass contains approximately 52% plagioclase, 26% cpx, 8% iddingsite (after olivine), 2% Fe-Ti oxides, with the remaining 12% composed of very fine grained aggregates of clays, relict glass and possibly some zeolites.



Microprobe observations and analysis of K budget
This is a very low-K sample, and the K is held largely in the very fine-grained aggregates of secondary minerals that are replacing glass. Specifically, ~53% is situated in a moderately Fe-rich clay ± glass aggregates averaging ~ 0.5 wt% K and K/Ca ~0.1, and an additional 33% is held in tiny (1-8μm) blebs of a high-K clay or zeolite with 0.8-2.5 wt% K, and K/Ca ≥ 2.0. The remaining 14% is situated in plagioclase of which ~ 5% is in the calcic cores (0.015 wt% K and K/Ca ~0.001) and ~9% is in the slightly more sodic rims (.04 wt% K, K/Ca ~0.005). Thus, the only plausible source for geochronologically meaningful radiogenic argon in this sample is the very small proportion that is situated in the very calcic/low K groundmass plagioclase





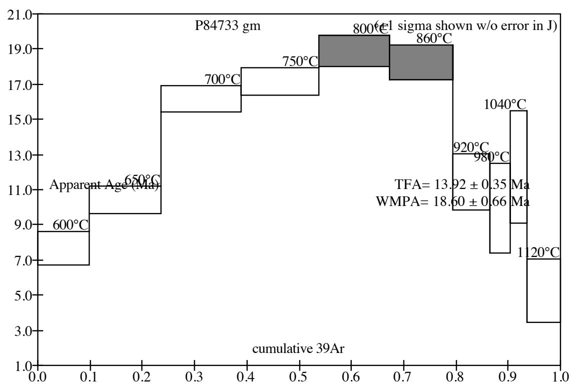
Sample P84733

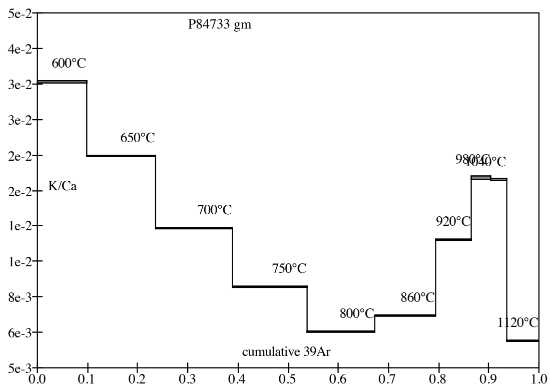
Phases present and their criteria

Phase	***Criteria***	***pixels***	***raw vol %***	***norm vol%***	***K (wt %)***	***fract K***	***% of K***	***K/Ca***	***An%***
voids	0-35% tot	3713	2.2%	**0.0%**	0	0	**0.0%**		
Fe-ti oxides	4-10 Ti	2730	1.6%	**2.1%**	0	0	**0.0%**		
cpx	4.2-7.3 Mg	34,328	20.6%	**26.2%**	0.001	0.000262	**0.3%**		
opx			0.0%	**0.0%**		0.000000	**0.0%**		
plag core	16-19 Al	39303	23.6%	**30.0%**	0.015	0.004497	**4.9%**	0.001	75-79
plag- rims	14-16,1 Al	28425	17.0%	**21.7%**	0.04	0.008674	**9.4%**	0.005	55-65
mod K clay	0.28-0.75 K	12651	7.6%	**9.7%**	0.5	0.048254	**52.5%**	0.1	
sanidine			0.0%	**0.0%**		0.000000	**0.0%**		
Fe-rich clays	24-53 Fe	10341	6.2%	**7.9%**		0.000000	**0.0%**		
hi K phase	0.8-2.9 K	3310	2.0%	**2.5%**	1.2	0.030300	**32.9%**	3.5	
Totals		**134801**	**80.8%**	**100.0%**		**0.091987**	**100.0%**		
Total pixels		166872							
Meas %		80.78%							
Missing %		19.22%							

Analysis of Spectrum

Not surprisingly, this sample yielded a very disturbed spectrum, compounded by large analytical uncertainties due to the very low K/Ca ratios. It is a strongly hump-shaped spectrum with ages that climb monotonically from 8 to 19 Ma over the first 60% of the gas released, level out somewhat, and then step back down to ages as young as 5 Ma at the highest T step. K/Ca ratios exhibit exactly the opposite behavior, producing a broadly U-shaped spectrum with apparent K/Ca ratios dropping from 0.03 at the lowest T step to 0.006 at the 800° step (which yielded the oldest apparent age), and then climbing back up to 0.017, before plummeting at the highest T step. In this sample, the radiogenic argon associated with most of the K present was held in very non-retentive glass/clays/zeolites and was probably largely removed during ultrasonic cleaning and initial degassing. The climbing portion of the age spectrum reflects the simultaneous degassing of plagioclase rims and residual non retentive K-rich clays that had experience argon loss in nature, with an increasing contribution from the plagioclase with increasing temperature. The top of the hump-shaped spectrum (19.0 ± 1.0) provides a reasonable, but minimum estimate for the age of the basalt, as it appears to mainly reflect degassing of the more sodic plagioclase rims with an average K/Ca of 0.006. The drop in ages and increasing apparent K/Ca values at high temperature is attributed mainly to recoil induced addition of excess ^{39}Ar embedded in the very low K cores of the calcic plagioclase. No plagioclase phenocryst phase is available to compare with these groundmass results, but it likely would have had an even lower K/Ca content (<0.001), and thus would likely have yielded worse results.





Sample: SB69-53 P84733 gm J=0.0041844 FINAL J (28.1 FCT)

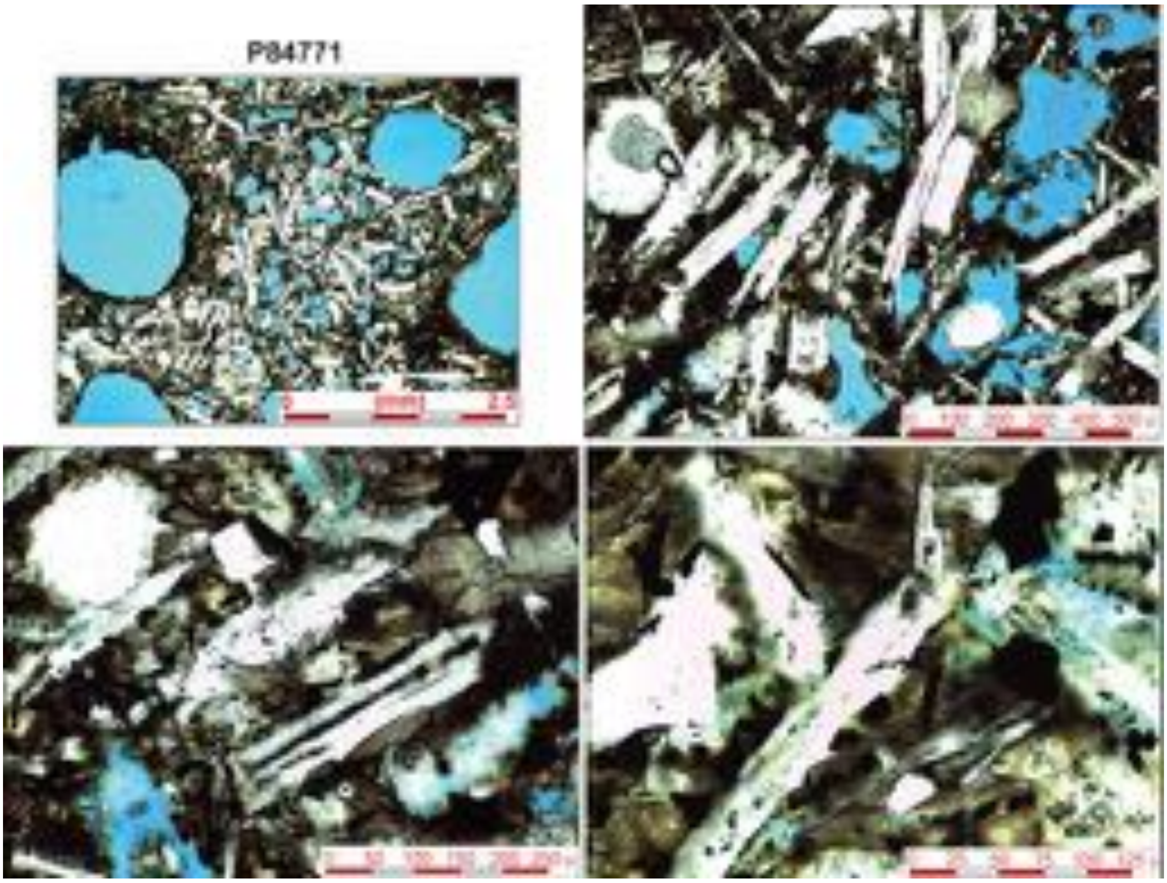
T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	1.8e-15	3.8959	0.0e+0	15.3503	0.0097	0.032	0.09945	0.261	7.7 ± 1.0
650	14	1.8e-15	2.8495	0.0e+0	24.8309	0.0050	0.020	0.23587	0.485	10.4 ± 0.8
700	14	2.0e-15	2.9279	0.0e+0	39.7373	0.0026	0.012	0.38870	0.735	16.2 ± 0.7
750	14	2.1e-15	3.2141	0.0e+0	58.1360	0.0031	0.008	0.53796	0.711	17.2 ± 0.8
800	14	2.0e-15	3.3403	0.0e+0	77.7609	0.0028	0.006	0.67354	0.754	18.9 ± 0.9
860	14	1.8e-15	3.3717	0.0e+0	70.0032	0.0032	0.007	0.79449	0.720	18.2 ± 1.0
920	14	1.2e-15	3.7481	0.0e+0	42.8198	0.0075	0.011	0.86572	0.405	11.4 ± 1.6
980	14	7.9e-16	4.5327	2.1e-3	28.5104	0.0109	0.017	0.90432	0.292	10.0 ± 2.5
1040	14	7.0e-16	4.7322	0.0e+0	28.9408	0.0105	0.017	0.93696	0.345	12.3 ± 3.2
1120	14	8.3e-16	3.0100	4.7e-3	82.1828	0.0078	0.006	1.00000	0.232	5.3 ± 1.8

Total fusion age, TFA= 13.92 ± 0.35 Ma (including J)
Weighted mean age, WMA= 18.60 ± 0.66 Ma (including J)

P84771

P84771 Type 4 Spectrum: Broad hump shape with meaningful flat top

Petrographic observations
This is a quenched basalt with abundant vesicles and a hypocrystalline groundmass of interlocking swallow-tailed/skeletal plag laths (150-300µ long x 30µ wide), pyroxene (50-100µ), and Fe-Ti oxides, with a brown weathering intersertal glass partially altered to clay. Modal compositions from elemental concentration maps indicate ~68% plagioclase, 15% pyroxene, 11% glass that is partially altered to smectite, 4.5% Fe-Ti oxides, and ~ 1% blebs of an unknown high K phase – either sanidine or perhaps a K-rich zeolite. Despite minor clay alteration and zeolites lining some of the vesicles, most phases look very fresh



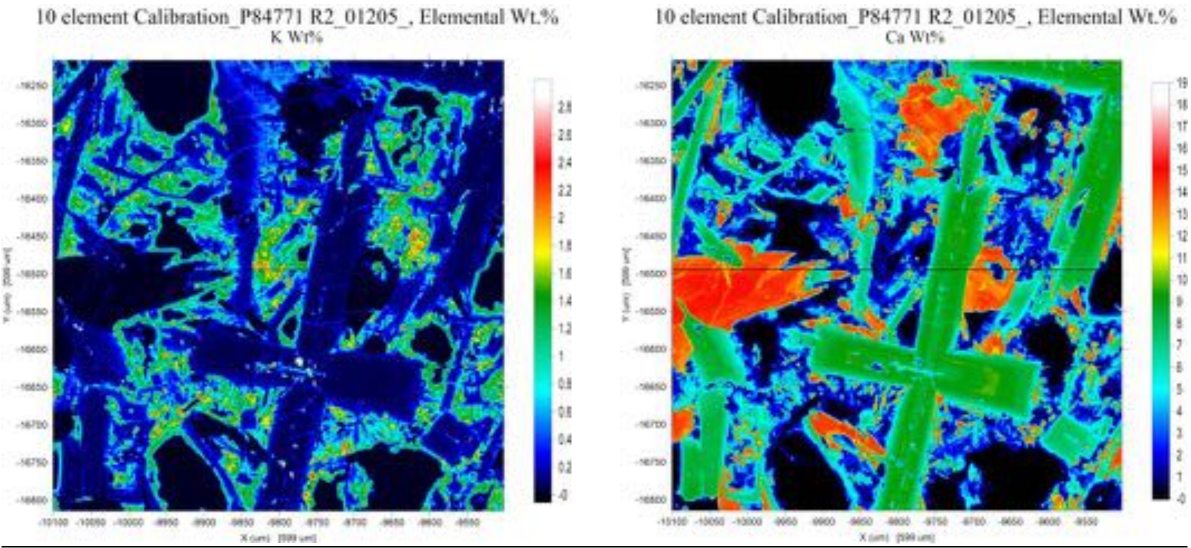
Microprobe observations and analysis of K budget
The potassium in the groundmass is distributed as follows: ~10% is An58-67 plagioclase cores containing 0.06 wt% K and K/Ca of 0.008; 25% is in An25-40 plagioclase rims containing ~0.25 wt% K and K/Ca of .09; 56% is in interstitial glass and Fe-rich clays with an average 1.4 wt% K and K/Ca of 1.25; and the final ~7% is in an unknown high-K phase (~1.8 wt% K, K/Ca of 1.0)

Sample P84771

Phases present and their criteria

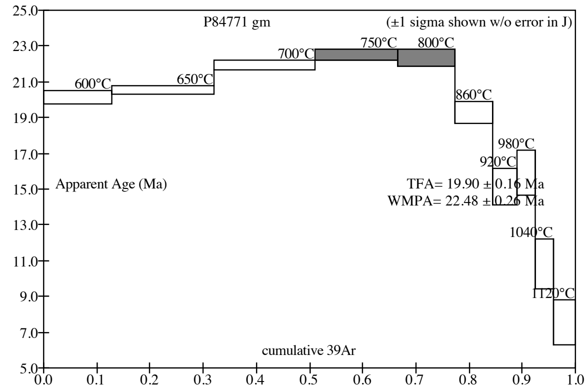
Phase	*Criteria*	*pixels*	*raw vol %*	*recalc vol%*	*Avg K (wt %)*	*fract K*	*% of total K*	*avg K/Ca*	*An %*
voids	<10% Tot	16014	9.7%	**0.0%**			**0.0%**		
Fe-ti oxides	5.8-20% Ti	6233	3.8%	**4.5%**		0	**0.0%**		

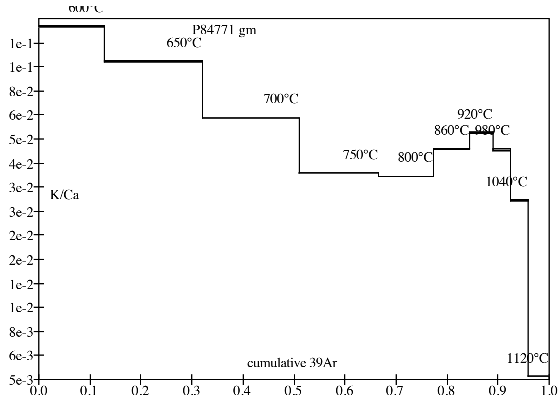
cpx	11.5-15% Ca	20611	12.4%	**15.0%**	0.05	0.00749	**2.8%**	
olv			0.0%	**0.0%**		0.00000	**0.0%**	
plag cores	6-11% Ca	58063	35.1%	**42.2%**	0.06	0.02531	**9.5%**	0.008
plag- rims	3-5.8 Ca	36505	22.0%	**26.5%**	0.245	0.06499	**24.3%**	0.09
glass			0.0%	**0.0%**		0.00000	**0.0%**	
sanidine			0.0%	**0.0%**		0.00000	**0.0%**	
glass/clays	13.7-17 Fe	14750	8.9%	**10.7%**	1.4	0.15005	**56.2%**	1.25
hi K phase	1.6-2.3 K	1460	0.9%	**1.1%**	1.8	0.01910	**7.2%**	1
Totals		**153636**	**92.8%**	**100.0%**		**0.26693**	**100.0%**	
Total pixels		165600						
Meas %		92.78%						
Missing %		7.22%						



Analysis of Spectrum

This is another sample (like P84602) where much of the argon associated with the relatively high K but non-retentive glass and clay was probably not analyzed, as much of it would have been removed during ultrasonic cleaning and initial sample degassing. This non-retentive material would likely have yielded anomalously young ages due to argon loss in nature or younger age of the secondary clays. The analyzed separate yields a broad hump-shaped spectrum, with a flat “miniplateau” at the top of the hump, followed by rapidly decreasing ages at the highest temperatures. Apparent K/Ca ratios steadily drop from 0.15 at the lowest T step to a central portion where they level at ~ 0.045, before dropping to 0.005 at the highest T. The early climbing part of the spectrum reflects degassing of groundmass glass/clays and plagioclase rims, with an ever-increasing contribution from the latter. The best estimate of the sample age (22.5 ± 0.5 Ma) comes from the flat top of the hump reflecting gas derived primarily from plagioclase rims. The drop in ages at the highest temperatures is likely a consequence of recoil induced excess ^{39}Ar added to the refractory low-K plagioclase cores. The ability to obtain a meaningful age from this sample is a consequence of there being a sufficient percentage of the K residing in the groundmass plagioclase, and the fact that our step heating experiment was able to effectively isolate and analyze the gas coming from the high-K rims of this plagioclase.





Sample: SB69-55 P84771 gm J=0.0041756 FINAL J (28.1 FCT)

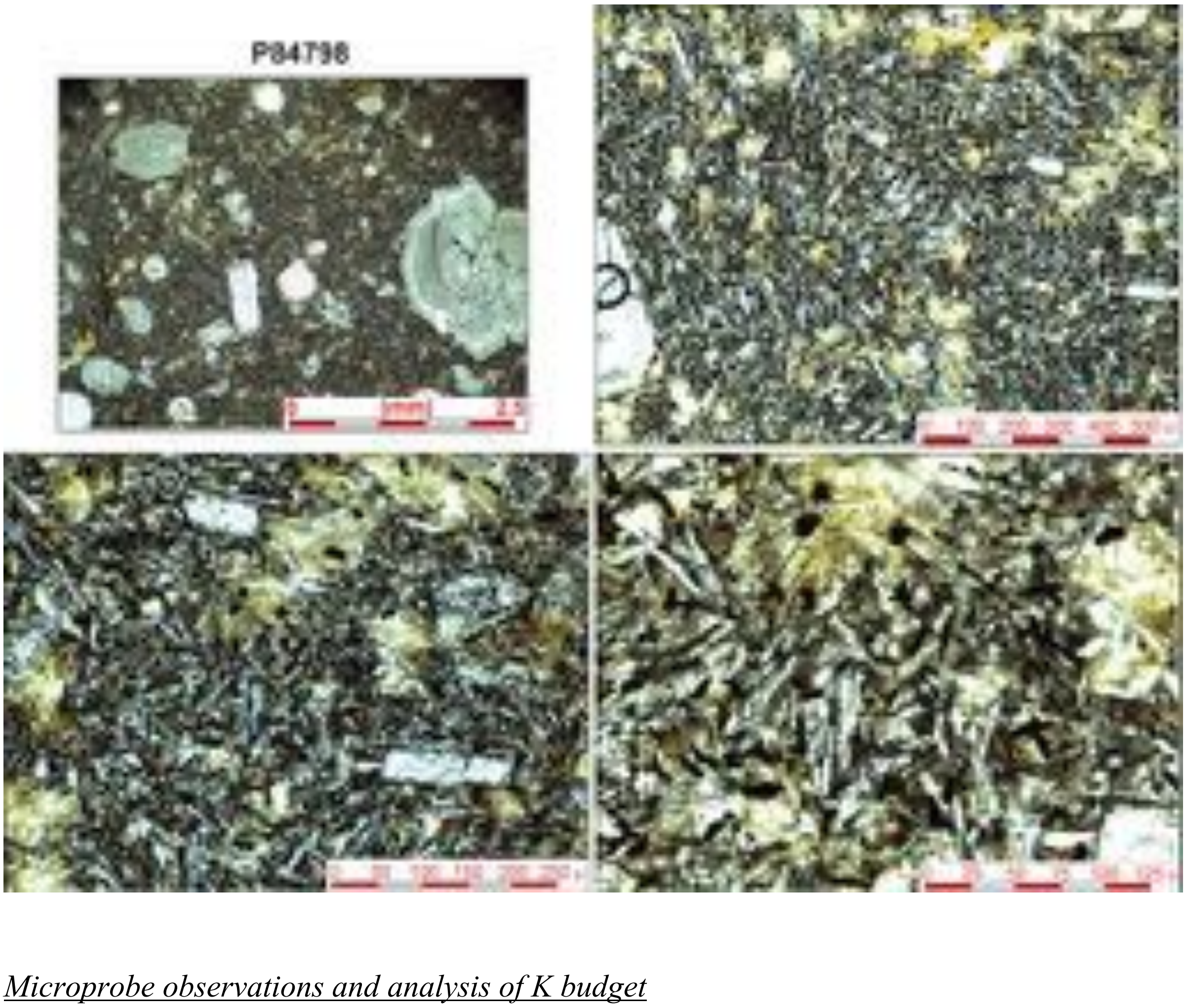
T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	6.1e-15	4.7661	0.0e+0	3.3419	0.0070	0.15	0.12886	0.564	20.1 ± 0.4
650	14	7.0e-15	3.6566	1.9e-5	4.6635	0.0031	0.11	0.31997	0.750	20.5 ± 0.2
700	14	6.3e-15	3.3475	1.0e-4	8.0224	0.0014	0.061	0.51002	0.876	21.9 ± 0.3
750	14	5.1e-15	3.2973	1.9e-3	13.6153	0.0010	0.036	0.66508	0.913	22.5 ± 0.3
800	14	3.5e-15	3.3060	3.9e-3	14.0430	0.0011	0.035	0.77270	0.904	22.4 ± 0.5
860	14	2.3e-15	3.1772	8.8e-3	10.8359	0.0020	0.045	0.84423	0.810	19.3 ± 0.6
920	14	1.5e-15	3.1035	1.2e-2	9.2497	0.0037	0.053	0.89117	0.650	15.1 ± 1.0
980	14	1.2e-15	3.5550	1.6e-2	10.8524	0.0048	0.045	0.92489	0.598	15.9 ± 1.3
1040	14	1.2e-15	3.7790	1.4e-2	17.6594	0.0079	0.028	0.95785	0.382	10.8 ± 1.4
1120	14	1.6e-15	3.9140	1.4e-2	95.2009	0.0098	0.005	1.00000	0.258	7.6 ± 1.3

Total fusion age, TFA= 19.90 ± 0.16 Ma (including J)
Weighted mean age, WMA= 22.48 ± 0.26 Ma (including J)
Inverse isochron age =24.10 ± 1.53 Ma. (MSWD =0.00; 40Ar/36Ar=78.4 ± 0.0)
Steps used: 750, 800, (4–5/10 or 26% ∑ 39Ar

P84798

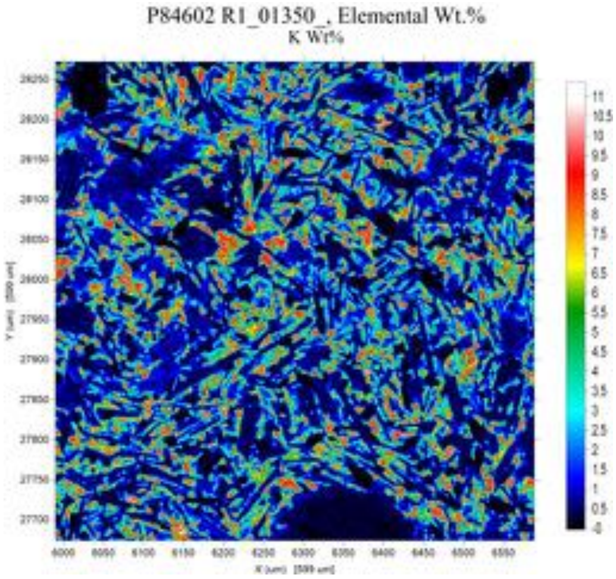
P84798 Type 3 Spectrum: Classic Recoil – S-Shape

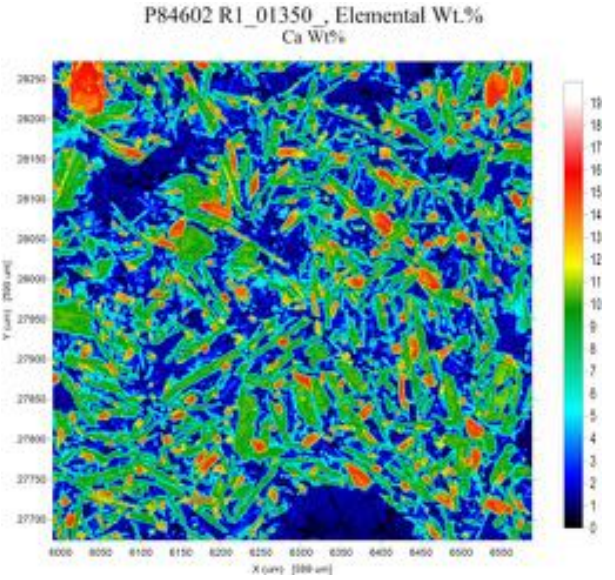
Petrographic observations
This sample is a very fresh porphyritic basalt with 15-20% phenocrysts (0.4 to 1.5 mm) of cpx, minor plag in a quenched microcrystalline to glassy groundmass. Groundmass plagioclase grains are acicular, mostly 25-50µm long, and 2-10µm wide. There are also abundant prismatic pyroxenes of similar size, and a dusting of tiny oxide grains, all set in a pale brown mostly glassy groundmass, with minor patchy clear sanidine(?) and fibrous mattes of clay. Visual estimation suggests groundmass is subequal proportions of pyx, plag, and glass. Subsequent X-ray elemental mapping and image analysis yields more quantitative groundmass modes of 50% plagioclase, 20% pyroxene (with ~ equal cpx and opx), 18% glass (with modest clay alteration), 9% late tiny interstitial blebs of sanidine, and 2% Fe-Ti oxides. Although sanidine is relatively abundant, it occurs mostly as thin films and tiny blebs typically only a few microns across on the margins of plagioclase laths. Even the largest sanidine patches are only 20µm across and likely consist of polycrystalline aggregates



Microprobe observations and analysis of K budget
The different groundmass phases are readily identifiable on the element maps using the criteria laid out below. Overall this sample is quite K-rich, and potassium is distributed between the following reservoirs: Sanidine (avg 8.8 wt% K) holds ~50%, and has an elevated K/Ca of 3-8; the sodic rims (An 45-50) on groundmass plagioclase (avg 1.8 wt% K) account for ~26% of the total K, and have a characteristic K/Ca of 0.6-0.8, whereas the more calcic cores of plag (An 65-75) with ~0.45 wt%

K account for ~7.5% of the K and have a much lower K/Ca of 0.05. The interstitial glass ± clay (~1.5 wt% K, K/Ca ~ 0.7) holds the remaining 16% of the total K.





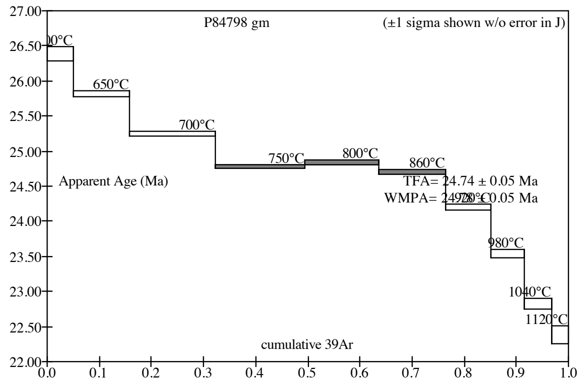
Sample P84798

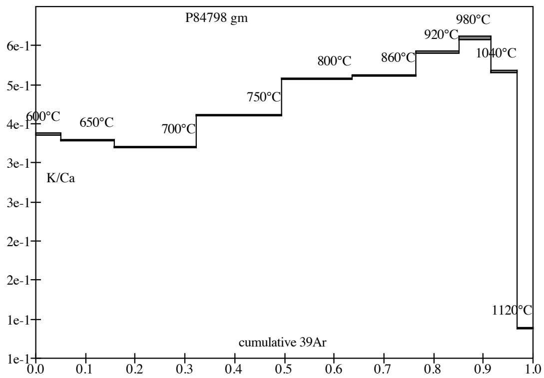
Phases present and their criteria

Phase	***Criteria***	***pixels***	***vol %***	***norm vol%***	***K (wt %)***	***fract K***	***% of K***	***avg K/Ca***	***An %***
voids	0-35% tot	949	0.6%	**0.0%**	0	0	**0.0%**		
Fe-ti ox	2.8-11.5% Ti	3248	2.0%	**2.0%**	0	0	**0.0%**		
cpx	11.9-17% Ca	15,607	9.5%	**9.6%**	0.01	0.000963	**0.1%**		
opx	6-14.5% Mg, (- cpx)	17,780	10.9%	**11.0%**	0.01	0.001098	**0.1%**		
plag core	8.4-11.4 Ca	43670	26.7%	**27.0%**	0.45	0.121312	**7.6%**	0.05	65-75
plag- rims	5.0-8.4 Ca	37149	22.7%	**22.9%**	1.8	0.412790	**25.8%**	0.4	45-50
glass	3-8 Al, 5.5-12 Fe, (-pyx)	29640	18.1%	**18.3%**	1.4	0.256162	**16.0%**	0.7	
sanidine	6.5-10.5 K	14897	9.1%	**9.2%**	8.8	0.809265	**50.5%**	5	
Fe-rich clays			0.0%	**0.0%**		0.000000	**0.0%**		
hi K phase			0.0%	**0.0%**		0.000000	**0.0%**		
Totals		**162940**	**99.6%**	**100.0%**		**1.601590**	**100.0%**		
Total pixels		163620							
Meas %		99.58%							
Missing %		0.42%							

<u>Analysis of Spectrum</u>

This sample yielded a classic recoil-type pattern, with ages that step down over the initial 30% of the gas released, flatten through the middle 50%, and then descend again at the highest Ts. The apparent K/Ca ratios are relatively constant, but climb from ~0.35 to 0.65, and then drop abruptly at the highest Ts. It is likely that much of the gas related to the very fine grained sanidine blebs was pumped away during the initial degassing and that most of the spectrum reflects the simultaneous degassing of the larger sanidine blebs, glass, and plagioclase rims. The central flat portion of the spectrum yields a well-defined WMPA of 24.78 ± 0.10 representing ~45% of the total gas released. The older but decreasing ages early in the incremental heating experiment are a consequence of recoil induced ^{39}Ar loss from the tiny sanidine blebs and outer rims of plagioclase. The central plateau represents primarily the degassing of plagioclase rims with a minor contribution from sanidine and glass. The decreasing ages at the highest T steps reflect degassing of the more retentive plagioclase cores, whose ages have been reduced by the addition of excess ^{39}Ar from the adjacent high K phases during reactor induced recoil. The modest climbing of apparent K/Ca over the middle part of the spectrum is a bit puzzling, but probably represents recoil induced redistribution of ^{37}Ar and ^{39}Ar – especially within the plagioclase rim domains. Thus, even though this sample is very fine-grained with a significant glass component, it is still possible to obtain a fairly good age because of the high overall K content, and the fact that K was distributed between several viable reservoirs (sanidine, relatively high K plagioclase, and fresh glass). Recoil effects and geologic argon loss were less than in other samples due to the paucity of clays and the fact that the majority of the groundmass phases were reasonably high K.





Sample: SB69-61 P84798 gm J=0.0041432 FINAL J (28.1 FCT)

T	t	40(mol)	40/39	38/39	37/39	36/39	K/Ca	∑ 39Ar	40Ar*	Age (Ma)
600	14	2.7e-14	4.7509	0.0e+0	1.3131	0.0040	0.37	0.04963	0.749	26.4 ± 0.1
650	14	4.7e-14	3.7976	0.0e+0	1.3614	0.0011	0.36	0.15713	0.916	25.8 ± 0.1
700	14	6.7e-14	3.5023	0.0e+0	1.4166	0.0003	0.35	0.32261	0.971	25.2 ± 0.1
750	14	6.8e-14	3.4119	0.0e+0	1.1749	0.0002	0.42	0.49372	0.978	24.8 ± 0.1
800	14	5.7e-14	3.4226	0.0e+0	0.9490	0.0003	0.52	0.63717	0.978	24.8 ± 0.1
860	14	5.0e-14	3.4163	0.0e+0	0.9299	0.0003	0.53	0.76424	0.974	24.7 ± 0.1
920	14	3.4e-14	3.3813	0.0e+0	0.8107	0.0004	0.60	0.85188	0.964	24.2 ± 0.1
980	14	2.4e-14	3.3199	1.6e-4	0.7444	0.0005	0.66	0.91447	0.955	23.5 ± 0.1
1040	14	2.0e-14	3.2833	2.9e-4	0.9060	0.0007	0.54	0.96829	0.936	22.8 ± 0.1
1120	14	1.3e-14	3.4568	1.1e-3	4.1181	0.0015	0.12	1.00000	0.872	22.4 ± 0.1

Total fusion age, TFA= 24.74 ± 0.05 Ma (including J)
Weighted mean plateau age, WMPA= 24.78 ± 0.05 Ma (including J)
Inverse isochron age =25.34 ± 0.41 Ma. (MSWD =1.83; 40Ar/36Ar=12.7 ± 12.7)
Steps used: 750, 800, 860, (4–6/10 or 44% ∑ 39Ar