Emplacement and deformation ages of the Wyangala Granite, Cowra, NSW

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SUPPLEMENTARY PAPERS

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SUPPLEMENTARY PAPERS

Appendix 1 SHRIMP U–Pb analysis

A zircon concentrate was prepared using procedures designed to minimise cross-sample contamination. Approximately 500 g of rock was crushed to ~ 1 cm-sized chips using a jaw-crusher. The chips were washed in water in an ultrasonic bath, dried, then crushed in a tungsten-carbide swing mill to pass a disposable 250 μm screen. Fines were removed by rinsing the crushings in water in a deep glass beaker. A high-density fraction ($> 2.96 \text{ g/cc}$) was then separated using tetrabromoethane, hand magnetic minerals were removed, and a higher density fraction ($> 3.3 \text{ g/cc}$) extracted using methylene iodide. Paramagnetic minerals were removed using a Franz isodynamic separator, leaving a relatively non-magnetic zircon concentrate. Final purification was by hand picking.

Approximately 400 selected zircon grains (clear, unaltered) were mounted on double-sided adhesive tape with zircon reference materials SL13 and Temora 1 then cast in Epirez Epimount epoxy. The epoxy disc was coarsely ground using 1200 grade SiC paper to expose the approximate centre of the crystals, then polished with 1 μm diamond paste. The zircon was then photographed under an optical microscope with reflected and transmitted light, then the internal textures of the grains were imaged by cathodoluminescence (CL) using an Hitachi S-2250N scanning electron microscope. After imaging, the mounts were chemically cleaned with petroleum spirit, RBS 35 laboratory detergent and Millipore water, dried, then coated with ~10 nm of high purity Au prior to loading into the SHRIMP II Sensitive High Resolution Ion Microprobe at the Research School of Earth Sciences, Australian National University for U–Th–Pb isotopic analysis.

The zircon was analysed using procedures similar to those described by Williams & Claesson (1987). A 4 nA, 10 kV, primary beam of negative O_2 ions was focused to a spot ~25 μm diameter on the sectioned zircon surface. Positive secondary ions sputtered from the zircon were extracted at 10 kV and analysed at a mass resolution of ~5000 by peak stepping through the Zr, Pb, U and Th isotopes of interest, using a single ETP discrete-dynode electron multiplier and magnet field switching. Each analysis consisted of seven cycles through the isotope sequence. The spots selected for dating the crystallisation of the magma were on areas near grain margins that were free of inclusions and fractures and had simple euhedral oscillatory zoning. Cores, most of which had zoning discordant to that in a surrounding zircon overgrowth, were avoided.

Uranium–lead ratios were determined by reference to multiple analyses of standard zircon Temora 1 (radiogenic $^{206}\text{Pb}/^{238}\text{U} = 0.06683$). U concentrations were referenced to an analysis of SL13 (U = 238 ppm). The data were reduced using SQUID 1 software (Ludwig 2000). All analyses initially were corrected for common Pb using the measured ^{204}Pb and a Broken Hill galena Pb composition, assuming all common Pb to be laboratory contamination. The mean $^{206}\text{Pb}/^{238}\text{U}$ age, preferred for the determination of Phanerozoic ages because of its high precision, was calculated by correcting for common Pb using ^{207}Pb , assuming concordance. Uncertainties in the analyses of individual spots listed in the data table and plotted on the concordia diagram are $\pm 1\sigma$.

Appendix 2 $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology analytical procedures

SAMPLES PL286-GM, PL286-CX, PL336-GM, PL336-CX

Four K-feldspar samples have been analysed using the furnace step-heating diffusional experiments technique at the ANU RSES Argon Laboratory (argon.anu.edu.au).

Mineral separates were done at RSES. For samples PL286-CX and PL336-CX large feldspar phenocrysts were cut out of the rock and crushed with a specific size split selected ($>250\text{ }\mu\text{m}$ $<420\text{ }\mu\text{m}$) and separated using heavy liquid to purify the grains; samples PL286-GM and PL336-GM were cut so that only ground mass material was included in the crushing process ($>160\text{ }\mu\text{m}$ $<250\text{ }\mu\text{m}$ grain size selected).

Groundmass grains were then separated using heavy liquids to separate the K-feldspars and then hand-picked to purify totally ($\sim 99\%$).

Irradiation of samples for $^{40}\text{Ar}/^{39}\text{Ar}$ analysis was undertaken at the USGS TRIGA reactor, Denver, USA. Irradiated was for 40 hours in position CT at 1 MWh. Irradiation times are based on the potential natural accumulation of radiogenic ^{40}Ar ratio to the produced ^{39}Ar . A cadmium liner was used to minimise interference from thermal neutrons. Biotite (GA 1550) has been used as the Flux Monitor (Spell & McDougall 2003). Samples and flux monitors were wrapped in aluminium for irradiation. Aluminium foil was removed and samples were rewrapped in tin for analysis in the mass spectrometer, so as to be able to melt the tin wrap and pump away the contaminated gases prior to the analysis of a sample. The $^{40}\text{Ar}/^{39}\text{Ar}$ analysis procedures are as described by McDougall & Brown (2006). Grains were analysed using the step-heating method using the furnace technique with temperature control monitored via a thermocouple at the base of a tantalum crucible within a double-vacuum resistance furnace. Analysis was done with liquid nitrogen Cold Trap to reduce contamination into the line and mass spectrometer.

The K-feldspars were analysed on a VG1200 gas source mass spectrometer with a Multiplier operating with sensitivities of approximately $8 \times 10^{-17}\text{ mol mV}^{-1}$. Machine discrimination was determined and used in the data reduction process. Line blanks were measured at different temperatures prior to analysis and backgrounds measured for every step; these were subtracted from final analysis.

Samples were heated prior to analysis with heating up to $\sim 400^\circ\text{C}$ then reduced to 380°C overnight. This is done to outgas contaminants at lower temperatures to minimise mixing contaminants with radiogenic argon released from low retentivity sites into the initial analytical steps. This contaminated gas was pumped away prior to analysis.

K-feldspars were analysed as diffusion experiments with 41 steps, with two or more isothermal steps throughout the schedule, and with temperatures of the overall schedule rising from 450°C to 1450°C (Lovera *et al.* 1989). The furnace was decontaminated prior to each sample at 1450°C for 15 minutes three times prior. The gases from the cleaning process were pumped away and not exposed to the extraction line.

Flux monitors were analysed using a continuous wave laser and the VG1200 Mass Spectrometer, with backgrounds subtracted. Gas released from each step is exposed to Zr–Al getters to remove active gases for 10 minutes, the purified gas then being isotopically analysed in the mass spectrometer.

^{40}K abundances and decay constants are taken from standard values recommended by the IUGS subcommission on Geochronology (Steiger & Jaeger 1977). Stated precisions for $^{40}\text{Ar}/^{39}\text{Ar}$ ages include all uncertainties in the measurement of isotope ratios and are quoted at the 1 sigma level. The method of asymptotes and limits was used in analysis of the data from this study (Forster & Lister 2004) due to the complex character of the apparent age spectra where a relict age and associated mixing can be recognised to have been preserved in the spectra. There is a notable degree of mixing between the plateau age (in Figure 7 this is marked in blue) and the relict age (in Figure 7 this is marked in red) in each of the spectrum. The method of asymptotes and limits has been automated using a MacOS eArgon (written by G. Lister @ RSES).

IRRADIATION TIMES, FLUX MONITOR, CORRECTION FACTORS

The samples were irradiated at the USGS TRIGA Reactor in Denver, USA, as CAN ANU #10. Irradiated position CT for 40.0 MWh with cadmium shielding.

^{40}K abundances and decay constants are taken from Steiger & Jaeger (1977).

Flux monitor: GA1550 biotite @ 98.5 Ma $\pm$ 0.8 Ma (Spell & McDougall 2003)

Discrimination Factor: (1 amu) 1.00044 with error 0.380% (calculated using the Power Equation from Renne *et al.* 2009)

$$\text{Lambda K}^{40} 5.5430 \text{E-10}$$

Corrections for argon produced by interaction of neutrons with K (using K_2SO_4) and Ca (using CaF_2) were made using the following correction factors (see Tetley *et al.* 1980):

$$(^{36}\text{Ar}/^{37}\text{Ar})\text{Ca correction factor } 2.95 \text{E-04}$$

$$(^{39}\text{Ar}/^{37}\text{Ar})\text{Ca correction factor } 7.38 \text{E-03}$$

$$(^{40}\text{Ar}/^{39}\text{Ar})\text{K correction factor } 6.86 \text{E-03}$$

$$(^{38}\text{Ar}/^{39}\text{Ar})\text{K correction factor } 1.19 \text{E-04}$$

$$\text{Ca/K conversion factor } 1.90$$

LIST OF SAMPLES

Sample	Lithology	Sample weight (mg)	Foil No.	Grains	Comment
PL286-GM	Leucocratic coarse to rarely megacrystic foliated granodiorite	9.7	P1	Groundmass	Less deformed
PL286-CX	Leucocratic coarse to rarely megacrystic foliated granodiorite	9.9	P2	Phenocryst	Less deformed
PL336-GM	Leucocratic coarse mylonitic granodiorite	11.5	P3	Groundmass	More deformed mylonite
PL336-CX	Leucocratic coarse mylonitic granodiorite	11.3	P4	Phenocryst	More deformed mylonite

Appendix 3 Ar/Ar data

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Appendix 3 Ar/Ar data

Sample P1 PL286-GM, K-Feldspar

Temp (C)	Ar36 (mol)	err (%)	Ar37 (mol)	err (%)	Ar38 (mol)	err (%)	Ar39 (mol)	err (%)	Ar40 (mol)	err (%)	% Ar40*	Ar40*/ Ar39(K)	Cumulative Ar39(%)	Calculated Age			Ca/K	Cl/K
														Ma	±	1 s.d.		
450	4.06E-17	4.71	6.95E-16	32.58	8.09E-17	17.10	5.81E-15	0.59	2.01E-13	0.71	94.00	32.58	0.09	457.73	±	3.29	2.28E-01	2.71E-02
450	4.56E-17	55.23	2.01E-18	29.80	1.14E-16	20.02	8.10E-15	0.50	1.82E-13	0.62	92.60	20.77	0.21	304.83	±	12.56	4.72E-04	4.36E-02
500	6.92E-17	10.19	9.62E-16	41.89	3.75E-16	5.74	2.06E-14	0.09	6.55E-13	0.39	96.90	30.88	0.52	436.54	±	2.01	8.90E-02	2.12E-01
500	1.19E-16	2.68	5.62E-16	7.26	2.89E-16	7.75	2.16E-14	0.20	4.50E-13	0.43	92.20	19.25	0.85	284.20	±	1.36	4.96E-02	1.66E-02
550	6.51E-17	4.00	1.69E-15	17.24	6.02E-16	3.61	4.28E-14	0.45	9.84E-13	0.63	98.00	22.56	1.50	328.87	±	1.94	7.50E-02	7.02E-02
550	4.35E-17	14.58	1.25E-15	3.23	6.12E-16	2.82	4.59E-14	0.31	9.79E-13	0.53	98.70	21.05	2.19	308.67	±	1.61	5.16E-02	4.66E-02
600	3.56E-17	36.31	1.12E-15	6.68	1.16E-15	2.35	8.55E-14	0.38	2.03E-12	0.57	99.50	23.61	3.49	342.78	±	1.87	2.48E-02	5.90E-02
600	3.82E-17	11.18	1.04E-15	11.11	9.78E-16	2.95	7.55E-14	0.41	1.78E-12	0.60	99.30	23.48	4.63	341.17	±	1.88	2.62E-02	3.58E-02
650	2.16E-17	31.58	1.36E-15	15.86	1.44E-15	1.34	1.13E-13	0.66	2.67E-12	0.94	99.70	23.61	6.35	342.84	±	2.95	2.28E-02	2.89E-02
650	2.59E-17	17.13	1.36E-15	10.29	1.16E-15	1.50	9.27E-14	0.76	2.21E-12	0.85	99.60	23.77	7.75	344.95	±	2.68	2.78E-02	2.19E-02
700	8.62E-18	30.59	1.34E-15	15.50	1.38E-15	0.79	1.02E-13	0.12	2.52E-12	0.54	99.90	24.58	9.30	355.56	±	1.76	2.49E-02	5.77E-02
700	9.21E-17	17.56	3.23E-16	21.68	9.50E-16	2.84	7.64E-14	0.33	1.86E-12	0.52	98.50	24.01	10.46	348.11	±	1.85	8.05E-03	1.15E-02
750	1.34E-19	20.98	2.17E-15	11.46	9.84E-16	1.27	7.65E-14	0.10	1.91E-12	0.39	100.00	24.91	11.62	359.93	±	1.27	5.39E-02	3.56E-02
750	3.26E-17	27.64	9.02E-16	19.73	9.20E-16	1.71	6.88E-14	0.26	1.74E-12	0.45	99.40	25.19	12.66	363.56	±	1.57	2.49E-02	5.13E-02
800	7.45E-17	6.99	7.03E-16	24.27	1.13E-15	1.92	8.54E-14	0.15	2.13E-12	0.40	98.90	24.71	13.96	357.34	±	1.33	1.56E-02	4.11E-02
800	2.77E-17	49.58	3.13E-16	38.06	1.17E-15	1.82	9.05E-14	0.33	2.31E-12	0.50	99.60	25.48	15.33	367.40	±	1.76	6.57E-03	3.49E-02
850	3.66E-17	23.32	1.21E-15	15.96	1.70E-15	1.93	1.25E-13	0.14	3.18E-12	0.40	99.60	25.34	17.23	365.52	±	1.36	1.84E-02	6.04E-02
850	5.85E-17	7.51	9.02E-16	16.77	1.76E-15	1.79	1.41E-13	0.54	3.52E-12	0.77	99.50	24.82	19.37	358.73	±	2.53	1.21E-02	1.83E-02
900	1.44E-16	3.66	1.51E-15	11.13	2.95E-15	0.93	2.24E-13	0.10	5.69E-12	0.63	99.20	25.23	22.76	364.10	±	2.10	1.28E-02	4.23E-02
900	4.85E-17	14.47	1.24E-15	4.65	3.27E-15	0.79	2.41E-13	0.39	6.09E-12	0.56	99.70	25.18	26.42	363.51	±	1.87	9.74E-03	5.94E-02
950	1.59E-16	4.61	3.67E-15	7.90	6.69E-15	0.91	5.03E-13	0.04	1.26E-11	0.36	99.60	24.92	34.05	360.06	±	1.19	1.39E-02	4.99E-02
950	4.44E-17	18.75	1.42E-15	12.35	3.55E-15	1.65	2.62E-13	0.27	6.60E-12	0.51	99.80	25.18	38.01	363.52	±	1.68	1.03E-02	6.05E-02
950	1.31E-16	7.77	3.22E-15	4.95	1.07E-14	1.12	7.97E-13	0.23	2.03E-11	0.54	99.80	25.35	50.10	365.74	±	1.80	7.67E-03	5.71E-02
1000	2.01E-16	1.97	3.96E-15	5.11	1.06E-14	0.97	7.69E-13	0.14	1.96E-11	0.42	99.70	25.34	61.76	365.56	±	1.38	9.79E-03	6.56E-02
1000	1.87E-16	15.28	4.75E-15	11.85	7.88E-15	1.01	5.83E-13	0.55	1.49E-11	0.69	99.60	25.53	70.59	368.11	±	2.33	1.55E-02	5.82E-02
1000	1.27E-16	30.54	3.31E-15	15.39	4.94E-15	0.44	3.64E-13	0.10	9.39E-12	0.44	99.60	25.69	76.11	370.14	±	1.52	1.73E-02	5.94E-02
1050	1.24E-16	16.18	7.52E-16	38.37	4.55E-15	0.64	3.70E-13	0.26	9.54E-12	0.61	99.60	25.66	81.73	369.78	±	2.05	3.86E-03	1.19E-02
1050	1.07E-16	24.03	7.08E-16	71.71	4.69E-15	0.49	3.48E-13	0.29	9.02E-12	0.52	99.60	25.80	87.01	371.58	±	1.78	3.86E-03	5.62E-02
1050	1.72E-16	16.33	7.32E-16	39.56	3.10E-15	1.73	2.35E-13	0.29	6.15E-12	0.50	99.10	25.98	90.56	373.95	±	1.76	5.93E-03	4.36E-02
1100	1.26E-16	8.14	5.65E-16	19.17	3.92E-15	0.97	2.96E-13	0.17	7.82E-12	0.52	99.50	26.33	95.04	378.42	±	1.77	3.64E-03	4.78E-02
1100	9.90E-17	20.79	5.76E-18	26.34	2.32E-15	1.90	1.82E-13	0.77	4.96E-12	0.92	99.40	27.06	97.80	387.88	±	3.26	6.02E-05	2.78E-02
1100	1.92E-16	19.37	1.91E-15	32.96	1.23E-15	4.28	8.88E-14	0.30	2.37E-12	0.49	97.60	26.04	99.15	374.63	±	2.33	4.08E-02	5.87E-02
1100	2.19E-16	10.85	2.17E-15	15.50	4.79E-16	8.98	3.19E-14	0.20	9.10E-13	0.44	92.90	26.50	99.63	380.60	±	3.27	1.29E-01	6.80E-02
1100	1.25E-16	21.15	1.50E-15	44.95	1.92E-16	20.20	9.76E-15	0.79	2.84E-13	0.89	87.00	25.33	99.78	365.46	±	10.97	2.91E-01	1.98E-01
1200	1.55E-17	22.40	2.10E-18	17.89	1.72E-16	9.09	1.28E-14	0.44	3.78E-13	0.61	98.80	29.24	99.97	415.75	±	2.49	3.12E-04	5.09E-02
1230	7.74E-17	7.26	7.83E-16	7.18	1.84E-17	37.77	8.23E-16	2.27	4.29E-14	2.33	46.80	24.53	99.99	354.92	±	30.92	1.82E+00	-2.64E-01
1260	9.45E-17	18.39	8.33E-16	20.64	3.23E-17	43.06	2.97E-16	4.55	3.10E-14	4.65	10.20	10.80	99.99	164.97	±	261.65	5.43E+00	1.37E+00
1290	6.21E-17	16.02	1.69E-15	7.29	1.54E-19	18.36	2.12E-16	4.32	2.77E-14	4.45	34.30	47.75	99.99	636.81	±	169.34	1.61E+01	-2.44E+00
1320	6.80E-17	13.66	2.11E-18	11.85	4.07E-17	26.08	1.93E-16	7.84	2.57E-14	7.91	21.80	29.16	100.00	414.82	±	225.41	2.08E-02	4.93E+00
1350	5.86E-17	19.45	9.45E-16	20.53	1.54E-19	14.51	1.30E-16	14.40	2.53E-14	14.44	31.90	65.40	100.00	824.95	±	385.72	1.45E+01	-3.51E+00
1450	9.21E-17	21.15	2.11E-18	33.64	2.66E-17	47.08	1.03E-16	19.90	3.35E-14	19.90	18.70	60.62	100.00	775.91	±	885.75	3.88E-02	2.90E+00
Total	3.51E-15		5.36E-14		8.81E-14		6.60E-12		1.68E-10			25.31		365.24	±	1.91		

Lambda K40=5.5430E-10 J=8.8646E-3; %error J=0.713

Sample P2 PL286-CX, K-Feldspar

Temp (C)	Ar36 (mol)	err (%)	Ar37 (mol)	err (%)	Ar38 (mol)	err (%)	Ar39 (mol)	err (%)	Ar40 (mol)	err (%)	% Ar40*	Ar40*/ Ar39(K)	Cumulative Ar39(%)	Calculated Age			Ca/K	Cl/K
														Ma	±	1 s.d.		
450	9.29E-17	5.29	2.26E-18	12.84	7.93E-17	11.56	4.73E-15	0.06	1.75E-13	0.37	84.30	31.26	0.08	441.32	±	4.20	9.08E-04	4.29E-02
450	4.82E-17	30.10	5.28E-16	40.26	1.10E-16	12.87	7.71E-15	0.14	1.90E-13	0.42	92.50	22.78	0.22	331.88	±	7.53	1.30E-01	4.63E-02
500	8.35E-17	1.29	1.35E-16	67.22	2.46E-16	6.06	1.88E-14	0.00	5.05E-13	0.41	95.10	25.57	0.56	368.63	±	1.46	1.36E-02	1.30E-02
500	6.66E-17	8.48	6.96E-16	19.11	2.70E-16	3.54	2.01E-14	0.56	4.37E-13	0.75	95.50	20.75	0.92	304.65	±	2.48	6.58E-02	3.31E-02
550	7.94E-17	16.27	3.58E-15	5.60	4.92E-16	2.28	3.84E-14	0.39	9.08E-13	0.61	97.40	23.02	1.60	335.05	±	2.33	1.77E-01	1.96E-02
550	7.58E-17	1.91	3.16E-15	13.43	5.14E-16	2.06	4.14E-14	0.47	9.19E-13	0.62	97.60	21.67	2.34	317.04	±	1.84	1.45E-01	6.08E-03
600	7.57E-17	15.52	4.00E-15	9.28	1.07E-15	2.99	8.23E-14	0.33	1.99E-12	0.56	98.90	23.90	3.80	346.70	±	1.88	9.24E-02	3.47E-02
600	2.44E-17	46.36	1.17E-15	17.54	9.90E-16	1.02	7.51E-14	0.33	1.82E-12	0.52	99.60	24.13	5.14	349.65	±	1.75	2.95E-02	4.53E-02
650	7.18E-17	11.99	1.78E-15	6.15	1.48E-15	1.98	1.09E-13	0.41	2.71E-12	0.57	99.20	24.62	7.09	356.17	±	1.87	3.10E-02	5.84E-02
650	3.69E-17	1.87	1.78E-15	20.65	1.10E-15	2.97	8.49E-14	0.17	2.09E-12	0.40	99.50	24.50	8.60	354.50	±	1.30	3.97E-02	3.61E-02
700	3.16E-17	39.40	5.44E-16	40.90	1.12E-15	0.86	8.29E-14	0.23	2.09E-12	0.46	99.50	25.10	10.08	362.40	±	1.62	1.25E-02	5.89E-02
700	4.82E-17	27.22	1.03E-15	24.84	7.97E-16	1.98	6.23E-14	0.03	1.54E-12	0.40	99.10	24.48	11.19	354.27	±	1.53	3.14E-02	2.81E-02
750	4.22E-17	4.52	3.95E-16	20.21	8.60E-16	3.56	6.89E-14	0.32	1.75E-12	0.53	99.30	25.15	12.42	363.13	±	1.76	1.09E-02	1.71E-02
750	6.30E-17	12.71	4.09E-16	66.28	7.44E-16	1.38	5.82E-14	0.48	1.47E-12	0.62	98.70	24.91	13.46	359.94	±	2.13	1.34E-02	2.49E-02
800	4.81E-17	20.37	9.58E-16	20.01	9.45E-16	2.29	7.16E-14	0.63	1.83E-12	0.78	99.20	25.42	14.73	366.56	±	2.65	2.54E-02	4.34E-02
800	4.53E-17	14.29	8.99E-16	31.29	9.86E-16	1.52	7.52E-14	0.10	1.92E-12	0.41	99.30	25.40	16.08	366.36	±	1.40	2.27E-02	4.04E-02
850	6.42E-17	12.08	1.31E-15	16.84	1.45E-15	2.08	1.10E-13	0.20	2.87E-12	0.42	99.30	25.77	18.04	371.12	±	1.44	2.26E-02	4.08E-02
850	3.99E-17	28.19	3.48E-16	50.45	1.56E-15	1.98	1.11E-13	0.25	2.93E-12	0.47	99.60	26.16	20.03	376.22	±	1.64	5.94E-03	7.68E-02
900	2.12E-16	3.71	2.30E-16	31.84	2.66E-15	1.33	1.99E-13	0.69	5.10E-12	0.81	98.70	25.34	23.57	365.62	±	2.74	2.20E-03	4.72E-02
900	1.46E-16	9.25	5.13E-16	16.97	2.94E-15	0.76	2.19E-13	0.10	5.67E-12	0.41	99.20	25.69	27.48	370.09	±	1.41	4.45E-03	5.19E-02
950	4.25E-16	11.23	1.81E-15	22.87	6.85E-15	0.73	5.12E-13	0.07	1.31E-11	0.41	99.00	25.35	36.60	365.72	±	1.41	6.73E-03	4.87E-02
950	4.22E-16	6.07	1.59E-15	9.55	7.70E-15	0.86	5.86E-13	0.40	1.53E-11	0.66	99.20	25.86	47.04	372.31	±	2.26	5.15E-03	4.11E-02
950	2.94E-16	8.71	3.82E-15	13.96	8.01E-15	0.95	5.93E-13	0.04	1.54E-11	0.41	99.40	25.89	57.62	372.77	±	1.40	1.22E-02	5.63E-02
1000	4.20E-16	5.63	4.93E-15	4.51	8.95E-15	0.79	6.64E-13	0.33	1.73E-11	0.49	99.30	25.83	69.46	371.92	±	1.67	1.41E-02	5.41E-02
1000	1.93E-16	10.02	1.87E-15	28.32	6.54E-15	0.85	4.71E-13	0.41	1.24E-11	0.55	99.50	26.14	77.86	375.92	±	1.87	7.52E-03	7.04E-02
1000	2.21E-17	47.55	1.59E-15	42.65	3.77E-15	1.96	2.84E-13	0.25	7.43E-12	0.45	99.90	26.18	82.92	376.47	±	1.53	1.07E-02	5.11E-02
1050	2.65E-16	3.10	3.35E-15	13.78	4.31E-15	1.55	3.12E-13	0.25	8.24E-12	0.54	99.00	26.21	88.47	376.89	±	1.86	2.04E-02	6.62E-02
1050	2.01E-16	2.53	3.63E-15	40.84	3.19E-15	2.36	2.24E-13	0.26	6.00E-12	0.46	99.00	26.56	92.46	381.46	±	1.60	3.08E-02	8.13E-02
1050	2.30E-16	3.25	6.45E-18	32.38	1.82E-15	3.44	1.29E-13	0.28	3.47E-12	0.52	98.00	26.45	94.75	380.01	±	1.83	9.53E-05	7.11E-02
1100	1.79E-16	9.80	2.18E-15	19.88	2.06E-15	2.45	1.56E-13	0.17	4.22E-12	0.42	98.70	26.71	97.54	383.33	±	1.52	2.66E-02	3.99E-02
1100	1.62E-16	20.23	6.47E-18	14.31	1.08E-15	2.64	8.02E-14	0.36	2.18E-12	0.54	97.80	26.53	98.97	381.10	±	2.45	1.53E-04	4.22E-02
1100	7.61E-17	16.17	6.69E-16	79.84	4.65E-16	9.77	2.91E-14	0.94	8.06E-13	1.08	97.20	26.97	99.49	386.71	±	4.19	4.38E-02	1.33E-01
1100	6.62E-17	14.68	2.34E-18	28.55	1.45E-16	11.20	1.04E-14	0.65	3.01E-13	0.79	93.50	27.05	99.67	387.75	±	4.63	4.28E-04	3.26E-02
1100	4.55E-17	16.36	7.38E-16	22.37	1.06E-16	16.24	4.25E-15	0.74	1.32E-13	0.84	89.80	27.93	99.75	399.06	±	7.42	3.30E-01	4.11E-01
1200	1.01E-16	3.24	2.35E-18	15.72	2.13E-16	6.51	1.27E-14	0.30	3.59E-13	0.60	91.60	25.91	99.97	372.98	±	2.41	3.52E-04	1.24E-01
1230	3.90E-17	19.57	2.36E-18	53.30	3.12E-17	31.73	7.84E-16	2.25	4.24E-14	2.30	72.80	39.40	99.99	540.36	±	37.11	5.71E-03	6.87E-01
1260	7.91E-17	13.67	2.36E-18	34.68	1.56E-16	19.07	2.47E-16	3.97	2.73E-14	4.05	14.50	16.06	99.99	240.08	±	191.69	1.81E-02	2.06E+01
1290	5.52E-17	25.72	2.36E-18	38.38	1.41E-17	80.84	8.41E-17	18.58	2.87E-14	18.60	43.20	147.78	99.99	1510.48	±	559.56	5.33E-02	1.18E+00
1320	7.47E-17	28.71	4.65E-16	54.34	4.52E-17	38.96	1.27E-16	25.60	3.18E-14	25.61	30.80	79.21	100.00	959.57	±	763.90	7.16E+00	8.64E+00
1350	1.23E-16	12.88	1.75E-15	17.36	2.74E-17	14.69	1.69E-16	10.19	4.03E-14	10.21	10.60	27.56	100.00	394.35	±	474.26	2.14E+01	5.45E-01
1450	3.32E-16	16.23	6.96E-16	32.28	4.11E-17	44.31	8.88E-17	15.59	1.09E-13	15.60	9.90	128.80	100.00	1374.00	±	1958.64	1.58E+01	-9.31E+00
Total	5.20E-15		5.26E-14		7.59E-14		5.61E-12		1.46E-10			25.72		370.50	±	1.87		

Lambda K40=5.5430E-10 J=8.8645E-3; %error J=0.713

Sample P3 PL366-GM, K-Feldspar

Temp (C)	Ar36 (mol)	err (%)	Ar37 (mol)	err (%)	Ar38 (mol)	err (%)	Ar39 (mol)	err (%)	Ar40 (mol)	err (%)	% Ar40*	Ar40*/ Ar39(K)	Cumulative Ar39(%)	Calculated Age			Ca/K	Cl/K
														Ma	±	1 s.d.		
450	1.50E-16	4.82	2.55E-15	11.16	1.23E-16	4.40	7.64E-15	0.59	2.57E-13	0.87	82.70	27.86	0.14	397.75	±	5.20	6.36E-01	1.67E-02
450	5.08E-17	19.16	5.59E-16	39.66	1.08E-16	15.04	7.71E-15	0.26	1.75E-13	0.45	91.40	20.70	0.28	303.69	±	5.22	1.38E-01	3.21E-02
500	7.77E-17	9.16	7.06E-16	0.87	2.80E-16	3.96	2.09E-14	0.47	6.11E-13	0.70	96.20	28.09	0.65	400.81	±	2.91	6.41E-02	2.96E-02
500	3.76E-17	9.10	2.60E-15	11.45	2.52E-16	2.43	1.95E-14	0.19	3.97E-13	0.44	97.20	19.85	1.00	292.12	±	1.41	2.54E-01	2.47E-02
550	1.93E-16	10.48	9.92E-16	21.78	5.61E-16	3.10	4.18E-14	0.15	9.48E-13	0.40	94.00	21.31	1.75	311.80	±	2.28	4.51E-02	2.36E-02
550	7.51E-17	10.90	1.34E-15	11.79	5.43E-16	4.27	4.16E-14	0.59	9.11E-13	0.72	97.50	21.40	2.50	313.06	±	2.26	6.15E-02	3.07E-02
600	7.59E-17	19.35	9.38E-16	10.98	9.77E-16	1.61	7.31E-14	0.24	1.70E-12	0.51	98.70	22.90	3.81	333.13	±	1.75	2.44E-02	4.71E-02
600	3.22E-17	20.90	2.08E-15	21.31	9.20E-16	1.44	6.92E-14	0.28	1.61E-12	0.53	99.40	23.10	5.06	335.80	±	1.67	5.71E-02	4.87E-02
650	3.38E-17	10.11	7.12E-16	41.88	1.32E-15	0.93	1.05E-13	0.26	2.49E-12	0.48	99.60	23.68	6.94	343.46	±	1.51	1.29E-02	2.20E-02
650	5.16E-17	29.76	1.26E-15	15.63	1.14E-15	2.04	8.62E-14	0.40	2.04E-12	0.58	99.20	23.46	8.49	340.52	±	1.93	2.77E-02	4.45E-02
700	7.43E-17	10.70	1.49E-15	16.15	1.22E-15	0.87	9.20E-14	0.31	2.21E-12	0.54	99.00	23.79	10.14	344.86	±	1.75	3.08E-02	4.57E-02
700	2.98E-17	4.67	1.80E-15	11.74	9.05E-16	1.56	6.75E-14	0.30	1.66E-12	0.50	99.50	24.50	11.36	354.25	±	1.63	5.08E-02	5.26E-02
750	1.17E-19	17.98	1.79E-15	5.03	1.01E-15	1.64	7.33E-14	0.38	1.83E-12	0.52	100.00	24.94	12.68	360.00	±	1.70	4.64E-02	7.03E-02
750	6.67E-17	21.40	1.03E-15	29.65	9.05E-16	2.07	7.13E-14	0.15	1.78E-12	0.43	98.90	24.67	13.96	356.43	±	1.60	2.75E-02	2.28E-02
800	9.90E-17	17.05	2.01E-15	7.77	1.21E-15	2.04	9.30E-14	0.45	2.31E-12	0.59	98.70	24.49	15.63	354.10	±	2.04	4.11E-02	3.39E-02
800	3.92E-17	19.21	1.64E-15	15.04	1.26E-15	0.82	9.71E-14	0.54	2.45E-12	0.70	99.50	25.10	17.37	362.11	±	2.34	3.21E-02	3.63E-02
850	7.19E-17	16.86	1.89E-15	5.22	1.93E-15	0.84	1.44E-13	0.06	3.57E-12	0.40	99.40	24.70	19.96	356.82	±	1.33	2.49E-02	5.22E-02
850	8.46E-17	10.47	2.57E-15	3.54	1.92E-15	0.81	1.47E-13	0.09	3.75E-12	0.38	99.30	25.24	22.61	363.87	±	1.30	3.31E-02	3.76E-02
900	1.49E-16	8.95	2.81E-15	5.92	3.40E-15	1.05	2.59E-13	0.58	6.45E-12	0.70	99.30	24.69	27.26	356.75	±	2.30	2.06E-02	4.11E-02
900	9.17E-17	14.01	3.43E-15	7.70	3.91E-15	0.86	2.90E-13	0.17	7.31E-12	0.41	99.60	25.14	32.47	362.58	±	1.35	2.25E-02	5.65E-02
950	2.92E-16	12.04	5.71E-15	7.81	8.74E-15	1.57	6.42E-13	0.13	1.63E-11	0.42	99.40	25.26	44.01	364.15	±	1.42	1.69E-02	6.07E-02
950	2.61E-16	8.05	6.14E-15	3.94	8.88E-15	1.08	6.73E-13	0.10	1.73E-11	0.42	99.50	25.63	56.11	368.98	±	1.41	1.73E-02	4.51E-02
950	1.98E-16	18.53	5.75E-15	6.61	7.66E-15	1.39	5.52E-13	0.24	1.44E-11	0.46	99.60	25.90	66.04	372.57	±	1.57	1.98E-02	7.05E-02
1000	2.53E-16	5.30	2.71E-15	26.99	6.45E-15	0.51	5.03E-13	0.20	1.31E-11	0.41	99.40	25.77	75.08	370.90	±	1.40	1.02E-02	3.07E-02
1000	1.17E-16	9.24	2.55E-15	26.02	5.35E-15	1.23	3.87E-13	0.44	1.03E-11	0.65	99.60	26.42	82.03	379.23	±	2.23	1.26E-02	7.01E-02
1000	9.62E-17	15.74	7.64E-16	49.82	3.50E-15	2.37	2.48E-13	0.58	6.56E-12	0.69	99.50	26.32	86.49	377.99	±	2.38	5.85E-03	7.90E-02
1050	1.87E-16	14.19	6.12E-16	77.78	3.60E-15	2.15	2.55E-13	0.44	6.78E-12	0.58	99.20	26.40	91.07	379.00	±	2.05	4.56E-03	7.74E-02
1050	1.55E-16	24.33	8.01E-16	25.46	2.53E-15	2.86	1.89E-13	0.20	5.10E-12	0.46	99.10	26.71	94.47	383.03	±	1.77	8.04E-03	4.75E-02
1050	1.55E-16	3.47	2.08E-15	7.63	1.67E-15	1.98	1.24E-13	0.58	3.32E-12	0.70	98.60	26.54	96.69	380.80	±	2.45	3.19E-02	5.02E-02
1100	1.30E-16	23.00	1.22E-15	32.40	1.66E-15	2.78	1.08E-13	0.26	2.94E-12	0.57	98.70	26.94	98.63	385.99	±	2.28	2.14E-02	1.21E-01
1100	6.89E-17	39.68	1.57E-15	55.14	7.17E-16	6.64	5.27E-14	0.59	1.39E-12	0.71	98.50	26.07	99.58	374.76	±	3.14	5.67E-02	5.44E-02
1100	1.06E-16	13.29	6.16E-18	33.08	2.18E-16	11.55	1.43E-14	1.33	4.13E-13	1.39	92.40	26.77	99.84	383.79	±	6.44	8.21E-04	7.26E-02
1100	8.34E-17	8.11	4.79E-16	37.53	7.65E-17	26.14	4.40E-15	0.50	1.40E-13	0.64	82.30	26.16	99.91	375.91	±	6.47	2.07E-01	7.24E-02
1100	8.62E-17	13.19	2.91E-16	36.34	4.63E-17	14.57	1.45E-15	0.49	5.98E-14	0.77	57.40	23.69	99.94	343.57	±	30.85	3.81E-01	3.28E-01
1200	4.18E-17	23.04	2.61E-16	52.80	5.18E-17	35.39	2.74E-15	1.29	9.31E-14	1.35	86.70	29.48	99.99	418.41	±	14.39	1.81E-01	1.53E-01
1230	5.23E-17	13.60	2.24E-18	32.34	2.80E-17	20.27	2.95E-16	3.47	2.46E-14	3.62	37.20	31.07	99.99	438.43	±	97.00	1.44E-02	1.84E+00
1260	2.11E-16	20.55	2.62E-16	38.56	1.81E-17	60.55	1.50E-16	18.88	2.34E-14	18.89	-165.30	0.00	100.00	0.02	±	1444.16	3.36E+00	-5.76E+00
1290	1.02E-16	18.52	7.43E-16	37.74	5.27E-17	44.95	5.79E-17	17.74	2.20E-14	17.74	-36.20	0.00	100.00	0.02	±	1880.13	2.70E+01	2.10E+01
1320	2.13E-18	243.89	2.25E-18	38.44	2.38E-17	93.23	1.54E-19	36.96	2.16E-14	36.97	97.10	152357	100.00	13003.80	±	627.25	3.11E+01	5.61E+03
1350	6.08E-17	16.60	2.26E-18	25.24	3.59E-17	36.51	6.43E-17	9.30	1.99E-14	9.37	9.90	30.65	100.00	433.20	±	687.92	6.67E-02	1.36E+01
1450	6.11E-17	55.07	2.26E-18	55.15	2.18E-17	94.87	3.10E-17	52.80	2.74E-14	52.80	34.10	302.37	100.00	2349.39	±	2462.68	1.39E-01	1.19E+01
Total	4.20E-15		6.62E-14		7.52E-14		5.56E-12		1.43E-10			25.43		366.40	±	1.86		

Lambda K40=5.5430E-10 J=8.8555E-3; %error J=0.714

Sample P4 PL336-CX, K-Feldspar

Temp (C)	Ar36 (mol)	err (%)	Ar37 (mol)	err (%)	Ar38 (mol)	err (%)	Ar39 (mol)	err (%)	Ar40 (mol)	err (%)	% Ar40*	Ar40* / Ar39(K)	Cumulative Ar39(%)	Calculated Age			Ca/K	Cl/K
														Ma	±	1 s.d.		
450	1.97E-16	6.83	6.34E-16	45.43	1.03E-16	12.07	5.17E-15	1.58	1.90E-13	1.64	69.30	25.49	0.09	367.02	±	12.75	2.33E-01	3.10E-02
450	3.60E-16	3.82	2.41E-18	34.50	1.49E-16	13.32	6.54E-15	0.93	2.51E-13	1.02	57.60	22.11	0.20	322.42	±	9.82	7.01E-04	1.82E-02
500	5.48E-16	2.89	2.42E-18	47.58	2.99E-16	8.39	1.58E-14	0.26	6.04E-13	0.53	73.10	28.00	0.47	399.43	±	4.60	2.91E-04	1.93E-02
500	7.11E-16	3.07	1.06E-16	45.24	3.80E-16	1.81	1.73E-14	0.57	5.60E-13	0.68	62.40	20.16	0.77	296.26	±	5.84	1.17E-02	8.67E-02
550	8.77E-16	1.75	3.36E-16	62.11	6.13E-16	2.84	3.66E-14	0.88	1.10E-12	0.97	76.30	22.86	1.40	332.42	±	4.19	1.74E-02	1.24E-02
550	1.11E-15	1.55	8.11E-16	36.27	7.52E-16	2.55	3.62E-14	0.27	1.16E-12	0.51	71.80	23.00	2.03	334.31	±	2.84	4.26E-02	1.16E-01
600	1.35E-15	2.29	1.44E-15	17.29	1.10E-15	2.45	6.44E-14	0.13	1.94E-12	0.51	79.40	23.94	3.14	346.68	±	2.76	4.25E-02	4.54E-02
600	1.72E-15	1.43	9.38E-16	14.93	1.13E-15	3.27	5.93E-14	0.45	1.96E-12	0.59	74.00	24.41	4.16	352.86	±	3.00	3.00E-02	6.43E-02
650	2.09E-14	1.12	1.09E-15	9.03	4.55E-15	0.93	3.79E-14	0.22	7.10E-12	0.43	12.80	24.01	4.81	347.60	±	2.24	5.46E-02	1.63E-01
650	1.91E-17	83.35	1.03E-15	32.15	8.86E-16	2.34	6.61E-14	0.42	1.69E-12	0.58	99.60	25.50	5.95	367.13	±	2.14	2.96E-02	5.36E-02
700	5.86E-17	15.58	2.43E-15	3.63	1.07E-15	1.75	8.10E-14	0.43	2.11E-12	0.61	99.20	25.82	7.35	371.38	±	2.12	5.70E-02	4.41E-02
700	4.10E-17	26.43	2.38E-15	10.00	8.24E-16	2.14	6.42E-14	0.40	1.67E-12	0.64	99.30	25.76	8.46	370.56	±	2.25	7.04E-02	3.03E-02
750	6.32E-17	1.60	3.89E-15	6.22	1.07E-15	1.52	8.51E-14	0.23	2.22E-12	0.44	99.10	25.83	9.92	371.42	±	1.49	8.70E-02	2.15E-02
750	5.22E-17	17.05	2.61E-15	7.05	9.01E-16	1.61	6.57E-14	0.44	1.73E-12	0.64	99.10	26.04	11.05	374.10	±	2.23	7.55E-02	6.18E-02
800	3.41E-17	22.86	2.60E-15	9.20	1.18E-15	1.33	9.02E-14	0.35	2.36E-12	0.51	99.60	26.02	12.61	373.92	±	1.75	5.47E-02	4.27E-02
800	1.53E-17	86.43	1.93E-15	10.42	1.12E-15	3.36	8.66E-14	0.25	2.27E-12	0.52	99.80	26.18	14.10	375.99	±	1.85	4.23E-02	3.71E-02
850	9.67E-17	13.69	3.25E-15	7.30	1.64E-15	1.89	1.24E-13	0.18	3.25E-12	0.41	99.10	26.12	16.23	375.15	±	1.46	4.99E-02	4.56E-02
850	6.64E-17	14.36	2.15E-15	13.06	1.61E-15	0.85	1.21E-13	0.13	3.19E-12	0.40	99.40	26.14	18.32	375.46	±	1.40	3.36E-02	4.65E-02
900	1.38E-16	3.06	2.44E-15	7.74	2.66E-15	1.16	2.01E-13	0.26	5.28E-12	0.45	99.20	26.10	21.78	374.90	±	1.52	2.31E-02	4.45E-02
900	5.55E-17	15.65	1.72E-15	16.90	2.71E-15	0.72	2.05E-13	0.05	5.36E-12	0.42	99.70	26.07	25.31	374.60	±	1.45	1.59E-02	4.78E-02
950	2.53E-16	13.95	3.91E-15	23.50	6.89E-15	1.86	5.10E-13	0.20	1.34E-11	0.48	99.40	26.12	34.10	375.15	±	1.65	1.46E-02	5.64E-02
950	2.44E-16	15.81	5.15E-15	15.67	6.93E-15	0.87	5.41E-13	0.35	1.42E-11	0.58	99.50	26.11	43.42	375.07	±	2.00	1.81E-02	3.06E-02
950	2.20E-16	16.82	5.66E-15	7.33	8.73E-15	0.73	6.67E-13	0.25	1.76E-11	0.46	99.60	26.30	54.91	377.55	±	1.58	1.61E-02	4.19E-02
1000	3.88E-16	3.21	8.75E-15	12.77	1.13E-14	0.74	9.03E-13	0.15	2.40E-11	0.40	99.50	26.49	70.47	379.95	±	1.39	1.84E-02	2.01E-02
1000	3.52E-16	5.91	4.52E-15	9.42	7.57E-15	0.99	6.01E-13	0.21	1.62E-11	0.45	99.30	26.74	80.82	383.26	±	1.58	1.43E-02	2.20E-02
1000	2.68E-16	4.13	3.29E-15	23.56	4.29E-15	1.17	3.17E-13	0.32	8.57E-12	0.54	99.10	26.81	86.28	384.16	±	1.89	1.97E-02	5.51E-02
1050	2.38E-16	14.37	4.91E-15	4.88	4.60E-15	2.60	3.36E-13	0.02	9.33E-12	0.44	99.20	27.57	92.07	393.94	±	1.61	2.78E-02	6.14E-02
1050	1.52E-16	19.52	1.31E-15	12.70	3.01E-15	1.86	2.23E-13	0.33	6.22E-12	0.56	99.30	27.70	95.91	395.56	±	2.06	1.11E-02	5.46E-02
1050	2.60E-16	5.84	3.51E-15	11.89	1.37E-15	1.85	9.81E-14	0.09	2.79E-12	0.42	97.20	27.71	97.60	395.66	±	1.66	6.80E-02	5.99E-02
1100	1.54E-16	17.82	5.10E-15	14.72	1.40E-15	3.84	1.01E-13	0.63	2.85E-12	0.78	98.40	27.91	99.33	398.31	±	3.03	9.64E-02	6.27E-02
1100	4.73E-17	70.45	3.06E-15	9.08	5.02E-16	9.74	3.03E-14	0.29	8.89E-13	0.50	98.40	28.91	99.86	411.01	±	4.53	1.92E-01	1.62E-01
1100	6.16E-17	14.17	1.20E-15	17.18	5.57E-17	17.39	2.91E-15	0.58	1.06E-13	0.70	82.80	30.11	99.91	426.21	±	11.61	7.82E-01	1.21E-01
1200	9.31E-17	4.71	4.57E-15	4.48	1.15E-16	9.98	4.29E-15	1.11	1.57E-13	1.19	82.70	30.60	99.98	432.39	±	6.69	2.04E+00	4.01E-01
1300	2.29E-16	5.88	9.53E-15	4.41	6.24E-17	16.17	8.34E-16	2.44	1.11E-13	2.49	39.70	57.73	99.99	744.58	±	61.37	2.37E+01	4.43E-01
1450	1.02E-16	4.18	5.01E-15	4.79	8.99E-17	10.22	4.24E-16	0.80	7.11E-14	0.97	58.30	107.04	100.00	1202.45	±	27.99	2.46E+01	5.77E+00
Total	3.15E-14		1.01E-13		8.17E-14		5.80E-12		1.63E-10			26.39		378.76	±	1.97		

$\Lambda K40=5.5430E-10$ $J=8.8511E-3$; %error $J=0.714$