A new precise date for the Tolmie Igneous Complex in northeastern Victoria

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SUPPLEMENTARY PAPER

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Table A1 LA-SF-ICP-MS U–Pb dating methodology CAF, Stellenbosch University.

Table A2 U–Pb age dating results for reference materials Plešovice and M127
obtained during this study by LA-SF-ICP-MS.

Table A3 U–Pb age dating results for sample Toom-1 obtained by LA-SF-ICP-MS.

Table A1 LA-SF-ICP-MS U–Pb dating methodology CAF, Stellenbosch University

Laboratory & Sample Preparation	
Laboratory name	Central Analytical Facility, Stellenbosch University
Sample type / mineral	Igneous/inherited zircons
Sample preparation	Conventional mineral separation, 1 inch resin mount, 1 µm polish to finish (see text for more details)
Imaging	CL, Zeiss Ultraplus (University of Salzburg)
Laser ablation system	
Make, Model & type	Resonetics Resolution S155, ArF Excimer
Ablation cell & volume	Laurin Technology S155 double Helix large volume cell
Laser wavelength	193 nm
Pulse width	20 ns
Fluence	Approx. 3 J/cm ²
Repetition rate	5.5 Hz
Spot size	30 µm
Sampling mode / pattern	30 µm single spot analyses
Carrier gas	100% He, Ar make-up gas injected into conical double Helix sampling funnel
Pre-ablation laser warm-up (background collection)	3 cleaning shots followed by 20 seconds background collection
Ablation duration	20 seconds
Wash-out delay	15 seconds
Cell carrier gas flow	330 mL/min He & 3.5 mL/min N ₂
ICP-MS Instrument	
Make, Model & type	Thermo Finnigan Element2 single collector HR-SF-ICP-MS
Sample introduction	via polyurethane tubing
RF power	1350 W
Make-up gas flow	840 mL/min Ar
Detection system	Single collector secondary electron multiplier
Masses measured	202, 204, 206, 207, 208, 232, 233, 235, 238
Integration time per peak	4 ms
Total integration time per reading	1 sec (<i>represents the time resolution of the data</i>)
Sensitivity	35000 cps/ppm Pb
Dead time	6 ns
Data Processing	
Gas blank	20 second on-peak
Calibration strategy	GJ-1 used as primary reference material, Plešovice & M127 used as secondary reference material (Quality Control)
Reference Material info	M127 (Nasdala <i>et al.</i> 2008; Mattinson 2010), Plešovice (Aftalion <i>et al.</i> 1989; Slama <i>et al.</i> 2008), GJ-1 (Jackson <i>et al.</i> 2004)
Data processing package used / Correction for LIEF*	In-house spreadsheet data processing using intercept method for LIEF correction
Mass discrimination	Standard-sample bracketing with ²⁰⁷ Pb/ ²⁰⁶ Pb and ²⁰⁶ Pb/ ²³⁸ U normalized to reference material GJ-1
Common-Pb correction, composition and uncertainty	204-method, Stacey & Kramers (1975) composition at the projected age of the mineral, 5% uncertainty assigned
Uncertainty level & propagation	Ages are quoted at 2 sigma absolute, propagation is by quadratic addition. Reproducibility and age uncertainty of reference material and common-Pb composition uncertainty are propagated.
Quality control / Validation	Plešovice: Concordia age = 339 ± 4 (2SD, MSWD = 0.81, Prob. = 0.69); M127: Concordia age = 529 ± 4 (2SD, MSWD = 0.09, Prob. = 1.00)
Other information	
For detailed method description see Frei & Gerdes (2009)	

*Laser-Induced Elemental Fractionation

Table 4 U–Pb age dating results for sample Toom-1 obtained by LA-SF-ICP-MS

Analysis	RATIOS									AGES [Ma]				Conc.			
	U [ppm] ^a	Pb [ppm] ^a	Th/U ^a	²⁰⁷ Pb/ ²³⁵ U ^b	2 σ ^d	²⁰⁶ Pb/ ²³⁸ U ^b	2 σ ^d	rho ^c	²⁰⁷ Pb/ ²⁰⁶ Pb ^e	2 σ ^d	²⁰⁷ Pb/ ²³⁵ U	2 σ	²⁰⁶ Pb/ ²³⁸ U	2 σ	²⁰⁷ Pb/ ²⁰⁶ Pb	2 σ	%
TO01_1C	324	20	0.13	0.453	0.017	0.0605	0.0016	0.72	0.0543	0.0014	379	14	378	10	385	58	98
TO01_2	244	15	0.73	0.450	0.022	0.0602	0.0018	0.60	0.0543	0.0021	377	18	377	11	382	85	99
TO03_1C	475	28	0.30	0.462	0.028	0.0596	0.0017	0.47	0.0563	0.0030	386	23	373	10	462	114	81
TO03_1R	403	24	0.39	0.441	0.027	0.0592	0.0024	0.67	0.0540	0.0025	371	23	371	15	371	100	100
TO06_1C	205	12	0.82	0.452	0.034	0.0606	0.0039	0.84	0.0541	0.0023	379	29	380	24	373	91	102
TO06_1R	203	12	0.70	0.449	0.034	0.0599	0.0036	0.78	0.0543	0.0026	376	29	375	22	384	102	98
TO06_2	261	16	0.08	0.456	0.032	0.0606	0.0017	0.41	0.0546	0.0035	381	26	379	10	394	136	96
TO06_3	155	9	0.35	0.450	0.034	0.0601	0.0032	0.71	0.0543	0.0029	377	28	376	20	381	114	99
TO07	506	31	0.10	0.452	0.029	0.0604	0.0020	0.50	0.0543	0.0031	379	25	378	12	385	122	98
TO08_1C	253	13	0.19	0.396	0.023	0.0530	0.0017	0.54	0.0542	0.0027	339	20	333	10	379	106	88
TO08_1R	188	11	0.21	0.455	0.068	0.0606	0.0071	0.78	0.0544	0.0051	381	57	379	43	389	198	97
TO08_2	303	18	0.08	0.448	0.025	0.0599	0.0017	0.50	0.0542	0.0026	376	21	375	10	379	104	99
TO09_1C	191	12	1.61	0.450	0.032	0.0603	0.0024	0.56	0.0541	0.0032	377	27	377	15	377	128	100
TO09_2C	387	23	0.21	0.452	0.018	0.0604	0.0017	0.69	0.0543	0.0016	378	15	378	10	382	65	99
TO09_2R	253	15	0.23	0.452	0.025	0.0605	0.0021	0.64	0.0542	0.0023	379	21	379	13	380	91	100
TO10_1C	309	19	0.27	0.451	0.034	0.0606	0.0032	0.70	0.0540	0.0030	378	29	379	19	371	118	102
TO10_2	214	13	0.23	0.444	0.033	0.0596	0.0031	0.70	0.0541	0.0028	373	28	373	19	373	113	100
TO11_1	210	13	1.54	0.507	0.028	0.0604	0.0016	0.49	0.0609	0.0030	416	23	378	10	636	102	59
TO11_2	261	16	3.05	0.546	0.028	0.0607	0.0017	0.54	0.0653	0.0028	442	23	380	10	783	88	48
TO11_3	159	10	1.48	0.450	0.024	0.0602	0.0018	0.56	0.0542	0.0024	378	20	377	11	381	95	99
TO11_4	115	7	1.40	0.800	0.038	0.0602	0.0021	0.75	0.0965	0.0030	597	28	377	13	1558	57	24
TO12_2C	201	12	1.61	0.463	0.073	0.0616	0.0073	0.75	0.0546	0.0057	387	61	385	44	396	217	97
TO13_1C	849	51	0.04	0.451	0.016	0.0604	0.0016	0.76	0.0542	0.0012	378	13	378	10	378	51	100
TO13_2C	177	11	0.96	0.466	0.029	0.0604	0.0018	0.48	0.0560	0.0030	388	24	378	11	450	116	84
TO13_2R	330	16	1.75	0.396	0.023	0.0493	0.0021	0.74	0.0582	0.0023	339	20	310	13	537	85	58
TO15	186	11	0.98	0.451	0.023	0.0604	0.0019	0.62	0.0542	0.0022	378	19	378	12	378	88	100
TO15C	152	9	1.03	0.452	0.025	0.0603	0.0022	0.65	0.0543	0.0023	378	21	378	14	383	92	98
TO15R	143	8	0.84	0.419	0.039	0.0550	0.0019	0.37	0.0552	0.0048	355	33	345	11	421	182	82
TO16	316	19	0.08	0.458	0.024	0.0610	0.0018	0.56	0.0544	0.0023	383	20	382	11	389	93	98
TO17C	262	14	0.24	0.408	0.018	0.0547	0.0014	0.59	0.0541	0.0020	347	16	344	9	373	80	92
TO17R	173	10	0.22	0.452	0.023	0.0603	0.0022	0.73	0.0544	0.0019	379	19	377	14	385	76	98
TO18_1	203	12	0.30	0.451	0.020	0.0604	0.0017	0.63	0.0542	0.0019	378	17	378	10	379	75	100
TO18_2	154	9	3.02	0.452	0.024	0.0603	0.0019	0.59	0.0544	0.0024	378	20	377	12	386	94	98
TO19	211	13	0.65	0.451	0.026	0.0602	0.0017	0.49	0.0543	0.0027	378	22	377	11	383	109	98
TO19C	183	11	0.98	0.450	0.022	0.0603	0.0019	0.64	0.0541	0.0020	377	18	378	12	374	82	101
TO19R	70	4	1.04	0.448	0.045	0.0603	0.0024	0.39	0.0539	0.0050	376	38	378	15	366	195	103

^aU and Pb concentrations and Th/U ratios are calculated relative to GJ-1 reference zircon. ^bCorrected for background and within-run Pb/U fractionation and normalised to reference zircon GJ-1 (ID-TIMS values/measured value); ²⁰⁷Pb/²³⁵U calculated using (²⁰⁷Pb/²⁰⁶Pb)/(²³⁸U/²⁰⁶Pb * 1/137.88). ^cRho is the error correlation defined as the quotient of the propagated errors of the ²⁰⁶Pb/²³⁸U and the ²⁰⁷Pb/²³⁵U ratio. ^dQuadratic addition of within-run errors (2 SD) and daily reproducibility of GJ-1 (2 SD). ^eCorrected for mass-bias by normalising to GJ-1 reference zircon (~0.6 per atomic mass unit) and common Pb using the model Pb composition of Stacey & Kramers (1975).

Table A3 U–Pb age dating results for reference materials Plešovice and M127 obtained during this study by LA-SF-ICP-MS

RATIOS																			AGES [Ma]				Conc.	
Sample	Analysis	U [ppm] ^a	Pb [ppm] ^a	Th/U ^a	²⁰⁷ Pb/ ²³⁵ U ^b	2 σ ^d	²⁰⁶ Pb/ ²³⁸ U ^b	2 σ ^d	rho ^c	²⁰⁷ Pb/ ²⁰⁶ Pb ^e	2 σ ^d	²⁰⁷ Pb/ ²³⁵ U	2 σ	²⁰⁶ Pb/ ²³⁸ U	2 σ	²⁰⁷ Pb/ ²⁰⁶ Pb	2 σ	%						
Plešovice	PL_001	851	46	0.12	0.395	0.011	0.0540	0.0011	0.76	0.0531	0.0009	338	9	339	7	335	39	101						
Plešovice	PL_002	877	47	0.12	0.393	0.011	0.0539	0.0011	0.76	0.0528	0.0009	336	9	339	7	320	39	106						
Plešovice	PL_003	856	46	0.12	0.386	0.010	0.0543	0.0011	0.76	0.0517	0.0009	332	9	341	7	270	40	126						
Plešovice	PL_004	854	46	0.12	0.395	0.011	0.0538	0.0011	0.75	0.0532	0.0010	338	9	338	7	336	41	101						
Plešovice	PL_005	786	42	0.12	0.393	0.012	0.0536	0.0011	0.71	0.0531	0.0011	336	10	337	7	333	47	101						
Plešovice	PL_006	860	46	0.12	0.400	0.012	0.0541	0.0011	0.72	0.0537	0.0011	342	10	339	7	357	45	95						
Plešovice	PL_007	965	52	0.12	0.396	0.013	0.0539	0.0011	0.64	0.0533	0.0013	339	11	338	7	341	56	99						
Plešovice	PL_008	687	37	0.09	0.400	0.015	0.0542	0.0012	0.59	0.0536	0.0017	342	13	340	8	353	68	96						
Plešovice	PL_009	575	31	0.09	0.398	0.014	0.0543	0.0013	0.66	0.0532	0.0014	340	12	341	8	337	59	101						
Plešovice	PL_010	406	22	0.07	0.393	0.015	0.0541	0.0013	0.62	0.0527	0.0016	336	13	339	8	315	67	108						
M127	127_001	841	72	0.39	0.685	0.017	0.0858	0.0017	0.79	0.0579	0.0009	530	13	531	10	526	33	101						
M127	127_002	834	71	0.39	0.685	0.017	0.0857	0.0017	0.79	0.0579	0.0009	530	13	530	10	527	34	101						
M127	127_003	813	70	0.39	0.687	0.017	0.0860	0.0017	0.78	0.0579	0.0009	531	13	532	10	526	34	101						
M127	127_004	877	75	0.40	0.686	0.019	0.0855	0.0017	0.74	0.0581	0.0011	530	15	529	10	535	41	99						
M127	127_005	802	69	0.39	0.683	0.018	0.0857	0.0017	0.76	0.0578	0.0010	529	14	530	10	524	37	101						
M127	127_006	838	71	0.40	0.680	0.019	0.0850	0.0017	0.75	0.0581	0.0011	527	14	526	10	532	40	99						
M127	127_007	816	70	0.40	0.683	0.019	0.0856	0.0018	0.75	0.0579	0.0011	529	15	529	11	526	40	101						

^aU and Pb concentrations and Th/U ratios are calculated relative to GJ-1 reference zircon. ^bCorrected for background and within-run Pb/U fractionation and normalised to reference zircon GJ-1 (ID-TIMS values/measured value); ²⁰⁷Pb/²³⁵U calculated using (²⁰⁷Pb/²⁰⁶Pb)/(²³⁸U/²⁰⁶Pb * 1/137.88). ^cRho is the error correlation defined as the quotient of the propagated errors of the ²⁰⁶Pb/²³⁸U and the ²⁰⁷Pb/²³⁵U ratio. ^dQuadratic addition of within-run errors (2 SD) and daily reproducibility of GJ-1 (2 SD). ^eCorrected for mass-bias by normalising to GJ-1 reference zircon (~0.6 per atomic mass unit) and common Pb using the model Pb composition of Stacey & Kramers (1975). Accepted values for the ages of Plešovice and M127 zircon standards are 337 ± 1 (Slama *et al.* 2008) and 524 ± 2 Ma (Klötzli *et al.* 2009), respectively.

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