Supplementary Publication

Ion microprobe analytical technique

Zircons were separated from several kilograms of sample by conventional means. The sub-300 µm fraction was processed using a Wilfey table, and then the Wilfey heavies were passed through a Frantz magnetic separator at 1 A. The non-paramagnetic portion was then placed in a filter funnel with di iodomethane. The resulting heavy fraction was then passed again through the Frantz magnetic separator at full current. All zircons were hand picked in ethanol using a binocular microscope. Zircons were mounted in a resin disk along with the zircon standard and polished to reveal the grain interiors. The mounts were gold-coated and imaged with a Hitachi S-4300 scanning electron microscope (SEM), using a cathodoluminescence probe (CL) to image internal structures, overgrowths and zonation. Secondary electron mode (SE) imaging was employed to detect fractures and inclusions within the grains.

U–Th–Pb zircon analyses were performed on a Cameca IMS 1270 ion-microprobe following methods described by Whitehouse & Kamber (2005) which were modified from Whitehouse *et al.* (1999). U/Pb ratio calibration was based on analyses of the Geostandards zircon 91500, which has an age of 1065.4 ± 0.3 Ma and U and Pb concentrations of 80 and 15 ppm, respectively (Wiedenbeck *et al.*, 1995). Replicate analyses of the same domain within a single zircon were used to independently assess the validity of the calibration. Data reduction employed Excel macros developed by Whitehouse at the Swedish Natural History Museum, Stockholm. Age calculations were made using Isoplot version 3.02 (Ludwig, 2003). U–Pb data are plotted as 2σ error ellipses. All age errors quoted in the text are 2σ unless specifically stated otherwise. Common lead corrections were only applied to samples which exhibited significant levels of ^{204}Pb, and where applied are indicated in the data tables. They assume a modern day average terrestrial common Pb composition (Stacey and Kramers, 1975), i.e., ^{207}Pb/^{206}Pb = 0.83. A detailed rationale for choosing present day Pb as a contaminant is given by Zeck and Whitehouse (1999).

LA-MC-ICPMS analytical technique

A c. 12kg sample of Tyrone Central Inlier gneiss (JTP-210) was was crushed and sieved using standard mineral preparation procedures. Heavy minerals were concentrated using a

Wilfley table prior to settling through tetrabromoethane for separation of the heavy mineral concentrate, which was subsequently washed in acetone and dried. Zircons were separated initially by paramagnetic behaviour using a Franz isodynamic separator and then hand-picked from the non-magnetic and least magnetic fractions. The zircon separates were mounted in an araldite resin block and polished prior to laser ablation.

U-Pb zircon analyses were determined by laser ablation multicollector inductively coupled plasma mass spectrometry (LA-MC-ICPMS) at the NERC Isotope Geosciences Laboratory using procedures outlined by Horstwood *et al*. (2003). This included a correction for common-Pb based on the measurement of ^{204}Pb, using an electron multiplier. Analyses used a Nu-Plasma MC-ICPMS system coupled to a New Wave Research solid-state Nd:YAG laser ablation system (UP193SS). A spot size of either 15 or 25 µm was used, depending on zircon size. Dwell time was 60 seconds, the first 15 seconds of which was not used to avoid any elevated common Pb from surface contamination. Pit depth for the acquisition period was approximately 10-12 µm. A ^{205}Tl/^{235}U solution was simultaneously aspirated during analysis, using a Cetac Technologies Aridus desolvating nebulizer, to correct for instrumental mass bias and plasma induced inter-element fractionation. Data were reduced and errors propagated using an in-house spreadsheet calculation package, with ages determined using the Isoplot 3 macro of Ludwig (2003). Between five and ten analyses of the zircon standard 91500 were preformed every hour and used to normalise data. Zircon standards GJ-1 and Mud Tank were run as unknown samples at the start and end of the analytical session to assess overall accuracy and precision. All dates quoted, unless otherwise stated, are ^{207}Pb/^{206}Pb ages. Only data less than 10% discordant are used. Where there was more than one analysis per grain, the mean ^{207}Pb/^{206}Pb age and error was employed.

Sm-Nd analyses

Analyses were performed on a semi-automated single collector VG Micromass 30 mass spectrometer at the Department of Geology, University College Dublin. ^{143}Nd/^{144}Nd ratios, Sm and Nd concentrations were determined using a mixed ^{147}Sm-^{150}Nd spike. ^{143}Nd/^{144}Nd ratios are normalized to ^{146}Nd/^{144}Nd = 0.7219. ^{143}Nd/^{144}Nd errors are within-run precision and reproducibility is approximately ± 0.00002, while reproducibility of ^{147}Sm/^{144}Nd ratios is typically 0.1%. These analytical errors correspond to typical uncertainties in T_{DM} ages of about 40 Ma. T_{DM} ages were calculated using the depleted mantle curve of DePaolo (1981).

Rb-Sr dating

For Rb-Sr analyses, standard ion exchange methods were used for chemical separation of elements. Samples were loaded on tantalum filaments and were analyzed on a semi-automated single collector VG Micromass 30 mass spectrometer at the Department of Geology, University College Dublin. During the course of analysis, NBS SRM 987 gave $^{87}Sr/^{86}Sr$ ratios of 0.71027±5 (n=8, 2σ) and NBS SRM 607 yielded $^{87}Rb/^{86}Sr$ ratios of 8.005±13 (n=7, 2σ). Sr blanks averaged 1.5 ng and are not significant. 2σ analytical uncertainties of 1.5% for $^{87}Rb/^{86}Sr$ and tabulated values (Table 1) for $^{87}Sr/^{86}Sr$ ratios were used in age calculations which employed a value of 0.0142 Ga^{-1} for the ^{87}Rb decay constant (Steiger and Jäger, 1977).

Ar-Ar dating

The muscovite and biotite grains selected for ^{40}Ar–^{39}Ar geochronology were irradiated together with the FCT sanidine standard (28.02 Ma; Renne *et al.*, 1998), for 70 hours in the 1MW, Cd-lined CLICIT facility at the University of Oregon. J values were calculated with a precision of 0.05%. The biotites and monitors were analysed at the ^{40}Ar–^{39}Ar geochronology laboratory at the University of Lund. The lab consists of a Micromass 5400 mass spectrometer with a Faraday detector and an electron multiplier, a metal extraction line, containing two SAES C50-ST101 Zr–Al getters and a cold finger cooled to c. -155 ºC by a Polycold P100 cryogenic refrigeration unit. Single grains of biotite were step-heated using a defocused 50W CO_2 laser rastered over the samples to provide even-heating of the grain. Samples were measured on the electron multiplier and time zero regressions were fitted to data collected from 10 scans over the mass range of 40–36. Peak heights and backgrounds were corrected for mass discrimination, isotopic decay and interfering nucleogenic Ca-, K-, and Cl-derived isotopes. ^{40}Ar blanks were calculated before every new sample and after every three unknown steps. ^{40}Ar blanks were between 4.0 and 2 x 10^{-16} moles. Blank values for masses 39–36 were all less than 7 x 10^{-18} moles. Blank values were subtracted for all incremental steps from the sample signal. Age plateaus were determined using the criteria of Dalrymple & Lanphere (1971), which specify the presence of at least three contiguous incremental heating steps with statistically indistinguishable ages that constitute >50% of the total ^{39}Ar released during the experiment.

Electron microprobe analyses

Quantitative microprobe analyses were carried out at the Institute of Mineralogy and Geochemistry at the University of Lausanne, using a Jeol 8200 superprobe with an accelerating voltage of 15 kV, a beam current of 15 nA for feldspars and hydrous phases and a beam current of 20 nA for garnet. A spot size as low as 1 micron was used for anhydrous phases such as garnet, while for feldspars and anhydrous phases such as amphiboles and micas, a beam size of up to 10 microns was used to prevent the loss of volatile elements such as Na and K Data reduction was carried out using ZAF corrections. A set of natural standards was used for calibration.

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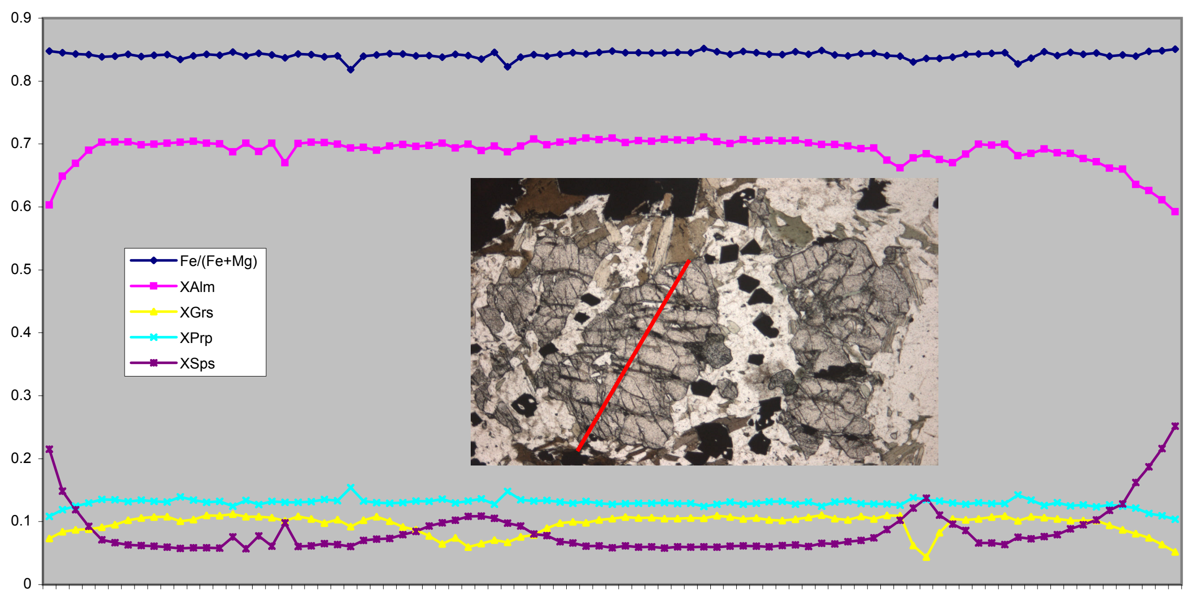
Table 1. *Representative mineral analyses in oxide wt %*

Sample	TCI-8 b49	TCI-8 m39	TCI-8 f152	TCI-8 g638	TCI-8 g651
Position	biotite rim	muscovite rim	plagioclase rim	garnet core	garnet rim
SiO_2	35.60	46.85	61.48	37.05	36.86
TiO_2	2.16	0.07	0.00	0.12	0.04
Al_2O_3	19.12	33.96	24.10	20.38	20.10
Cr_2O_3	0.00	0.00	0.00	0.00	0.00
FeO^*	20.21	3.17	0.05	32.00	26.66
MgO	8.68	0.61	0.00	3.30	2.62
MnO	0.48	0.02	0.00	2.86	11.19
CaO	0.02	0.01	5.62	3.88	1.83
Na_2O	0.06	0.66	8.59	0.00	0.00
K_2O	10.02	11.07	0.10	0.00	0.00
Total	96.35	96.42	99.94	99.59	99.30
Si	2.701	3.121	2.775	2.993	3.010
Al	0.123	0.004	1.224	1.940	1.935
Ti	1.710	2.666	0.000	0.008	0.002
Cr	0.000	0.000	0.000	0.000	0.000
Fe^{2+}	1.282	0.177	0.000	2.162	1.821
Mg	0.982	0.061	0.000	0.397	0.319
Mn	0.031	0.001	0.000	0.196	0.774
Ca	0.002	0.001	0.228	0.000	0.000
Na	0.009	0.085	0.760	0.336	0.160
K	0.970	0.941	0.009	0.004	0.001
$X_{Fe}2+$	0.567	0.743	-	0.845	0.851
			X_{alb} 0.763	X_{alm} 0.700	0.592
			X_{an} 0.228	X_{grs} 0.109	0.052
			X_{Kfs} 0.009	X_{prp} 0.128	0.104
				X_{sps} 0.063	0.252

*Total Fe as FeO. Structural formulae normalized to 12 oxygens for garnet, 11 oxygens for biotite and muscovite, and 8 for plagioclase.



TCI-8 garnet zoning profile

Table 2. *THERMOCALC* * *average P-T results*

Phase	TCI-8
Garnet	
py	0.00150
gr	0.00017
alm	0.18000
spss	0.01500
Muscovite	
mu	0.71000
pa	0.01900
fcel	0.05600
pa	0.44500
Biotite	
phl	0.03600
ann	0.06400
east	0.03600
Plagioclase	
ab	0.39000
an	0.73000
Other	quartz, sillimanite, H_20
Results	
a H_20	1.0
T (ºC)	670
s.d. (T)	113
P (kbar)	6.8
s.d. (P)	1.7
Correlation	0.73
Fit	1.54
No. of reactions	4
Eliminated	mu, fcel, pa

*Average P-T data calculated with THERMOCALC V3.26 using the November 22, 2003 version of the thermodynamic dataset (Holland & Powell, 1998). Activities calculated using the program AX.

Table 3. LA-MC-ICPMS U-Pb zircon data, sample JTP-210 (H71800 81350)

Zircon ID	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	ρ	Age (Ma)						%
								$^{207}Pb/^{206}Pb$	2σ	$^{206}Pb/^{238}U$	2σ	$^{207}Pb/^{235}U$	2σ	discordance
Z1_1	0.07335	2.82	1.75232	3.57	0.17326	2.18	0.611	1023.7	57.1	1030.0	24.3	1028.0	61.6	-0.6
Z1_2	0.07448	0.94	1.81729	2.14	0.17695	1.93	0.899	1054.6	18.9	1050.3	21.9	1051.7	38.8	0.4
Z1_3_S	0.07454	0.55	1.79087	2.39	0.17424	2.33	0.973	1056.2	11.1	1035.4	26.1	1042.1	42.6	2.0
Z1_4	0.07370	1.90	1.80887	2.87	0.17802	2.16	0.751	1033.1	38.3	1056.1	24.7	1048.7	51.4	-2.2
Z1_5	0.07459	0.79	1.80844	2.06	0.17585	1.90	0.923	1057.4	15.9	1044.3	21.5	1048.5	37.1	1.2
Z2_1	0.09245	0.80	3.13257	2.02	0.24576	1.85	0.917	1476.6	15.3	1416.6	29.2	1440.7	62.2	4.1
Z2_2	0.09330	0.84	3.25793	2.11	0.25326	1.93	0.917	1493.9	15.9	1455.3	31.4	1471.1	67.4	2.6
Z2_3	0.09286	0.75	3.30290	2.22	0.25797	2.09	0.941	1485.0	14.3	1479.4	34.7	1481.7	71.9	0.4
Z2_4	0.09271	0.64	3.31404	2.32	0.25925	2.23	0.961	1482.0	12.1	1486.0	37.2	1484.4	75.2	-0.3
Z2_5	0.09224	0.75	3.22662	2.11	0.25371	1.97	0.935	1472.3	14.2	1457.6	32.1	1463.6	66.8	1.0
Z3_1	0.07449	1.18	1.87311	2.78	0.18237	2.51	0.904	1054.8	23.9	1079.9	29.4	1071.6	51.5	-2.4
Z3_2	0.07464	1.51	1.86421	2.87	0.18113	2.44	0.851	1058.9	30.3	1073.2	28.4	1068.5	52.9	-1.3
Z3_3	0.07458	1.61	1.89179	3.04	0.18397	2.58	0.848	1057.2	32.5	1088.6	30.5	1078.2	56.8	-3.0
Z3_4	0.07431	1.25	1.83711	2.68	0.17931	2.37	0.884	1049.8	25.3	1063.2	27.4	1058.8	48.9	-1.3
Z4_1	0.07845	0.98	2.10867	2.61	0.19496	2.42	0.928	1158.2	19.3	1148.2	30.4	1151.6	54.4	0.9
Z4_3	0.07902	2.15	2.08587	3.10	0.19145	2.23	0.719	1172.6	42.6	1129.2	27.4	1144.2	63.6	3.7
Z5	0.18443	0.50	13.06740	2.15	0.51388	2.09	0.972	2693.1	8.3	2673.2	69.0	2684.5	251.7	0.7
Z6	0.09118	0.38	3.20004	2.04	0.25453	2.01	0.983	1450.4	7.2	1461.8	32.9	1457.2	64.4	-0.8
Z7	0.17321	0.65	11.91198	2.17	0.49879	2.07	0.954	2588.9	10.9	2608.6	66.1	2597.5	233.3	-0.8
Z8_1	0.10043	1.02	4.05298	2.69	0.29270	2.50	0.926	1632.0	18.9	1655.0	46.9	1644.9	105.3	-1.4
Z8_2	0.10058	1.43	4.17610	3.02	0.30112	2.66	0.881	1634.9	26.5	1696.9	51.4	1669.3	120.5	-3.8
Z9_1	0.09266	0.64	3.35563	3.09	0.26266	3.02	0.978	1480.9	12.2	1503.5	51.0	1494.1	100.2	-1.5
Z9_2	0.09317	0.57	3.43032	3.74	0.26702	3.70	0.988	1491.4	10.9	1525.6	63.4	1511.4	122.7	-2.3
Z10_1	0.07613	2.18	1.93045	3.65	0.18390	2.92	0.802	1098.5	43.6	1088.3	34.6	1091.7	69.1	0.9
Z10_2	0.07646	1.37	1.89980	2.95	0.18021	2.61	0.885	1107.1	27.5	1068.1	30.3	1081.0	55.4	3.5
Z11	0.07548	3.92	1.95138	4.77	0.18751	2.72	0.569	1081.2	78.7	1107.9	32.8	1098.9	90.4	-2.5
Z12_1	0.07470	1.77	1.90011	2.99	0.18448	2.42	0.807	1060.5	35.6	1091.4	28.7	1081.1	56.2	-2.9
Z12_2	0.07522	2.56	1.90362	3.64	0.18354	2.58	0.710	1074.5	51.4	1086.3	30.5	1082.4	68.0	-1.1
Z13	0.09179	2.75	3.23822	3.65	0.25586	2.41	0.659	1463.1	52.2	1468.6	39.6	1466.4	113.5	-0.4
Z14_1	0.08769	2.08	2.89385	4.55	0.23935	4.04	0.890	1375.6	39.9	1383.3	62.1	1380.3	125.5	-0.6
Z14_2	0.08670	1.30	2.72605	2.55	0.22803	2.19	0.861	1353.9	25.0	1324.2	32.1	1335.6	68.1	2.2
Z14_3	0.08089	1.09	2.34832	2.58	0.21056	2.33	0.905	1218.7	21.5	1231.8	31.6	1227.0	59.6	-1.1
Z15_1	0.08169	2.96	2.34797	3.57	0.20846	1.99	0.557	1238.1	58.1	1220.6	26.6	1226.9	81.6	1.4

Z15_2	0.08082	2.58	2.24091	3.21	0.20111	1.91	0.597	1217.0	50.6	1181.3	24.8	1193.9	70.5	2.9
Z16_2	0.08341	3.74	2.36330	4.82	0.20550	3.04	0.631	1278.7	72.9	1204.8	40.1	1231.6	109.5	5.8
Z17_1	0.11185	0.65	4.91321	2.94	0.31859	2.87	0.975	1829.7	11.8	1782.8	58.6	1804.5	137.0	2.6
Z17_2	0.11252	0.58	5.08026	3.17	0.32744	3.12	0.983	1840.6	10.6	1826.0	65.5	1832.8	151.7	0.8
Z18_1	0.18762	0.46	13.04434	2.33	0.50423	2.28	0.981	2721.4	7.5	2632.0	73.8	2682.9	269.5	3.3
Z18_2	0.18616	0.83	13.23232	3.43	0.51552	3.33	0.970	2708.5	13.7	2680.1	109.6	2696.4	379.9	1.0
Z19_1	0.08140	1.98	2.26152	4.03	0.20150	3.51	0.871	1231.1	38.8	1183.4	45.4	1200.4	88.5	3.9
Z19_2	0.07635	0.95	1.95120	2.52	0.18536	2.33	0.926	1104.2	19.0	1096.2	27.8	1098.9	48.7	0.7
Z20_1	0.09227	1.20	3.21598	3.21	0.25280	2.97	0.927	1472.9	22.8	1452.9	48.3	1461.0	99.7	1.4
Z20_2	0.09272	1.30	3.23719	3.43	0.25322	3.17	0.925	1482.2	24.7	1455.1	51.5	1466.1	106.8	1.8
Z21_1	0.09257	1.23	3.30338	2.39	0.25881	2.04	0.856	1479.1	23.4	1483.8	34.0	1481.9	77.1	-0.3
Z21_2	0.09299	1.16	3.31990	2.43	0.25894	2.13	0.878	1487.6	22.0	1484.4	35.5	1485.7	78.8	0.2
Z22_1	0.08045	2.42	2.23954	3.44	0.20189	2.45	0.712	1208.2	47.6	1185.4	31.8	1193.5	75.4	1.9
Z22_2	0.08083	1.42	2.26128	2.46	0.20289	2.00	0.815	1217.4	28.0	1190.8	26.1	1200.3	54.9	2.2
Z23_1	0.08017	1.30	2.22291	2.32	0.20110	1.92	0.828	1201.2	25.7	1181.2	24.8	1188.3	51.0	1.7
Z24_2	0.07490	3.50	1.88389	4.46	0.18243	2.76	0.619	1065.8	70.4	1080.2	32.4	1075.4	81.9	-1.4
Z25_1	0.07660	1.61	1.98668	2.71	0.18810	2.18	0.804	1110.9	32.2	1111.1	26.3	1111.0	53.2	0.0
Z25_2	0.07782	1.94	2.03587	2.66	0.18975	1.82	0.685	1142.2	38.6	1120.0	22.3	1127.6	53.6	1.9
Z26_1_S	0.18034	0.49	12.57200	2.26	0.50561	2.20	0.976	2656.0	8.2	2637.9	71.4	2648.1	253.8	0.7
Z27_1	0.07851	1.58	2.17117	2.47	0.20057	1.89	0.767	1159.8	31.4	1178.4	24.4	1171.9	53.0	-1.6
Z27_2	0.07952	1.63	2.22062	2.58	0.20254	2.00	0.775	1185.1	32.3	1188.9	26.1	1187.6	56.6	-0.3
Z28_1	0.07900	0.71	2.16761	2.37	0.19900	2.26	0.954	1172.2	14.0	1169.9	28.9	1170.7	50.8	0.2
Z28_2	0.07903	0.53	2.19578	1.96	0.20150	1.89	0.962	1173.0	10.6	1183.4	24.5	1179.7	42.9	-0.9
Z29_1	0.16782	0.85	10.87196	2.40	0.46985	2.25	0.936	2536.0	14.2	2482.9	67.7	2512.2	235.5	2.1
Z30_1	0.17733	0.80	12.75800	2.00	0.52179	1.83	0.916	2628.1	13.3	2706.7	61.4	2661.9	230.7	-3.0
Z31_1	0.23757	0.43	20.47074	2.06	0.62494	2.02	0.979	3103.8	6.8	3129.6	80.9	3113.9	358.0	-0.8
Z31_2	0.23513	0.72	20.12435	1.98	0.62076	1.84	0.930	3087.3	11.6	3112.9	73.1	3097.4	339.9	-0.8
Z31_3	0.23652	0.38	20.28248	2.06	0.62195	2.02	0.982	3096.7	6.1	3117.7	80.6	3104.9	354.4	-0.7
Z32_2	0.07377	2.52	1.89391	3.38	0.18621	2.26	0.667	1035.1	50.9	1100.8	27.0	1079.0	63.0	-6.3
Z33_1	0.13326	0.63	7.15131	2.62	0.38920	2.54	0.970	2141.4	11.1	2119.1	63.4	2130.5	174.1	1.0
Z34_2	0.07274	1.60	1.66934	3.80	0.16644	3.44	0.907	1006.8	32.4	992.5	36.8	996.9	62.4	1.4