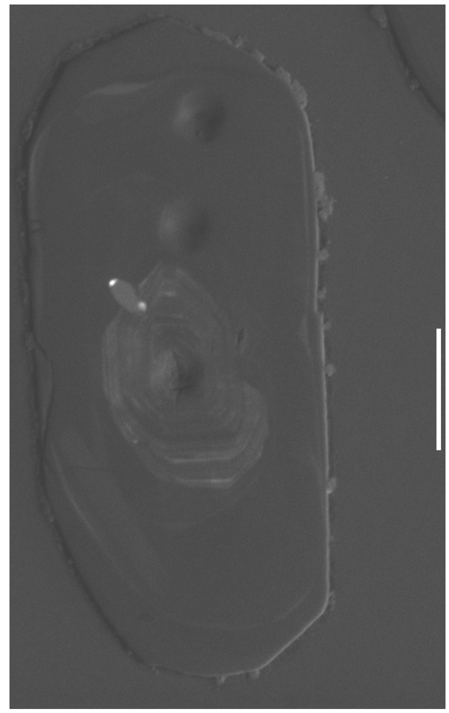
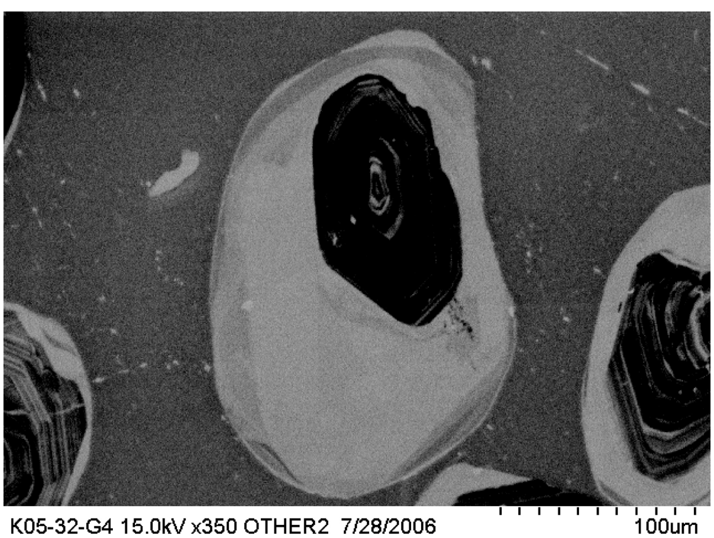
Appendix 1: Methods

A selection of pink detrital grains representing the size range in the sample as well as large brown grains, the largest containing colourless rounded cores, were mounted along with oxygen and U-Pb standard zircons. U-Pb geochronology and trace element analysis were performed with the SHRIMP-RG at the U.S.G.S.-Stanford Ion Probe Laboratory. Age determinations utilized a 5 nA O_2^- primary beam, producing a ~25 μm diameter spot, and were referenced to VP-10, a 1200 Ma in-house zircon age standard from southern California. Subsequent to U-Pb dating, the mounts were re-coated with gold, and trace elements (including Ti) were measured adjacent to the U-Pb spots. Trace element measurement conditions are comparable to those for geochronology, except a smaller diameter spot (15-20 μm) is used and the mass resolution (M/ΔM) is increased from ~8000 to ~10500 (at 10% peak height) to eliminate isobaric interferences (e.g. $^{96}Zr^{2+}$ and $^{48}Ca^{+}$ on $^{48}Ti^{+}$) (Mazdab and Wooden, 2006). Nonetheless, both $^{48}Ti^{+}$ and $^{49}Ti^{+}$ are measured as a check. Trace element concentrations are standardized against the Sri Lankan megacryst zircon CZ3 which was calibrated against a set of synthetic trace element-doped zircons. 1σ precision of the measured Ti concentrations is less than 3%. The mount was re-imaged with SEM-CL to locate SHRIMP-RG pits and then re-polished to a depth sufficient to remove these pits (~2 microns). Oxygen isotope analysis was then performed with the CAMECA ims-1280 ion microprobe at the University of Wisconsin – Madison (Wisc-SIMS) and standardized to the UW KIM-5 zircon standard using measurement protocols described in Kita et al. (2007) and Page et al. (2007). Full data for samples are reported in Supplemental Table 1. Wisc-SIMS spots were placed in the same location as the pre-existing U-Pb spots using both 15 micron and 7 micron spot diameters. U-Pb pits were ground away and repolished before oxygen isotope analysis. Tests show that no residual oxygen remains from the primary O-beam used for age determination. Spot to spot precision (2 s.d.) on standards ranged from ±0.2 to ±0.6‰ (depending inversely on spot size). Grains with detailed transects were imaged by SEM (CL & BSE) following analysis to locate beam pits with respect to the core/rim boundary and to check for cracks or inclusions.

DR2008059





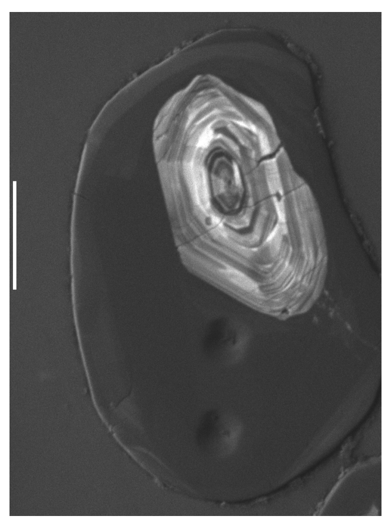


Fig DR1. Moser et al.
Inverted and normal greyscale CL images of Grain 4 (bottom) and Grain 6 illustrating the broadly concentric nature of zoning in the metamorphic rims surrounding detrital magmatic cores . Fig. 3a and 3b are composites of conventional CL images of the cores and inverted CL images of the low CL emission rims. The locations of the dashed core-rim boundaries in Fig. 3 are based upon the core rim boundaries in the inverted images. Note that the CL banding in the rims is broadly concentric to the detrital core, whether the core-rim boundary is parallel to igneous CL zoning, locally truncates this zoning on curved surfaces, or whether the boundary constitutes partly rounded tips and edges of the detrital core.

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Sample No.	δ18Ocorr*	2sd error**	# of multi-spot δ18O analyses***	207/206 age	2sd error	Conc(%)	Pb204corr 207r /206r
Igneous Detrital Cores							
KAP05-32 G 1	5.44	0.29	2	2750	24	4	0.1909
KAP05-32-G3c	6.65	0.54	2	2696	32	-2	.1847
KAP05-32 G4	5.93	0.33	7	2687	26	4	.1838
KAP-1 KO5-32 c 11-1	6.32	0.29		2753	26	9	.1913
KAP-1 KO5-32 c 12-1	6.23	0.19		2672	20	1	.1821
KAP05-32 G13	5.69	0.52	12	2710	22	2	.1863
KAP-1 K05-32 c 14-1	6.54	0.33		2682	24	3	.1831
KAP05-32 G15a	5.83	0.56	3	2674	44	1	.1824
KAP05-32 G15b	5.6	0.23	3	2702	24	5	.1854
KAP05-32 G16a	5.3	0.25	3	2746	32	-3	.1904
KAP05-32 G16b	6.4	0.59	7	2678	30	-1	.1829
KAP-1 K05-32 c 17-1	5.87	0.25		2742	20	7	.1900
KAP-1 K05-32 c18-1	6.64	0.25		2715	34	4	.1869
KAP05-32 G19-1	5.9	0.25		2783	30	0	.1948
KAP05-32 G19-2	6.2	0.25		2690	28	4	.1841
KAP05-32 G19-3	6.1	0.25		2835	52	2	.2011
KAP05-32 G20	6.38	0.29	2	2697	32	2	.1849
KAP-1 KO5-32 c 21-1	5.9	0.29		2692	10	4	.1843
KAP05-32 G22	6.1	0.33	2	2684	28	0	.1834
KAP-1 KO5-32 c 23-1	7.04	0.23		2682	32	0	.1832
KAP05-32 G24	5.96	0.45	5	2711	16	0	.1864
KAP-1 K05-32 c 26-1	6.45	0.25		2706	24	2	.1859
KAP05-32 G27-2	7	0.42	9	2765	28	6	.1927
KAP05-32 G27-4	5.85	0.42	5	2827	16	5	.2001
KAP-1 K05 32 c 28 -1	5.79	0.33		2689	20	-1	.1840
KAP-1 K05-32 c 29-1	5.58	0.25		2708	42	3	.1861
KAP-1 K05-32 mc 31-1	9.14	0.49		2732	14	4	.1889
KAP-1 K05-32 mc 32-1	5.75	0.49		2691	28	-1	.1842
KAP05-32 G32.2R	5.4	0.49		2695	14	5	.1847
KAP-1 K05-32 c 35-1	6.97	0.49		2684	26	2	.1835
KAP-1 K05-32 c 37-1	5.56	0.39		2731	24	4	.1888
KAP-1 K05-32 c 38-1	5.9	0.39		2682	24	-4	.1832
KAP-1 K05-32 mc 39-1	5.76	0.39		2710	22	7	.1863
KAP-1 K05-32 c 41-1	6.78	0.39		2712	16	-1	.1866
KAP05-32 G42	5.74	0.61	7	2698	18	1	.1850
KAP-1 K05-32 c 43-1	5.14	0.39		2736	36	0	.1893
KAP05-32 G44	6.35	0.57	10	2713	30	6	.1867
KAP-1 K05-32 c 45-1	5.74	0.36		2688	46	0	.1838
KAP-1 K05-32 c 46-1	6.86	0.36		2869	136	2	.2053
KAP-1 K05-32 c 47-1	6.25	0.36		2662	26	7	.1810
KAP-1 K05-32 c 50-1	5.97	0.36		2681	26	3	.1830
KAP-1 K05-32 c 51-1	5.49	0.45		2714	16	-4	.1868
KAP-1 K05-32 c 53-1	6.56	0.45		2675	26	0	.1824
KAP-1 K05-32 c 57-1	6.07	0.29		2640	54	2	.1789
KAP-1 K05-32 c 59-1	6.62	0.29		2679	20	2	.1829
KAP-1 K05-32 c 61-1	6.47	0.29		2671	30	1	.1820
KAP-1 K05-32 c 63	9.01	0.28		2671	24	8	.1820
avg.	6.22			2710.9	31.31	2.2	

Metamorphic Rims

Sample No.	δ18Ocorr*	2sd error**	207/206 age	2sd error	Conc(%)

KAP05-32 G2	8.7	0.29		2625	6	2	.1770
KAP05-32 G3	9	0.54	7	2619	20	0	.1755
KAP05-32 G4	8.74	0.19	14	2628	8	-1	.1773
KAP05-32 G5	9.41	0.19	2	2639	8	11	.1784
KAP05-32 G6m	8.8	0.59	18	2622	10	0	.1767
KAP05-32 G6o	9.6	0.43	3	2512	8	0	.1654
KAP05-32 G7	8.38	0.23		2616	10	7	.1760
KAP05-32 G8	8.57	0.23		2630	8	4	.1777
KAP05-32 G9	9.39	0.23	4	2601	8	5	.1744
KAP05-32 G10	10.02	0.33		2594	6	0	.1738
KAP05-32 G15	10.11	0.56	4	2640	4	3	.1786
KAP05-32 G27	10.04	0.45	13	2619	8	3	.1763
KAP05-32 G34	9.27	0.49		2615	10	-1	.1760
KAP05-32 G35	8.7	0.49		2612	10	1	.1756
KAP05-32 G37	10.13	0.39		2631	8	-1	.1776
KAP05-32 G39	9.14	0.39		2620	12	0	.1765
KAP05-32 G42	9.86	0.61	7	2630	8	9	.1775
KAP05-32 G43	9.32	0.39		2623	6	1	.1768
KAP05-32 G46	9.97	0.36		2635	6	1	.1781
KAP05-32 G50	8.54	0.36		2619	10	2	.1763
KAP05-32 G53	9.61	0.45		2620	10	1	.1764
KAP05-32 G56	9.98	0.45		2623	14	5	.1768
KAP05-32 G57	10	0.29		2659	8	5	.1807
KAP05-32 G59	10.18	0.29		2606	10	5	.1750
KAP05032 G61	9.38	0.29		2617	16	0	.1761
KAP05-32 G63	9.93	0.28		2620	8	3	.1764
avg.				2618	9.45	2.5	

Altered cores below

A	δ18Ocorr*	2sd error**		207/206 age	2sd error	F	
KAP05-32-G3	8.6	0.54	2	2668	18	2	.1817
KAP05-32 G6	7.7	0.43	12	2645	12	6	.1792
KAP05-32 G16c	7.4	0.59	3	2606	56	-5	.1751
						2.3	

*Oxygen isotope analyses corrected with respect to measured δ18O values of bracketing standards, and reported in permil rela

** 2 standard deviation errors assigned for single analyses are reproducibility of bracketing standard; those for multiple analys

***δ18O values reported for rims or cores with multi-spot analyses are averages of these analyses

% err	Pb204corr 207r /235	% err	Pb204corr 206r /238	% err	err corr	U (ppm)	Th (ppm)	Th/U
0.7	13.27	1.2	0.5042	1.0	0.810	56	20	0.36
1.0	13.53	1.3	.5312	0.8	.625	209	172	0.82
0.8	12.40	1.2	.4895	0.9	.759	68	49	0.72
0.8	12.65	1.4	.4797	1.2	.821	42	20	0.48
0.6	12.69	1.0	.5054	0.8	.795	80	50	0.62
0.7	13.15	1.1	.5119	0.9	.816	56	14	0.25
0.7	12.59	1.3	.4984	1.0	.817	45	43	0.97
1.4	12.75	2.2	.5071	1.7	.786	29	18	0.62
0.8	12.50	1.2	.4890	1.0	.796	58	36	0.62
1.0	14.44	1.7	.5499	1.4	.823	55	19	0.33
1.2	11.81	1.5	.4684	0.9	.607	69	39	0.57
0.6	12.83	1.0	.4896	0.8	.818	78	43	0.56
1.0	12.89	1.6	.5003	1.3	.778	30	13	0.44
0.9	14.47	1.6	.5389	1.3	.814	31	12	0.39
0.8	12.56	1.2	.4951	0.9	.744	49	14	0.28
1.6	14.96	2.7	.5396	2.2	.805	12	4	0.37
1.0	12.90	1.6	.5060	1.2	.774	33	14	0.42
0.3	12.53	0.7	.4932	0.6	.871	298	244	0.82
0.8	12.99	1.4	.5137	1.2	.819	50	24	0.49
0.9	12.98	1.7	.5140	1.4	.823	36	17	0.47
0.5	13.44	0.8	.5229	0.7	.826	142	71	0.50
0.8	13.09	1.3	.5109	1.0	.803	57	35	0.62
0.8	13.26	1.3	.4991	1.0	.782	65	20	0.30
0.5	14.29	0.9	.5177	0.8	.823	111	51	0.46
0.6	13.20	1.1	.5204	0.9	.809	75	53	0.71
1.3	13.00	1.9	.5064	1.5	.763	30	12	0.40
0.4	13.08	0.8	.5024	0.6	.811	230	130	0.57
0.9	13.38	1.5	.5268	1.2	.824	60	67	1.12
0.4	12.43	0.6	.4881	0.5	.794	287	238	0.83
0.8	12.82	1.2	.5069	0.9	.762	107	46	0.43
0.7	13.12	1.3	.5041	1.0	.806	90	58	0.65
0.7	13.62	1.4	.5390	1.2	.855	70	45	0.64
0.6	12.40	1.1	.4828	0.8	.793	124	63	0.51
0.5	13.61	0.7	.5290	0.6	.784	264	135	0.51
0.5	13.07	0.9	.5123	0.7	.815	165	119	0.72
1.1	13.79	2.0	.5285	1.7	.830	33	20	0.60
0.9	12.50	1.5	.4857	1.2	.811	58	49	0.84
1.4	13.12	1.8	.5176	1.0	.590	82	40	0.48
4.2	15.52	6.1	.5483	4.5	.730	72	90	1.25
0.8	11.82	1.3	.4737	1.0	.798	63	21	0.33
0.8	12.52	1.3	.4962	1.1	.812	58	21	0.37
0.5	14.17	0.8	.5501	0.7	.803	170	63	0.37
0.8	12.97	1.3	.5154	1.1	.814	53	32	0.61
1.6	12.20	2.0	.4944	1.1	.570	55	23	0.42
0.6	12.68	1.1	.5026	0.8	.800	95	176	1.86
0.9	12.67	1.6	.5047	1.2	.801	47	34	0.72
0.7	11.78	1.1	.4697	0.9	.767	100	33	0.33
						104	56	0.54

0.2	11.85	0.4	.4858	0.3	.838	**633**	**57**	0.09
0.2	12.15	0.4	.5019	0.3	.808	**490**	**46**	0.09
0.2	12.43	0.4	.5084	0.3	.814	**496**	**52**	0.11
0.2	10.94	0.6	.4448	0.5	.918	**604**	**67**	0.11
0.3	12.30	0.4	.5048	0.3	.685	**595**	**54**	0.09
0.2	10.82	0.4	.4746	0.3	.794	**558**	**16**	0.03
0.3	11.16	0.5	.4598	0.4	.755	**466**	**47**	0.10
0.2	12.01	0.4	.4902	0.3	.798	**461**	**41**	0.09
0.2	11.24	0.4	.4675	0.3	.751	**666**	**24**	0.04
0.2	11.91	0.3	.4970	0.3	.805	**805**	**24**	0.03
0.1	11.97	0.3	.4859	0.2	.806	**1460**	**32**	0.02
0.2	11.81	0.4	.4857	0.3	.803	**721**	**16**	0.02
0.3	12.33	0.5	.5080	0.4	.813	**448**	**38**	0.09
0.3	11.95	0.5	.4937	0.4	.813	**609**	**51**	0.08
0.3	12.46	0.4	.5087	0.3	.780	**800**	**15**	0.02
0.4	12.15	0.6	.4994	0.4	.741	**516**	**49**	0.09
0.2	11.05	0.3	.4517	0.2	.731	**1538**	**67**	0.04
0.2	12.06	0.3	.4946	0.2	.712	**2678**	**27**	0.01
0.2	12.19	0.3	.4965	0.2	.808	**1165**	**14**	0.01
0.3	11.90	0.5	.4896	0.4	.809	**489**	**39**	0.08
0.3	12.05	0.4	.4954	0.3	.721	**751**	**12**	0.02
0.4	11.59	0.6	.4757	0.4	.639	**506**	**15**	0.03
0.3	11.97	0.4	.4803	0.3	.779	**640**	**16**	0.02
0.3	11.30	0.5	.4684	0.4	.799	**647**	**16**	0.02
0.5	12.22	0.6	.5034	0.3	.546	**613**	**74**	0.12
0.3	11.75	0.4	.4829	0.4	.805	**544**	**45**	0.08
						765	37	0.05
0.6	12.49	0.7	.4988	0.5	.658	**209**	**172**	0.82
0.4	11.60	0.6	.4694	0.4	.757	**315**	**206**	0.65
1.7	12.84	2.1	.5317	1.3	.608	**54**	**10**	0.19

ative to VSMOW.
ses are the largest 2 standard deviation error of multiple analyses.

Temp @ Ti act.=.7

690
703
714

698
679

675
683
710
693
721
671
688
709

707

707-682
706-662
682
740
600
705-666
678
687
684

703-694
739
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Detailed oxygen isotope data for KAP05-32 Grain 4

Sample*	δ^{18}O_corr**	2S error***	Beam size	Run No.
KAP-1 KO5-32 c 4-1	7.00	0.19	15 µm	20060726-81
KAP-1 KO5-32 c 4-2	5.48	0.19	15 µm	20060726-82
KAP-1 KO5-32 r 4-3	8.66	0.19	15 µm	20060726-83
KAP-1 KO5-32 r 4-4	8.51	0.19	15 µm	20060726-84
KAP-1 KO5-32 r 4-5	8.91	0.19	15 µm	20060726-85
KAP-1 KO5-32 r 4-6	8.85	0.19	15 µm	20060726-86
KAP-1 K05-32 c 4-7	5.60	0.33	7 µm	20060726-544
KAP-1 K05-32 c 4-8	6.08	0.33	7 µm	20060726-545
KAP-1 K05-32 c 4-9	6.23	0.33	7 µm	20060726-546
KAP-1 K05-32 c 4-10	5.43	0.33	7 µm	20060726-547
KAP-1 K05-32 c 4-11	5.71	0.33	7 µm	20060726-548
KAP-1 K05-32 mix 4-12	6.93	0.33	7 µm	20060726-549
KAP-1 K05-32 r 4-13	8.65	0.33	7 µm	20060726-550
KAP-1 K05-32 r 4-14	8.30	0.28	7 µm	20060726-555
KAP-1 K05-32 r 4-15	8.51	0.28	7 µm	20060726-556
KAP-1 K05-32 r 4-16	8.33	0.28	7 µm	20060726-557
KAP-1 K05-32 r 4-17	9.25	0.28	7 µm	20060726-558
KAP-1 K05-32 mix 4-18	6.90	0.28	7 µm	20060726-559
KAP-1 K05-32 r 4-19	9.44	0.28	7 µm	20060726-560
KAP-1 K05-32 r 4-20	8.54	0.28	7 µm	20060726-561
KAP-1 K05-32 r 4-21	8.85	0.28	7 µm	20060726-562
KAP-1 K05-32 r 4-22	8.75	0.28	7 µm	20060726-563
KAP-1 K05-32 r 4-23	8.75	0.28	7 µm	20060726-564

Detailed oxygen isotope data for KAP05-32 Grain 6

Sample*	δ^{18}O_corr**	2S error***		Run No.
KAP-1 KO5-32 c 6-1	9.04	0.19	15 µm	20060726-91
KAP-1 K05-32 c 6-2	7.01	0.33	15 µm	20060726-96
KAP-1 K05-32 r 6-3	10.11	0.33	15 µm	20060726-97
KAP-1 K05-32 r 6-4	10.06	0.33	15 µm	20060726-98
KAP-1 K05-32 r 6-5	9.73	0.33	15 µm	20060726-99
KAP-1 K05-32 c 6-6	8.62	0.33	15 µm	20060726-100
KAP-1 K05-32 c 6-7	6.25	0.33	15 µm	20060726-101
KAP-1 K05-32 c 6-8	8.16	0.33	15 µm	20060726-102
KAP-1 K05 32 c 6-9	9.10	0.71	7 µm	20060726-427
KAP-1 K05 32 c 6-10	8.82	0.71	7 µm	20060726-428
KAP-1 K05 32 c 6-11	6.90	0.71	7 µm	20060726-429
KAP-1 K05 32 r 6-12	9.49	0.43	7 µm	20060726-496
KAP-1 K05 32 r 6-13	9.34	0.43	7 µm	20060726-497
KAP-1 K05 32 r 6-14	8.23	0.43	7 µm	20060726-498
KAP-1 K05 32 r 6-15	9.99	0.43	7 µm	20060726-499
KAP-1 K05 32 mix 6-16	8.01	0.43	7 µm	20060726-500
KAP-1 K05 32 c 6-17	7.15	0.43	7 µm	20060726-501
KAP-1 K05 32 c 6-18	6.62	0.43	7 µm	20060726-502
KAP-1 K05 32 c 6-19	7.84	0.43	7 µm	20060726-503

KAP-1	K05 32 c 6-20	6.95	0.43	7 µm	20060726-504
KAP-1	K05 32 mix 6-21	8.00	0.43	7 µm	20060726-505
KAP-1	K05-32 r 6-22	9.05	0.59	7 µm	20060726-511
KAP-1	K05-32 r 6-23	9.14	0.59	7 µm	20060726-512
KAP-1	K05-32 r 6-24	9.49	0.59	7 µm	20060726-513
KAP-1	K05-32 r 6-25	10.59	0.59	7 µm	20060726-514
KAP-1	K05-32 r 6-26	9.47	0.59	7 µm	20060726-515
KAP-1	K05-32 r 6-27	8.35	0.59	7 µm	20060726-516
KAP-1	K05-32 r 6-28	8.21	0.59	7 µm	20060726-517
KAP-1	K05-32 r 6-29	8.34	0.59	7 µm	20060726-518
KAP-1	K05-32 r 6-30	9.03	0.59	7 µm	20060726-519
KAP-1	K05-32 r 6-31	9.92	0.59	7 µm	20060726-520
KAP-1	K05-32 r 6-32	9.25	0.54	7 µm	20060726-526
KAP-1	K05-32 r 6-33	9.73	0.54	7 µm	20060726-527
KAP-1	K05-32 mix 6-34	8.24	0.54	7 µm	20060726-528
KAP-1	K05-32 r 6-35	8.74	0.54	7 µm	20060726-529
KAP-1	K05-32 r 6-36	9.04	0.54	7 µm	20060726-530

*Zircon domains analyzed: c = core; r = rim; mix= beam spot overlaps core-rim boundary

Oxygen isotope data (laser fluorination), garnet, sample K05-32

paragneiss matrix	9.83
paragneiss matrix	9.76
leucosome	9.22
leucosome	9.13

**Oxygen isotope analyses corrected with respect to measured $\delta^{18}O$ values of bracketing standards, and reported in permil relative to VSMOW.

*** 2 standard deviation errors assigned for single analyses are reproducibility of bracketing standard; those for multiple analyses are the largest 2 standard deviation error of multiple analyses.