DATA REPOSITORY 2010254

DESCRIPTION OF SAMPLE R623

This xenolith was found in rhyolite at the Taupo Rubbish Tip (NZMS 260 grid reference U18/818751, Figure 1). The sample has been catalogued in the GNS Science Petrology Collection as P76162 and all analytical details, and images can be found at <http://pet.gns.cri.nz>.

The xenolith consists of three distinct rock types, in order of decreasing volume: paragneiss host rock, granite veins and vesicular buchite. Most of the xenolith is a fine grained (0.1-0.2 mm) banded gneiss (Figure DR1(a)) made up of biotite (45%), plagioclase (andesine, 40 %), quartz (10 %,) and ilmenite (5 %) (approximate average proportions from point counting). Trace amounts of apatite and zircon are present. Banding in the gneiss is the result of changes in the modal percentages, particularly of biotite, and implies a metasedimentary (paragneiss) protolith. Despite the high mica content, granofelsic textures predominate, and only one anastomosing foliation is readily apparent. Common metamorphic index minerals, such as garnet and Al_2SiO_5 polymorphs, are absent. The presence of andesine and ilmenite (and absence of albite and titanite) indicate an amphibolite facies assemblage.

The gneiss is cut by ptygmatically folded, 1-10 mm wide granite veins that make up about 5% of the xenolith (Figure DR1(b)). Prior to examination of a feldspar-stained thin section, these were mistaken for synmetamorphic quartz veins, as feldspar twinning is virtually absent. The grain size of the veins is distinctly coarser (0.2 - 0.5 mm) than the gneiss, and K-feldspar is present. The mineralogy of the granite is plagioclase (albite-oligoclase) 30%, K-feldspar 35%, quartz 30%, and biotite 5%. The gneiss foliation is axial planar to the folded veins (Figure DR1(c)),

hence granite injection occurred prior to or during penetrative deformation and high grade metamorphism of the gneiss. Within and along the edges of the granite veins are <1 mm wide veins of vesicular glass containing acicular mullite (Figure DR1(d)). The freshness of the glass, and its restriction to the granitic veins indicate an origin as a minimum melting of the granite, probably as a result of immersion of the xenolith in the enclosing rhyolite. The melt was chilled on eruption.

WHOLE ROCK COMPOSITION OF SAMPLE R623

Five whole rock X-ray fluorescence analyses of different parts of the xenolith show a restricted compositional range. As with the zircon ages described above, major and trace element concentrations and ratios match those expected for Cretaceous greywacke-argillite suites (Pahau Terrane). The analysis of the most psammitic part of the xenolith (black square in Figure DR2) falls in the field of quartzofeldpathic Pahau, it is likely that the other four analyses were of more argillaceous parts of the xenolith and fall on a quartzofeldspathic grain size trend. In terms of age-uncorrected Sr, Nd and Pb isotope ratios (e.g. Figure DR2(c)), the analyses fall on trajectories consistent with New Zealand Eastern Province (including Torlesse) protoliths; these reference datasets comprise only pre-Cretaceous metasedimentary suites so detailed comparisons cannot be made. The petrochemical data support the correlation with quartzofeldpathic Pahau Terrane, but the zircon data are definitive.

SHRIMP-RG ANALYTICAL TECHNIQUES

Age determinations on zircons were made by conventional SIMS U-Pb analyses using the U.S. Geological Survey – Stanford University SHRIMP-RG joint facility, with techniques used being

similar to those of Williams (1998). Zircons were mounted in epoxy resin, polished to expose the cores of the grains, photographed in reflected light, and imaged by cathodoluminescence. The mount was first rinsed in dilute EDTA, then acid rinsed in 1 N HCl acid for 5 minutes prior to gold coating. Prior to data acquisition, the primary beam was rastered for 240 s on a 150 μm^2 area. Secondary ions were sputtered from zircons with a 5 to 6 nA primary O_2^- beam focused to a 20 x 15 μm spot. The mass spectrometer was cycled eight times through peaks corresponding to $^{90}Zr_2{}^{16}O$, ^{204}Pb, background, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{238}U, $^{232}Th^{16}O$ and $^{238}U^{16}O$. Grains that returned Quaternary ages were corrected for initial ^{230}Th disequilibrium using the measured Th and U concentrations for each zircon analysis (relative to the concentration standard, MAD; a 555 Ma gem-quality zircon from Madagascar with U = 4196 ppm and Th = 1166 ppm: F.K. Mazdab, *pers comm*), and a whole rock Th/U value of 4.4. A correction factor was applied using $f=(Th/U_{zir})/(Th/U_{magma})$ (Schärer, 1984). The age corrections resulting from initial Th-U disequilibrium ranged from +62 to +95 ka.

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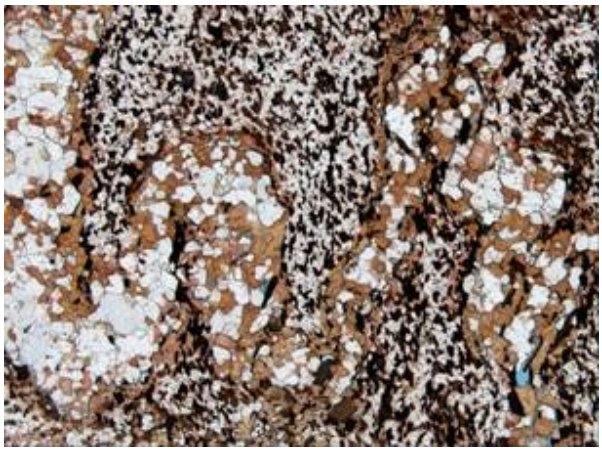
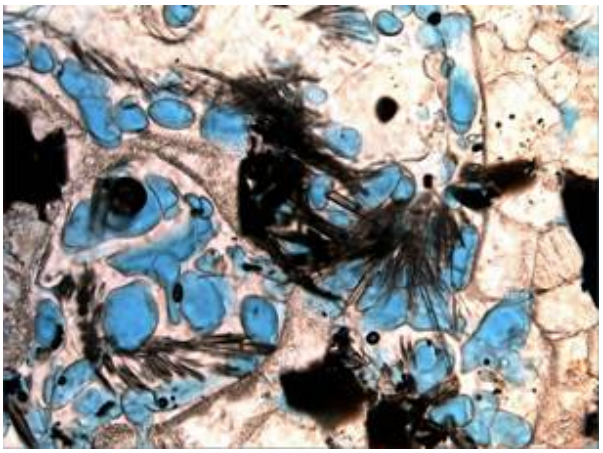
(a)

(b)



(c)



(d)

Figure DR1: (a) Hand specimen of xenolith P76162: banded biotite paragneiss cut by ptygmatically folded granite veins. Some of the enclosing host rhyolite is visible at the top of sample. (b)-(d). Plane polarised light microscope images of R623. (b) Weakly foliated biotite gneiss (field of view 6 mm wide). (c) Ptygmatically folded granite veins, with folds axial planar to foliation (feldspar stained section, field of view 6 mm wide). (d) Mullite crystals in vesicular glass; granite vein is on right (impregnated section, field of view 0.7 mm wide).

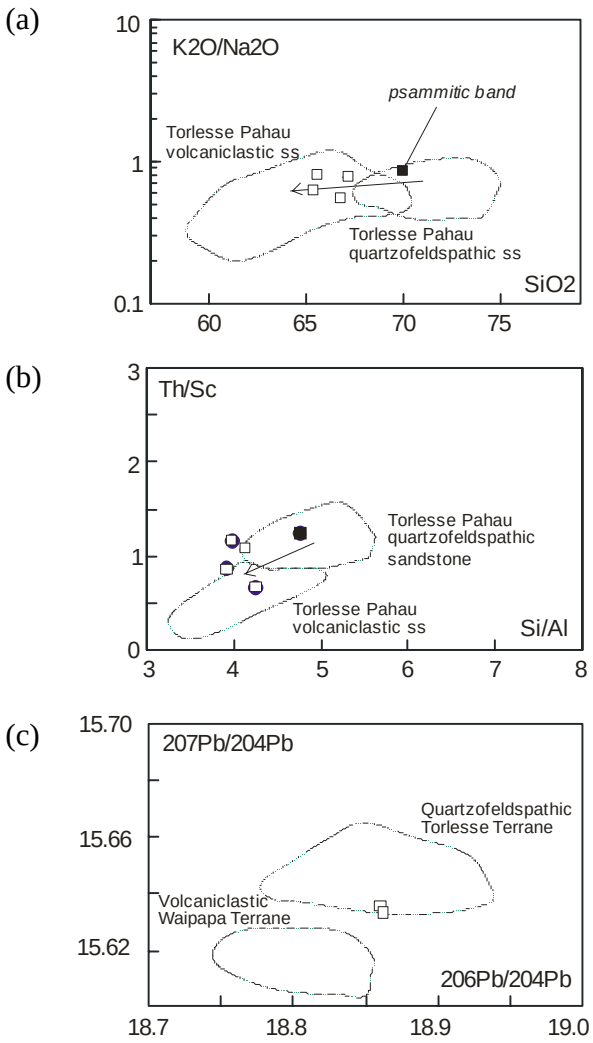


Figure DR2. Whole rock composition of R623 gneiss is compatible with Cretaceous Pahau terrane (Torlesse composite terrane) metasediments. (a) SiO_2 vs K_2O/Na_2O diagram (Roser and Korsch, 1986; Mortimer, 1994). (b) Si/Al vs Th/Sc diagram (Roser and Korsch, 1999; Mortimer, 1994). (c) Sample R623 plotted on an uncorrected Pb isotope plot (after Graham et al., 1992). Arrows show general compositional trends from quartzofeldspathic sandstones to mudstones (which overlap volcaniclastic sandstone compositions).

TABLE DR1. Whole rock X-ray fluorescence and isotopic analyses of xenolith P76162. Open U = Open University: majors and traces from Sutton (1995); isotopes from Charlier, (unpub. data), SCA = Spectrachem Analytical, Wellington. 76162PS is psammitic gneiss band.

Lab number	R623	R623A	R623B	R623C	76162PS
Laboratory	Open U	Open U	Open U	Open U	SCA
SiO_2 (wt %)	66.85	67.07	65.62	65.40	69.16
TiO_2	0.68	0.70	0.77	0.74	0.62
Al_2O_3	16.29	15.80	16.46	16.67	14.55
Fe_2O_3T	4.86	4.93	5.22	5.27	4.36
MnO	0.07	0.07	0.08	0.08	0.06
MgO	1.66	1.71	1.75	1.81	1.45
CaO	3.17	2.57	2.69	3.08	2.30
Na_2O	4.05	3.93	4.02	4.14	3.29
K_2O	2.21	3.07	3.22	2.63	2.86
P_2O_5	0.17	0.16	0.18	0.19	0.11
LOI	0.48	1.00	0.69	0.72	0.51
Majors total	100.49	101.01	100.70	100.73	99.27
Ba (ppm)	418	683	669	478	634
Cr	36	39	40	40	29
Ga	18	17	17	19	15
Ni	10	12	11	13	7
Pb	18	19	19	17	25
Rb	96	112	117	110	96
Sc	12	15	12	15	8
Sr	327	308	320	322	288
Th	13	10	14	13	10
U	3	4	4	3	<2
V	100	101	105	111	85
Y	22	21	23	23	17
Zn	71	76	78	78	65
Zr	204	197	224	195	208
$^{87}Sr/^{86}Sr$	0.70738	0.70728	-	-	-
$^{143}Nd/^{144}Nd$	0.512541	-	-	-	-
$^{206}Pb/^{204}Pb$	18.860	-	18.861	-	-
$^{207}Pb/^{204}Pb$	15.635	-	15.634	-	-
$^{208}Pb/^{204}Pb$	38.809	-	38.808	-	-

DATA REPOSITORY TABLE 2: U-Pb AGES FOR SAMPLE R623

Spot Name	ppm U	ppm Th	% comm 206	$^{206}Pb/^{238}U$	% error	^{207}Pb corr $^{206}Pb/^{238}U$ Age	1 sigma error
R623-78	240	260	0.5	.018	2.2	112.8	2.4
R623-46	760	900	0.1	.018	2.0	113.3	2.3
R623-81	310	320	0.0	.018	2.0	113.7	2.3
R623-9	330	310	0.7	.018	1.2	114.2	1.4
R623-44	390	200	0.0	.018	2.0	114.7	2.3
R623-109	500	230	0.2	.018	1.9	115.0	2.2
R623-76	240	160	2.0	.018	2.2	115.8	2.5
R623-20	560	450	1.8	.019	1.1	116.1	1.3
R623-7	260	230	0.4	.018	1.3	116.1	1.5
R623-112	280	230	0.2	.018	2.0	116.6	2.3
R623-5	250	230	4.1	.019	1.3	116.8	1.6
R623-1	420	390	0.0	.019	1.1	117.8	1.3
R623-62	160	110	0.0	.018	2.3	117.9	2.7
R623-50	580	760	0.1	.019	2.0	118.3	2.4
R623-10	640	510	0.3	.019	1.1	118.5	1.3
R623-91	570	530	0.3	.019	1.9	118.6	2.2
R623-27	190	180	0.0	.019	1.4	118.7	1.7
R623-97	300	270	0.0	.019	2.0	118.9	2.4
R623-69	260	190	0.3	.019	2.1	119.0	2.5
R623-101	260	260	0.0	.019	2.0	119.2	2.4
R623-75	350	180	0.6	.019	2.1	119.2	2.5
R623-53	220	190	0.0	.019	2.2	119.4	2.6
R623-86	190	140	0.4	.019	2.1	119.5	2.5
R623-60	110	90	1.4	.019	2.5	119.7	3.0
R623-82	570	320	0.2	.019	1.8	119.7	2.2
R623-35	240	150	0.0	.019	1.3	119.8	1.5
R623-84	100	90	1.8	.019	2.7	120.2	3.3
R623-106	210	160	0.7	.019	2.1	120.3	2.6
R623-15	190	150	0.4	.019	1.4	120.7	1.7
R623-8	180	170	0.4	.019	1.4	120.9	1.8
R623-39	1030	1310	0.2	.019	1.0	120.9	1.2
R623-22	410	360	-0.3	.019	1.1	121.1	1.4
R623-37	390	290	0.3	.019	1.1	121.3	1.4
R623-38	160	150	0.0	.019	1.5	121.3	1.8
R623-121	300	290	0.0	.019	2.0	121.6	2.4
R623-85	170	130	1.2	.019	2.2	121.6	2.7
R623-57	90	90	0.7	.019	2.5	121.6	3.0
R623-29	190	180	-1.6	.019	1.4	122.0	1.8
R623-71	140	150	0.4	.019	2.2	122.1	2.7
R623-28	140	100	1.3	.019	1.5	122.1	1.9
R623-111	220	190	-0.4	.019	2.2	122.1	2.7
R623-58	70	50	1.2	.019	2.6	122.2	3.1
R623-88	670	550	2.6	.020	1.8	122.3	2.2
R623-63	750	1230	0.0	.019	2.0	122.6	2.4

DATA REPOSITORY TABLE 2: U-Pb AGES FOR SAMPLE R623 (*continued*)

			%			^{207}Pb corr	

Spot Name	ppm U	ppm Th	comm 206	$^{206}Pb/^{238}U$	% error	$^{206}Pb/^{238}U$ Age	1 sigma error
R623-25	200	130	0.7	.019	1.4	122.6	1.7
R623-95	340	350	0.4	.011	1.9	122.7	2.4
R623-117	120	110	7.9	.022	2.4	122.7	3.5
R623-30	170	170	0.0	.019	1.5	122.7	1.8
R623-93	750	660	0.0	.019	1.8	122.8	2.2
R623-100	110	70	-1.1	.019	2.5	122.9	3.1
R623-64	180	180	1.6	.020	2.2	123.0	2.7
R623-80	300	270	0.0	.019	2.0	123.0	2.5
R623-90	125	98	-1.5	.019	2.4	123.2	3.0
R623-67	6400	6500	0.0	.019	1.9	123.6	2.4
R623-39	170	210	0.4	.020	1.4	124.3	1.8
R623-98	60	30	1.6	.020	3.1	124.5	3.9
R623-49	100	70	0.0	.020	2.5	124.8	3.2
R623-116	790	930	0.0	.020	1.8	124.8	2.2
R623-65	480	360	0.2	.020	2.0	125.1	2.5
R623-70	320	250	0.2	.020	2.1	126.1	2.6
R623-102	290	70	0.0	.020	2.0	126.7	2.5
R623-26	160	190	1.0	.020	1.4	126.9	1.8
R623-12	260	303	5.0	.022	1.2	128.3	1.9
R623-59	260	170	0.5	.020	2.1	129.3	2.7
R623-45	130	110	-0.8	.020	2.4	130.2	3.1
R623-52	2100	4500	0.6	.021	2.0	130.5	2.5
R623-40	120	120	0.8	.021	1.6	130.6	2.1
R623-48	240	200	0.5	.021	2.1	130.6	2.8
R623-68	660	680	0.2	.021	2.0	130.9	2.6
R623-108	80	50	-1.4	.021	2.7	131.7	3.6
R623-113	520	490	0.1	.021	1.8	132.1	2.4
R623-96	250	160	0.6	.021	2.0	132.6	2.7
R623-16	860	1180	0.4	.021	1.0	136.2	1.3
R623-118	340	250	0.0	.022	1.9	136.7	2.6
R623-33	1210	1770	0.1	.022	0.9	137.1	1.3
R623-23-1	1850	1740	0.1	.022	0.9	137.5	1.3
R623-23-2	1250	1400	0.2	.022	0.9	138.7	1.3
R623-79	380	250	0.2	.022	1.9	139.0	2.6
R623-110	1560	1660	-0.1	.023	1.7	146.2	2.5
R623-83	150	210	0.7	.024	2.2	151.0	3.3
R623-4	130	100	1.3	.025	1.4	157.0	2.2
R623-115	640	1000	-0.3	.025	1.8	157.8	2.8
R623-29	330	290	0.7	.026	1.1	164.4	1.9
R623-104	80	60	1.4	.026	2.5	164.5	4.1
R623-41	130	110	0.0	.028	1.5	173.7	2.6
R623-94	330	230	0.5	.027	1.8	174.0	3.2
R623-36	880	780	0.2	.028	0.9	175.9	1.7
R623-43	2700	3200	0.4	.028	0.9	176.4	1.6

DATA REPOSITORY TABLE 2: U-Pb AGES FOR SAMPLE R623 (*continued*)

Spot Name	ppm U	ppm Th	% comm 206	$^{206}Pb/^{238}U$	% error	^{207}Pb corr $^{206}Pb/^{238}U$ Age	1 sigma error
R623-99	140	90	0.00	.028	2.1	179.2	3.8
R623-61	160	100	-1.1	.028	2.2	179.7	3.9
R623-51	1860	1730	0.1	.028	2.0	180.1	3.5
R623-66	430	350	0.1	.029	2.0	184.8	3.7
R623-18	270	200	0.0	.030	1.2	188.8	2.2
R623-55	50	40	1.0	.033	2.6	207.5	5.3
R623-77	250	210	0.0	.034	2.1	218.2	4.5
R623-31	170	100	0.4	.039	1.3	245.1	3.1
R623-119	200	100	0.0	.039	1.9	247.4	4.7
R623-92	440	220	0.1	.040	1.8	251.5	4.4
R623-105	120	80	0.3	.040	2.1	251.9	5.2
R623-47	680	680	0.1	.040	2.0	255.9	5.0
R623-14	250	160	0.0	.042	1.1	262.4	3.0
R623-72	570	170	7.0	.053	2.0	307.6	6.7
R623-73	830	330	0.1	.049	2.0	308.3	6.0
R623-13	190	160	0.0	.054	1.2	337.5	4.0
R623-89	200	130	0.0	.055	1.9	344.4	6.4
R623-74	300	240	0.0	.055	2.0	347.1	6.9
R623-42	210	120	0.0	.056	1.2	348.0	4.1
R623-54	390	110	-0.1	.056	2.0	348.2	6.9
R623-6	540	250	0.2	.057	1.0	358.0	3.4
R623-19	800	330	0.0	.057	0.9	359.1	3.3
R623-87	560	650	-0.1	.058	1.7	359.5	6.1
R623-103	240	180	0.1	.058	1.8	362.7	6.5
R623-24	670	300	0.1	.059	0.9	367.5	3.4
R623-114	690	550	0.0	.059	1.7	368.0	6.2
R623-107	80	40	0.0	.060	2.1	376.8	7.9
R623-120	590	330	-0.1	.061	1.7	380.0	6.4
R623-17	330	180	0.2	.084	1.0	522.4	5.1
R623-34	360	170	0.1	.085	1.0	526.9	5.1
R623-11	420	170	0.1	.096	1.0	588.4	5.7
R623-56	100	33	0.0	.149	2.1	889	18
R623-21	820	590	0.0	.281	0.9	1568	15
R623-3	1080	40	0.0	.296	0.9	1659	15

DATA REPOSITORY TABLE 3: U-Pb AGES FOR SAMPLE P1106 (UNIT OMEGA)

Spot Name	ppm U	ppm Th	% comm 206	$^{206}Pb/^{238}U$	% error	^{207}Pb corr $^{206}Pb/^{238}U$ Age	1 sigma error
Omega-36	2100	1700	14	2.38E-05	10.8	0.21	0.02
P1106-11	580	340	14	4.84E-05	14.0	0.24	0.05
Omega-10	700	680	38	4.95E-05	13.9	0.27	0.05
P1106-14	570	710	30	8.22E-05	16.6	0.27	0.07
Omega-42	1220	1540	74	1.21E-04	6.6	0.28	0.09
P1106-5.r	770	970	30	3.37E-04	5.0	0.32	0.16
Omega-26	1820	2800	12	4.63E-05	8.9	0.33	0.03
Omega-19	980	930	31	5.84E-05	11.3	0.34	0.04
Omega-1	1570	1920	54	8.84E-05	7.6	0.34	0.05
P1106-15-4.r	250	110	11	7.31E-05	17.3	0.34	0.10
Omega-50.r	260	140	34	6.17E-05	20.5	0.36	0.09
P1106-10	400	220	13	7.30E-05	19.4	0.37	0.08
Omega-20	4000	7400	31	7.89E-05	5.3	0.41	0.03
Omega-9	1700	2800	11	6.38E-05	8.2	0.43	0.03
Omega-49	1460	1740	19	7.05E-05	8.0	0.45	0.04
P1106-15-5	1400	1700	29	6.32E-05	8.3	0.45	0.03
P1106-9	550	510	23	9.82E-05	10.1	0.46	0.07
P1106-13.r	1900	2300	30	8.36E-05	5.7	0.47	0.03
Omega-24	430	540	48	1.21E-04	10.2	0.48	0.09
Omega-51	3000	3200	69	2.12E-04	3.3	0.51	0.06
P1106-6	250	150	14	1.13E-04	13.7	0.51	0.11
Omega-4	320	260	33	1.19E-04	13.4	0.60	0.11
Omega-46	3300	1800	8.4	1.10E-04	4.4	0.74	0.03
P1106-2	350	230	0.0	0.017	1.9	108.2	2.1
P1106-15-4.c	300	140	0.5	0.018	2.0	111.0	2.2
Omega-13	1270	680	0.1	0.018	0.6	112.6	0.7
Omega-37	350	300	0.0	0.027	1.0	170.9	1.8
Omega-69	370	340	0.9	0.028	1.0	177.3	1.8
Omega-22	1420	1280	0.4	0.028	0.5	180.3	1.0
Omega-33	180	260	0.5	0.029	1.4	182.9	2.6
Omega-59	150	90	0.2	0.030	1.5	188.0	2.9
Omega-11	670	900	-0.1	0.030	0.8	188.5	1.5
Omega-53	930	220	0.0	0.031	0.6	195.2	1.2
Omega-43	650	1130	0.6	0.031	0.7	196.1	1.5
Omega-25	180	470	0.3	0.031	1.5	197.4	2.9
Omega-8	150	300	0.3	0.033	1.5	207.4	3.2
Omega-44	570	600	0.0	0.033	0.8	209.2	1.6
Omega-27	220	200	-0.3	0.033	1.4	211.7	2.9
Omega-21	600	730	-0.1	0.033	0.8	212.1	1.7
Omega-12	810	490	0.3	0.034	0.7	215.7	1.4
Omega-34	1560	720	0.1	0.034	0.5	216.3	1.0
Omega-65	680	710	0.1	0.036	0.7	226.3	1.6
Omega-77	480	180	0.3	0.036	0.8	229.8	1.8
Omega-64	450	490	0.3	0.037	0.8	234.7	1.9

DATA REPOSITORY TABLE 3: U-Pb AGES FOR SAMPLE P1106 (continued)

Spot Name	ppm U	ppm Th	% comm 206	$^{206}Pb/^{238}U$	% error	^{207}Pb corr $^{206}Pb/^{238}U$ Age	1 sigma error
Omega-6	540	490	-0.1	0.038	0.8	239.2	1.9
Omega-52	420	380	0.3	0.038	0.9	241.7	2.1
Omega-58	320	460	0.4	0.038	0.9	242.2	2.3
Omega-5.c	180	100	0.1	0.039	1.4	245.7	3.4
Omega-50	730	840	0.8	0.039	0.6	247.3	1.6
Omega-66	720	450	0.3	0.039	0.7	247.8	1.8
Omega-16	310	480	0.4	0.039	1.0	248.6	2.5
P1106-3	120	110	0.0	0.040	2.2	254.7	5.6
Omega-18	70	50	0.3	0.041	2.2	257.4	5.6
Omega-71	130	110	1.8	0.045	1.5	277.4	4.1
Omega-23	500	180	0.1	0.046	0.7	288.2	2.2
Omega-70	900	260	0.2	0.049	0.6	305.3	1.7
Omega-3	550	360	0.4	0.050	0.7	311.5	2.2
Omega-30	420	170	0.5	0.053	0.9	331.5	2.9
Omega-17	910	790	0.8	0.056	0.5	347.3	1.8
Omega-61	410	160	0.1	0.057	0.8	355.6	2.8
P1106-15.c	530	220	0.1	0.057	1.8	357.4	6.3
P1106-13.c	250	140	0.0	0.059	1.9	371.0	6.9
Omega-72	1050	340	0.2	0.068	0.4	422.6	1.9
Omega-48	380	80	0.0	0.068	0.8	426.3	3.4
Omega-32	150	50	0.1	0.069	1.2	431.9	5.4
Omega-56	560	900	-0.1	0.071	0.6	441.0	2.8
Omega-74	60	90	-0.2	0.083	1.8	512.7	9.0
P1106-5.c	130	40	1.1	0.085	2.0	523.7	10.1
Omega-67	320	150	0.2	0.090	0.7	553.4	4.1
Omega-63	260	40	0.6	0.154	0.8	920.7	7.3
Omega-76	190	60	0.6	0.175	0.9	1034.3	9.4
Omega-73	70	60	-0.1	0.195	1.5	1148.7	16.5

Note: Samples with P1106-X label were previously published in Charlier et al. (2005). Grains with the same number represent core (.c) and rim (.r) analyses from the same grain.