DR2004148

Data Repository Item

Appendix DR1

SHRIMP analytical results

Grimes Intrusive Suite

Instrumental performance varied significantly during the analytical session, which has necessitated the division of that time into three different sub-sessions. Stable conditions during the first of those sub-sessions were interrupted by a failure of the (3 nA) primary ion-beam. The following (short) sub-session was characterised by an unstable and much diminished primary beam (1 nA), resulting in data of too poor a quality to be reported. The recovery of a stable primary beam of suitable intensity (3 nA) generated useable data from the third sub-session. However, the latter was now marred by a dearth of suitable analytical sites. An attempt to minimise this shortcoming was not particularly successful (see below).

The first sub-session produced a 2.3% calibration (2 σ) for $^{206}Pb/^{238}U$ from the 14 analyses of TEMORA 1. All 14 interspersed analyses of the Grimes Intrusive Suite zircon yield $^{206}Pb/^{238}U$ ages that are within error of each other (MSWD=1.31, probability of equivalence=0.20) and produce a weighted mean age of 572.8±5.9 Ma (Fig. 1).

As forewarned above, the second useful sub-session was hampered by a lack of suitable remaining sites for analysis. In an attempt to circumvent this problem, with the intention of deriving a more precise age for the Grimes Intrusive Suite, ten of the original analytical sites were revisited. In hindsight, this proved to be a poor decision, because a large proportion of the resulting ages are offset below the others (Fig. 1). The exclusion of merely the most obviously aberrant of those analyses would be too subjective a process, and consequently all ten of these have been rejected from further consideration. As none of the 22 interspersed analyses of TEMORA 1 have been similarly compromised, they can validly be used to derive the calibration (1.5%) for this sub-session. Thirteen analyses of the Grimes Intrusive Suite zircon remain after the deletion of the analyses of the revisited sites. One of the remaining analyses is clearly older (620 Ma) than the others, and it is separated from them on the basis that it probably represents a xenocryst. The other twelve yield a weighted mean $^{206}Pb/^{238}U$ age of 575.6±4.1 Ma (MSWD=1.48, probability of equivalence=0.13).

Validity of the SHRIMP $^{206}Pb/^{238}U$ ages

As the $^{206}Pb/^{238}U$ ages for the two sub-sessions are within error of each other (MSWD=0.73, probability of equivalence=0.39), they can be combined to yield a preferred age of 574.7±3.0 Ma (Table 1; Fig. 2). However, the observation of Williams and Hergt (2000) that $^{206}Pb/^{238}U$ SHRIMP ages can be affected by high concentrations of U, necessitate closer scrutiny of the data. Even though the U contents of the zircon in the Grimes Intrusive Suite (average of 355 ppm, range from

70 to 1200 ppm) are well below the threshold value (2500 ppm) nominated by Williams and Hergt (2000), the Th concentrations of the Grimes Intrusive Suite zircon are dramatically high (average of 2900, range from 270 to 9000 ppm). In addition, Black et al. (submitted) have reported an influence of trace element content (probably including both U and Th) on SHRIMP $^{206}Pb/^{238}U$ ages. A useful measure of whether or not the high Th might have significantly biased the Grimes Intrusive Suite zircon age is provided by the $^{207}Pb/^{206}Pb$ isotopic system, which produces ages that are independent of Pb/U fractionation. The weighted mean $^{207}Pb/^{206}Pb$ age for all of these zircons is 571±14 Ma, well within error of the mean $^{206}Pb/^{238}U$ age, though considerably less precise than it. There is thus no evidence of any gross Pb/U age bias resulting from the high Th contents. This conclusion is supported by a lack of obvious correlation between Th content and $^{206}Pb/^{238}U$ age for the individual analyses, even though they span a large range of Th contents (Fig. 3).

Rhyodacite from the Kanunnah Subgroup

This analytical session was considerably less complex than that in which the syenite was dated. A steady primary beam intensity of about 5.5 nA produced a constant 3.1% calibration (2 σ) for $^{206}Pb/^{238}U$ from the 50 analyses of the TEMORA standard. All 46 analyses of the zircon from the Togari Group sample are within error of each other (MSWD=0.94, probability of equivalence=0.58), and produce a weighted mean age of 582.1±4.1 Ma for the crystallisation of their host rock (Table 2; Fig. 4). The data are also concordant (Fig. 5). In contrast to the Grimes Intrusive Suite sample, neither U (average of 202 ppm, range from 96 to 401 ppm) nor Th (average of 119 ppm, range from 45 to 255 ppm) concentrations are not abnormally enriched, eliminating any possibility of a gross age aberration of the kind reported by Williams and Hergt (2000).

Geochemistry

Major and trace element compositions, by standard XRF procedures, of the two dated samples are given in Table 3.

Our assignation of the Conglomerate Creek locality to the Grimes Intrusive Suite concurs with previous mapping (Waldron & Brown, 1993; Meffre et al., in press). The whole-rock analysis of this sample shows the distinctive chemistry of the Grimes Intrusive Suite, combining high MgO, Cr and Ni with high incompatible element abundances (Table 3). On discrimination diagrams the sample clusters with previous analyses of the Grimes Intrusive Suite, in particular with other basal cumulates (Fig. 6). The sample is evidently not an intrusive equivalent of any of the other volcanic units of the Grassy Group.

References

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Waldron, H.M., and Brown, A.V., 1993. Geological setting and petrochemistry of Eocambrian-Cambrian volcano-sedimentary rock sequences from southeast King Island, Tasmania. Mineral Resources Tasmania Report 1993/28.

Williams, I.S., Hergt, J.M., 2000. U-Pb dating of Tasmanian dolerites: a cautionary tale of SHRIMP analysis of high-U zircon. In Woodhead, J.D., Hergt, J.M. and Noble, W.P. (eds). Beyond 2000: New Frontiers in Isotope Geoscience, Lorne, 2000, Abstracts and Proceedings, 185-188.

Tables

Table DR1: U-Th-Pb data for the zircons from the Grimes Intrusive Suite.

Table DR2. U-Th-Pb data for the zircons from the rhyodacite from the Kanunnah Subgroup.

Table DR3: Major and trace-element analyses of dated samples from the Grimes Intrusive Suite and the rhyodacite from the Kanunnah Subgroup.

Figures

Fig. DR1. $^{206}Pb/^{238}U$ ages (in analytical sequence) derived from the individual analyses within the two useful sub-sessions of the Grimes Intrusive Suite sample. The bars represent ±2 sigma errors, with the thicker ones depicting revisited analytical sites.

Fig. DR2. $^{207}Pb/^{235}U$ - $^{206}Pb/^{238}U$ concordia diagram for Grimes Intrusive Suite showing the analyses obtained in the two useful sub-sessions, but excluding the revisited sites and the 620 Ma grain.

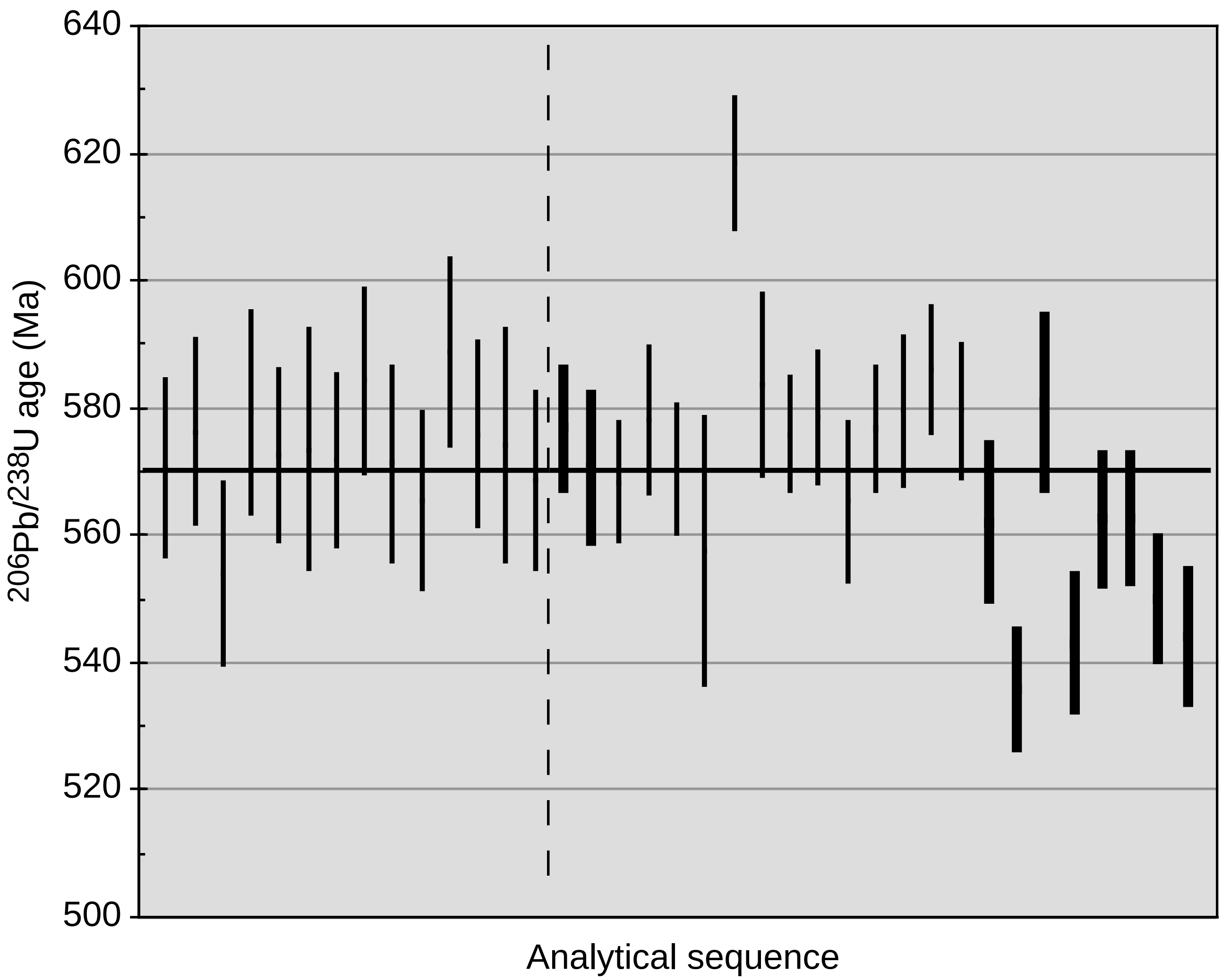
Fig. DR3. Th - $^{206}Pb/^{238}U$ diagram for the Grimes Intrusive Suite zircons, showing a lack of obvious correlation between those two parameters.

Fig. DR4. $^{206}Pb/^{238}U$ ages (in analytical sequence) derived from the individual analyses of the rhyodacite from the Kanunnah Subgroup. The bars represent ±2 sigma errors.

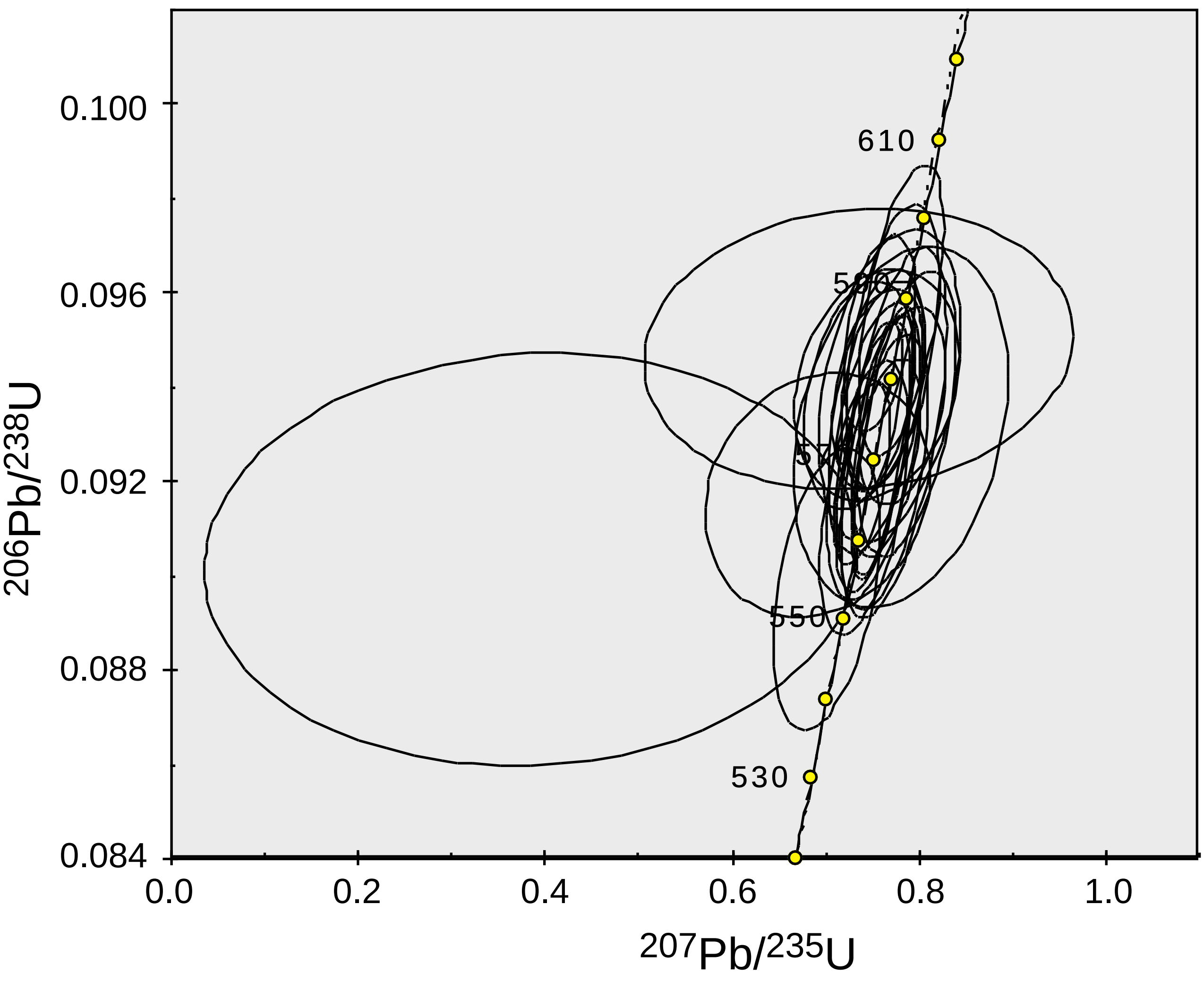
Fig. DR5: Concordia diagram for rhyodacite from the Kanunnah Subgroup.

Fig. DR6: TiO_2 vs. Zr/Y discrimination diagram of Grimes Intrusive Suite sample and other igneous rocks from the Grassy Group; other data from Meffre et al. (2004).

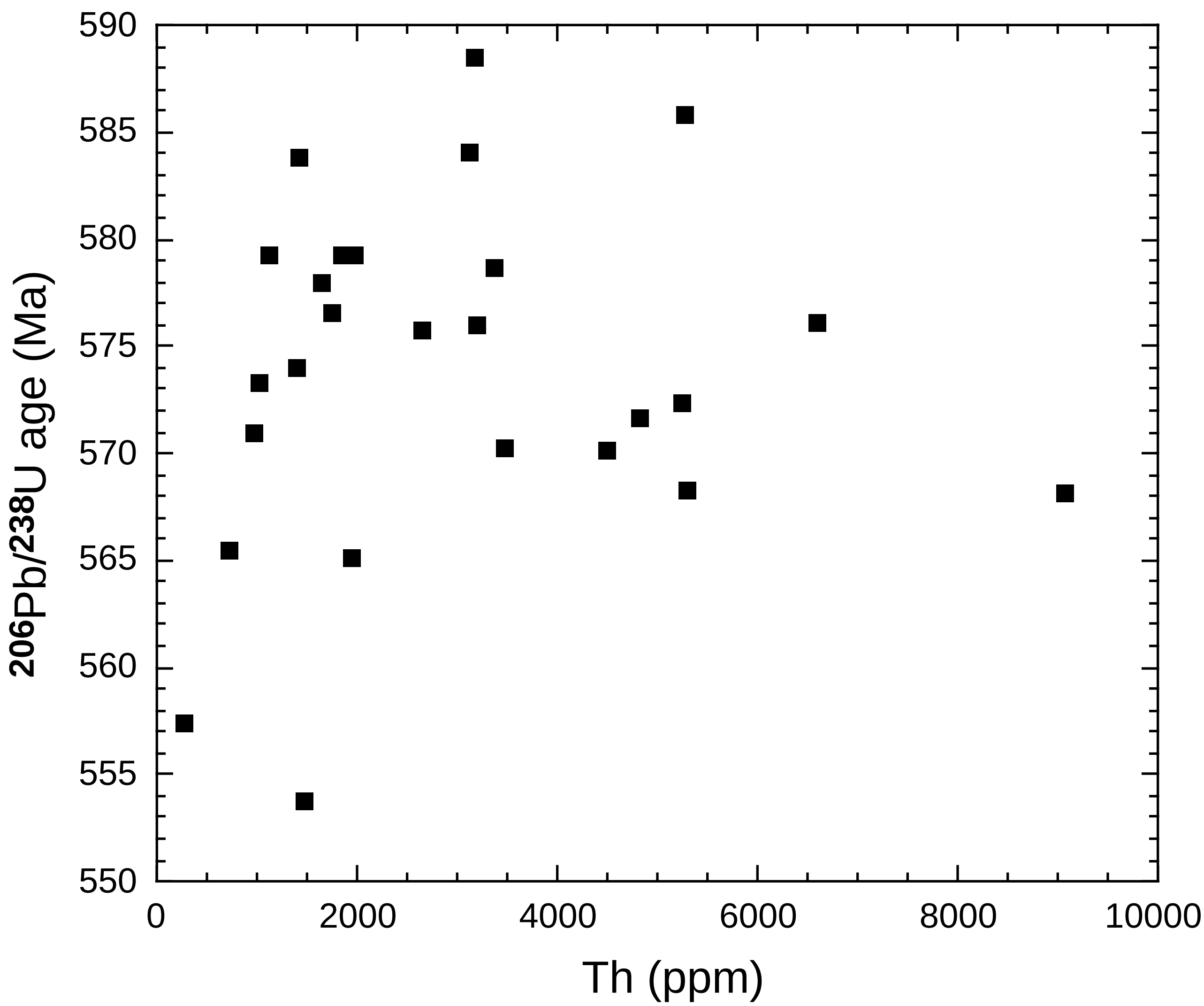
Fig. DR7: Lower contact of sill of Grimes Intrusive Suite in Yarra Creek Shale, northern shore of City of Melbourne Bay, showing strongly undulose contact (dashed line) suggestive of unlithified sediment at time of intrusion; trace of bedding in shale (short-dashed line). Pick is 400 mm long.



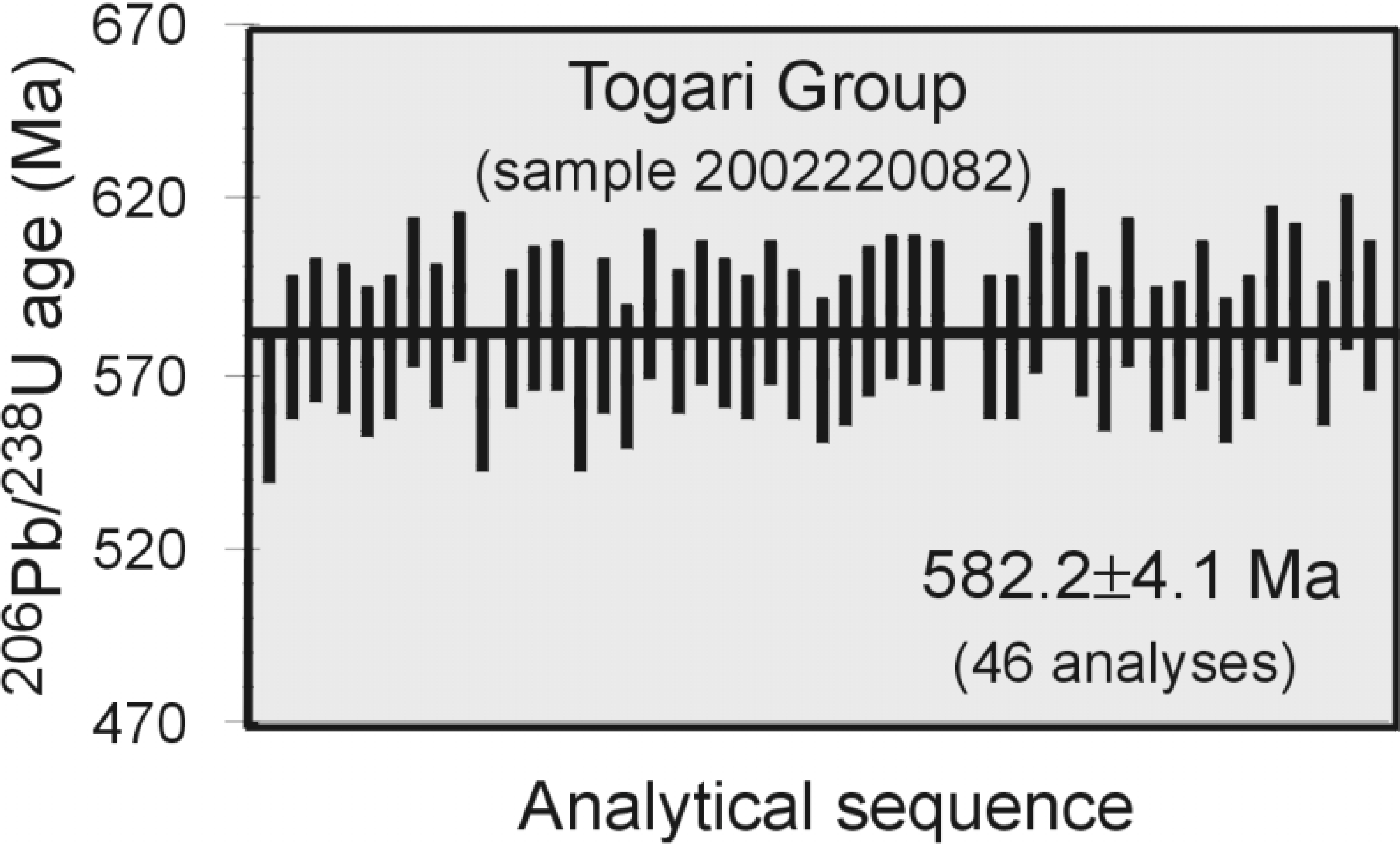
640
620
600
580
560
540
520
500
206Pb/238U age (Ma)
Analytical sequence

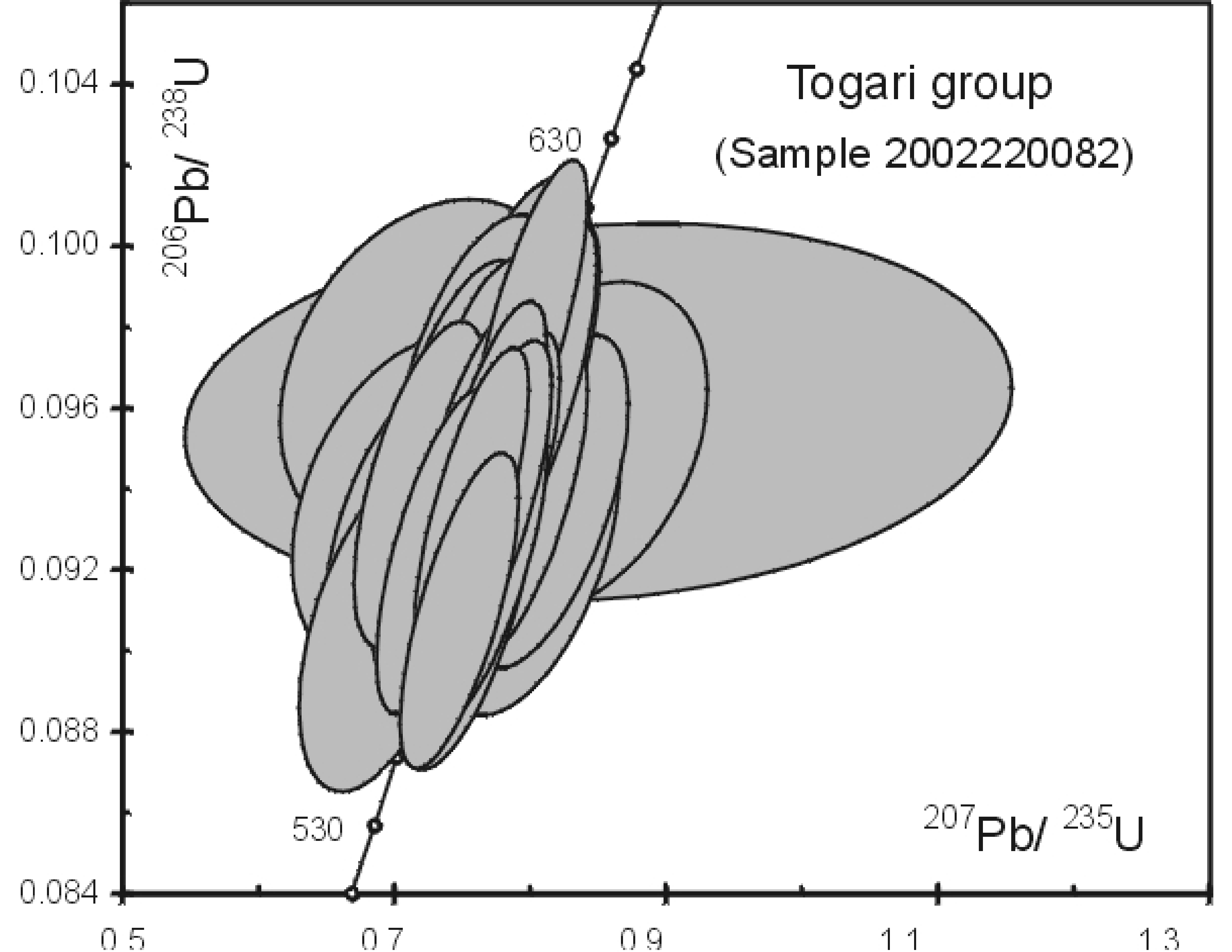


0.100
0.096
0.092
0.088
0.084
0.0
0.2
0.4
0.6
0.8
1.0
610
550
530
$^{206}Pb/^{238}U$
$^{207}Pb/^{235}U$



590
585
580
575
570
565
560
555
550
0
2000
4000
6000
8000
10000
Th (ppm)
206Pb/238U age (Ma)


Togari Group
(sample 2002220082)
582.2±4.1 Ma
(46 analyses)
670
620
570
520
470
206Pb/238U age (Ma)
Analytical sequence


Togari group
(Sample 2002220082)
206Pb/ 238U
207Pb/ 235U
630
530
0.084
0.088
0.092
0.096
0.100
0.104
0.5
0.7
0.9
1.1
1.3

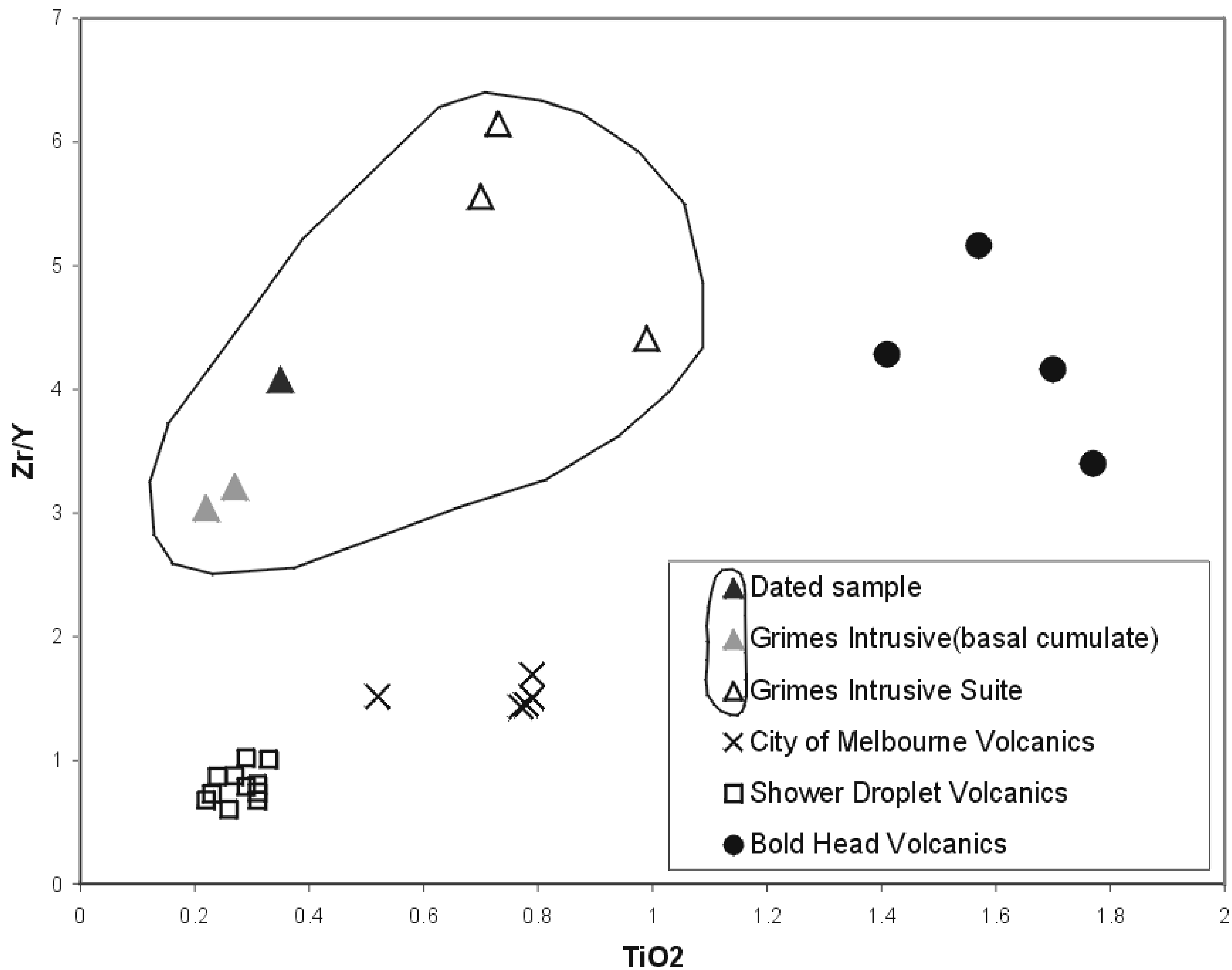

Zr/Y
TiO2
0
1
2
3
4
5
6
7
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Dated sample
Grimes Intrusive(basal cumulate)
Grimes Intrusive Suite
City of Melbourne Volcanics
Shower Droplet Volcanics
Bold Head Volcanics

Table DR1. U-Th-Pb data for the zircons from the Grimes Intrusive Suite.

Spot name	U (ppm)	Th (ppm)	Th/U	% common ^{206}Pb	^{206}Pb/^{238}U	± 1 σ	^{207}Pb/^{235}U	± 1 σ	^{207}Pb/^{206}Pb	± 1 σ	^{206}Pb/^{238}U age	± 1 σ
1st subsession												
201.1	547	3484	6.58	0.198	0.0925	0.0012	0.753	0.016	0.0590	0.0010	570.3	6.9
202.1	359	3193	9.19	0.314	0.0935	0.0012	0.755	0.020	0.0586	0.0014	576.0	7.2
203.1	260	1468	5.82	0.343	0.0897	0.0012	0.702	0.023	0.0568	0.0017	553.8	7.1
204.1	173	1846	11.00	0.861	0.0940	0.0013	0.770	0.030	0.0594	0.0022	579.2	7.9
205.1	760	5238	7.12	0.056	0.0928	0.0011	0.765	0.013	0.0597	0.0007	572.3	6.8
206.1	239	1021	4.41	0.091	0.0930	0.0016	0.774	0.023	0.0603	0.0014	573.3	9.4
205.2	792	4828	6.30	0.044	0.0927	0.0011	0.762	0.013	0.0596	0.0007	571.6	6.7
207.1	435	3130	7.43	0.361	0.0948	0.0012	0.773	0.020	0.0591	0.0013	584.1	7.2
208.1	239	980	4.24	0.148	0.0926	0.0013	0.753	0.020	0.0589	0.0013	571.0	7.6
209.1	422	1962	4.81	0.332	0.0916	0.0012	0.742	0.019	0.0588	0.0013	565.1	6.9
210.1	355	3177	9.24	0.173	0.0956	0.0012	0.782	0.018	0.0594	0.0011	588.5	7.3
211.1	354	2660	7.77	0.358	0.0934	0.0012	0.788	0.021	0.0612	0.0014	575.7	7.2
212.1	195	1409	7.45	1.265	0.0931	0.0015	0.782	0.046	0.0609	0.0035	574.0	9.1
213.1	436	5307	12.56	0.195	0.0922	0.0012	0.764	0.018	0.0601	0.0012	568.3	7.0
3rd subsession												
205.11	705	4581	6.71	0.037	0.0936	0.0008	0.756	0.012	0.0586	0.0008	576.7	4.7
216.11	192	788	4.23	0.000	0.0925	0.0010	0.762	0.018	0.0597	0.0012	570.3	5.7
218.1	809	9081	11.60	0.171	0.0921	0.0008	0.740	0.012	0.0583	0.0008	568.1	4.6
219.1	271	1648	6.27	0.494	0.0938	0.0010	0.737	0.024	0.0570	0.0017	578.0	5.8
220.1	420	4499	11.07	0.121	0.0925	0.0008	0.765	0.014	0.0600	0.0010	570.1	5.0
221.1	70	269	3.95	5.690	0.0903	0.0018	0.386	0.142	0.0310	0.0114	557.4	10.5
222.1	601	6687	11.50	0.039	0.1007	0.0009	0.835	0.014	0.0601	0.0008	618.7	5.2
223.1	362	1422	4.06	7.535	0.0948	0.0012	0.736	0.093	0.0563	0.0071	583.8	7.1
214.2	1207	6590	5.64	0.171	0.0935	0.0008	0.755	0.011	0.0586	0.0007	576.1	4.5
224.1	412	3381	8.49	0.308	0.0939	0.0009	0.758	0.020	0.0585	0.0014	578.7	5.1
225.1	178	732	4.24	1.859	0.0917	0.0010	0.693	0.049	0.0548	0.0038	565.5	6.2
226.1	432	1760	4.21	0.258	0.0936	0.0008	0.784	0.018	0.0607	0.0013	576.6	5.0
227.1	208	1128	5.60	1.091	0.0940	0.0010	0.756	0.035	0.0583	0.0027	579.3	5.8
202.2	540	5284	10.11	0.304	0.0951	0.0008	0.758	0.015	0.0578	0.0010	585.8	4.9
203.2	329	1981	6.21	0.260	0.0940	0.0009	0.764	0.018	0.0589	0.0013	579.3	5.2
215.11	309	2695	9.00	1.092	0.0911	0.0010	0.718	0.031	0.0572	0.0024	561.8	6.0
201.11	580	3853	6.86	0.250	0.0866	0.0008	0.707	0.014	0.0592	0.0011	535.6	4.6
204.11	152	1583	10.75	1.480	0.0943	0.0011	0.698	0.052	0.0537	0.0039	580.7	6.7
208.11	242	1039	4.44	0.147	0.0879	0.0009	0.710	0.016	0.0586	0.0012	542.8	5.2
210.11	329	2921	9.16	0.151	0.0912	0.0009	0.754	0.016	0.0600	0.0012	562.3	5.1
207.11	327	2083	6.59	0.341	0.0912	0.0008	0.735	0.015	0.0585	0.0011	562.4	4.9
209.11	388	1924	5.12	0.113	0.0890	0.0008	0.728	0.013	0.0593	0.0009	549.8	4.8
202.11	323	2427	7.77	0.320	0.0880	0.0009	0.686	0.015	0.0565	0.0011	543.9	5.0

The suffix .11 in a spot names indicates that it represents a revisit to an analytical site.

Table DR2. U-Th-Pb data for the zircons from the Togari Group rhyodacite.

Spot	U (ppm)	Th (ppm)	Th/U	% common ^{206}Pb	$^{206}Pb/^{238}U$	± 1 σ	$^{207}Pb/^{235}U$	± 1 σ	$^{207}Pb/^{206}Pb$	± 1 σ	$^{206}Pb/^{238}U$ age	± 1 σ
101	151	122	0.83	0.29	0.0908	0.0015	0.69	0.025	0.0554	0.002	560.3	3.2
102	238	182	0.79	0.1	0.0938	0.0016	0.77	0.018	0.0598	0.001	578.2	1.6
103	222	106	0.49	0.15	0.0947	0.0016	0.77	0.018	0.059	9E-04	583.5	1.6
104	197	110	0.58	-0.14	0.0942	0.0016	0.79	0.022	0.0607	0.001	580.5	2.2
105	107	124	1.19	0.5	0.093	0.0017	0.72	0.03	0.0564	0.002	573.5	3.8
106	189	85	0.46	-0.21	0.0939	0.0016	0.82	0.025	0.063	0.002	578.4	2.4
107	192	130	0.7	0.03	0.0965	0.0016	0.81	0.019	0.0606	0.001	593.9	1.7
108	237	144	0.63	0.42	0.0945	0.0016	0.74	0.023	0.0568	0.002	582.3	2.7
109	254	174	0.71	0.66	0.0968	0.0016	0.77	0.027	0.0574	0.002	595.5	3.1
110	213	112	0.54	0.06	0.0912	0.0016	0.75	0.017	0.0597	0.001	562.8	1.7
111	232	128	0.57	0.27	0.0943	0.0016	0.72	0.02	0.0556	0.001	580.8	2.2
112	169	118	0.72	0.04	0.0953	0.0016	0.79	0.02	0.0603	0.001	586.6	1.8
113	197	110	0.58	0.17	0.0954	0.0016	0.79	0.021	0.06	0.001	587.1	2
114	150	64	0.44	0.12	0.0913	0.0016	0.76	0.02	0.0601	0.001	563.2	2
115	167	180	1.12	0.09	0.0944	0.0017	0.79	0.021	0.0608	0.001	581.8	1.9
116	195	103	0.55	0.09	0.0924	0.0016	0.77	0.018	0.0604	0.001	569.7	1.7
117	194	98	0.52	-0.22	0.096	0.0016	0.79	0.019	0.0599	0.001	590.8	1.7
118	208	104	0.52	0.05	0.0941	0.0016	0.78	0.019	0.06	0.001	579.5	1.7
119	175	64	0.38	0.17	0.0956	0.0016	0.79	0.022	0.06	0.001	588.4	2.2
120	248	124	0.52	0.14	0.0946	0.0016	0.76	0.018	0.0583	0.001	582.5	1.8
121	227	129	0.59	1.26	0.0938	0.0016	0.71	0.038	0.0551	0.003	578.2	5.1
122	210	151	0.74	0.11	0.0956	0.0016	0.79	0.021	0.0598	0.001	588.5	2
123	115	74	0.67	0.06	0.0941	0.0016	0.79	0.023	0.0608	0.001	579.6	2.3
124	154	66	0.44	-0.1	0.0926	0.0016	0.8	0.027	0.0628	0.002	571.2	3
125	154	106	0.71	-0.05	0.0937	0.0016	0.8	0.029	0.0618	0.002	577.4	3.2
126	220	93	0.44	2.15	0.0951	0.0016	0.83	0.05	0.0636	0.004	585.8	5.8
127	261	163	0.65	0.19	0.0958	0.0015	0.76	0.02	0.0577	0.001	589.6	2
128	169	71	0.43	0.32	0.0956	0.0016	0.75	0.023	0.0569	0.001	588.8	2.5
129	164	79	0.49	-0.01	0.0954	0.0016	0.78	0.019	0.0596	0.001	587.2	1.8
131	235	147	0.64	0.18	0.0939	0.0016	0.8	0.02	0.0615	0.001	578.6	1.9
132	229	134	0.6	0.11	0.094	0.0016	0.77	0.019	0.0596	0.001	579	1.9
133	150	98	0.67	0.23	0.0962	0.0016	0.78	0.023	0.0588	0.001	592	2.4
134	401	255	0.66	0.18	0.0981	0.0016	0.8	0.018	0.0593	9E-04	603.5	1.5
135	198	108	0.56	0.32	0.095	0.0016	0.76	0.02	0.0579	0.001	585	1.9
136	192	45	0.24	0.3	0.0933	0.0016	0.77	0.025	0.0596	0.002	575	2.8
137	276	181	0.68	0.06	0.0966	0.0015	0.81	0.018	0.0607	9E-04	594.3	1.5
138	173	88	0.53	0.32	0.0932	0.0016	0.74	0.023	0.0578	0.002	574.3	2.6
139	267	174	0.67	0.13	0.0937	0.0015	0.76	0.017	0.0588	9E-04	577.4	1.5
140	330	254	0.8	0.27	0.0955	0.0016	0.76	0.019	0.0579	0.001	587.8	1.8
142	174	80	0.48	0.25	0.0927	0.0016	0.74	0.019	0.0576	0.001	571.4	1.9
143	197	116	0.61	0.18	0.0939	0.0016	0.76	0.021	0.0585	0.001	578.7	2
144	177	87	0.51	1.95	0.097	0.0016	0.73	0.053	0.0544	0.004	596.7	6.9
145	213	127	0.62	5.61	0.096	0.0018	0.85	0.148	0.0645	0.011	591.1	17.3
146	215	117	0.56	0.68	0.0936	0.0016	0.75	0.026	0.0582	0.002	576.6	3.1
147	96	82	0.88	0.26	0.0974	0.0018	0.79	0.024	0.0588	0.002	599.2	2.5
148	136	86	0.65	0.14	0.0953	0.0016	0.77	0.02	0.0588	0.001	586.9	2

Table DR3: Whole-rock analyses of dated samples

Sample No.	R009545	R011510
	Grimes Intrusive Suite	Rhyodacite
SiO_2	45.49	69.34
TiO_2	0.33	0.71
Al_2O_3	8.35	12.29
Fe_2O_3	1.53	0.59
FeO	8.08	5.06
MnO	0.15	0.09
MgO	21.94	1.27
CaO	6.55	1.09
Na_2O	0.22	3.24
K_2O	0.03	3.86
P_2O_5	0.08	0.17
SO_3	0.08	0.01
CO_2	0.10	0.27
H_2O^+	6.70	1.60
TOTAL	99.64	99.58
L.O.I.	5.91	1.115
TRACE (%)		
Th	<10	24
Sr	8	73
U	<10	<10
Rb	<5	80
Y	13	70
Zr	53	300
Nb	5	37
Mo	<5	<5
Cr	2800	22
V	160	68
Sc	26	17
Co	96	9
As	<20	<20
Bi	<5	<5
Ga	10	17
Zn	100	51
W	<10	<10
Cu	100	14
Ni	770	9
Sn	<9	<9
Pb	<10	19
Nd	<20	45
Ce	<28	100
La	<20	48
Ba	<23	610