

論説 : LA-ICP-MS U–Pb zircon and FE-EPMA U–Th–Pb monazite dating of pelitic granulites from the Mt. Ukidake area, Sefuri Mountains, northern Kyushu

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**Fig. A1.** Representative time-resolved isotopic ratio profiles determined by ablation of zircons from Temora (a) and an unknown sample (060101A) (b). In the case of these analyses, isotopic ratios are consistent between 48 to 120 s for the Temora sample and 53 and 120 s for sample 060101A. These portions of data were integrated and then calibrated during age determination.

**Table A1.** Short- and long-term precision of U–Pb isotope ratios and calculated ages of the FC-1 zircon standard.

**Table A2.** U–Pb isotope ratios and calculated ages from analysis of zircons from Temora and the Itoshima granodiorites calibrated against the FC-1 zircon standard.

**Table A3.** Comparison of U–Pb isotope ratios and calculated age data from analysis of the FC-1 zircon with different laser beam diameters.

**Table A4.** Chemical compositions and U–Th–Pb ages of reference monazites.

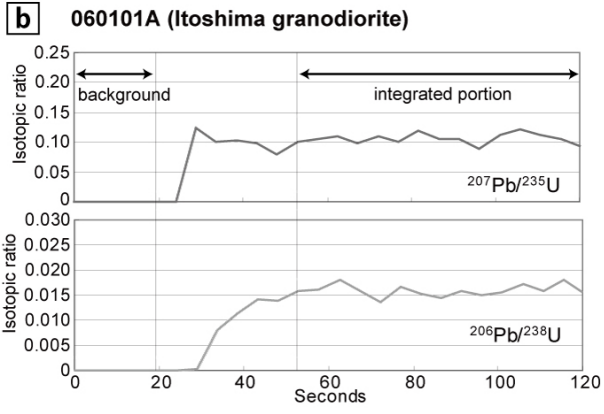
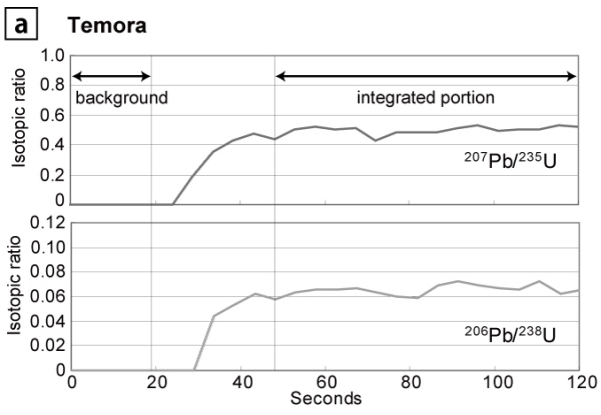


Fig. A1. Adachi et al.

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Analysis date/ Analysis No.	Isotopic ratios and errors (2 $\sigma$ )				Calculated ages and errors (Ma, 2 $\sigma$ )			
	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error
<i>2010/Dec/23</i>								
FC1-g1	0.1896	0.0053	1.9936	0.0729	1119	29	1113	25
FC1-g2	0.1913	0.0057	1.9519	0.0837	1128	31	1099	29
FC1-g3	0.1888	0.0065	1.9766	0.1151	1115	35	1108	39
FC1-g4	0.1916	0.0057	2.0009	0.0849	1130	31	1116	29
FC1-g5	0.1854	0.0064	1.9898	0.1176	1096	35	1112	40
FC1-g6	0.1936	0.0054	2.0185	0.0675	1141	29	1122	23
FC1-g7	0.1778	0.0053	1.9093	0.0754	1055	29	1084	26
FC1-g8	0.1843	0.0060	1.9203	0.0897	1090	32	1088	31
<i>2011/Jan/20 (the day when the unknown samples in this study were analyzed)</i>								
FC1-g1	0.1872	0.0055	1.9874	0.0634	1106	30	1111	22
FC1-g2	0.1845	0.0054	1.9322	0.0614	1091	29	1092	21
FC1-g3	0.1831	0.0057	1.8783	0.0734	1084	31	1073	26
FC1-g4	0.1870	0.0054	1.9420	0.0614	1105	29	1096	21
FC1-g5	0.1849	0.0054	1.9116	0.0609	1094	29	1085	21
FC1-g6	0.1835	0.0056	1.9515	0.0717	1086	31	1099	25
FC1-g7	0.1857	0.0058	1.9149	0.0748	1098	32	1086	26
<i>2011/Feb/3-4</i>								
FC1-g1	0.1824	0.0051	1.9124	0.0618	1080	28	1085	22
FC1-g2	0.1852	0.0059	1.9745	0.0947	1095	32	1107	32
FC1-g3	0.1985	0.0060	2.0542	0.0859	1167	32	1134	29
FC1-g4	0.1881	0.0054	1.9871	0.0682	1111	29	1111	23
FC1-g5	0.1877	0.0054	1.9591	0.0692	1109	29	1102	24
FC1-g6	0.1835	0.0053	1.9176	0.0578	1086	29	1087	20
FC1-g7	0.1867	0.0060	1.9598	0.0894	1103	33	1102	31
<i>2011/Feb/5</i>								
FC1-g1	0.1879	0.0053	1.9763	0.0606	1110	29	1107	21
FC1-g2	0.1872	0.0057	1.9543	0.0771	1106	31	1100	26
FC1-g3	0.1868	0.0054	2.0027	0.0713	1104	30	1116	24
FC1-g4	0.1852	0.0056	2.0053	0.0881	1095	31	1117	30
FC1-g5	0.1875	0.0055	1.9391	0.0679	1108	30	1095	23
FC1-g6	0.1869	0.0061	1.9202	0.0869	1104	33	1088	30
FC1-g7	0.2226	0.0077	2.2566	0.1169	1296	41	1199	36
FC1-g8	0.1812	0.0051	1.9137	0.0594	1074	28	1086	21
FC1-g9	0.1853	0.0053	1.9666	0.0628	1096	29	1104	22
FC1-g10	0.1936	0.0058	1.9297	0.0736	1141	31	1091	26
FC1-g11	0.1863	0.0050	1.9558	0.0624	1101	27	1100	21
FC1-g12	0.1920	0.0058	1.9972	0.0789	1132	31	1115	27

Table A1. Adachi et al.

A4サイズ

Samples/ Analysis No.	Isotopic ratios and errors (2 $\sigma$ )				Calculated ages and errors (Ma, 2 $\sigma$ )			
	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error
<i>060101A (Itoshima granodiorite)</i>								
01A-g1	0.0163	0.0009	0.1081	0.0237	104	6	104	22
01A-g2	0.0161	0.0009	0.1112	0.0281	103	6	107	26
01A-g3.1	0.0167	0.0007	0.1070	0.0117	107	4	103	11
01A-g3.2	0.0165	0.0006	0.1036	0.0103	106	4	100	9
01A-g4.1	0.0167	0.0006	0.1028	0.0094	107	4	99	9
01A-g4.2	0.0161	0.0006	0.1075	0.0077	103	4	104	7
01A-g5.1	0.0162	0.0006	0.1085	0.0107	104	4	105	10
01A-g5.2	0.0158	0.0006	0.1165	0.0099	101	4	112	9
01A-g6	0.0163	0.0006	0.1136	0.0087	104	4	109	8
01A-g7	0.0153	0.0006	0.1051	0.0089	98	4	101	8
<i>Temora</i>								
Temora-g1	0.0719	0.0022	0.5292	0.0194	447	13	431	13
Temora-g2	0.0678	0.0020	0.5165	0.0171	423	12	423	11
Temora-g3	0.0678	0.0022	0.5199	0.0317	423	13	425	21
Temora-g4	0.0675	0.0020	0.5164	0.0178	421	12	423	12
Temora-g5	0.0709	0.0020	0.5242	0.0193	441	12	428	13
Temora-g6	0.0713	0.0019	0.5399	0.0174	444	12	438	11
Temora-g7	0.0697	0.0019	0.5233	0.0174	434	11	427	12
Temora-g8	0.0652	0.0017	0.4862	0.0145	407	10	402	10
Temora-g9	0.0647	0.0017	0.4987	0.0152	404	10	411	10

Table A2. Adachi et al.

A4サイズ

Spot size/ Analysis No.	Isotopic ratios and errors (2 $\sigma$ )				Calculated ages and errors (Ma, 2 $\sigma$ )			
	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error	$^{206}\text{Pb}/^{238}\text{U}$	error	$^{207}\text{Pb}/^{235}\text{U}$	error
<i>2011/Jul/14</i>								
Laser diameter: 30 $\mu\text{m}$								
FC1-g1	0.1858	0.0051	1.9596	0.0618	1099	28	1102	21
FC1-g2	0.1863	0.0051	1.9209	0.0595	1101	28	1088	21
FC1-g3	0.1868	0.0052	2.0098	0.0637	1104	28	1119	22
FC1-g4	0.1862	0.0051	1.9292	0.0605	1101	28	1091	21
FC1-g5	0.1839	0.0051	1.9889	0.0625	1088	28	1112	21
FC1-g6	0.1862	0.0053	1.9199	0.0657	1101	29	1088	23
FC1-g7	0.1865	0.0053	1.9735	0.0663	1102	29	1107	23
FC1-g8	0.1864	0.0052	1.9954	0.0658	1102	28	1114	22
FC1-g9	0.1838	0.0051	1.9904	0.0625	1088	28	1112	21
FC1-g10	0.1854	0.0052	1.9497	0.0651	1097	28	1098	22
Laser diameter: 55 $\mu\text{m}$								
FC1-g1	0.1863	0.0055	1.9576	0.0742	1101	30	1101	25
FC1-g2	0.1866	0.0056	1.9340	0.0747	1103	30	1093	26
FC1-g3	0.1847	0.0054	1.9864	0.0716	1093	29	1111	24
FC1-g4	0.1876	0.0056	1.9317	0.0740	1108	30	1092	26
FC1-g5	0.1837	0.0058	1.9490	0.0842	1087	32	1098	29
FC1-g6	0.1840	0.0059	1.9779	0.0883	1089	32	1108	30
FC1-g7	0.1847	0.0054	1.9467	0.0705	1093	29	1097	24
FC1-g8	0.1838	0.0053	1.9350	0.0685	1088	29	1093	24
FC1-g9	0.1874	0.0055	2.0041	0.0725	1107	30	1117	25
FC1-g10	0.1872	0.0058	1.9879	0.0815	1106	31	1111	28

Table A3. Adachi et al.

A4サイズ

Sample	Namaqualand (reference age: 1033 Ma)									
wt. %										
SiO <sub>2</sub>	1.15	1.17	1.08	1.01	0.99	1.13	1.08	1.00	1.05	1.08
UO <sub>2</sub>	0.22	0.21	0.22	0.22	0.21	0.22	0.22	0.21	0.23	0.23
ThO <sub>2</sub>	8.34	8.33	8.36	8.30	8.32	8.37	8.39	8.35	8.38	8.93
Y <sub>2</sub> O <sub>3</sub>	2.36	2.35	2.34	2.36	2.27	2.30	2.32	2.27	2.30	2.27
La <sub>2</sub> O <sub>3</sub>	12.71	13.14	12.23	12.71	12.57	12.64	12.67	12.75	12.19	12.13
Ce <sub>2</sub> O <sub>3</sub>	26.54	27.01	26.55	27.24	26.37	26.43	26.73	27.28	26.02	26.41
Pr <sub>2</sub> O <sub>3</sub>	2.63	2.61	2.91	2.59	3.02	2.65	2.71	2.68	2.60	2.49
Nd <sub>2</sub> O <sub>3</sub>	10.27	10.72	10.68	10.64	10.47	10.18	10.39	10.04	10.19	10.42
Sm <sub>2</sub> O <sub>3</sub>	1.82	1.99	1.72	1.88	1.68	1.86	1.68	1.85	1.83	1.71
Gd <sub>2</sub> O <sub>3</sub>	1.41	1.29	1.49	1.44	1.54	1.27	1.56	1.55	1.55	1.24
Dy <sub>2</sub> O <sub>3</sub>	0.22	0.28	0.35	0.39	0.49	0.51	0.28	0.45	0.18	0.38
Er <sub>2</sub> O <sub>3</sub>	<i>n.d.</i>	0.23	0.11	0.03	0.04	0.24	0.01	0.12	0.24	0.06
Yb <sub>2</sub> O <sub>3</sub>	0.32	<i>n.d.</i>	0.56	0.09	0.17	0.17	0.24	0.08	<i>n.d.</i>	<i>n.d.</i>
CaO	1.06	1.06	1.15	1.18	1.21	1.07	1.16	1.18	1.18	1.26
PbO	0.41	0.41	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.43
P <sub>2</sub> O <sub>5</sub>	31.12	31.17	31.41	31.37	31.25	31.32	31.05	31.16	30.80	31.30
Total	100.57	101.95	101.54	101.83	100.98	100.77	100.89	101.36	99.13	100.31
Age [Ma]	1038	1053	1022	1039	1037	1017	1029	1031	1033	1022
Error [Ma]	35	35	35	35	35	35	35	35	35	33

Sample	Napier (reference age: 2450-2500 Ma)									
wt. %										
SiO <sub>2</sub>	1.72	2.56	2.44	2.76	1.76	2.21	2.61	1.80	1.80	
UO <sub>2</sub>	0.45	0.64	0.65	0.64	0.58	0.58	0.64	0.42	0.45	
ThO <sub>2</sub>	6.55	10.09	10.21	10.54	10.08	10.09	10.39	7.75	7.79	
Y <sub>2</sub> O <sub>3</sub>	5.74	5.41	5.65	5.23	3.88	4.56	5.32	5.44	5.80	
La <sub>2</sub> O <sub>3</sub>	12.39	12.79	12.44	12.90	13.20	13.23	13.04	13.36	12.70	
Ce <sub>2</sub> O <sub>3</sub>	24.85	22.69	22.61	21.95	22.88	23.17	23.06	24.12	24.02	
Pr <sub>2</sub> O <sub>3</sub>	2.52	2.17	2.35	2.41	2.26	2.55	2.31	2.03	2.25	
Nd <sub>2</sub> O <sub>3</sub>	9.37	8.27	8.28	8.19	8.15	8.74	8.04	9.36	9.08	
Sm <sub>2</sub> O <sub>3</sub>	1.61	1.70	1.54	1.76	1.56	1.76	1.58	1.14	0.23	
Gd <sub>2</sub> O <sub>3</sub>	2.02	1.92	1.93	1.80	1.60	1.62	1.77	1.91	1.93	
Dy <sub>2</sub> O <sub>3</sub>	0.67	0.34	0.83	0.47	0.64	0.57	0.70	0.57	0.63	
Er <sub>2</sub> O <sub>3</sub>	0.22	0.38	0.34	0.55	0.33	0.27	0.26	0.40	0.43	
Yb <sub>2</sub> O <sub>3</sub>	0.31	0.76	0.56	0.48	0.51	0.28	0.39	0.35	0.64	
CaO	0.26	0.42	0.49	0.38	1.18	0.68	0.43	0.49	0.51	
PbO	0.91	1.42	1.41	1.48	1.36	1.38	1.45	1.05	1.05	
P <sub>2</sub> O <sub>5</sub>	29.52	28.78	28.87	28.64	30.03	28.65	28.32	30.26	30.10	
Total	99.10	100.34	100.60	100.16	100.00	100.32	100.29	100.44	99.40	
Age [Ma]	2448	2508	2475	2521	2453	2492	2503	2493	2459	
Error [Ma]	46	30	30	29	30	31	29	40	39	

Sample	Sor Rondane Mountains pelitic gneiss (reference age: 641 Ma)									
wt. %										
SiO <sub>2</sub>	0.26	0.29	0.31	0.24	0.27	0.29	0.25	0.26	0.25	
UO <sub>2</sub>	0.20	0.20	0.19	0.19	0.20	0.18	0.19	0.19	0.19	
ThO <sub>2</sub>	7.13	7.26	7.30	7.18	7.15	7.25	6.89	6.35	6.13	
Y <sub>2</sub> O <sub>3</sub>	0.14	0.14	0.13	0.17	0.11	0.18	0.13	0.19	0.16	
La <sub>2</sub> O <sub>3</sub>	11.56	11.84	11.51	11.74	11.14	11.97	11.94	12.41	12.09	
Ce <sub>2</sub> O <sub>3</sub>	25.96	26.83	26.64	27.30	27.10	26.90	27.75	27.03	27.19	
Pr <sub>2</sub> O <sub>3</sub>	2.95	3.39	3.07	3.18	3.23	3.01	3.09	3.05	3.37	
Nd <sub>2</sub> O <sub>3</sub>	13.81	13.61	12.87	13.27	13.50	13.12	12.79	13.00	12.64	
Sm <sub>2</sub> O <sub>3</sub>	2.73	2.58	2.56	2.57	2.37	2.46	2.39	2.67	2.64	
Gd <sub>2</sub> O <sub>3</sub>	1.23	1.20	1.08	1.20	1.38	1.15	1.21	1.17	1.36	
Dy <sub>2</sub> O <sub>3</sub>	<i>n.d.</i>	0.08	0.12	<i>n.d.</i>	0.11	0.07	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	
Er <sub>2</sub> O <sub>3</sub>	0.13	<i>n.d.</i>	<i>n.d.</i>	0.09	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.13	
Yb <sub>2</sub> O <sub>3</sub>	<i>n.d.</i>	<i>n.d.</i>	0.21	0.02	<i>n.d.</i>	0.22	0.17	0.13	<i>n.d.</i>	
CaO	1.56	1.59	1.57	1.56	1.54	1.57	1.52	1.39	1.36	
PbO	0.21	0.22	0.22	0.21	0.21	0.22	0.20	0.19	0.18	
P <sub>2</sub> O <sub>5</sub>	31.20	31.51	31.48	31.06	31.51	31.21	31.57	31.69	31.85	
Total	99.08	100.73	99.25	99.97	99.82	99.81	100.09	99.71	99.55	
Age [Ma]	641	650	655	640	643	661	623	637	635	
Error [Ma]	40	40	40	40	40	40	42	45	46	

*n.d.* : not detected. Age error are quoted at 2 $\sigma$ .

Table A4. Adachi et al.

Sample	Kontum (reference age: 245 Ma)									
wt. %										
SiO <sub>2</sub>	0.37	0.45	0.35	0.36	0.50	0.32	0.32	0.45	0.34	0.34
UO <sub>2</sub>	0.64	0.88	0.80	0.96	0.79	0.86	0.89	0.69	0.91	0.69
ThO <sub>2</sub>	4.60	5.85	4.95	4.82	6.15	5.41	4.92	5.14	5.09	4.76
Y <sub>2</sub> O <sub>3</sub>	1.25	1.44	1.82	2.57	1.17	3.01	2.40	1.59	2.33	1.70
La <sub>2</sub> O <sub>3</sub>	14.26	13.37	14.32	13.35	14.70	13.07	13.23	13.73	13.75	14.34
Ce <sub>2</sub> O <sub>3</sub>	28.77	28.03	28.46	27.71	28.12	26.30	27.89	28.36	27.44	28.78
Pr <sub>2</sub> O <sub>3</sub>	2.90	2.85	3.01	2.32	2.64	3.10	2.76	3.23	2.65	2.67
Nd <sub>2</sub> O <sub>3</sub>	11.37	10.86	10.94	10.86	11.11	11.09	11.10	11.41	11.06	11.03
Sm <sub>2</sub> O <sub>3</sub>	1.88	1.95	1.87	1.96	1.94	1.91	2.01	1.90	1.66	1.43
Gd <sub>2</sub> O <sub>3</sub>	1.50	1.42	1.85	2.00	1.69	1.75	1.85	1.57	1.75	1.78
Dy <sub>2</sub> O <sub>3</sub>	0.45	0.38	0.79	0.77	0.32	0.61	0.61	0.33	0.66	0.50
Er <sub>2</sub> O <sub>3</sub>	0.02	<i>n.d.</i>	<i>n.d.</i>	0.11	<i>n.d.</i>	0.14	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.09
Yb <sub>2</sub> O <sub>3</sub>	<i>n.d.</i>	0.31	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.20	0.21	<i>n.d.</i>	0.33	0.43
CaO	0.98	1.27	1.12	1.18	1.26	1.24	1.16	1.10	1.28	1.14
PbO	0.06	0.09	0.08	0.09	0.09	0.08	0.09	0.07	0.08	0.07
P <sub>2</sub> O <sub>5</sub>	31.35	31.31	31.44	31.50	30.99	31.66	31.27	31.54	31.99	32.08
Total	100.40	100.46	101.79	100.54	101.47	100.73	100.68	101.11	101.32	101.83
Age [Ma]	225	238	249	269	251	246	262	233	242	235
Error [Ma]	48	37	43	41	37	39	41	43	40	46

Sample	Kontum (reference age: 245 Ma)								
wt. %									
SiO <sub>2</sub>	0.37	0.41	0.43	0.32	0.60	0.33	0.39	0.44	
UO <sub>2</sub>	1.02	0.81	0.91	0.84	0.87	0.85	0.80	1.05	
ThO <sub>2</sub>	5.23	4.55	6.31	4.86	6.60	4.95	4.51	5.78	
Y <sub>2</sub> O <sub>3</sub>	2.41	1.34	1.84	1.92	1.85	2.39	2.14	2.46	
La <sub>2</sub> O <sub>3</sub>	13.85	14.81	13.48	13.98	13.86	14.47	14.12	13.40	
Ce <sub>2</sub> O <sub>3</sub>	27.20	28.45	27.07	27.97	27.28	27.03	28.53	26.66	
Pr <sub>2</sub> O <sub>3</sub>	2.83	2.88	2.83	2.43	2.57	2.69	2.58	2.84	
Nd <sub>2</sub> O <sub>3</sub>	11.37	11.60	11.21	11.04	10.51	10.87	10.86	10.69	
Sm <sub>2</sub> O <sub>3</sub>	2.06	1.91	1.59	1.52	1.99	1.73	1.62	1.80	
Gd <sub>2</sub> O <sub>3</sub>	1.71	1.55	1.80	1.65	1.58	1.52	1.78	1.73	
Dy <sub>2</sub> O <sub>3</sub>	0.59	0.42	0.52	0.63	0.61	0.28	0.74	0.30	
Er <sub>2</sub> O <sub>3</sub>	0.19	<i>n.d.</i>	0.03	0.12	<i>n.d.</i>	0.17	<i>n.d.</i>	0.02	
Yb <sub>2</sub> O <sub>3</sub>	0.16	0.02	0.26	0.14	<i>n.d.</i>	0.40	0.18	0.19	
CaO	1.24	0.99	1.33	1.11	1.35	1.10	1.05	1.29	
PbO	0.09	0.08	0.10	0.07	0.10	0.08	0.09	0.09	
P <sub>2</sub> O <sub>5</sub>	31.20	31.71	31.88	31.90	31.80	31.76	31.97	31.63	
Total	101.50	101.52	101.57	100.49	101.59	100.61	101.37	100.37	
Age [Ma]	255	255	246	235	252	255	303	243	
Error [Ma]	38	45	35	42	34	42	45	35	

*n.d.* : not detected. Age error are quoted at 2 $\sigma$ .

Table A4. Continued.

A4サイズ