

### Supplementary Data

This supplementary data is a part of paper entitled "Analysis Methods for Development of Certified Reference Material (CRM) Zircon Minerals Synthesis".

**Supplement 1 (S-1).** Homogeneity test data of ZrO<sub>2</sub> concentrations (macro compounds) in the Kalimantan zircon mineral CRM candidate

Sample code	Test result of ZrO <sub>2</sub> (%)		Xt	Xt-Xr	(Xt-Xr) <sup>2</sup>	Wt	Wt <sup>2</sup>
	A	B					
1	39.706	41.340	40.523	0.9549	0.91183401	1.634	2.669956
2	39.067	39.287	39.177	-0.3911	0.15295921	-0.220	0.048400
3	39.604	39.840	39.722	0.1539	0.02368521	-0.236	0.055696
4	39.730	39.970	39.850	0.2819	0.07946761	0.240	0.057600
5	39.875	39.975	39.925	0.3569	0.12737761	-0.100	0.010000
6	38.471	39.840	39.156	-0.4126	0.17023876	-1.369	1.874161
7	39.067	39.287	39.177	-0.3911	0.15295921	0.220	0.048400
8	38.986	39.131	39.059	-0.5096	0.25969216	-0.450	0.021025
9	39.572	39.465	39.519	-0.0496	0.00246016	-0.107	0.011449
10	39.631	39.518	39.575	0.0064	4.096E-05	0.113	0.012769
		Xr	39.5681				
		Total			1.8807149		4.809456
				Sx	0.04484161	Sw	0.202364
				Sx <sup>2</sup>	0.01091694	Sw <sup>2</sup>	0.014456792
						Sw <sup>2</sup> /2	0.007228396
						Sx <sup>2</sup> - (Sw <sup>2</sup> /2)	0.003688544
						Ss	0.001844272

**Supplement 2 (S-2).** Homogeneity test data of HfO<sub>2</sub> concentrations (micro compounds) in the Kalimantan zircon mineral CRM candidate

Sample code	Test result of HfO <sub>2</sub> (%)		Xt	Xt-Xr	(Xt-Xr) <sup>2</sup>	Wt	Wt <sup>2</sup>
	A	B					
1	0.6589	0.6596	0.659225	0.659225	0.000117278	0.00073	5.329E-07
2	0.6583	0.6594	0.658855	0.658855	0.000109401	-0.00103	1.0609E-06
3	0.6210	0.6280	0.62450	0.62450	0.000570995	-0.00700	4.9E-05
4	0.6586	0.6566	0.657565	0.657565	8.40797E-05	-0.00197	3.8809E-06
5	0.6595	0.6583	0.658875	0.658875	0.000109820	0.00121	1.4641E-06
6	0.6320	0.6360	0.63400	0.63400	0.000207230	-0.00400	0.000016
7	0.6589	0.6574	0.658115	0.658115	9.44687E-05	-0.00149	2.2201E-06
8	0.6150	0.6180	0.616500	0.61650	0.001017323	-0.00300	9.0E-06
9	0.6566	0.6588	0.657695	0.657695	8.64807E-05	0.00211	4.4521E-06
10	0.6568	0.6604	0.658625	0.658625	0.000104643	-0.00361	1.30321E-05
		Xr	<b>0.6483955</b>				
		Total			<b>0.002501719</b>		<b>0.000100643</b>
				Sx	<b>0.000138984</b>	Sw	<b>2.51608E-06</b>
				Sx <sup>2</sup>	<b>1.93167E-08</b>	Sw <sup>2</sup>	<b>6.33065E-12</b>
						Sw <sup>2</sup> /2	<b>3.16532E-12</b>
						Sx <sup>2</sup> - (Sw <sup>2</sup> /2)	<b>1.93135E-08</b>
						Ss	<b>9.65675E-09</b>

**Supplement 3 (S-3).** Homogeneity test data of ZrO<sub>2</sub> concentrations (macro compounds) in the Bangka zircon mineral CRM candidate

Sample code	Test result of ZrO <sub>2</sub> , %		Xt	Xt-Xr	(Xt-Xr) <sup>2</sup>	Wt	Wt <sup>2</sup>
	A	B					
1	29.629	29.771	29.70040	0.4650195	0.21624314	0.14222	0.020227
2	29.022	29.082	29.05173	-0.1836455	0.03372567	-0.06021	0.003625
3	28.716	29.180	28.94781	-0.2875755	0.08269967	-0.46431	0.215584
4	28.110	29.696	28.90327	-0.3321055	0.11029406	1.58607	2.515618
5	30.339	29.062	29.70029	0.4649145	0.21614549	1.27673	1.630039
6	28.645	27.218	27.93153	-1.3038505	1.70002613	1.42648	2.034845
7	28.443	29.482	28.96245	-0.2729305	0.07449106	1.0393	1.080144
8	30.645	29.112	29.87817	0.6427895	0.41317834	1.53324	2.350825
9	29.589	30.645	30.11706	0.8816845	0.77736756	1.05545	1.113975
10	28.885	29.437	29.16108	-0.0743005	0.00552056	-0.55114	0.303755
		Xr	29.235381				
		Total			3.62969168		11.26864
				Sx	0.20164954	Sw	0.281716
				Sx <sup>2</sup>	0.04066254	Sw <sup>2</sup>	0.079364
						Sw <sup>2</sup> /2	0.039682
						Sx <sup>2</sup> - (Sw <sup>2</sup> /2)	0.000981
						Ss	0.00049

**Supplement 4 (S-4).** Homogeneity test data of CeO<sub>2</sub> concentrations (micro compounds) in the Bangka zircon mineral CRM candidate

Sample code	Test result of CeO <sub>2</sub> , %		Xt	Xt-Xr	(Xt-Xr) <sup>2</sup>	Wt	Wt <sup>2</sup>
	A	B					
1	4.2665	4.3709	4.318695	-0.128582	0.01653333	0.10437	0.010893
2	4.4537	4.3561	4.404925	-0.042352	0.00179369	0.09765	0.009536
3	4.2438	4.3677	4.305735	-0.141542	0.02003414	-0.12389	0.015349
4	4.3575	4.2712	4.314355	-0.132922	0.01766826	-0.08633	0.007453
5	4.6049	4.6029	4.603895	0.156618	0.0245292	0.00201	4.04E-06
6	4.3051	4.5416	4.423375	-0.023902	0.00057131	-0.23655	0.055956
7	4.5641	4.5282	4.54619	0.098913	0.00978378	-0.03588	0.001287
8	4.5830	4.4599	4.52143	0.074153	0.00549867	0.1231	0.015154
9	4.5587	4.5106	4.534635	0.087358	0.00763142	-0.04807	0.002311
10	4.5619	4.4372	4.499535	0.052258	0.0027309	0.12475	0.015563
		Xr	4.447277				
		Total			0.10677469		0.133504
				Sx	0.00593193	Sw	0.003338
				Sx <sup>2</sup>	3.5188E-05	Sw <sup>2</sup>	1.11E-05
						Sw <sup>2</sup> /2	5.57E-06
						Sx <sup>2</sup> - (Sw <sup>2</sup> /2)	2.96E-05
						Ss	1.48E-05

**Supplement 5 (S-5).** Stability test data of ZrO<sub>2</sub> concentrations (macro compounds) in the Bangka zircon mineral CRM candidate according to ISO 13528: 2008

No.	Sample code	Test results of ZrO <sub>2</sub> after 6 months		Yt (%) on average Y <sub>A</sub> and Y <sub>B</sub>
		Y <sub>A</sub>	Y <sub>B</sub>	
1	2	39.706	39.067	39.386
2	5	39.067	38.986	39.026
3	9	39.604	39.287	39.446
			Yr (%)	39.247

**Supplement 6 (S-6).** Stability test data of HfO<sub>2</sub> concentrations (micro compounds) in the Kalimantan zircon mineral CRM candidate

No.	Sample code	Test results of HfO <sub>2</sub> after 6 months		Yt (%) on average Y <sub>A</sub> and Y <sub>B</sub>
		Y <sub>A</sub>	Y <sub>B</sub>	
1	2	0.659	0.648	0.653
2	5	0.660	0.631	0.650
3	9	0.657	0.640	0.653
			Yr (%)	0.652

**Supplement 7 (S-7).** Stability test data of ZrO<sub>2</sub> concentrations (macro compounds) in the Bangka zircon mineral CRM candidate according to ISO 13528: 2008

No.	Sample code	Test results of ZrO <sub>2</sub> after 6 months		Yt (%) On average Y <sub>A</sub> and Y <sub>B</sub>
		Y <sub>A</sub>	Y <sub>B</sub>	
1	2	29.022	28.970	28.996
2	5	28.716	29.100	28.908
3	9	28.110	28.920	28.515
			Yr (%)	28.836

**Supplement 8 (S-8).** Stability test data of CeO<sub>2</sub> concentrations (micro compounds) in the Bangka zircon mineral CRM candidate

No.	Sample code	Test results of CeO <sub>2</sub> after 6 months		Yt (%) on average Y <sub>A</sub> and Y <sub>B</sub>
		Y <sub>A</sub>	Y <sub>B</sub>	
1	2	4.305	4.320	4.308
2	5	4.454	4.420	4.437
3	9	4.357	4.380	4.358
			Yr (%)	4.368

**Supplement 9 (S-9).** Calculation certification concentrations of ZrO<sub>2</sub> in the Kalimantan zircon mineral CRM candidate

Lab number	X <sub>i</sub>	μ <sub>i</sub>	W <sub>i</sub> '	W <sub>i</sub>	W <sub>i</sub> .X <sub>i</sub>	W <sub>i</sub> <sup>2</sup> μ <sub>i</sub> <sup>2</sup>
1	39.875	1.172	0.7305	0.0105	0.4179	0.000150364
2	39.601	0.281	1.7551	0.1830	7.2468	0.002625421
3	39.732	0.243	17.3611	0.2491	9.8964	0.003573489
4	39.067	0.220	20.6612	0.2964	11.5804	0.004252748
5	39.639	1.241	0.6504	0.0093	0.3699	0.000133866
6	38.986	0.245	16.6597	0.2390	9.3182	0.003429121
7	38.416	1.309	0.5836	0.0084	0.3217	0.000120126
8	38.473	3.417	0.0856	0.0012	0.0473	1.76289E-05
9	39.648	2.160	0.2143	0.0031	0.1219	4.41172E-05
Total			69.7016			0.014346881
X average					39.3204	
μ <sub>x</sub>						0.1198

**Supplement 10 (S-10).** Calculation Certification Concentrations of HfO<sub>2</sub> in the Kalimantan Zircon Mineral CRM Candidate

Lab number	X <sub>i</sub>	μ <sub>i</sub>	W <sub>i</sub> '	W <sub>i</sub>	W <sub>i</sub> .X <sub>i</sub>	W <sub>i</sub> <sup>2</sup> μ <sub>i</sub> <sup>2</sup>
1	0.621	0.082	148.7210	0.0355	0.0221	8.49488E-06
2	0.593	0.029	1189.0606	0.2842	0.1685	6.79187E-05
3	0.601	0.033	918.2736	0.2195	0.1319	5.24514E-05
4	0.632	0.071	198.3733	0.0474	0.0300	1.1331E-05
5	0.636	0.075	177.7778	0.0425	0.0270	1.01546E-05
6	0.615	0.055	330.5785	0.0790	0.0486	1.88825E-05
7	0.628	0.077	168.6625	0.0403	0.0253	9.63393E-06
8	0.607	0.034	865.0519	0.2067	0.1255	4.94114E-05
9	0.618	0.073	187.6525	0.0448	0.0277	1.07186E-05
Total			4184.1518			0.000238997
X average					0.6066	
μ <sub>x</sub>						0.0155

**Supplement 11 (S-11).** Calculation certification concentrations of TiO<sub>2</sub> in the Kalimantan zircon mineral CRM candidate

Lab number	$X_i$	$\mu_i$	$W_i'$	$W_i$	$W_i.X_i$	$W_i^2\mu_i^2$
1	23.919	0.17	34.6021	0.1348	3.2239	0.000525009
2	24.421	0.21	22.6757	0.0883	2.1570	0.000344053
3	24.434	0.21	22.6757	0.0883	2.1582	0.000344053
4	23.413	0.13	59.1716	0.2305	5.3964	0.000897796
5	23.921	0.17	34.6021	0.1348	3.2241	0.000525009
6	24.425	0.21	22.6757	0.0883	2.1574	0.000344053
7	23.916	0.19	27.7008	0.1079	2.5806	0.000420298
8	24.332	0.27	13.7174	0.0534	1.3001	0.000208131
9	23.218	0.23	18.9036	0.0736	1.7096	0.000286819
Total			256.7248			0.003895222
X average					23.9073	
$\mu_x$						0.0624

**Supplement 12 (S-12).** Calculation certification concentrations of Al<sub>2</sub>O<sub>3</sub> in the Kalimantan zircon mineral CRM candidate

Lab number	$X_i$	$\mu_i$	$W_i'$	$W_i$	$W_i.X_i$	$W_i^2\mu_i^2$
1	1.32	0.08	156.2500	0.0493	0.0651	1.55493E-05
2	1.41	0.06	277.7778	0.0876	0.1236	2.76431E-05
3	1.43	0.07	204.0816	0.0644	0.0921	2.03093E-05
4	1.38	0.04	625.0000	0.1972	0.2721	6.21971E-05
5	1.39	0.05	400.0000	0.1262	0.1754	3.98061E-05
6	1.42	0.07	204.0816	0.0644	0.0914	2.03093E-05
7	1.38	0.05	400.0000	0.1262	0.1741	3.98061E-05
8	1.39	0.06	277.7778	0.0876	0.1218	2.76431E-05
9	1.32	0.04	625.0000	0.1972	0.2603	6.21971E-05
Total			3169.9688			0.000315461
X average					1.3758	
$\mu_x$						0.0178

**Supplement 13 (S-13).** Calculation certification concentrations of ZrO<sub>2</sub> in the Bangka zircon mineral CRM candidate

Lab number	$X_i$	$\mu_i$	$W_i'$	$W_i$	$W_i.X_i$	$W_i^2\mu_i^2$
1	28.77	0.23	18.9036	0.0796	2.2914	0.00033558
2	28.92	0.23	18.9036	0.0796	2.3034	0.00033558
3	27.93	0.17	36.7309	0.1548	4.3224	0.000652055
4	27.91	0.17	36.7309	0.1548	4.3193	0.000652055
5	28.74	0.23	18.9036	0.0796	2.2891	0.00033558
6	28.42	0.20	25.7672	0.1086	3.0854	0.000457425
7	28.41	0.20	25.7672	0.1086	3.0844	0.000457425
8	28.53	0.17	36.7309	0.1548	4.4153	0.000652055
9	28.45	0.23	18.9036	0.0796	2.2660	0.00033558
Total			237.3416			0.004213336
X average					28.3768	
$\mu_x$						0.0649

**Supplement 14 (S-14).** Calculation certification concentrations of HfO<sub>2</sub> in the Kalimantan zircon mineral CRM candidate

Lab number	Xi	μi	Wi'	Wi	Wi.Xi	Wi <sup>2</sup> μi <sup>2</sup>
1	0.62	0.08	156.2500	0.0182	0.0113	2.11502E-06
2	0.68	0.02	2500.0000	0.2909	0.1978	3.38403E-05
3	0.65	0.04	625.0000	0.0727	0.0473	8.46008E-06
4	0.63	0.05	400.0000	0.0465	0.0293	5.41445E-06
5	0.68	0.02	2500.0000	0.2909	0.1978	3.38403E-05
6	0.65	0.06	277.7778	0.0323	0.0210	3.76003E-06
7	0.66	0.03	1111.1111	0.1293	0.0853	1.50401E-05
8	0.65	0.04	625.0000	0.0727	0.0473	8.46008E-06
9	0.64	0.05	400.0000	0.0465	0.0298	5.41445E-06
Total			8595.1389			0.000116345
X average					0.6668	
μx						0.0108

**Supplement 15 (S-15).** Calculation Certification Concentrations of TiO<sub>2</sub> in the Bangka zircon mineral CRM candidate

Lab number	Xi	μi	Wi'	Wi	Wi.Xi	Wi <sup>2</sup> μi <sup>2</sup>
1	2.88	0.04	625.0000	0.2135	0.6150	7.29559E-05
2	2.83	0.08	156.2500	0.0534	0.1511	1.8239E-05
3	2.91	0.08	156.2500	0.0534	0.1553	1.8239E-05
4	2.88	0.05	400.0000	0.1367	0.3936	4.66918E-05
5	2.91	0.07	204.0816	0.0697	0.2029	2.38223E-05
6	2.82	0.08	156.2500	0.0534	0.1505	1.8239E-05
7	2.89	0.04	625.0000	0.2135	0.6171	7.29559E-05
8	2.87	0.05	400.0000	0.1367	0.3922	4.66918E-05
9	2.86	0.07	204.0816	0.0697	0.1994	2.38223E-05
Total			2926.9133			0.000341657
X average					2.8772	
μx						0.0185