Supplementary Materials

Gem-Quality Zircon Megacrysts from Placer Deposits in the Central Highlands, Vietnam—Potential Source and Links to Cenozoic Alkali Basalts

Vuong Bui Thi Sinh *, Yasuhito Osanai, Christoph Lenz, Nobuhiko Nakano, Tatsuro Adachi, Elena Belousova and Ippei Kitano

Table S1. Results of LA-ICP-MS trace-element analyses of multiple measurement spots on zircon samples from Central Highlands, Vietnam (DL1, DL2, DL3, C05, C07, and C16) and from Ratanakiri, Cambodia (Rata). All values are given in ppm.

Sample / Spot	Nb	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	Th	U	Σ Y + REE
DL1-01	4.7	260	bdl	0.55	0.01	0.4	0.7	0.5	4.6	1.9	25.6	9.2	41.7	9.9	102	16.4	5873	1.29	0.28	27.0	60.7	474
DL1-02	4.7	219	bdl	0.59	0.05	0.7	1.5	0.9	6.0	2.0	24.0	8.1	35.4	8.5	88.8	14.3	5504	1.48	0.25	31.3	66.3	410
DL1-03	3.6	93	bdl	0.24	0.02	0.2	0.7	0.3	2.3	0.8	9.9	3.3	14.5	3.5	36.8	6.1	5778	0.67	0.08	10.0	22.5	172
DL1-04	3.8	128	bdl	0.24	0.01	0.2	0.3	0.2	1.8	0.8	11.7	4.5	21.9	5.4	57.8	9.7	5868	0.87	0.11	9.3	28.5	243
DL1-05	3.4	72	bdl	0.19	0.00	0.1	0.2	0.2	1.2	0.5	6.8	2.5	12.1	3.1	34.1	5.7	5996	0.73	0.06	5.7	18.3	139
DL1-06	2.9	60	bdl	0.17	0.01	0.0	0.1	0.1	1.1	0.4	5.5	2.0	10.1	2.5	28.1	4.9	6503	0.42	0.04	3.3	11.4	115
DL1-07	2.9	52	bdl	0.12	0.01	0.0	0.2	0.1	0.9	0.4	5.1	1.8	8.8	2.2	24.9	4.4	6748	0.39	0.03	3.2	10.7	101
DL1-08	3.3	104	bdl	0.22	0.03	0.3	0.6	0.4	2.4	0.9	11.1	3.8	16.4	4.0	42.3	6.8	5795	0.86	0.11	11.7	26.4	193
DL1-09	3.2	102	bdl	0.21	0.00	0.1	0.2	0.2	1.7	0.7	9.3	3.7	17.3	4.4	48.7	8.3	6162	0.64	0.09	7.2	23.2	196
DL1-10	4.9	278	bdl	0.59	0.03	0.3	0.9	0.7	5.6	2.2	29.1	10.2	44.9	10.3	103	16.6	5851	1.55	0.30	43.7	74.6	503
DL1-11	3.6	128	bdl	0.27	0.02	0.4	0.7	0.5	3.3	1.2	13.6	4.6	20.8	5.0	52.8	8.5	5693	1.03	0.13	16.4	36.0	240
DL1-12	5.4	283	0.01	0.85	0.09	1.1	1.8	1.3	7.8	2.6	31.7	10.4	45.5	10.7	112	18.0	5595	1.77	0.34	44.8	87.4	527
DL1-13	4.3	215	bdl	0.31	0.01	0.2	0.5	0.4	3.1	1.4	19.5	7.6	36.1	8.9	94.2	15.8	5933	1.24	0.19	12.3	40.4	403
DL2-01	28.9	1202	0.16	8.92	1.17	14.1	15.9	9.7	53.1	15.1	159	44.8	166	33.9	301	41.1	8114	7.39	1.63	472	444	2067
DL2-02	30.5	1248	0.24	9.78	1.20	15.1	18.1	10.3	57.1	15.7	162	46.1	170	34.3	307	41.3	8016	7.41	1.75	498	461	2137
DL2-03	26.6	1119	0.15	7.97	0.99	12.3	14.8	9.1	47.7	13.7	144	41.8	156	32.2	290	39.2	8099	7.37	1.61	419	440	1929
DL2-04	37.4	1345	0.28	15.1	1.80	22.3	25.0	13.2	68.0	18.3	183	50.5	182	36.7	326	42.0	8040	8.13	1.82	590	517	2329
DL2-05	39.8	1400	0.36	16.8	2.06	24.5	26.7	14.3	72.5	19.4	192	52.0	186	37.2	327	42.9	8034	8.20	1.89	635	523	2414
DL2-06	28.8	1196	0.19	9.00	1.18	14.6	17.4	9.9	52.0	15.1	156	44.4	165	33.7	305	41.1	8169	7.52	1.67	468	450	2060
DL2-07	39.6	895	0.14	10.2	0.98	12.6	14.8	8.2	44.5	11.8	118	32.7	119	23.9	217	29.1	8563	16.9	1.74	573	475	1536
DL2-08	41.1	794	0.11	9.46	0.85	10.8	12.4	7.1	39.1	10.3	104	29.0	106	21.7	197	26.6	8595	18.5	1.35	473	403	1369

DL2-09	46.2	767	0.14	10.1	0.84	10.9	12.2	6.8	36.6	10.0	99.4	28.2	102	21.0	191	25.6	8419	19.5	1.49	472	398	1322
DL2-10	38.2	897	0.15	9.42	0.95	12.0	13.8	7.8	44.0	11.7	117	32.5	119	23.9	214	28.7	8251	15.5	1.77	575	471	1531
DL2-11	24.6	1050	0.12	6.94	0.82	10.3	13.5	7.7	43.7	12.5	133	38.9	146	30.6	279	37.8	7750	7.21	1.53	371	407	1810
DL2-12	11.3	554	0.04	2.64	0.27	3.5	5.1	3.1	18.2	5.7	64.8	20.1	82.0	18.3	179	25.4	7778	5.47	0.91	130	241	982
DL2-13	18.5	660	0.05	3.84	0.25	4.1	6.1	4.2	26.1	7.6	82.2	24.0	91.1	19.1	177	24.3	8266	8.20	0.99	229	272	1129
DL2-14	14.3	608	0.01	3.29	0.07	1.5	4.4	3.2	21.1	6.6	73.7	22.3	86.3	18.1	169	23.3	8685	4.77	0.56	113	164	1041
DL2-15	2.7	55	0.00	0.10	0.00	0.0	0.0	0.1	0.5	0.2	3.9	1.9	11.0	3.2	38.5	6.8	7911	0.44	0.04	3.3	17.7	122
DL2-16	3.0	112	0.00	0.15	0.00	0.0	0.1	0.1	0.9	0.5	7.9	3.8	22.3	6.3	74.4	12.6	8088	0.67	0.15	5.8	28.3	241

Table S1. *Cont*.

Sample / Spot	Nb	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	Th	U	Σ Y +REE
DL3-01	1.2	152	bdl	1.02	0.01	0.2	0.4	0.5	3.7	1.4	16.8	5.5	23.6	4.7	41.7	5.2	5919	0.54	0.09	7.0	17.4	256
DL3-02	1.2	195	bdl	1.18	0.03	0.2	1.0	0.6	4.4	1.7	21.5	7.3	29.3	6.2	54.6	7.0	5797	0.51	bdl	10.3	22.6	330
DL3-03	1.1	161	0.01	1.07	0.01	0.2	0.5	0.5	4.0	1.5	18.4	5.8	25.0	5.0	43.4	5.7	5702	0.43	0.11	7.2	18.0	272
DL3-04	1.2	88	bdl	0.64	bdl	0.1	0.5	0.2	1.6	0.8	9.0	3.2	12.8	2.9	27.0	3.6	6411	0.48	0.07	5.3	15.3	150
DL3-05	1.2	125	bdl	0.76	0.02	0.2	0.7	0.4	3.5	1.2	14.6	4.7	18.8	3.9	35.5	4.6	6758	0.51	0.13	7.3	18.9	214
DL3-06	3.7	456	bdl	3.04	0.05	0.8	1.8	1.5	12.6	4.4	51.1	17.1	67.0	13.3	110	14.3	5739	1.66	0.37	52.3	82.8	753
DL3-07	5.6	572	0.28	4.53	0.14	1.7	2.6	2.0	17.5	5.8	66.5	20.9	85.1	16.3	130	17.3	5656	2.21	0.74	90.2	117	942
DL3-08	3.8	695	bdl	2.35	0.11	2.4	5.5	3.6	24.9	8.3	90.2	26.5	99.9	19.3	157	19.5	5657	1.91	0.34	50.9	81.9	1155
DL3-09	3.1	588	bdl	1.81	0.09	2.1	4.4	2.9	21.0	7.0	74.1	22.2	83.8	16.3	134	16.6	5422	1.62	0.24	40.1	65.4	974
DL3-10	1.8	205	0.01	0.91	0.02	0.4	1.4	0.9	6.6	2.3	25.6	8.0	30.3	6.0	52.4	6.2	6626	0.81	0.09	14.6	30.3	346
DL3-11	3.6	650	0.02	1.84	0.10	2.1	5.5	3.6	25.1	7.8	85.1	24.9	94.1	18.0	147	18.6	5590	1.68	0.31	48.3	78.3	1083
DL3-12	5.4	566	bdl	3.86	0.08	1.1	2.9	1.8	15.2	5.7	66.5	21.5	83.4	16.3	135	17.0	5967	2.37	0.37	94.1	125	936
DL3-13	1.7	322	bdl	1.27	0.08	1.1	2.4	1.5	11.0	3.7	40.3	11.8	47.2	9.1	75.2	9.4	6338	0.85	0.15	19.8	35.5	536
DL3-14	1.7	260	0.01	1.08	0.05	1.0	1.9	1.3	9.9	3.0	31.8	9.8	37.7	7.2	61.5	7.4	6315	0.72	0.11	18.5	32.9	434
DL3-15	1.1	95	bdl	0.54	0.00	0.2	0.4	0.3	2.1	0.8	10.5	3.4	14.1	3.1	28.2	3.7	6261	0.40	0.07	5.5	15.7	162

Table S1. *Cont.*

Sample / Spot	Nb	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	Th	U	Σ Y + REE
C05-1	1.38	202	0.00	1.00	0.01	0.24	0.68	0.60	4.4	1.8	22.3	8.2	34.1	7.0	67.1	11.7	6898	0.78	bdl	15.8	42.1	361
C05-2	1.38	298	0.01	1.18	0.09	1.19	2.21	1.60	9.5	3.4	36.4	11.8	45.4	8.6	79.1	13.1	6491	0.76	bdl	19.6	36.7	512
C05-3	2.05	392	0.01	1.67	0.11	1.62	3.19	2.25	13.2	4.5	52.1	16.7	66.6	12.9	117	17.6	5913	1.10	bdl	31.4	60.4	701
C05-4	1.55	276	0.00	1.17	0.06	0.97	1.82	1.32	8.0	2.9	31.7	10.6	42.5	8.3	79.1	12.6	6293	0.84	bdl	16.8	35.6	477
C05-5	1.36	292	0.01	1.25	0.08	1.19	2.04	1.47	9.4	3.3	34.7	11.3	44.3	8.6	80.5	12.5	6248	0.74	bdl	18.6	36.9	503
C05-6	1.43	301	0.01	1.20	0.08	1.12	2.20	1.50	9.3	3.4	35.5	11.6	45.0	8.8	82.4	12.8	6339	0.79	bdl	19.3	37.5	516
C05-7	0.65	102	0.01	0.58	0.01	0.12	0.29	0.32	2.2	0.9	10.7	3.8	15.8	3.3	33.6	5.6	7056	0.37	bdl	4.6	15.6	179
C07-1	1.38	199	0.00	1.02	0.06	0.98	1.96	1.44	7.6	2.6	28.5	8.5	31.3	6.8	62.5	7.8	5233	0.89	0.01	18.1	39.3	360
C07-2	1.76	106	0.00	0.83	0.02	0.28	0.76	0.67	3.2	1.3	14.7	4.6	18.3	4.3	45.0	5.6	4963	1.17	0.02	9.2	29.2	205
C07-4	1.24	161	0.00	0.92	0.01	0.22	0.67	0.57	4.1	1.7	20.2	7.0	28.5	5.9	52.3	8.3	6791	0.70	bdl	11.2	31.2	292
C07-5	1.55	212	0.00	1.07	0.02	0.30	0.84	0.76	4.9	2.0	24.5	8.5	35.4	7.2	63.9	9.9	6495	0.83	bdl	15.3	39.3	371
C07-6	0.98	115	0.00	0.70	0.01	0.18	0.47	0.47	3.2	1.2	14.7	5.1	20.8	4.4	42.4	5.7	5322	0.61	0.01	11.4	31.9	214
C07-7	0.80	105	0.00	0.54	0.01	0.15	0.46	0.37	2.4	1.1	12.7	4.2	17.9	3.9	39.2	5.1	4955	0.48	bdl	7.2	24.6	194
C16-1	0.58	124	0.00	0.38	0.02	0.36	0.69	0.49	2.5	1.2	13.7	4.5	17.0	3.5	32.2	5.0	4353	0.35	0.01	7.9	15.6	206
C16-2	0.69	80	0.00	0.29	0.01	0.11	0.29	0.26	1.4	0.7	8.3	2.9	11.7	2.7	26.7	4.5	4554	0.48	bdl	5.6	13.9	140
C16-3	0.47	108	0.00	0.31	0.00	0.10	0.28	0.25	1.5	0.8	10.2	3.9	16.3	3.7	35.8	6.3	5159	0.31	0.01	7.7	20.0	187
C16-4	0.31	26	0.00	0.15	0.00	0.02	0.07	0.08	0.5	0.2	3.1	1.0	4.6	1.1	12.4	1.7	3735	0.21	bdl	1.9	8.6	50
C16-5	0.42	77	0.00	0.27	0.00	0.07	0.27	0.24	1.4	0.7	8.7	3.0	12.4	2.9	30.7	4.0	4131	0.25	bdl	4.6	16.4	142
C16-6	0.39	80	0.00	0.28	0.01	0.09	0.30	0.25	1.6	0.7	8.8	3.1	12.5	3.1	31.9	4.1	4389	0.28	bdl	4.3	15.4	146

Table S2. U-Pb isotopic ratios and ages obtained from LA-ICP-MS analyses of zircon samples from Central Highlands, Vietnam.

Sample/Spot	Isotopic Ratios							Ages [Ma]			
	$^{207}Pb/^{206}Pb$	±2σ	$^{206}Pb/^{238}U$	±2σ	$^{207}Pb/^{235}U$	±2σ	Th/U	$^{206}Pb/^{238}U$	±2σ	$^{207}Pb/^{235}U$	±2σ
C05-1	0.0998	0.0493	0.0001	0.00001	0.0018	0.0008	0.376	0.8	0.16	1.8	0.82
C05-2	0.0722	0.0793	0.0001	0.00002	0.0014	0.0015	0.469	0.9	0.26	1.4	1.48
C05-3	0.0316	0.0397	0.0002	0.00001	0.0007	0.0008	0.421	1.0	0.16	0.7	0.84
C05-4	0.0897	0.0706	0.0001	0.00002	0.0016	0.0012	0.396	0.9	0.22	1.7	1.26
C05-5	0.0925	0.0737	0.0001	0.00001	0.0018	0.0013	0.375	0.9	0.20	1.7	1.34
C05-6	0.1632	0.0833	0.0001	0.00002	0.0029	0.0012	0.372	0.8	0.22	2.9	1.24
C05-7	0.0907	0.1015	0.0002	0.00002	0.0019	0.0021	0.345	1.0	0.30	1.9	2.08
C07-1	0.0741	0.0326	0.0002	0.00001	0.0017	0.0007	0.449	1.1	0.14	1.7	0.72
C07-2	0.0931	0.0420	0.0001	0.00001	0.0018	0.0007	0.454	0.9	0.16	1.8	0.74
C07-3	0.0965	0.0464	0.0001	0.00001	0.0017	0.0008	0.395	0.9	0.18	1.8	0.78
C07-4	0.0740	0.0405	0.0002	0.00001	0.0015	0.0008	0.306	1.0	0.16	1.5	0.82
C07-5	0.0767	0.0562	0.0001	0.00002	0.0015	0.0010	0.301	0.9	0.22	1.5	1.04
C07-6	0.0821	0.0503	0.0002	0.00002	0.0019	0.0011	0.311	1.1	0.20	1.9	1.12
C07-7	0.0975	0.0703	0.0001	0.00002	0.0019	0.0013	0.291	0.9	0.24	1.9	1.26
C16-1	0.0691	0.0132	0.0009	0.00003	0.0081	0.0014	0.350	5.5	0.40	8.2	1.44
C16-2	0.0653	0.0172	0.0009	0.00004	0.0084	0.0021	0.357	6.0	0.50	8.4	2.08
C16-3	0.0598	0.0141	0.0010	0.00004	0.0079	0.0018	0.299	6.2	0.46	8.0	1.80
C16-4	0.0592	0.0153	0.0010	0.00004	0.0085	0.0021	0.341	6.7	0.50	8.6	2.12
C16-5	0.0623	0.0219	0.0010	0.00005	0.0086	0.0029	0.331	6.4	0.66	8.7	2.90
C16-6	0.0623	0.0251	0.0011	0.00007	0.0090	0.0035	0.309	6.8	0.86	9.1	3.48

Table S3. U-Th-Pb isotopic ratios and ages obtained from LA-ICP-MS analyses of zircon samples from Dak Lak, Central Highlands, Vietnam.

Sample/Spot	Isotopic Ratios								Ages [Ma]					
	$^{207}Pb/^{206}Pb$	±2σ	$^{206}Pb/^{238}U$	±2σ	$^{207}Pb/^{235}U$	±2σ	$^{208}Pb/^{232}Th$	±2σ	$^{206}Pb/^{238}U$	±2σ	$^{208}Pb/^{232}Th$	±2σ	$^{207}Pb/^{235}U$	±2σ
DL1-1	0.0486	0.0046	0.0011	0.0000	0.0070	0.0006	0.0003	0.0000	6.8	0.2	7.0	0.6	7.1	0.6
DL1-2	0.0483	0.0036	0.0011	0.0000	0.0071	0.0005	0.0003	0.0000	6.9	0.2	6.9	0.4	7.2	0.5
DL1-3	0.0460	0.0081	0.0010	0.0000	0.0066	0.0011	0.0003	0.0000	6.7	0.3	6.6	0.8	6.7	1.1
DL1-4	0.0508	0.0048	0.0011	0.0000	0.0075	0.0007	0.0004	0.0000	6.9	0.2	8.3	0.6	7.6	0.7
DL1-5	0.0433	0.0105	0.0011	0.0001	0.0063	0.0015	0.0004	0.0001	6.8	0.4	8.3	1.3	6.4	1.5
DL2-1	0.0494	0.0013	0.0010	0.0000	0.0068	0.0002	0.0003	0.0000	6.5	0.1	6.5	0.1	6.9	0.2
DL2-2	0.0472	0.0014	0.0010	0.0000	0.0064	0.0002	0.0003	0.0000	6.3	0.1	6.5	0.1	6.4	0.2
DL2-3	0.0502	0.0014	0.0010	0.0000	0.0067	0.0002	0.0003	0.0000	6.2	0.1	6.4	0.1	6.8	0.2
DL2-4	0.0518	0.0019	0.0010	0.0000	0.0072	0.0003	0.0003	0.0000	6.5	0.1	6.9	0.1	7.3	0.3
DL2-5	0.0525	0.0013	0.0010	0.0000	0.0072	0.0002	0.0003	0.0000	6.4	0.1	6.4	0.1	7.3	0.2