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Electronic Supplementary Information

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3 **Precise and accurate Lu–Hf isotope analysis of columbite-group**
4 **minerals by MC–ICP–MS**

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19 Method S1 to S2

20 Fig. S1

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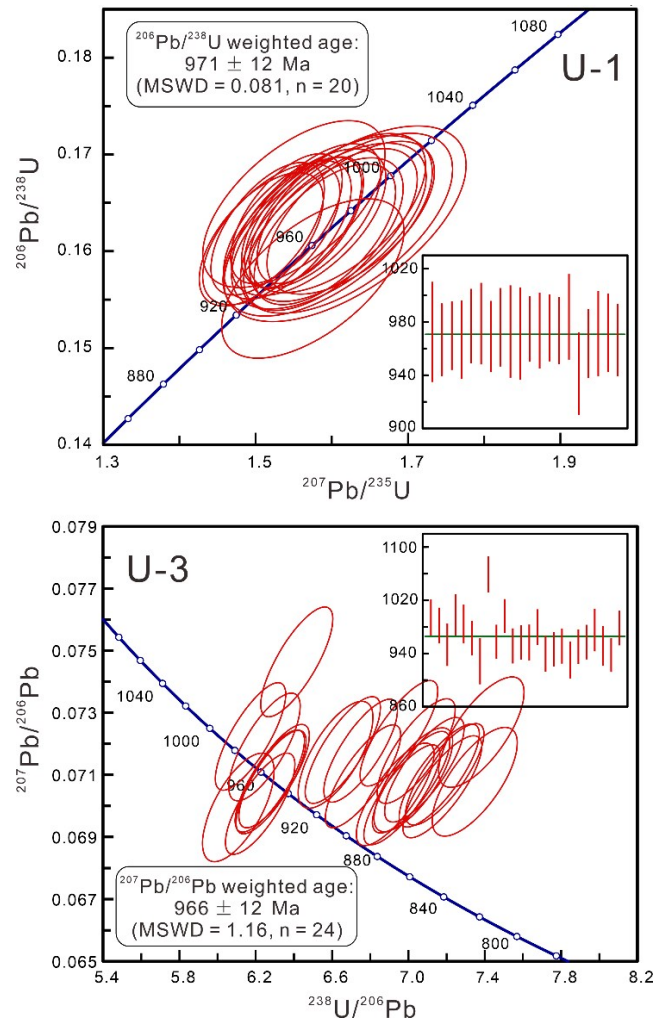
22 **Method S1. Major-element analyses by EPMA**

23 Grains of samples NP-2, U-1, U-3, Coltan139 and 713-79 were extracted, mounted
24 in epoxy resin and polished. Then their back-scattered electron (BSE) images and
25 quantitative analyses of samples were acquired with two electron probe microanalyzers
26 (EPMA) involving JEOL JXA-8100M and JXA-8230 at State Key Laboratory for
27 Mineral Deposits Research, Nanjing University (NJU), Nanjing, China. The operating
28 conditions were an accelerating voltage of 15 kV, a beam current of 20 nA and a beam
29 size of ca. 1 μm . The peak counting times were 20 s for Sn, W and Sc, and 10 s for
30 others. Pure metals (Ta, Nb, Sc), scheelite (W), synthetic Fe_2O_3 (Fe), synthetic MnO_2
31 (Mn), sintered MnTiO_3 (Ti) and SnO_2 (Sn) were used as standards. Data were corrected
32 using standard ZAF correction procedures.

33 **Method S2. *In situ* trace-element and U-Pb by LA-ICP-MS**

34 The trace elements and *in situ* U-Pb dating of these CGM samples were conducted
35 using a Geolas Plus 193 nm excimer ArF laser ablation system coupled to an Agilent
36 7500a quadrupole (Q) ICP-MS at State Key Laboratory of Lithospheric Evolution,
37 Institute of Geology and Geophysics, Chinese Academy of Sciences (CAS), Beijing,
38 China, and a RESOLUTION S155 laser ablation system integrated with a Thermo Fisher
39 Scientific iCAP-Q ICP-MS instrument at NJU. For detailed information on analytical
40 methods, see Che *et al.*¹. During analysis of trace elements and *in situ* U-Pb dating of
41 CGMs at CAS, each group of five unknowns was followed by zircon standards (91500
42 and GJ-1), CGM reference material (Coltan139) and NIST standard (SRM 610)
43 measurement. The laser was set to a 5-10 J/cm^2 fluence, a 44-90 μm spot size and a 3-

44 4 Hz repetition rate. Off-line data analysis was performed using GLITTER 4.0
45 computer program (GEMOC, Macquarie University). The U-Pb ages were calculated
46 using the ISOPLOT/EX 3.23 software package. During analysis of CGMs trace element
47 at NJU, each run included eight sample analyses following by duplicate analysis of
48 SRM 610, United States Geological Survey standards (BCR-2G and GSE-1G) and
49 Coltan139. The analyses were performed using a 5.24-5.31 J/cm² fluence, a 30-43 μm
50 diameter beam size and 4 Hz repetition rate. Off-line data analysis was performed using
51 the ICPMSDataCal program.²



52

53

Fig. S1 The ages of CGM samples U-1 and U-3 acquired from LA-ICP-MS.

54

55 Table S1

56 Average major- and trace-element concentrations of the CGM and ferrotapiolite
 57 samples, measured by EPMA and LA-ICP-MS.

Sample	NP-2	U-1	U-3	Coltan139	713-79
<i>Major elements (wt.%)</i>					
Number	21	15	16	20	20
WO ₃	0.18	1.08	0.88	0.74	0.21
Nb ₂ O ₅	43.78	33.45	44.82	62.57	10.87
Ta ₂ O ₅	36.65	47.78	34.55	12.67	65.71
TiO ₂	0.11	0.01	0.08	3.32	6.50
SnO ₂	0.28	0.09	0.27	0.61	0.97
Sc ₂ O ₃	0.14	0.05	0.07	0.88	0.00
FeO	11.40	3.20	18.06	10.38	15.11
MnO	6.96	13.92	0.98	8.99	0.64
Total	99.50	99.58	99.71	100.15	100.00
Ta [#]	0.34	0.46	0.32	0.11	0.78
Mn [#]	0.38	0.81	0.05	0.49	0.04
<i>Trace elements(ppm)</i>					
Number	32	27	25	30	20
Zr	1785	797	7108	2925	1790
Hf	211	469	1430	454	712
Pb	9.77	3.95	157	147	12.8
Th	0.145	2.08	0.330	85.9	0.0065
U	192	27.4	1089	2118	443
Y	1.244	1.02	0.120	2350	0.155
La	10.2	0.0299	0.105	0.251	0.0473
Ce	19.7	0.0272	0.123	4.53	0.0291
Pr	1.588	0.0087	0.0306	2.18	0.016
Nd	0.893	0.0264	0.0420	29.1	0.0249
Sm	<D.L.	0.0460	0.0748	128	0.03
Eu	<D.L.	0.0128	0.0292	0.156	0.0086
Gd	<D.L.	0.101	0.225	309	0.116
Tb	<D.L.	0.0247	0.0170	94.8	0.013
Dy	0.237.	0.205	0.0466	491	0.016
Ho	0.068	0.0372	0.0138	49	0.0035
Er	0.298	0.131	0.0265	82.8	0.0084
Tm	0.107	0.0390	0.0112	12.3	0.0035
Yb	1.610	0.483	0.0804	95.4	0.017
Lu	0.355	0.0681	0.0165	11.2	0.0043

58 All Fe is expressed as Fe²⁺; Ta[#] = molar Ta/(Ta + Nb); Mn[#] = molar Mn/(Mn + Ta).

59 <D.L.: lower than detection limit.

60 Data of samples Coltan139 and 713-79 quoted from Che *et al.* (2015).¹

61 Table S2

62 U-Pb isotopic data of samples U-1 and U-3.

Analysis_#	Th/ppm	U/ppm	U/Th	Isotope ratios						Ages (Ma)					
				$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm 1\sigma$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm 1\sigma$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm 1\sigma$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm 1\sigma$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm 1\sigma$
U-1															
U-1_01	1.15	16.1	13.9	0.0721	0.0051	1.6175	0.1049	0.1628	0.0067	988	137	977	41	973	37
U-1_02	1.98	25.0	12.6	0.0682	0.0029	1.5206	0.0595	0.1618	0.0048	876	84	939	24	967	27
U-1_03	3.02	45.9	15.2	0.0678	0.0023	1.5159	0.0492	0.1623	0.0045	862	70	937	20	970	25
U-1_04	2.00	24.3	12.1	0.0713	0.0034	1.5891	0.0691	0.1618	0.0052	966	93	966	27	967	29
U-1_05	2.09	24.1	11.5	0.0698	0.0029	1.5730	0.0603	0.1636	0.0049	922	83	960	24	977	27
U-1_06	1.64	17.1	10.4	0.0712	0.0036	1.6072	0.0765	0.1639	0.0054	962	101	973	30	979	30
U-1_07	2.06	31.4	15.3	0.0690	0.0027	1.5418	0.0553	0.1622	0.0047	899	77	947	22	969	26
U-1_08	1.82	24.3	13.4	0.0722	0.0035	1.6248	0.0726	0.1635	0.0052	991	95	980	28	976	29
U-1_09	1.88	25.2	13.4	0.0722	0.0045	1.6195	0.0919	0.1629	0.0061	991	121	978	36	973	34
U-1_10	1.70	18.1	10.7	0.0712	0.0044	1.5947	0.0907	0.1626	0.0062	963	122	968	36	971	34
U-1_11	3.04	42.2	13.9	0.0699	0.0022	1.5717	0.0461	0.1632	0.0043	926	63	959	18	975	24
U-1_12	2.01	24.0	12.0	0.0699	0.0032	1.5697	0.0669	0.1630	0.0050	926	91	958	26	973	28
U-1_13	2.61	39.2	15.0	0.0685	0.0023	1.5404	0.0483	0.1634	0.0044	883	68	947	19	976	24
U-1_14	2.82	40.9	14.5	0.0696	0.0024	1.5623	0.0507	0.1630	0.0044	917	70	955	20	973	25
U-1_15	2.05	27.0	13.1	0.0683	0.0038	1.5503	0.0790	0.1649	0.0057	877	110	951	31	984	32
U-1_16	2.18	26.4	12.1	0.0728	0.0040	1.5751	0.0790	0.1572	0.0054	1007	107	960	31	941	30
U-1_17	1.47	16.5	11.2	0.0679	0.0026	1.5074	0.0537	0.1612	0.0046	865	78	933	22	964	25
U-1_18	1.82	19.0	10.4	0.0713	0.0041	1.5963	0.0843	0.1626	0.0057	965	112	969	33	971	31
U-1_19	2.21	33.1	15.0	0.0715	0.0035	1.6023	0.0726	0.1627	0.0052	972	97	971	28	972	29
U-1_20	2.72	36.6	13.4	0.0714	0.0030	1.5910	0.0613	0.1618	0.0048	969	83	967	24	967	27
U-3															
U-3_01	0.199	727	3652	0.0723	0.0009	1.6128	0.0200	0.1620	0.0032	994	26	968	18	975	8
U-3_02	0.2	693	3467	0.0719	0.0009	1.4866	0.0180	0.1502	0.0030	982	25	902	17	925	7

U-3_03	<D.L.	491	-	0.0709	0.0011	1.3274	0.0190	0.1360	0.0027	953	31	822	16	858	8
U-3_04	0.129	473	3666	0.0724	0.0011	1.3509	0.0190	0.1354	0.0027	998	30	819	15	868	8
U-3_05	0.224	759	3387	0.0720	0.0010	1.5861	0.0207	0.1600	0.0032	985	28	957	18	965	8
U-3_06	0.313	1032	3298	0.0712	0.0009	1.3844	0.0164	0.1411	0.0027	963	25	851	15	882	7
U-3_07	0.139	583	4192	0.0700	0.0012	1.5785	0.0244	0.1637	0.0033	928	33	977	18	962	10
U-3_08	0.424	987	2327	0.0747	0.0010	1.6030	0.0197	0.1558	0.0030	1059	26	933	17	971	8
U-3_09	0.337	1198	3555	0.0710	0.0009	1.3656	0.0157	0.1396	0.0027	958	24	842	15	874	7
U-3_10	0.462	1361	2947	0.0724	0.0009	1.4342	0.0165	0.1438	0.0028	996	24	866	16	903	7
U-3_11	0.282	1321	4684	0.0708	0.0009	1.5527	0.0184	0.1591	0.0031	951	25	952	17	952	7
U-3_12	0.374	1323	3538	0.0710	0.0009	1.4458	0.0167	0.1478	0.0029	957	24	889	16	908	7
U-3_13	0.378	1336	3534	0.0710	0.0009	1.5528	0.0187	0.1587	0.0031	957	26	950	17	952	7
U-3_14	0.282	1091	3870	0.0718	0.0009	1.4045	0.0169	0.1420	0.0027	980	26	856	15	891	7
U-3_15	0.374	1181	3158	0.0704	0.0009	1.3992	0.0168	0.1442	0.0028	940	26	869	16	889	7
U-3_16	0.444	1445	3254	0.0706	0.0009	1.3559	0.0156	0.1393	0.0027	946	25	841	15	870	7
U-3_17	0.395	1533	3881	0.0708	0.0009	1.5553	0.0183	0.1593	0.0031	951	25	953	17	953	7
U-3_18	0.480	1488	3100	0.0701	0.0009	1.5518	0.0189	0.1606	0.0031	930	26	960	17	951	8
U-3_19	0.488	1447	2965	0.0708	0.0009	1.3901	0.0161	0.1425	0.0027	950	25	859	15	885	7
U-3_20	0.489	1712	3501	0.0710	0.0009	1.3610	0.0157	0.1390	0.0026	957	25	839	15	872	7
U-3_21	0.192	773	4028	0.0716	0.0011	1.4916	0.0212	0.1510	0.0030	975	31	907	17	927	9
U-3_22	0.334	1374	4114	0.0708	0.0010	1.3895	0.0182	0.1423	0.0028	952	28	858	16	885	8
U-3_23	0.441	1805	4093	0.0703	0.0008	1.3921	0.0156	0.1435	0.0027	938	24	865	15	886	7
U-3_24	0.442	1656	3747	0.0717	0.0009	1.4653	0.0172	0.1481	0.0028	979	25	890	16	916	7

64 Table S3

65 Ta/Hf ratios and concentrations of Ta and Hf in the mixed standard solutions.

Spex Hf (ng/mL)	Ta (ng/mL)	Ta/Spex Hf	Alfa Hf (ng/mL)	Ta (ng/mL)	Ta/Alfa Hf
50	0	0	200	0	0
50	50	1	200	200	1
50	100	2	200	400	2
50	250	5	200	1000	5
50	500	10	200	1600	8
50	750	15	200	2000	10
50	1000	20	200	2400	12
50	1250	25	200	3000	15
50	1500	30	200	4000	20
50	1750	35	200	5000	25
50	2000	40	200	6000	30
50	2500	50	200	7000	35
50	3000	60	200	8000	40
			200	10000	50

67 Table S4

68 Comparisons of Hf isotopic ratios obtained in this study with published values for
 69 standard materials.

Standard	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE	spike	Lab.	Reference values
<i>MC-ICP-MS</i>					
BCR-2	0.282870	0.000015			0.282870 ± 08 (Weis <i>et al.</i> , 2007) ³
BCR-2	0.282877	0.000013	yes	CAS	0.282858 ± 06 (Nebel <i>et al.</i> , 2009) ⁴
					0.282877 ± 03 (Yang <i>et al.</i> , 2010) ⁵
Mean(±2SD)	0.282874(09)				
AGV-2	0.282984	0.000016			0.282984 ± 09 (Weis <i>et al.</i> , 2007) ³
AGV-2	0.282988	0.000014	yes	CAS	0.282978 ± 04 (Lei <i>et al.</i> , 2019) ⁶
Mean(±2SD)	0.282986(05)				
Alfa Hf	0.282192	0.000007			
Alfa Hf	0.282195	0.000008			
Alfa Hf	0.282185	0.000010	yes	CAS	0.282185 ± 30 (In-house CAS Hf standard)
Alfa Hf	0.282189	0.000010			
Alfa Hf	0.282183	0.000010			
Mean(±2SD)	0.282189(10)				
BHVO-2	0.283098	0.000004			
BHVO-2	0.283099	0.000007			0.283105 ± 11 (Weis <i>et al.</i> , 2007) ³
BHVO-2	0.283097	0.000007	yes	CAS	0.283097 ± 14 (Fourny <i>et al.</i> , 2016) ⁷
BHVO-2	0.283099	0.000007			
Mean(±2SD)	0.283098(01)				
BHVO-2	0.283098	0.000008	no	CAS	Same as above
BIR-1a	0.283245	0.000028	no	CAS	0.283266 ± 17 (Blichert-Toft, 2001) ⁸
					0.283243 ± 34 (Fourny <i>et al.</i> , 2016) ⁷
JMC475	0.282163	0.000011			
JMC475	0.282164	0.000007	no	NJU	0.282158 ± 18 (Yang <i>et al.</i> , 2010) ⁵
JMC475	0.282162	0.000015			0.282150 ± 7 (Lei <i>et al.</i> , 2019) ⁶
Mean(±2SD)	0.282163(01)				
BCR-2	0.282853	0.000010			
BCR-2	0.282855	0.000007	no	NJU	Same as above
Mean(±2SD)	0.282854(04)				
<i>LA-MC-ICP-MS</i>				NJU	
91500_01	0.282281	0.000031			0.282306 ± 8 (solution); 0.282296 ± 28
91500_02	0.282282	0.000020			(laser) (Woodhead and Hergt, 2005) ⁹
91500_03	0.282267	0.000020			0.282307 ± 31 (laser) (Wu <i>et al.</i> ,
91500_04	0.282308	0.000020			2006) ¹⁰
91500_05	0.282329	0.000022			
91500_06	0.282333	0.000019			
91500_07	0.282302	0.000023			
91500_08	0.282311	0.000020			
91500_09	0.282299	0.000020			
91500_10	0.282286	0.000019			

91500_11	0.282296	0.000019
91500_12	0.282301	0.000019
91500_13	0.282294	0.000018
91500_14	0.282293	0.000021
91500_15	0.282270	0.000021
91500_16	0.282298	0.000021
91500_17	0.282274	0.000021
91500_18	0.282305	0.000022
91500_19	0.282288	0.000020
91500_20	0.282284	0.000021
91500_21	0.282318	0.000020
91500_22	0.282282	0.000021
91500_23	0.282288	0.000020
91500_24	0.282274	0.000020
91500_25	0.282263	0.000022
91500_26	0.282289	0.000021
91500_27	0.282288	0.000021
91500_28	0.282299	0.000022
91500_29	0.282288	0.000021
91500_30	0.282310	0.000021
Mean(±2SD)	0.282293(34)	

70 2SE means the 2 standard error of the individual analysis. 2SD means the 2 standard deviation on the
71 mean of multiple analyses.

72 Table S5

73 Signal values in Alfa Hf and high concentration of Ta standard solutions using MC-ICP-MS.

Ta (ng/mL)	Alfa Hf (ng/mL)	¹⁷³ Yb (V)	¹⁷⁵ Lu (V)	¹⁷⁶ Hf (V)	¹⁷⁷ Hf (V)	¹⁷⁸ Hf (V)	¹⁷⁹ Hf (V)	¹⁸⁰ Hf (V)	¹⁸¹ Ta* (V)	¹⁸³ W (V)	Calculated value of Hf (ng/mL)
0	200	-0.00001	-0.00001	0.28391	1.01509	1.50238	0.75670	1.96592	0.00003	0.00004	
0	200	-0.00001	0.00000	0.27996	1.00105	1.48171	0.74634	1.93921	0.00003	0.00005	
0	200	-0.00001	-0.00001	0.28866	1.03221	1.52786	0.76959	1.99961	0.00003	0.00012	
0	200	-0.00001	0.00000	0.29174	1.04321	1.54417	0.77782	2.02101	0.00003	0.00007	
0	200	0.00000	0.00000	0.28987	1.03657	1.53439	0.77293	2.00839	0.00003	0.00003	
0	200	-0.00001	0.00000	0.27108	0.96964	1.43574	0.72346	1.88042	0.00004	0.00005	
0	200	0.00000	-0.00001	0.26907	0.96252	1.42521	0.71817	1.86671	0.00003	0.00011	
0	200	-0.00001	-0.00001	0.26921	0.96306	1.42610	0.71864	1.86802	0.00003	0.00023	
0	200	-0.00001	0.00000	0.27041	0.96734	1.43245	0.72183	1.87630	0.00003	0.00003	
	Mean	-0.00001	0.00000	0.27932	0.99897	1.47889	0.74505	1.93618	0.00003	0.00008	
1000	0	-0.00001	-0.00001	0.00002	0.00007	0.00011	0.00008	0.00304	0.00056	0.00328	0.015
10000	0	0.00004	0.00001	0.00009	0.00016	0.00024	0.00040	0.02831	0.00560	0.02532	0.033

74 ¹⁸¹Ta*: Signal of ¹⁸¹Ta of 1000 ng/mL and 10000 ng/mL Ta solutions can not be collected in Faraday cup, the data in this column does not represent the true value.

75

76 Table S6

77 Hf isotopes of Spex Hf + Ta and Alfa Hf + Ta solution passed through column II and no column.

Hf (ng/mL)	Ta (ng/mL)	Ta/Hf	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE
			no column (raw value)		no column (normalization of $^{179}\text{Hf}/^{177}\text{Hf} = 0.7325$)		no column (normalization of $^{178}\text{Hf}/^{177}\text{Hf} = 1.4672$)		column II (raw value)	
<i>Spex Hf + Ta solution</i>										
50	0	0	0.282141	0.000013						
50	0	0	0.282142	0.000017						
50	0	0	0.282140	0.000017						
50	50	1	0.282154	0.000016	0.282126	0.000016	0.282117	0.000016		
50	100	2	0.282150	0.000016	0.282133	0.000016	0.282117	0.000016		
50	250	5	0.282164	0.000016	0.282142	0.000016	0.282118	0.000016		
50	500	10	0.282187	0.000013	0.282171	0.000013	0.282128	0.000013		
50	750	15	0.282219	0.000017	0.282212	0.000017	0.282156	0.000017		
50	1000	20	0.282211	0.000017	0.282226	0.000017	0.282152	0.000017		
50	1250	25	0.282231	0.000013	0.282215	0.000013	0.282147	0.000013		
50	1500	30	0.282255	0.000015	0.282233	0.000015	0.282151	0.000015		
50	1750	35	0.282257	0.000014	0.282242	0.000014	0.282148	0.000014		
50	2000	40	0.282279	0.000016	0.282273	0.000016	0.282164	0.000016		
50	2500	50	0.282314	0.000015	0.282310	0.000015	0.282180	0.000015		
50	3000	60	0.282353	0.000017	0.282340	0.000017	0.282171	0.000017		
<i>Alfa Hf + Ta solution</i>										
200	0	0	0.282172	0.000011						
200	0	0	0.282161	0.000010						
200	0	0	0.282178	0.000010						
200	0	0	0.282167	0.000012						

200	0	0	0.282177	0.000013						
200	0	0	0.282166	0.000011						
200	0	0	0.282169	0.000012						
200	0	0	0.282171	0.000011						
200	200	1	0.282169	0.000013	0.282170	0.000013	0.282151	0.000013	0.282177	0.000006
200	400	2	0.282180	0.000010	0.282175	0.000010	0.282154	0.000010	0.282180	0.000011
200	1000	5	0.282197	0.000011	0.282196	0.000011	0.282168	0.000011	0.282184	0.000008
200	1600	8	0.282184	0.000012	0.282184	0.000012	0.282157	0.000012	0.282178	0.000009
200	2000	10	0.282191	0.000010	0.282189	0.000010	0.282162	0.000010	0.282176	0.000009
200	2400	12	0.282207	0.000011	0.282202	0.000011	0.282176	0.000011	0.282179	0.000009
200	3000	15	0.282202	0.000011	0.282201	0.000011	0.282173	0.000011	0.282174	0.000010
200	4000	20	0.282210	0.000010	0.282210	0.000010	0.282173	0.000010	0.282180	0.000010
200	5000	25	0.282221	0.000011	0.282216	0.000011	0.282174	0.000011	0.282180	0.000010
200	6000	30	0.282218	0.000012	0.282220	0.000012	0.282171	0.000012	0.282182	0.000009
200	7000	35	0.282236	0.000009	0.282232	0.000009	0.282180	0.000009	0.282176	0.000011
200	8000	40	0.282246	0.000010	0.282243	0.000010	0.282177	0.000010	0.282173	0.000012
200	10000	50	0.282250	0.000013	0.282256	0.000013	0.282182	0.000013	0.282174	0.000011

79 Table S7

80 Hf isotopes of CGM and ferrotapiolite samples by LA-MC-ICP-MS ($^{179}\text{Hf}/^{177}\text{Hf}$ normalization).

	beta 2/3Yb	2SE	beta 7/9Hf	2SE	$^{176}\text{Yb}/^{177}\text{Hf}$	2SE	$^{176}\text{Lu}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE
<i>NP-2 (120$\mu\text{m}20\text{Hz}$)</i>										
NP-2_01	-2.63	0.57	-1.95	0.01	0.00603	0.00001	0.000251	0.00000	0.282455	0.000033
NP-2_02	-2.88	0.55	-1.93	0.01	0.00599	0.00002	0.000248	0.00000	0.282399	0.000030
NP-2_03	-2.49	0.52	-1.93	0.01	0.00616	0.00005	0.000256	0.00000	0.282479	0.000028
NP-2_04	-3.00	0.71	-1.95	0.01	0.00607	0.00002	0.000252	0.00000	0.282431	0.000035
NP-2_05	-3.30	0.62	-1.94	0.01	0.00604	0.00002	0.000249	0.00000	0.282366	0.000032
NP-2_06	-2.28	0.47	-1.91	0.01	0.00647	0.00005	0.000269	0.00000	0.282427	0.000028
NP-2_07	-2.23	0.54	-1.94	0.01	0.00614	0.00003	0.000257	0.00000	0.282497	0.000033
NP-2_08	-2.50	0.54	-1.94	0.01	0.00674	0.00012	0.000275	0.00000	0.282450	0.000030
NP-2_09	-1.97	0.51	-1.94	0.01	0.00594	0.00001	0.000250	0.00000	0.282515	0.000031
NP-2_10	-2.83	0.65	-1.99	0.01	0.00642	0.00003	0.000266	0.00000	0.282513	0.000038
NP-2_11	-2.45	0.55	-1.95	0.01	0.00574	0.00008	0.000239	0.00000	0.282489	0.000030
NP-2_12	-2.62	0.48	-1.93	0.01	0.00598	0.00001	0.000248	0.00000	0.282401	0.000032
NP-2_13	-1.97	0.79	-2.03	0.01	0.00616	0.00007	0.000258	0.00000	0.282678	0.000045
NP-2_14	-2.86	0.56	-1.94	0.01	0.00571	0.00001	0.000237	0.00000	0.282403	0.000029
NP-2_15	-2.89	0.62	-1.93	0.01	0.00583	0.00002	0.000242	0.00000	0.282432	0.000031
NP-2_16	-3.01	0.68	-1.94	0.01	0.00602	0.00001	0.000248	0.00000	0.282362	0.000031
NP-2_17	-2.87	0.64	-1.93	0.01	0.00584	0.00001	0.000243	0.00000	0.282391	0.000032
NP-2_18	-2.59	0.66	-1.95	0.01	0.00565	0.00003	0.000236	0.00000	0.282505	0.000036
NP-2_19	-2.34	0.50	-1.90	0.01	0.00577	0.00006	0.000241	0.00000	0.282389	0.000030
NP-2_20	-2.82	0.60	-1.93	0.01	0.00591	0.00001	0.000245	0.00000	0.282413	0.000030
NP-2_21	-2.97	0.67	-1.96	0.01	0.00592	0.00001	0.000246	0.00000	0.282422	0.000038
Mean [$\pm 2\text{SD}$]									0.282448[142]	
<i>U-1 (120$\mu\text{m}20\text{Hz}$)</i>										
U-1_01	-10.40	3.38	-2.02	0.01	0.00122	0.00001	0.000033	0.00000	0.282140	0.000027

U-1_02	-12.68	2.76	-2.03	0.01	0.00133	0.00001	0.000034	0.00000	0.282045	0.000032
U-1_03	-11.38	2.74	-2.03	0.01	0.00134	0.00001	0.000035	0.00000	0.282083	0.000034
U-1_04	-8.45	2.92	-2.03	0.01	0.00122	0.00001	0.000034	0.00000	0.282168	0.000029
U-1_05	-5.34	5.65	-2.05	0.01	0.00115	0.00001	0.000033	0.00000	0.282280	0.000032
U-1_06	-10.10	2.80	-2.03	0.01	0.00130	0.00001	0.000035	0.00000	0.282142	0.000029
U-1_07	-9.59	2.96	-2.07	0.01	0.00138	0.00002	0.000038	0.00000	0.282186	0.000031
U-1_08	-8.69	3.09	-2.03	0.01	0.00121	0.00001	0.000034	0.00000	0.282179	0.000030
U-1_09	-9.00	3.97	-2.17	0.01	0.00165	0.00002	0.000045	0.00000	0.282440	0.000048
U-1_10	-9.11	2.74	-2.06	0.01	0.00133	0.00001	0.000037	0.00000	0.282184	0.000034
U-1_11	-14.75	3.53	-2.11	0.01	0.00131	0.00002	0.000034	0.00000	0.282173	0.000034
U-1_12	-16.14	5.67	-2.33	0.01	0.00163	0.00003	0.000044	0.00000	0.282546	0.000063
U-1_13	-9.66	4.56	-2.13	0.01	0.00109	0.00002	0.000032	0.00000	0.282350	0.000032
U-1_14	-18.49	6.49	-2.47	0.01	0.00195	0.00005	0.000052	0.00000	0.282707	0.000075
U-1_15	-9.67	3.47	-2.09	0.01	0.00126	0.00001	0.000035	0.00000	0.282255	0.000034
U-1_16	-9.21	2.68	-2.11	0.01	0.00162	0.00003	0.000045	0.00000	0.282237	0.000037
U-1_17	-9.36	2.53	-2.04	0.01	0.00123	0.00001	0.000034	0.00000	0.282140	0.000029
U-1_18	-11.77	2.74	-2.05	0.01	0.00129	0.00001	0.000035	0.00000	0.282076	0.000031
U-1_19	-12.43	4.39	-2.36	0.01	0.00206	0.00003	0.000059	0.00000	0.282646	0.000061
U-1_20	-11.98	5.64	-2.07	0.01	0.00128	0.00002	0.000035	0.00000	0.282184	0.000047
U-1_21	-12.03	4.14	-2.03	0.01	0.00110	0.00002	0.000031	0.00000	0.282126	0.000031
U-1_22	-11.13	3.24	-2.05	0.01	0.00120	0.00001	0.000033	0.00000	0.282159	0.000032
U-1_23	-9.78	3.12	-2.06	0.01	0.00128	0.00002	0.000036	0.00000	0.282176	0.000039
U-1_24	-12.10	3.29	-2.05	0.01	0.00114	0.00001	0.000031	0.00000	0.282139	0.000031
U-1_25	-15.73	4.05	-2.04	0.01	0.00117	0.00002	0.000031	0.00000	0.282002	0.000035
U-1_26	-10.41	2.88	-2.06	0.01	0.00148	0.00002	0.000040	0.00000	0.282084	0.000039
U-1_27	-11.28	3.20	-2.05	0.01	0.00118	0.00001	0.000032	0.00000	0.282121	0.000031
U-1_28	-13.99	3.86	-2.11	0.01	0.00126	0.00002	0.000033	0.00000	0.282225	0.000034
U-1_29	-9.57	3.68	-2.13	0.01	0.00125	0.00002	0.000035	0.00000	0.282313	0.000037

Mean [±2SD]	0.282224[338]									
<i>U-3 (120µm20Hz)</i>										
U-3_01	-1.83	0.01	-1.83	0.01	0.00002	0.00000	0.000002	0.00000	0.281845	0.000018
U-3_02	-1.82	0.01	-1.82	0.01	0.00002	0.00000	0.000002	0.00000	0.281852	0.000015
U-3_03	-1.82	0.01	-1.82	0.01	0.00002	0.00000	0.000002	0.00000	0.281850	0.000015
U-3_04	-1.82	0.00	-1.82	0.00	0.00002	0.00000	0.000002	0.00000	0.281820	0.000015
U-3_05	-1.83	0.01	-1.83	0.01	0.00002	0.00000	0.000002	0.00000	0.281833	0.000014
U-3_06	-1.83	0.00	-1.83	0.00	0.00006	0.00000	0.000004	0.00000	0.281826	0.000014
U-3_07	-1.83	0.00	-1.83	0.00	0.00052	0.00003	0.000025	0.00000	0.281849	0.000015
U-3_08	-1.82	0.00	-1.82	0.00	0.00009	0.00001	0.000004	0.00000	0.281823	0.000016
U-3_09	-1.82	0.00	-1.82	0.00	0.00007	0.00001	0.000003	0.00000	0.281832	0.000016
U-3_10	-1.81	0.00	-1.81	0.00	0.00002	0.00000	0.000002	0.00000	0.281837	0.000015
U-3_11	-1.81	0.00	-1.81	0.00	0.00002	0.00000	0.000002	0.00000	0.281833	0.000016
U-3_12	-1.81	0.00	-1.81	0.00	0.00002	0.00000	0.000002	0.00000	0.281829	0.000016
U-3_13	-1.81	0.00	-1.81	0.00	0.00009	0.00000	0.000004	0.00000	0.281815	0.000016
U-3_14	-1.80	0.00	-1.80	0.00	0.00002	0.00000	0.000002	0.00000	0.281814	0.000015
U-3_15	-1.80	0.00	-1.80	0.00	0.00007	0.00000	0.000004	0.00000	0.281816	0.000016
U-3_16	-1.81	0.00	-1.81	0.00	0.00003	0.00000	0.000002	0.00000	0.281817	0.000015
U-3_17	-1.81	0.00	-1.81	0.00	0.00002	0.00000	0.000002	0.00000	0.281822	0.000016
U-3_18	-1.80	0.00	-1.80	0.00	0.00002	0.00000	0.000002	0.00000	0.281823	0.000015
U-3_19	-1.81	0.00	-1.81	0.00	0.00006	0.00000	0.000004	0.00000	0.281798	0.000015
U-3_20	-1.80	0.00	-1.80	0.00	0.00002	0.00000	0.000002	0.00000	0.281826	0.000016
U-3_21	-1.82	0.01	-1.82	0.01	0.00326	0.00017	0.000120	0.00001	0.281837	0.000016
U-3_22	-1.82	0.00	-1.82	0.00	0.00087	0.00008	0.000035	0.00000	0.281858	0.000018
Mean [±2SD]	0.281830[29]									
<i>Coltan139 (160µm20Hz)</i>										
Coltan139_01	-1.51	0.02	-1.81	0.00	0.13323	0.00003	0.003371	0.00000	0.282104	0.000021
Coltan139_02	-1.50	0.02	-1.81	0.00	0.13303	0.00005	0.003374	0.00000	0.282130	0.000022

Coltan139_03	-1.52	0.02	-1.81	0.00	0.13367	0.00008	0.003383	0.00000	0.282033	0.000022
Coltan139_04	-1.54	0.02	-1.81	0.00	0.13418	0.00006	0.003389	0.00000	0.281999	0.000023
Coltan139_05	-1.52	0.02	-1.81	0.00	0.13402	0.00004	0.003381	0.00000	0.282050	0.000021
Coltan139_06	-1.53	0.02	-1.81	0.00	0.13403	0.00004	0.003388	0.00000	0.282031	0.000024
Coltan139_07	-1.51	0.02	-1.80	0.00	0.13466	0.00003	0.003389	0.00000	0.282073	0.000023
Coltan139_08	-1.52	0.02	-1.80	0.00	0.13550	0.00005	0.003408	0.00000	0.282028	0.000020
Coltan139_09	-1.52	0.02	-1.81	0.00	0.13813	0.00004	0.003474	0.00000	0.282101	0.000022
Coltan139_10	-1.53	0.02	-1.81	0.00	0.14006	0.00004	0.003516	0.00000	0.282044	0.000020
Coltan139_11	-1.51	0.02	-1.81	0.00	0.13405	0.00004	0.003400	0.00000	0.282091	0.000023
Coltan139_12	-1.51	0.02	-1.81	0.00	0.13488	0.00003	0.003423	0.00000	0.282087	0.000024
Coltan139_13	-1.51	0.02	-1.81	0.00	0.13573	0.00008	0.003447	0.00000	0.282153	0.000024
Coltan139_14	-1.51	0.02	-1.81	0.00	0.13438	0.00003	0.003414	0.00000	0.282111	0.000023
Coltan139_15	-1.50	0.02	-1.82	0.00	0.13524	0.00003	0.003440	0.00000	0.282165	0.000023
Coltan139_16	-1.54	0.02	-1.82	0.00	0.13356	0.00005	0.003383	0.00000	0.281999	0.000022
Coltan139_17	-1.52	0.02	-1.81	0.00	0.13428	0.00006	0.003402	0.00000	0.282064	0.000023
Coltan139_18	-1.52	0.02	-1.81	0.00	0.13554	0.00005	0.003429	0.00000	0.282072	0.000021
Coltan139_19	-1.51	0.02	-1.81	0.00	0.13636	0.00021	0.003468	0.00001	0.282120	0.000024
Coltan139_20	-1.51	0.02	-1.81	0.00	0.13496	0.00005	0.003424	0.00000	0.282120	0.000023
Mean [±2SD]									0.282079[96]	
<hr/>										
713-79 (160µm20Hz)										
713-79_01	-1.86	0.00	-1.86	0.00	0.00017	0.00001	0.000012	0.00000	0.283006	0.000019
713-79_02	-1.96	0.01	-1.96	0.01	0.00021	0.00001	0.000015	0.00000	0.283221	0.000031
713-79_03	-1.93	0.01	-1.93	0.01	0.00030	0.00001	0.000019	0.00000	0.283131	0.000027
713-79_04	-1.96	0.01	-1.96	0.01	0.00019	0.00001	0.000013	0.00000	0.283227	0.000033
713-79_05	-1.94	0.01	-1.94	0.01	0.00025	0.00001	0.000018	0.00000	0.283185	0.000026
713-79_06	-2.00	0.01	-2.00	0.01	0.00040	0.00002	0.000023	0.00000	0.283307	0.000037
713-79_07	-1.94	0.01	-1.94	0.01	0.00064	0.00002	0.000028	0.00000	0.283191	0.000031
713-79_08	-1.96	0.01	-1.96	0.01	0.00052	0.00008	0.000027	0.00000	0.283158	0.000030

713-79_09	-1.96	0.01	-1.96	0.01	0.00036	0.00001	0.000019	0.00000	0.283184	0.000031
713-79_10	-1.97	0.01	-1.97	0.01	0.00286	0.00024	0.000105	0.00001	0.283207	0.000034
713-79_11	-2.05	0.01	-2.05	0.01	0.00059	0.00002	0.000038	0.00000	0.283386	0.000043
713-79_12	-1.90	0.00	-1.90	0.00	0.00021	0.00001	0.000015	0.00000	0.283095	0.000021
713-79_13	-1.96	0.01	-1.96	0.01	0.00024	0.00001	0.000015	0.00000	0.283241	0.000027
713-79_14	-1.94	0.01	-1.94	0.01	0.00025	0.00001	0.000017	0.00000	0.283193	0.000030
713-79_15	-1.95	0.01	-1.95	0.01	0.00023	0.00001	0.000016	0.00000	0.283184	0.000028
713-79_16	-1.95	0.01	-1.95	0.01	0.00022	0.00001	0.000016	0.00000	0.283201	0.000029
713-79_17	-1.94	0.01	-1.94	0.01	0.00024	0.00001	0.000016	0.00000	0.283155	0.000029
713-79_18	-1.95	0.01	-1.95	0.01	0.00025	0.00001	0.000017	0.00000	0.283179	0.000025
713-79_19	-1.94	0.01	-1.94	0.01	0.00024	0.00001	0.000017	0.00000	0.283180	0.000026
713-79_20	-1.95	0.01	-1.95	0.01	0.00023	0.00001	0.000016	0.00000	0.283183	0.000029
713-79_21	-1.96	0.00	-1.96	0.00	0.00020	0.00001	0.000015	0.00000	0.283178	0.000029
713-79_22	-1.95	0.00	-1.95	0.00	0.00024	0.00001	0.000017	0.00000	0.283157	0.000024
713-79_23	-1.95	0.01	-1.95	0.01	0.00025	0.00001	0.000017	0.00000	0.283165	0.000027
713-79_24	-1.97	0.01	-1.97	0.01	0.00019	0.00001	0.000014	0.00000	0.283217	0.000024
713-79_25	-1.96	0.01	-1.96	0.01	0.00018	0.00001	0.000013	0.00000	0.283170	0.000031
713-79_26	-1.98	0.01	-1.98	0.01	0.00018	0.00001	0.000013	0.00000	0.283258	0.000030
713-79_27	-1.94	0.01	-1.94	0.01	0.00025	0.00001	0.000017	0.00000	0.283148	0.000026
713-79_28	-1.95	0.01	-1.95	0.01	0.00024	0.00001	0.000018	0.00000	0.283170	0.000027
713-79_29	-1.89	0.00	-1.89	0.00	0.00017	0.00001	0.000012	0.00000	0.283011	0.000019

Mean [±2SD]

0.283182[145]

81

82

83 Table S8

84 Hf isotopes of CGM and ferrotapiolite samples by LA-MC-ICP-MS ($^{178}\text{Hf}/^{177}\text{Hf}$ normalization).

	beta 2/3Yb	2SE	beta 7/8Hf	2SE	$^{176}\text{Yb}/^{177}\text{Hf}$	2SE	$^{176}\text{Lu}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE
<i>NP-2 (120$\mu\text{m}20\text{Hz}$)</i>										
NP-2_01	-2.63	0.57	-1.79	0.01	0.006025	0.000013	0.000250	0.000001	0.282204	0.000033
NP-2_02	-2.88	0.55	-1.77	0.01	0.005983	0.000019	0.000247	0.000001	0.282152	0.000030
NP-2_03	-2.49	0.52	-1.77	0.01	0.006158	0.000047	0.000256	0.000002	0.282216	0.000028
NP-2_04	-3.00	0.71	-1.78	0.01	0.006061	0.000018	0.000251	0.000001	0.282146	0.000035
NP-2_05	-3.30	0.62	-1.77	0.01	0.006034	0.000019	0.000249	0.000001	0.282097	0.000032
NP-2_06	-2.28	0.47	-1.75	0.01	0.006464	0.000050	0.000269	0.000002	0.282169	0.000028
NP-2_07	-2.23	0.54	-1.80	0.02	0.006134	0.000028	0.000257	0.000001	0.282266	0.000033
NP-2_08	-2.50	0.54	-1.77	0.01	0.006736	0.000116	0.000274	0.000004	0.282177	0.000030
NP-2_09	-1.97	0.51	-1.78	0.01	0.005940	0.000011	0.000249	0.000001	0.282257	0.000031
NP-2_10	-2.83	0.65	-1.78	0.01	0.006415	0.000027	0.000266	0.000001	0.282183	0.000038
NP-2_11	-2.45	0.55	-1.77	0.01	0.005739	0.000079	0.000238	0.000003	0.282206	0.000030
NP-2_12	-2.62	0.48	-1.77	0.01	0.005970	0.000012	0.000247	0.000001	0.282143	0.000032
NP-2_13	-1.97	0.79	-1.78	0.01	0.006149	0.000068	0.000257	0.000002	0.282277	0.000045
NP-2_14	-2.86	0.56	-1.79	0.01	0.005706	0.000011	0.000237	0.000000	0.282165	0.000029
NP-2_15	-2.89	0.62	-1.77	0.01	0.005827	0.000022	0.000241	0.000001	0.282177	0.000031
NP-2_16	-3.01	0.68	-1.76	0.01	0.006019	0.000013	0.000247	0.000001	0.282086	0.000031
NP-2_17	-2.87	0.64	-1.76	0.01	0.005833	0.000013	0.000242	0.000001	0.282121	0.000032
NP-2_18	-2.59	0.66	-1.81	0.02	0.005649	0.000025	0.000236	0.000001	0.282279	0.000036
NP-2_19	-2.34	0.50	-1.76	0.01	0.005768	0.000055	0.000241	0.000002	0.282167	0.000030
NP-2_20	-2.82	0.60	-1.77	0.01	0.005908	0.000015	0.000244	0.000001	0.282170	0.000030
NP-2_21	-2.97	0.67	-1.77	0.01	0.005920	0.000015	0.000246	0.000001	0.282124	0.000038
Mean [$\pm 2\text{SD}$]									0.282180[111]	
<i>U-1 (120$\mu\text{m}20\text{Hz}$)</i>										
U-1_01	-10.40	3.38	-1.90	0.01	0.001216	0.000014	0.000033	0.000000	0.281945	0.000027

U-1_02	-12.68	2.76	-1.91	0.01	0.001326	0.000013	0.000034	0.000001	0.281854	0.000032
U-1_03	-11.38	2.74	-1.90	0.01	0.001337	0.000015	0.000035	0.000000	0.281875	0.000034
U-1_04	-8.45	2.92	-1.89	0.01	0.001222	0.000013	0.000034	0.000001	0.281944	0.000029
U-1_05	-5.34	5.65	-1.93	0.03	0.001154	0.000014	0.000033	0.000000	0.282080	0.000031
U-1_06	-10.10	2.80	-1.88	0.01	0.001297	0.000014	0.000035	0.000001	0.281896	0.000029
U-1_07	-9.59	2.96	-1.89	0.01	0.001377	0.000018	0.000038	0.000001	0.281896	0.000031
U-1_08	-8.69	3.09	-1.92	0.02	0.001205	0.000012	0.000033	0.000001	0.281989	0.000030
U-1_09	-9.00	3.97	-1.94	0.02	0.001646	0.000022	0.000045	0.000001	0.282067	0.000048
U-1_10	-9.11	2.74	-1.90	0.02	0.001325	0.000014	0.000037	0.000001	0.281943	0.000034
U-1_11	-14.75	3.53	-1.93	0.01	0.001309	0.000017	0.000034	0.000001	0.281887	0.000034
U-1_12	-16.14	5.67	-2.01	0.02	0.001628	0.000033	0.000044	0.000001	0.282021	0.000063
U-1_13	-9.66	4.56	-1.92	0.01	0.001092	0.000017	0.000032	0.000001	0.282022	0.000032
U-1_14	-18.49	6.49	-2.02	0.02	0.001941	0.000047	0.000051	0.000001	0.281993	0.000075
U-1_15	-9.67	3.47	-1.91	0.01	0.001255	0.000015	0.000035	0.000001	0.281970	0.000034
U-1_16	-9.21	2.68	-1.92	0.02	0.001622	0.000026	0.000045	0.000001	0.281931	0.000037
U-1_17	-9.36	2.53	-1.88	0.01	0.001229	0.000011	0.000034	0.000000	0.281884	0.000029
U-1_18	-11.77	2.74	-1.88	0.02	0.001286	0.000012	0.000035	0.000000	0.281795	0.000031
U-1_19	-12.43	4.39	-1.97	0.02	0.002052	0.000032	0.000059	0.000001	0.282020	0.000060
U-1_20	-11.98	5.64	-1.90	0.02	0.001279	0.000021	0.000035	0.000001	0.281914	0.000047
U-1_21	-12.03	4.14	-1.87	0.01	0.001102	0.000016	0.000031	0.000001	0.281865	0.000031
U-1_22	-11.13	3.24	-1.89	0.02	0.001198	0.000012	0.000033	0.000001	0.281910	0.000032
U-1_23	-9.78	3.12	-1.90	0.02	0.001283	0.000016	0.000036	0.000001	0.281926	0.000038
U-1_24	-12.10	3.29	-1.89	0.02	0.001144	0.000013	0.000031	0.000000	0.281884	0.000031
U-1_25	-15.73	3.93	-1.88	0.02	0.001166	0.000017	0.000031	0.000001	0.281738	0.000034
U-1_26	-10.41	2.88	-1.89	0.02	0.001481	0.000016	0.000040	0.000001	0.281810	0.000039
U-1_27	-11.28	3.20	-1.87	0.01	0.001180	0.000012	0.000032	0.000001	0.281834	0.000031
U-1_28	-13.99	3.86	-1.90	0.01	0.001257	0.000018	0.000033	0.000001	0.281882	0.000034
U-1_29	-9.57	3.68	-1.91	0.02	0.001249	0.000018	0.000035	0.000001	0.281957	0.000037

Mean [$\pm 2SD$]

0.281922[159]

U-3 (120 μ m20Hz)

U-3_01	-1.79	0.01	-1.79	0.01	0.000024	0.000005	0.000002	0.000000	0.281780	0.000018
U-3_02	-1.79	0.01	-1.79	0.01	0.000024	0.000004	0.000002	0.000000	0.281797	0.000015
U-3_03	-1.78	0.01	-1.78	0.01	0.000018	0.000004	0.000002	0.000000	0.281782	0.000015
U-3_04	-1.78	0.01	-1.78	0.01	0.000019	0.000004	0.000002	0.000000	0.281750	0.000015
U-3_05	-1.79	0.01	-1.79	0.01	0.000018	0.000004	0.000002	0.000000	0.281767	0.000014
U-3_06	-1.79	0.01	-1.79	0.01	0.000063	0.000004	0.000004	0.000000	0.281746	0.000014
U-3_07	-1.78	0.01	-1.78	0.01	0.000520	0.000029	0.000025	0.000001	0.281758	0.000016
U-3_08	-1.76	0.01	-1.76	0.01	0.000090	0.000007	0.000004	0.000000	0.281722	0.000016
U-3_09	-1.75	0.01	-1.75	0.01	0.000067	0.000007	0.000003	0.000000	0.281732	0.000016
U-3_10	-1.76	0.01	-1.76	0.01	0.000015	0.000004	0.000002	0.000000	0.281755	0.000015
U-3_11	-1.76	0.01	-1.76	0.01	0.000018	0.000004	0.000002	0.000000	0.281757	0.000016
U-3_12	-1.76	0.01	-1.76	0.01	0.000020	0.000004	0.000002	0.000000	0.281748	0.000016
U-3_13	-1.76	0.01	-1.76	0.01	0.000090	0.000004	0.000004	0.000000	0.281744	0.000016
U-3_14	-1.75	0.01	-1.75	0.01	0.000021	0.000005	0.000002	0.000000	0.281732	0.000015
U-3_15	-1.75	0.01	-1.75	0.01	0.000067	0.000005	0.000004	0.000000	0.281731	0.000016
U-3_16	-1.76	0.01	-1.76	0.01	0.000031	0.000004	0.000002	0.000000	0.281736	0.000015
U-3_17	-1.76	0.01	-1.76	0.01	0.000017	0.000004	0.000002	0.000000	0.281738	0.000016
U-3_18	-1.74	0.01	-1.74	0.01	0.000018	0.000004	0.000002	0.000000	0.281731	0.000015
U-3_19	-1.75	0.01	-1.75	0.01	0.000065	0.000004	0.000004	0.000000	0.281710	0.000015
U-3_20	-1.75	0.01	-1.75	0.01	0.000021	0.000004	0.000002	0.000000	0.281741	0.000016
U-3_21	-1.76	0.01	-1.76	0.01	0.003256	0.000172	0.000120	0.000006	0.281748	0.000016
U-3_22	-1.76	0.01	-1.76	0.01	0.000873	0.000084	0.000035	0.000003	0.281756	0.000018

Mean [$\pm 2SD$]

0.281748[41]

Coltan139 (160 μ m20Hz)

Coltan139_01	-1.51	0.02	-1.76	0.01	0.133207	0.000032	0.003366	0.000001	0.282006	0.000021
Coltan139_02	-1.50	0.02	-1.75	0.01	0.133003	0.000054	0.003369	0.000001	0.282020	0.000022

Coltan139_03	-1.52	0.02	-1.74	0.01	0.133638	0.000080	0.003377	0.000002	0.281915	0.000022
Coltan139_04	-1.54	0.02	-1.75	0.01	0.134150	0.000057	0.003384	0.000001	0.281891	0.000023
Coltan139_05	-1.52	0.02	-1.75	0.01	0.133993	0.000038	0.003376	0.000001	0.281942	0.000021
Coltan139_06	-1.53	0.02	-1.76	0.01	0.134002	0.000044	0.003383	0.000001	0.281928	0.000024
Coltan139_07	-1.51	0.02	-1.74	0.01	0.134628	0.000033	0.003384	0.000001	0.281962	0.000023
Coltan139_08	-1.52	0.02	-1.75	0.01	0.135477	0.000045	0.003403	0.000001	0.281920	0.000020
Coltan139_09	-1.52	0.02	-1.76	0.01	0.138112	0.000036	0.003469	0.000001	0.282004	0.000022
Coltan139_10	-1.53	0.02	-1.74	0.01	0.140027	0.000037	0.003511	0.000001	0.281921	0.000020
Coltan139_11	-1.51	0.02	-1.75	0.01	0.134025	0.000042	0.003395	0.000001	0.281983	0.000023
Coltan139_12	-1.51	0.02	-1.75	0.01	0.134845	0.000032	0.003418	0.000001	0.281971	0.000024
Coltan139_13	-1.51	0.02	-1.75	0.01	0.135701	0.000082	0.003442	0.000003	0.282043	0.000024
Coltan139_14	-1.51	0.02	-1.75	0.01	0.134345	0.000028	0.003409	0.000001	0.281996	0.000023
Coltan139_15	-1.50	0.02	-1.76	0.01	0.135211	0.000033	0.003435	0.000001	0.282057	0.000023
Coltan139_16	-1.54	0.02	-1.76	0.01	0.133534	0.000047	0.003378	0.000001	0.281889	0.000022
Coltan139_17	-1.52	0.02	-1.76	0.01	0.134251	0.000056	0.003397	0.000001	0.281962	0.000023
Coltan139_18	-1.52	0.02	-1.76	0.01	0.135511	0.000052	0.003424	0.000001	0.281968	0.000021
Coltan139_19	-1.51	0.02	-1.75	0.01	0.136330	0.000208	0.003463	0.000007	0.282008	0.000024
Coltan139_20	-1.51	0.02	-1.75	0.01	0.134935	0.000046	0.003419	0.000001	0.282018	0.000023
Mean [$\pm 2SD$]									0.281970[98]	
<hr/>										
713-79 (160μm20Hz)										
713-79_01	-1.77	0.01	-1.77	0.01	0.000166	0.000006	0.000012	0.000000	0.282858	0.000019
713-79_02	-1.78	0.01	-1.78	0.01	0.000213	0.000012	0.000015	0.000001	0.282945	0.000030
713-79_03	-1.77	0.01	-1.77	0.01	0.000294	0.000012	0.000019	0.000000	0.282871	0.000027
713-79_04	-1.77	0.01	-1.77	0.01	0.000187	0.000012	0.000013	0.000000	0.282929	0.000033
713-79_05	-1.77	0.01	-1.77	0.01	0.000248	0.000009	0.000018	0.000000	0.282918	0.000026
713-79_06	-1.79	0.01	-1.79	0.01	0.000402	0.000017	0.000023	0.000001	0.282977	0.000037
713-79_07	-1.77	0.01	-1.77	0.01	0.000633	0.000016	0.000027	0.000001	0.282920	0.000031
713-79_08	-1.76	0.01	-1.76	0.01	0.000522	0.000079	0.000027	0.000003	0.282846	0.000030

713-79_09	-1.78	0.01	-1.78	0.01	0.000358	0.000014	0.000019	0.000001	0.282892	0.000031
713-79_10	-1.79	0.01	-1.79	0.01	0.002848	0.000242	0.000105	0.000007	0.282928	0.000034
713-79_11	-1.78	0.01	-1.78	0.01	0.000582	0.000016	0.000038	0.000001	0.282947	0.000042
713-79_12	-1.77	0.01	-1.77	0.01	0.000208	0.000009	0.000015	0.000000	0.282880	0.000021
713-79_13	-1.77	0.01	-1.77	0.01	0.000242	0.000012	0.000015	0.000001	0.282938	0.000027
713-79_14	-1.77	0.01	-1.77	0.01	0.000249	0.000010	0.000017	0.000000	0.282923	0.000030
713-79_15	-1.78	0.01	-1.78	0.01	0.000232	0.000010	0.000016	0.000000	0.282907	0.000028
713-79_16	-1.77	0.01	-1.77	0.01	0.000222	0.000010	0.000016	0.000000	0.282911	0.000029
713-79_17	-1.78	0.01	-1.78	0.01	0.000234	0.000010	0.000016	0.000000	0.282891	0.000029
713-79_18	-1.77	0.01	-1.77	0.01	0.000246	0.000010	0.000017	0.000000	0.282901	0.000025
713-79_19	-1.77	0.01	-1.77	0.01	0.000238	0.000010	0.000017	0.000000	0.282910	0.000026
713-79_20	-1.78	0.01	-1.78	0.01	0.000225	0.000010	0.000016	0.000000	0.282909	0.000029
713-79_21	-1.76	0.01	-1.76	0.01	0.000201	0.000009	0.000015	0.000000	0.282869	0.000029
713-79_22	-1.79	0.01	-1.79	0.01	0.000235	0.000009	0.000017	0.000000	0.282909	0.000024
713-79_23	-1.78	0.01	-1.78	0.01	0.000248	0.000010	0.000017	0.000000	0.282892	0.000027
713-79_24	-1.78	0.01	-1.78	0.01	0.000194	0.000010	0.000014	0.000000	0.282920	0.000024
713-79_25	-1.77	0.01	-1.77	0.01	0.000180	0.000010	0.000013	0.000000	0.282860	0.000031
713-79_26	-1.79	0.01	-1.79	0.01	0.000180	0.000012	0.000013	0.000000	0.282948	0.000030
713-79_27	-1.76	0.01	-1.76	0.01	0.000247	0.000009	0.000016	0.000000	0.282865	0.000026
713-79_28	-1.78	0.01	-1.78	0.01	0.000239	0.000010	0.000018	0.000000	0.282889	0.000027
713-79_29	-1.77	0.01	-1.77	0.01	0.000172	0.000007	0.000012	0.000000	0.282819	0.000019

Mean [$\pm 2SD$]

0.282903[70]

86 Table S9

87 CGM and ferrotapiolite Hf isotopic analytical results by (LA)-MC-ICP-MS.

	t(Ma)	$^{176}\text{Yb}/^{177}\text{Hf}$	$^{176}\text{Lu}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}$	2SE	$^{176}\text{Hf}/^{177}\text{Hf}_i$	$\epsilon_{\text{Hf}(0)}$	$\epsilon_{\text{Hf}(t)}$	2SE	$T_{\text{MD}}(\text{Ma})$	TC (Ma)	DM	2SE	$f_{\text{Lu/Hf}}$
<i>Solution</i>															
NP-2															
NP-2-1	387		0.000178		0.282151	0.000037	0.282150	-21.9	-13.5	1.3	1518	2226	83	-0.99	
NP-2-2	387		0.000223		0.282190	0.000018	0.282188	-20.6	-12.1	0.6	1467	2141	39	-0.99	
NP-2-3	387		0.000152		0.282168	0.000024	0.282167	-21.3	-12.9	0.9	1494	2188	54	-1.00	
NP-2-4	387		0.000182		0.282164	0.000021	0.282163	-21.5	-13.0	0.7	1500	2197	46	-0.99	
U-1															
U-1-2	971		0.000011		0.281862	0.000026	0.281862	-32.2	-10.7	0.9	1902	2492	57	-1.00	
U-1-3	971		0.000025		0.281824	0.000044	0.281824	-33.5	-12.1	1.6	1954	2575	98	-1.00	
U-1-4	971		0.000008		0.281848	0.000020	0.281848	-32.7	-11.2	0.8	1921	2522	45	-1.00	
U-3															
U-3-1	966		0.000013		0.281712	0.000007	0.281712	-37.5	-16.1	0.4	2104	2824	16	-1.00	
U-3-2	966		0.000010		0.281717	0.000007	0.281717	-37.3	-16.0	0.4	2098	2814	17	-1.00	
			0.000006		0.281691	0.000011	0.281691	-38.2	-16.9	0.5	2132	2871	26	-1.00	
U-3-3	966		0.000008		0.281693	0.000010	0.281693	-38.2	-16.8	0.5	2130	2867	24	-1.00	
Coltan139															
Coltan139-1	505		0.003495		0.281992	0.000012	0.281959	-27.6	-17.6	0.4	1896	2571	27	-0.89	
Coltan139-2	505		0.003596		0.281991	0.000010	0.281957	-27.6	-17.7	0.4	1904	2577	22	-0.89	
Coltan139-3	505		0.003663		0.281990	0.000010	0.281955	-27.7	-17.8	0.4	1909	2581	23	-0.89	
713-79															
713-79-1	218		0.000010		0.282762	0.000008	0.282762	-0.4	4.4	0.3	677	968	18	-1.00	
713-79-2	218		0.000032		0.282740	0.000010	0.282740	-1.1	3.7	0.4	707	1016	22	-1.00	
			0.000026		0.282743	0.000011	0.282742	-1.0	3.7	0.4	704	1011	24	-1.00	
713-79-3	218		0.000011		0.282765	0.000005	0.282765	-0.3	4.5	0.2	673	961	11	-1.00	

	218		0.000008		0.282733	0.000006	0.282733	-1.4	3.4	0.2	716	1032	14	-1.00
LA														
NP-2														
NP-2_01	387	0.006025	0.000250	0.000001	0.282204	0.000033	0.282203	-20.1	-11.6	1.2	1448	2109	73	-0.99
NP-2_02	387	0.005983	0.000247	0.000001	0.282152	0.000030	0.282150	-21.9	-13.5	1.1	1520	2226	67	-0.99
NP-2_03	387	0.006158	0.000256	0.000002	0.282216	0.000028	0.282214	-19.7	-11.2	1.0	1433	2084	62	-0.99
NP-2_04	387	0.006061	0.000251	0.000001	0.282146	0.000035	0.282144	-22.1	-13.7	1.2	1528	2239	77	-0.99
NP-2_05	387	0.006034	0.000249	0.000001	0.282097	0.000032	0.282095	-23.9	-15.4	1.1	1595	2348	70	-0.99
NP-2_06	387	0.006464	0.000269	0.000002	0.282169	0.000028	0.282167	-21.3	-12.9	1.0	1497	2189	62	-0.99
NP-2_07	387	0.006134	0.000257	0.000001	0.282266	0.000033	0.282264	-17.9	-9.5	1.2	1365	1974	73	-0.99
NP-2_08	387	0.006736	0.000274	0.000004	0.282177	0.000030	0.282175	-21.1	-12.6	1.1	1487	2172	67	-0.99
NP-2_09	387	0.005940	0.000249	0.000001	0.282257	0.000031	0.282255	-18.2	-9.8	1.1	1377	1993	68	-0.99
NP-2_10	387	0.006415	0.000266	0.000001	0.282183	0.000038	0.282181	-20.8	-12.4	1.4	1478	2157	85	-0.99
NP-2_11	387	0.005739	0.000238	0.000003	0.282206	0.000030	0.282205	-20.0	-11.6	1.1	1445	2105	68	-0.99
NP-2_12	387	0.005970	0.000247	0.000001	0.282143	0.000032	0.282141	-22.3	-13.8	1.1	1533	2246	70	-0.99
NP-2_13	387	0.006149	0.000257	0.000002	0.282277	0.000045	0.282275	-17.5	-9.1	1.6	1350	1950	99	-0.99
NP-2_14	387	0.005706	0.000237	0.000000	0.282165	0.000029	0.282163	-21.5	-13.0	1.0	1501	2197	64	-0.99
NP-2_15	387	0.005827	0.000241	0.000001	0.282177	0.000031	0.282176	-21.0	-12.6	1.1	1485	2169	68	-0.99
NP-2_16	387	0.006019	0.000247	0.000001	0.282086	0.000031	0.282084	-24.3	-15.8	1.1	1610	2372	68	-0.99
NP-2_17	387	0.005833	0.000242	0.000001	0.282121	0.000032	0.282120	-23.0	-14.6	1.1	1561	2293	72	-0.99
NP-2_18	387	0.005649	0.000236	0.000001	0.282279	0.000036	0.282278	-17.4	-9.0	1.3	1345	1943	79	-0.99
NP-2_19	387	0.005768	0.000241	0.000002	0.282167	0.000030	0.282165	-21.4	-13.0	1.1	1499	2192	66	-0.99
NP-2_20	387	0.005908	0.000244	0.000001	0.282170	0.000030	0.282168	-21.3	-12.8	1.1	1495	2185	66	-0.99
NP-2_21	387	0.005920	0.000246	0.000001	0.282124	0.000038	0.282123	-22.9	-14.5	1.4	1557	2287	85	-0.99
U-1														
U-1_01	971	0.001216	0.000033	0.000000	0.281945	0.000027	0.281945	-29.2	-7.8	1.0	1791	2309	61	-1.00
U-1_02	971	0.001326	0.000034	0.000001	0.281854	0.000032	0.281854	-32.5	-11.0	1.2	1914	2510	72	-1.00
U-1_03	971	0.001337	0.000035	0.000000	0.281875	0.000034	0.281874	-31.7	-10.3	1.2	1886	2465	74	-1.00

U-1_04	971	0.001222	0.000034	0.000001	0.281944	0.000029	0.281943	-29.3	-7.8	1.1	1793	2313	64	-1.00
U-1_05	971	0.001154	0.000033	0.000000	0.282080	0.000031	0.282079	-24.5	-3.0	1.1	1610	2013	70	-1.00
U-1_06	971	0.001297	0.000035	0.000001	0.281896	0.000029	0.281895	-31.0	-9.5	1.1	1858	2418	64	-1.00
U-1_07	971	0.001377	0.000038	0.000001	0.281896	0.000031	0.281895	-31.0	-9.5	1.1	1858	2419	70	-1.00
U-1_08	971	0.001205	0.000033	0.000001	0.281989	0.000030	0.281989	-27.7	-6.2	1.1	1732	2213	68	-1.00
U-1_09	971	0.001646	0.000045	0.000001	0.282067	0.000048	0.282067	-24.9	-3.5	1.7	1627	2041	107	-1.00
U-1_10	971	0.001325	0.000037	0.000001	0.281943	0.000034	0.281942	-29.3	-7.9	1.2	1795	2316	76	-1.00
U-1_11	971	0.001309	0.000034	0.000001	0.281887	0.000034	0.281887	-31.3	-9.8	1.2	1869	2437	76	-1.00
U-1_12	971	0.001628	0.000044	0.000001	0.282021	0.000063	0.282020	-26.5	-5.1	2.3	1689	2143	140	-1.00
U-1_13	971	0.001092	0.000032	0.000001	0.282022	0.000032	0.282021	-26.5	-5.1	1.2	1688	2141	72	-1.00
U-1_14	971	0.001941	0.000051	0.000001	0.281993	0.000075	0.281992	-27.5	-6.1	2.7	1727	2205	166	-1.00
U-1_15	971	0.001255	0.000035	0.000001	0.281970	0.000034	0.281970	-28.4	-6.9	1.2	1758	2255	76	-1.00
U-1_16	971	0.001622	0.000045	0.000001	0.281931	0.000037	0.281930	-29.7	-8.3	1.3	1811	2342	81	-1.00
U-1_17	971	0.001229	0.000034	0.000000	0.281884	0.000029	0.281883	-31.4	-10.0	1.1	1874	2445	65	-1.00
U-1_18	971	0.001286	0.000035	0.000000	0.281795	0.000031	0.281794	-34.5	-13.1	1.1	1994	2640	69	-1.00
U-1_19	971	0.002052	0.000059	0.000001	0.282020	0.000060	0.282019	-26.6	-5.1	2.2	1691	2145	134	-1.00
U-1_20	971	0.001279	0.000035	0.000001	0.281914	0.000047	0.281913	-30.4	-8.9	1.7	1834	2380	104	-1.00
U-1_21	971	0.001102	0.000031	0.000001	0.281865	0.000031	0.281864	-32.1	-10.7	1.1	1900	2487	68	-1.00
U-1_22	971	0.001198	0.000033	0.000001	0.281910	0.000032	0.281909	-30.5	-9.1	1.1	1839	2388	70	-1.00
U-1_23	971	0.001283	0.000036	0.000001	0.281926	0.000038	0.281925	-29.9	-8.5	1.4	1817	2353	85	-1.00
U-1_24	971	0.001144	0.000031	0.000000	0.281884	0.000031	0.281883	-31.4	-10.0	1.1	1874	2445	70	-1.00
U-1_25	971	0.001166	0.000031	0.000001	0.281738	0.000034	0.281738	-36.6	-15.1	1.2	2070	2765	74	-1.00
U-1_26	971	0.001481	0.000040	0.000001	0.281810	0.000039	0.281810	-34.0	-12.6	1.4	1973	2607	86	-1.00
U-1_27	971	0.001180	0.000032	0.000001	0.281834	0.000031	0.281833	-33.2	-11.7	1.1	1941	2555	68	-1.00
U-1_28	971	0.001257	0.000033	0.000001	0.281882	0.000034	0.281882	-31.5	-10.0	1.2	1876	2448	76	-1.00
U-1_29	971	0.001249	0.000035	0.000001	0.281957	0.000037	0.281957	-28.8	-7.4	1.3	1775	2283	83	-1.00
U-3														
U-3_01	966	0.000024	0.000002	0.000000	0.281780	0.000018	0.281780	-35.1	-13.7	0.7	2012	2675	40	-1.00

U-3_02	966	0.000024	0.000002	0.000000	0.281797	0.000015	0.281796	-34.5	-13.2	0.6	1990	2639	34	-1.00
U-3_03	966	0.000018	0.000002	0.000000	0.281782	0.000015	0.281782	-35.0	-13.7	0.6	2009	2670	34	-1.00
U-3_04	966	0.000019	0.000002	0.000000	0.281750	0.000015	0.281750	-36.1	-14.8	0.6	2052	2740	34	-1.00
U-3_05	966	0.000018	0.000002	0.000000	0.281767	0.000014	0.281767	-35.5	-14.2	0.6	2029	2703	32	-1.00
U-3_06	966	0.000063	0.000004	0.000000	0.281746	0.000014	0.281746	-36.3	-14.9	0.6	2058	2749	32	-1.00
U-3_07	966	0.000520	0.000025	0.000001	0.281758	0.000016	0.281758	-35.8	-14.5	0.6	2042	2723	35	-1.00
U-3_08	966	0.000090	0.000004	0.000000	0.281722	0.000016	0.281722	-37.1	-15.8	0.6	2090	2802	37	-1.00
U-3_09	966	0.000067	0.000003	0.000000	0.281732	0.000016	0.281732	-36.8	-15.5	0.6	2077	2781	36	-1.00
U-3_10	966	0.000015	0.000002	0.000000	0.281755	0.000015	0.281755	-36.0	-14.6	0.6	2045	2729	35	-1.00
U-3_11	966	0.000018	0.000002	0.000000	0.281757	0.000016	0.281757	-35.9	-14.6	0.6	2043	2726	35	-1.00
U-3_12	966	0.000020	0.000002	0.000000	0.281748	0.000016	0.281748	-36.2	-14.9	0.6	2056	2746	35	-1.00
U-3_13	966	0.000090	0.000004	0.000000	0.281744	0.000016	0.281744	-36.3	-15.0	0.6	2060	2754	37	-1.00
U-3_14	966	0.000021	0.000002	0.000000	0.281732	0.000015	0.281732	-36.8	-15.4	0.6	2077	2781	35	-1.00
U-3_15	966	0.000067	0.000004	0.000000	0.281731	0.000016	0.281731	-36.8	-15.5	0.6	2078	2782	36	-1.00
U-3_16	966	0.000031	0.000002	0.000000	0.281736	0.000015	0.281736	-36.6	-15.3	0.6	2071	2771	33	-1.00
U-3_17	966	0.000017	0.000002	0.000000	0.281738	0.000016	0.281738	-36.6	-15.2	0.6	2069	2768	36	-1.00
U-3_18	966	0.000018	0.000002	0.000000	0.281731	0.000015	0.281731	-36.8	-15.5	0.6	2078	2782	34	-1.00
U-3_19	966	0.000065	0.000004	0.000000	0.281710	0.000015	0.281710	-37.5	-16.2	0.6	2106	2828	33	-1.00
U-3_20	966	0.000021	0.000002	0.000000	0.281741	0.000016	0.281741	-36.5	-15.1	0.6	2064	2761	37	-1.00
U-3_21	966	0.003256	0.000120	0.000006	0.281748	0.000016	0.281745	-36.2	-15.0	0.6	2062	2751	37	-1.00
U-3_22	966	0.000873	0.000035	0.000003	0.281756	0.000018	0.281755	-35.9	-14.6	0.7	2046	2729	41	-1.00

Coltan139

Coltan139_01	505	0.133207	0.003366	0.000001	0.282006	0.000021	0.281974	-27.1	-17.1	0.7	1870	2539	46	-0.90
Coltan139_02	505	0.133003	0.003369	0.000001	0.282020	0.000022	0.281988	-26.6	-16.6	0.8	1848	2508	49	-0.90
Coltan139_03	505	0.133638	0.003377	0.000002	0.281915	0.000022	0.281883	-30.3	-20.3	0.8	2004	2740	49	-0.90
Coltan139_04	505	0.134150	0.003384	0.000001	0.281891	0.000023	0.281859	-31.2	-21.2	0.8	2039	2792	51	-0.90
Coltan139_05	505	0.133993	0.003376	0.000001	0.281942	0.000021	0.281910	-29.3	-19.4	0.7	1964	2679	47	-0.90
Coltan139_06	505	0.134002	0.003383	0.000001	0.281928	0.000024	0.281896	-29.9	-19.9	0.8	1985	2711	52	-0.90

Coltan139_07	505	0.134628	0.003384	0.000001	0.281962	0.000023	0.281930	-28.7	-18.7	0.8	1935	2636	51	-0.90
Coltan139_08	505	0.135477	0.003403	0.000001	0.281920	0.000020	0.281888	-30.1	-20.2	0.7	1998	2728	44	-0.90
Coltan139_09	505	0.138112	0.003469	0.000001	0.282004	0.000022	0.281971	-27.1	-17.2	0.8	1877	2544	49	-0.90
Coltan139_10	505	0.140027	0.003511	0.000001	0.281921	0.000020	0.281888	-30.1	-20.2	0.7	2002	2728	43	-0.89
Coltan139_11	505	0.134025	0.003395	0.000001	0.281983	0.000023	0.281951	-27.9	-17.9	0.8	1904	2589	50	-0.90
Coltan139_12	505	0.134845	0.003418	0.000001	0.281971	0.000024	0.281939	-28.3	-18.3	0.8	1923	2615	52	-0.90
Coltan139_13	505	0.135701	0.003442	0.000003	0.282043	0.000024	0.282010	-25.8	-15.8	0.8	1819	2459	53	-0.90
Coltan139_14	505	0.134345	0.003409	0.000001	0.281996	0.000023	0.281964	-27.4	-17.5	0.8	1886	2562	51	-0.90
Coltan139_15	505	0.135211	0.003435	0.000001	0.282057	0.000023	0.282025	-25.3	-15.3	0.8	1797	2427	51	-0.90
Coltan139_16	505	0.133534	0.003378	0.000001	0.281889	0.000022	0.281857	-31.2	-21.3	0.8	2042	2796	49	-0.90
Coltan139_17	505	0.134251	0.003397	0.000001	0.281962	0.000023	0.281930	-28.6	-18.7	0.8	1935	2635	50	-0.90
Coltan139_18	505	0.135511	0.003424	0.000001	0.281968	0.000021	0.281936	-28.4	-18.5	0.7	1927	2622	46	-0.90
Coltan139_19	505	0.136330	0.003463	0.000007	0.282008	0.000024	0.281976	-27.0	-17.1	0.8	1870	2535	53	-0.90
Coltan139_20	505	0.134935	0.003419	0.000001	0.282018	0.000023	0.281985	-26.7	-16.7	0.8	1855	2514	50	-0.90

713-79

713-79_01	218	0.000166	0.000012	0.000000	0.282858	0.000019	0.282858	3.0	7.8	0.7	544	751	43	-1.00
713-79_02	218	0.000213	0.000015	0.000001	0.282945	0.000030	0.282945	6.1	10.9	1.1	424	554	69	-1.00
713-79_03	218	0.000294	0.000019	0.000000	0.282871	0.000027	0.282871	3.5	8.3	1.0	527	722	61	-1.00
713-79_04	218	0.000187	0.000013	0.000000	0.282929	0.000033	0.282929	5.6	10.3	1.2	446	590	74	-1.00
713-79_05	218	0.000248	0.000018	0.000000	0.282918	0.000026	0.282918	5.2	10.0	0.9	461	614	59	-1.00
713-79_06	218	0.000402	0.000023	0.000001	0.282977	0.000037	0.282977	7.2	12.0	1.3	380	482	84	-1.00
713-79_07	218	0.000633	0.000027	0.000001	0.282920	0.000031	0.282920	5.2	10.0	1.1	458	610	70	-1.00
713-79_08	218	0.000522	0.000027	0.000003	0.282846	0.000030	0.282846	2.6	7.4	1.1	560	777	67	-1.00
713-79_09	218	0.000358	0.000019	0.000001	0.282892	0.000031	0.282892	4.2	9.0	1.1	497	674	70	-1.00
713-79_10	218	0.002848	0.000105	0.000007	0.282928	0.000034	0.282928	5.5	10.3	1.2	448	593	76	-1.00
713-79_11	218	0.000582	0.000038	0.000001	0.282947	0.000042	0.282947	6.2	11.0	1.5	421	549	96	-1.00
713-79_12	218	0.000208	0.000015	0.000000	0.282880	0.000021	0.282880	3.8	8.6	0.8	513	700	48	-1.00
713-79_13	218	0.000242	0.000015	0.000001	0.282938	0.000027	0.282938	5.9	10.7	1.0	434	570	62	-1.00

713-79_14	218	0.000249	0.000017	0.000000	0.282923	0.000030	0.282922	5.3	10.1	1.1	455	605	69	-1.00
713-79_15	218	0.000232	0.000016	0.000000	0.282907	0.000028	0.282907	4.8	9.6	1.0	477	641	63	-1.00
713-79_16	218	0.000222	0.000016	0.000000	0.282911	0.000029	0.282911	4.9	9.7	1.0	470	630	66	-1.00
713-79_17	218	0.000234	0.000016	0.000000	0.282891	0.000029	0.282890	4.2	9.0	1.0	499	677	65	-1.00
713-79_18	218	0.000246	0.000017	0.000000	0.282901	0.000025	0.282901	4.6	9.4	0.9	484	653	56	-1.00
713-79_19	218	0.000238	0.000017	0.000000	0.282910	0.000026	0.282910	4.9	9.7	0.9	473	634	58	-1.00
713-79_20	218	0.000225	0.000016	0.000000	0.282909	0.000029	0.282909	4.8	9.6	1.0	474	636	66	-1.00
713-79_21	218	0.000201	0.000015	0.000000	0.282869	0.000029	0.282869	3.4	8.2	1.0	529	726	66	-1.00
713-79_22	218	0.000235	0.000017	0.000000	0.282909	0.000024	0.282909	4.9	9.6	0.9	473	635	55	-1.00
713-79_23	218	0.000248	0.000017	0.000000	0.282892	0.000027	0.282892	4.3	9.0	1.0	497	674	61	-1.00
713-79_24	218	0.000194	0.000014	0.000000	0.282920	0.000024	0.282920	5.2	10.0	0.8	458	610	54	-1.00
713-79_25	218	0.000180	0.000013	0.000000	0.282860	0.000031	0.282860	3.1	7.9	1.1	541	746	69	-1.00
713-79_26	218	0.000180	0.000013	0.000000	0.282948	0.000030	0.282948	6.2	11.0	1.0	419	546	67	-1.00
713-79_27	218	0.000247	0.000016	0.000000	0.282865	0.000026	0.282865	3.3	8.1	0.9	535	736	60	-1.00
713-79_28	218	0.000239	0.000018	0.000000	0.282889	0.000027	0.282889	4.1	8.9	1.0	502	682	62	-1.00
713-79_29	218	0.000172	0.000012	0.000000	0.282819	0.000019	0.282819	1.7	6.5	0.7	597	838	44	-1.00

88 $^{176}\text{Hf}/^{177}\text{Hf}_i = ((^{176}\text{Hf}/^{177}\text{Hf})_S - (^{176}\text{Lu}/^{177}\text{Hf})_S \times (e^{\lambda t} - 1));$

89 $\epsilon_{\text{Hf}(0)} = ((^{176}\text{Hf}/^{177}\text{Hf})_S / (^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR},0} - 1) \times 10000;$

90 $\epsilon_{\text{Hf}(t)} = (((^{176}\text{Hf}/^{177}\text{Hf})_S - (^{176}\text{Lu}/^{177}\text{Hf})_S \times (e^{\lambda t} - 1)) / ((^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR},0} - (^{176}\text{Lu}/^{177}\text{Hf})_{\text{CHUR}} \times (e^{\lambda t} - 1)) - 1) \times 10000;$

91 $T_{\text{DM}} = 1/\lambda \times \ln(1 + ((^{176}\text{Hf}/^{177}\text{Hf})_S - (^{176}\text{Hf}/^{177}\text{Hf})_{\text{DM}}) / ((^{176}\text{Lu}/^{177}\text{Hf})_S - (^{176}\text{Lu}/^{177}\text{Hf})_{\text{DM}}));$

92 $\text{TC DM} = T_{\text{DM}} - (T_{\text{DM}} - t) \times ((f_{\text{CC}} - f_S) / (f_{\text{CC}} - f_{\text{DM}}));$

93 $f_{\text{Lu}/\text{Hf}} = (^{176}\text{Lu} / ^{177}\text{Hf})_S / (^{176}\text{Lu} / ^{177}\text{Hf})_{\text{CHUR}} - 1.$

94 Where, $(^{176}\text{Lu}/^{177}\text{Hf})_S$ and $(^{176}\text{Hf}/^{177}\text{Hf})_S$ are the measured values of the sample, $(^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR},0} = 0.282772$ and $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{CHUR}} = 0.0332$ (Blichert-Toft and
95 Albarède, 1997),¹¹ $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{DM}} = 0.0384$ and $(^{176}\text{Hf}/^{177}\text{Hf})_{\text{DM}} = 0.28325$ (Griffin *et al.*, 2000),¹² $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{C}} = 0.015$ (Griffin *et al.*, 2002),¹³ t = crystallization
96 times of columbite-tantalite group mineral, ^{176}Lu decay constant $\lambda = 1.867 \times 10^{-5} \text{ m.y}^{-1}$ (Söderlund *et al.*, 2004),¹⁴ $f_{\text{Lu}/\text{Hf}}$ value of the crust = -0.55, $f_{\text{Lu}/\text{Hf}}$ value of the
97 depleted mantle = 0.16.

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99 References

- 100 1. X. D. Che, F. Y. Wu, R. C. Wang, A. Gerdes, W. Q. Ji, Z. H. Zhao, J. H. Yang and Z. Y. Zhu,
101 *Ore Geol. Rev.*, 2015, **65**, 979-989.
- 102 2. Y. Liu, Z. Hu, S. Gao, D. Günther, J. Xu, C. Gao and H. Chen, *Chem. Geol.*, 2008, **257**, 34-43.
- 103 3. D. Weis, B. Kieffer, D. Hanano, I. N. Silva, J. Barling, W. Pretorius, C. Maerschalk and N.
104 Mattielli, *Geochem., Geophys., Geosyst.*, 2007, **8**, Q06006.
- 105 4. O. Nebel, M. L. A. Morel and P. Z. Vroon, *Geostand. Geoanal. Res.*, 2009, **33**, 487-499.
- 106 5. Y. H. Yang, H. F. Zhang, Z. Y. Chu, L. W. Xie and F. Y. Wu, *Int. J. Mass Spectrom.*, 2010, **290**,
107 120-126.
- 108 6. H. L. Lei, T. Yang, S. Y. Jiang and W. Pu, *J. Sep. Sci.*, 2019, **42**, 3261-3276.
- 109 7. A. Fourny, D. Weis and J. S. Scoates, *Geochem., Geophys., Geosyst.*, 2016, **17**, 739-773.
- 110 8. J. Blichert-Toft, *Geostand. Newsl.*, 2001, **25**, 41-56.
- 111 9. J. D. Woodhead and J. M. Hergt, *Geostand. Geoanal. Res.*, 2005, **29**, 183-195.
- 112 10. F. Y. Wu, Y. H. Yang, L. W. Xie, J. H. Yang and P. Xu, *Chem. Geol.*, 2006, **234**, 105-126.
- 113 11. J. Blichert-Toft and F. Albarède, *Earth Planet. Sci. Lett.*, 1997, **148**, 243-258.
- 114 12. W. L. Griffin, N. J. Pearson, E. Belousova, S. E. Jackson, E. V. Achterbergh, S. Y. O'Reilly and
115 S. R. Shee, *Geochim. Cosmochim. Acta*, 2000, **64**, 133-147.
- 116 13. W. L. Griffin, X. Wang, S. E. Jackson, N. J. Pearson, S. Y. O'Reilly, X. S. Xu and X. M. Zhou,
117 *Lithos*, 2002, **61**, 237-269.
- 118 14. U. Söderlund, P. J. Patchett, J. D. Vervoort and C. E. Isachsen, *Earth Planet. Sci. Lett.*, 2004,
119 **219**, 311-324.
- 120