Jian Xu, Xiao-Ping Xia, Qiang Wang, Christopher J. Spencer, Bin He, and Chun-Kit Lai, 2021, Low-δ^{18}O A-type granites in SW China: Evidence for the interaction between the subducted Paleotethyan slab and the Emeishan mantle plume: GSA Bulletin, https://doi.org/10.1130/B35929.1.

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1. ANALYTICAL METHODS

Zircon SIMS U-Pb dating and oxygen isotope analyses

Zircon U-Th-Pb isotopes were determined by CAMECA IMS-1280-HR secondary ion mass spectrometry (SIMS) at the State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences (SKLaBIG, GIG-CAS). The analytical procedure was as described in Xu et al. (2020). The ellipsoidal spot is ~20 × 30 μm in size. Pb/U ratios, U and Th conentrations of unknowns were calibrated using the ca. 337 Ma standard zircon Plešovice (Sláma et al., 2008). To monitor the external uncertainties of whole procedure of SIMS zircon U-Pb dating, a secondary standard zircon Qinghu (Li et al., 2013) was analyzed along with other unknown zircon samples. Nine measurements on standard zircon Qinghu during the course of this study yielded a concordant age of 159 ± 2 Ma (2σ, n = 10, MSWD = 0.5), which is within analytical errors of the reported value of 160 ± 3 Ma (Li et al., 2013).

Oxygen isotopes of zircons were also determined using the CAMECA IMS1280-HR SIMS at the SKLaBIG, GIG-CAS. Detailed analytical procedures were the same as those described by Xu et al. (2020). The analytical spot is ~20 μm in diameter. Penglai zircon standard ($\delta^{18}O$-VSMOW = 5.3 ± 0.1 ‰; Li et al., 2010) was used to correct the measured oxygen isotope for instrumental mass fractionation (IMF). Single analysis has internal precision better than 0.15‰ (1σ) for the $^{18}O/^{16}O$ ratio. A weighted mean of $\delta^{18}O$ = 5.5 ± 0.2‰ (2σ) was obtained from twelve measurements of the Qinghu zircon standard, which is within analytical errors of the recommended value of 5.4 ± 0.2‰ (Li et al., 2013).

Zircon LA-ICP-MS Lu–Hf isotope composition analyses

Zircon in situ Lu-Hf isotopes were measured on a Neptune Plus MC-ICP-MS, at the SKLaBIG, GIG-CAS. Detailed description of zircon Hf isotope analytical procedure is identical to that by Xia et al. (2013). The analytical spot is ~45μm in diameter. Data reduction procedure follows the description by Zhang et al. (2015). Standard zircon Plešovice was measured to monitor the external uncertainties of whole analytical procedures. Twenty-two measurements on zircon Plešovice have yielded a weighted mean of $^{176}Hf/^{177}Hf$ = 0.282484 ± 0.000011 (2SD), consistent with the value ($^{176}Hf/^{177}Hf$ = 0.282482 ± 0.000013, 2SD) recommended by Sláma et al. (2008) within errors.

Element and Sr-Nd-Hf isotope composition analyses

Before the geochemical analyses, granite samples were powdered to ~200-mesh size in an agate mortar. Major-element oxides were measured at the Wuhan Samplesolution Analytical Technology Co., Ltd., Wuhan. Major-element oxides were analyzed on fused glass beads using a Rigaku Primus II X-ray fluorescence (XRF) spectrometer. Analytical accuracies are between 1% and 5%. Detailed analytical procedures are the same as description by Xu et al. (2020). Trace elements were determined by Agilent 7700e ICP-MS at the Wuhan SampleSolution Analytical Technology Co., Ltd., Wuhan, China. Detailed procedures are described in Xu et al. (2020). Analytical precisions are better than 3% for most elements.

The Sr-Nd-Hf isotope measurements were conducted on a Neptune Plus MC-ICP-MS at the Wuhan Sample Solution Analytical Technology Co., Ltd, Wuhan, China. The measured Sr, Nd and Hf isotopic ratios were normalized using $^{86}Sr/^{88}Sr$ value of 0.1194, $^{146}Nd/^{144}Nd$ value of 0.7219, and $^{179}Hf/^{177}Hf$ = 0.7325, respectively. Analyses of standard references solutions yielded $^{87}Sr/^{86}Sr$ of 0.710241 ± 0.000012 (2SD, n = 7), $^{143}Nd/^{144}Nd$ of 0.512440 ± 0.000010 (2SD, n = 6), and $^{176}Hf/^{177}Hf$ = 0.282224 ± 0.000007 for NBS987, GBS, and AlfaHf respectively. The Rock standard BCR-2, analyzed along with samples, yielded $^{87}Sr/^{86}Sr$ = 0.705000 ± 0.000010, $^{143}Nd/^{144}Nd$ = 0.512635 ± 0.000007, and $^{176}Hf/^{177}Hf$ = 0.282859 ± 0.000009, which are consistent with the reported values of $^{87}Sr/^{86}Sr$ = 0.705034 ± 0.000014, $^{143}Nd/^{144}Nd$ = 0.512644 ± 0.000015, and $^{176}Hf/^{177}Hf$ = 0.282870 ± 0.000008, respectively (Weis et al., 2007).

2. SUPPLEMENTAL FIGURES

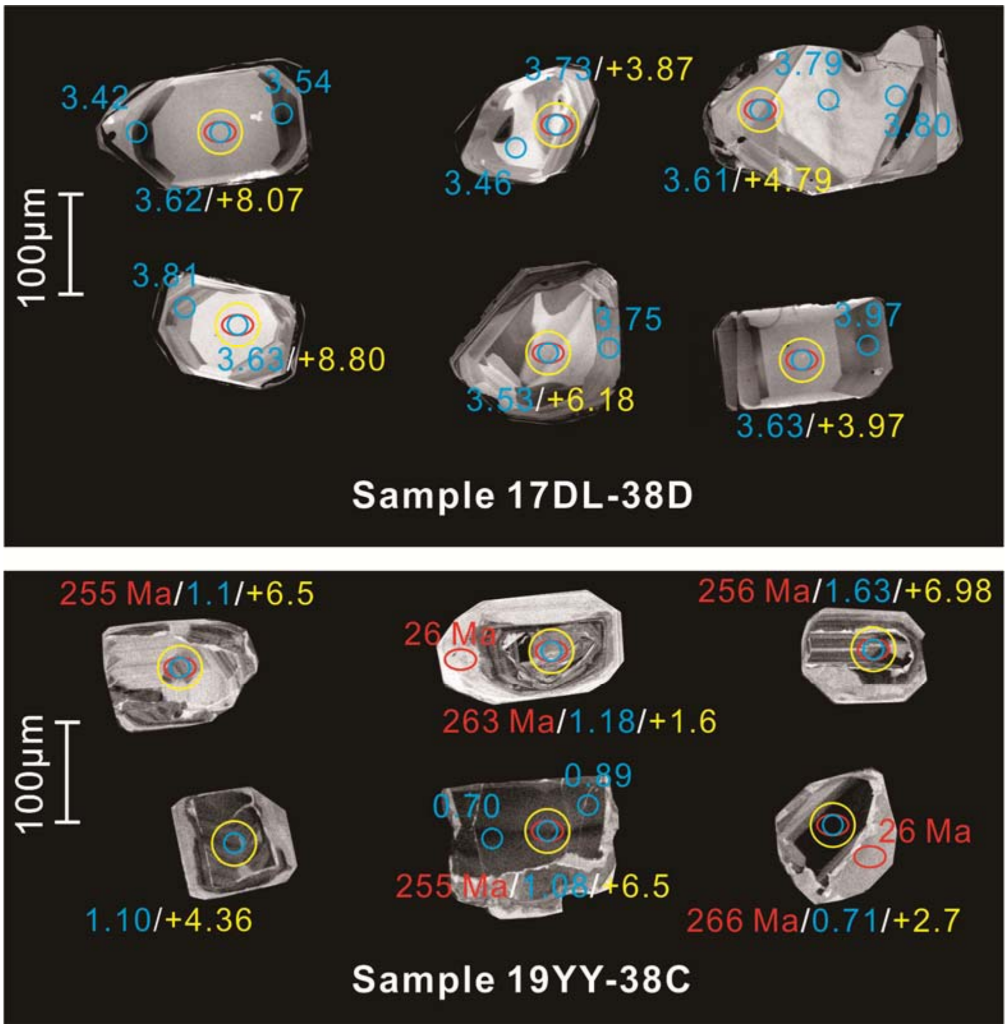

Figure S1. Cathodoluminescene (CL) images of zircon grains from the Yuanyang A-type granite samples 17DL-38D and 19YY-38C. The red, blue and yellow circles indicate the location of U-Pb, O and Hf isotope analyses, respectively.

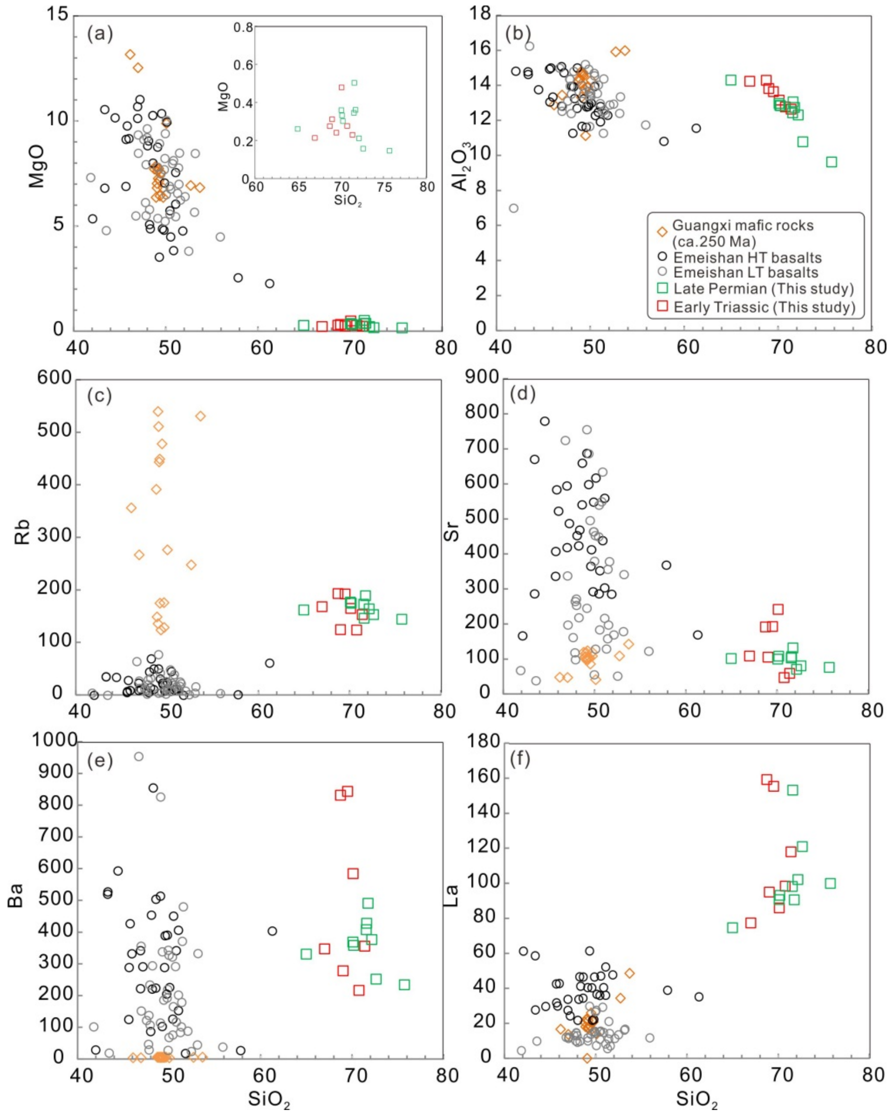

Figure S2. Major- and trace-element variations of the Late Permian and Early Triassic Yuanyang A-type granites. Date sources: Guangxi mafic rocks (Qin et al., 2012); Emeishan high-Ti (HT) and low-Ti (LT) basalts (Xiao et al., 2004; Xu et al., 2001).

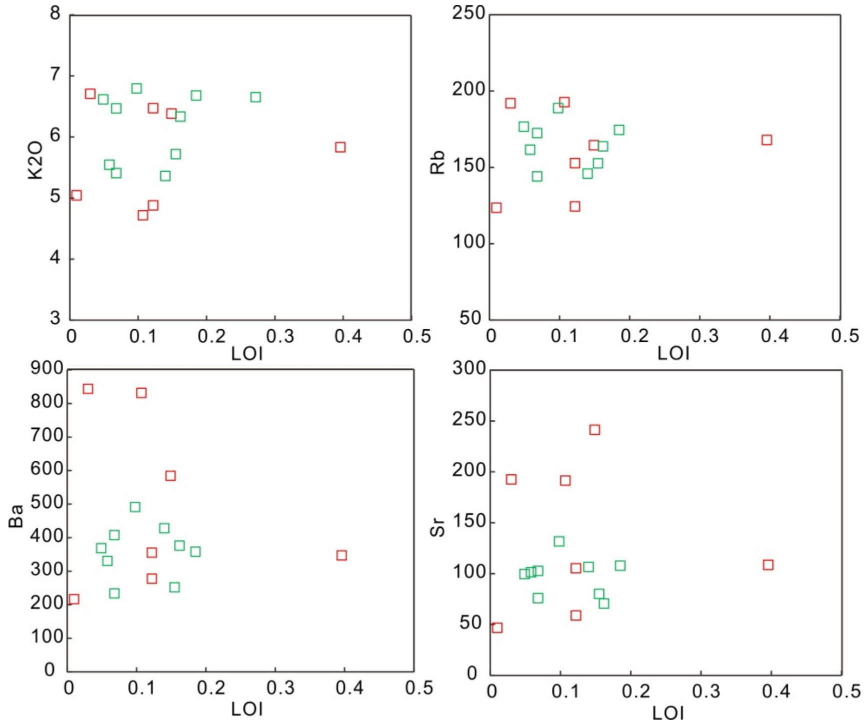

Figure S3. Major- and Trace-element versus loss on ignition (LOI) for the Yuanyang A-type granites, showing no post-magmatic alteration trend.

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3. Supplementary Tables

Table S1. SIMS U-Pb data for the Yuanyang A-type granites.

Analysis	Content (ppm)		α-decay event/mg	Th/U	Isotopic ratios						Isotopic ages (Ma)					
	Th	U			$^{207}Pb/^{206}Pb$	±1σ(%)	$^{207}Pb/^{235}U$	±1σ(%)	$^{206}Pb/^{238}U$	±1σ(%)	$^{207}Pb/^{206}Pb$	±1σ	$^{207}Pb/^{235}U$	±1σ	$^{206}Pb/^{238}U$	±1σ
Sample 19YY-38C																
19YY-38C@02	120	687	2.4E+14	0.18	0.05102	1.58	0.28412	2.24	0.04039	1.59	242	36	254	5	255	4
19YY-38C@04	94	2248	5.6E+13	0.04	0.04693	2.11	0.02753	2.59	0.00425	1.50	46	50	28	1	27	0
19YY-38C@06	150	592	2.4E+14	0.25	0.05147	1.62	0.28759	2.21	0.04052	1.51	262	37	257	5	256	4
19YY-38C@07	97	635	2.1E+14	0.15	0.05156	0.52	0.28320	1.61	0.03984	1.53	266	12	253	4	252	4
19YY-38C@09	345	1894	7.0E+14	0.18	0.05167	0.36	0.30013	1.55	0.04213	1.51	271	8	267	4	266	4
19YY-38C@10	53	471	1.4E+13	0.11	0.04759	1.87	0.02696	2.40	0.00411	1.50	79	44	27	1	26	0
19YY-38C@11	78	486	1.6E+14	0.16	0.05128	0.68	0.28869	1.65	0.04083	1.51	254	16	258	4	258	4
19YY-38C@12	81	491	1.6E+13	0.16	0.04771	1.97	0.02624	2.49	0.00399	1.51	85	46	26	1	26	0
19YY-38C@15	100	421	1.7E+14	0.24	0.05005	1.35	0.27866	2.04	0.04038	1.52	197	31	250	5	255	4
19YY-38C@16	140	663	2.6E+14	0.21	0.05109	0.61	0.30008	1.66	0.04260	1.55	245	14	266	4	269	4
19YY-38C@17	119	454	1.9E+13	0.26	0.04892	1.82	0.02751	3.16	0.00408	2.59	144	42	28	1	26	1
19YY-38C@18	108	425	1.8E+14	0.25	0.04977	0.76	0.28588	1.81	0.04166	1.64	184	18	255	4	263	4
19YY-38C@19	84	311	1.3E+14	0.27	0.05104	1.91	0.27763	2.48	0.03945	1.58	243	43	249	5	249	4
19YY-38C@20	202	691	3.1E+14	0.29	0.05123	3.10	0.29070	3.46	0.04116	1.54	251	70	259	8	260	4
19YY-38C@21	224	665	3.3E+14	0.34	0.05134	2.09	0.29624	2.58	0.04185	1.51	256	47	263	6	264	4
19YY-38C@25	167	1213	4.0E+14	0.14	0.05146	2.41	0.29862	2.85	0.04209	1.52	262	54	265	7	266	4
19YY-38C@28	20	307	7.8E+13	0.07	0.05149	1.43	0.28623	2.08	0.04032	1.51	263	32	256	5	255	4
Sample 17DL-38D																
17DL-38D@1	161	217	1.7E+14	0.74	0.05157	1.60	0.27387	2.21	0.03852	1.51	266	36	246	5	244	4
17DL-38D@02	221	322	2.5E+14	0.69	0.05073	1.55	0.27901	2.16	0.03989	1.51	229	36	250	5	252	4

17DL-38D@03	115	193	1.3E+14	0.60	0.05029	1.78	0.27684	2.33	0.03992	1.50	209	41	248	5	252	4
17DL-38D@04	181	271	2.0E+14	0.67	0.05107	1.30	0.27652	1.99	0.03927	1.51	244	30	248	4	248	4
17DL-38D@06	153	261	1.8E+14	0.59	0.05171	1.50	0.28059	2.21	0.03936	1.63	273	34	251	5	249	4
17DL-38D@08	180	256	2.0E+14	0.70	0.05128	1.48	0.27701	2.11	0.03918	1.50	253	34	248	5	248	4
17DL-38D@09	116	175	1.3E+14	0.66	0.05004	2.52	0.26675	2.98	0.03866	1.60	197	57	240	6	245	4
17DL-38D@10	162	298	1.9E+14	0.54	0.05101	1.33	0.27626	2.01	0.03928	1.50	241	30	248	4	248	4
17DL-38D@11	156	352	1.9E+14	0.44	0.05084	1.17	0.27101	1.97	0.03866	1.58	233	27	244	4	245	4
17DL-38D@12	370	472	4.0E+14	0.78	0.05087	1.01	0.27566	1.84	0.03930	1.54	235	23	247	4	248	4
17DL-38D@13	358	477	3.8E+14	0.75	0.05109	0.93	0.27538	1.78	0.03910	1.52	245	21	247	4	247	4
17DL-38D@14	138	215	1.5E+14	0.64	0.05056	1.81	0.27237	2.36	0.03907	1.52	221	41	245	5	247	4
17DL-38D@15	63	103	7.1E+13	0.61	0.05243	2.20	0.27986	2.98	0.03872	2.01	304	49	251	7	245	5

*19YY-38C represents zircon grains selected from sample 19YY-38C.

Table S2. In-situ zircon O isotope data for the Yuanyang A-type granites.

Sample	$^{18}O/^{16}Om$	1SE(%)	$\delta^{18}O$ (‰)	$2\sigma_m$
Sample 17DL-38D				
17DL-38D@01	0.0020156	0.011	3.62	0.21
17DL-38D@02	0.0020158	0.008	3.73	0.17
17DL-38D@03	0.0020156	0.011	3.61	0.22
17DL-38D@04	0.0020157	0.012	3.66	0.25
17DL-38D@05	0.0020154	0.010	3.53	0.20
17DL-38D@06	0.0020156	0.008	3.63	0.17
17DL-38D@07	0.0020168	0.013	4.22	0.26
17DL-38D@08	0.0020170	0.011	4.31	0.22
17DL-38D@09	0.0020156	0.010	3.63	0.21
17DL-38D@10	0.0020156	0.009	3.62	0.18
17DL-38D@11	0.0020151	0.012	3.38	0.24
17DL-38D@12	0.0020163	0.009	3.94	0.19
17DL-38D@13	0.0020157	0.008	3.67	0.16
17DL-38D@14	0.0020158	0.010	3.73	0.20
17DL-38D@15	0.0020156	0.009	3.61	0.18
17DL-38D@16	0.0020152	0.010	3.42	0.19
17DL-38D@17	0.0020155	0.012	3.54	0.24
17DL-38D@18	0.0020153	0.011	3.46	0.22
17DL-38D@19	0.0020148	0.008	3.22	0.17
17DL-38D@20	0.0020149	0.010	3.23	0.20
17DL-38D@21	0.0020151	0.010	3.32	0.21
17DL-38D@22	0.0020160	0.013	3.80	0.26
17DL-38D@23	0.0020165	0.012	4.06	0.24
17DL-38D@24	0.0020165	0.007	4.06	0.14
17DL-38D@25	0.0020170	0.010	4.28	0.19
17DL-38D@26	0.0020160	0.010	3.79	0.19
17DL-38D@27	0.0020164	0.009	4.01	0.19
17DL-38D@28	0.0020162	0.012	3.91	0.24
17DL-38D@30	0.0020169	0.012	4.23	0.25
17DL-38D@31	0.0020157	0.015	3.64	0.31
17DL-38D@34	0.0020180	0.012	4.78	0.24
17DL-38D@35	0.0020166	0.013	4.09	0.25
17DL-38D@36	0.0020163	0.013	3.93	0.26
17DL-38D@37	0.0020169	0.012	4.23	0.24
17DL-38D@38	0.0020163	0.010	3.97	0.21
17DL-38D@40	0.0020159	0.007	3.75	0.13
17DL-38D@41	0.0020164	0.009	3.97	0.18
17DL-38D@42	0.0020162	0.007	3.90	0.14
17DL-38D@43	0.0020167	0.014	4.15	0.28
17DL-38D@44	0.0020148	0.007	3.19	0.15
17DL-38D@45	0.0020160	0.012	3.81	0.25

17DL-38D@46	0.0020165	0.007	4.05	0.13
17DL-38D@47	0.0020166	0.011	4.10	0.23
17DL-38D@49	0.0020152	0.014	3.39	0.27
17DL-38D@50	0.0020160	0.007	3.78	0.14
17DL-38D@51	0.0020163	0.012	3.93	0.23
Sample 19YY-38C				
19YY-38C@01	0.0020089	0.007	0.70	0.15
19YY-38C@01-2	0.0020089	0.006	1.08	0.11
19YY-38C@01-4	0.0020088	0.009	1.00	0.19
19YY-38C@01-5	0.0020085	0.007	0.89	0.14
19YY-38C@02	0.0020097	0.008	1.12	0.17
19YY-38C@02-2	0.0020105	0.008	1.84	0.15
19YY-38C@02-3	0.0020094	0.007	1.33	0.13
19YY-38C@04	0.0020079	0.008	0.22	0.16
19YY-38C@05	0.0020093	0.009	0.92	0.18
19YY-38C@06	0.0020108	0.006	1.63	0.12
19YY-38C@09	0.0020089	0.011	0.71	0.22
19YY-38C@18	0.0020091	0.010	1.18	0.20
19YY-38C@21	0.0020075	0.008	0.36	0.15
19YY-38C@23	0.0020082	0.006	0.73	0.11
19YY-38C@24	0.0020092	0.010	1.23	0.20
19YY-38C@26	0.0020086	0.009	0.92	0.18
19YY-38C@28	0.0020107	0.006	1.95	0.12
19YY-38C@29	0.0020084	0.009	0.83	0.18
19YY-38C@33	0.0020073	0.006	0.25	0.12

Table S3. In-situ zircon Hf isotope data for the Yuanyang A-type granites.

Sample	t (Ma)	$^{176}Yb/^{177}Hf$	$^{176}Lu/^{177}Hf$	$^{176}Hf/^{177}Hf$	$2\sigma_m$	$\varepsilon Hf_{(t)}$	$2\sigma_m$	$T_{DM}(Hf)$
Sample 17DL-38D								
17DL-38D@1	248	0.158130	0.002787085	0.282858991	0.000010	8.1	1.1	585
17DL-38D@2	248	0.130963	0.002288844	0.282737809	0.000011	3.9	1.1	754
17DL-38D@3	248	0.066004	0.001183627	0.282758686	0.000010	4.8	1.1	702
17DL-38D@4	248	0.128793	0.002238848	0.282779444	0.000010	5.3	1.1	692
17DL-38D@5	248	0.052608	0.000946998	0.282796845	0.000010	6.2	1.1	644
17DL-38D@6	248	0.075847	0.001371271	0.282736424	0.000011	4.0	1.1	738
17DL-38D@7	248	0.142681	0.002481822	0.282867301	0.000011	8.4	1.1	568
17DL-38D@8	248	0.100660	0.001782863	0.282834108	0.000011	7.4	1.1	605
17DL-38D@9	248	0.090346	0.001608321	0.282874031	0.000011	8.8	1.1	545
17DL-38D@10	248	0.137630	0.002454154	0.282799205	0.000010	6.0	1.1	668
17DL-38D@11	248	0.094822	0.001754303	0.282770864	0.000012	5.1	1.1	696
17DL-38D@12	248	0.211456	0.003696974	0.282833247	0.000012	7.0	1.1	639
17DL-38D@13	248	0.218777	0.00383435	0.282859003	0.000010	7.9	1.1	602
17DL-38D@14	248	0.173666	0.003076723	0.282809627	0.000011	6.3	1.1	664
17DL-38D@15	248	0.161189	0.002828486	0.282820704	0.000012	6.7	1.1	643
Sample 19YY-38C								
19YY-38C@01-2	260	0.023646	0.001046494	0.282799092	0.000009	6.5	1.1	643
19YY-38C@02-2	260	0.005948	0.000157505	0.282734569	0.000011	4.4	1.1	717
19YY-38C@04	260	0.018298	0.000463578	0.282753006	0.000009	5.0	1.1	697
19YY-38C@05	260	0.010925	0.000355229	0.282747015	0.000010	4.8	1.1	703
19YY-38C@06	260	0.013825	0.000603067	0.282810736	0.000009	7.0	1.1	619
19YY-38C@09	260	0.013450	0.000347007	0.282689491	0.000011	2.7	1.1	783
19YY-38C@18	260	0.012237	0.000431085	0.282656634	0.000009	1.6	1.1	831

19YY-38C@21	260	0.005435	0.000142532	0.282693928	0.000009	2.9	1.1	773
19YY-38C@23	260	0.017512	0.000510346	0.282746566	0.000008	4.7	1.1	707
19YY-38C@24	260	0.028664	0.001259462	0.282725088	0.000010	3.8	1.1	752
19YY-38C@26	260	0.015425	0.000394821	0.282744167	0.000009	4.7	1.1	708
19YY-38C@28	260	0.034791	0.001488222	0.282752303	0.000011	4.8	1.1	717
19YY-38C@29	260	0.016769	0.000526431	0.282728452	0.000010	4.1	1.1	733
19YY-38C@33	260	0.012505	0.000401097	0.282726492	0.000011	4.0	1.1	733

Table S4. Major (wt.%) and trace element (ppm) and Sr-Nd-Hf isotope data for the Yuanyang A-type granites.

Sample	17DL-38A	17DL-38B	17DL-38D	17DL-38E	17DL-38F	17DL-38G	17DL-38H	19YY-38A	19YY-38C	19YY-38D	19YY-38E	19YY-38F	19YY-38G	19YY-38H	19YY-38I	19YY-38J
Latitude	23.23° N							23.23° N								
Longtitude	102.77° E							102.77° E								
SiO_2	69.54	68.67	70.69	71.55	66.80	69.71	68.14	71.28	71.76	69.61	69.80	70.96	71.96	64.80	75.74	72.53
TiO_2	0.51	0.63	0.54	0.52	0.64	0.49	0.63	0.55	0.53	0.66	0.55	0.42	0.55	0.80	0.63	0.60
Al_2O_3	13.64	13.75	12.75	12.67	14.19	13.07	14.16	12.38	12.73	12.74	12.91	12.93	12.27	14.25	9.62	10.76
$Fe_2O_3^T$	5.59	5.68	5.76	5.21	6.87	4.65	5.63	4.89	3.98	4.89	5.39	3.77	4.99	8.30	6.11	7.19
MnO	0.09	0.18	0.17	0.17	0.16	0.16	0.18	0.11	0.09	0.11	0.12	0.14	0.08	0.16	0.11	0.12
MgO	0.24	0.31	0.28	0.23	0.21	0.48	0.27	0.34	0.36	0.33	0.36	0.50	0.21	0.26	0.15	0.16
CaO	0.90	1.23	0.52	0.58	1.20	1.19	1.22	0.79	0.93	1.22	0.83	1.54	0.62	1.62	0.35	0.53
Na_2O	2.76	4.10	4.05	2.73	3.71	3.24	4.12	2.75	2.76	2.91	2.95	3.43	2.66	3.86	1.88	2.21
K_2O	6.71	4.86	5.04	6.48	5.81	6.34	4.68	6.44	6.80	6.62	6.59	5.31	6.31	5.53	5.41	5.71
P_2O_5	0.06	0.10	0.08	0.07	0.11	0.08	0.10	0.08	0.08	0.08	0.08	0.10	0.07	0.13	0.03	0.04
LOI	0.03	0.12	0.00	0.12	0.40	0.15	0.11	0.07	0.10	0.19	0.05	0.14	0.16	0.06	0.07	0.16
Total	100.06	99.62	99.87	100.33	100.16	99.56	99.22	99.67	100.10	99.36	99.62	99.24	99.88	99.75	100.09	100.00
A/CNK	1.02	0.97	0.98	1.01	0.97	0.91	1.01	0.96	0.94	0.90	0.96	0.91	0.99	0.93	1.00	1.00
V	9	16	11	7	9	20	9	11	24	12	13	16	6	10	4	6
Cr	21	33	51	13	11	15	21	2	2	2	2	3	1	1	0	1
Co	2.7	3.0	2.5	2.4	2.4	3.8	2.8	2.4	3.4	2.3	2.3	3.0	1.2	2.8	1.4	1.4
Ni	2.5	3.1	3.0	1.8	2.1	5.1	2.5	1.9	3.8	2.8	1.8	3.5	1.1	1.9	0.9	1.4
Cu	49.7	18.9	20.3	28.2	6.6	5.8	49.7	7.8	15.4	1.4	1.3	26.7	2.0	8.5	3.2	3.5
Zn	96.6	106.0	88.1	84.5	96.7	105.0	96.2	117.3	94.6	116.4	121.1	104.2	109.2	142.5	150.3	148.7
Ga	27.9	29.2	32.7	29.1	30.8	29.6	28.4	26.5	24.7	26.8	26.9	25.4	28.0	32.1	25.8	27.6
Rb	192	124	124	153	168	165	193	172	189	174	177	146	164	162	144	153
Sr	192	105	47	59	108	241	191	103	132	108	99	107	71	101	76	80

Y	100	102	74	96	79	80	99	93	93	104	63	90	78	97	85	79
Zr	1115	745	587	884	542	641	1058	666	614	703	602	1014	702	669	628	655
Nb	90.29	123.49	100.97	108.62	113.77	95.55	88.07	78.34	96.27	112.49	68.02	91.79	90.90	132.32	112.01	92.97
Sn	4.67	6.34	4.80	5.63	4.45	4.61	4.71	4.20	4.23	5.37	3.91	4.65	4.82	5.27	5.73	5.38
Cs	0.61	0.39	0.33	0.47	0.89	0.84	0.63	0.43	0.72	0.48	0.44	0.54	0.46	0.90	0.50	0.97
Ba	843.10	277.79	216.31	355.21	346.86	583.94	831.02	407.64	490.84	357.97	368.39	427.48	376.28	330.23	233.66	251.49
La	155.32	94.91	98.34	117.86	77.35	85.91	159.13	98.12	90.50	92.99	90.63	153.10	102.01	74.52	99.82	120.85
Ce	305.01	190.60	195.40	239.35	162.86	171.23	310.63	191.94	181.41	191.09	175.53	277.54	197.42	160.72	209.66	264.84
Pr	33.64	21.98	21.69	26.36	19.41	19.32	33.82	22.79	22.19	23.89	20.38	29.17	24.51	21.44	24.40	28.34
Nd	118.74	82.61	78.38	97.58	74.34	72.09	120.07	84.16	85.09	93.27	73.03	97.81	90.85	84.21	90.59	100.98
Sm	22.03	17.03	14.96	18.72	15.30	14.39	21.94	15.94	16.57	17.87	12.23	15.81	15.82	17.47	16.42	16.72
Eu	2.13	2.09	1.66	2.02	2.30	1.89	2.24	1.91	2.15	2.11	1.74	1.79	1.86	2.54	1.78	1.81
Gd	17.20	15.44	12.25	15.61	13.11	13.15	17.14	14.50	14.76	15.78	10.41	14.08	13.20	15.50	13.61	13.60
Tb	2.92	2.70	1.97	2.80	2.25	2.20	2.96	2.65	2.74	2.83	1.79	2.63	2.22	2.69	2.37	2.38
Dy	19.04	18.13	13.08	17.78	14.58	14.18	19.27	17.06	17.29	18.33	11.09	16.65	13.93	16.93	15.29	15.15
Ho	3.86	3.77	2.71	3.61	2.91	2.96	3.66	3.39	3.47	3.77	2.25	3.44	2.82	3.51	3.19	2.97
Er	10.55	10.24	7.52	9.81	7.93	8.07	10.06	9.57	9.59	10.83	6.42	9.24	7.99	10.14	9.20	8.41
Tm	1.42	1.46	1.07	1.42	1.14	1.18	1.40	1.34	1.37	1.59	0.97	1.29	1.18	1.53	1.39	1.20
Yb	8.05	8.37	6.67	8.08	6.71	6.87	7.75	7.72	8.04	9.39	5.93	7.85	7.05	9.33	8.31	7.31
Lu	1.24	1.32	1.17	1.32	1.12	1.12	1.18	1.03	1.12	1.32	0.87	1.16	1.02	1.38	1.12	1.02
Hf	26.84	18.20	14.41	21.33	13.33	15.81	25.57	16.45	14.72	16.92	14.27	23.87	16.64	15.98	15.25	15.90
Ta	6.49	9.98	5.73	7.21	8.12	6.73	6.20	6.73	7.70	9.69	4.72	9.28	6.30	11.67	7.19	6.84
Tl	0.55	0.39	0.35	0.52	0.52	0.50	0.54	0.53	0.54	0.54	0.53	0.40	0.51	0.45	0.40	0.48
Pb	37.76	34.43	18.10	26.80	32.60	42.66	36.01	34.18	41.33	35.81	37.85	34.17	36.77	33.79	30.77	30.42
Th	24.61	15.11	14.40	16.03	12.50	14.85	23.99	16.25	14.86	14.15	13.18	29.95	13.13	14.14	14.67	18.85
U	2.92	2.51	2.84	2.33	2.81	2.86	2.72	2.10	2.47	2.54	1.83	3.85	1.91	3.82	2.01	2.08

$(Na_2O+K_2O)/CaO$	10.56	7.28	17.62	15.88	7.93	8.03	7.21	11.71	10.33	7.79	11.43	5.69	14.55	5.80	20.88	15.03
10000*Ga/Al	3.87	3.99	4.84	4.35	4.09	4.25	3.76	4.03	3.67	3.95	3.92	3.68	4.31	4.25	5.06	4.85
FeOT/(FeOT+MgO)	0.95	0.94	0.95	0.95	0.97	0.90	0.95	0.93	0.91	0.93	0.93	0.87	0.96	0.97	0.97	0.98
Tzr(℃)	967	893	871	938	847	863	952	886	871	872	868	930	905	856	907	901
$^{87}Sr/^{86}Sr$	0.714075	0.722277	0.733227	0.729596	0.721453	0.715319		0.722127	0.721186	0.722632	0.723675	0.721996224				
2σ	0.000003	0.000007	0.000006	0.000004	0.000007	0.000005		0.000009	0.000010	0.000007	0.000009	0.000009				
$(^{87}Sr/^{86}Sr)i$	0.703397	0.709620	0.704942	0.701827	0.704890	0.708024		0.704141	0.705828	0.705320	0.704677	0.707348				
$^{143}Nd/^{144}Nd$	0.512453	0.512494	0.512487	0.512492	0.512487	0.512504		0.512492	0.512500	0.512500	0.512485	0.512463				
2σ	0.000006	0.000005	0.000006	0.000006	0.000006	0.000006		0.000006	0.000006	0.000007	0.000005	0.000007				
εNd(t)	-0.83	-0.44	-0.27	-0.20	-0.58	-0.13		-0.15	-0.10	-0.03	0.16	-0.15				
$(^{176}Hf/^{177}Hf)s$	0.282726	0.282739	0.282743	0.282749	0.282748	0.282752		0.282754	0.282745	0.282747	0.282743	0.282718				
2σ	0.000006	0.000006	0.000007	0.000005	0.000007	0.000006		0.000004	0.000006	0.000005	0.000006	0.000005				
εHf(t)	2.96	2.78	2.71	3.39	2.83	3.29		3.55	2.91	2.92	3.20	2.62				
T_{DM}	874	964	1000	899	1004	931		893	969	977	905	897				