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Supplementary Table S1 LA-ICP-MS zircon rare earth elements analysis of the Gaohushan granite (GHSH)

Sample	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	δEu	LREE	HREE
1	0.02	6.45	0.19	2.58	6.08	0.41	25.90	8.66	94.17	32.65	137.43	26.84	243.50	45.53	26.22	15.74	614.68
2	0.02	2.43	0.06	1.49	3.37	0.32	19.38	7.32	91.63	33.40	144.81	29.45	275.89	52.89	14.56	7.69	654.77
3	0.01	2.62	0.10	1.68	4.85	0.40	25.10	9.49	112.69	41.75	179.21	36.41	332.12	64.50	23.96	9.66	801.27
4	0.07	8.35	0.66	12.65	36.18	2.96	159.68	49.14	438.56	125.53	459.37	83.00	697.03	121.20	1159.49	60.86	2133.51
5	0.06	7.41	0.45	7.91	14.91	1.22	70.56	24.66	281.38	100.05	406.14	78.04	685.50	123.60	208.55	31.96	1769.93
6	0.02	6.23	0.14	2.71	6.67	0.23	37.26	14.48	173.50	64.31	286.04	60.17	553.14	104.76	20.21	16.00	1293.66
7	0.02	1.49	0.08	1.35	4.18	0.21	26.27	9.64	102.26	29.51	96.02	16.47	124.44	20.47	12.79	7.32	425.08
8	0.08	1.70	0.08	1.58	5.05	0.18	31.16	12.57	138.67	44.90	167.72	31.15	262.25	46.39	13.04	8.66	734.81
9	0.04	2.50	0.17	2.58	5.90	0.51	30.11	10.75	121.51	45.24	193.89	40.37	366.55	70.00	36.73	11.70	878.42
10	2.47	16.54	2.09	13.28	17.00	0.96	55.13	21.54	214.76	64.85	269.65	60.00	584.75	110.30	138.49	52.34	1380.98
11	0.01	5.37	0.06	1.69	4.98	0.20	29.40	12.90	156.58	57.84	257.08	56.20	536.67	102.16	13.75	12.31	1208.83
12	0.08	4.10	0.45	7.20	12.92	1.30	67.89	22.68	254.55	94.37	393.90	77.89	697.68	129.63	210.11	26.04	1738.59
13	0.04	2.80	0.18	3.45	6.98	0.53	39.83	14.69	180.38	67.52	290.68	58.41	519.33	96.21	49.62	13.99	1267.05
14	0.02	1.15	0.06	1.50	7.26	0.23	59.07	25.57	225.71	47.39	111.23	13.67	82.43	10.50	30.51	10.22	575.57
15	0.71	7.10	0.43	3.81	6.52	0.61	33.64	10.99	115.46	38.45	151.86	28.70	250.64	46.69	49.00	19.18	676.43
16	0.85	6.90	0.53	3.32	4.91	0.11	21.71	8.19	94.63	35.86	160.57	33.57	324.97	63.88	5.86	16.61	743.38
17	0.03	3.05	0.04	1.02	3.69	0.17	23.60	9.31	101.95	33.32	131.53	25.35	226.64	41.63	9.28	8.00	593.33
18	0.02	3.44	0.13	2.54	6.38	0.32	43.53	16.12	191.85	68.72	288.86	58.50	526.99	98.98	31.94	12.82	1293.55
19	4.90	22.18	2.00	12.74	10.38	0.61	40.77	13.74	151.51	54.41	226.72	45.36	409.68	77.27	62.40	52.81	1019.46
20	0.46	5.09	1.13	8.10	17.40	0.54	87.35	43.25	453.87	128.06	441.11	78.99	629.79	102.01	113.13	32.72	1964.43
21	0.07	3.43	0.14	3.15	7.25	0.56	40.74	14.46	158.14	55.45	223.38	42.73	378.36	69.32	53.75	14.59	982.58
22	0.05	2.54	0.21	2.79	6.24	0.42	35.28	14.35	155.71	50.21	192.92	36.71	320.58	56.90	34.88	12.25	862.66
23	1.78	12.98	1.10	9.24	10.95	0.71	43.90	13.77	149.30	54.17	230.87	46.02	418.82	78.99	77.89	36.75	1035.84
24	0.01	2.35	0.09	1.59	4.40	0.30	27.06	9.94	118.15	45.08	194.91	40.04	363.11	69.94	18.88	8.74	868.23
25	0.0	2.4	0.0	1.3	3.8	0.3	22.1	9.0	104.	38.3	161.	31.	290.	54.9	15.60	7.94	713.0

	0	2	7	0	4	0	6	1	00	2	61	96	97	9	2

Note: $\delta Eu = Eu_N/2Eu_N/(Sm+Gd)_N$, chondrite data for normalization taken from [68].

Supplementary Table S2 LA-ICP-MS zircon Th-U-Pb isotopic analysis of the Gaohushan granite (GHSH)

Sample	Element content ($\times10^{-6}$) and ratio			Isotope ratio								Surface age (Ma)							
GHSH	^{232}Th	^{238}U	Th/U	^{207}Pb/^{206}Pb	1σ	^{207}Pb/^{235}U	1σ	^{206}Pb/^{238}U	1σ	^{208}Pb/^{232}Th	1σ	^{207}Pb/^{206}Pb	1σ	^{207}Pb/^{235}U	1σ	^{206}Pb/^{238}U	1σ	^{208}Pb/^{232}Th	1σ
1	88	109	0.81	0.04976	0.00618	0.14065	0.0171	0.0205	0.00049	0.00616	0.00029	184	229	134	15	131	3	124	6
2	56	143	0.39	0.05406	0.00278	0.36744	0.01761	0.04929	0.00079	0.01576	0.00054	374	79	318	13	310	5	316	11
3	41	81	0.51	0.05263	0.00761	0.14795	0.02088	0.02039	0.00064	0.00637	0.00055	313	260	140	18	130	4	128	11
4	277	247	1.12	0.05009	0.00331	0.13939	0.0088	0.02018	0.00033	0.00613	0.00014	199	114	133	8	129	2	124	3
5	214	190	1.12	0.05288	0.00338	0.14203	0.00863	0.01948	0.00032	0.00634	0.00014	324	108	135	8	124	2	128	3
6	185	606	0.3	0.04912	0.00361	0.12155	0.00853	0.01795	0.00035	0.00551	0.00025	154	122	116	8	115	2	111	5
7	39	259	0.15	0.0486	0.00198	0.12187	0.00447	0.01818	0.00025	0.00706	0.00032	129	60	117	4	116	2	142	6
8	47	254	0.19	0.04927	0.00322	0.14312	0.00891	0.02107	0.00036	0.00738	0.00046	161	110	136	8	134	2	149	9
9	48	115	0.42	0.05268	0.00535	0.15475	0.01529	0.0213	0.00046	0.00751	0.00039	315	184	146	13	136	3	151	8
10	117	3088	0.04	0.05261	0.00141	0.15272	0.00324	0.02105	0.00026	0.02514	0.00062	312	27	144	3	134	2	502	12
11	189	1072	0.18	0.04947	0.00256	0.14287	0.00689	0.02094	0.00033	0.00576	0.00026	170	83	136	6	134	2	116	5
12	150	207	0.72	0.04893	0.00399	0.13292	0.01045	0.0197	0.00039	0.00645	0.00026	144	139	127	9	126	2	130	5
13	83	185	0.45	0.05012	0.00348	0.14069	0.00933	0.02036	0.00036	0.00744	0.00031	201	118	134	8	130	2	150	6

14	111	1730	0.06	0.04957	0.00201	0.12404	0.00451	0.01815	0.00026	0.00578	0.00032	175	58	119	4	116	2	116	6
15	96	160	0.6	0.05685	0.00471	0.16149	0.0129	0.0206	0.00041	0.00659	0.00025	486	142	152	11	131	3	133	5
16	100	366	0.27	0.04879	0.00235	0.13165	0.00587	0.01957	0.00029	0.00656	0.00023	138	76	126	5	125	2	132	5
17	73	488	0.15	0.04907	0.00199	0.14124	0.00516	0.02087	0.00029	0.00685	0.00026	151	59	134	5	133	2	138	5
18	77	224	0.34	0.0494	0.00282	0.14241	0.00767	0.0209	0.00033	0.00717	0.00029	167	94	135	7	133	2	144	6
19	214	445	0.48	0.04952	0.0028	0.13937	0.0074	0.02041	0.00033	0.00681	0.0002	173	92	132	7	130	2	137	4
20	197	4021	0.05	0.04837	0.00123	0.11629	0.00227	0.01743	0.00021	0.0057	0.00017	117	24	112	2	111	1	115	3
21	85	171	0.5	0.04952	0.00388	0.14234	0.01073	0.02084	0.00039	0.00672	0.00037	173	135	135	10	133	2	135	7
22	79	580	0.14	0.05149	0.00196	0.12949	0.00439	0.01824	0.00025	0.00614	0.00029	263	53	124	4	117	2	124	6
23	381	369	1.03	0.05254	0.00308	0.152	0.00839	0.02097	0.00035	0.00697	0.00016	309	95	144	7	134	2	140	3
24	42	88	0.48	0.04995	0.00558	0.14095	0.01541	0.02046	0.00042	0.00601	0.00038	193	208	134	14	131	3	121	8
25	38	122	0.31	0.04911	0.00582	0.13505	0.01561	0.01994	0.0005	0.00601	0.00049	153	212	129	14	127	3	121	10

Supplementary Table S3 Major element data components (%) and trace element abundance ($\times 10^{-6}$) of Gaohushan granite

Sample	1	2	3	4	5	6	7	8	9	10	11	12	Average
SiO_2	75.31	75.79	74.74	74.33	76.04	74.57	73.97	74.28	74.21	75.65	74.00	75.09	74.83
TiO_2	0.07	0.06	0.06	0.09	0.06	0.05	0.06	0.10	0.06	0.06	0.07	0.09	0.07
Al_2O_3	14.14	13.95	14.36	14.49	13.60	14.52	14.20	14.35	14.27	13.98	14.21	14.38	14.20
FeO^T	1.13	1.00	1.18	1.09	0.93	0.86	1.20	1.47	1.31	1.03	1.23	1.19	1.14
MnO	0.04	0.03	0.04	0.03	0.03	0.03	0.04	0.05	0.03	0.04	0.03	0.04	0.04
MgO	0.10	0.06	0.07	0.11	0.06	0.03	0.04	0.09	0.07	0.04	0.07	0.05	0.07
CaO	0.48	0.40	0.30	0.26	0.40	0.33	0.59	0.50	0.48	0.45	0.38	0.24	0.40
Na_2O	3.45	3.45	2.71	3.37	3.80	3.49	3.55	3.32	2.49	3.23	2.54	2.83	3.19
K_2O	4.31	4.22	4.37	5.06	4.06	4.40	3.99	4.70	4.97	4.63	4.98	5.10	4.57
P_2O_5	0.28	0.29	0.22	0.21	0.27	0.27	0.34	0.24	0.28	0.29	0.29	0.23	0.27
LOI	1.03	0.96	1.34	1.33	0.89	1.05	1.12	1.21	1.45	1.01	1.33	1.00	1.14
Tatal	100.34	100.21	99.39	100.37	100.14	99.60	99.10	100.31	99.62	100.41	99.13	100.24	99.90
$Mg^{\#}$	14.92	10.62	10.52	16.66	11.33	6.46	6.19	10.82	9.57	7.14	10.13	7.68	10.17
K_2O/Na_2O	1.25	1.22	1.61	1.50	1.07	1.26	1.12	1.42	2.00	1.43	1.96	1.80	1.47
K_2O+Na_2O	7.76	7.67	7.08	8.43	7.86	7.89	7.54	8.02	7.46	7.86	7.52	7.93	7.75
σ	1.86	1.79	1.58	2.27	1.87	1.97	1.84	2.06	1.78	1.89	1.82	1.96	1.89
A/CNK	1.26	1.27	1.47	1.26	1.19	1.31	1.26	1.25	1.38	1.25	1.38	1.35	1.30
A/NK	1.37	1.36	1.56	1.31	1.28	1.38	1.40	1.36	1.50	1.35	1.48	1.41	1.40
La	0.72	0.27	0.24	1.73	0.23	0.25	0.17	3.45	0.90	0.29	0.42	1.98	0.89
Ce	2.28	1.38	1.43	5.98	1.30	1.44	1.05	9.93	3.54	1.88	1.48	6.95	3.22
Pr	0.22	0.11	0.10	0.57	0.10	0.12	0.07	1.05	0.30	0.12	0.15	0.66	0.30
Nd	0.94	0.49	0.43	2.65	0.46	0.55	0.30	5.03	1.40	0.58	0.68	3.12	1.39
Sm	0.35	0.22	0.22	0.75	0.20	0.31	0.16	1.34	0.49	0.29	0.28	0.92	0.46
Eu	0.04	0.01	0.01	0.01	0.00	0.00	0.01	0.04	0.01	0.00	0.01	0.01	0.01
Gd	0.36	0.21	0.25	0.72	0.20	0.41	0.19	1.29	0.53	0.40	0.33	0.89	0.48
Tb	0.07	0.04	0.05	0.10	0.03	0.09	0.04	0.16	0.09	0.08	0.06	0.12	0.08
Dy	0.28	0.18	0.23	0.48	0.15	0.47	0.20	0.73	0.45	0.45	0.30	0.55	0.37
Ho	0.05	0.03	0.03	0.07	0.02	0.07	0.03	0.10	0.07	0.07	0.05	0.07	0.05
Er	0.12	0.06	0.07	0.15	0.05	0.15	0.06	0.21	0.15	0.16	0.11	0.15	0.12
Tm	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.03	0.02	0.02	0.01	0.02	0.02
Yb	0.10	0.05	0.06	0.10	0.04	0.11	0.06	0.14	0.12	0.14	0.09	0.11	0.09
Lu	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01
Li	259.30	232.20	311.70	180.60	214.20	182.40	208.70	322.70	160.70	146.20	57.43	249.90	210.50
Be	5.02	4.69	4.42	2.47	4.17	3.94	2.83	4.14	3.49	3.59	1.64	3.01	3.62
Sc	0.24	0.26	0.25	0.33	0.20	0.29	0.24	0.40	0.29	0.22	0.13	0.31	0.26
V	3.73	1.77	1.70	2.77	1.32	0.92	1.71	3.02	2.13	1.37	0.94	2.12	1.96
Cr	4.06	5.36	1.31	1.19	1.09	1.30	1.43	1.32	1.11	2.67	0.31	0.88	1.84
Co	4.22	2.35	2.04	2.20	2.41	2.38	3.48	3.07	3.71	3.66	1.77	3.83	2.93
Ni	1.24	1.47	0.56	0.54	0.39	0.34	0.57	0.59	0.46	0.63	0.18	0.38	0.61
Cu	1.50	0.69	1.20	1.02	0.73	0.89	1.55	1.86	1.42	1.51	0.40	1.38	1.18
Zn	45.75	39.55	51.64	40.72	37.68	40.95	49.58	63.29	58.01	48.00	29.18	51.62	46.33
Ga	15.36	15.87	20.63	16.12	15.15	16.65	16.81	16.01	16.08	16.14	7.95	16.03	15.90
Rb	734.20	762.20	855.10	810.90	732.60	736.80	829.70	813.50	891.40	791.40	405.60	883.60	770.57
Sr	15.38	20.28	17.22	8.89	17.43	8.89	10.39	17.57	13.67	13.34	7.28	10.74	13.42

Y	1.09	0.71	1.01	2.11	0.62	2.19	0.81	2.87	1.94	2.28	1.36	2.33	1.61
Nb	13.23	17.67	27.28	24.03	18.19	15.07	26.78	20.62	18.28	16.63	7.77	24.43	19.17
Cd	0.05	0.04	0.03	0.03	0.04	0.03	0.03	0.05	0.04	0.04	0.02	0.03	0.04
In	0.17	0.19	0.43	0.20	0.15	0.20	0.18	0.21	0.15	0.15	0.07	0.19	0.19
Cs	82.02	76.22	71.77	64.33	73.18	60.08	86.66	82.00	74.26	62.72	25.94	89.04	70.69
Ba	16.82	6.46	8.46	15.36	4.77	3.75	5.04	17.98	15.94	6.88	10.00	12.92	10.37
Hf	1.01	1.10	0.86	1.54	1.02	1.99	1.05	1.45	1.48	1.28	0.61	1.65	1.25
Ta	3.36	5.35	3.09	3.74	5.05	3.30	3.86	3.68	4.61	3.79	1.61	4.42	3.82
Pb	7.34	6.89	7.08	8.95	7.40	8.12	6.43	12.66	8.52	9.20	4.22	10.54	8.11
Bi	3.25	2.69	2.95	4.87	4.55	11.13	4.27	3.17	4.21	4.91	3.09	4.72	4.48
Th	0.78	0.57	0.77	2.02	0.60	0.83	0.42	3.17	1.20	0.57	0.62	2.60	1.18
U	7.32	4.80	4.34	5.75	5.60	9.21	16.46	19.24	26.02	25.49	9.08	6.26	11.63
Zr	20.45	19.77	13.52	42.33	18.12	43.28	16.57	46.28	32.61	27.74	13.00	50.51	28.68
∑REE	5.54	3.06	3.12	13.35	2.80	3.99	2.33	23.50	8.07	4.52	3.96	15.56	7.48
∑LREE	4.53	2.47	2.41	11.69	2.30	2.65	1.74	20.83	6.65	3.17	3.00	13.65	6.26
∑HREE	1.01	0.59	0.70	1.66	0.50	1.34	0.59	2.67	1.43	1.34	0.96	1.92	1.23
∑LREE/∑HREE	4.49	4.20	3.43	7.06	4.57	1.99	2.95	7.79	4.66	2.36	3.12	7.12	4.48
δEu	0.32	0.17	0.08	0.06	0.06	0.03	0.09	0.10	0.07	0.03	0.06	0.02	0.09
$(La/Yb)_N$	5.10	3.38	2.72	11.90	3.75	1.52	1.79	16.65	5.23	1.45	3.21	12.52	5.77
$(La/Sm)_N$	1.30	0.77	0.70	1.45	0.70	0.51	0.67	1.62	1.15	0.63	0.95	1.35	0.98
$(Gd/Yb)_N$	3.03	3.19	3.36	5.96	3.86	3.03	2.42	7.47	3.66	2.36	3.05	6.72	4.01
10^4×Ga/Al	2.05	2.15	2.71	2.10	2.10	2.17	2.24	2.24	2.26	2.18	1.06	2.11	2.11

Note: $\sigma 43=(Na_2O+K_2O)^2/(SiO_2-43)$, Na_2O, K_2O, SiO_2 are *wt*%; $A/CNK=Al_2O_3/(CaO+Na_2O+K_2O)$, $A/NK=Al_2O_3/(Na_2O+K_2O)$, Al_2O_3, CaO, Na_2O, and K_2O are all molecular; $\delta Eu=Eu_N/2Eu_N/(Sm+Gd)_N$, chondrite data for normalization taken from [68].