

## Supplementary Materials

**Table S1.** The compositions of amphiboles from the monzogranite porphyries at Wandongshan and Bailiancun, respectively.

Sample	WDS15-45-1	WDS15-45-2	WDS15-45-3	WDS15-45-4	WDS15-45-5	WDS15-45-6	WDS16-29-1	WDS16-29-2
SiO <sub>2</sub>	52.17	50.66	50.83	49.84	48.55	51.72	49.56	49.43
TiO <sub>2</sub>	0.08	0.15	0.07	0.01	0.02	0.16	0.23	0.22
Al <sub>2</sub> O <sub>3</sub>	1.97	3.00	2.67	3.35	4.66	2.37	5.10	4.10
Cr <sub>2</sub> O <sub>3</sub>	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
FeO	14.17	14.14	14.65	14.64	16.29	13.61	16.04	15.04
MnO	0.95	0.80	1.00	0.90	0.18	0.66	0.68	1.09
MgO	13.84	14.20	13.82	13.73	12.49	14.58	12.46	13.72
CaO	12.31	12.04	12.15	11.96	11.07	12.02	11.17	10.50
Na <sub>2</sub> O	0.55	0.81	0.80	0.92	1.91	1.01	2.18	1.57
K <sub>2</sub> O	0.33	0.45	0.39	0.46	0.82	0.39	0.94	0.66
F	0.72	0.82	0.91	0.86	1.87	0.87	1.44	1.74
Cl	0.01	0.01	0.03	0.01	0.02	0.02	0.02	0.01
Si	7.6764	7.4787	7.5089	7.4215	7.2054	7.5746	7.2134	7.2716
Al <sup>IV</sup>	0.3236	0.5213	0.4649	0.5785	0.7946	0.4091	0.7866	0.7108
Al <sup>VI</sup>	0.0181	0.0007	0.0000	0.0094	0.0205	0.0000	0.0883	0.0000
Ti	0.0089	0.0167	0.0078	0.0011	0.0022	0.0176	0.0252	0.0243
Fe <sup>3+</sup>	0.9155	0.7908	0.8141	0.7438	0.7042	0.8209	0.6150	0.7715
Fe <sup>2+</sup>	0.8283	0.9550	0.9958	1.0793	1.3177	0.8461	1.3374	1.0788
Mn	0.1184	0.1000	0.1251	0.1135	0.0226	0.0819	0.0838	0.1358
Mg	3.0359	3.1251	3.0435	3.0478	2.7634	3.1832	2.7036	3.0089
Ca	1.9408	1.9044	1.9231	1.9082	1.7603	1.8862	1.7419	1.6550
Na	0.1569	0.2318	0.2291	0.2656	0.5496	0.2868	0.6152	0.4478
K	0.0619	0.0847	0.0735	0.0874	0.1553	0.0729	0.1745	0.1239
Total cations	15.0845	15.2092	15.1859	15.2562	15.2958	15.1791	15.3850	15.2285
Si <sup>r*</sup>	7.6764	7.4787	7.5089	7.4215	7.2054	7.5746	7.2134	7.2716
Al <sup>r</sup>	0.3236	0.5213	0.4649	0.5785	0.7946	0.4091	0.7866	0.7108
Al <sup>c</sup>	0.0181	0.0007	0.0000	0.0094	0.0205	0.0000	0.0883	0.0000

Fe <sup>3+</sup> c	0.9155	0.7908	0.8141	0.7438	0.7042	0.8209	0.6150	0.7715
Tic	0.0089	0.0167	0.0078	0.0011	0.0022	0.0176	0.0252	0.0243
Mgc	3.0359	3.1251	3.0435	3.0478	2.7634	3.1832	2.7036	3.0089
Fe <sup>2+</sup> c	0.8283	0.9550	0.9958	1.0793	1.3177	0.8461	1.3374	1.0788
Mnc	0.1184	0.1000	0.1251	0.1135	0.0226	0.0819	0.0838	0.1164
Fe <sup>2+</sup> B	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MnB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0194
CaB	1.9408	1.9044	1.9231	1.9082	1.7603	1.8862	1.7419	1.6550
NaB	0.0592	0.0956	0.0769	0.0918	0.2397	0.1138	0.2581	0.3256
CaA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NaA	0.0977	0.1363	0.1523	0.1738	0.3099	0.1729	0.3571	0.1222
KA	0.0619	0.0847	0.0735	0.0874	0.1553	0.0729	0.1745	0.1239
(K + Na) <sub>A</sub>	0.16	0.22	0.23	0.26	0.47	0.25	0.53	0.25
Mg/Mg + Fe <sup>2+</sup>	0.79	0.77	0.75	0.74	0.68	0.79	0.67	0.74
T (°C)	660	697	688	706	727	680	736	720
P (MPa)	31.5	40.7	37.6	44.8	63.0	34.7	68.6	53.4
continental depth (km)	1.2	1.5	1.4	1.7	2.4	1.3	2.4	2.02
ΔNNO	1.73	1.85	1.75	1.75	1.25	1.89	1.00	1.81
logfO <sub>2</sub>	-15.59	-14.46	-14.79	-14.32	-14.30	-14.87	-14.31	-13.91
H <sub>2</sub> O <sub>melt</sub> (wt %)	4.11	3.67	3.82	3.84	3.05	3.28	3.06	3.15
<b>Sample</b>	<b>WDS16-5-1</b>	<b>BLC2-1</b>	<b>BLC2-2</b>	<b>BLC2-3</b>	<b>BLC2-4</b>	<b>BLC2-5</b>	<b>BLC2-6</b>	<b>BLC3-1</b>
SiO <sub>2</sub>	49.68	43.30	42.46	42.69	42.84	42.75	42.56	43.84
TiO <sub>2</sub>	0.39	0.06	0.13	0.15	0.00	0.16	0.11	0
Al <sub>2</sub> O <sub>3</sub>	4.29	8.61	8.67	8.91	8.70	8.91	8.48	7.7
Cr <sub>2</sub> O <sub>3</sub>	0.01	0.03	0.03	0.02	0.05	0.03	0.06	0.05
FeO	14.78	20.40	20.26	20.77	20.40	20.68	21.16	20.2
MnO	0.95	0.27	0.18	0.15	0.20	0.19	0.20	0.2
MgO	13.58	9.90	9.68	9.78	9.67	9.57	9.90	9.87
CaO	10.66	10.85	10.64	10.54	10.54	10.41	10.32	9.54
Na <sub>2</sub> O	1.56	2.22	2.23	2.34	2.34	2.28	2.30	2.34
K <sub>2</sub> O	0.63	1.34	1.31	1.33	1.32	1.44	1.29	1.22
F	1.76	1.70	1.71	1.78	2.27	2.02	1.96	2.47
Cl	0.02	0.03	0.03	0.04	0.03	0.02	0.03	0.03

Si	7.2744	6.5821	6.5500	6.5157	6.5372	6.5242	6.5200	6.7101
Al <sup>IV</sup>	0.7256	1.4179	1.4500	1.4843	1.4628	1.4758	1.4800	1.2899
Al <sup>VI</sup>	0.0147	0.1246	0.1263	0.1185	0.1019	0.1268	0.0510	0.0991
Ti	0.0430	0.0069	0.0151	0.0172	0.0000	0.0184	0.0127	0.0000
Fe <sup>3+</sup>	0.8173	0.3156	0.3119	0.2934	0.3965	0.3564	0.3092	0.5400
Fe <sup>2+</sup>	0.9927	2.2778	2.3019	2.3578	2.2069	2.2830	2.4017	2.0457
Mn	0.1178	0.0348	0.0235	0.0194	0.0258	0.0246	0.0260	0.0259
Mg	2.9643	2.2435	2.2261	2.2253	2.1998	2.1773	2.2609	2.2521
Ca	1.6724	1.7672	1.7586	1.7237	1.7233	1.7022	1.6939	1.5645
Na	0.4429	0.6543	0.6670	0.6925	0.6923	0.6746	0.6832	0.6944
K	0.1177	0.2599	0.2578	0.2590	0.2570	0.2804	0.2521	0.2382
Total cations	15.1827	15.6844	15.6881	15.7066	15.6035	15.6436	15.6908	15.4600
Si <sub>T</sub> *	7.2744	6.5821	6.5500	6.5157	6.5372	6.5242	6.5200	6.7101
Al <sub>T</sub>	0.7256	1.4179	1.4500	1.4843	1.4628	1.4758	1.4800	1.2899
Al <sub>C</sub>	0.0147	0.1246	0.1263	0.1185	0.1019	0.1268	0.0510	0.0991
Fe <sup>3+</sup> <sub>C</sub>	0.8173	0.3156	0.3119	0.2934	0.3965	0.3564	0.3092	0.5400
Ti <sub>C</sub>	0.0430	0.0069	0.0151	0.0172	0.0000	0.0184	0.0127	0.0000
Mg <sub>C</sub>	2.9643	2.2435	2.2261	2.2253	2.1998	2.1773	2.2609	2.2521
Fe <sup>2+</sup> <sub>C</sub>	0.9927	2.2778	2.3019	2.3457	2.2069	2.2830	2.3661	2.0457
Mn <sub>C</sub>	0.1178	0.0317	0.0188	0.0000	0.0258	0.0246	0.0000	0.0259
Fe <sup>2+</sup> <sub>B</sub>	0.0000	0.0000	0.0000	0.0121	0.0000	0.0000	0.0356	0.0000
Mn <sub>B</sub>	0.0000	0.0031	0.0047	0.0194	0.0000	0.0000	0.0260	0.0000
Ca <sub>B</sub>	1.6724	1.7672	1.7586	1.7237	1.7233	1.7022	1.6939	1.5645
Na <sub>B</sub>	0.3276	0.2298	0.2366	0.2448	0.2767	0.2978	0.2445	0.4355
Ca <sub>A</sub>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Na <sub>A</sub>	0.1153	0.4245	0.4303	0.4477	0.4156	0.3769	0.4387	0.2589
K <sub>A</sub>	0.1177	0.2599	0.2578	0.2590	0.2570	0.2804	0.2521	0.2382
(K+Na) <sub>A</sub>	0.23	0.68	0.69	0.71	0.67	0.66	0.69	0.50
Mg/Mg + Fe <sup>2+</sup>	0.75	0.50	0.49	0.49	0.50	0.49	0.48	0.52
T (°C)	716	834	839	842	834	837	833	789
P (MPa)	55.9	176.3	185.1	191.4	184.3	192.8	171.7	142.3
continental depth (km)	2.1	6.7	7.0	7.2	7.0	7.3	6.5	5.4
ΔNNO	1.61	0.46	0.42	0.45	0.43	0.39	0.60	0.67

$\log f_{\text{O}_2}$	-14.20	-12.66	-12.61	-12.52	-12.70	-12.67	-12.55	-13.39
$\text{H}_2\text{O}_{\text{melt}}$ (wt %)	3.39	3.85	3.91	3.80	3.91	3.75	3.46	3.63

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**Table S2.** The Zircon trace elements in the monzogranite porphyry from Wandongshan and Bailiancun districts.

Location Lithology Samples	Bailiancun Area											
	Monzogranite Porphyry											
	BLC-3-2	BLC-3-3	BLC-3-4	BLC-3-5	BLC-3-6	BLC-3-7	BLC-3-8	BLC-3-9	BLC-3-10	BLC-3-11	BLC-3-13	BLC-3-14
Ti49	12.35	4.29	2.84	6.92	10.28	10.54	5.92	10.10	9.08	4.90	8.50	11.61
La139	0.16	0.02	0.11	0.08	0.11	0.13	0.18	0.07	0.10	0.07	0.08	0.11
Ce140	10.46	5.70	11.66	7.08	18.11	4.89	16.64	11.95	10.91	23.43	12.31	16.45
Pr141	0.18	0.06	0.07	0.13	0.15	0.08	0.10	0.11	0.08	0.17	0.05	0.16
Nd143	1.95	0.58	1.35	1.42	2.22	0.26	0.61	1.71	0.65	3.41	1.07	1.63
Sm147	3.18	1.16	2.02	2.88	4.00	0.93	0.98	3.51	2.12	5.33	2.31	3.50
Eu151	1.66	0.88	1.03	0.75	2.18	0.57	0.82	2.25	0.16	1.85	1.47	2.53
Gd157	12.28	11.47	10.35	14.96	18.74	8.10	8.76	14.90	14.19	28.42	11.70	18.68
Tb159	4.19	4.78	3.71	5.93	5.57	4.78	3.60	4.35	6.14	10.32	3.97	6.92
Dy163	45.40	67.51	48.19	68.45	60.27	68.13	46.32	48.19	82.02	117.86	44.89	72.41
Ho165	15.85	27.60	19.82	25.27	20.65	25.77	19.64	14.52	33.33	42.57	15.22	24.98
Er166	74.18	134.61	100.04	118.02	89.71	108.11	101.40	59.04	163.04	191.46	62.84	110.52
Tm169	16.42	31.31	24.35	25.90	17.97	21.68	24.76	11.77	38.04	40.01	12.74	22.93
Yb173	166.88	327.13	267.67	248.56	176.41	191.49	274.15	107.20	399.23	382.90	115.09	216.08
Lu175	33.78	66.56	56.23	47.18	35.58	33.25	56.46	18.51	74.37	72.15	20.33	40.40
T(°C)	819	715	680	760	799	802	745	797	786	727	778	812
T(K)	1092	988	953	1033	1072	1075	1018	1070	1059	1000	1053	1085
δCe	15.11	37.24	32.21	16.57	33.00	11.42	30.37	32.25	30.38	53.49	45.27	30.41
Ln( <i>f</i> <sub>o2</sub> )	-33.37	-37.04	-42.76	-38.85	-28.60	-37.51	-35.30	-28.99	-30.66	-32.46	-27.93	-27.99
<i>f</i> <sub>o2</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Log( <i>f</i> <sub>o2</sub> )	-14.49	-16.08	-18.57	-16.87	-12.42	-16.29	-15.33	-12.59	-13.32	-14.10	-12.13	-12.16
ΔFMQ	-0.14	0.65	-0.91	-1.22	2.35	-1.58	0.68	2.22	1.73	2.34	3.06	2.34
Ce <sup>4+</sup> /Ce <sup>3+</sup>	11.52	32.93	26.64	13.61	21.75	15.35	39.37	18.26	37.40	33.87	28.20	22.06
ΣREE	386.56	679.37	546.60	566.61	451.68	468.17	554.42	298.08	824.37	919.95	304.08	537.30
LREE/HREE	0.05	0.01	0.03	0.02	0.06	0.01	0.04	0.07	0.02	0.04	0.06	0.05
δEu	0.81	0.74	0.69	0.35	0.77	0.63	0.85	0.95	0.09	0.46	0.86	0.96
10000/TK	9.2	10.1	10.5	9.7	9.3	9.3	9.8	9.3	9.4	10.0	9.5	9.2
Location Lithology Samples	Bailiancun						Wandongshan Area					
	Monzogranite Porphyry						Monzogranite Porphyry					
	BLC-3-16	WDS-4-02	WDS-4-03	WDS-4-05	WDS-4-06	WDS-4-08	WDS-4-10	WDS-4-11	WDS-4-12	WDS-4-13	WDS-4-14	WDS-4-18

Ti49	3.38	28.57	2.83	11.69	2.53	48.29	4.91	4.93	12.36	5.74	8.25	3.67
La139	0.20	0.18	0.25	0.02	0.48	0.42	0.05	0.05	0.43	0.31	0.00	0.01
Ce140	13.49	7.03	39.62	14.44	28.70	28.68	16.32	8.71	55.48	5.75	8.11	21.46
Pr141	0.04	0.06	0.08	0.06	0.07	0.14	0.05	0.06	0.31	0.07	0.02	0.05
Nd143	1.39	0.91	0.89	1.22	0.72	1.09	0.68	1.17	4.34	0.76	0.41	0.96
Sm147	1.15	0.80	2.39	2.40	1.48	1.14	1.74	2.61	6.97	1.16	1.02	1.60
Eu151	1.04	0.65	1.08	1.48	0.79	0.85	0.32	0.78	4.36	0.57	0.37	0.41
Gd157	10.84	7.67	12.88	11.30	10.57	9.13	9.20	9.92	37.82	9.59	6.19	7.84
Tb159	3.56	2.69	4.58	3.20	3.37	3.10	3.87	3.44	11.88	4.41	2.32	2.51
Dy163	47.33	32.12	59.77	27.63	45.25	40.15	50.93	40.71	133.60	63.66	29.75	29.77
Ho165	19.61	10.39	25.76	7.73	18.96	17.38	23.42	15.30	48.17	26.41	11.78	10.62
Er166	93.73	38.81	138.46	26.98	99.82	93.01	120.63	70.94	214.32	129.29	57.82	50.94
Tm169	21.12	7.32	34.61	4.68	24.73	23.71	28.67	15.81	45.62	29.20	13.83	11.17
Yb173	235.37	64.29	372.80	39.98	271.12	261.84	303.28	156.23	446.22	298.25	141.02	109.90
Lu175	47.48	11.22	82.60	7.83	60.40	59.23	66.96	30.88	87.04	62.77	29.26	25.09
T(°C)	695	917	680	813	671	988	727	728	819	742	777	702
T(K)	968	1190	953	1086	944	1261	1000	1001	1092	1015	1050	975
δCe	35.01	16.59	65.85	117.99	38.47	28.52	77.05	41.52	36.69	9.25	201.46	203.83
Ln( <i>f</i> <sub>o2</sub> )	-40.16	-23.46	-36.63	-16.18	-42.47	-13.08	-29.28	-34.60	-25.68	-45.93	-15.34	-24.02
<i>f</i> <sub>o2</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Log( <i>f</i> <sub>o2</sub> )	-17.44	-10.19	-15.91	-7.03	-18.45	-5.68	-12.72	-15.02	-11.15	-19.95	-6.66	-10.43
ΔFMQ	-0.17	2.28	1.77	7.45	-0.52	5.60	3.71	1.40	3.20	-3.87	8.60	6.65
Ce <sup>4+</sup> /Ce <sup>3+</sup>	29.15	14.85	78.61	53.76	51.97	42.15	83.03	29.78	30.78	12.11	140.46	144.60
ΣREE	496.35	184.14	775.77	148.95	566.46	539.87	626.14	356.58	1096.56	632.20	301.93	272.34
LREE/HREE	0.04	0.06	0.06	0.15	0.06	0.06	0.03	0.04	0.07	0.01	0.03	0.10
δEu	0.90	0.81	0.59	0.87	0.61	0.81	0.24	0.47	0.82	0.52	0.45	0.36
10000/TK	10.3	8.4	10.5	9.2	10.6	7.9	10.0	10.0	9.2	9.9	9.5	10.3