

Yanfei Xia, Changqing Yin, Shoufa Lin, Jian Zhang, Jiahui Qian, Shangjing Wu, and Jingna Liu, 2021, Metamorphism and geochronology of high-pressure mafic granulites (retrograded eclogites?) in East Cathaysia terrane of South China: Implications for Mesozoic tectonic evolution: GSA Bulletin, <https://doi.org/10.1130/B36025.1>.

Supplemental Material

Table S1. Representative composition analyses of garnets of sample 16LQ18-9 and 16LQ18-10

Table S2. Representative composition analyses of clinopyroxene of sample 16LQ18-9 and 16LQ18-10

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Table S6. PT estimates of HP mafic rocks using conventional geothermometers and geobarometers

Table S7. Zircon SIMS Th-U-Pb DATA

Table S8. Trace element data

ANALYTICAL TECHNIQUES OF SIMS ZIRCON U-Pb DATING

Zircons crystals from these samples were separated through conventional density and magnetic separation techniques, and then handpicked under a binocular microscope in the Mineral Separation Laboratory of the Institute of Regional Geological Survey in Langfang, Hebei Province, China. The selected grains, together with the zircon standards Plésovice (337 Ma; Sláma et al., 2008) and Qinghu (159.5 Ma; Li et al., 2009), were embedded in an epoxy resin, and then polished to expose the grain center for analysis.

Cathodoluminescence (CL) images were taken to reveal external and internal structures of polished zircons using a Garton Mono CL3+ scanning electron microscope. Zircon U-Pb isotopes of U, Th, and Pb were analyzed using the Cameca IMS-1280HR SIMS at Guangzhou Institute of Geochemistry, Chinese Academy of Sciences. A primary beam of O^{2-} was accelerated at 13 kV, with an intensity of ca. 8–11 nA, and the ellipsoidal spot is about $20 \times 30 \mu\text{m}$ in size. U-Th-Pb ratios were determined relative to the Plésovice standard zircon (Sláma et al., 2008), Analyses of which were interspersed with those of unknown grains. Detailed of operating and data processing procedures are similar to those described by Li et al. (2009). A long-term uncertainty of 1.5% (1 RSD) for $^{206}\text{Pb}/^{238}\text{U}$ measurements of the standard zircon was propagated to the unknowns (Li et al., 2010), even though the measured $^{206}\text{Pb}/^{238}\text{U}$ error during the course of this study is ca.1% (1 RSD). In order to monitor the external uncertainties of SIMS

U-Pb measurements, a secondary zircon standard Qinghu was alternately analyzed as an unknown, yielding a concordia age of 160.9 ± 1.5 Ma (MSWD = 1.00) which is in good agreement within errors with the recommended value of 159.5 ± 0.2 Ma (Li et al., 2009). Measured Pb isotopic compositions were corrected using non-radiogenic ^{204}Pb , and an average of present-day crustal composition (Stacey and Kramers, 1975) is used for the common Pb on the basis that any common Pb was most likely to be surface contamination introduced during sample preparation. Uncertainties on individual analyses in the data tables are reported at a 1σ level and calculated weighted mean ages are quoted with 2σ and/or 95% confidence intervals. Concordia plots were processed using Isoplot/Ex (4.15) program (Ludwig, 2003).

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TABLE S1. REPRESENTATIVE COMPOSITION ANALYSES OF GARNETS OF SAMPLE 16LQ18-9 AND 16LQ18-10

Mineral	Garnet of sample 16LQ18-9												Garnet of sample 16LQ18-10										
	Part I				Part II								Rim			Mantle				Core			
SiO ₂	38.22	38.37	38.20	38.26	39.22	38.41	38.32	38.37	38.36	38.53	37.94	38.41	38.1	38.74	39.05	38.52	38.52	37.60	38.75	38.0	38.21	37.58	38.05
TiO ₂	0.09	0.08	0.01	0.00	0.04	0.09	0.11	0.07	0.05	0.05	0.08	0.09	0.09	0.10	0.05	0.09	0.07	0.08	0.07	0.08	0.03	0.08	0.07
Al ₂ O ₃	22.35	22.47	22.21	22.23	22.46	22.00	22.04	22.12	22.16	22.18	22.25	22.31	22.3	22.73	23.06	22.62	22.51	21.53	22.63	22.2	22.30	21.98	22.14
Cr ₂ O ₃	0.00	0.09	0.06	0.00	0.03	0.06	0.00	0.03	0.07	0.00	0.01	0.09	0.00	0.03	0.09	0.07	0.02	0.07	0.06	0.07	0.05	0.05	0.06
Fe ₂ O ₃	0.00	0.00	0.04	0.17	0.00	0.00	0.00	0.00	0.80	0.38	0.86	0.00	0.51	0.68	0.89	1.18	0.00	1.24	0.01	0.41	0.76	0.00	0.00
FeO	25.39	24.88	26.16	26.87	25.26	25.55	26.06	27.31	27.62	27.65	27.15	27.37	23.7	21.33	20.50	20.31	21.42	19.85	20.62	23.0	20.94	23.74	23.00
MnO	0.79	1.34	1.29	0.80	0.49	0.40	0.32	0.35	0.20	0.20	0.16	0.31	0.94	0.29	1.13	1.22	1.19	1.27	1.27	1.83	1.43	1.75	1.66
MgO	2.76	3.01	2.63	2.87	2.93	3.18	3.49	3.86	4.20	4.54	4.76	5.47	6.24	5.95	5.66	5.34	4.91	4.77	4.97	4.46	4.67	4.23	3.97
CaO	11.36	10.74	10.39	10.10	11.64	10.63	9.65	8.72	8.27	7.88	7.32	6.44	7.69	10.94	11.69	11.76	11.21	12.00	12.12	9.79	11.64	9.11	10.40
Na ₂ O	0.00	0.01	0.04	0.00	0.00	0.06	0.02	0.00	0.00	0.01	0.05	0.04	0.01	0.03	0.00	0.00	0.03	0.00	0.02	0.03	0.02	0.00	0.00
K ₂ O	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	100.96	100.99	101.04	101.30	102.07	100.38	100.01	100.84	101.73	101.43	100.59	100.53	99.68	100.83	102.13	101.11	99.88	98.41	100.52	99.93	100.05	98.52	99.35
Oxygens	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.0	12.00	12.00	12.00	12.00	12.00	12.00	12.0	12.00	12.00	12.00
Si	2.97	2.98	2.98	2.98	3.01	3.00	3.00	2.99	2.96	2.98	2.95	2.98	2.96	2.96	2.95	2.94	2.98	2.96	2.97	2.96	2.96	2.97	2.98
Ti	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
Al	2.05	2.06	2.04	2.04	2.03	2.02	2.03	2.03	2.02	2.02	2.04	2.04	2.04	2.04	2.05	2.04	2.05	2.00	2.05	2.04	2.04	2.05	2.05
Cr	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe ³⁺	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.02	0.05	0.00	0.03	0.04	0.05	0.07	0.00	0.07	0.00	0.02	0.04	0.00	0.00
Fe ²⁺	1.65	1.62	1.71	1.75	1.62	1.67	1.71	1.78	1.79	1.79	1.77	1.78	1.54	1.36	1.29	1.30	1.39	1.31	1.32	1.50	1.36	1.57	1.51
Mn	0.05	0.09	0.09	0.05	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.02	0.06	0.02	0.07	0.08	0.08	0.09	0.08	0.12	0.09	0.12	0.11
Mg	0.32	0.35	0.31	0.33	0.34	0.37	0.41	0.45	0.48	0.52	0.55	0.63	0.72	0.68	0.64	0.61	0.57	0.56	0.57	0.52	0.54	0.50	0.46
Ca	0.95	0.89	0.87	0.84	0.96	0.89	0.81	0.73	0.68	0.65	0.61	0.54	0.64	0.89	0.95	0.96	0.93	1.01	1.00	0.82	0.97	0.77	0.87
Na	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
K	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	8.00	7.99	8.00	8.00	7.98	7.99	7.98	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	7.99	7.99
X _{Ca} [*]	0.32	0.31	0.30	0.29	0.33	0.30	0.28	0.25	0.23	0.22	0.21	0.18	0.22	0.31	0.33	0.34	0.32	0.35	0.34	0.29	0.34	0.27	0.31
X _{Mg} [†]	0.11	0.12	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.25	0.23	0.22	0.21	0.20	0.19	0.20	0.18	0.19	0.18	0.16

Notes: Major oxides are given in wt%, and cations are reported per formula unit (pfu); $X_{Ca} = Ca/(Mg + Ca + Fe^{2+})$; $X_{Mg} = Mg/(Mg + Ca + Fe^{2+})$.

TABLE S2. REPRESENTATIVE COMPOSITION ANALYSES OF CLINOPYROXENE OF SAMPLE 16LQ18-9 AND 16LQ18-10

Mineral	Clinopyroxene of sample 16LQ18-9				Reintegrated clinopyroxene		Clinopyroxene of sample 16LQ18-10					
	Intergrowing with pl				25vol.% pl	20vol.% pl	Matrix					
SiO ₂	51.85	51.13	53.62	51.73	54.37	54.02	53.08	53.50	53.87	52.80	53.09	53.64
TiO ₂	0.16	0.38	0.01	0.38	0.11	0.11	0.12	0.16	0.02	0.24	0.04	0.01
Al ₂ O ₃	1.16	2.79	0.72	2.79	6.98	5.80	0.74	0.90	0.25	2.21	0.71	0.23
Cr ₂ O ₃	0.03	0.00	0.00	0.00	0.08	0.07	0.03	0.01	0.06	0.06	0.00	0.06
Fe ₂ O ₃	1.13	1.49	0.00	0.72	0.72	0.76	0.00	1.31	0.00	0.00	0.34	0.68
FeO	11.66	10.18	18.47	10.87	8.88	9.48	8.93	6.80	8.44	8.90	8.04	7.69
MnO	0.23	0.07	0.31	0.07	0.13	0.14	0.22	0.04	0.22	0.23	0.15	0.27
MgO	11.65	12.84	13.08	12.83	9.62	10.26	14.13	14.53	13.95	13.35	14.03	14.12
CaO	22.29	20.40	11.51	20.40	16.44	17.07	21.72	23.55	23.56	22.14	22.74	23.92
Na ₂ O	0.20	0.41	0.10	0.42	1.99	1.63	0.27	0.26	0.15	0.33	0.25	0.08
K ₂ O	0.00	0.10	0.02	0.10	0.05	0.04	0.00	0.00	0.00	0.01	0.01	0.00
Totals	100.36	99.79	97.84	100.31	99.37	99.38	99.24	101.06	100.52	100.27	99.40	100.70
Oxygens	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Si	1.96	1.92	2.06	1.94	1.99	1.99	1.99	1.97	2.00	1.96	1.99	1.99
Ti	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Al	0.05	0.12	0.03	0.12	0.30	0.25	0.03	0.04	0.01	0.10	0.03	0.01
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe ³⁺	0.03	0.04	0.00	0.02	0.02	0.02	0.00	0.04	0.00	0.00	0.01	0.02
Fe ²⁺	0.37	0.32	0.59	0.34	0.27	0.29	0.28	0.21	0.26	0.28	0.25	0.24
Mn	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
Mg	0.66	0.72	0.75	0.72	0.53	0.56	0.79	0.80	0.77	0.74	0.78	0.78
Ca	0.90	0.82	0.47	0.82	0.65	0.68	0.87	0.93	0.94	0.88	0.91	0.95
Na	0.02	0.03	0.01	0.03	0.14	0.12	0.02	0.02	0.01	0.02	0.02	0.01
K	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	4.00	4.00	3.93	4.00	3.91	3.93	4.00	4.00	4.00	4.00	4.00	4.00
X _{Mg} [*]	0.64	0.69	0.56	0.68	0.66	0.66	0.74	0.79	0.75	0.73	0.76	0.77
Jd	0.01	0.05	0.09	0.06	0.29	0.24	0.02	0.01	0.01	0.06	0.02	0.00

Notes: Major oxides are given in wt%, and cations are reported per formula unit (pfu); ^{*}X_{Mg} = Mg/(Mg + Fe²⁺).

TABLE S3. REPRESENTATIVE COMPOSITION ANALYSES OF HORNBLENDES OF SAMPLE 16LQ18-9 AND 16LQ18-10

Mineral	Hornblendes of sample 16LQ18-9					Hornblendes of sample 16LQ18-10						
	Grains in matrix		Corona			Matrix		Corona			Inclusions	
SiO ₂	48.33	43.99	46.41	50.36	45.11	51.45	50.65	44.50	42.52	43.38	41.27	43.95
TiO ₂	0.59	1.84	1.69	0.09	1.00	0.50	0.61	0.69	0.90	1.09	1.81	2.11
Al ₂ O ₃	7.16	11.08	9.31	5.64	10.55	4.91	5.57	11.54	13.03	12.25	12.29	12.20
Cr ₂ O ₃	0.02	0.03	0.00	0.01	0.00	0.01	0.09	0.01	0.12	0.04	0.22	0.00
Fe ₂ O ₃	4.39	2.90	1.90	1.18	5.62	2.82	3.51	4.51	3.48	4.22	2.25	1.17
FeO	13.21	13.71	14.83	17.91	15.13	11.37	10.11	12.07	14.18	13.59	17.16	11.70
MnO	0.11	0.14	0.24	0.24	0.10	0.10	0.24	0.25	0.20	0.19	0.31	0.15
MgO	12.26	10.83	11.26	10.53	10.05	14.84	15.38	11.57	9.94	10.60	8.24	12.44
CaO	11.30	11.22	11.82	11.65	10.04	11.96	11.30	10.87	11.09	11.09	11.60	11.92
Na ₂ O	0.77	1.42	1.24	0.42	1.34	0.59	0.90	1.72	1.79	1.74	1.51	1.65
K ₂ O	0.26	0.72	0.55	0.37	0.53	0.20	0.34	0.65	0.99	0.91	1.19	1.05
Totals	98.40	97.88	99.25	98.40	99.47	98.75	98.70	98.38	98.24	99.10	97.85	98.34
Oxygens	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.05	6.52	6.77	7.42	6.62	7.36	7.24	6.53	6.33	6.38	6.27	6.42
Ti	0.07	0.21	0.19	0.01	0.11	0.05	0.07	0.08	0.10	0.12	0.21	0.23
Al	1.23	1.94	1.60	0.98	1.82	0.83	0.94	2.00	2.29	2.12	2.20	2.10
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.03	0.00
Fe ³⁺	0.48	0.32	0.21	0.13	0.62	0.30	0.38	0.50	0.39	0.47	0.26	0.13
Fe ²⁺	1.61	1.70	1.81	2.21	1.86	1.36	1.21	1.48	1.76	1.67	2.18	1.43
Mn	0.01	0.02	0.03	0.03	0.01	0.01	0.03	0.03	0.03	0.02	0.04	0.02
Mg	2.67	2.39	2.45	2.31	2.20	3.16	3.28	2.53	2.20	2.32	1.87	2.71
Ca	1.77	1.78	1.85	1.84	1.58	1.83	1.73	1.71	1.77	1.75	1.89	1.87
Na	0.22	0.41	0.35	0.12	0.38	0.16	0.25	0.49	0.52	0.50	0.45	0.47
K	0.05	0.14	0.10	0.07	0.10	0.04	0.06	0.12	0.19	0.17	0.23	0.20
Sum	15.32	15.53	15.43	15.16	15.50	15.22	15.31	15.63	15.71	15.69	15.70	15.61
X _{Mg} [*]	0.62	0.58	0.58	0.52	0.51	0.56	0.58	0.70	0.73	0.63	0.46	0.65

Notes: Major oxides are given in wt%, and cations are reported per formula unit (pfu); ^{*}X_{Mg} = Mg/(Mg + Fe²⁺).

TABLE S4. REPRESENTATIVE COMPOSITION ANALYSES OF PLAGIOCLASES OF SAMPLE 16LQ18-9 AND 16LQ18-10

Mineral	Plagioclases of sample 16LQ18-9										Plagioclases of sample 16LQ18-10									
	Matrix				Corona			Intergrowing with Cpx			Matrix				Corona		Inclusions in garnet			
SiO ₂	55.55	53.62	56.97	55.63	46.53	47.31	47.73	59.36	59.05	60.83	58.26	58.61	58.92	58.06	55.09	58.09	56.46	57.77	57.94	57.46
TiO ₂	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.04	0.02	0.03	0.01	0.00	0.04	0.00
Al ₂ O ₃	27.51	29.02	26.93	27.55	33.66	33.48	31.97	24.67	24.71	24.42	25.93	25.69	25.76	26.13	27.48	26.05	26.94	25.73	26.05	26.03
Cr ₂ O ₃	0.00	0.00	0.03	0.00	0.01	0.02	0.01	0.55	0.00	0.01	0.00	0.02	0.00	0.07	0.00	0.05	0.00	0.00	0.00	0.00
Fe ₂ O ₃	0.20	0.22	0.07	0.11	0.27	0.30	0.16	0.13	0.16	0.12	0.26	0.02	0.11	0.22	0.23	0.08	0.26	0.19	0.11	0.17
FeO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MnO	0.03	0.05	0.00	0.02	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.02	0.00	0.00	0.04	0.10	0.00	0.04	0.00	0.00
MgO	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00
CaO	10.47	12.27	9.24	10.93	18.34	16.89	15.91	7.03	7.10	7.05	8.30	7.88	7.83	8.17	10.71	8.39	9.66	8.53	8.78	8.95
Na ₂ O	5.62	4.61	6.12	5.55	1.23	1.98	2.46	7.38	7.29	7.64	7.11	7.35	7.54	7.37	5.25	6.81	6.13	6.86	6.24	6.56
K ₂ O	0.12	0.09	0.13	0.09	0.01	0.03	0.03	0.10	0.07	0.22	0.16	0.10	0.17	0.10	0.09	0.14	0.09	0.15	0.18	0.17
Totals	99.50	99.91	99.49	99.91	100.05	100.03	98.28	99.28	98.40	100.30	100.05	99.69	100.38	100.16	98.91	99.74	99.57	99.27	99.35	99.34
Oxygens	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Si	2.51	2.43	2.57	2.51	2.14	2.17	2.23	2.67	2.67	2.70	2.61	2.63	2.63	2.60	2.51	2.61	2.55	2.61	2.61	2.59
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.47	1.55	1.43	1.47	1.83	1.81	1.76	1.31	1.32	1.28	1.37	1.36	1.35	1.38	1.48	1.38	1.43	1.37	1.38	1.39
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe ³⁺	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01
Fe ²⁺	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	0.51	0.60	0.45	0.53	0.91	0.83	0.80	0.34	0.34	0.34	0.40	0.38	0.37	0.39	0.52	0.40	0.47	0.41	0.42	0.43
Na	0.49	0.41	0.54	0.49	0.11	0.18	0.22	0.64	0.64	0.66	0.62	0.64	0.65	0.64	0.46	0.59	0.54	0.60	0.55	0.57
K	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sum	5.00	5.00	4.99	5.00	4.99	5.01	5.01	4.99	4.99	4.99	5.02	5.01	5.02	5.03	4.98	5.00	5.00	5.01	4.98	5.00
An*	0.50	0.59	0.45	0.52	0.89	0.82	0.78	0.34	0.35	0.33	0.39	0.37	0.36	0.38	0.53	0.40	0.46	0.40	0.43	0.43

Notes: Major oxides are given in wt%, and cations are reported per formula unit (pfu); *An = Ca/(Ca + Na).

TABLE S5. WHOLE-ROCK COMPOSITIONS OF THE STUDIED SAMPLES

Sample	XRF whole-rock composition (wt%)										
	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI
16LQ18-9	48.59	1.54	12.31	17.58	0.29	6.92	8.87	1.37	0.75	0.12	1.48
16LQ18-10	47.23	0.99	14.41	12.59	0.25	9.39	10.90	2.18	0.84	0.07	1.29

Sample	Normalized mole-proportions (mol%) to construct the phase diagrams									
	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MgO	CaO	Na ₂ O	O	H ₂ O	Figure
16LQ18-9	51.00	1.21	7.62	12.08	10.83	9.80	1.39	0.90	5.15	Fig. 8
16LQ18-10	48.54	0.77	8.73	8.47	14.38	11.89	2.17	0.63	4.42	Fig. 9

TABLE S6. PT ESTIMATES OF HP MAFIC ROCKS USING CONVENTIONAL GEOTHERMOMETERS AND GEOBAROMETERS

Sample	Metamorphic stage	Mineral assemblage	Mineral pair used for PT estimate	Methods	Pressure/kbar	Temperature/°C
16LQ18-9	M1	g+cpx(jd)+hb+ru	—	—	—	—
	M2	g+cpx+pl+hb+ru+ilm	g(r)+cpx+pl(m)	1*,2†	12-14.7	746.5-884.4
	M3	hb+pl+ilm	hb(sym)+pl(sym)	3§	5.4-6.4	613-668
16LQ18-10	M1	g+cpx+pl+hb+ru	g(r)+cpx+pl(m)	1*,2†	13.6-14.4	769-789
	M2	hb+pl+ilm	hb(sym)+pl(sym)	3§	5.2-7.2	607-676

Notes: Mineral abbreviations: g(r)-rim compositions of garnet; pl(m)-compositions of plagioclase in the matrix; pl (sym)-compositions of plagioclase in the amphibole + plagioclase symplectite around garnet; hb(sym)- compositions of plagioclase in the amphibole + plagioclase symplectite around garnet.

*1 = Garnet-clinopyroxene-plagioclase-quartz barometer (Newton & Perkins, 1982).

†2 = Garnet-clinopyroxene thermometer (Ravna, 2000).

§3 = Hornblende-plagioclase thermobarometer (Holland & Blundy, 1994).

REFERENCES CITED:

- Holland, T. J. B., and Blundy, J. D., 1994, Non-ideal interactions in calcic amphiboles and their bearing on amphibole-plagioclase thermometry: Contributions to Mineralogy and Petrology, v. 116: p. 433-447, <https://doi.org/10.1007/BF00310910>.
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- Ravna, E.K., 2000, The garnet-clinopyroxene Fe²⁺-Mg geothermometer: an updated calibration: Journal of Metamorphic Geology, v. 18, p. 211–219, <https://doi.org/10.1046/j.1525-1314.2000.00247.x>.

TABLE S7. ZIRCON SIMS Th-U-Pb DATA

Spot	Th (ppm)	U (ppm)	Th/U	$f_{(206)}^*$ %	$^{207}\text{Pb}/^{206}\text{Pb}$	$1\sigma(\%)$	$^{207}\text{Pb}/^{235}\text{U}$	$1\sigma(\%)$	$^{206}\text{Pb}/^{238}\text{U}$	$1\sigma(\%)$	Conc. [†]	Disc. % [§]	Ages (Ma)		$^{207}\text{Pb}/^{206}\text{Pb}$	1σ	$^{207}\text{Pb}/^{235}\text{U}$	1σ	$^{206}\text{Pb}/^{238}\text{U}$	1σ	
<i>Sample 16LQ18-9</i>																					
1	9	100	0.09	0.34	0.0515	1.68	0.2704	2.32	0.0381	1.59	0.9918	-8.0629	261.8	38	243	5	241	3.8			
2	5	134	0.04	0.17	0.0513	2.25	0.2711	2.72	0.0384	1.52	0.9963	-3.9429	252.4	51	243.6	5.9	242.7	3.6			
3	1	77	0.02	0.55	0.0501	3.19	0.2632	3.54	0.0381	1.53	1.0152	19.8284	201.6	72	237.3	7.5	240.9	3.6			
4	7	73	0.1	0.19	0.0519	2.47	0.2687	2.99	0.0376	1.68	0.9839	-15.329	279.9	56	241.7	6.4	237.8	3.9			
5	1	101	0.01	0.25	0.0524	2.65	0.2721	3.19	0.0377	1.79	0.9758	-21.504	302.1	59	244.3	7	238.4	4.2			
6	7	76	0.09	0.27	0.0512	2.95	0.2675	3.33	0.0379	1.55	0.995	-5.0649	252.1	66	240.7	7.2	239.5	3.6			
7	10	114	0.09	0.27	0.0522	2.36	0.2695	2.8	0.0375	1.5	0.9785	-19.526	293.3	53	242.3	6	237.1	3.5			
8	2	64	0.03	0.53	0.0499	3.57	0.2559	4.03	0.0372	1.86	1.0169	22.8313	192.1	81	231.3	8.4	235.2	4.3			
9	2	174	0.01	0.1	0.0534	1.57	0.2826	2.2	0.0383	1.54	0.96	-30.856	347.9	35	252.7	4.9	242.6	3.7			
10	10	90	0.11	0.27	0.0509	2.72	0.2676	3.25	0.0381	1.78	1.0025	2.6768	235.1	62	240.7	7	241.3	4.2			
11	4	85	0.05	0.35	0.0521	2.91	0.2758	3.27	0.0384	1.5	0.9822	-16.137	288.7	65	247.4	7.2	243	3.6			
12	6	99	0.06	0.32	0.0517	3.01	0.268	3.38	0.0376	1.54	0.9876	-12.061	270.1	68	241.1	7.3	238.1	3.6			
13	8	304	0.03	0.14	0.0524	1.23	0.2761	2.04	0.0382	1.62	0.977	-20.318	302.1	28	247.6	4.5	241.9	3.9			
14	1	67	0.02	0.2	0.0528	2.21	0.2653	2.67	0.0365	1.5	0.9661	-28.137	319.1	49	239	5.7	230.9	3.4			
15	8	128	0.06	0.19	0.0501	1.64	0.2689	2.25	0.0389	1.54	1.0174	22.7279	201.1	38	241.8	4.9	246	3.7			
16	12	351	0.03	0.07	0.0523	1.01	0.2783	2.02	0.0386	1.75	0.9791	-18.432	298.1	23	249.3	4.5	244.1	4.2			
17	1	76	0.01	0.3	0.0506	2.59	0.2648	2.99	0.038	1.51	1.0071	8.86146	221.1	59	238.6	6.4	240.3	3.6			
18	11	125	0.08	0	0.0528	1.9	0.2812	2.48	0.0386	1.59	0.971	-24.223	320.5	43	251.6	5.5	244.3	3.8			
19	6	95	0.06	0.24	0.0523	2.43	0.277	2.91	0.0384	1.6	0.9787	-19.03	298.8	55	248.3	6.4	243	3.8			
20	1	91	0.01	0.3	0.0515	3.04	0.2547	4.27	0.0359	2.99	0.9861	-13.894	263.1	68	230.4	8.8	227.2	6.7			
21	8	397	0.02	0.05	0.0519	1.05	0.2827	2.38	0.0395	2.13	0.9885	-10.803	279.5	24	252.8	5.3	249.9	5.2			
23	6	315	0.02	0.07	0.0515	1.25	0.2949	1.96	0.0415	1.51	0.9992	-0.811	264.3	28	262.4	4.5	262.2	3.9			
<i>Sample 16LQ18-10</i>																					
2	0	35	0	0.98	0.0478	6.01	0.2484	6.21	0.0377	1.53	1.06	177	87	137	225	13	239	4			
6	1	30	0.04	0.96	0.0541	7.07	0.2852	7.24	0.0383	1.53	0.95	-36	374	152	255	16	242	4			
1	0	29	0	1.38	0.0492	7.3	0.2599	7.45	0.0383	1.5	1.03	54	159	162	235	16	242	4			
4	1	57	0.01	0.34	0.0544	2.83	0.2904	3.21	0.0387	1.52	0.95	-38	389	62	259	7	245	4			
9	0	41	0.01	1.41	0.0497	6.83	0.2655	7	0.0387	1.55	1.02	34	183	152	239	15	245	4			

5	1	39	0.04	1.78	0.0496	8.57	0.2647	8.74	0.0387	1.72	1.03	41	175	189	238	19	245	4
3	0	50	0	0.27	0.0527	2.9	0.2824	3.43	0.0388	1.83	0.97	-23	317	65	253	8	246	4
12	0	28	0.01	1.41	0.0494	9.44	0.2646	9.59	0.0388	1.69	1.03	48	167	207	238	21	246	4
10	1	62	0.01	1.64	0.0533	5.68	0.2891	5.94	0.0393	1.74	0.96	-28	343	124	258	14	249	4
8	1	29	0.03	1.83	0.0493	8.19	0.2699	8.34	0.0397	1.58	1.03	55	163	181	243	18	251	4
14	0	36	0	0.98	0.0527	5.75	0.2815	5.97	0.0388	1.58	0.97	-23	315	126	252	13	245	4
16	0	28	0.01	1.07	0.049	6.84	0.2578	7.05	0.0381	1.73	1.04	64	149	153	233	15	241	4
17	1	70	0.02	0.3	0.0517	2.29	0.2811	2.75	0.0395	1.52	0.99	-8	271	52	252	6	249	4
18	3	50	0.06	0.45	0.0516	3.87	0.2715	4.17	0.0381	1.55	0.99	-10	268	86	244	9	241	4
19	1	56	0.01	0.78	0.0487	3.91	0.2604	4.19	0.0388	1.5	1.04	87	132	90	235	9	245	4
20	0	28	0.01	0.87	0.0525	5.62	0.2809	5.84	0.0388	1.58	0.98	-20	307	123	251	13	246	4

Notes: * f_{206} is the percentage of common ^{206}Pb in total measured ^{206}Pb .

†Conc. is concordance defined as $[(^{206}\text{Pb}/^{238}\text{U age}) / (^{207}\text{Pb}/^{235}\text{U age})]$.

§Disc. (%) denotes degree of discordance.

TABLE S8. TRACE ELEMENT DATA

Point	Rare earth elements (ppm)													
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
<i>Zircon/ Sample 16LQ18-9</i>														
1	0.0089	1.5400	0.0075	0.4800	1.3690	0.9720	6.4600	1.3000	8.4500	1.6000	4.1000	0.6360	5.0600	0.5170
2	0.0084	0.3770	0.0030	0.0733	0.5250	0.2220	1.5100	0.3630	2.5300	0.5400	1.5300	0.2450	2.3600	0.2490
3	0.0312	0.2640	0.0032	0.0169	0.4240	0.3350	2.0100	0.6350	5.3800	1.4900	4.6700	0.9700	8.6500	1.0700
4	0.0252	1.8300	0.0320	0.6000	1.4800	0.8610	5.5000	1.1000	6.6200	1.1900	3.0900	0.5150	3.8800	0.4210
5	0.0079	0.5550	0.0026	0.3230	0.9090	0.7000	3.5800	0.8900	6.1700	1.3000	3.8200	0.5980	5.3300	0.5800
6	0.0307	1.5500	0.0356	0.4730	2.0800	1.1200	5.1100	1.0800	6.1900	1.2100	3.2800	0.6020	4.4000	0.4090
7	0.1075	1.4300	0.0277	0.0570	1.3900	0.7080	3.4300	0.7540	3.9800	0.7700	1.7000	0.2780	2.3400	0.2960
8	0.0083	0.2190	0.0039	0.1148	1.1190	0.5270	3.7500	1.1000	8.7900	1.9400	5.4300	1.0100	8.0900	0.9700
9	0.0648	0.9800	0.0026	0.3340	0.9020	0.8000	4.9700	0.8760	6.1400	1.1800	3.2700	0.5740	3.7700	0.4780
10	0.0105	1.3000	0.0465	0.4050	1.2970	1.0280	5.1300	1.2100	8.4100	1.8500	5.0800	1.0400	8.0300	0.9300
11	0.0110	1.1600	0.0328	0.5150	1.5700	1.0900	5.9100	1.1000	6.2400	1.1000	2.4700	0.4540	2.5100	0.2980
12	0.0246	1.2200	0.0045	0.4960	2.1100	1.1900	6.0400	1.3500	8.4000	1.8700	4.7200	0.7900	6.0900	0.7500
13	0.0498	0.6960	0.0114	0.2860	0.9030	0.4490	2.9800	0.7270	4.9100	0.8900	2.5100	0.3730	4.1300	0.4050
14	0.0070	1.8200	0.0374	1.0610	3.1200	1.7800	7.6000	1.1700	5.4000	0.8500	2.0600	0.2890	2.2700	0.2100
15	0.0256	1.7100	0.0346	1.2310	3.4400	1.8000	7.7300	1.1600	6.4800	0.8400	2.2700	0.3570	2.2400	0.1830
16	0.0287	1.3900	0.0132	0.0824	0.3470	0.3330	2.1400	0.7600	7.5200	2.2100	7.6200	1.5100	12.2300	1.8000
17	0.0063	0.7800	0.0119	0.1350	0.8530	0.5630	3.2800	0.7100	4.8000	1.0700	2.9500	0.3970	3.6100	0.3830
19	0.0269	1.5500	0.0300	0.5430	1.6700	1.0000	4.8100	0.9600	4.8300	0.9600	2.3200	0.3580	2.7900	0.2710
20	0.0117	0.3250	0.0047	0.1760	0.4310	0.4350	2.5000	0.8300	5.5700	1.3200	3.6500	0.6700	5.1200	0.6700
21	0.0072	0.5450	0.0044	0.4030	1.4700	1.1600	6.2100	1.4700	9.6000	1.6400	3.9300	0.5900	5.3100	0.5800
23	0.0080	0.4800	0.0033	0.1460	0.5300	0.4690	4.5800	1.2200	9.9400	2.2600	6.2400	1.0700	7.6900	0.7500
<i>Zircon/ Sample 16LQ18-10</i>														
1	0.0096	0.0422	0.0036	0.0665	0.0270	0.1910	1.0650	0.5200	4.7300	1.2670	2.9900	0.3410	2.9800	0.3630
2	0.0147	0.0061	0.0025	0.0676	0.1700	0.0518	0.5680	0.3020	2.9200	0.7310	1.7700	0.2210	2.4500	0.1790
3	0.0541	0.0135	0.0075	0.0475	0.1760	0.0643	0.6590	0.2440	2.0200	0.3660	1.0800	0.1260	1.1340	0.1235
4	0.0101	0.0878	0.0056	0.0996	0.2880	0.5170	3.3600	0.9900	7.8700	1.4820	3.9600	0.5110	3.9200	0.4650
5	0.0096	0.1301	0.0049	0.0241	0.2350	0.1570	1.1830	0.4900	4.1200	0.9940	2.4300	0.3400	2.6200	0.2710
6	0.0332	0.1230	0.0027	0.0841	0.0202	0.1260	0.8480	0.2880	2.4500	0.6900	2.3400	0.5490	6.4500	1.0900
8	0.0066	0.0584	0.0025	0.0596	0.1800	0.2260	1.6900	0.4760	3.8700	0.8340	2.0490	0.3060	2.5100	0.3070
9	0.0170	0.0400	0.0051	0.1450	0.0470	0.0610	0.7410	0.3600	4.8300	1.2120	4.0400	0.7730	7.5900	0.9950
10	0.0722	0.1220	0.0126	0.1940	0.4550	0.4870	3.2700	1.1380	8.6400	2.0100	5.7100	0.8910	6.6000	0.8080
12	0.0079	0.0415	0.0042	0.0657	0.0607	0.1036	1.0680	0.4980	4.9600	1.1770	3.3200	0.4960	3.5200	0.4680
14	0.0085	0.0049	0.0020	0.0536	0.1740	0.1650	0.4780	0.3630	3.2600	0.7620	1.7880	0.2730	1.8600	0.1550
16	0.0090	0.0487	0.0036	0.0663	0.1790	0.1580	0.8510	0.2910	2.6200	0.5900	1.6050	0.2230	2.0300	0.2770
17	0.0057	0.1440	0.0037	0.0179	0.2400	0.4060	3.2400	0.8240	6.3000	1.3520	2.8400	0.4670	3.2500	0.3730
18	0.0190	0.1410	0.0389	0.0870	0.4700	0.3880	2.9000	0.8370	5.7000	1.2180	3.2900	0.4570	3.4700	0.3910
19	0.0219	0.1690	0.0065	0.1150	0.4470	0.6740	4.1900	1.1600	8.7600	2.0100	4.8000	0.7470	5.9400	0.7830
20	0.0123	0.0697	0.0040	0.1610	0.4120	0.6930	4.5800	1.1300	8.8100	1.8000	4.1900	0.6980	4.6300	0.6180