

Table S1. Representative analyses of core and rim of garnet and orthopyroxene (wt %) in metapelitic granulite of the Bunger Hills

Rock	Grt-Sil-Crd		Grt-Crd		Grt-Opx-Crd					
Sample	67**	67**	75**	75*	15**	15**	61**	61**	61**	61**
Mineral	Grt	Grt	Grt	Grt	Grt	Grt	Grt	Grt	Opx	Opx
Position	Core	Rim	Core	Rim, near Crd	Core	Rim, near Bt	Core	Rim, near Crd	Core	Rim
Analysis	005	009	059	057	011	015	074	071	025	027
Photo	S1,a	S1,a	S1,b	S1,b	S1,c	S1,c	S1,d	S1,d	S1,f	S1,f
SiO ₂	39.80	40.05	38.67	38.69	38.35	37.25	39.51	39.40	49.29	48.67
TiO ₂	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al ₂ O ₃	21.62	21.90	21.12	22.13	20.91	20.61	21.09	21.31	7.98	8.00
FeO*	27.11	26.25	28.34	28.91	30.78	33.80	25.15	25.06	20.31	20.45
MnO	0.78	0.85	2.62	3.20	0.66	1.09	2.16	2.44	0.59	0.43
MgO	10.28	10.25	8.22	7.35	8.08	5.27	10.30	10.13	21.22	21.73
CaO	0.85	0.70	1.03	1.08	0.41	0.37	1.07	1.09	0.06	0.00
Na ₂ O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.44	100.00	100.00	101.36	99.19	98.39	99.28	99.43	99.45	99.28
Si	3.035	3.051	3.014	2.986	3.019	3.013	3.035	3.046	1.827	1.810
Al	1.943	1.966	1.940	2.013	1.940	1.965	1.935	1.916	0.349	0.351
Fe ³⁺									0.023	0.023
Fe ²⁺	1.729	1.672	1.847	1.866	2.026	2.286	1.615	1.621	0.625	0.625
Mn	0.050	0.055	0.173	0.209	0.044	0.075	0.159	0.141	0.019	0.014
Mg	1.168	1.164	0.955	0.845	0.948	0.635	1.163	1.183	1.172	1.204
Ca	0.069	0.057	0.086	0.089	0.035	0.032	0.090	0.088	0.002	0.000
Total	7.994	7.965	8.015	8.008	8.012	8.006	7.997	7.995	3.999	4.015
X _{Alm}	0.573	0.567	0.603	0.620	0.664	0.755	0.534	0.533		
X _{Py}	0.387	0.395	0.312	0.281	0.310	0.210	0.390	0.384		
X _{Sps}	0.017	0.019	0.057	0.007	0.014	0.025	0.047	0.053		
X _{Grs}	0.023	0.019	0.028	0.003	0.012	0.011	0.029	0.030		
X _{En}									0.651	0.654
X _{Fs}									0.349	0.346
X _{Al} ^{M1}									0.177	0.153

Note: * analyses obtained using JEOL JSM-7001F SEM at SPMU, ** using JEOL JSM-6510LA SEM at IPGG RAS. FeO*, total iron. Structural formulae normalized to 12 oxygens (garnet), 4 cations and 12 charges (orthopyroxene). Garnet: $X_{Alm} = \text{Fe}/(\text{Fe} + \text{Mg} + \text{Mn} + \text{Ca})$, $X_{Py} = \text{Mg}/(\text{Fe} + \text{Mg} + \text{Mn} + \text{Ca})$, $X_{Sps} = \text{Mn}/(\text{Fe} + \text{Mg} + \text{Mn} + \text{Ca})$, $X_{Grs} = \text{Ca}/(\text{Fe} + \text{Mg} + \text{Mn} + \text{Ca})$. Orthopyroxene: $X_{En} = \text{Mg}/(\text{Fe} + \text{Mg})$, $X_{Fs} = \text{Fs}/(\text{Fe} + \text{Mg})$, $X_{Al}^{M1} = \text{Si} - (2 - \text{Al})$.

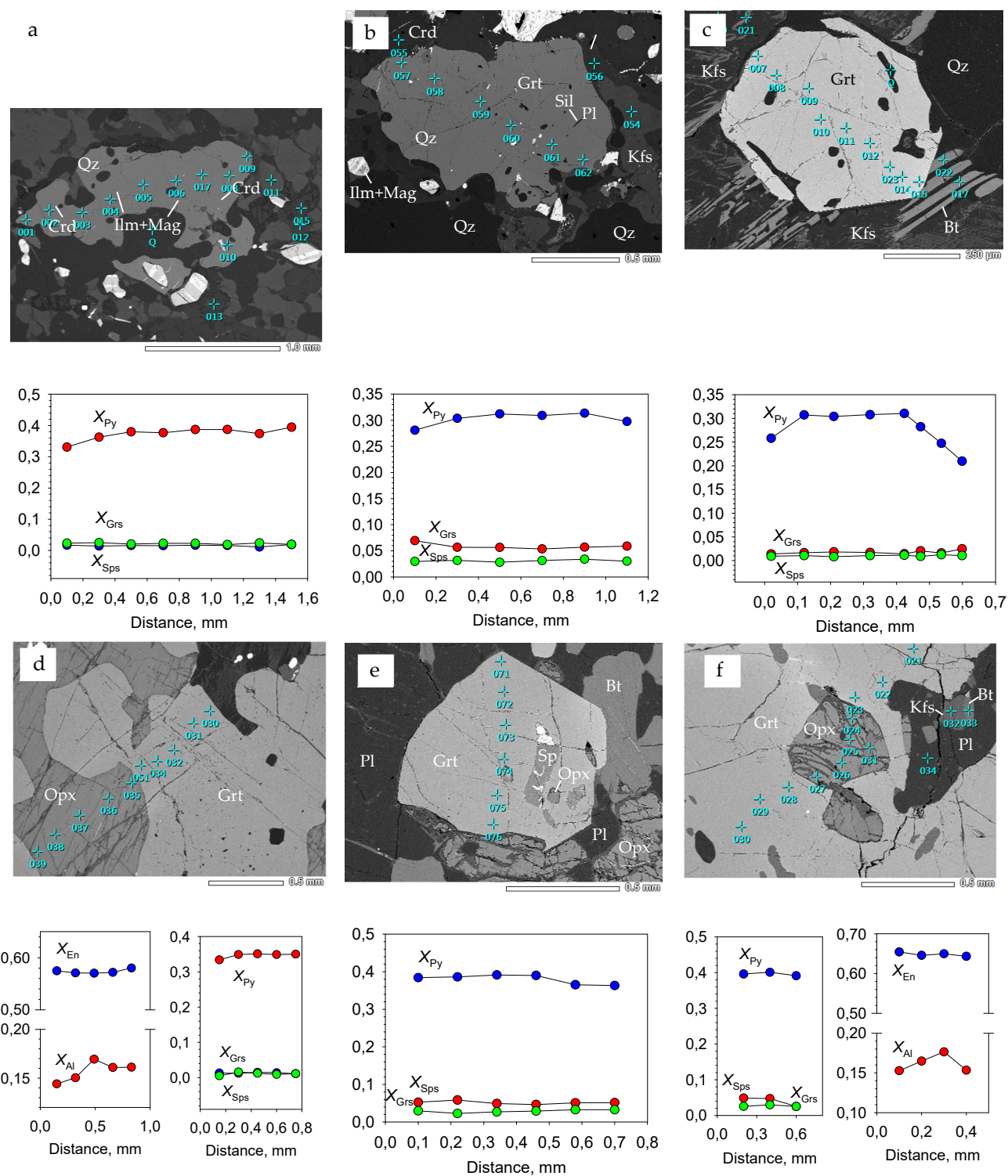


Figure S1. Back-scattered electron (BSE) images of garnet and orthopyroxene and rim-core-rim zoning profiles. (a) Garnet (sample 67). (b) Garnet (sample 75). (c) Garnet (sample 15). (d) Garnet and orthopyroxene (sample 15). (e) Garnet (sample 61). (f) Garnet and orthopyroxene (sample 61).

Table S2. Representative analyses of cordierite (wt %) in metapelitic granulite of the Bonger Hills

Rock	Grt-Sil-Crd			Grt-Crd		Grt-Opx			
Sample	55**	67**	67**	75**	78**	61**	63**	63**	67**
Analysis	012	013	015	014	077	054	042	101	015
SiO ₂	46.46	46.98	49.31	48.95	48.47	49.37	48.04	48.77	49.31
Al ₂ O ₃	32.58	32.39	33.50	32.16	32.62	33.32	31.61	32.14	33.50
FeO*	3.95	4.19	4.78	4.54	3.65	3.76	3.84	3.38	4.78
MnO	0.00	0.00	0.00	0.12	0.08	0.00	0.02	0.00	0.00
MgO	10.58	9.73	10.33	10.53	10.44	11.02	11.22	11.49	10.33
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na ₂ O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K ₂ O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	93.57	93.29	97.92	96.30	95.26	97.47	94.73	95.78	97.92
Si	4.931	4.997	5.008	5.054	5.035	5.014	5.030	5.036	5.008
Al	4.076	4.061	4.010	3.913	3.994	3.989	3.901	3.912	4.010
Fe	0.351	0.373	0.406	0.392	0.317	0.319	0.336	0.292	0.406
Mn	0.000	0.000	0.000	0.010	0.007	0.000	0.002	0.000	0.000
Mg	1.674	1.542	1.563	1.620	1.616	1.668	1.751	1.768	1.563
Na	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
K	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	11.032	10.973	10.987	10.990	10.969	10.990	11.020	11.008	10.987
Mg#	0.83	0.81	0.79	0.81	0.84	0.84	0.84	0.86	0.79

Note: ** analyses obtained using JEOL JSM-6510LA SEM at IPGG RAS. FeO*, total iron. Structural formulae normalized to 18 oxygens. Mg# = Mg/(Mg +Fe).

Table S3. Representative analyses of biotite (wt %) in metapelitic granulite of the Bunker Hills and the results of thermobarometry calculations

Rock	Grt-Sil, Grt-Sil-Crd					Grt-Crd		Grt-Opx	
Sample	2a*	2a*	2a*	11a*	67**	78**	78**	61**	63**
Position	In Grt	Matrix, core	Matrix, rim	Matrix	In Grt	Around Crn-Mag	With late Sill	In Opx	Q-Bt symplectite
Analysis	10	1	3	025	032	081	129	031	030
Photo	S2,a	S2,c	S2,c	S2,d	S2,e	S2,f	S2,g	S2,h	S2,i
SiO ₂	39.57	38.96	38.91	38.78	39.05	37.51	37.92	37.14	37.41
TiO ₂	5.96	3.50	3.18	4.51	4.93	2.96	3.31	5.38	4.07
Al ₂ O ₃	16.11	15.50	16.52	14.79	15.55	17.71	17.85	14.98	15.74
FeO*	8.54	13.21	11.67	10.94	9.73	11.45	12.63	10.67	10.37
MnO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
MgO	16.90	14.05	15.34	17.06	16.57	16.01	15.11	15.34	15.86
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na ₂ O	0.00	0.00	0.00	0.00	0.22	0.00	0.06	0.00	0.00
K ₂ O	10.03	10.16	9.10	10.07	10.39	10.42	10.01	10.76	10.51
Total	97.11	95.38	94.72	96.15	96.44	96.06	96.89	94.27	94.03
Si	2.802	2.875	2.849	2.816	2.813	2.735	2.746	2.770	2.783
Al ^{IV}	1.198	1.125	1.151	1.184	1.187	1.265	1.254	1.230	1.217
Al ^{VI}	0.147	0.223	0.274	0.082	0.134	0.257	0.270	0.086	0.164
Ti	0.318	0.194	0.175	0.246	0.267	0.162	0.180	0.302	0.228
Fe	0.506	0.815	0.715	0.664	0.586	0.698	0.765	0.665	0.645
Mn	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
Mg	1.784	1.545	1.674	1.846	1.779	1.740	1.631	1.705	1.759
Na	0.000	0.000	0.000	0.000	0.031	0.000	0.008	0.000	0.000
K	0.907	0.956	0.850	0.933	0.955	0.969	0.925	1.024	0.998
Total	7.661	7.733	7.688	7.771	7.752	7.826	7.779	7.782	7.797
Mg#	0.78	0.65	0.70	0.74	0.75	0.71	0.68	0.72	0.73
T _{H05} , °C	738	668	651	703	773	700	705	731	692

Note: * analyses obtained using JEOL JSM-7001F SEM at SPMU, ** using JEOL JSM-6510LA SEM at IPGG RAS. FeO*, total iron. Structural formulae normalized to 11 oxygens. Mg# = Mg/(Mg + Fe). T_{H05}, °C, temperature calculated with Henry et al. (2005) Ti-in-biotite geothermometer [38].

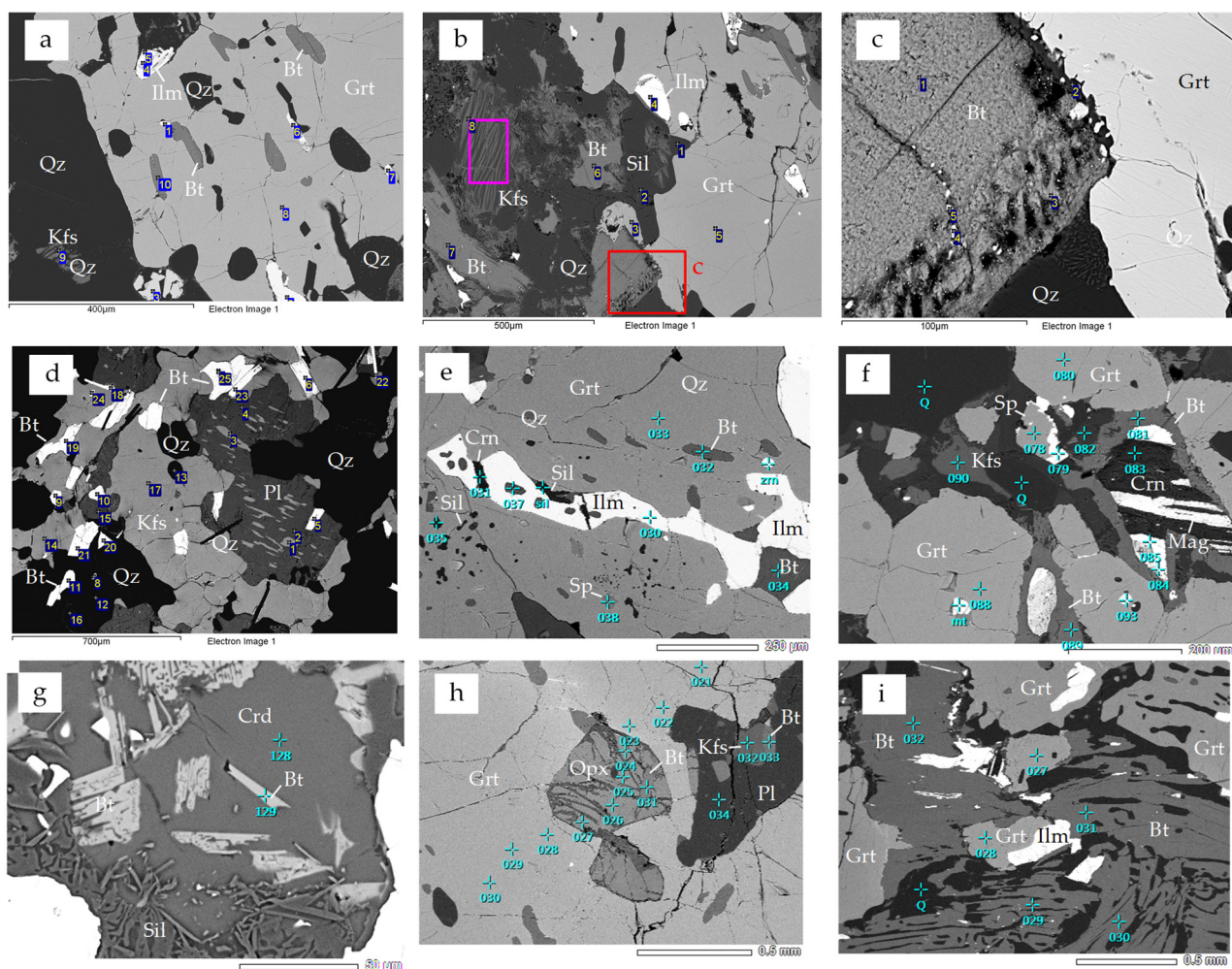


Figure S2. Back-scattered electron (BSE) images showing occurrences of analyzed biotite in granulite. (a) Biotite inclusions in garnet (sample 2a). (b) Biotite in the matrix (sample 2a). (c) Biotite replacing garnet rim. Enlarged detail of the previous photo. (d) Biotite in the matrix (sample 11a). (e) Biotite inclusions in garnet (sample 67). (f) Biotite reaction rim around corundum-ilmenite-magnetite intergrowth (sample 78). (g) Acicular sillimanite and biotite replacing cordierite along grain boundaries (sample 78). (h) Biotite inclusions in orthopyroxene (sample 61). (i) Quartz-biotite symplectite (sample 63). .

Table S4. Representative analyses of K-feldspar and plagioclase (wt %) in metapelitic granulite of the Bunger Hills

Rock	Grt-Sil-Crd							Grt-Crd	Grt-Opx-Crd	
Sample	2a*	2a*	2a*	11a*	11a*	11a*	11a*	75**	15*	15*
Mineral	Kfs	Pl	Msp	Kfs	Pl	Pl	Kfs	Pl	Ab	Kfs
Domain	Host	Lamellae	Re-int.	Host	Lamellae	Host	Lamellae	Host	Host	Lamellae
Position	Matrix	Matrix	Matrix	Matrix	Matrix	Matrix	Matrix	Mantled Sp	Matrix	Matrix
Analysis	3	4	6	2	1	2	1	65	2	3
Photo	S3,a	S3,a	S3,a	S3,b	S3,b	S3,c	S3,c	S3,d	S3,f	S3,f
SiO ₂	65.54	69.97	67.49	64.58	67.44	55.14	64.65	59.49	65.88	64.43
Al ₂ O ₃	17.45	18.81	18.14	18.20	19.71	27.72	18.58	25.49	20.55	19.72
FeO*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	0.00	0.00	0.00	0.36	0.44	10.47	0.00	7.58	1.44	0.84
Na ₂ O	1.52	10.53	6.78	1.43	11.40	6.31	0.83	7.48	11.91	4.19
K ₂ O	13.42	0.04	6.09	14.94	0.40	0.00	15.55	0.00	0.08	10.39
BaO	1.28	0.11	0.79	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	99.21	99.46	99.29	99.51	99.39	99.64	99.61	100.04	99.87	99.57
Si	3.040	3.051	3.036	2.992	2.973	2.497	2.992	2.653	2.908	2.932
Al	0.954	0.967	0.962	0.994	1.024	1.480	1.013	1.340	1.069	1.058
Fe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ca	0.000	0.000	0.000	0.018	0.021	0.508	0.000	0.362	0.068	0.041
Na	0.137	0.891	0.592	0.129	0.974	0.554	0.074	0.647	1.020	0.370
K	0.794	0.002	0.349	0.884	0.022	0.000	0.918	0.000	0.004	0.603
Ba	0.023	0.002	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	4.948	4.913	4.953	5.017	5.014	5.039	4.997	5.001	5.069	5.015
X _{An}	0.00	0.00	0.00	0.02	0.02	0.48	0.00	0.36	0.06	0.04
X _{Ab}	0.15	1.00	0.63	0.12	0.96	0.52	0.07	0.64	0.93	0.36
X _{Ort}	0.85	0.00	0.37	0.86	0.02	0.00	0.93	0.00	0.01	0.60

Note: * analyses obtained using JEOL JSM-7001F SEM at SPMU, ** using JEOL JSM-6510LA SEM at IPGG RAS. Msp, mesoperthite. FeO*, total iron. Structural formulae normalized to 8 oxygens. $X_{An} = Ca/(Ca + Na + K)$, $X_{Ab} = Na/(Ca + Na + K)$, $X_{Ort} = K/(Ca + Na + K)$.

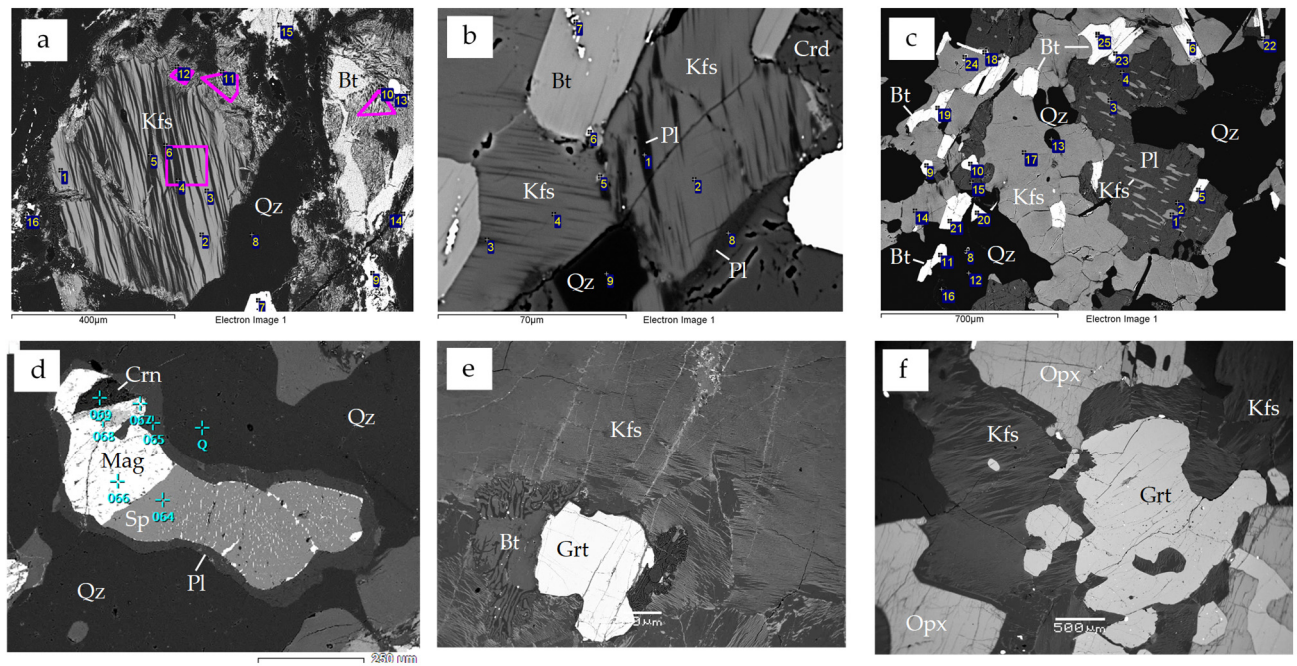


Figure S3. Back-scattered electron (BSE) images showing occurrences of analyzed feldspars in granulite. (a) Mesoperthite (sample 2a). (b) Mesoperthite (sample 11a). (c) Antiperthitic plagioclase (sample 11a). (d) Plagioclase mantled spinel-magnetite-ilmenite intergrowth (sample 75). (e) Mesoperthite (sample 15). (f) Mesoperthite (sample 15).

Table S5. Representative analyses of spinel (wt %) in metapelitic granulite of the Bunger Hills

Rock	Grt-Sil-Crd			Grt-Crd				Grt-Opx-Crd		
Sample	11a*	55**	67**	75**	75**	78**	78**	61**	61**	63**
Position	Matrix	Matrix	In Grt	In Grt	Matrix	Matrix	In Grt	In Crd	In Crd	In Grt
Analysis	3	78	042	010	013	078	112	009	012	015
Photo	S4,a	S4,b	S4,c	S4,d	S4,d	S4,e	S4,f	S4,g	S4,h	S4,i
SiO ₂	0.00	0.00	0.00	0.38	0.44	0.63	0.59	0.86	0.53	0.61
TiO ₂	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al ₂ O ₃	56.02	59.26	57.87	61.79	59.06	58.70	61.10	55.91	57.39	58.50
Cr ₂ O ₃	2.39	1.51	1.36	0.45	0.72	0.35	0.22	1.55	0.76	0.31
FeO*	23.42	26.44	27.79	25.93	30.78	23.55	25.03	28.26	26.55	23.53
MnO	0.00	0.00	0.00	0.09	0.23	0.00	0.00	0.49	0.62	0.00
MgO	4.16	8.91	9.12	11.55	9.01	6.82	9.80	9.15	10.26	12.08
ZnO	13.63	2.49	2.97	0.94	0.67	9.96	3.14	2.21	2.10	2.79
Total	99.62	98.61	99.11	101.13	100.91	100.01	99.88	98.43	98.21	97.82
Si	0.000	0.000	0.000	0.010	0.012	0.018	0.016	0.024	0.015	0.017
Ti	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Al	1.909	1.935	1.889	1.930	1.891	1.933	1.953	1.842	1.872	1.888
Cr	0.055	0.033	0.030	0.009	0.015	0.008	0.005	0.034	0.017	0.007
Fe ³⁺	0.036	0.032	0.081	0.041	0.070	0.023	0.010	0.075	0.081	0.072
B	2.000	2.000	2.000	1.990	1.988	1.982	1.984	1.975	1.985	1.984
Fe ²⁺	0.530	0.581	0.563	0.534	0.629	0.528	0.557	0.586	0.534	0.467
Mn	0.000	0.000	0.000	0.002	0.005	0.000	0.000	0.012	0.015	0.000
Mg	0.179	0.368	0.376	0.456	0.365	0.284	0.396	0.381	0.423	0.493
Zn	0.291	0.051	0.061	0.018	0.013	0.206	0.063	0.046	0.043	0.056
A	1.000	1.000	1.000	1.010	1.012	1.018	1.016	1.025	1.015	1.016
Total	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
X _{Hc}	0.53	0.58	0.56	0.02	0.02	0.48	0.00	0.58	0.53	0.46
X _{Sp}	0.17	0.37	0.38	0.12	0.96	0.52	0.07	0.38	0.42	0.49
X _{Ghn}	0.30	0.05	0.06	0.86	0.02	0.00	0.93	0.04	0.04	0.05

Note: * analyses obtained using JEOL JSM-7001F SEM at SPMU, ** using JEOL JSM-6510LA SEM at IPGG RAS. FeO*, total iron. Structural formulae of spinel AB_2O_4 normalized to 3 cations and 8 charges. $X_{Hc} = Fe^{2+}/(Fe^{2+} + Mg + Zn)$, $X_{Sp} = Mg/(Fe^{2+} + Mg + Zn)$, $X_{Ghn} = Zn/(Fe^{2+} + Mg + Zn)$.

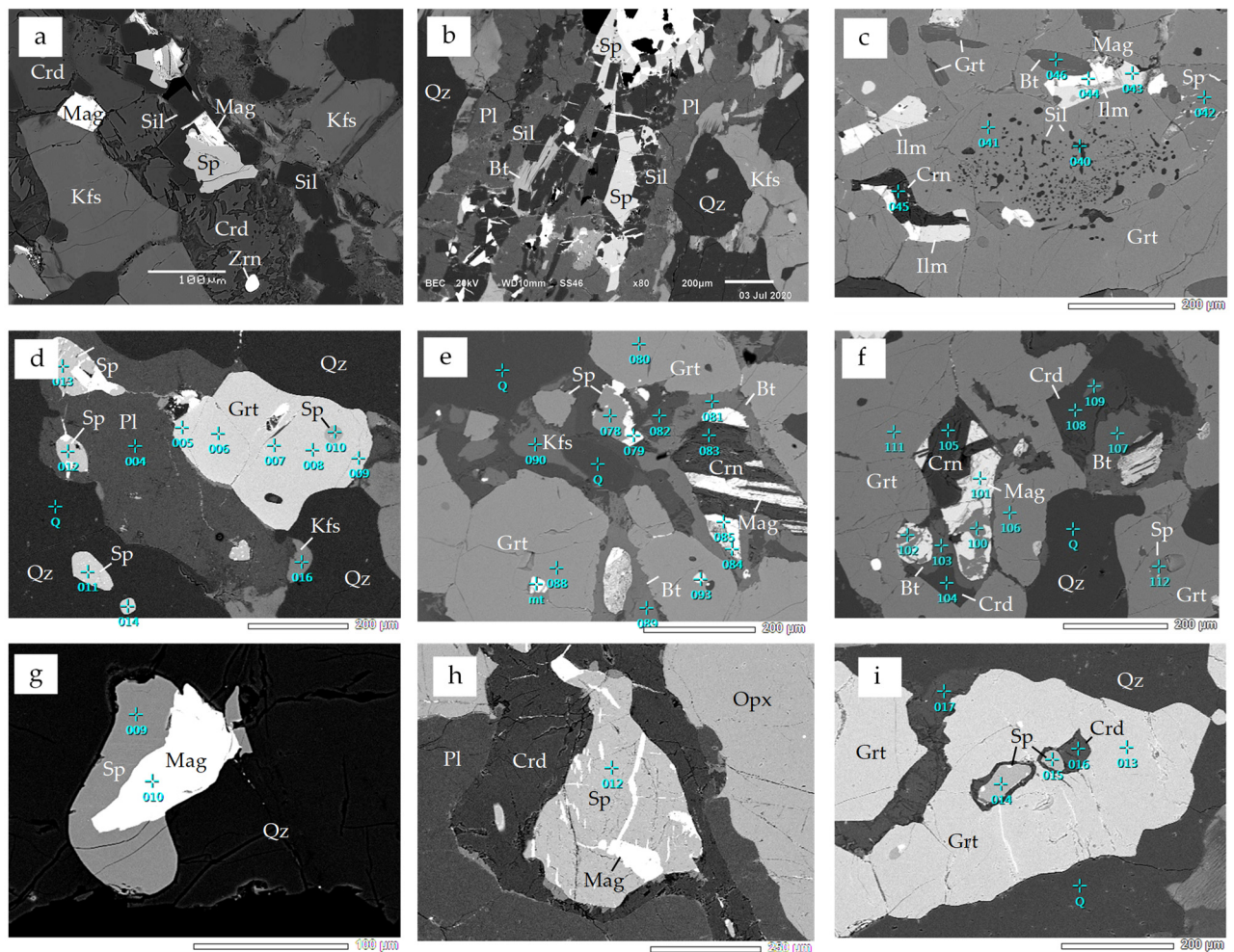


Figure S4. Back-scattered electron (BSE) images showing occurrences of analyzed spinel in granulite. (a) Spinel overgrowing on prismatic sillimanite (sample 11a). (b) Spinel overgrowing on prismatic sillimanite (sample 55). (c) Spinel inclusion in garnet (sample 67). (d) Spinel inclusions in garnet and quartz (sample 75). (e) Spinel-magnetite intergrowths in the matrix (sample 78). (f) Spinel inclusion in garnet and spinel intergrowing with magnetite, corundum, and cordierite (sample 78). (g) Spinel-magnetite intergrowth in quartz (sample 61). (h) Spinel partially replaced by magnetite and mantled by cordierite (sample 61). (i) Spinel inclusions in garnet (sample 63).

Table S6. Representative analyses of titaniferous magnetite and ilmenite (wt %) in sample 63 and the results of thermobarometry calculations

Location	Intergrowth 1		Intergrowth 2		Intergrowth 3		Intergrowth 4		Intergrowth 5	
Mineral	Ti-Mag	Ilm	Ti-Mag	Ilm	Ti-Mag	Ilm	Ti-Mag	Ilm	Ti-Mag	Ilm
Domain	Host	Lamel.	Host	Lamel.	Host	Lamel.	Host	Lamel.	Host	Lamel.
Analysis	1-5**	1-7**	2-5**	2-3**	3-9**	3-7**	4-2**	4-3**	020*	021*
SiO ₂	0.00	0.00	0.23	0.24	0.28	0.25	0.35	0.00	0.00	0.00
TiO ₂	19.65	47.87	25.57	46.34	16.14	48.43	13.99	46.36	14.10	40.72
Al ₂ O ₃	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO*	77.01	50.33	71.85	51.43	81.59	49.06	83.80	51.01	84.67	58.48
MnO	0.15	0.27	0.00	0.00	0.00	0.11	0.00	0.39	0.00	0.00
MgO	0.00	0.94	0.30	0.85	0.00	1.13	0.00	0.84	0.00	0.62
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
V ₂ O ₅	0.85	0.00	0.94	0.67	1.34	0.55	0.87	0.57	0.00	0.00
Total	97.65	99.41	99.17	99.52	99.36	99.53	99.01	99.17	98.77	99.82
Si	0.000	0.000	0.008	0.006	0.010	0.006	0.013	0.000	0.000	0.000
Ti	0.555	0.903	0.712	0.873	0.446	0.916	0.387	0.877	0.391	0.761
Al	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe ³⁺	0.844	0.194	0.496	0.218	1.016	0.154	1.154	0.226	1.218	0.478
Fe ²⁺	1.573	0.862	1.729	0.859	1.492	0.878	1.423	0.847	1.391	0.738
Mn	0.005	0.006	0.000	0.000	0.000	0.002	0.000	0.008	0.000	0.000
Mg	0.000	0.035	0.016	0.032	0.000	0.043	0.000	0.032	0.000	0.023
V	0.023	0.000	0.025	0.012	0.036	0.000	0.023	0.010	0.000	0.000
Total	3.000	2.000	3.000	2.000	3.000	2.000	3.000	2.000	3.000	2.000
X _{Ulv}	0.555		0.712		0.446		0.387		0.391	
X _{Mag}	0.422		0.254		0.508		0.577		0.609	
X _{Ilm}		0.903		0.873		0.916		0.877		0.761
X _{Hem}		0.097		0.109		0.078		0.113		0.239
T _{AL85} , °C	945		1245		830		870		960	
T _{SL08} , °C	955		1175		880		875		965	

Note: * analyses obtained using JEOL JSM-7001F SEM at SPMU, ** using JEOL JSM-6510LA SEM at IPGG RAS. FeO*, total iron. Structural formulae normalized to 3 cations and 8 charges (magnetite) and 2 cations and 6 charges (ilmenite). Magnetite: $X_{Ulv} = Ti$, $X_{Mag} = Fe^{3+}/2$. Ilmenite: $X_{Ilm} = Ti$, $X_{Hem} = Fe^{3+}/2$. T_{AL85} , T_{SL08} , temperature calculated with Andersen and Lindsley (1985) and Sauerzapf et al. (2008) FeTi-oxide geothermometer/oxygen barometer, respectively [81, 82].

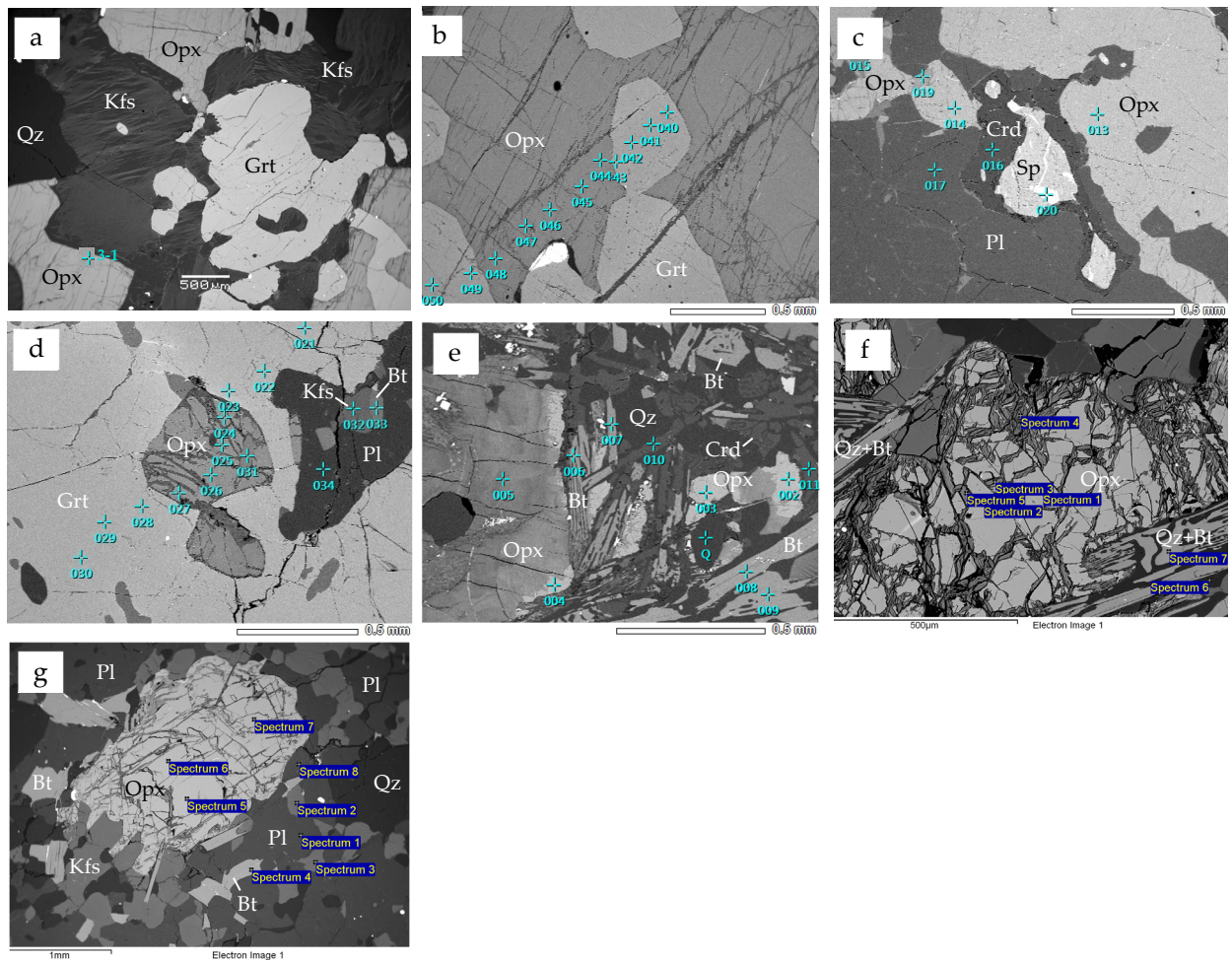


Figure S5. Back-scattered electron (BSE) images showing crystals of orthopyroxene with points of microprobe analyses used for thermobarometry. (a) Sample 15, analysis 3-1. (b) Sample 15, analysis 045. (c) Sample 61, analysis 013. (d) Sample 61, analysis 025. (e) Sample 63, analysis 001, 004. (f) Sample 116, analysis 3-2. (g) Sample 116, analysis 4-5.

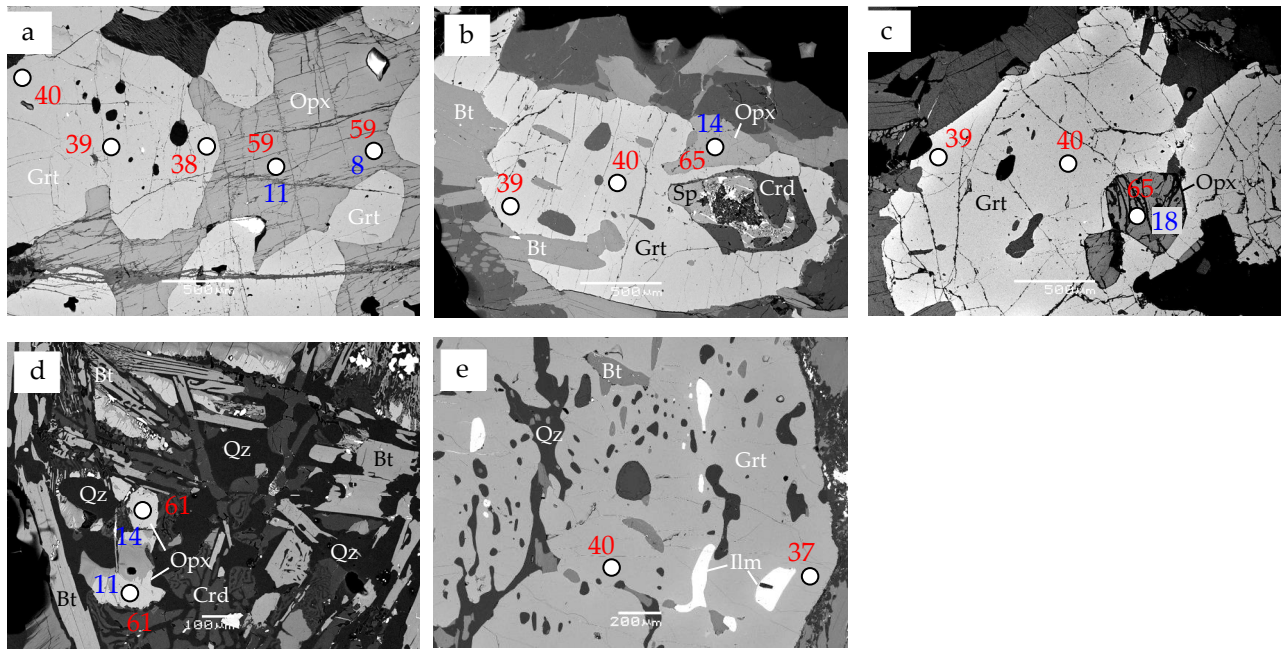


Figure S6. Back-scattered electron (BSE) images showing crystals of garnet and orthopyroxene in which major and trace element compositions were measured. (a) Sample 15. (b, c) Sample 61. (d, e) Sample 63. Points with numbers are locations of microprobe analyses. The contents (mol.%) of pyrope in garnet and enstatite in orthopyroxene are shown in red, while the X_{Al}^{M1} values (mol.%) are shown in blue.