

High-grade metamorphism in the Chapleau-Foleyset Area, Ontario

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Abstract

High-grade Archean rocks are exposed in the central Superior Province of the Canadian Shield in the Kapuskasing Structural Zone, a partly fault-bounded region up to 50 × 500 km. In migmatitic mafic gneiss, paragneiss, dioritic and tonalitic rocks, a lower-grade garnet-clinopyroxene-plagioclase (Gt-Cpx-Pl) zone and patchy, higher-grade orthopyroxene zones are distinguished. Grade decreases abruptly to greenschist in the Abitibi subprovince to the east across the Ivanhoe Lake cataclastic zone. Grade decreases gradually through amphibolite to greenschist facies in the Wawa subprovince to the west. Based on mineral-melt equilibria, minimum conditions for the Gt-Cpx-Pl zone are 750°C, 6 kbar, $a_{\text{H}_2\text{O}} = 0.5-0.7$ and for the orthopyroxene zone, 770°C, 6 kbar, $a_{\text{H}_2\text{O}} < 0.5$.

Various garnet-biotite and garnet-pyroxene geothermometers and geobarometers yield apparent temperatures ranging from <600°C in the west to locally >800°C. Apparent pressure values derived from the pyrope-grossular-anorthite-diopside-quartz equilibrium are 5.4-8.4 kbar (average 6.3) and define a NNE-trending area of relatively high P in the eastern and central Kapuskasing Zone, supporting the interpretation of a tilted crustal section.

Introduction

Regional metamorphism variably affected rocks of the Superior Province over an area of $\sim 3 \times 10^6$ km². The erosion level throughout the southern part of the province exposes metamorphic rocks of the greenschist and amphibolite facies except in the Kapuskasing Structural Zone, where pyroxene-bearing gneisses are associated with a linear gravity high (Innes, 1960; Bennett *et al.*, 1967; MacLaren *et al.*, 1968; Thurston *et al.*, 1977). The Kapuskasing Zone in the relatively well-exposed Chapleau-Foleyset area consists of a variety of migmatitic pyroxene-garnet-hornblende-biotite-bearing rocks. The assemblages preserved at the time of metamorphic quenching provide insight into reactions leading to the decomposition of hornblende and biotite in an amphibolite-granulite facies transition zone. The metamorphic history and equilibration conditions of rocks in the Kapuskasing Zone and adjacent Wawa subprovince are examined in this study.

Metamorphism in the Kapuskasing Zone is Archean as inferred from U-Pb dates on zircon from leucosome in paragneiss (2627 ± 5 Ma) and on metamorphic zircon in mafic gneiss (2650 ± 2 Ma) (Percival and Krogh, 1983).

Geological setting

The Superior Province can be divided into meta-volcanic-plutonic and metasedimentary subprovinces (Stockwell, 1970) (Fig. 1). In the south-central Superior

Province, the easterly trends of the Abitibi-Wawa and Quetico-Opatoca subprovinces are transected over a distance of 500 km by the north-northeast-trending Kapuskasing Structural Zone (Thurston *et al.*, 1977) (Fig. 1). It is made up of gneisses in the upper amphibolite to granulite facies (Bennett *et al.*, 1967; MacLaren *et al.*, 1968) and is characterized by positive gravity and aeromagnetic anomalies over most of its length (Innes, 1960).

The Chapleau-Foleyset area straddles the Kapuskasing Zone and includes parts of the adjacent Abitibi and Wawa subprovinces. Supracrustal rocks of the Abitibi subprovince in the study area comprise mostly mafic metavolcanic flows and tuffs up to 6100 m thick (Goodwin, 1965). Easterly-trending belts of felsic metavolcanic and meta-sedimentary rock make up about 5 and 3% respectively of the supracrustal succession. Massive to foliated plutons of tonalite to granite composition (Streckeisen, 1976) range in diameter from ~ 1 to ~ 25 km. The intensity of metamorphism increases from the cores of supracrustal belts, where greenschist-facies assemblages are common (Thurston *et al.*, 1977), to contact areas with large intrusive bodies, where hornblende-plagioclase ± garnet assemblages prevail. Both primary structures, including bedding and volcanic features, and sub-vertical tectonic foliation, schistosity and lineation, are present in the supracrustal succession.

The contact between rocks of the Abitibi subprovince and the Kapuskasing Structural Zone to the west is the Ivanhoe Lake cataclastic zone (Fig. 2), comprising blas-

Appendix 1: Microprobe Analyses of Minerals

to accompany

High-grade Metamorphism in the Chapleau-Foley area,
Ontario

by

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Sample	MG 1	MG 2	MG 3	MG 4	MG 5	MG 6	MG 7	MG 8	MG 9	MG 10	MG 11
SiO ₂	38.26	37.55	38.43	38.32	37.80	37.90	38.03	38.39	37.30	38.30	36.68
TiO ₂	0.28	0.24	0.04	0.04	0.01	0.13	0.13	0.06	0.04	0.14	0.04
Al ₂ O ₃	18.14	15.30	20.27	20.91	20.74	21.06	21.61	21.19	20.51	21.22	20.78
Cr ₂ O ₃	0.04	0.13	0.10	0.10	0.12	0.19	0.03	0.09	0.09	0.10	0.24
FeO*	13.11	17.27	24.54	29.52	26.27	23.99	28.27	29.85	26.20	26.33	24.28
MnO	4.62	3.13	3.97	1.81	1.42	1.27	2.07	2.07	1.71	2.08	1.45
MgO	0.28	0.48	2.06	2.51	1.42	2.07	1.52	0.97	1.71	2.08	1.45
CaO	21.99	24.10	12.06	8.54	10.89	12.25	2.74	1.19	2.85	2.96	2.82
Na ₂ O	0.01	0.14	0.52	0.00	0.35	0.11	0.24	0.26	0.12	0.11	0.31
K ₂ O	0.06	0.02	0.00	0.02	0.00	0.00	0.04	0.01	0.00	0.01	0.00
Total	98.82	98.40	101.79	101.98	99.97	100.02	101.91	101.72	98.08	101.85	97.06
Si	3.057	3.037	3.013	3.004	3.003	2.990	2.939	3.006	3.023	2.964	2.961
Al(IV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al(VI)	1.708	0.458	0.872	0.932	0.942	0.958	1.968	1.955	1.959	1.935	1.977
Ti	0.017	0.015	0.002	0.002	0.000	0.000	0.008	0.004	0.002	0.008	0.002
Cr	0.001	0.008	0.006	0.006	0.008	0.012	0.002	0.006	0.006	0.006	0.015
Fe ³	0.243	0.464	0.025	0.041	0.00	0.00	0.00	0.00	0.00	0.013	0.00
Fe ²	0.633	0.704	1.583	1.892	1.745	1.582	1.827	1.954	1.776	1.690	1.639
Mn	0.313	0.214	0.264	0.120	0.096	0.138	0.099	0.066	0.117	0.136	0.099
Mg	0.033	0.058	0.241	0.293	0.281	0.266	0.316	0.332	0.344	0.341	0.339
Ca	2.053	2.088	1.013	0.717	0.927	1.035	0.769	0.648	0.786	0.876	0.906
Na	0.002	0.022	0.079	0.000	0.054	0.017	0.036	0.039	0.050	0.016	0.049
K	0.006	0.002	0.00	0.002	0.00	0.00	0.004	0.001	0.00	0.001	0.00

Sample	MG 12	MG 13	MG 14	MG 15	MG 16	MG 17	MG 18	MG 19	MG 20	MG 21	MG 22
SiO ₂	38.58	38.04	37.47	38.17	38.17	37.82	38.90	38.31	38.01	37.82	37.81
TiO ₂	0.02	0.00	0.04	0.06	0.02	0.08	0.00	0.00	0.00	0.05	0.00
Al ₂ O ₃	21.02	29.72	20.41	21.46	22.15	21.18	21.79	20.75	20.99	21.25	19.94
Cr ₂ O ₃	0.22	0.01	0.15	0.23	0.01	0.05	0.12	0.23	0.22	0.11	0.06
FeO*	26.10	27.33	25.66	25.73	26.73	27.51	27.44	28.46	28.06	26.07	28.36
MnO	2.99	1.82	1.73	1.37	1.31	1.33	1.06	1.06	0.70	1.22	2.48
MgO	3.07	3.15	3.06	3.20	3.38	3.49	3.52	3.81	4.11	3.89	4.12
CaO	10.02	9.01	9.87	9.60	9.14	8.05	8.97	8.08	8.32	9.20	6.40
Na ₂ O	0.06	0.01	0.04	0.00	0.24	0.00	0.16	0.08	0.27	0.30	0.0
K ₂ O	0.04	0.08	0.03	0.02	0.01	0.00	0.02	0.00	0.00	0.00	0.03
Total	101.91	100.20	98.93	100.07	101.39	99.43	101.64	100.62	100.67	99.95	99.25
Si	3.029	3.012	3.000	3.020	3.000	3.000	3.041	3.016	2.974	2.998	3.014
Al(IV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al(VI)	1.945	1.933	1.912	1.906	1.902	1.982	1.969	1.925	1.935	1.961	1.886
Ti	0.001	0.00	0.002	0.004	0.002	0.005	0.00	0.00	0.00	0.003	0.00
Cr	0.014	0.001	0.010	0.014	0.001	0.003	0.007	0.003	0.014	0.007	0.004
Fe ³	0.00	0.055	0.044	0.00	0.00	0.00	0.00	0.053	0.00	0.00	0.010
Fe ²	1.713	1.754	1.679	1.698	1.721	1.792	1.826	1.820	1.815	1.710	1.803
Mn	0.139	0.122	0.138	0.092	0.095	0.099	0.070	0.071	0.040	0.081	0.169
Mg	0.159	0.172	0.166	0.176	0.188	0.181	0.410	0.449	0.479	0.455	0.491
Ca	0.841	0.764	0.849	0.811	0.770	0.685	0.751	0.681	0.697	0.773	0.550
Na	0.009	0.002	0.006	0.00	0.036	0.00	0.024	0.012	0.041	0.046	0.00
K	0.004	0.008	0.003	0.002	0.001	0.00	0.002	0.00	0.00	0.00	0.003

Sample	MG 23	MG 24	MG 25	MG 26	MG 27	MG 28	MG 29	MG 30	MG 31	MG 32	MG 33	MG 34
SiO ₂	38.83	38.77	38.22	38.36	38.77	37.58	38.43	39.15	38.40	39.51	37.98	38.54
TiO ₂	0.04	0.06	0.04	0.10	0.03	0.14	0.08	0.00	0.08	0.11	0.03	0.03
Al ₂ O ₃	22.03	21.69	21.59	21.53	21.43	20.46	21.45	22.57	21.64	22.29	21.08	21.94
Cr ₂ O ₃	0.06	0.14	0.23	0.10	0.01	0.13	0.13	0.06	0.14	0.13	0.12	0.11
FeO*	28.40	26.97	23.70	26.75	27.88	28.31	25.79	24.04	26.67	20.84	28.95	22.81
MnO	1.09	1.61	1.20	1.55	1.28	0.71	1.81	1.84	0.78	1.07	1.57	0.80
MgO	4.47	4.26	3.76	4.39	4.58	5.01	5.36	5.31	5.96	8.94	3.66	4.71
CaO	7.56	9.11	10.57	7.30	7.18	6.92	7.98	9.49	7.09	7.75	7.05	4.17
Na ₂ O	0.18	0.19	0.04	0.10	0.10	0.10	0.12	0.26	0.23	0.11	0.07	0.21
K ₂ O	0.04	0.01	0.00	0.03	0.04	0.04	0.03	0.00	0.01	0.02	0.05	0.02
Total	102.78	102.06	99.37	100.25	101.34	99.87	100.61	102.72	101.67	100.66	100.59	102.62
Si	2.960	2.952	3.006	3.009	3.020	2.965	2.977	2.938	2.946	2.971	2.995	2.935
Al(IV)	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(VI)	1.979	1.946	2.001	1.990	1.967	1.902	1.958	1.996	1.957	1.975	1.959	1.969
Ti	0.002	0.003	0.002	0.006	0.002	0.008	0.005	0.00	0.005	0.006	0.002	0.002
Cr	0.004	0.008	0.014	0.006	0.002	0.008	0.008	0.004	0.008	0.008	0.007	0.007
Fe ³	0.00	0.00	0.00	0.00	0.005	0.017	0.00	0.00	0.00	0.00	0.00	0.00
Fe ²	1.810	1.717	1.558	1.755	1.811	1.830	1.632	1.508	1.711	1.31	1.909	2.090
Mn	0.070	0.104	0.080	0.103	0.084	0.047	0.119	0.117	0.051	0.068	0.105	0.052
Mg	0.508	0.483	0.441	0.513	0.532	0.589	0.619	0.594	0.681	1.002	0.430	0.535
Ca	0.617	0.743	0.890	0.613	0.599	0.585	0.662	0.763	0.583	0.624	0.596	0.340
Na	0.027	0.028	0.006	0.015	0.015	0.015	0.018	0.018	0.014	0.016	0.011	0.031
K	0.004	0.001	0.00	0.003	0.004	0.004	0.003	0.00	0.001	0.002	0.005	0.002

*Total Iron as FeO

Table A2-1: Microprobe analyses of garnet from mafic gneiss. Structural formulae based on 12 oxygens.

Sample	MG 1	MG 2	MG 3	MG 4	MG 5	MG 6	MG 7	MG 8	MG 9	MG 10	MG 11
SiO ₂	50.16	48.07	51.58	51.46	50.38	50.31	51.12	52.03	49.52	50.84	51.31
TiO ₂	0.29	0.28	0.17	0.32	0.15	0.23	0.22	0.25	0.20	0.20	0.11
Al ₂ O ₃	1.21	3.57	1.57	1.13	2.47	2.85	1.92	2.33	2.38	2.58	1.95
Cr ₂ O ₃	0.14	0.12	0.10	0.11	0.24	0.22	0.18	0.09	0.07	0.10	0.28
FeO*	13.76	17.63	13.17	13.01	13.91	13.82	15.95	13.60	12.97	13.11	11.45
MnO	1.24	0.66	0.55	0.12	0.11	0.17	0.08	0.10	0.11	0.36	0.24
MgO	8.96	6.15	10.22	10.66	9.54	9.41	9.63	10.74	9.78	10.38	10.80
CaO	22.28	21.43	23.33	22.60	22.32	21.67	21.67	21.41	20.17	21.56	21.86
Na ₂ O	0.23	0.14	0.49	0.19	0.41	0.62	0.70	0.86	0.67	0.53	0.63
K ₂ O	0.05	0.03	0.00	0.06	0.00	0.00	0.02	0.02	0.03	0.00	0.00
Total	98.35	99.12	100.67	99.70	99.55	99.12	100.61	101.47	99.94	99.73	98.61
Si	1.963	1.882	1.941	1.967	1.933	1.932	1.942	1.943	1.962	1.963	1.966
Al(IV)	0.037	0.118	0.059	0.033	0.067	0.068	0.058	0.057	0.038	0.064	0.034
Al(VI)	0.019	0.047	0.011	0.019	0.045	0.061	0.028	0.045	0.073	0.052	0.054
Ti	0.008	0.008	0.005	0.009	0.004	0.007	0.006	0.007	0.006	0.008	0.002
Cr	0.004	0.004	0.003	0.003	0.007	0.007	0.005	0.003	0.002	0.003	0.008
Fe ¹	0.016	0.124	0.071	0.011	0.032	0.034	0.064	0.050	0.005	0.012	0.008
Fe ²	0.434	0.454	0.141	0.406	0.409	0.411	0.414	0.400	0.425	0.386	0.354
Mn	0.041	0.027	0.018	0.004	0.004	0.006	0.003	0.003	0.004	0.012	0.008
Mg	0.523	0.370	0.573	0.607	0.545	0.539	0.545	0.598	0.577	0.589	0.617
Ca	0.934	0.899	0.941	0.925	0.917	0.891	0.882	0.856	0.856	0.880	0.897
Na	0.017	0.071	0.036	0.014	0.030	0.046	0.052	0.062	0.051	0.039	0.047
K	0.002	0.001	0.000	0.001	0.000	0.000	1.001	0.002	0.000	0.000	0.000

Sample	MG 12	MG 13	MG 14	MG 15	MG 16	MG 17	MG 18	MG 19	MG 20	MG 21	MG 22
SiO ₂	50.34	50.87	48.28	50.64	50.49	50.45	51.58	51.16	51.57	50.22	51.53
TiO ₂	0.37	0.37	0.33	0.21	0.34	0.30	0.24	0.40	0.34	0.43	0.23
Al ₂ O ₃	3.23	2.07	2.49	2.35	1.84	2.63	2.51	2.82	2.92	2.81	0.93
Cr ₂ O ₃	0.16	0.15	0.09	0.14	0.15	0.18	0.19	0.10	0.21	0.06	0.21
FeO*	12.91	12.62	12.55	11.95	12.84	12.52	12.68	12.98	11.81	11.05	10.67
MnO	0.25	0.31	0.15	0.16	0.05	0.17	0.20	0.08	0.08	0.12	0.31
MgO	10.26	10.36	9.90	11.06	10.53	10.84	10.65	10.88	11.34	11.61	12.06
CaO	21.71	21.69	21.24	21.24	21.27	19.89	22.79	21.45	22.65	21.45	21.13
Na ₂ O	0.66	0.50	0.68	0.58	1.24	0.60	0.66	0.73	0.74	0.61	0.46
K ₂ O	0.05	0.03	0.02	0.03	0.03	0.02	0.01	0.04	0.08	0.00	0.06
Total	99.92	98.99	95.75	98.18	100.76	97.65	101.45	99.78	101.79	98.00	97.56
Si	1.911	1.951	1.912	1.958	1.889	1.954	1.936	1.936	1.908	1.932	1.988
Al(IV)	0.089	0.047	0.058	0.058	0.113	0.046	0.024	0.064	0.092	0.068	0.012
Al(VI)	0.055	0.047	0.028	0.056	0.056	0.075	0.086	0.062	0.035	0.059	0.034
Ti	0.011	0.010	0.013	0.014	0.010	0.009	0.007	0.011	0.009	0.012	0.007
Cr	0.005	0.005	0.003	0.004	0.004	0.006	0.003	0.003	0.008	0.002	0.006
Fe ¹	0.057	0.015	0.091	0.027	0.025	0.030	0.070	0.031	0.087	0.027	0.060
Fe ²	0.353	0.390	0.324	0.352	0.276	0.406	0.426	0.351	0.278	0.328	0.344
Mn	0.008	0.010	0.005	0.005	0.002	0.006	0.006	0.003	0.003	0.010	0.010
Mg	0.580	0.593	0.584	0.627	0.586	0.592	0.592	0.614	0.625	0.631	0.693
Ca	0.883	0.892	0.902	0.876	0.849	0.825	0.911	0.870	0.898	0.884	0.873
Na	0.049	0.037	0.052	0.043	0.090	0.045	0.048	0.054	0.053	0.045	0.030
K	0.00	0.001	0.001	0.001	0.001	0.001	0.000	0.002	0.004	0.000	0.003

Sample	MG 23	MG 24	MG 25	MG 26	MG 27	MG 28	MG 29	MG 30	MG 31	MG 32
SiO ₂	52.92	51.49	51.39	51.76	51.36	51.82	51.99	52.79	51.88	51.72
TiO ₂	0.17	0.43	0.57	0.17	0.31	0.36	0.08	0.05	0.33	0.14
Al ₂ O ₃	1.56	3.28	1.26	1.74	2.98	3.18	2.52	1.96	2.80	2.79
Cr ₂ O ₃	0.21	0.16	0.26	0.19	0.17	0.00	0.17	0.15	0.25	0.10
FeO*	10.89	11.44	10.02	11.74	11.28	10.70	9.09	9.18	9.37	6.76
MnO	0.15	0.08	0.13	0.19	0.09	0.04	0.09	0.11	0.12	0.15
MgO	12.67	11.56	12.09	12.14	11.67	11.97	11.17	13.23	12.92	13.81
CaO	21.88	21.79	21.71	20.50	21.15	21.48	21.45	22.20	21.31	21.84
Na ₂ O	0.57	0.84	0.50	0.65	0.78	0.98	0.77	1.64	0.67	0.65
K ₂ O	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.05
Total	101.02	101.08	99.94	99.13	99.76	99.61	99.44	100.94	99.70	98.05
Si	1.965	1.914	1.927	1.965	1.935	1.915	1.946	1.943	1.940	1.947
Al(IV)	0.035	0.086	0.073	0.035	0.065	0.085	0.056	0.057	0.060	0.053
Al(VI)	0.034	0.057	0.071	0.043	0.067	0.056	0.055	0.028	0.063	0.071
Ti	0.005	0.011	0.016	0.005	0.009	0.010	0.002	0.001	0.009	0.004
Cr	0.006	0.005	0.008	0.006	0.005	0.00	0.005	0.004	0.007	0.003
Fe ¹	0.026	0.063	0.00	0.025	0.032	0.073	0.048	0.097	0.020	0.022
Fe ²	0.312	0.293	0.317	0.348	0.323	0.263	0.236	0.185	0.273	0.191
Mn	0.005	0.003	0.004	0.006	0.003	0.001	0.005	0.010	0.004	0.005
Mg	0.701	0.640	0.675	0.687	0.650	0.670	0.734	0.725	0.720	0.775
Ca	0.870	0.867	0.872	0.834	0.854	0.864	0.859	0.875	0.854	0.881
Na	0.041	0.061	0.036	0.048	0.057	0.064	0.056	0.074	0.049	0.047
K	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.001	0.002

*Total iron as FeO

Table A2-2: Microprobe analyses of clinopyroxene from mafic gneiss. Structural formulae based on 6 oxygens.

Sample	MG 3A	MG 3B	MG 4A	MG 4B	MG 5	MG 6	MG 7	MG 8	MG 9	MG 10	MG 11A	MG 11B
SiO ₂	45.45	53.09	43.82	45.61	42.54	41.30	41.92	43.81	40.79	42.49	45.30	53.58
TiO ₂	0.49	0.03	1.25	0.45	1.05	1.23	1.84	1.48	2.18	1.12	0.24	0.03
Al ₂ O ₃	9.86	1.44	11.59	9.95	12.23	12.42	12.05	12.01	12.91	12.23	9.74	1.58
Cr ₂ O ₃	0.19	0.09	0.05	0.16	0.15	0.08	0.00	0.16	0.10	0.17	0.08	0.14
FeO*	16.17	15.37	18.74	17.65	19.78	21.00	21.00	21.16	20.62	20.06	16.66	13.38
MnO	0.46	0.69	0.16	0.16	0.00	0.46	0.31	0.10	0.00	0.30	0.30	0.50
MgO	10.13	12.79	8.41	9.92	7.58	8.36	7.34	8.63	7.56	8.67	10.37	14.74
CaO	12.39	13.39	11.34	11.34	11.77	10.68	11.25	11.37	10.96	11.14	11.20	12.16
Na ₂ O	0.97	0.29	1.26	0.86	0.78	1.77	1.71	1.98	1.97	1.60	1.15	0.43
K ₂ O	0.20	0.00	1.20	0.90	0.45	1.15	0.88	0.34	1.73	0.63	0.04	0.00
Total	96.31	97.18	97.37	97.01	96.32	98.46	98.30	101.07	98.79	98.51	95.09	96.54
Si	6.836	7.825	6.587	6.825	6.481	6.215	6.353	6.399	6.183	6.349	6.847	7.832
Al(iv)	1.164	0.172	1.414	1.176	1.520	1.786	1.647	1.601	1.817	1.652	1.154	0.169
Al(vi)	0.584	0.078	0.640	0.579	0.677	0.417	0.505	0.466	0.489	0.502	0.581	0.104
Ti	0.055	0.003	0.142	0.051	0.171	0.140	0.210	0.163	0.249	0.126	0.027	0.003
Cr	0.023	0.010	0.006	0.019	0.018	0.010	0.00	0.019	0.012	0.020	0.010	0.016
Fe ₃	0.084	0.00	0.143	0.244	0.315	0.621	0.254	0.366	0.206	0.466	0.344	0.051
Fe ₂	1.951	1.895	2.213	1.965	2.205	2.021	2.408	2.219	2.408	2.021	1.762	1.584
Mn	0.059	0.086	0.020	0.020	0.00	0.059	0.040	0.012	0.00	0.038	0.039	0.062
Mg	2.271	2.810	1.884	2.212	1.721	1.875	1.879	1.708	1.930	2.336	3.211	4.732
Ca	1.996	2.115	1.826	1.818	1.921	1.722	1.826	1.779	1.780	1.783	1.813	1.904
Na	0.283	0.083	0.367	0.250	0.231	0.516	0.503	0.561	0.579	0.464	0.337	0.122
K	0.038	0.00	0.230	0.172	0.088	0.221	0.170	0.064	0.335	0.120	0.008	0.00

Sample	MG 12	MG 13	MG 14	MG 15	MG 16	MG 17	MG 18	MG 19	MG 20A	MG 20B	MG 21	MG 22
SiO ₂	41.88	42.08	41.08	42.97	41.98	40.27	42.28	41.86	42.29	47.53	43.13	42.37
TiO ₂	1.37	2.01	1.75	1.41	1.51	2.21	1.65	1.82	2.03	0.56	1.42	1.87
Al ₂ O ₃	12.51	11.52	13.53	12.21	13.44	11.72	12.07	11.94	12.98	7.65	11.57	9.85
Cr ₂ O ₃	0.00	0.00	0.06	0.02	0.00	0.24	0.08	0.24	0.08	0.27	0.06	0.04
FeO*	20.30	18.57	21.76	18.22	18.85	17.22	18.98	19.17	18.43	18.95	16.37	16.90
MnO	0.32	0.04	0.49	0.22	0.40	0.11	0.06	0.04	0.17	0.00	0.02	0.37
MgO	7.70	8.48	7.74	8.98	8.80	8.42	8.64	8.99	9.28	11.05	9.96	10.19
CaO	11.43	10.91	11.10	11.12	11.12	10.54	11.66	10.73	11.41	10.35	11.31	10.80
Na ₂ O	1.30	1.71	1.33	1.08	1.84	1.46	1.76	2.13	1.95	1.19	1.58	1.34
K ₂ O	0.83	0.83	1.05	0.51	1.03	1.41	0.83	0.86	0.69	0.45	0.19	0.95
Total	97.65	96.15	100.50	96.73	98.96	93.60	98.04	97.76	99.31	98.01	95.61	94.68
Si	6.337	6.439	6.088	6.453	6.239	6.345	6.375	6.316	6.252	6.997	6.525	6.530
Al(iv)	1.663	1.562	1.913	1.547	1.761	1.656	1.626	1.684	1.748	1.004	1.460	1.471
Al(vi)	0.568	0.516	0.450	0.614	0.592	0.521	0.519	0.439	0.513	0.324	0.588	0.318
Ti	0.156	0.231	0.195	0.159	0.169	0.262	0.187	0.207	0.226	0.062	0.162	0.217
Cr	0.00	0.00	0.007	0.002	0.00	0.030	0.010	0.029	0.009	0.032	0.009	0.005
Fe ₃	0.400	0.215	0.724	0.420	0.359	0.150	0.168	0.312	0.288	0.491	0.240	0.351
Fe ₂	2.169	2.161	1.972	1.868	1.984	2.119	2.225	2.107	1.990	1.842	1.832	1.827
Mn	0.041	0.005	0.062	0.028	0.051	0.015	0.008	0.005	0.021	0.00	0.003	0.049
Mg	1.736	1.934	1.710	2.010	1.949	1.977	1.941	2.021	2.044	2.424	2.246	2.340
Ca	1.853	1.789	1.762	1.789	1.770	1.779	1.883	1.734	1.807	1.632	1.833	1.783
Na	0.381	0.508	0.382	0.315	0.530	0.446	0.514	0.623	0.559	0.350	0.464	0.400
K	0.160	0.162	0.199	0.098	0.196	0.283	0.160	0.166	0.130	0.085	0.037	0.167

Sample	MG 23	MG 24A	MG 24B	MG 25	MG 26	MG 27	MG 28	MG 29	MG 30A	MG 30B	MG 31	MG 32
SiO ₂	42.94	43.29	46.67	42.90	44.15	42.56	43.09	43.42	44.12	54.66	42.95	46.18
TiO ₂	2.00	1.57	0.56	1.68	1.98	2.08	1.58	1.34	0.74	4.15	1.96	0.41
Al ₂ O ₃	11.92	12.23	10.16	12.86	11.88	11.69	11.57	12.59	13.21	1.00	11.72	10.25
Cr ₂ O ₃	0.18	0.04	0.08	0.26	0.00	0.00	0.06	0.16	0.13	0.09	0.24	0.01
FeO*	16.31	17.84	17.58	15.12	17.47	17.61	16.65	13.66	16.58	18.73	15.81	11.12
MnO	0.00	0.03	0.26	0.21	0.39	0.17	0.36	0.21	0.15	0.05	0.20	0.21
MgO	10.35	9.81	11.51	10.29	10.09	9.70	10.89	12.17	11.26	9.68	10.75	14.91
CaO	11.03	11.24	11.56	11.02	11.30	11.05	11.02	11.30	11.27	0.60	11.06	11.44
Na ₂ O	1.36	1.75	1.70	1.17	1.25	2.05	1.82	1.56	1.40	8.53	2.00	1.24
K ₂ O	0.86	0.55	0.09	1.28	1.31	0.77	0.24	0.99	1.14	1.40	0.84	0.69
Total	96.96	98.40	100.17	96.67	99.80	97.71	97.29	97.41	100.00	98.89	97.52	96.51
Si	6.418	6.409	-	6.400	6.449	6.380	6.396	6.387	6.361	7.976	6.402	6.704
Al(iv)	1.583	1.591	-	1.600	1.551	1.620	1.604	1.614	1.639	0.024	1.599	1.296
Al(vi)	0.517	0.543	-	0.666	0.494	0.446	0.420	0.570	0.605	0.148	0.460	0.458
Ti	0.225	0.175	-	0.189	0.218	0.235	0.177	0.148	0.081	0.455	0.220	0.045
Cr	0.021	0.005	-	0.224	0.00	0.00	0.007	0.019	0.015	0.010	0.028	0.00
Fe ₃	0.295	0.327	-	1.666	0.311	0.264	0.505	0.318	0.503	0.073	0.220	0.504
Fe ₂	1.744	1.742	-	0.027	1.823	1.944	1.562	1.362	1.496	2.213	1.751	0.846
Mn	0.00	0.004	-	2.293	0.049	0.022	0.046	0.026	0.018	0.006	0.025	0.026
Mg	2.305	2.165	-	1.765	2.196	2.167	2.409	2.668	2.420	2.105	2.388	3.226
Ca	1.766	1.783	-	0.339	1.768	1.775	1.753	1.781	1.741	0.094	1.766	1.779
Na	0.394	0.503	-	0.244	0.354	0.596	0.524	0.445	0.392	2.413	0.578	0.349
K	0.164	0.104	-	0.031	0.244	0.147	0.046	0.186	0.210	0.261	0.160	0.128

*Total Iron as FeO

Table A2-3: Microprobe analyses of hornblende and secondary amphibole (B-designation) from mafic gneiss. Structural formulae based on 46 cationic charges.

Sample	PG 1	PG 2	PG 3	PG 4	PG 5	PG 6	PG 7	PG 8	PG 9	PG 10	PG 11	PG 12
SiO ₂	38.05	37.96	37.15	37.09	37.45	37.02	37.59	38.21	37.59	38.60	38.02	38.02
TiO ₂	0.01	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.10	0.13	0.05	0.02
Al ₂ O ₃	21.53	21.05	20.29	20.48	21.17	20.65	21.31	20.98	21.28	21.90	21.54	21.73
Cr ₂ O ₃	0.05	0.00	0.06	0.11	0.03	0.05	0.08	0.05	0.06	0.03	0.03	0.01
FeO*	30.73	30.01	29.18	32.10	33.57	28.92	26.96	28.17	33.80	28.87	31.60	32.71
MnO	3.24	4.05	3.54	3.80	4.35	5.24	4.55	3.01	2.40	2.72	3.51	2.85
MgO	2.98	2.98	2.91	3.32	3.48	3.17	3.27	3.64	4.42	3.96	4.34	4.51
CaO	6.17	5.78	5.98	3.49	1.07	4.35	5.05	6.46	1.50	7.00	2.67	2.11
Na ₂ O	0.29	0.09	0.05	0.08	0.00	0.03	0.14	0.00	0.40	0.27	0.14	0.02
K ₂ O	0.04	0.01	0.00	0.00	0.02	0.03	0.02	0.05	0.03	0.02	0.02	0.00
Total	103.09	101.93	99.26	100.47	99.46	101.29	98.90	100.59	101.58	103.57	101.95	101.98
Si	2.930	2.969	2.994	2.950	2.965	2.970	3.027	3.025	2.940	2.930	2.961	2.954
Al(IV)	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(VI)	1.953	1.939	1.927	1.919	1.975	1.952	2.022	1.957	1.961	1.959	1.976	1.989
Ti	0.001	0.00	0.00	0.00	0.009	0.00	0.00	0.00	0.006	0.007	0.003	0.001
Cr	0.003	0.00	0.004	0.007	0.002	0.003	0.005	0.003	0.004	0.002	0.002	0.001
Fe ₃	0.00	0.040	0.054	0.048	0.00	0.031	0.00	0.029	0.00	0.00	0.00	0.004
Fe ₂	1.978	1.915	1.912	2.086	2.222	1.909	1.809	1.836	0.210	1.832	2.057	2.121
Mn	0.211	0.268	0.242	0.256	0.292	0.356	0.310	0.202	0.159	0.175	0.231	0.187
Mg	0.342	0.347	0.349	0.393	0.411	0.379	0.392	0.429	0.515	0.448	0.504	0.522
Ca	0.509	0.484	0.516	0.297	0.091	0.374	0.436	0.548	0.126	0.569	0.223	0.176
Na	0.043	0.014	0.008	0.012	0.00	0.005	0.022	0.00	0.00	0.040	0.021	0.003
K	0.004	0.001	0.00	0.00	0.002	0.003	0.002	0.005	0.003	0.002	0.002	0.00

Sample	PG 13	PG 14	PG 15	PG 16	PG 17	PG 18	PG 19	PG 20	PG 21	PG 22	PG 23	PG 24
SiO ₂	37.65	37.64	38.01	38.55	37.40	37.67	39.22	39.25	38.48	38.87	38.48	38.01
TiO ₂	0.03	0.03	0.08	0.00	0.11	0.02	0.04	0.05	0.04	0.00	0.08	0.04
Al ₂ O ₃	21.20	20.99	21.28	21.24	20.20	21.06	22.15	22.83	21.42	21.78	22.05	22.32
Cr ₂ O ₃	0.04	0.04	0.07	0.04	0.14	0.16	0.02	0.06	0.01	0.08	0.15	0.02
FeO*	30.87	29.64	28.52	30.40	27.48	31.29	30.10	27.94	28.94	27.33	29.80	27.75
MnO	1.87	2.36	1.67	1.45	1.13	1.19	0.86	0.66	0.76	0.86	0.53	1.16
MgO	4.66	4.51	4.36	5.73	5.19	6.04	6.65	6.83	8.03	7.30	8.85	8.37
CaO	2.22	5.64	5.88	3.35	6.34	2.39	4.32	5.60	2.89	3.73	1.50	2.87
Na ₂ O	0.09	0.16	0.15	0.04	0.00	0.00	0.40	0.54	0.02	0.10	0.00	0.23
K ₂ O	0.01	0.00	0.04	0.04	0.00	0.03	0.00	0.01	0.05	0.01	0.00	0.00
Total	98.62	101.01	100.08	100.69	98.03	99.85	103.87	103.94	100.64	100.09	102.44	101.57
Si	3.038	2.927	2.999	3.021	3.00	2.963	2.940	2.903	2.952	3.023	2.982	2.929
Al(IV)	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(VI)	2.016	1.923	1.979	1.961	1.909	1.952	1.956	1.990	1.936	1.996	1.962	1.985
Ti	0.002	0.002	0.005	0.00	0.007	0.001	0.002	0.003	0.002	0.00	0.005	0.002
Cr	0.003	0.002	0.004	0.002	0.009	0.010	0.001	0.004	0.001	0.005	0.009	0.001
Fe ₃	0.00	0.042	0.06	0.021	0.051	0.013	0.00	0.00	0.049	0.00	0.002	0.00
Fe ₂	2.082	1.885	1.881	1.971	1.792	2.045	1.886	1.728	1.807	1.777	1.880	1.751
Mn	0.127	0.155	0.112	0.096	0.077	0.079	0.055	0.041	0.049	0.057	0.034	0.074
Mg	0.560	0.523	0.513	0.669	0.620	0.708	0.743	0.753	0.918	0.846	0.996	0.941
Ca	0.192	0.470	0.497	0.281	0.545	0.201	0.347	0.444	0.237	0.311	0.121	0.232
Na	0.014	0.024	0.023	0.006	0.00	0.00	0.058	0.077	0.003	0.015	0.00	0.034
K	0.001	0.00	0.004	0.004	0.00	0.003	0.00	0.001	0.005	0.001	0.00	0.00

*Total Iron as FeO

Table A2-4: Microprobe analyses of garnet in paragneiss. Structural formulae based on 12 oxygens.

Sample	PG 1	PG 2	PG 3	PG 4	PG 5	PG 6	PG 7	PG 8	PG 9	PG 10	PG 11	PG 12
SiO ₂	36.74	35.64	35.30	34.06	35.47	35.89	36.41	36.61	34.61	33.78	36.47	35.85
TiO ₂	3.85	1.28	2.73	1.50	2.37	0.80	2.67	2.71	2.44	1.52	2.99	1.33
Al ₂ O ₃	16.99	19.52	16.71	17.96	16.17	16.88	15.42	15.24	17.92	16.12	18.00	18.23
Cr ₂ O ₃	0.00	0.03	0.00	0.02	0.16	0.00	0.14	0.11	0.13	0.06	0.02	0.13
FeO*	22.69	22.38	20.26	21.90	18.72	19.01	17.79	17.74	19.05	22.45	18.75	19.78
MnO	0.30	0.30	0.15	0.16	0.04	0.29	0.20	0.21	0.08	0.30	0.15	0.14
MgO	9.03	6.81	8.80	8.27	10.80	11.90	11.74	11.97	11.28	10.40	10.98	10.70
CaO	0.04	0.13	0.10	0.03	0.10	0.15	0.01	0.12	0.04	0.06	0.03	0.00
Na ₂ O	0.28	0.19	0.00	0.11	0.07	0.27	0.19	0.12	0.04	0.06	0.03	0.00
K ₂ O	9.68	8.86	9.09	8.90	8.86	8.63	9.27	9.37	9.07	7.66	9.48	9.17
Total	99.60	95.14	93.14	92.95	92.75	93.82	93.88	94.10	94.85	92.44	97.26	95.70
Si	2.722	2.745	2.767	2.701	2.770	2.768	2.803	2.810	2.652	2.694	2.713	2.723
Al(IV)	0.278	0.255	0.233	0.299	0.230	0.232	0.197	0.190	0.348	0.306	0.287	0.277
Al(VI)	1.205	1.516	1.311	1.379	1.257	1.302	1.201	1.188	1.270	1.209	1.291	1.355
Ti	0.214	0.074	0.161	0.089	0.139	0.046	0.155	0.156	0.141	0.091	0.167	0.076
Cr	0.00	0.002	0.00	0.001	0.010	0.00	0.009	0.007	0.008	0.004	0.00	0.008
Fe ³⁺	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 ²⁺	1.406	1.441	1.328	1.452	1.222	1.226	1.145	1.138	1.220	1.497	1.166	1.256
Mn	0.019	0.020	0.010	0.011	0.003	0.019	0.013	0.014	0.005	0.020	0.009	0.009
Mg	0.997	0.782	1.028	0.977	1.257	1.368	1.347	1.369	1.288	1.236	1.217	1.211
Ca	0.003	0.011	0.008	0.003	0.008	0.012	0.001	0.010	0.003	0.005	0.002	0.00
Na	0.040	0.028	0.000	0.017	0.011	0.040	0.028	0.00	0.034	0.006	0.052	0.044
K	0.915	0.870	0.909	0.900	0.882	0.849	0.910	0.917	0.886	0.779	0.899	0.888

Sample	PG 13	PG 14	PG 15	PG 16	PG 17	PG 18	PG 19	PG 20	PG 21	PG 22	PG 23	PG 24	PG 25
SiO ₂	36.49	36.62	36.19	35.77	36.83	36.03	35.81	37.67	37.56	37.16	36.85	36.92	36.73
TiO ₂	2.73	2.17	3.91	4.90	2.99	4.67	3.02	3.56	3.90	4.02	3.52	3.02	3.49
Al ₂ O ₃	16.36	16.90	15.34	14.94	16.41	14.48	16.27	16.27	16.25	15.14	15.65	17.83	17.47
Cr ₂ O ₃	0.13	0.13	0.00	0.03	0.17	0.11	0.14	0.12	0.04	0.09	0.15	0.10	0.00
FeO*	19.47	16.75	18.96	16.99	15.19	14.65	16.10	14.39	15.23	13.07	12.83	14.23	14.39
MnO	0.05	0.09	0.06	0.10	0.08	0.00	0.07	0.05	0.06	0.09	0.10	0.00	0.14
MgO	11.96	12.53	11.41	11.38	13.77	12.71	13.70	14.17	15.05	15.35	14.37	13.81	14.39
CaO	0.04	0.00	0.10	0.03	0.00	0.07	0.08	0.00	0.10	0.03	0.02	0.01	0.39
Na ₂ O	0.44	0.32	0.26	0.15	0.19	0.00	0.36	0.00	0.57	0.09	0.09	0.11	0.43
K ₂ O	8.89	8.71	8.99	9.37	9.32	9.54	9.48	10.03	9.12	9.76	9.42	9.37	9.03
Total	96.60	94.25	95.27	94.69	95.00	92.29	94.18	96.63	97.90	95.02	93.01	95.44	96.46
Si	2.741	2.775	2.757	2.756	2.760	2.788	2.728	2.771	2.728	2.767	2.792	2.733	2.698
Al(IV)	0.259	0.225	0.243	0.244	0.240	0.272	0.229	0.272	0.272	0.233	0.208	0.267	0.302
Al(VI)	1.189	1.285	1.135	1.113	1.209	1.108	1.168	1.181	1.119	1.096	1.189	1.289	1.210
Ti	0.154	0.124	0.224	0.284	0.168	1.272	0.173	0.197	0.213	0.235	0.201	0.165	0.193
Cr	0.008	0.008	0.00	0.00	0.00	0.00	0.008	0.007	0.002	0.005	0.009	0.006	0.00
Fe ³⁺	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
Fe ²⁺	1.223	1.051	1.208	1.095	0.952	0.948	1.025	0.885	0.925	0.814	0.813	0.881	0.884
Mn	0.003	0.006	0.004	0.007	0.005	0.00	0.005	0.004	0.004	0.006	0.006	0.00	0.009
Mg	1.339	1.415	1.295	1.307	1.538	1.466	1.498	1.553	1.629	1.703	1.623	1.524	1.575
Ca	0.003	0.00	0.008	0.002	0.00	0.006	0.007	0.00	0.008	0.002	0.002	0.001	0.031
Na	0.064	0.047	0.038	0.022	0.028	0.00	0.001	0.051	0.080	0.013	0.013	0.016	0.061
K	0.852	0.842	0.874	0.921	0.891	0.941	0.921	0.941	0.845	0.927	0.910	0.885	0.846

*Total Iron as Fe

Table A2-5: Microprobe analyses of biotite in paragneiss. Structural formulae based on 22 cationic charges.

Sample	PG 10A	PG 10B	PG 13	PG 16	PG 18	PG 20	PG 21	PG 22
SiO ₂	51.13	52.17	52.64	50.55	52.08	49.55	48.38	51.72
TiO ₂	0.03	0.34	0.03	0.01	0.10	0.06	0.04	0.04
Al ₂ O ₃	0.91	1.46	1.11	1.31	0.00	3.49	2.64	1.74
Cr ₂ O ₃	0.00	0.11	0.04	0.62	0.16	0.06	0.00	0.04
FeO	29.37	10.63	25.25	29.10	8.71	32.51	24.34	24.74
MnO	0.87	0.26	0.78	0.62	0.15	1.05	0.18	0.26
MgO	17.88	12.85	16.39	17.28	13.11	13.21	17.71	21.21
CaO	0.61	20.94	0.67	0.37	21.71	0.00	0.51	0.06
Na ₂ O	0.32	0.72	0.33	0.26	0.08	0.49	0.89	0.04
K ₂ O	0.02	0.00	0.02	0.03	0.00	0.00	0.16	0.00
Total	101.17	99.51	97.30	99.64	96.15	101.83	94.34	100.05
Si	1.939	1.963	2.043	1.950	2.019	1.906	1.918	1.939
Al(iv)	0.041	0.037	0.00	0.050	0.00	0.094	0.082	0.061
Al(vi)	0.00	0.028	0.051	0.009	0.00	0.064	0.041	0.016
Ti	0.001	0.010	0.001	0.002	0.003	0.00	0.001	0.002
Cr	0.00	0.003	0.001	0.00	0.005	0.002	0.00	0.001
Fe ³	0.104	0.040	0.00	0.057	0.00	0.064	0.115	0.043
Fe ²	0.828	0.295	0.819	0.882	0.282	0.983	0.692	0.733
Mn	0.028	0.008	0.026	0.020	0.005	0.034	0.006	0.008
Mg	1.011	0.720	0.948	0.993	0.757	0.757	1.046	1.185
Ca	0.025	0.844	0.028	0.015	0.901	0.059	0.022	0.009
Na	0.024	0.053	0.025	0.019	0.006	0.037	0.068	0.003
K	0.001	0.00	0.001	0.001	0.00	0.00	0.008	0.00

Table A2-6: Microprobe analyses of pyroxene in paragneiss.

All orthopyroxene except PG10B, PG18 (clinopyroxene). Structural formulae based on 6 oxygens.

	OG-1	OG-1	OG-1	OG-1	OG-1	OG-1
	1	2	3	4	5	6
SiO ₂	41.18	53.67	12.80	0.26	44.04	44.29
TiO ₂	0.03	0.00	0.08	0.03	0.10	0.05
Al ₂ O ₃	23.01	4.66	62.27	64.11	19.04	16.02
Cr ₂ O ₃	0.09	0.05	0.06	0.06	0.18	0.08
FeO	19.70	13.48	6.33	19.09	11.01	7.80
MnO	0.55	0.12	0.06	0.06	0.18	0.08
MgO	14.15	27.74	16.75	15.43	21.11	15.50
CaO	3.38	0.07	0.04	0.00	0.62	11.00
Na ₂ O	0.44	0.65	0.00	0.07	2.03	1.74
K ₂ O	0.01	0.08	0.00	0.01	0.00	0.21
Total	102.60	100.56	98.41	99.21	98.22	96.82
Si	2.981	1.894	0.769	0.007	6.115	6.273
Ti	0.002	0.00	0.004	0.001	0.010	0.005
Al(iv)	0.00	0.108	0.231	0.00	1.885	1.728
Al(vi)	1.962	0.088	4.176	1.974	1.230	0.946
Cr	0.005	0.001	0.003	0.002	0.008	0.011
Fe ₃	0.00	0.065	0.034	0.002	0.065	0.474
Fe ₂	1.192	0.333	0.284	0.415	1.214	0.450
Mn	0.034	0.004	0.003	0.001	0.021	0.010
Mg	1.526	1.459	1.499	0.601	4.368	3.271
Ca	0.262	0.003	0.003	0.00	0.092	1.669
Na	0.062	0.044	0.00	0.004	0.546	0.478
K	0.001	0.004	0.00	0.00	0.00	0.038

Table A2-7: Microprobe analyses of minerals in OG-1 (magnesian melagabbro from Shawmere anorthosite complex). 1: garnet; 2: orthopyroxene; 3: sapphirine; 4: spinel; 5: orthoamphibole; 6: clinoamphibole. Also present is anorthite (An₉₄).

Table A2-8: Microprobe analyses of ferromagnesian minerals in orthogneisses.
 1-5: clinopyroxene (6 oxygens); 6-7: garnet (12 oxygens);
 8: olivine (4 oxygens); 9: spinel (4 oxygens).

	OG-2	OG-5	OG-6	OG-7	OG-8	OG-3	OG-4	OG-7	OG-7
SiO ₂	52.81	51.61	51.83	51.26	51.83	40.87	38.14	39.32	0.12
TiO ₂	0.21	0.21	0.24	0.46	0.14	0.13	0.07	0.08	0.02
Al ₂ O ₃	2.22	2.94	1.99	2.05	2.43	22.96	21.82	0.00	58.24
Cr ₂ O ₃	0.10	0.13	0.16	0.20	0.34	0.01	0.07	0.00	3.96
FeO	4.38	5.82	6.79	4.06	6.18	17.42	23.73	15.14	18.98
MnO	0.12	0.18	0.16	0.07	0.14	0.55	1.09	0.29	0.19
MgO	15.20	14.25	13.53	15.52	14.71	14.20	8.22	43.90	15.15
CaO	24.06	21.63	21.20	23.05	21.43	4.54	5.65	0.03	0.05
Na ₂ O	0.65	0.81	0.73	0.00	0.49	0.01	0.36	0.00	0.00
K ₂ O	0.03	0.01	0.08	0.07	0.06	0.00	0.00	0.02	0.04
Total	99.89	97.63	98.74	98.76	97.77	100.73	99.20	98.78	96.80
Si	1.935	1.941	1.949	1.942	1.951	2.996	2.927	1.001	0.003
Ti	0.006	0.006	0.007	0.013	0.004	0.007	0.004	0.001	0.00
Al(IV)	0.065	0.059	0.051	0.058	0.049	0.00	0.00	0.00	0.00
Al(VI)	0.030	0.072	0.038	0.033	0.059	1.983	1.974	0.00	1.873
Cr	0.005	0.004	0.005	0.006	0.010	0.001	0.004	0.00	0.085
Fe ³	0.066	0.031	0.052	0.00	0.010	0.00	0.00	0.00	0.00
Fe ²	0.068	0.152	0.225	0.129	0.184	1.068	1.523	0.322	0.433
Mn	0.004	0.006	0.005	0.002	0.004	0.034	0.071	0.006	0.004
Mg	0.830	0.799	0.758	0.876	0.825	1.551	0.940	1.665	0.616
Ca	0.944	0.872	0.854	0.935	0.864	0.356	0.456	0.001	0.001
Na	0.046	0.059	0.053	0.00	0.036	0.001	0.054	0.00	0.00
K	0.001	0.00	0.004	0.003	0.003	0.00	0.00	0.00	0.001

	OG-2	OG-3	OG-4	OG-5	OG-6	OG-7	OG-8
SiO ₂	54.27	54.14	52.26	52.26	52.28	52.70	52.00
TiO ₂	0.05	0.14	0.03	0.08	0.15	0.13	0.03
Al ₂ O ₃	1.71	3.59	2.47	1.99	0.98	0.76	1.59
Cr ₂ O ₃	0.05	0.12	0.02	0.07	0.04	0.02	0.52
FeO	14.23	11.81	19.80	17.67	24.53	10.51	19.65
MnO	0.53	0.25	0.31	0.36	0.86	0.02	0.52
MgO	27.39	29.78	21.76	25.18	21.24	30.88	24.10
CaO	0.33	0.13	0.37	0.42	0.38	0.01	0.02
Na ₂ O	0.68	0.00	0.57	0.42	0.38	0.01	0.02
K ₂ O	0.03	0.00	0.01	0.00	0.00	0.10	0.35
Total	99.32	99.96	97.93	98.78	100.51	95.18	98.38
Si	1.952	1.914	1.974	1.931	1.956	1.939	1.940
Ti	0.001	0.004	0.001	0.002	0.004	0.00	0.001
Al(iv)	0.048	0.086	0.026	0.069	0.043	0.033	0.060
Al(vi)	0.024	0.063	0.083	0.017	0.00	0.00	0.010
Cr	0.001	0.003	0.001	0.002	0.001	0.004	0.001
Fe ³	0.069	0.013	0.00	0.076	0.038	0.089	0.055
Fe ²	0.359	0.336	0.622	0.476	0.729	0.234	0.558
Mn	0.016	0.007	0.01	0.011	0.027	0.011	0.016
Mg	1.468	1.568	1.218	1.378	1.184	1.693	1.340
Ca	0.013	0.005	0.015	0.017	0.015	0.004	0.014
Na	0.047	0.00	0.041	0.030	0.002	0.00	0.005
K	0.001	0.00	0.00	0.00	0.00	0.004	0.001

Table A2-9: Microprobe analyses of orthopyroxene in orthogneisses. Structural formulae based on 6 oxygens.