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Chemical compositions of garnets from the Sambagawa pelitic schists in central Shikoku, Japan

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Abstract

Garnet in the Sambagawa pelitic schists from the Asemi-gawa and Besshi districts in central Shikoku show distinct chemical zoning. The chemical compositions of the garnets within pelitic schists from the garnet to oligoclase-biotite zone are provided in this paper. The chemical compositions of garnets are plotted in Mn-Fe-Mg and Mn-(Fe+Mg)-Ca diagrams. Some garnets from the oligoclase-biotite zone in the Besshi district are different in chemical composition from those described by Banno et al. (1986). These garnets restrictedly occur close to the Tonaru amphibolite mass. There is possibility that these garnets were formed under the thermal influence of the emplacement of the Tonaru amphibolite mass.

Key word : garnet, Sambagawa pelitic schist, Tonaru amphibolite mass, zoning, chemical composition

Introduction

Garnets is a solid solution mineral and their chemical compositions reflect metamorphic conditions. Therefore, the chemical compositions and zoning of garnets are important indicator of metamorphic conditions and evolution of the garnet bearing metamorphic rocks.

The chemical zoning of garnets in the Sambagawa pelitic schists generally show normal zoning, decreasing in MnO from core to rim (e. g. Sakai et al., 1985).

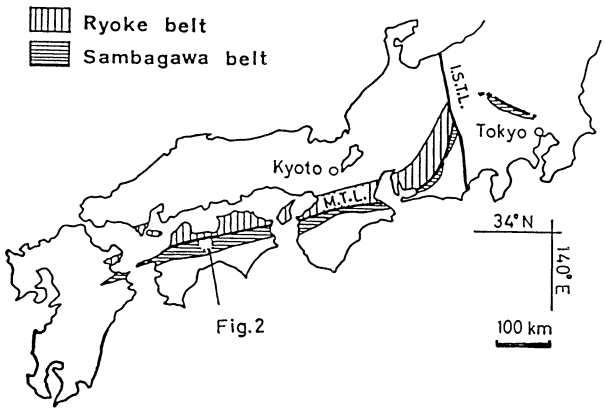

Fig. 1 Location of the Asemi-gawa and Besshi districts in the Sambagawa metamorphic belt, Southwest Japan. M. T. L.: Median Tectonic Line, I. S. T. L.: Itoigawa-Shizuoka Tectonic Line.

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However, recent studies revealed that several types of zoned garnetes show reverse zorning (e. g. Itaya, 1978; Higashino et al., 1981), resorption-overgrowth texture (e. g. Takasu, 1986; Takasu and Fujita, 1994) and sector zoening (e. g. Kitamura et al., 1993; Takasu and Kondo, 1993; Shirahata and Hirajima, 1995). A number of Chemical compositions of zoned garnets in the Sambagawa schists have been reported (e. g. Higashino, 1975; Banno et al., 1986; Hara et al., 1992). In this paper, micro probe chemical compositions of garnets in Sambagawa pelitic schists in central Shikoku (Fig. 1) are provided, and the compositional trends of zoned garnets from each metamorphic zone are discussed.

Geology of the Sambagawa metamorphic belt in central Shikoku

The Sambagawa metamorphic belt is a typical high-pressur intermediate type metamorphic belt. The Sambagawa metamorphic belt exposed in central Shikoku is tectonostratigraphically represented by the Oboke and structurally overlying Besshi units (Takasu and Dallmeyer, 1990). Oboke unit consists of metamorphic rocks largely derived from clastic protoliths, whereas Besshi unit is dominated by rocks with oceanic affinities (shale, chert and greenstone).

The Sambagawa pelitic schists exposed in central Shikoku hava been divided into four mineral zones, i. e. the chlolite, garnet, albite-biotite and oligoclase-biotite zones

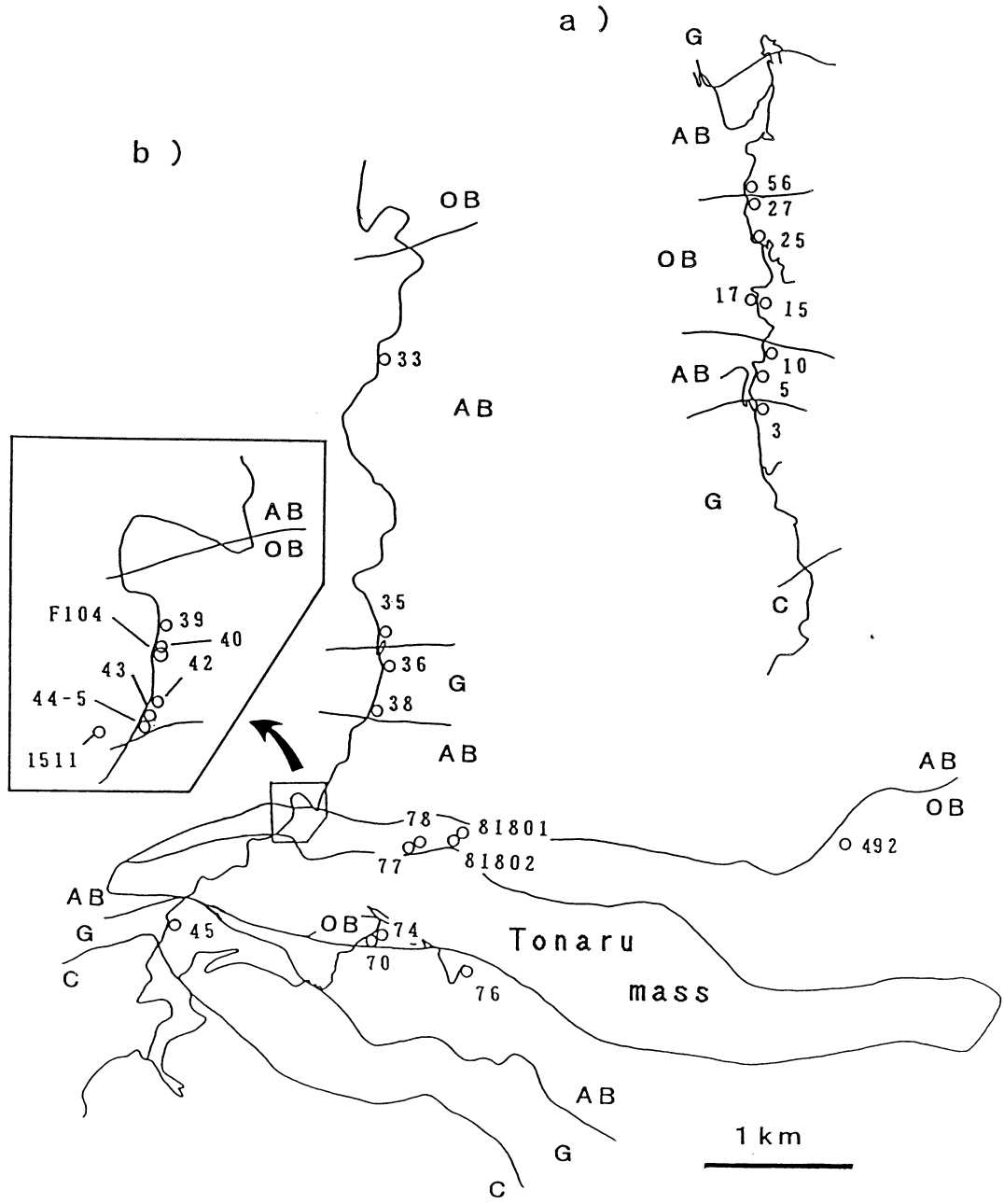

Fig. 2. Localities of anaiyzed sample. **a**) Asemi–gawa district **b**) Besshi district. C, G, AB and OB ; chlorite zone, garnet zone, albite–biotite zone and oligoclase–biotite zone, respectively.

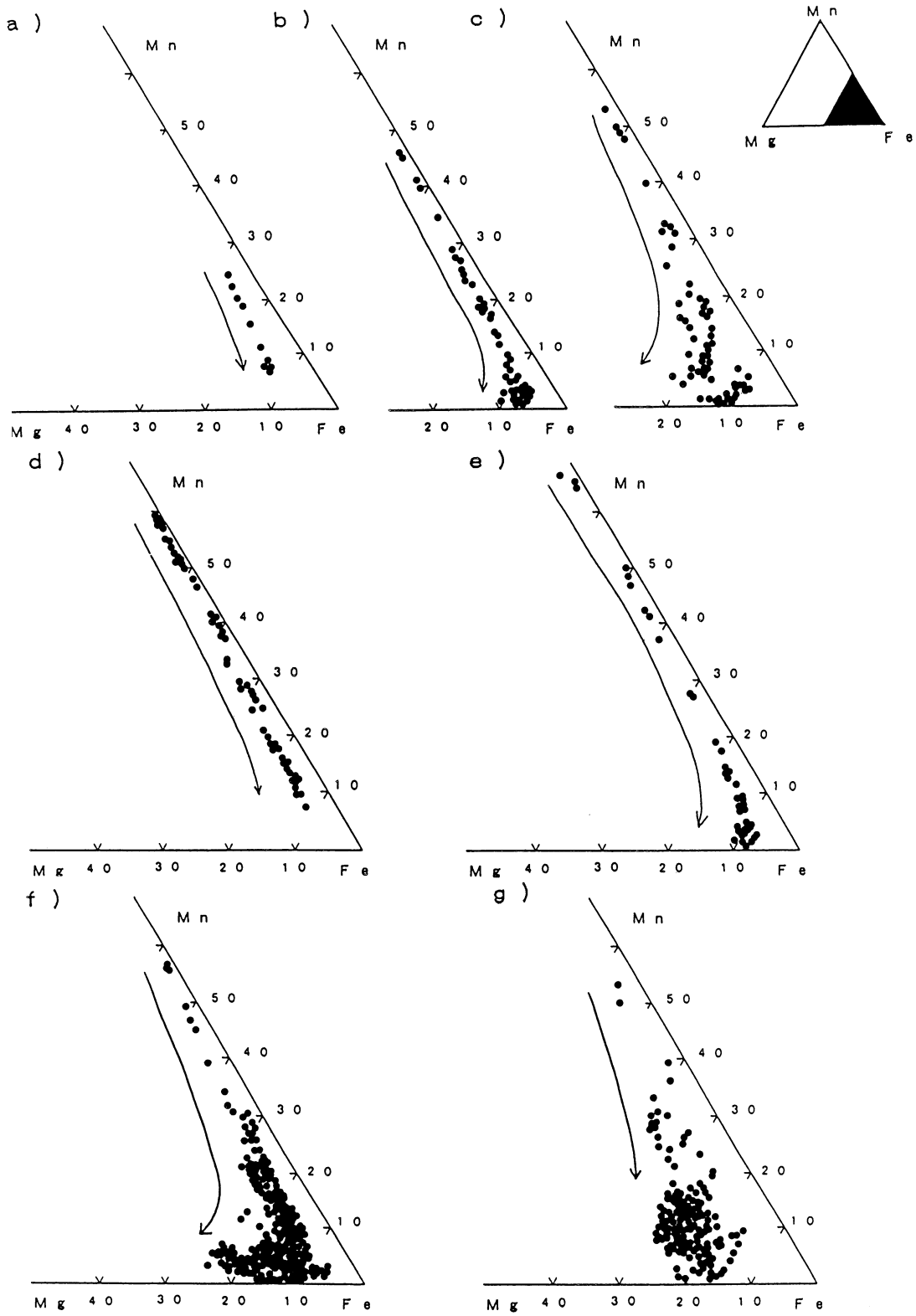

Fig. 3. Cemical compositional trend of garnets in Mn–Fe–Mg diagrams. Arrow shows compositional trend of garnet from core to rim. **a**) Garnet zone in the Asemi–gawa district **b**) Albite–biotite zone in the Asemi–gawa district **c**) Oligoclase–biotite zone in the Asemi–gawa district **d**) Garnet zone in the Besshi district **e**) Albite–biotite zone in the Besshi district **f**) Oligoclase–biotite zone in the Besshi district **g**) Oligoclase–biotite zone in the Besshi district. These chemical compositions are different from those of Banno et al. (1986).

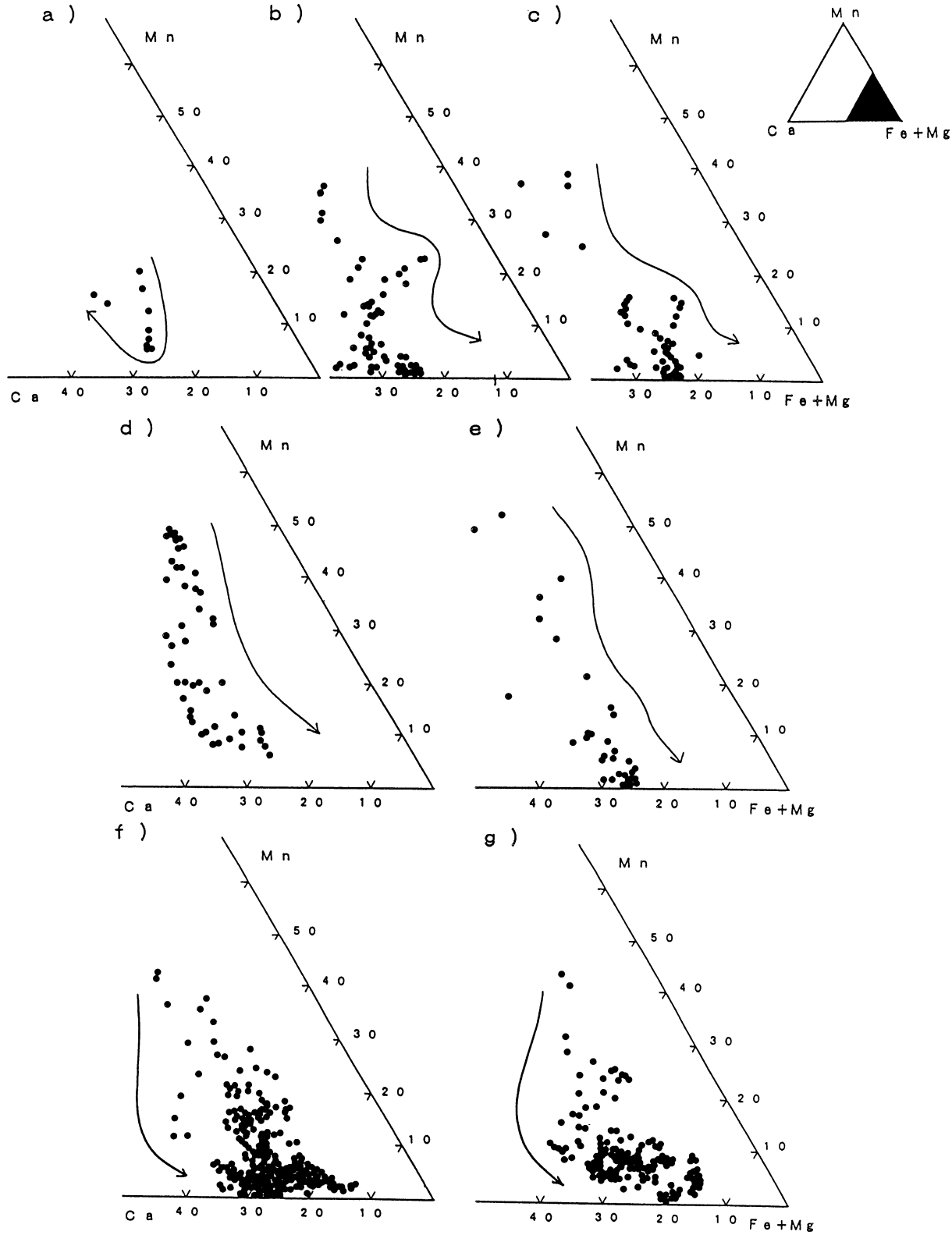

Fig. 4. Chemical compositions of garnets in Mn–(Fe+Mg)–Ca diagrams. Arrow shows compositional trend of garnet from core to rim. **a**) Garnet zone in the Asemi-gawa district **b**) Albite-biotite zone in the Asemi-gawa district **c**) Oligoclase-biotite zone in the Asemi-gawa district **d**) Garnet zone in the Besshi district **e**) Albite-biotite zone in the Besshi district **f**) Oligoclase-biotite zone in the Besshi district **g**) Oligoclase-biotite zone in the Besshi district. These chemical compositions are different from those of Banno et al. (1986).

in ascending order of metamorphic grade (e. g. Higashino, 1990). Several amphibolite and ultramafic masses, which were regarded as the tectonic blocks, occur in the high-grade zones in the Besshi district. According to Takasu(1984, 1986), the Sebadani metagabbro mass, one of the tectonic blocks, gave a contact metamorphism to surrounding Sambagawa schists, and the schists in the contact aureole partly reach the eclogite faces. Takasu and Fujita(1994), Asada et al. (1995) and Shirahata and Hirajima(1995) suggested contact metamorphism around the Tonaru amphibolite mass, a tectonic block emplaced in the oligoclase-biotite zone, according to the zonal texture and the chemistry of the garnets. The study area includes the Asemi-gawa and Besshi districts in central Shikoku. Sample localities are shown in Fig. 2.

Analytical methods

Mineral analyses were made by electron probe microanalyser (JEOL JAX-8800 M) at the Reserch Center for Coastal Lagoon Environments, Shimane University. The accelerating voltage, specimen current and beam diameter were 15 kV, 2 x 10^{-8}A and 10 μm, respectively. Correction procedures follow the methods of Bence and Albee (1968).

Result and discussion

Analytical results are shown in Appendix. Fig. 3 and 4. show the chemical composition of garnets plotted in Mn-Fe-Mg and Mn-(Fe+Mg)-Ca diagrams. Most of the compositional trends in garnets from the Asemi-gawa and Besshi districts are similar to those described by Banno et al. (1986). However, the chemical compositions of some garnets from the oligoclase-biotite zone in the Besshi district are different from those of Banno et al. (1986). They are shifting to Mg-rich side compared with the garnets of Banno et al. (1986). These garnets restrictely occur close to the Tonaru amphibolite mass. Therefore, as already suggested by Takasu and Fujita(1994), Asada et al. (1995) and Shirahata and Hirajima(1995), there is a possibility of thermal influence to garnet zoning due to the emplacement of the Tonaru amphibolite mass.

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* In Japanese with English abstract.

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（要　旨）

ざくろ石は複雑な固溶体であり，変成条件に敏感に反応し，その組成を変化させる．そのため累帯構造を示すざくろ石は変成条件や変成履歴のよい指標となる．

四国中央部の三波川変成帯は低変成度から高変成度へ緑泥石帯，ざくろ石帯，曹長石－黒雲母帯，灰曹長石－黒雲母帯に変成分帯される．ここでは，汗見川地域と別子地域においてざくろ石帯から灰曹長石－黒雲母帯までの泥質片岩中のざくろ石に明瞭な累帯構造がみられる．本論文では，この地域のざくろ石をX線マイクロアナライザーで分析し，それらの化学組成の傾向をBanno et al.（1986）のものと比較した．東平岩体北側の灰曹長石－黒雲母帯の一部にBanno et al.（1986）で示されたMn–Fe–Mg及び，Mn－(Fe+Mg)－Ca三角ダイアグラム上での化学組成と一致しないものがみられたが，他では一致した．一致しないざくろ石は東平岩体に接した場所にのみ分布している．これらのざくろ石は東平岩体が三波川帯へ迸入してきた際の熱の影響下で形成された可能性がある．

Appendix Chemical compositions of garnets in the Asemi-gawa and Besshi districts.

Table 1. Chemical compositions of garnets from the garnet zone in the Asemi-gawa district.

sample no.	3								
grain no.	1-1								
	core								rim
point no.	2	3	4	6	7	9	10	11	12
SiO2	36.81	36.09	36.43	37.33	37.35	36.21	36.73	36.87	36.59
TiO2	0.10	0.07	0.07	0.05	0.08	0.07	0.12	0.08	0.05
Al2O3	20.83	20.99	20.64	20.96	21.03	21.35	21.31	21.14	21.28
FeO	27.08	28.46	28.87	29.36	29.65	29.82	28.96	23.45	25.00
MnO	7.27	5.56	3.97	2.66	2.41	2.42	2.47	7.06	6.18
MgO	0.84	0.96	1.06	1.23	1.25	1.21	1.19	0.76	0.77
CaO	7.10	7.56	8.04	8.80	8.69	8.66	8.95	9.95	9.61
Total	100.03	99.69	99.08	100.39	100.46	99.74	99.73	99.31	99.48
O=12									
Si	2.979	2.937	2.976	2.989	2.988	2.970	2.959	2.977	2.957
Ti	0.006	0.005	0.004	0.003	0.005	0.004	0.007	0.005	0.003
Al	1.987	2.014	1.984	1.978	1.983	2.009	2.023	2.012	2.027
Fe	1.833	1.937	1.969	1.966	1.984	1.910	1.951	1.583	1.690
Mn	0.498	0.384	0.274	0.180	0.163	0.164	0.168	0.483	0.423
Mg	0.102	0.117	0.129	0.147	0.149	0.144	0.142	0.091	0.093
Ca	0.616	0.659	0.703	0.755	0.744	0.741	0.773	0.860	0.833
Total	8.021	8.053	8.039	8.018	8.016	7.942	8.023	8.011	8.026

Table 2. Chemical compositions of garnets from the albite-biotite zone in the Asemi-gawa district.

sample no.	5																			10
grain no.	5-1									5-3										1-1
	core								rim	core									rim	core
point no.	3	5	7	8	9	10	11	12	14	15	17	18	19	20	21	22	24	25	26	2
SiO2	36.28	35.91	36.55	36.78	36.68	36.52	36.76	36.82	37.13	36.30	36.52	36.32	36.49	36.07	36.42	36.35	36.85	36.81	36.70	35.83
TiO2	0.14	0.08	0.12	0.07	0.09	0.06	0.03	0.11	0.08	0.10	0.08	0.12	0.09	0.13	0.14	0.09	0.08	0.10	0.06	0.07
Al2O3	20.14	20.20	20.06	20.49	20.41	20.69	20.47	19.98	20.14	19.86	20.04	20.11	20.23	19.97	19.84	20.06	20.48	20.75	20.10	20.52
FeO	27.59	27.33	27.32	28.95	28.95	28.22	27.19	29.78	32.09	27.06	26.74	26.91	26.92	26.81	26.71	28.43	28.33	27.11	27.67	27.53
MnO	5.68	5.37	4.68	3.18	1.86	0.97	0.99	0.82	0.45	8.79	8.40	6.32	6.31	6.29	6.09	4.41	1.02	0.90	2.74	10.13
MgO	0.61	0.60	0.65	0.74	0.79	0.76	0.76	0.76	1.06	0.58	0.52	0.54	0.58	0.60	0.60	0.70	0.77	0.73	0.49	0.49
CaO	8.61	9.08	9.59	9.57	10.72	11.84	12.77	10.90	9.05	5.89	6.93	8.51	9.27	8.93	8.86	9.26	12.23	12.99	11.16	5.45
Total	99.05	98.57	98.97	99.78	99.50	99.06	98.97	99.17	100.00	98.58	99.23	98.83	99.89	98.80	98.66	99.30	99.76	99.39	98.92	100.02
O=12																				
Si	2.974	2.959	2.988	2.979	2.973	2.962	2.978	2.995	3.007	3.002	2.996	2.982	2.968	2.968	2.993	2.972	2.971	2.967	2.992	2.940
Ti	0.008	0.005	0.007	0.004	0.006	0.004	0.002	0.007	0.005	0.006	0.005	0.008	0.005	0.008	0.008	0.005	0.005	0.006	0.004	0.005
Al	1.946	1.961	1.933	1.956	1.951	1.978	1.954	1.915	1.918	1.936	1.938	1.946	1.940	1.936	1.922	1.933	1.946	1.971	1.931	1.985
Fe	1.891	1.883	1.868	1.961	1.963	1.914	1.842	2.025	2.169	1.871	1.835	1.848	1.831	1.845	1.836	1.944	1.910	1.828	1.886	1.889
Mn	0.394	0.375	0.324	0.218	0.128	0.067	0.068	0.057	0.031	0.616	0.584	0.440	0.435	0.438	0.424	0.305	0.070	0.061	0.189	0.704
Mg	0.075	0.073	0.079	0.089	0.094	0.092	0.091	0.093	0.128	0.071	0.064	0.066	0.070	0.073	0.073	0.085	0.092	0.088	0.060	0.060
Ca	0.756	0.802	0.840	0.830	0.931	1.029	1.108	0.949	0.784	0.522	0.609	0.749	0.808	0.787	0.781	0.811	1.057	1.122	0.975	0.479
Total	8.044	8.058	8.039	8.037	8.046	8.046	8.043	8.041	8.042	8.024	8.031	8.039	8.057	8.055	8.037	8.055	8.051	8.043	8.037	8.062

Table 2. (Continued)

sample no.														56						
grain no.						2								1-1						
					rim	core							rim	core						
point no.	4	24	25	26	27	13	14	15	16	17	18	19	20	2	3	4	5	6	7	8
SiO2	35.59	36.36	36.48	36.23	36.41	36.01	35.91	35.98	36.44	36.25	36.10	36.56	36.36	36.25	36.34	36.63	36.69	36.77	36.39	36.63
TiO2	0.07	0.08	0.04	0.05	0.05	0.08	0.08	0.07	0.09	0.08	0.07	0.10	0.06	0.19	0.18	0.18	0.11	0.04	0.08	0.07
Al2O3	20.06	20.49	20.61	20.48	20.65	20.32	20.24	20.30	20.52	20.55	20.46	20.46	20.54	20.49	20.62	20.54	20.64	20.53	20.55	20.40
FeO	28.99	31.39	31.58	31.19	30.72	24.36	24.49	25.72	30.47	32.02	31.45	31.76	31.12	19.19	19.85	22.17	24.64	27.48	27.98	28.63
MnO	6.98	1.82	0.73	0.42	0.50	10.00	9.42	5.31	0.89	1.07	1.00	0.39	0.33	15.82	14.00	11.74	8.34	3.70	2.45	2.10
MgO	0.56	1.01	1.14	1.23	1.32	0.47	0.45	0.44	0.74	1.08	1.02	1.14	1.30	0.24	0.30	0.36	0.50	0.76	0.93	0.97
CaO	7.80	8.45	9.15	8.96	9.05	7.93	8.25	10.86	10.83	8.33	8.63	8.84	9.16	7.91	8.38	8.46	9.23	10.53	10.58	10.53
Total	100.05	99.60	99.73	98.56	98.70	99.17	98.84	98.68	99.98	99.38	98.73	99.25	98.87	100.09	99.67	100.08	100.15	99.81	98.96	99.33
O=12																				
Si	2.957	2.960	2.959	2.966	2.969	2.957	2.958	2.952	2.950	2.956	2.959	2.974	2.965	2.953	2.961	2.971	2.968	2.973	2.973	2.973
Ti	0.004	0.005	0.002	0.003	0.003	0.005	0.005	0.004	0.005	0.005	0.004	0.006	0.004	0.011	0.011	0.011	0.007	0.002	0.002	0.004
Al	1.965	1.966	1.970	1.976	1.985	1.967	1.965	1.963	1.958	1.975	1.977	1.962	1.974	1.968	1.980	1.964	1.968	1.957	1.957	1.951
Fe	1.875	2.137	2.142	2.135	2.095	1.673	1.687	1.765	2.063	2.184	2.156	2.161	2.122	1.308	1.352	1.505	1.667	1.858	1.858	1.943
Mn	0.491	0.126	0.050	0.029	0.034	0.696	0.657	0.369	0.061	0.074	0.069	0.027	0.023	1.092	0.966	0.807	0.572	0.253	0.253	0.144
Mg	0.069	0.123	0.135	0.150	0.161	0.057	0.056	0.054	0.089	0.130	0.125	0.138	0.158	0.029	0.036	0.043	0.061	0.092	0.092	0.118
Ca	0.694	0.737	0.795	0.786	0.791	0.698	0.728	0.955	0.939	0.728	0.758	0.771	0.801	0.691	0.732	0.736	0.800	0.912	0.912	0.916
Total	8.055	8.054	8.053	8.045	8.038	8.053	8.056	8.062	8.065	8.052	8.048	8.039	8.047	8.052	8.038	8.037	8.043	8.047	8.047	8.049

Table 2. (Continued)

sample no.			
grain no.			
		rim	
point no.	10	11	12
SiO2	37.26	36.96	36.24
TiO2	0.08	0.07	0.20
Al2O3	20.47	20.63	20.46
FeO	30.82	31.12	20.12
MnO	0.71	0.55	13.28
MgO	1.93	1.81	0.32
CaO	8.33	8.31	8.74
Total	99.60	99.45	99.36
O=12			
Si	3.001	2.985	2.961
Ti	0.005	0.004	0.012
Al	1.943	1.964	1.971
Fe	2.076	2.102	1.375
Mn	0.049	0.037	0.919
Mg	0.232	0.217	0.039
Ca	0.718	0.719	0.765
Total	8.024	8.028	8.042

Table 3. Chemical compositions of garnets from the oligoclase-biotite zone in the Asemi-gawa district.

sample no.	15									17										
grain no.	13									2-4		2-1			3-1					
	core								rim			core			core			rim	core	
point no.	20	21	22	23	24	25	26	27	28	1	2	3	6	7	8	9	10	12	15	16
SiO2	36.83	37.26	36.92	36.78	37.46	37.64	38.02	37.77	37.17	36.97	37.02	36.76	37.04	37.71	36.93	36.60	36.95	36.73	37.29	37.17
TiO2	0.06	0.05	0.07	0.08	0.06	0.05	0.07	0.06	0.05	0.10	0.13	0.13	0.11	0.03	0.07	0.08	0.08	0.07	0.05	0.04
Al2O3	20.55	20.59	20.65	20.68	20.78	20.70	20.85	21.03	20.60	20.20	20.35	20.17	20.28	20.33	18.96	20.13	20.09	20.11	20.33	20.49
FeO	27.65	27.51	28.28	28.28	28.66	27.61	28.21	28.27	27.58	24.95	25.15	24.64	27.94	27.98	24.33	23.50	23.71	28.23	28.90	28.72
MnO	6.04	5.79	5.31	4.46	3.05	2.29	0.51	0.50	6.77	9.32	7.60	9.16	3.25	2.33	12.06	11.90	11.15	3.98	2.18	1.86
MgO	1.93	1.90	1.87	1.90	1.81	1.96	2.42	2.71	1.78	1.03	0.88	1.53	2.34	2.49	0.73	0.82	0.93	1.59	2.37	3.41
CaO	5.60	5.69	6.09	6.53	7.41	8.63	8.55	8.52	5.80	6.47	7.94	6.28	7.84	7.70	5.42	5.63	7.05	8.01	7.44	6.82
Total	98.66	98.79	99.19	98.71	99.23	98.88	98.63	98.86	99.75	99.04	99.07	98.67	98.80	98.57	98.50	98.66	98.96	98.72	98.56	98.51
O=12																				
Si	3.003	3.024	2.995	2.994	3.018	3.028	3.042	3.021	3.004	3.017	3.009	3.006	3.001	3.042	3.021	3.010	3.018	2.997	3.022	3.001
Ti	0.003	0.003	0.004	0.005	0.003	0.003	0.004	0.004	0.003	0.006	0.008	0.008	0.007	0.002	0.004	0.005	0.005	0.004	0.003	0.003
Al	1.975	1.976	1.975	1.984	1.973	1.963	1.976	1.983	1.962	1.943	1.949	1.944	1.937	1.933	1.924	1.951	1.984	1.934	1.941	1.950
Fe	1.885	1.868	1.919	1.919	1.931	1.858	1.888	1.891	1.864	1.703	1.709	1.685	1.893	1.888	1.664	1.616	1.620	1.926	1.958	1.940
Mn	0.417	0.398	0.365	0.307	0.208	0.156	0.034	0.034	0.464	0.645	0.523	0.635	0.223	0.159	0.835	0.829	0.702	0.275	0.149	0.127
Mg	0.235	0.230	0.227	0.231	0.218	0.235	0.289	0.323	0.214	0.126	0.119	0.187	0.282	0.300	0.089	0.101	0.114	0.194	0.286	0.410
Ca	0.489	0.495	0.529	0.569	0.640	0.744	0.733	0.730	0.502	0.566	0.691	0.550	0.680	0.666	0.475	0.497	0.617	0.701	0.646	0.590
Total	8.007	7.994	8.014	8.009	7.991	7.987	7.966	7.986	8.013	8.006	8.008	8.015	8.023	7.990	8.012	8.009	8.060	8.031	8.005	8.021

Table 3. (Continued)

sample no.												25								
grain no.		3-3										1-1								
	rim	core					rim	core			rim	core								
point no.	17	4	7	8	9	11	12	17	19	20	21	2	3	4	5	7	8	9	10	11
SiO2	37.46	36.90	37.00	36.64	37.33	37.37	37.39	36.61	37.04	37.17	37.21	37.53	37.03	37.32	37.06	37.47	37.84	37.55	37.98	37.80
TiO2	0.04	0.06	0.06	0.08	0.08	0.07	0.06	0.12	0.08	0.11	0.06	0.28	0.11	0.10	0.11	0.15	0.10	0.10	0.13	0.09
Al2O3	20.57	20.62	20.70	20.51	20.49	20.45	20.74	20.55	20.36	20.76	20.80	20.63	20.44	20.60	20.63	20.50	20.60	20.93	20.63	20.62
FeO	29.51	25.77	26.30	27.94	27.95	28.57	29.77	25.75	26.79	28.64	28.57	14.74	17.79	28.52	27.87	29.40	29.78	30.64	30.48	31.09
MnO	1.37	5.84	4.53	3.95	3.51	2.69	1.80	6.57	4.20	2.18	2.01	14.38	11.98	1.59	0.93	0.97	1.26	1.31	1.13	0.83
MgO	3.16	0.99	1.10	1.44	1.63	1.77	1.99	0.93	1.27	2.10	2.17	0.33	0.46	0.83	0.95	1.13	1.31	1.40	1.46	1.56
CaO	6.76	8.73	9.29	8.03	7.89	7.79	7.81	8.51	8.77	7.84	7.73	11.06	10.82	10.27	11.05	9.15	8.25	7.51	7.44	7.54
Total	98.87	98.91	98.98	98.59	98.88	98.71	99.56	99.04	98.51	98.80	98.55	98.95	98.63	99.23	98.60	98.77	99.14	99.44	99.25	99.53
O=12																				
Si	3.015	2.999	2.997	2.988	3.022	3.027	3.006	2.982	3.015	3.003	3.009	3.027	3.009	3.013	3.002	3.032	3.047	3.022	3.055	3.038
Ti	0.002	0.004	0.004	0.005	0.005	0.004	0.004	0.007	0.005	0.007	0.003	0.017	0.007	0.006	0.007	0.009	0.006	0.006	0.008	0.006
Al	1.951	1.975	1.977	1.972	1.955	1.953	1.965	1.973	1.953	1.977	1.982	1.961	1.958	1.960	1.970	1.955	1.955	1.985	1.956	1.953
Fe	1.986	1.751	1.782	1.906	1.892	1.936	2.001	1.754	1.824	1.935	1.932	0.994	1.209	1.926	1.888	1.990	2.006	2.062	2.050	2.090
Mn	0.093	0.402	0.311	0.273	0.241	0.185	0.123	0.453	0.290	0.149	0.138	0.982	0.825	0.108	0.064	0.066	0.086	0.090	0.077	0.057
Mg	0.379	0.119	0.133	0.175	0.196	0.214	0.239	0.113	0.154	0.253	0.262	0.040	0.056	0.100	0.115	0.136	0.157	0.168	0.175	0.187
Ca	0.583	0.760	0.807	0.702	0.684	0.676	0.673	0.742	0.765	0.678	0.670	0.956	0.942	0.888	0.959	0.793	0.712	0.648	0.641	0.650
Total	8.009	8.010	8.011	8.021	7.995	7.995	8.011	8.024	8.006	8.002	7.996	7.977	8.006	8.001	8.005	7.981	7.969	7.981	7.962	7.981

Table 3. (Continued)

sample no.					27		
grain no.					1-6		
					rim	core	
point no.	12	13	14	15	16	1	6
SiO2	37.71	38.06	37.94	37.88	37.86	36.93	37.57
TiO2	0.09	0.09	0.09	0.08	0.12	0.18	0.08
Al2O3	20.81	20.82	20.93	20.85	20.87	20.34	21.07
FeO	30.47	30.89	29.84	29.46	29.65	16.80	29.04
MnO	0.58	0.43	0.36	0.28	0.34	16.85	0.79
MgO	1.66	1.75	1.87	2.16	2.21	0.37	1.77
CaO	7.91	7.69	8.68	8.19	8.04	7.23	8.31
Total	99.23	99.73	99.71	98.90	99.09	98.70	98.63
O=12							
Si	3.032	3.042	3.028	3.038	3.033	3.021	3.026
Ti	0.005	0.006	0.005	0.005	0.007	0.011	0.005
Al	1.972	1.962	1.969	1.971	1.971	1.961	2.000
Fe	2.049	2.065	1.992	1.976	1.987	1.149	1.956
Mn	0.040	0.029	0.024	0.019	0.023	1.168	0.054
Mg	0.199	0.208	0.223	0.258	0.264	0.045	0.213
Ca	0.682	0.659	0.742	0.704	0.690	0.633	0.717
Total	7.979	7.971	7.983	7.971	7.975	7.988	7.971

Table 4. Chemical compositions of garnets from the garnet zone in the Besshi district.

sample no.	36						38											45		
grain no.	1-1	7-1					2-1				2-2							4		
	core	core					core			rim	core						rim	core		
point no.	1	13	14	15	16	17	1	2	3	6	7	8	9	10	11	12	13	2	3	4
SiO2	36.34	36.58	36.47	36.00	36.17	36.60	36.66	36.68	36.66	36.73	36.25	36.04	36.99	36.84	37.02	36.39	36.73	36.30	36.57	36.95
TiO2	0.20	0.13	0.18	0.17	0.17	0.10	0.17	0.17	0.16	0.10	0.14	0.12	0.15	0.08	0.11	0.05	0.08	0.11	0.04	0.12
Al2O3	20.67	20.70	20.69	20.79	20.79	20.74	20.53	20.61	21.07	20.59	20.57	20.78	20.78	20.93	20.82	20.86	20.48	20.18	20.32	20.30
FeO	15.07	14.69	14.52	14.58	15.49	15.96	15.02	15.88	17.79	23.72	14.88	15.77	18.72	19.76	21.54	23.44	26.04	17.07	19.58	22.69
MnO	21.31	20.41	21.12	20.74	20.80	17.31	20.63	19.89	17.92	8.76	20.61	19.56	16.26	14.33	13.40	9.73	5.85	18.58	11.97	8.93
MgO	0.20	0.24	0.21	0.22	0.23	0.37	0.24	0.29	0.29	0.56	0.22	0.24	0.33	0.32	0.36	0.53	0.67	0.28	0.44	0.47
CaO	6.50	6.48	6.30	6.87	6.44	8.32	6.42	6.26	6.58	8.18	6.29	6.53	6.89	7.52	7.21	7.81	8.88	7.31	10.34	9.89
Total	100.29	99.23	99.49	99.37	100.09	99.40	99.67	99.78	100.47	98.64	98.96	99.04	100.12	99.78	100.46	98.81	98.73	99.83	99.26	99.35
O=12																				
Si	2.957	2.990	2.979	2.950	2.950	2.978	2.990	2.988	2.965	3.001	2.979	2.960	2.994	2.987	2.989	2.976	2.997	2.970	2.978	3.000
Ti	0.012	0.008	0.011	0.010	0.010	0.006	0.010	0.010	0.001	0.006	0.009	0.007	0.009	0.005	0.007	0.003	0.005	0.007	0.002	0.007
Al	1.983	1.994	1.993	2.008	1.998	1.989	1.973	1.979	2.009	1.983	1.992	2.012	1.983	2.000	1.981	2.011	1.970	1.945	1.950	1.943
Fe	1.026	1.004	0.992	0.999	1.056	1.086	1.025	1.082	1.203	1.621	1.023	1.083	1.267	1.340	1.455	1.603	1.778	1.168	1.333	1.541
Mn	1.469	1.413	1.461	1.440	1.437	1.193	1.426	1.372	1.228	0.606	1.434	1.361	1.115	0.984	0.916	0.674	0.404	1.288	0.826	0.614
Mg	0.025	0.029	0.025	0.027	0.028	0.045	0.027	0.035	0.036	0.068	0.027	0.029	0.040	0.039	0.043	0.064	0.082	0.034	0.054	0.057
Ca	0.567	0.567	0.552	0.603	0.563	0.725	0.561	0.547	0.571	0.717	0.554	0.575	0.598	0.653	0.623	0.684	0.776	0.641	0.902	0.861
Total	8.039	8.005	8.013	8.037	8.042	8.022	8.012	8.013	8.013	8.002	8.018	8.027	8.006	8.008	8.014	8.015	8.012	8.053	8.045	8.023

Table 4. (Continued)

sample no.											
grain no.				7							
			rim	core							rim
point no.	5	7	8	1	2	4	5	6	7	8	9
SiO2	37.30	36.93	36.76	36.52	36.14	36.45	36.48	36.82	36.44	36.44	36.05
TiO2	0.08	0.16	0.10	0.21	0.14	0.07	0.09	0.10	0.09	0.11	0.10
Al2O3	20.52	20.30	20.32	20.57	20.73	20.89	20.85	20.71	20.67	20.53	20.75
FeO	22.55	27.22	28.54	16.06	17.00	19.52	20.45	23.68	28.36	29.43	29.30
MnO	8.65	4.50	4.86	19.10	18.49	13.72	12.45	8.20	3.39	4.56	3.54
MgO	0.45	0.75	0.83	0.27	0.30	0.39	0.39	0.46	0.79	0.75	0.82
CaO	10.41	9.15	7.92	7.49	7.04	9.07	9.55	9.70	9.73	8.20	8.10
Total	99.96	99.01	99.33	100.22	99.84	100.11	100.26	99.67	99.47	100.02	98.66
O=12											
Si	3.004	3.005	2.995	2.966	2.950	2.951	2.950	2.981	2.960	2.960	2.956
Ti	0.005	0.010	0.006	0.013	0.009	0.004	0.006	0.006	0.006	0.007	0.006
Al	1.948	1.947	1.951	1.969	1.994	1.994	1.987	1.976	1.979	1.966	2.006
Fe	1.519	1.852	1.945	1.091	1.161	1.322	1.383	1.603	1.926	2.000	2.010
Mn	0.590	0.310	0.336	1.314	1.279	0.941	0.853	0.562	0.233	0.314	0.246
Mg	0.054	0.091	0.101	0.033	0.037	0.047	0.047	0.055	0.095	0.091	0.100
Ca	0.898	0.797	0.691	0.652	0.616	0.787	0.827	0.842	0.846	0.713	0.711
Total	8.018	8.012	8.025	8.038	8.046	8.046	8.053	8.025	8.045	8.051	8.035

Table 5. Chemical compositions of garnets from the albite-biotite zone in the Besshi district.

sample no.	33				35						76									
grain no.	1-1				2-1		6-1				5-1									
				rim			core			rim	core									rim
point no.	19	20	22	25	5	15	17	19	20	21	1	2	4	5	7	8	9	10	11	12
SiO2	37.84	36.04	36.38	36.34	37.16	37.01	37.26	37.24	37.36	37.13	35.94	36.27	36.14	36.61	36.56	36.75	36.20	36.09	36.19	36.56
TiO2	0.13	0.11	0.10	0.12	0.12	0.10	0.10	0.10	0.07	0.04	0.08	0.20	0.12	0.09	0.10	0.05	0.07	0.08	0.06	0.02
Al2O3	19.89	20.27	20.50	20.54	20.84	20.83	20.95	21.08	21.08	21.19	20.41	20.18	20.32	20.53	20.40	20.44	20.40	20.39	20.51	20.51
FeO	26.94	27.27	28.86	30.32	27.60	27.90	31.18	31.00	30.74	30.30	18.56	18.42	21.26	26.59	29.60	30.81	31.22	31.34	30.85	31.08
MnO	4.50	4.37	2.49	0.82	6.67	6.02	1.62	1.07	0.94	0.91	17.45	16.34	12.82	3.98	2.62	1.39	0.37	0.27	0.34	0.63
MgO	0.75	0.68	0.80	1.02	0.57	0.63	1.07	1.21	1.33	1.45	0.38	0.35	0.47	0.76	0.99	1.06	1.28	1.45	1.57	1.85
CaO	9.54	9.92	9.69	9.76	7.44	7.66	8.31	8.65	8.95	8.74	5.92	8.04	8.43	10.81	9.10	9.45	9.42	9.17	9.08	8.64
Total	99.59	98.66	98.82	98.92	100.40	100.15	100.49	100.35	100.47	99.76	98.74	99.80	99.56	99.37	99.37	99.95	98.96	98.79	98.60	99.29
O=12																				
Si	3.053	2.958	2.970	2.962	2.994	2.989	2.988	2.983	2.985	2.981	2.969	2.963	2.955	2.969	2.974	2.973	2.955	2.951	2.956	2.965
Ti	0.008	0.007	0.006	0.007	0.007	0.006	0.006	0.006	0.004	0.003	0.005	0.012	0.008	0.005	0.006	0.003	0.004	0.005	0.004	0.001
Al	1.892	1.960	1.973	1.974	1.980	1.983	1.980	1.990	1.986	2.006	1.987	1.943	1.958	1.962	1.955	1.948	1.963	1.965	1.975	1.961
Fe	1.819	1.872	1.971	2.067	1.861	1.885	2.091	2.077	2.054	2.035	1.282	1.258	1.454	1.804	2.014	2.084	2.132	2.143	2.108	2.109
Mn	0.308	0.304	0.172	0.057	0.456	0.412	0.110	0.073	0.064	0.062	1.221	1.131	0.888	0.273	0.180	0.095	0.026	0.019	0.024	0.043
Mg	0.090	0.083	0.098	0.124	0.069	0.076	0.128	0.145	0.158	0.174	0.045	0.043	0.058	0.092	0.120	0.128	0.156	0.177	0.191	0.223
Ca	0.824	0.873	0.848	0.853	0.642	0.663	0.714	0.743	0.767	0.752	0.524	0.704	0.739	0.939	0.793	0.819	0.824	0.804	0.795	0.751
Total	7.994	8.057	8.038	8.044	8.009	8.014	8.017	8.017	8.018	8.013	8.033	8.054	8.060	8.044	8.042	8.050	8.060	8.064	8.053	8.053

Table 6. Chemical compositions of garnets from the oligoclase-biotite zone in the Besshi district.

sample no.	39																			
grain no.	1-1	3-1						3-3				3-1					2-1			
		core				rim											core			
point no.	9	14	19	25	28	29	31	34	35	37	40	42	43	44	45	46	3	5	8	9
SiO2	37.01	36.31	37.50	37.29	37.01	37.51	37.51	37.57	37.58	38.02	37.64	37.50	37.27	37.47	36.84	37.18	36.50	36.62	37.17	37.23
TiO2	0.88	0.00	0.02	0.08	0.01	0.05	0.04	0.06	0.10	0.09	0.03	0.04	0.04	0.07	0.06	0.09	0.06	0.02	0.05	0.04
Al2O3	20.45	19.91	20.56	20.16	20.47	20.67	20.98	20.77	20.69	20.87	20.71	20.45	20.67	20.70	20.09	20.38	20.47	20.52	20.68	20.80
FeO	27.11	28.01	26.70	28.22	27.90	27.83	26.88	27.76	27.19	26.28	26.89	27.84	26.84	27.44	28.41	27.84	28.16	26.69	26.29	27.64
MnO	2.08	8.11	1.65	2.66	1.98	2.00	1.90	2.14	1.22	1.89	1.94	1.17	1.43	2.05	6.64	0.92	7.25	7.06	5.65	3.52
MgO	1.76	1.25	3.17	1.38	3.99	3.74	3.81	3.45	2.34	3.61	3.43	1.94	2.81	3.74	1.42	2.00	1.42	1.31	1.35	1.45
CaO	9.64	5.04	8.99	9.08	7.19	7.29	7.68	6.88	10.35	8.77	8.51	9.58	9.78	7.41	5.27	10.12	5.38	6.29	7.82	8.37
Total	98.93	98.63	98.59	98.87	98.55	99.09	98.80	98.63	99.47	99.53	99.15	98.52	98.84	98.88	98.73	98.53	99.24	98.51	99.01	99.05
O=12																				
Si	2.983	2.997	3.011	3.025	2.986	3.004	2.994	3.016	3.001	3.013	3.009	3.026	2.992	3.000	3.019	3.006	2.983	2.999	3.010	3.008
Ti	0.053	0.000	0.001	0.005	0.001	0.003	0.002	0.003	0.006	0.005	0.002	0.002	0.002	0.004	0.004	0.005	0.003	0.001	0.003	0.003
Al	1.942	1.937	1.946	1.928	1.947	1.951	1.974	1.966	1.948	1.948	1.951	1.945	1.957	1.954	1.941	1.943	1.972	1.981	1.975	1.981
Fe	1.827	1.934	1.793	1.914	1.883	1.851	1.795	1.864	1.817	1.742	1.783	1.879	1.802	1.838	1.947	1.883	1.924	1.827	1.781	1.867
Mn	0.142	0.567	0.112	0.183	0.135	0.136	0.128	0.145	0.083	0.127	0.132	0.080	0.097	0.140	0.461	0.063	0.502	0.490	0.387	0.241
Mg	0.212	0.154	0.379	0.166	0.468	0.447	0.465	0.413	0.279	0.427	0.408	0.238	0.336	0.447	0.173	0.241	0.173	0.160	0.163	0.175
Ca	0.833	0.446	0.773	0.795	0.621	0.626	0.657	0.591	0.886	0.745	0.729	0.828	0.841	0.636	0.462	0.877	0.471	0.552	0.679	0.725
Total	7.992	8.035	8.015	8.016	8.041	8.018	8.015	7.998	8.020	8.007	8.014	7.998	8.027	8.019	8.007	8.018	8.028	8.010	7.998	8.000

Table 6. (Continued)

sample no.																		40		
grain no.																		1-1		
							rim	core									rim	core		
point no.	10	12	13	15	16	17	19	20	22	23	24	25	26	27	29	31	32	1	2	3
SiO2	37.03	37.44	37.21	37.47	37.59	37.51	37.92	37.13	36.76	37.38	37.39	37.79	37.66	37.42	37.45	37.55	38.21	36.86	36.78	37.12
TiO2	0.07	0.07	0.06	0.05	0.06	0.04	0.00	0.01	0.01	0.05	0.02	0.05	0.06	0.07	0.05	0.03	0.00	0.03	0.02	0.09
Al2O3	20.92	20.53	20.70	20.58	20.72	21.15	21.13	20.40	20.52	20.70	20.77	20.81	20.96	21.31	21.33	21.16	21.54	20.40	20.43	20.68
FeO	28.48	28.41	28.95	28.31	27.68	27.45	27.85	25.98	25.81	27.79	27.62	27.92	28.33	27.10	27.65	26.53	26.45	26.05	25.29	26.39
MnO	2.25	1.94	1.22	0.94	0.85	0.97	1.97	6.11	6.26	2.60	1.89	1.34	0.82	0.89	1.77	1.78	1.91	7.53	7.30	5.88
MgO	1.63	1.70	1.60	1.64	1.67	2.05	3.61	1.18	1.25	1.66	1.85	1.99	1.99	2.12	3.73	3.95	3.79	1.65	1.14	1.18
CaO	8.74	8.87	9.17	9.68	9.98	10.22	7.06	7.92	7.99	8.79	9.43	9.33	9.61	10.10	7.37	7.54	7.77	7.11	7.98	8.41
Total	99.12	98.96	98.91	98.67	98.55	99.39	99.54	98.73	98.60	98.97	98.97	99.23	99.43	99.01	99.35	98.54	99.67	99.63	98.94	99.75
O=12																				
Si	2.989	3.021	3.006	3.024	3.028	2.996	3.012	3.021	2.999	3.015	3.010	3.026	3.011	2.993	2.981	2.999	3.013	2.987	2.996	2.994
Ti	0.004	0.004	0.003	0.003	0.004	0.002	0.000	0.001	0.001	0.003	0.001	0.003	0.004	0.004	0.003	0.002	0.000	0.002	0.001	0.005
Al	1.990	1.952	1.970	1.958	1.967	1.991	1.978	1.956	1.973	1.968	1.970	1.964	1.975	2.009	2.001	1.992	2.002	1.949	1.962	1.966
Fe	1.923	1.918	1.956	1.911	1.865	1.834	1.850	1.768	1.761	1.875	1.860	1.869	1.894	1.813	1.841	1.772	1.744	1.766	1.723	1.781
Mn	0.154	0.133	0.084	0.064	0.058	0.066	0.133	0.421	0.432	0.177	0.129	0.091	0.056	0.061	0.119	0.121	0.128	0.517	0.504	0.402
Mg	0.196	0.204	0.193	0.198	0.201	0.244	0.427	0.144	0.152	0.199	0.222	0.237	0.237	0.253	0.442	0.471	0.455	0.200	0.138	0.142
Ca	0.756	0.767	0.794	0.837	0.862	0.875	0.601	0.691	0.698	0.760	0.813	0.800	0.823	0.865	0.628	0.646	0.656	0.617	0.697	0.727
Total	8.012	7.999	8.006	7.995	7.985	8.008	8.001	8.002	8.016	7.997	8.005	7.990	8.000	7.998	8.015	8.003	7.988	8.038	8.021	8.017

Table 6. (Continued)

sample no.																				
grain no.									3-1											
									rim	core										rim
point no.	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	22	23	24
SiO2	37.26	37.04	37.05	37.49	37.61	37.30	37.20	37.05	37.68	36.25	36.18	36.57	36.62	36.64	36.73	37.13	36.87	37.08	37.12	37.09
TiO2	0.02	0.06	0.05	0.11	0.06	0.09	0.07	0.10	0.04	0.12	0.08	0.09	0.06	0.13	0.09	0.09	0.08	0.04	0.03	0.02
Al2O3	20.35	20.67	20.71	20.70	20.76	20.87	21.01	20.94	21.11	20.32	20.56	20.68	20.43	20.30	20.45	20.57	20.77	20.74	20.90	20.70
FeO	27.20	27.71	28.71	29.83	30.35	29.13	29.97	30.14	29.67	21.62	24.10	26.19	27.03	27.56	27.95	29.79	30.54	30.30	30.52	29.98
MnO	5.24	3.78	2.58	2.03	1.66	1.23	1.21	1.19	1.59	11.92	8.93	7.07	5.52	4.86	3.83	2.51	1.47	1.14	1.12	0.57
MgO	1.19	1.38	2.01	2.36	2.79	2.99	3.84	3.98	3.75	1.22	1.64	1.27	0.98	1.06	1.14	1.36	1.74	2.03	3.53	3.40
CaO	8.89	9.57	8.45	7.64	7.20	8.55	6.25	6.58	6.04	7.13	7.01	7.82	8.40	9.14	8.85	8.59	7.91	8.30	6.35	7.06
Total	100.15	100.21	99.56	100.16	100.43	100.16	99.55	99.98	99.88	98.58	98.50	99.69	99.04	99.69	99.04	100.04	99.38	99.63	99.57	98.82
O=12																				
Si	3.001	2.975	2.983	2.998	2.995	2.971	2.973	2.955	2.996	2.975	2.963	2.905	2.986	2.973	2.987	2.990	2.981	2.984	2.974	2.987
Ti	0.001	0.004	0.003	0.006	0.004	0.005	0.004	0.006	0.002	0.007	0.005	0.005	0.004	0.008	0.006	0.005	0.005	0.003	0.002	0.002
Al	1.931	1.957	1.965	1.950	1.949	1.959	1.979	1.868	1.978	1.965	1.985	1.976	1.963	1.941	1.960	1.952	1.978	1.967	1.974	1.965
Fe	1.832	1.861	1.933	1.994	2.021	1.940	2.003	2.010	1.973	1.484	1.651	1.776	1.843	1.870	1.901	2.006	2.065	2.039	2.045	2.019
Mn	0.357	0.257	0.176	0.137	0.112	0.083	0.082	0.081	0.107	0.829	0.619	0.485	0.381	0.334	0.264	0.171	0.100	0.078	0.076	0.039
Mg	0.143	0.165	0.242	0.281	0.331	0.355	0.457	0.474	0.445	0.149	0.200	0.154	0.119	0.128	0.138	0.164	0.210	0.244	0.422	0.408
Ca	0.767	0.824	0.729	0.654	0.615	0.730	0.535	0.562	0.514	0.627	0.615	0.680	0.734	0.795	0.771	0.741	0.685	0.716	0.545	0.609
Total	8.032	8.043	8.031	8.020	8.027	8.043	8.033	7.956	8.015	8.036	8.038	7.981	8.030	8.049	8.027	8.029	8.024	8.031	8.038	8.029

Table 6. (Continued)

sample no.													42							
grain no.	9-1												2							
	core											rim	core							
point no.	28	29	30	31	32	33	34	35	36	37	38	39	2	3	4	5	6	7	8	9
SiO2	36.93	36.58	36.66	36.77	36.80	36.40	36.86	37.65	36.76	37.42	37.45	37.69	36.36	36.31	37.01	37.07	37.41	36.91	37.21	36.85
TiO2	0.08	0.07	0.13	0.11	0.08	0.06	0.07	0.06	0.10	0.09	0.05	0.00	0.06	0.01	0.03	0.06	0.09	0.05	0.06	0.04
Al2O3	20.50	20.45	20.52	20.24	20.45	20.18	20.36	20.60	20.48	20.65	20.97	21.20	20.22	20.48	20.71	20.91	21.03	20.67	20.78	20.86
FeO	20.30	20.93	22.24	24.10	25.04	26.79	29.86	30.64	30.78	30.38	29.39	29.02	25.80	26.46	27.98	28.11	28.94	29.73	28.91	28.68
MnO	15.05	13.21	11.97	9.68	7.04	6.48	4.72	3.29	2.17	1.38	0.87	1.18	10.40	10.05	7.50	4.74	2.87	1.69	0.81	0.95
MgO	0.60	0.63	0.71	0.78	0.91	1.07	1.46	1.56	1.57	1.74	3.11	3.89	0.81	0.87	0.99	1.08	1.22	1.38	1.85	2.13
CaO	6.76	7.45	7.68	8.01	8.41	7.73	5.73	6.70	7.49	7.98	7.26	6.53	5.19	4.90	5.97	7.73	8.51	8.85	9.69	9.63
Total	100.22	99.32	99.91	99.69	98.73	98.71	99.06	100.50	99.35	99.64	99.10	99.51	98.84	99.08	100.19	99.70	100.07	99.28	99.31	99.14
O=12																				
Si	2.993	2.985	2.976	2.990	3.001	2.985	3.007	3.018	2.984	3.010	3.001	2.997	2.994	2.984	2.995	2.994	2.999	2.987	2.992	2.970
Ti	0.005	0.004	0.008	0.007	0.005	0.004	0.005	0.004	0.006	0.005	0.003	0.000	0.004	0.001	0.002	0.003	0.005	0.003	0.003	0.003
Al	1.958	1.967	1.963	1.940	1.966	1.951	1.957	1.946	1.960	1.957	1.980	1.986	1.963	1.984	1.975	1.990	1.987	1.972	1.969	1.981
Fe	1.376	1.428	1.510	1.639	1.708	1.837	2.037	2.054	2.090	2.044	1.969	1.930	1.777	1.818	1.894	1.898	1.940	2.012	1.944	1.933
Mn	1.033	0.913	0.823	0.667	0.486	0.45	0.326	0.223	0.149	0.094	0.059	0.080	0.725	0.699	0.514	0.324	0.195	0.116	0.055	0.065
Mg	0.073	0.077	0.085	0.095	0.111	0.131	0.178	0.186	0.190	0.209	0.372	0.461	0.099	0.106	0.120	0.130	0.146	0.166	0.222	0.255
Ca	0.587	0.652	0.668	0.698	0.735	0.68	0.501	0.575	0.651	0.687	0.623	0.557	0.458	0.432	0.518	0.669	0.731	0.768	0.835	0.831
Total	8.025	8.026	8.033	8.036	8.012	8.038	8.011	8.006	8.030	8.006	8.007	8.011	8.020	8.024	8.018	8.008	8.003	8.024	8.020	8.038

Table 6. (Continued)

sample no.					43															
grain no.					4-1															
				rim	core															
point no.	10	11	12	13	1	2	3	4	5	7	8	9	10	11	17	27	28	29	32	33
SiO2	37.61	37.64	38.15	37.93	36.85	37.41	37.41	36.93	37.40	37.12	37.20	37.25	37.05	36.87	37.46	36.75	36.89	37.13	37.28	37.43
TiO2	0.03	0.04	0.07	0.00	0.09	0.09	0.10	0.07	0.07	0.06	0.07	0.05	0.05	0.10	0.06	0.08	0.07	0.10	0.08	0.05
Al2O3	20.94	20.94	21.25	21.29	20.71	20.69	20.70	20.36	20.38	20.70	20.65	20.60	20.78	20.75	20.89	20.73	20.87	20.69	20.68	20.94
FeO	27.09	28.04	27.57	27.27	24.30	24.47	25.03	27.87	28.70	29.26	29.34	29.44	30.41	31.30	31.86	28.65	28.35	28.32	28.19	28.87
MnO	1.36	0.83	1.04	1.27	8.78	6.96	6.27	4.76	2.99	1.96	1.64	1.44	1.21	1.19	0.97	3.18	2.66	2.31	1.88	1.72
MgO	3.50	1.94	2.62	3.46	0.79	0.77	0.84	1.10	1.51	2.05	2.06	2.63	3.06	3.21	3.72	1.77	2.10	1.97	2.33	2.47
CaO	8.49	9.72	9.55	7.93	7.60	8.51	9.08	7.71	7.90	8.12	7.79	7.53	6.06	5.11	4.33	7.72	7.94	8.24	8.08	7.95
Total	99.02	99.15	100.25	99.15	99.12	98.90	99.43	98.80	98.95	99.27	98.75	98.94	98.62	98.53	99.29	98.88	98.88	98.76	98.52	99.43
O=12																				
Si	3.002	3.015	3.011	3.014	2.997	3.030	3.017	3.011	3.029	2.993	3.009	3.003	2.995	2.990	3.005	2.983	2.983	3.003	3.012	2.999
Ti	0.002	0.002	0.004	0.000	0.006	0.006	0.006	0.004	0.004	0.003	0.004	0.003	0.003	0.006	0.004	0.005	0.004	0.006	0.005	0.003
Al	1.967	1.977	1.977	1.994	1.986	1.975	1.968	1.956	1.945	1.968	1.958	1.958	1.980	1.983	1.975	1.983	1.990	1.972	1.969	1.978
Fe	1.808	1.878	1.820	1.812	1.653	1.657	1.688	1.900	1.944	1.973	1.985	1.985	2.056	2.122	2.138	1.945	1.917	1.916	1.905	1.935
Mn	0.092	0.057	0.070	0.085	0.605	0.478	0.428	0.329	0.205	0.134	0.113	0.098	0.083	0.082	0.066	0.218	0.182	0.158	0.128	0.117
Mg	0.416	0.231	0.308	0.410	0.096	0.093	0.101	0.134	0.182	0.246	0.248	0.316	0.369	0.388	0.445	0.214	0.253	0.237	0.280	0.295
Ca	0.726	0.834	0.808	0.676	0.662	0.739	0.785	0.674	0.686	0.702	0.675	0.651	0.525	0.444	0.372	0.672	0.688	0.714	0.699	0.682
Total	8.013	7.994	7.998	7.991	8.005	7.978	7.993	8.008	7.995	8.019	7.992	8.014	8.011	8.015	8.005	8.020	8.017	8.006	7.998	8.009

Table 6. (Continued)

sample no.																					
grain no.			5-1																1-12		
		rim	core															rim	core		
point no.	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50	52	53	54	55	
SiO2	37.54	37.39	36.76	36.67	37.53	37.69	37.66	37.33	37.40	37.36	37.49	37.23	37.48	38.26	38.12	38.41	37.71	37.90	36.72	37.09	
TiO2	0.03	0.08	0.11	0.13	0.15	0.11	0.07	0.08	0.06	0.07	0.03	0.06	0.07	0.02	0.04	0.03	0.07	0.05	0.15	0.11	
Al2O3	20.89	20.93	20.42	20.65	20.66	20.73	20.80	20.73	20.64	20.44	20.88	20.57	20.67	21.07	21.58	21.30	21.31	21.14	20.58	20.81	
FeO	28.21	30.73	23.31	23.70	24.87	25.50	24.94	26.30	26.67	27.93	29.14	28.48	28.58	27.79	29.50	28.47	31.00	29.01	26.14	26.58	
MnO	1.49	1.19	10.82	8.62	6.59	5.47	5.70	4.87	4.43	3.50	3.00	2.24	1.82	1.48	1.33	1.39	1.24	1.28	5.41	4.08	
MgO	2.75	3.64	0.85	0.98	1.27	1.26	1.16	1.14	1.25	1.57	1.74	2.17	2.63	3.17	3.81	3.55	4.27	4.26	2.14	2.44	
CaO	7.72	5.29	6.68	7.99	8.36	8.89	9.17	8.87	8.83	8.22	7.71	7.93	7.89	7.91	6.05	6.73	4.06	5.05	7.53	7.67	
Total	98.63	99.25	98.95	98.74	99.43	99.65	99.50	99.32	99.28	99.09	99.99	98.68	99.14	99.70	100.43	99.88	99.66	98.69	98.67	98.78	
O=12																					
Si	3.018	2.997	3.003	2.990	3.022	3.024	3.024	3.012	3.017	3.020	3.005	3.010	3.010	3.031	3.001	3.032	2.999	3.025	2.982	2.994	
Ti	0.002	0.005	0.007	0.008	0.009	0.006	0.004	0.005	0.004	0.004	0.002	0.004	0.004	0.001	0.002	0.002	0.004	0.030	0.009	0.007	
Al	1.979	1.978	1.967	1.985	1.960	1.960	1.969	1.971	1.963	1.948	1.973	1.961	1.956	1.967	2.003	1.982	1.998	1.989	1.970	1.980	
Fe	1.896	2.060	1.593	1.616	1.675	1.711	1.675	1.774	1.799	1.888	1.953	1.927	1.920	1.841	1.943	1.880	2.062	1.937	1.776	1.795	
Mn	0.101	0.081	0.749	0.595	0.450	0.372	0.388	0.332	0.303	0.240	0.204	0.154	0.124	0.100	0.089	0.093	0.084	0.086	0.372	0.279	
Mg	0.329	0.435	0.104	0.119	0.152	0.151	0.138	0.137	0.150	0.190	0.207	0.262	0.315	0.374	0.447	0.418	0.506	0.507	0.259	0.293	
Ca	0.665	0.454	0.585	0.698	0.721	0.765	0.789	0.767	0.763	0.712	0.662	0.687	0.680	0.671	0.511	0.569	0.346	0.432	0.656	0.663	
Total	7.990	8.010	8.008	8.011	7.989	7.989	7.987	7.998	7.999	8.002	8.006	8.005	8.009	7.985	7.996	7.976	7.999	8.006	8.024	8.011	

Table 6. (Continued)

sample no.	44-5																				
grain no.	1-8			4-3		2-3							rim	core							rim
	core		rim			core															
point no.	1	6	10	14	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	17	
SiO2	36.59	37.63	37.70	37.35	37.78	36.91	36.40	37.10	37.15	37.39	37.74	37.79	37.77	36.68	37.08	37.42	37.61	37.88	37.59	37.56	
TiO2	0.02	0.09	0.06	0.00	0.03	0.32	1.61	0.10	0.04	0.04	0.04	0.09	0.02	0.29	0.11	0.03	0.06	0.01	0.06	0.06	
Al2O3	18.49	19.70	20.81	19.56	20.80	19.02	19.11	20.01	20.06	20.06	20.66	20.50	20.71	19.14	19.97	19.94	20.33	20.55	20.65	20.76	
FeO	21.16	26.16	24.84	24.15	25.02	16.93	21.97	22.75	23.07	23.07	24.39	25.73	24.90	16.13	21.70	21.69	23.11	25.40	24.62	26.07	
MnO	14.40	6.34	4.13	9.34	2.72	18.53	11.06	10.61	9.17	9.17	3.13	2.44	3.30	19.49	12.05	10.36	7.54	4.13	3.24	3.08	
MgO	0.63	1.80	2.84	1.47	2.65	1.02	1.82	2.01	1.27	1.17	2.58	2.08	2.33	0.72	1.62	1.45	1.45	2.64	2.61	3.13	
CaO	7.50	7.53	8.39	6.90	9.54	6.45	6.61	6.65	8.25	8.50	10.24	10.19	9.74	6.32	6.51	8.06	9.50	8.54	9.87	7.85	
Total	98.79	99.25	98.77	98.77	98.54	99.18	98.58	99.23	99.01	99.40	98.78	98.82	98.77	98.77	99.04	98.95	99.60	99.15	98.64	98.51	
O=12																					
Si	3.033	3.047	3.021	3.049	3.027	3.029	2.980	3.011	3.02	3.032	3.021	3.032	3.028	3.025	3.019	3.037	3.023	3.032	3.016	3.017	
Ti	0.001	0.006	0.003	0.000	0.002	0.020	0.099	0.006	0.002	0.001	0.003	0.005	0.001	0.018	0.007	0.002	0.004	0.000	0.004	0.004	
Al	1.806	1.880	1.965	1.882	1.964	1.840	1.845	1.914	1.922	1.903	1.949	1.939	1.957	1.861	1.917	1.907	1.926	1.938	1.953	1.965	
Fe	1.467	1.771	1.664	1.649	1.677	1.162	1.505	1.544	1.568	1.648	1.632	1.726	1.669	1.113	1.478	1.472	1.553	1.700	1.652	1.751	
Mn	1.011	0.435	0.281	0.646	0.184	1.288	0.767	0.730	0.632	0.552	0.212	0.166	0.224	1.362	0.831	0.713	0.513	0.280	0.220	0.210	
Mg	0.078	0.217	0.339	0.179	0.316	0.124	0.222	0.243	0.154	0.141	0.308	0.249	0.279	0.089	0.197	0.176	0.174	0.315	0.313	0.375	
Ca	0.666	0.653	0.720	0.603	0.819	0.567	0.580	0.578	0.718	0.738	0.878	0.876	0.836	0.559	0.568	0.701	0.818	0.733	0.849	0.676	
Total	8.062	8.009	7.993	8.008	7.989	8.030	7.998	8.026	8.016	8.015	8.003	7.993	7.994	8.027	8.017	8.008	8.011	7.998	8.007	7.998	

Table 6. (Continued)

sample no.																					
grain no.	2-10									2-11		7									
	core						rim				rim	core									rim
point no.	22	23	25	27	29	30	31	32	33	38	42	43	44	45	46	47	48	49	51	52	
SiO2	37.68	37.53	37.25	37.34	38.07	37.92	38.13	37.35	37.23	37.61	37.98	36.88	37.81	37.32	37.43	37.63	37.41	37.78	37.88	38.20	
TiO2	0.16	0.02	0.03	0.00	0.01	0.04	0.03	0.06	0.11	0.02	0.05	0.33	0.18	0.10	0.09	0.08	0.08	0.04	0.07	0.06	
Al2O3	19.90	20.33	20.10	20.92	21.07	20.79	20.72	20.00	20.12	19.95	20.79	19.49	20.00	20.00	20.76	20.93	20.90	21.03	21.16	21.12	
FeO	25.68	24.95	25.44	25.40	25.31	25.39	25.59	24.62	24.29	26.10	25.06	26.47	26.79	28.47	25.86	25.15	25.68	26.48	26.82	26.91	
MnO	4.32	4.08	5.66	4.22	4.16	4.26	3.94	6.39	6.39	4.47	3.80	4.27	3.81	3.04	3.92	2.99	2.23	2.11	1.39	1.58	
MgO	2.77	2.36	1.65	2.43	3.09	3.12	3.16	1.20	1.16	2.34	3.01	1.99	2.30	1.62	1.75	2.22	2.44	2.94	2.99	3.35	
CaO	8.25	9.36	8.77	8.85	7.43	7.38	7.31	9.12	9.40	8.10	7.90	9.07	8.44	8.57	9.41	10.09	9.81	8.82	8.73	8.04	
Total	98.76	98.63	98.90	99.16	99.14	98.90	98.88	98.74	98.70	98.59	98.59	98.50	99.33	99.12	99.22	99.09	98.55	99.20	99.04	99.26	
O=12																					
Si	3.037	3.025	3.020	2.995	3.032	3.034	3.046	3.034	3.025	3.043	3.040	3.007	3.038	3.023	3.007	3.009	3.005	3.011	3.016	3.030	
Ti	0.010	0.001	0.002	0.000	0.001	0.002	0.002	0.004	0.007	0.001	0.003	0.020	0.011	0.006	0.005	0.005	0.005	0.002	0.004	0.004	
Al	1.880	1.931	1.921	1.979	1.978	1.960	1.951	1.916	1.927	1.903	1.961	1.873	1.894	1.910	1.967	1.973	1.979	1.976	1.986	1.974	
Fe	1.731	1.682	1.725	1.704	1.686	1.695	1.710	1.673	1.650	1.767	1.677	1.805	1.800	1.929	1.738	1.682	1.725	1.765	1.786	1.785	
Mn	0.295	0.279	0.388	0.287	0.281	0.288	0.267	0.440	0.439	0.306	0.258	0.295	0.259	0.209	0.267	0.202	0.152	0.142	0.084	0.106	
Mg	0.333	0.283	0.199	0.290	0.366	0.371	0.377	0.146	0.140	0.282	0.359	0.242	0.276	0.196	0.210	0.264	0.292	0.349	0.355	0.396	
Ca	0.713	0.808	0.762	0.760	0.634	0.633	0.625	0.794	0.818	0.702	0.677	0.794	0.727	0.744	0.811	0.865	0.844	0.754	0.745	0.683	
Total	7.999	8.009	8.017	8.015	7.978	7.983	7.978	8.007	8.006	8.004	7.975	8.036	8.005	8.017	8.005	8.000	8.002	7.999	7.976	7.978	

Table 6. (Continued)

sample no.	70																			
grain no.	6-1												1-3							
	core											rim	core							
point no.	1	2	3	4	5	6	8	9	10	11	12	13	1	2	3	4	5	6	7	8
SiO2	36.99	37.15	36.97	37.56	37.78	37.83	37.80	37.96	38.07	38.10	38.24	37.96	37.08	36.95	37.01	37.14	37.09	37.58	37.03	37.25
TiO2	0.12	0.11	0.10	0.10	0.04	0.06	0.07	0.10	0.05	0.06	0.01	0.05	0.05	0.02	0.08	0.07	0.09	0.08	0.13	0.08
Al2O3	20,28	20.18	20.24	20.54	20.39	20.61	21.00	20.55	20.70	20.73	20.69	20.52	20.75	20.99	20.87	20.64	20.87	20.69	20.83	20.75
FeO	26.13	26.48	26.91	27.91	28.08	28.10	28.97	29.18	29.13	29.41	28.85	28.86	27.95	28.15	28.57	28.77	28.45	27.58	29.73	29.77
MnO	9.42	8.69	7.92	6.43	5.07	2.49	1.03	0.39	0.96	0.68	1.20	1.62	6.81	6.66	5.47	4.48	3.11	2.02	0.50	0.20
MgO	0.70	0.73	0.79	0.87	0.96	1.32	1.76	1.86	2.35	2.60	2.59	2.48	1.59	1.57	1.46	1.27	1.12	1.39	1.64	1.86
CaO	6.65	6.30	6.22	7.05	7.60	9.10	9.65	9.67	8.59	8.25	8.03	7.80	5.52	5.62	6.70	7.55	9.08	10.29	9.38	9.12
Total	100.29	99.64	99.15	100.46	99.92	99.51	100.28	99.71	99.85	99.83	99.61	99.29	99.75	99.96	100.16	99.92	99.81	99.63	99.24	99.03
O=12																				
Si	2.999	3.023	3.020	3.021	3.042	3.037	3.006	3.031	3.032	3.031	3.046	3.040	3.000	2.984	2.982	2.997	2.987	3.012	2.985	3.001
Ti	0.007	0.007	0.006	0.006	0.002	0.003	0.004	0.006	0.003	0.004	0.000	0.003	0.003	0.001	0.005	0.004	0.005	0.005	0.008	0.005
Al	1.938	1.936	1.948	1.947	1.936	1.950	1.969	1.934	1.943	1.944	1.942	1.937	1.978	1.998	1.982	1.963	1.981	1.954	1.979	1.971
Fe	1.772	1.802	1.838	1.877	1.891	1.886	1.927	1.949	1.940	1.957	1.922	1.933	1.890	1.901	1.926	1.942	1.916	1.849	2.004	2.006
Mn	0.647	0.599	0.548	0.438	0.346	0.169	0.070	0.026	0.065	0.046	0.081	0.110	0.467	0.455	0.374	0.306	0.212	0.137	0.034	0.014
Mg	0.084	0.088	0.096	0.104	0.115	0.158	0.209	0.222	0.279	0.308	0.308	0.296	0.182	0.189	0.175	0.152	0.134	0.166	0.197	0.224
Ca	0.578	0.549	0.545	0.608	0.656	0.783	0.822	0.827	0.733	0.703	0.686	0.669	0.478	0.487	0.578	0.683	0.783	0.883	0.810	0.788
Total	8.025	8.004	8.001	8.001	7.988	7.986	8.007	7.995	7.995	7.993	7.985	7.988	7.998	8.015	8.022	8.047	8.018	8.006	8.017	8.009

Table 6. (Continued)

sample no.																				74
grain no.			2-1					3-2												1-2
		rim					rim	core						rim	core					
point no.	9	10	24	25	26	27	28	29	30	31	32	34	35	36	37	40	41	42	43	6
SiO2	37.48	37.84	36.40	36.82	37.11	36.94	36.96	36.37	36.10	36.22	36.57	36.86	37.16	37.01	36.22	36.45	37.14	37.14	37.58	36.40
TiO2	0.07	0.02	0.11	0.07	0.09	0.07	0.04	0.09	0.05	0.09	0.08	0.04	0.03	0.04	0.10	0.06	0.07	0.05	0.09	0.06
Al2O3	20.96	20.93	20.42	20.68	20.87	20.78	21.19	20.79	20.89	20.56	20.50	21.13	21.13	20.91	20.32	20.73	20.69	20.95	21.13	20.89
FeO	29.18	29.51	28.39	27.84	29.29	30.18	29.10	27.27	27.73	27.48	28.24	26.48	28.31	29.40	27.03	28.10	27.67	27.94	28.02	27.68
MnO	1.11	1.59	4.12	1.88	0.65	0.26	1.14	7.77	7.92	7.29	4.78	1.63	1.16	0.82	7.83	5.24	3.52	2.62	2.17	0.70
MgO	2.22	2.39	1.20	1.75	1.72	1.71	2.29	0.82	0.80	0.87	0.94	1.80	1.95	1.69	0.86	1.13	1.28	1.31	1.24	1.07
CaO	8.15	7.74	7.87	9.47	9.27	9.18	8.38	6.13	6.16	6.35	7.63	10.68	9.22	9.27	6.16	7.39	8.57	9.13	9.55	12.50
Total	99.17	100.02	98.51	98.51	99.00	99.12	99.10	99.24	99.65	98.86	98.74	98.62	98.96	99.14	98.52	99.10	98.94	99.14	99.78	99.30
O=12																				
Si	3.008	3.016	2.981	2.987	2.993	2.984	2.974	2.972	2.949	2.974	2.991	2.973	2.989	2.985	2.984	2.972	3.008	2.997	3.007	3.021
Ti	0.004	0.001	0.007	0.004	0.005	0.004	0.003	0.006	0.003	0.005	0.005	0.002	0.002	0.003	0.006	0.003	0.004	0.003	0.005	0.003
Al	1.983	1.966	1.972	1.977	1.984	1.978	2.010	2.003	2.012	1.989	1.976	2.009	2.004	1.988	1.973	1.992	1.975	1.993	1.992	1.937
Fe	1.959	1.967	1.945	1.889	1.975	2.038	1.958	1.864	1.895	1.887	1.931	1.786	1.905	1.983	1.863	1.916	1.874	1.885	1.875	1.821
Mn	0.075	0.107	0.286	0.129	0.044	0.018	0.078	0.538	0.548	0.507	0.331	0.111	0.079	0.056	0.546	0.362	0.241	0.179	0.147	0.047
Mg	0.265	0.284	0.146	0.212	0.207	0.206	0.275	0.100	0.097	0.106	0.115	0.216	0.234	0.204	0.106	0.138	0.154	0.158	0.148	0.125
Ca	0.701	0.661	0.691	0.824	0.801	0.795	0.722	0.537	0.539	0.559	0.669	0.923	0.795	0.801	0.544	0.645	0.744	0.790	0.819	1.053
Total	7.995	8.002	8.028	8.022	8.009	8.023	8.020	8.020	8.043	8.027	8.018	8.020	8.008	8.020	8.022	8.028	8.000	8.005	7.993	8.007

Table 6. (Continued)

sample no.				77																
grain no.				2-1									11							
			rim	core								rim	core							
point no.	9	10	14	1	2	3	7	8	19	22	23	24	1	2	3	4	5	6	7	8
SiO2	37.87	37.87	38.37	36.72	36.79	36.80	37.34	37.80	37.60	38.22	38.15	38.15	37.06	37.45	38.21	37.80	37.72	37.48	37.13	37.93
TiO2	0.07	0.05	0.04	0.22	0.17	0.17	0.15	0.06	0.10	0.08	0.08	0.07	0.27	0.20	0.05	0.11	0.10	0.16	0.13	0.11
Al2O3	20.74	20.38	20.84	20.12	20.27	20.55	20.57	20.58	20.65	20.94	20.90	20.98	20.39	20.62	20.82	20.95	20.54	20.63	20.68	20.68
FeO	27.03	27.52	29.13	14.46	14.49	16.04	21.00	20.78	29.06	27.96	28.15	28.06	14.52	14.27	22.97	25.96	27.36	27.72	28.75	30.39
MnO	0.58	0.61	0.83	18.57	18.19	15.84	10.20	8.20	0.33	0.13	0.16	0.16	18.89	18.07	5.06	2.78	1.94	0.82	1.17	0.89
MgO	1.04	1.18	1.86	0.30	0.30	0.41	0.68	0.47	2.04	2.50	2.67	2.79	0.30	0.35	0.75	0.83	1.01	1.15	1.39	1.55
CaO	13.08	11.96	9.43	8.24	8.48	8.72	9.23	10.89	8.95	8.78	9.03	8.84	8.38	8.66	11.86	11.13	10.55	11.11	9.56	8.30
Total	100.41	99.57	100.50	98.63	98.69	98.53	99.17	98.78	98.73	98.61	99.14	99.05	99.81	99.62	99.72	99.56	99.22	99.07	98.81	99.85
O=12																				
Si	3.006	3.030	3.037	3.009	3.009	3.005	3.020	3.043	3.027	3.053	3.038	3.037	3.002	3.022	3.044	3.024	3.033	3.015	3.004	3.035
Ti	0.004	0.003	0.003	0.013	0.011	0.010	0.009	0.003	0.006	0.005	0.005	0.004	0.016	0.012	0.003	0.006	0.006	0.010	0.008	0.007
Al	1.941	1.922	1.944	1.944	1.954	1.978	1.961	1.962	1.959	1.972	1.961	1.969	1.947	1.961	1.955	1.975	1.947	1.956	1.971	1.951
Fe	1.794	1.842	1.929	0.991	0.991	1.096	1.420	1.407	1.957	1.868	1.875	1.868	0.984	0.963	1.530	1.737	1.840	1.865	1.945	2.034
Mn	0.039	0.042	0.056	1.289	1.260	1.096	0.699	0.562	0.023	0.008	0.011	0.011	1.296	1.235	0.341	0.189	0.132	0.056	0.080	0.061
Mg	0.124	0.141	0.220	0.037	0.037	0.050	0.082	0.056	0.245	0.298	0.317	0.331	0.037	0.043	0.090	0.099	0.121	0.138	0.167	0.185
Ca	1.113	1.026	0.800	0.723	0.743	0.763	0.800	0.940	0.772	0.752	0.770	0.754	0.727	0.748	1.012	0.954	0.909	0.957	0.828	0.712
Total	8.021	8.006	7.989	8.006	8.005	7.998	7.991	7.973	7.989	7.956	7.977	7.974	8.009	7.984	7.975	7.984	7.988	7.997	8.003	7.985

Table 6. (Continued)

sample no.																				
grain no.																				
							rim													
point no.	9	10	11	13	15	16	17	18	19	20	21	23	24	25	26	28	29	30	31	32
SiO2	37.77	37.42	37.19	37.56	37.62	38.47	38.69	37.91	37.94	37.80	37.43	37.60	37.91	38.16	37.86	37.23	37.48	37.47	37.93	37.82
TiO2	0.05	0.07	0.09	0.08	0.07	0.06	0.03	0.11	0.16	0.07	0.07	0.11	0.11	0.14	0.06	0.10	0.15	0.09	0.11	0.07
Al2O3	20.78	20.64	20.88	20.90	21.32	21.32	21.41	20.77	20.78	20.83	20.86	20.71	20.76	20.89	20.67	20.73	20.50	20.62	20.74	20.81
FeO	31.48	30.18	30.10	29.17	29.48	28.04	26.40	26.73	25.89	26.59	27.33	26.97	26.43	27.07	27.87	26.84	30.47	31.13	30.84	30.42
MnO	0.68	0.42	0.22	0.09	0.17	0.24	2.40	2.64	3.00	2.87	2.40	2.10	2.53	2.10	1.61	2.53	0.78	0.77	0.84	0.62
MgO	1.71	1.94	2.15	2.31	2.80	3.06	3.61	0.88	0.86	0.98	0.96	1.04	0.88	0.96	1.07	0.96	1.72	1.72	1.69	1.75
CaO	7.73	8.14	8.39	8.57	8.58	8.67	7.82	10.70	10.87	10.24	10.45	10.57	10.88	10.46	10.37	10.51	7.87	7.77	7.77	8.04
Total	100.20	98.81	99.02	98.68	100.04	99.86	100.36	99.74	99.50	99.38	99.50	99.10	99.50	99.78	99.51	98.90	98.97	99.57	99.92	99.53
O=12																				
Si	3.020	3.021	2.996	3.019	2.986	3.033	3.032	3.031	3.035	3.031	3.007	3.024	3.035	3.042	3.034	3.008	3.027	3.016	3.034	3.031
Ti	0.003	0.005	0.005	0.005	0.004	0.003	0.002	0.007	0.010	0.004	0.004	0.006	0.007	0.008	0.004	0.006	0.007	0.006	0.006	0.004
Al	1.958	1.964	1.982	1.980	1.994	1.981	1.977	1.958	1.960	1.969	1.976	1.964	1.959	1.963	1.953	1.974	1.952	1.956	1.955	1.966
Fe	2.105	2.038	2.028	1.961	1.956	1.849	1.730	1.788	1.733	1.784	1.836	1.814	1.769	1.805	1.868	1.813	2.058	2.096	2.063	2.039
Mn	0.046	0.029	0.015	0.006	0.011	0.016	0.159	0.179	0.203	0.195	0.163	0.143	0.172	0.142	0.109	0.173	0.053	0.053	0.057	0.042
Mg	0.204	0.233	0.258	0.277	0.331	0.360	0.422	0.105	0.102	0.117	0.115	0.124	0.105	0.115	0.128	0.116	0.208	0.206	0.201	0.210
Ca	0.662	0.704	0.724	0.738	0.721	0.732	0.656	0.917	0.932	0.880	0.899	0.911	0.933	0.893	0.896	0.910	0.681	0.670	0.666	0.690
Total	7.998	7.994	8.008	7.986	8.003	7.974	7.978	7.985	7.975	7.980	8.000	7.986	7.980	7.968	7.992	8.000	7.986	8.003	7.982	7.982

Table 6. (Continued)

sample no.						78														
grain no.						3-1							5-2							
							rim	core				rim	core							rim
point no.	33	34	35	39	43	7	9	10	12	13	15	16	17	18	19	20	21	22	24	25
SiO2	38.18	37.72	37.42	37.32	36.85	37.36	37.43	37.24	37.41	37.33	37.76	37.61	37.02	36.24	36.51	36.76	37.07	37.34	37.17	37.16
TiO2	0.12	0.15	0.11	0.08	0.09	0.01	0.03	0.12	0.09	0.11	0.10	0.03	0.10	0.13	0.11	0.07	0.02	0.04	0.01	0.05
Al2O3	20.72	20.56	20.62	20.61	20.79	20.85	21.10	20.80	20.90	20.65	20.65	20.75	20.42	20.09	20.42	20.82	20.83	20.80	20.96	20.92
FeO	30.55	30.14	30.00	30.59	30.50	31.91	30.39	26.24	30.36	30.57	31.33	30.50	26.39	26.50	27.37	28.06	30.30	31.52	30.04	29.43
MnO	0.96	0.75	0.74	0.68	0.67	1.10	1.42	6.73	1.62	0.71	1.52	1.81	7.11	6.56	5.44	2.34	1.99	1.59	2.08	2.16
MgO	1.54	1.51	1.69	1.75	1.80	3.51	3.49	0.80	1.41	1.77	3.43	3.29	0.94	1.00	1.24	2.35	2.71	3.37	2.93	2.77
CaO	8.12	8.19	8.01	7.69	7.95	5.54	5.98	8.55	8.13	9.19	5.47	6.01	7.86	8.44	8.82	9.05	7.13	5.21	6.23	7.12
Total	100.19	99.02	98.59	98.72	98.65	100.28	99.84	100.48	99.92	100.33	100.26	100.00	99.84	98.96	99.91	99.45	100.05	99.87	99.42	99.61
O=12																				
Si	3.044	3.040	3.028	3.022	2.990	2.981	2.986	2.990	2.982	2.987	3.008	3.002	2.998	2.970	2.959	2.959	2.972	2.991	2.987	2.981
Ti	0.007	0.009	0.007	0.005	0.006	0.000	0.002	0.007	0.006	0.007	0.006	0.002	0.006	0.008	0.007	0.004	0.001	0.002	0.000	0.003
Al	1.946	1.953	1.967	1.967	1.989	1.961	1.984	1.969	1.964	1.947	1.939	1.953	1.948	1.940	1.950	1.976	1.968	1.964	1.985	1.978
Fe	2.037	2.032	2.031	2.071	2.070	2.130	2.028	1.762	2.024	2.045	2.087	2.036	1.787	1.816	1.855	1.889	2.031	2.111	2.019	1.975
Mn	0.065	0.051	0.051	0.047	0.046	0.074	0.096	0.458	0.109	0.048	0.103	0.122	0.487	0.455	0.373	0.160	0.135	0.108	0.142	0.147
Mg	0.184	0.181	0.204	0.211	0.218	0.418	0.415	0.096	0.168	0.211	0.407	0.391	0.114	0.123	0.150	0.282	0.324	0.402	0.351	0.331
Ca	0.694	0.707	0.695	0.667	0.692	0.474	0.511	0.735	0.780	0.788	0.467	0.514	0.682	0.741	0.766	0.780	0.613	0.447	0.536	0.612
Total	7.977	7.973	7.983	7.990	8.011	8.038	8.022	8.017	8.033	8.033	8.017	8.020	8.022	8.053	8.060	8.050	8.044	8.025	8.020	8.027

Table 6. (Continued)

sample no.	F104																			
grain no.																				
															core					
point no.	5	6	12	23	25	27	28	29	31	32	34	35	37	43	50	52	53	55	60	62
SiO2	36.99	37.24	37.23	37.25	36.91	36.70	36.78	37.24	36.70	36.56	37.08	37.10	37.48	36.96	36.64	36.64	36.55	37.09	36.51	36.59
TiO2	0.12	0.02	0.12	0.06	0.11	0.10	0.10	0.10	0.08	0.08	0.06	0.06	0.09	0.07	0.06	0.11	0.09	0.09	0.06	0.03
Al2O3	20.82	20.64	20.78	20.56	20.51	20.27	20.48	20.46	20.75	20.63	20.80	20.69	20.95	20.67	20.46	20.52	20.28	20.64	20.33	20.51
FeO	30.07	31.24	30.89	30.91	31.13	30.73	32.09	32.34	31.53	31.35	31.64	32.52	30.15	30.70	32.86	31.70	31.77	29.90	27.93	30.16
MnO	2.33	2.19	1.86	2.35	2.53	2.48	2.05	2.16	2.02	2.02	2.04	1.83	1.47	2.18	2.80	2.62	2.47	1.39	5.30	4.00
MgO	2.49	1.98	2.79	1.87	1.54	1.60	2.21	1.98	2.11	2.36	2.23	2.22	2.25	2.46	1.59	1.59	1.61	2.58	1.00	1.12
CaO	7.37	7.04	6.80	7.14	7.60	7.89	6.45	6.20	7.04	7.14	6.00	5.92	7.92	6.46	6.03	7.01	7.08	7.95	8.92	7.85
Total	100.19	100.35	100.47	100.14	100.33	99.77	100.16	100.48	100.23	100.14	99.85	100.34	100.31	99.50	100.44	100.19	99.85	99.64	100.05	100.26
O=12																				
Si	2.965	2.986	2.974	2.996	2.975	2.975	2.968	2.994	2.957	2.948	2.987	2.982	2.990	2.983	2.967	2.964	2.967	2.980	2.962	2.963
Ti	0.007	0.001	0.007	0.004	0.006	0.006	0.006	0.006	0.005	0.005	0.004	0.004	0.005	0.004	0.004	0.007	0.005	0.006	0.004	0.002
Al	1.967	1.953	1.957	1.949	1.949	1.937	1.948	1.938	1.970	1.961	1.975	1.960	1.969	1.967	1.952	1.957	1.941	1.955	1.944	1.958
Fe	2.016	2.098	2.063	2.079	2.099	2.084	2.166	2.174	2.125	2.114	2.131	2.187	2.011	2.072	2.225	2.145	2.159	2.009	1.894	2.043
Mn	0.158	0.149	0.126	0.160	0.173	0.171	0.140	0.147	0.138	0.138	0.139	0.125	0.100	0.149	0.192	0.179	0.170	0.084	0.364	0.274
Mg	0.298	0.237	0.332	0.224	0.186	0.193	0.266	0.238	0.253	0.284	0.268	0.265	0.267	0.296	0.192	0.191	0.195	0.309	0.121	0.135
Ca	0.633	0.606	0.582	0.615	0.656	0.685	0.558	0.534	0.608	0.617	0.518	0.510	0.677	0.559	0.523	0.608	0.617	0.684	0.775	0.681
Total	8.044	8.030	8.041	8.027	8.044	8.051	8.052	8.031	8.056	8.067	8.022	8.033	8.019	8.030	8.055	8.051	8.054	8.027	8.064	8.056

Table 6. (Continued)

sample no.	1511																		81801	
grain no.	1														2				4-4	
								rim										rim		
point no.	63	64	65	66	68	69	70	72	3	6	8	13	14	15	9	10	16	18	2	4
SiO2	36.55	36.18	36.51	36.21	36.13	36.35	36.58	37.51	37.81	37.13	36.68	37.12	37.19	37.67	36.81	37.42	37.94	37.70	36.75	37.44
TiO2	0.08	0.13	0.08	0.06	0.02	0.07	0.02	0.02	0.09	0.04	0.03	0.11	0.11	0.07	0.03	0.07	0.10	0.02	0.06	0.01
Al2O3	20.16	19.82	19.93	20.49	20.19	20.26	20.26	20.90	20.82	20.73	20.34	20.64	20.87	20.91	20.48	20.60	21.09	20.97	21.21	21.33
FeO	30.37	30.35	31.19	32.66	31.91	31.38	31.38	30.96	28.26	32.95	33.42	30.69	29.35	29.16	33.52	28.32	28.59	28.23	28.45	27.43
MnO	3.97	3.22	2.91	2.64	1.97	1.67	1.67	1.27	0.76	1.43	1.50	0.32	0.27	0.14	2.32	4.07	0.20	0.28	4.95	3.09
MgO	1.23	1.22	1.34	1.85	2.30	2.37	2.37	4.13	0.77	1.35	1.35	1.70	1.72	1.98	1.22	0.94	2.30	2.86	2.71	3.49
CaO	6.87	7.85	7.54	5.82	6.26	6.89	6.89	5.27	11.88	6.79	6.40	9.83	9.97	10.34	5.58	9.02	10.10	9.31	5.68	7.24
Total	99.23	98.77	99.50	99.73	98.78	98.99	99.17	100.06	100.39	100.42	99.72	100.41	99.48	100.27	99.96	100.44	100.32	99.37	99.81	100.03
O=12																				
Si	2.988	2.975	2.980	2.950	2.960	2.963	2.979	2.985	3.010	2.990	2.985	2.972	2.986	2.995	2.992	3.002	3.002	3.004	2.956	2.973
Ti	0.005	0.008	0.005	0.003	0.001	0.005	0.002	0.001	0.005	0.003	0.002	0.007	0.007	0.004	0.002	0.004	0.006	0.001	0.003	0.000
Al	1.942	1.921	1.918	1.968	1.950	1.947	1.941	1.961	1.954	1.968	1.951	1.948	1.975	1.959	1.962	1.948	1.967	1.970	2.011	1.997
Fe	2.076	2.088	2.129	2.226	2.186	2.139	2.231	2.061	1.882	2.219	2.274	2.055	1.971	1.939	2.278	1.900	1.892	1.881	1.914	1.822
Mn	0.275	0.224	0.201	0.182	0.137	0.115	0.103	0.085	0.052	0.098	0.104	0.022	0.018	0.009	0.160	0.276	0.013	0.019	0.337	0.208
Mg	0.150	0.150	0.163	0.225	0.281	0.288	0.356	0.491	0.091	0.183	0.164	0.202	0.205	0.235	0.148	0.112	0.271	0.340	0.325	0.413
Ca	0.601	0.692	0.659	0.508	0.549	0.602	0.438	0.450	1.013	0.586	0.558	0.844	0.858	0.881	0.486	0.776	0.856	0.795	0.490	0.616
Total	8.037	8.058	8.055	8.062	8.064	8.059	8.050	8.034	8.007	8.047	8.038	8.050	8.020	8.022	8.028	8.018	8.007	8.010	8.036	8.029

Table 6. (Continued)

sample no.																				
grain no.											5-3									
		rim	core								core					rim	core			
point no.	5	7	8	9	10	11	12	13	14	16	19	20	21	22	23	25	27	28	31	32
SiO2	37.60	37.44	36.72	36.75	36.72	37.23	37.26	37.45	37.22	37.44	36.77	37.53	37.34	37.42	37.25	37.18	36.67	37.30	36.76	37.32
TiO2	0.01	0.00	0.08	0.07	0.01	0.02	0.05	0.05	0.06	0.04	0.06	0.05	0.01	0.02	0.04	0.03	0.31	0.07	0.08	0.04
Al2O3	21.29	21.26	20.98	20.99	21.14	20.96	21.00	21.20	21.53	21.43	20.91	20.96	21.09	21.33	21.28	21.15	20.98	21.14	20.84	21.21
FeO	26.49	28.40	28.56	28.49	28.26	27.84	27.76	27.38	27.18	26.01	28.42	28.45	28.20	26.59	26.87	24.75	28.43	28.75	26.29	25.28
MnO	2.36	2.19	5.34	5.01	4.99	4.48	3.79	3.71	2.76	2.16	3.67	3.74	3.88	3.37	2.96	2.79	3.67	3.91	2.34	2.33
MgO	3.02	3.95	2.30	2.64	2.70	2.32	2.60	2.31	1.97	2.80	3.47	3.45	3.47	3.36	3.54	3.74	3.63	3.59	2.13	2.68
CaO	9.68	6.98	6.10	5.60	5.88	7.06	7.62	8.31	9.75	10.20	5.91	5.63	5.48	7.46	7.81	8.88	5.35	5.50	10.21	10.12
Total	100.45	100.22	100.08	99.55	99.70	99.91	100.08	100.41	100.47	100.08	99.21	99.81	99.47	99.55	99.75	98.52	99.04	100.26	98.65	98.98
O=12																				
Si	2.971	2.967	2.957	2.965	2.957	2.985	2.977	2.979	2.957	2.965	2.962	2.996	2.989	2.980	2.964	2.975	2.955	2.971	2.969	2.983
Ti	0.001	0.000	0.050	0.004	0.000	0.001	0.003	0.003	0.004	0.003	0.004	0.003	0.001	0.001	0.003	0.002	0.019	0.004	0.005	0.002
Al	1.983	1.985	1.910	1.996	2.007	1.981	1.978	1.988	2.016	2.000	1.985	1.972	1.990	2.002	1.996	1.995	1.993	1.984	1.984	1.998
Fe	1.751	1.882	1.923	1.923	1.903	1.867	1.855	1.822	1.806	1.723	1.915	1.900	1.888	1.771	1.788	1.657	1.916	1.915	1.776	1.689
Mn	0.158	0.147	0.365	0.343	0.340	0.304	0.257	0.250	0.186	0.145	0.250	0.253	0.263	0.227	0.200	0.189	0.251	0.264	0.160	0.158
Mg	0.356	0.467	0.276	0.318	0.324	0.278	0.310	0.273	0.234	0.331	0.417	0.411	0.414	0.399	0.420	0.446	0.436	0.427	0.257	0.319
Ca	0.819	0.593	0.526	0.484	0.508	0.607	0.652	0.708	0.830	0.866	0.510	0.481	0.470	0.637	0.666	0.762	0.462	0.469	0.883	0.867
Total	8.039	8.041	8.007	8.033	8.039	8.023	8.032	8.023	8.033	8.033	8.043	8.016	8.015	8.017	8.037	8.026	8.032	8.034	8.034	8.016

Table 6. (Continued)

sample no.			81802																		
grain no.			5-1															8-1			
		rim	core									rim	core					core			
point no.	33	34	1	2	4	5	6	7	8	11	12	13	14	16	17	19	24	25	26	27
SiO2	37.36	38.04	37.07	37.27	36.95	36.79	37.00	37.29	37.57	37.56	38.00	38.00	36.96	36.99	37.58	37.75	37.56	37.34	37.48	37.43
TiO2	0.05	0.02	0.06	0.01	0.03	0.05	0.08	0.04	0.06	0.02	0.05	0.02	0.03	0.06	0.08	0.03	0.06	0.02	0.01	0.06
Al2O3	21.61	21.28	20.95	20.88	20.83	19.94	21.13	21.05	21.10	21.41	21.46	21.55	21.06	21.20	21.23	21.42	20.97	20.92	21.22	21.35
FeO	26.12	27.22	29.75	31.53	32.70	32.96	33.13	33.18	32.78	30.90	29.43	25.87	30.34	31.16	31.67	30.39	31.81	30.41	31.19	31.42
MnO	2.41	2.35	3.85	3.93	3.48	2.93	2.55	2.20	1.58	0.42	0.49	1.96	2.98	1.88	1.74	1.23	2.70	2.34	2.16	2.02
MgO	3.74	3.99	3.30	2.35	1.87	1.89	2.00	2.28	2.49	3.35	3.63	3.05	3.68	3.56	3.21	3.30	2.45	3.02	3.22	3.32
CaO	8.31	7.45	4.01	3.94	3.80	4.13	4.13	4.20	4.53	6.83	7.31	9.13	4.21	4.34	4.55	5.80	4.10	4.80	4.47	4.71
Total	99.60	100.35	98.99	99.91	99.66	98.69	100.02	100.24	100.11	100.49	100.37	99.58	99.26	99.19	100.06	99.92	99.65	98.85	99.75	100.31
O=12																				
Si	2.962	2.995	2.993	3.004	2.997	3.020	2.985	2.996	3.009	2.975	2.995	3.005	2.974	2.976	2.998	3.000	3.000	3.012	2.999	2.981
Ti	0.003	0.001	0.004	0.001	0.002	0.003	0.005	0.002	0.004	0.001	0.003	0.001	0.002	0.003	0.005	0.002	0.004	0.002	0.001	0.004
Al	2.019	1.975	1.994	1.984	1.992	1.929	2.009	1.993	1.992	1.989	1.993	2.009	1.998	2.011	1.996	2.006	1.988	1.989	2.001	2.004
Fe	1.732	1.792	2.009	2.125	2.218	2.263	2.235	2.230	2.195	2.047	1.940	1.711	2.043	2.096	2.113	2.020	2.139	2.052	2.087	2.093
Mn	0.162	0.157	0.263	0.268	0.239	0.204	0.175	0.150	0.107	0.028	0.033	0.131	0.203	0.128	0.117	0.083	0.184	0.160	0.146	0.136
Mg	0.442	0.469	0.397	0.282	0.226	0.231	0.240	0.273	0.297	0.395	0.426	0.359	0.441	0.427	0.381	0.391	0.294	0.363	0.384	0.394
Ca	0.706	0.628	0.347	0.340	0.330	0.363	0.357	0.361	0.389	0.580	0.618	0.774	0.363	0.374	0.389	0.494	0.353	0.415	0.383	0.402
Total	8.026	8.017	8.007	8.004	8.004	8.013	8.006	8.005	7.993	8.015	8.008	7.990	8.024	8.015	7.999	7.996	7.962	7.993	8.001	8.014

Table 6. (Continued)

sample no.					492															
grain no.					2-1											3-1				
				rim	core						core				rim	core				
point no.	28	29	30	32	1	2	3	4	5	6	10	12	14	15	16	17	22	23	24	25
SiO2	37.33	37.04	37.26	38.01	37.41	38.07	37.39	37.60	37.89	37.56	37.14	37.17	38.06	37.34	37.70	37.08	37.19	37.65	36.85	37.46
TiO2	0.03	0.05	0.03	0.03	0.04	0.04	0.04	0.04	0.09	0.04	0.08	0.04	0.09	0.01	0.02	0.19	0.06	0.04	0.04	0.07
Al2O3	21.04	21.28	21.43	21.53	20.92	20.87	21.01	21.22	21.49	21.41	21.38	21.43	21.24	21.12	21.15	20.93	21.62	21.46	21.41	21.19
FeO	31.64	31.74	31.31	28.22	25.07	23.89	23.09	23.19	24.45	25.04	23.59	23.06	23.87	25.52	26.27	22.35	22.40	21.56	22.25	23.03
MnO	1.59	1.51	0.79	0.45	4.25	4.44	5.06	4.52	3.12	3.20	4.55	3.93	3.13	3.59	3.17	10.46	7.56	6.79	5.06	3.83
MgO	3.11	3.20	2.89	4.23	3.53	3.16	2.54	1.91	3.21	3.48	3.07	2.38	3.09	3.84	4.08	2.21	2.19	2.02	1.86	2.36
CaO	4.65	4.58	6.23	7.07	7.93	9.14	10.11	11.44	9.81	8.48	8.80	10.91	10.19	7.18	6.70	6.58	9.40	10.52	11.63	11.62
Total	99.39	99.40	99.94	99.54	99.15	99.61	99.24	99.92	100.06	99.21	98.61	98.92	99.67	98.60	99.09	99.80	100.42	100.04	99.10	99.56
O=12																				
Si	3.000	2.977	2.975	3.000	2.989	3.019	2.987	2.986	2.986	2.986	2.976	2.971	3.006	2.990	3.001	2.979	2.952	2.985	2.953	2.978
Ti	0.002	0.003	0.002	0.002	0.002	0.002	0.003	0.003	0.005	0.003	0.005	0.003	0.005	0.001	0.001	0.012	0.004	0.002	0.002	0.004
Al	1.993	2.017	2.017	2.003	1.971	1.951	1.979	1.987	1.996	2.006	2.019	2.019	1.977	1.994	1.985	1.982	2.023	2.005	2.023	1.985
Fe	2.126	2.134	2.091	1.863	1.675	1.584	1.543	1.540	1.611	1.665	1.581	1.541	1.577	1.709	1.749	1.502	1.487	1.429	1.491	1.531
Mn	0.109	0.103	0.054	0.030	0.288	0.298	0.343	0.304	0.208	0.215	0.309	0.266	0.209	0.244	0.214	0.712	0.508	0.456	0.343	0.258
Mg	0.373	0.383	0.343	0.500	0.420	0.373	0.302	0.226	0.377	0.412	0.366	0.284	0.364	0.459	0.484	0.265	0.259	0.239	0.223	0.280
Ca	0.400	0.394	0.533	0.598	0.679	0.776	0.865	0.973	0.828	0.722	0.755	0.934	0.862	0.616	0.571	0.566	0.800	0.894	0.998	0.990
Total	8.003	8.011	8.015	7.996	8.024	8.003	8.022	8.019	8.011	8.009	8.011	8.018	8.000	8.013	8.005	8.018	8.033	8.010	8.033	8.026

Table 6. (Continued)

sample no.																				
grain no.									4-1											
		rim	core					rim	core			rim	core							rim
point no.	27	29	30	31	32	37	38	39	41	42	43	44	45	46	47	48	49	50	52	
SiO2	37.21	37.13	36.32	36.76	36.37	37.51	37.51	37.38	37.73	37.63	37.72	37.34	37.79	37.28	37.07	37.67	37.51	38.01	37.93	
TiO2	0.01	0.00	0.06	0.04	0.06	0.05	0.05	0.05	0.04	0.07	0.09	0.03	0.04	0.05	0.06	0.03	0.06	0.03	0.04	
Al2O3	21.35	21.17	20.99	21.05	21.20	21.49	21.49	21.18	21.18	21.03	21.30	21.20	21.00	21.22	21.13	21.21	21.23	21.32	21.56	
FeO	25.41	25.92	22.88	24.35	22.27	25.45	25.83	26.52	25.30	22.68	24.72	25.49	26.60	26.39	27.72	24.82	22.37	24.04	25.73	
MnO	3.37	3.63	10.76	10.17	8.24	3.55	3.51	3.20	3.76	5.02	2.88	2.63	3.76	3.50	3.81	3.72	4.41	3.22	2.96	
MgO	3.40	3.52	2.31	2.43	2.02	3.62	3.58	4.08	3.58	1.81	3.29	3.19	3.78	3.35	3.82	3.40	2.38	3.29	3.79	
CaO	8.32	7.29	5.29	4.93	8.95	7.65	7.24	6.82	7.67	11.88	9.18	9.26	6.36	8.58	6.26	8.94	11.35	10.03	7.46	
Total	99.07	98.66	98.61	99.73	99.11	99.32	99.21	99.23	99.26	100.12	99.18	99.14	99.33	100.37	99.87	99.79	99.31	99.94	99.47	
O=12																				
Si	2.972	2.980	2.961	2.967	2.939	2.982	2.991	2.980	3.002	2.987	2.994	2.979	3.010	2.972	2.958	2.985	2.985	2.996	3.000	
Ti	0.001	0.000	0.004	0.002	0.004	0.003	0.001	0.003	0.000	0.004	0.006	0.002	0.003	0.003	0.003	0.002	0.004	0.002	0.002	
Al	2.009	2.003	2.017	2.003	2.019	2.013	2.002	1.990	1.986	1.967	1.993	1.994	1.971	1.994	1.987	1.981	1.991	1.981	2.010	
Fe	1.697	1.740	1.560	1.644	1.505	1.692	1.729	1.768	1.684	1.505	1.641	1.701	1.772	1.692	1.850	1.645	1.489	1.585	1.702	
Mn	0.228	0.247	0.743	0.695	0.564	0.239	0.238	0.216	0.254	0.338	0.200	0.178	0.254	0.236	0.258	0.250	0.297	0.215	0.199	
Mg	0.405	0.421	0.281	0.293	0.243	0.429	0.427	0.484	0.425	0.214	0.389	0.379	0.449	0.399	0.455	0.402	0.283	0.386	0.447	
Ca	0.712	0.627	0.462	0.427	0.775	0.652	0.621	0.582	0.654	1.010	0.781	0.792	0.543	0.733	0.535	0.759	0.968	0.847	0.632	
Total	8.024	8.018	8.028	8.031	8.049	8.010	8.009	8.023	8.005	8.025	8.004	8.025	8.002	8.029	8.046	8.024	8.017	8.012	7.992	