Electron Microprobe Analyses of Rock-forming Minerals from the Sanbagawa Metamorphic Rocks, Shikoku Part II. Sazare, Kotu and Bessi Areas

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Electron Microprobe Analyses of Rock-forming Minerals from the Sanbagawa Metamorphic Rocks, Shikoku Part II. Sazare, Kotu and Bessi Areas

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Abstract Chemical compositions of rock-forming minerals from the Sanbagawa metamorphic rocks in the Sazare and Bessi areas in central Shikoku, and the Kotu area in eastern Shikoku, are tabulated. They include 330 electron microprobe analyses of plagioclase, muscovite, paragonite, biotite, chlorite, amphibole, pyroxene, garnet and epidote.

Introduction

This is the second report of "*Electron microprobe analyses of rock-forming minerals from the Sanbagawa metamorphic rocks, Shikoku*". It deals with the chemical data of plagioclase, muscovite, paragonite, biotite, chlorite, amphibole, garnet, pyroxene, and epidote in the Sazare[1)] and Bessi[2)] areas in central Shikoku, and the Kotu[3)] area in eastern Shikoku, which are presented in Tables 1-9. Chemical analyses were made using two electronprobe microanalyzers, Hitachi XMA-5A of the Kanazawa University and J.E.O.L JXA-5A of the Nagoya University. Mineral assemblages of the samples containing the analyzed minerals are shown in Table 10.

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1）佐々連, 2）別子, 3）高越

Sanbagawa, Bessi and Kotu have to be spelled Sambagawa, Besshi and Kotsu, respectively, to be consistent with the spelling of Shikoku instead of Sikoku. The localities of geologically famous areas are, however, spelled following the papers widely read in international geological world (cf. Miyashiro, 1973).

Reprint requests to S. Banno.

Sazare area

The Sazare area is located in Iyo-Mishima city, Ehime Prefecture[1] (Fig. 1), being north of the Asemi River area, whose chemical mineralogy were described in Part I of this series of papers (Higashino et al., 1982). According to the conventional stratigraphy of the Sanbagawa schists in central Shikoku, this area is underlain by the Minawa and Ojoin formations. The structural analysis of the geology of the area has been made by Oyagi (1964), Kawachi (1968) and Hara et al. (1977) in detail. In Fig. 1, the sample localities and the traverse map along the Saruta River are shown. The schists trend roughly E-W with moderately dipping, and are gently folded with approximate E-W axis of syncline (Tomisato syncline). Most of the samples are collected along the Saruta and Dozan Rivers, and the other near the Sazare mine.

Metamorphic zonal mapping of the area has been done by Kurata and Banno (1974) and Banno et al. (1978) on the basis of the mineral assemblage in pelitic schists. Zones A, B and C of Kurata and Banno (1974) approximately correspond to the chlorite, garnet and biotite zones[2] of Banno et al. (1978), respectively. Pelitic schists near the Fujiwara mass (metamorphosed peridotite-gabbro complex), which belong to the garnet zone according to Banno et al. (1978), contain sometimes biotite and have the chemistry of the rock-forming minerals transitional between the garnet and biotite zones of the Asemi River area (Enami, 1980), but we regard them to belong to the garnet zone in this report.

Chemical compositions of muscovite, biotite, chlorite, amphibole, garnet and epidote from the pelitic schists, muscovite, chlorite, amphibole and pyroxene from the siliceous schists, and plagioclase, muscovite, chlorite, amphibole, garnet and epidote from the basic schists are listed in Table 1 – 9. Modes of occurence and chemical characteristics of the minerals are the same as those in the Asemi River area described by Higashino et al. (1982), except for amphiboles from the siliceous schists, 2160 and 2162, which are nearly homogeneous.

Analyses of chlorite from the pelitic schists were made on the varieties forming the schistosity plane and in the pseudomorphs after garnet, the latter being distinguished from the former by marking their GRAIN NO with "(PG)". The schistosity-forming chlorites generally exhibit chemical heterogeneity mainly with regard to Fe-Mg substitution in the high-grade area. In such a case, Mg-rich and sometimes Fe-rich parts were analyzed, and they are marked with "A" and "B" in their POINT NO, respectively. Most of the zoned garnets and amphiboles were analyzed on the rim, and sometimes the core and the intermediate part of the grain. The analysis of some amphiboles was done on the arbitrarily selected points. The analyses of the rim, core and intermediate part of them are distinguished from the other analyses by marking their POINT NO with "RIM",

1) 愛媛県伊予三島市

2) Recently, Enami (1982) has subdivided the bioite zone into albite-biotite and oligoclase-biotite zones based upon the chemistry of plagioclase in the Bessi area. According to his definition, the biotite zone in the Sazare area is the albite-biotite zone, for plagioclase in the area is albite so far as we have examined.

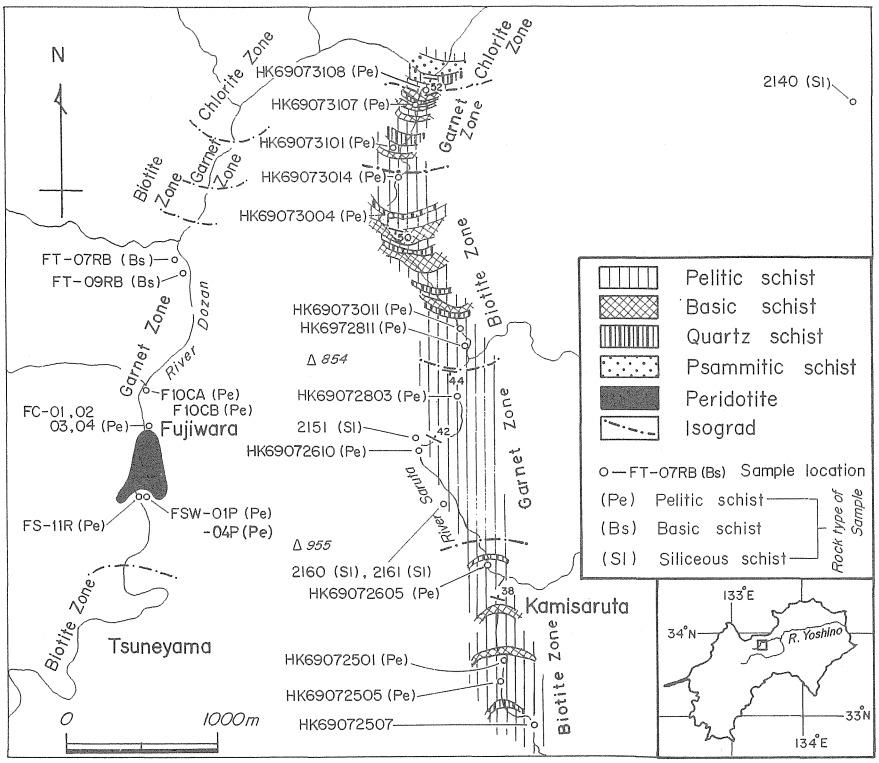

Fig. 1 Traverse map and sample locations of the Sazare area.

"CORE" and "INTER", respectively. Analyzed points of the other minerals are chosen arbitrarily.

Our discussions on the mineralogy and petrology of the Sanbagawa schists of the area have been given in Banno and Kurata (1972), Kurata (1972) and Kurata and Banno (1974) for the pelitic schists along the Saruta River, Enami (1980) for the pelitic and basic schists around the Fujiwara mass, and Hiramura (1977) for the siliceous schists.

Kotu area

The Kotu area is located in Yamakawa-cho, Oe-gun, Tokushima Prefecture[1], and a part of the Kotu-Bizan district described by Iwasaki (1963). The Sanbagawa schists of the Kotu area and its surroundings are divided into five formations, the Nonowaki, Shozanji, Kashidaira, Kotu and Kawata formations in ascending order of stratigraphy; the lower part of the Nonowaki formation, and the higher part of that formation and the remaining formations are correlated with the Koboke and Minawa formations in central Shikoku, respectively (Iwasaki et al., 1968). The samples in this report were collected along the Okunoidani River and its tributary (Fig. 2), where the Kotu formation, maily composed of basic schists (notably glaucophane schists) with subordinate siliceous schists, and minor

1) 徳島県麻植郡山川町

pelitic schists and ultrabasic rocks, is distributed.

Iwasaki (1963) and Iwasaki et al. (1968) have performed the metamorphic zonal mapping of the Kotu area and its surroundings. The study area belongs to zone II of Iwasaki et al. (1968), which is characterized by the appearance of garnet in pelitic schists and absence of pumpellyite in basic schists, corresponding to the garnet zone in central Shikoku. In this report, the chemical data of basic epidote-glaucophane schists are mainly described along with those of two siliceous epidote-glaucophane schists.

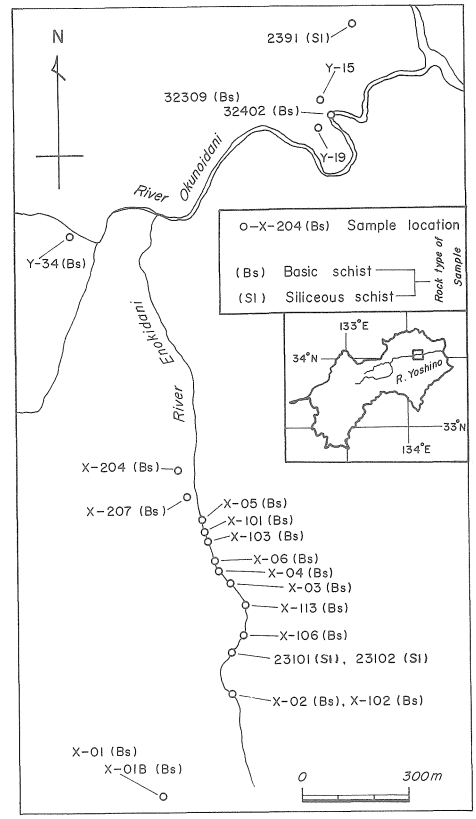

Fig. 2 Map of the Kotu area showing sample locations.

Muscovite, paragonite, chlorite, amphihole (alkali amphibole and calcic amphibole), garnet and epidote are analyzed. Although the zoning with alkali amphibole core and actinolite rim is not uncommon, alkali amphibole itself is no distinctly zoned. For most of alkali amphiboles in the basic schists, the average compositions of 3 to 7 grains are tabulated, and their POINT NO are marked with "*". Epidote is often slightly zoned with Al-rich core and Fe-rich rim, but the core is relatively homogeneous. The analyses of epidotes in the basic schists were made on the aluminous core, and the average compositions of 3 to 5 points are tabulated with the mark "*" in their POINT NO. Zoning is common in garnet and shows decrease of Mn towards the rim. The analyses of garnets from the basic schists are at the rim, but the garnet from the siliceous schists (23102) was on arbitrarily selected point. Muscovite, paragonite and chlorite are rather homogeneous, and their analyzed points are chosen arbitrarily.

The detailed mineral paragenesis of basic epidote-glaucophane schists and paragonite-bearing siliceous schists are given in Hosotani and Banno (in prep.) and Hiramura (1978), respectively.

Bessi area

The Bessi area is located in Bessiyama-mura, Uma-gun, Ehime Prefecture[1], being about 12km to the west of the Sazare area. Analyzed minerals are alkali amphibole and epidote from basic epidote-glaucophane schists in the Minawa formation, one from the garnet zone, and the others from the chlorite zone. The sample localities are shown in Fig.

1) 愛媛県宇磨郡別子山村

3. Mode of occurence, chemical characteristics and analyzed points of the minerals are the same as those from the basic epidote-glaucophane schists in the Kotu area described above, and the average of the point analyses are presented.

The petrology and geology of the area have been worked out by Banno (1964) and Hosotani and Banno (in prep.), and Hide (1961), Hide et al. (1956), Hara et al. (1977) and Takasu and Makino (1980), respectively.

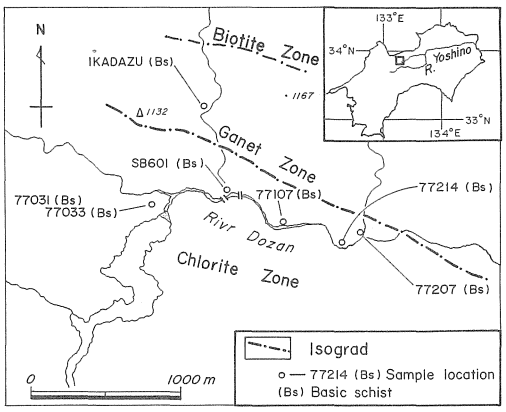

Fig. 3 Map of the Bessi area showing sample locations.

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References

(References listed in Part I of this series of papers (Higashino et al., 1982) are excluded.)

BANNO,S. and KURATA,H., 1972, Distribution of Ca in zoned garnet of low-grade pelitic schists. *Jour. Geol. Soc. Japan,* **78**, 507-512.

ENAMI, M., 1980, Petrology of the Fujiwara mass and the surrounding pelitic schists in the Sanbagawa metamorphic belt, central Shikoku. *Jour. Geol. Soc. Japan,* **86**, 461-473 (in Japanese with English abstract).

———,1982, Oligoclase-biotite zone of the Sanbagawa metamorphic terrain in the Bessi district, central Shikoku, Japan. *Jour. Geol. Soc. Japan,* 88, 887-900 (in Japanese with English abstract).

HIDE, K., 1961, Geologic structure and metamorphism of the Sanbagawa crystalline schists of the Besshi -Shirataki Mining district in Shikoku, southwestern Japan. *Hiroshima Univ. Geol. Rept.,* No.9, 1-87 (in Japanese with English abstract).

HIDE, K., KOJIMA, K. and YOSHINO, G., 1956, Preliminary report of the geologic structure of the Besshi spotted schist zone. *Jour. Geol. Soc. Japan,* **62**, 574-584 (in Japanese with English abstract).

HIGASHINO, T., SAKAI, C., OTSUKI, M., ITAYA, T. and BANNO, S., 1981, Electron microprobe analyses of rock -forming minerals from the Sanbagawa metamorphic rocks, Shikoku, Part I Asemi River area. *Sci. Rept. Kanazawa Univ.*, **26**, 73-123.

HIRAMURA, M., 1977, Chemical compositions and optical properties of amphiboles in quartzose schists from Sanbagawa metamorphic belt in Shikoku. Grad. Thesis, Kanazawa Univ. (in Japanese with English abstract).

———, 1978, Notes on petrography and rock-forming minerals (2) Find of a paragonite-bearing quartz schist from the Kotu district, eastern Shikoku. *Jour. Japan Assoc. Min. Petr. Econ. Geol.*, **73**, 142-151.

IWASAKI, M., HARA, I., NUREKI, T., BANDO, Y., UCHIBAYASHI, S., YOKOTA, Y., TAKAHASHI, S., MATSUKI, M. and HOSHINA, T., 1968, Report of Mineral. Expla. Corp. "Yoshino-gawa" . Ministry of Intern. Trade & Industry (in Japanese).

KURATA, H., 1972, Local chemical heterogeneity of chlorites in Sanbagawa pelitic schists from Sazare area, central Shikoku. *Jour. Geol. Soc. Japan*, **78**, 653-657.

———and BANNO, S., 1974, Low-grade progressive metamorphism of pelitic schists of the Sazare area, Sanbagawa metamorphic terrain in central Sikoku, Japan. *Jour. Petrol.*, **15**, 361-382

OYAGI, N., 1964, Structural analysis of the Sanbagawa crystalline schists from the Sazare Mine in central Shikoku, Japan. *Hiroshima Univ. Geol. Rept.*, No.12, 493-502.

TAKASU, A. and MAKINO, K., 1980, Stratigraphy and geologic structure of the Sanbagawa metamorphic belt in the Besshi district, Shikoku, Japan. *Earth Sci.*, **34**, 16-26 (in Japanese with English abstract).

Abbreviations used in Tables 1-9 are as follows.

(Tables 1-9) PE = pelitic schist, BE = basic schist, SL = siliceous schist, CHL = chlorite zone, GAR = garnet zone, BIO = biotite zone, ME = Masaki Enami, HK = Hisayuki Kurata, HH = Hiroshi Hosotani, MH = Makiko Hiramura, KU = Hitachi XMA-5A of the Kanazawa University, NU = J. E. O. L JXA-5A of the Nagoya University.

(Table 5) PG = occuring in the pseudomorphs after garnet, A = Mg-rich part, B = Fe-rich part.

(Table 6) NA-A = alkali amphibole, CA-A = calcic amphibole, INTER = intermediate part, * = average composition.

(Table 7) N = normal zoning with a decrease in Mn towards the rim, INTER = intermediate part.

(Table 9) * = average composition.

TABLE 1. CHEMICAL COMPOSITION AND ATOMIC RATIO OF PLAGIOCLASE

SAMPLE NO	FT-09RB
ROCK TYPE	BS
ZONE	GAR
GRAIN NO	1
POINT NO	1
SIO2	69.14
AL2O3	19.35
CAO	0.68
NA2O	11.61
K2O	0.03
TOTAL	100.81
ATOMIC RATIOS (O = 8.0)	
SI	2.998
AL	0.989
CA	0.032
NA	0.976
K	0.002
ANALYST	ME
INSTRUMENT	NU

TABLE 2. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF MUSCOVITES

SAMPLE NO	FT-07RB	FT-09RB	F-10CA		FSW-01P		FS-11R		HK69073108	HK69073107	HK69073101
ROCK TYPE	BS	BS	PE		PE		PE		PE	PE	PE
ZONE	GAR	GAR	GAR		GAR		GAR		CHL	GAR	GAR
GRAIN NO	1	1	1	2	1	2	1	2	1	1	1
POINT NO	1	1	1	1	1	1	1	1	1	1	1
SIO2	49.97	49.74	49.38	48.60	50.95	50.16	48.98	49.14	51.00	50.80	50.20
TIO2	0.05	0.24	0.07	0.13	0.53	0.41	0.30	0.24	N.D.	N.D.	N.D.
AL2O3	27.29	28.28	29.70	30.02	28.34	28.24	28.89	29.28	29.50	28.90	30.60
FEO	4.04	3.24	2.58	3.19	3.50	3.49	3.19	3.13	2.61	2.28	3.05
MNO	0.01	0.0	0.01	0.02	0.03	0.0	0.0	0.0	0.05	0.05	0.01
MGO	2.36	3.09	2.05	1.96	2.62	2.69	2.36	2.31	2.39	2.47	2.20
CAO	0.21	0.06	0.0	0.0	0.0	0.0	0.0	0.0	N.D.	N.D.	0.31
NA2O	0.12	0.54	0.10	0.20	0.55	0.49	0.76	0.73	N.D.	N.D.	0.58
K2O	10.39	9.79	9.65	9.25	9.84	10.06	9.20	9.52	9.60	10.20	9.18
TOTAL	94.44	94.98	93.54	93.37	96.36	95.54	93.68	94.35	95.15	94.70	96.13
ATOMIC RATIOS (O = 22.0)											
SI	6.780	6.673	6.671	6.593	6.734	6.701	6.640	6.622	6.756	6.780	6.610
TI	0.005	0.024	0.007	0.013	0.053	0.041	0.031	0.024			
AL	4.364	4.472	4.729	4.800	4.414	4.446	4.616	4.651	4.606	4.546	4.749
FE	0.458	0.364	0.291	0.362	0.387	0.390	0.362	0.353	0.289	0.254	0.336
MN	0.001	0.0	0.001	0.002	0.003	0.0	0.0	0.0	0.006	0.006	0.001
MG	0.477	0.618	0.413	0.396	0.516	0.536	0.477	0.464	0.472	0.491	0.432
CA	0.031	0.009	0.0	0.0	0.0	0.0	0.0	0.0			0.044
NA	0.032	0.140	0.026	0.053	0.141	0.127	0.200	0.191			0.148
K	1.799	1.676	1.663	1.601	1.659	1.714	1.591	1.637	1.622	1.737	1.542
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	HK	HK	HK
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	KU	KU	KU

TABLE 2. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF MUSCOVITES (CONTINUED)

SAMPLE NO	HK69073014	HK69073004	HK69073011	HK69072811	HK69072803	HK69072610	HK69072605	HK69072501	HK69072507	2140	Y-15
ROCK TYPE	PE	PE	PE	PE	PE	PE	PE	PE	PE	SL	BS
ZONE	BIO	BIO	BIO	BIO	GAR	GAR	BIO	BIO	BIO	CHL	GAR
GRAIN NO	1	1	1	1	1	1	1	1	1	1	1
POINT NO	1	1	1	1	1	1	1	1	1	1	1
SIO2	50.90	51.30	49.70	51.30	48.50	49.70	48.60	51.30	48.50	49.36	51.05
TIO2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0	N.D.	0.09	0.24
AL2O3	27.50	29.00	29.50	28.60	28.10	27.70	28.30	26.70	28.80	23.94	26.63
FEO	3.63	2.76	2.21	2.84	3.01	3.45	2.83	2.84	2.76	4.19	4.83
MNO	0.0	0.01	0.01	0.01	0.01	0.0	0.01	0.03	0.02	0.05	0.02
MGO	2.54	2.57	2.82	2.84	2.70	2.17	2.50	2.88	2.38	3.95	2.88
CAO	N.D.	N.D.	0.04	N.D.	N.D.	N.D.	0.02	0.02	N.D.	0.0	0.0
NA2O	0.55	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.48	N.D.	0.41	0.31
K2O	9.37	8.99	8.78	9.89	9.05	9.05	8.89	10.00	8.71	10.76	11.54
TOTAL	94.49	94.63	93.06	95.48	91.37	92.07	91.15	94.25	91.17	92.75	97.50
ATOMIC RATIOS (O = 22.0)											
SI	6.839	6.809	6.697	6.795	6.711	6.823	6.724	6.909	6.696	6.878	6.784
TI								0.0		0.009	0.024
AL	4.354	4.537	4.685	4.465	4.582	4.482	4.614	4.238	4.686	3.932	4.171
FE	0.408	0.306	0.249	0.315	0.348	0.396	0.327	0.320	0.319	0.488	0.537
MN	0.0	0.001	0.001	0.001	0.001	0.0	0.001	0.003	0.002	0.006	0.002
MG	0.509	0.509	0.567	0.561	0.557	0.444	0.516	0.578	0.490	0.821	0.571
CA			0.006				0.003	0.003		0.0	0.0
NA	0.143							0.125		0.111	0.080
K	1.606	1.522	1.509	1.671	1.597	1.585	1.569	1.718	1.534	1.913	1.956
ANALYST	HK	HK	HK	HK	HK	HK	HK	HK	HK	MH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	Y-19	X-207	X-106	23102
ROCK TYPE	BS	BS	BS	SL
ZONE	GAR	GAR	GAR	GAR
GRAIN NO	1	1	1	1
POINT NO	1	1	1	1
SIO2	49.88	48.54	50.23	49.71
TIO2	0.26	0.19	0.21	0.19
AL2O3	26.30	27.45	26.08	26.77
FEO	4.33	4.83	3.04	3.58
MNO	0.03	0.0	0.0	0.0
MGO	2.60	3.26	3.41	3.15
CAO	0.03	0.12	0.09	0.0
NA2O	0.52	0.39	0.45	0.66
K2O	11.28	10.75	10.34	10.35
TOTAL	95.23	95.53	93.85	94.41
ATOMIC RATIOS (O = 22.0)				
SI	6.778	6.586	6.837	6.752
TI	0.027	0.019	0.021	0.019
AL	4.212	4.389	4.184	4.286
FE	0.492	0.548	0.346	0.407
MN	0.003	0.0	0.0	0.0
MG	0.527	0.659	0.692	0.638
CA	0.004	0.017	0.013	0.0
NA	0.137	0.103	0.119	0.174
K	1.955	1.861	1.795	1.794
ANALYST	HH	HH	HH	MH
INSTRUMENT	KU	KU	KU	KU

TABLE 3. CHEMICAL COMPOSITION AND ATOMIC RATIO OF PARAGONITE

SAMPLE NO	23102
ROCK TYPE	SL
ZONE	GAR
GRAIN NO	1
POINT NO	1
SIO2	47.28
TIO2	0.04
AL2O3	37.58
FEO	1.01
MNO	0.02
MGO	0.14
CAO	0.08
NA2O	6.87
K2O	1.04
TOTAL	94.06
ATOMIC RATIOS (O = 22.0)	
SI	6.135
TI	0.004
AL	5.747
FE	0.110
MN	0.002
MG	0.027
CA	0.011
NA	1.728
K	0.172
ANALYST	MH
INSTRUMENT	KU

TABLE 4. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF BIOTITES

SAMPLE NO	FSW-01P							FSW-04P			
ROCK TYPE	PE							PE			
ZONE	GAR							GAR			
GRAIN NO	1	1	2	3	3	4	5	1	2	3	4
POINT NO	1	2	1	1	2	1	1	1	1	1	1
SIO2	36.96	36.66	36.78	38.97	37.99	37.27	37.33	36.88	39.02	37.35	36.57
TIO2	1.35	1.45	1.44	1.22	1.22	1.31	1.23	1.36	1.51	1.56	1.31
AL2O3	15.34	15.40	15.13	15.32	15.50	15.13	15.03	16.29	16.10	15.29	17.31
FEO	23.02	23.76	23.57	20.18	20.88	23.72	23.20	22.34	23.04	22.69	22.13
MNO	0.18	0.18	0.18	0.15	0.16	0.23	0.19	0.09	0.08	0.05	0.11
MGO	8.59	8.51	8.61	8.94	8.66	8.68	8.56	8.11	8.03	8.98	7.51
CAO	0.0	0.0	0.01	0.06	0.03	0.0	0.0	0.33	0.73	0.19	0.35
NA2O	0.02	0.04	0.03	0.01	0.0	0.03	0.03	0.03	0.05	0.03	0.04
K2O	8.78	8.67	8.18	7.45	7.66	8.48	8.69	7.63	7.56	7.23	7.22
TOTAL	94.24	94.67	93.93	92.30	92.10	94.85	94.26	93.06	96.12	93.37	92.55
ATOMIC RATIOS (O = 22.0)											
SI	5.771	5.720	5.762	6.037	5.943	5.788	5.826	5.767	5.891	5.814	5.725
TI	0.159	0.170	0.170	0.142	0.144	0.153	0.144	0.160	0.171	0.183	0.154
AL	2.823	2.832	2.794	2.797	2.858	2.769	2.764	3.002	2.864	2.805	3.194
FE	3.006	3.100	3.088	2.614	2.731	3.081	3.028	2.921	2.909	2.954	2.897
MN	0.024	0.024	0.024	0.020	0.021	0.030	0.025	0.012	0.010	0.007	0.015
MG	1.999	1.979	2.011	2.065	2.019	2.009	1.991	1.890	1.807	2.084	1.753
CA	0.0	0.0	0.002	0.010	0.005	0.0	0.0	0.055	0.118	0.032	0.059
NA	0.006	0.012	0.009	0.003	0.0	0.009	0.009	0.009	0.015	0.009	0.012
K	1.749	1.726	1.635	1.472	1.529	1.680	1.730	1.522	1.456	1.436	1.442
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	HK69073011	HK69072507
ROCK TYPE	PE	PE
ZONE	BIO	BIO
GRAIN NO	1	1
POINT NO	1	1
SIO2	37.80	38.30
TIO2	1.38	1.43
AL2O3	15.40	15.50
FEO	20.80	19.70
MNO	0.19	N.D.
MGO	10.40	10.12
CAO	0.23	N.D.
NA2O	N.D.	N.D.
K2O	7.17	6.98
TOTAL	93.37	92.03
ATOMIC RATIOS (O = 22.0)		
SI	5.824	5.927
TI	0.160	0.166
AL	2.797	2.827
FE	2.680	2.549
MN	0.025	
MG	2.386	2.335
CA	0.038	
NA		
K	1.409	1.378
ANALYST	HK	HK
INSTRUMENT	KU	KU

TABLE 5. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF CHLORITES

SAMPLE NO	FT-07RB		FT-09RB			F-10CA					
ROCK TYPE	BS		BS			PE					
ZONE	GAR		GAR			GAR					
GRAIN NO	1	2	1	2	3	1	1	2	2	2	3
POINT NO	1	1	1	1	1	A1	A2	A1	A2	A3	A
SIO2	25.00	25.26	25.21	24.69	24.94	23.35	23.98	23.95	23.86	23.83	24.08
AL2O3	19.77	19.15	19.26	19.04	19.10	20.24	20.43	20.66	20.63	20.45	20.42
FEO	29.70	31.32	33.97	33.94	33.41	32.48	30.99	32.81	32.68	31.95	32.68
MNO	0.23	0.27	0.38	0.38	0.35	0.41	0.21	0.51	0.59	0.37	0.42
MGO	13.12	12.31	9.95	10.03	9.79	10.18	11.47	9.87	9.38	10.63	9.81
TOTAL	87.82	88.31	88.77	88.08	87.59	86.66	87.08	87.80	87.14	87.23	87.41
ATOMIC RATIOS (O = 28.0)											
SI	5.404	5.477	5.513	5.456	5.521	5.223	5.276	5.280	5.302	5.267	5.327
AL	5.036	4.893	4.964	4.959	4.983	5.336	5.297	5.368	5.403	5.327	5.324
FE	5.369	5.679	6.213	6.273	6.186	6.076	5.702	6.049	6.073	5.905	6.046
MN	0.042	0.050	0.070	0.071	0.066	0.078	0.039	0.095	0.111	0.069	0.079
MG	4.228	3.979	3.244	3.304	3.231	3.395	3.762	3.244	3.107	3.502	3.235
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	F-10CA	F-10CB					FC-01				
ROCK TYPE	PE	PE					PE				
ZONE	GAR	GAR					GAR				
GRAIN NO	4	1	2	3	4	4	1	1	1	2	2
POINT NO	A	A	A	A	A1	A2	A1	A2	A3	A1	A2
SIO2	24.80	24.67	24.54	24.75	24.49	24.39	24.91	24.98	24.75	24.84	24.33
AL2O3	20.71	20.46	20.22	21.00	20.52	20.40	20.22	20.24	20.42	20.18	20.61
FEO	30.44	30.76	31.26	31.17	30.42	32.31	28.96	29.05	29.96	29.06	29.40
MNO	0.28	0.15	0.30	0.23	0.09	0.40	0.15	0.11	0.28	0.14	0.20
MGO	11.50	12.34	11.72	11.89	12.57	10.96	13.18	13.76	12.75	13.47	13.07
TOTAL	87.73	88.38	88.04	89.04	88.09	88.46	87.42	88.14	88.16	87.69	87.61
ATOMIC RATIOS (O = 28.0)											
SI	5.381	5.323	5.339	5.306	5.295	5.313	5.383	5.354	5.335	5.356	5.267
AL	5.296	5.203	5.185	5.306	5.229	5.237	5.150	5.113	5.188	5.128	5.259
FE	5.523	5.551	5.688	5.588	5.500	5.886	5.234	5.207	5.401	5.240	5.323
MN	0.051	0.027	0.055	0.042	0.016	0.074	0.027	0.020	0.051	0.026	0.037
MG	3.720	3.970	3.801	3.800	4.051	3.559	4.246	4.396	4.097	4.330	4.218
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

TABLE 5. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF CHLORITES (CONTINUED)

SAMPLE NO	FC-01	FC-02			FC-03				FC-04		
ROCK TYPE	PE	PE			PE				PE		
ZONE	GAR	GAR			GAR				GAR		
GRAIN NO	3	1	2	3	1	3	3	4	1	2	3
POINT NO	A	A	A	A	A	A	A	A	A	A	A1
SIO2	25.00	24.87	24.54	24.49	24.78	24.80	24.57	24.75	24.46	24.33	24.67
AL2O3	20.24	20.68	20.88	20.51	20.33	20.21	20.17	20.02	20.26	20.05	20.15
FEO	29.12	29.13	30.32	29.57	29.21	28.72	28.80	28.66	29.98	30.38	29.60
MNO	0.11	0.10	0.31	0.16	0.18	0.12	0.16	0.12	0.15	0.17	0.11
MGO	13.84	13.10	12.20	12.81	13.37	13.48	13.32	13.71	12.80	12.60	13.14
TOTAL	88.31	87.88	88.25	87.54	87.87	87.33	87.02	87.26	87.65	87.53	87.67
ATOMIC RATIOS (O = 28.0)											
SI	5.349	5.345	5.294	5.307	5.337	5.360	5.338	5.355	5.308	5.304	5.338
AL	5.104	5.238	5.309	5.239	5.160	5.148	5.165	5.106	5.182	5.151	5.139
FE	5.211	5.236	5.470	5.359	5.261	5.191	5.233	5.186	5.441	5.539	5.356
MN	0.020	0.018	0.057	0.029	0.033	0.022	0.029	0.022	0.028	0.031	0.020
MG	4.415	4.197	3.923	4.139	4.293	4.344	4.314	4.423	4.141	4.095	4.239
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	FC-04	FSW-01P			FS-11R				HK69073108	HK69073107	HK69073101
ROCK TYPE	PE	PE			PE				PE	PE	PE
ZONE	GAR	GAR			GAR				CHL	GAR	GAR
GRAIN NO	3	1	2	3	1	1	2	2	1	1	1
POINT NO	A2	A	A	A	A1	A2	A1	A2	1	1	1
SIO2	24.37	25.53	25.10	25.20	24.75	24.71	24.89	25.09	26.10	26.10	25.90
AL2O3	20.18	19.32	19.54	19.53	19.60	19.62	19.84	19.86	21.10	20.70	21.10
FEO	30.10	30.18	30.51	30.54	29.45	29.17	29.47	29.42	29.10	28.10	29.70
MNO	0.15	0.24	0.25	0.25	0.09	0.11	0.08	0.04	0.99	1.19	0.47
MGO	12.89	12.18	12.41	12.44	13.01	12.94	13.06	13.15	10.50	11.50	12.10
TOTAL	87.69	87.45	87.81	87.96	86.90	86.55	87.34	87.56	87.79	87.59	89.27
ATOMIC RATIOS (O = 28.0)											
SI	5.292	5.549	5.449	5.460	5.404	5.410	5.401	5.424	5.607	5.602	5.478
AL	5.165	4.949	5.000	4.987	5.043	5.063	5.074	5.060	5.343	5.237	5.260
FE	5.467	5.486	5.539	5.534	5.377	5.341	5.348	5.318	5.228	5.044	5.254
MN	0.028	0.044	0.046	0.046	0.017	0.020	0.015	0.007	0.180	0.216	0.084
MG	4.173	3.947	4.017	4.018	4.234	4.224	4.225	4.238	3.363	3.680	3.815
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	HK	HK	HK
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	KU	KU	KU

TABLE 5. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF CHLORITES (CONTINUED)

SAMPLE NO	HK69073101	HK69073014		HK69073004		HK69073011	HK69072811			HK69072803	
ROCK TYPE	PE	PE		PE		PE	PE			PE	
ZONE	GAR	BIO		BIO		BIO	BIO			GAR	
GRAIN NO	2(PG)	1	2(PG)	1	1	1	1	1	2(PG)	1	1
POINT NO	1	1	1	A	B	A	A	B	1	A	B
SIO2	25.70	26.40	26.40	29.10	28.50	26.40	28.30	28.00	27.60	26.20	26.10
AL2O3	21.30	20.50	20.60	19.70	19.70	20.40	20.40	20.30	20.30	20.50	20.50
FEO	30.20	30.50	31.60	25.10	28.30	23.10	25.50	28.40	28.10	27.80	27.50
MNO	0.82	0.22	0.45	0.23	0.40	0.12	0.11	0.22	0.21	0.34	0.30
MGO	11.20	11.90	10.60	16.30	12.80	16.90	17.00	16.00	14.90	13.70	13.90
TOTAL	89.22	89.52	89.65	90.43	89.70	86.92	91.31	92.92	91.11	88.54	88.30
ATOMIC RATIOS (O = 28.0)											
SI	5.464	5.580	5.607	5.883	5.915	5.538	5.683	5.613	5.642	5.532	5.519
AL	5.337	5.107	5.157	4.693	4.819	5.044	4.828	4.796	4.891	5.102	5.109
FE	5.369	5.391	5.613	4.243	4.912	4.052	4.283	4.761	4.804	4.909	4.863
MN	0.148	0.039	0.081	0.039	0.070	0.021	0.019	0.037	0.036	0.061	0.054
MG	3.550	3.750	3.356	4.912	3.960	5.285	5.089	4.782	4.541	4.313	4.382
ANALYST	HK	HK	HK	HK	HK	HK	HK	HK	HK	HK	HK
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	HK69072610		2160	2161	HK69072605	HK69072501			HK69072505	HK69072507	
ROCK TYPE	PE		SL	SL	PE	PE			PE	PE	
ZONE	GAR		GAR	GAR	BIO	BIO			BIO	BIO	
GRAIN NO	1	1	1	1	1	1	1	2(PG)	1	1	1
POINT NO	A	B	1	1	A	A	B	1	A	A	B
SIO2	26.10	25.70	29.98	28.96	26.10	26.50	26.30	25.90	27.80	26.30	26.50
AL2O3	19.70	19.80	19.54	19.96	20.40	20.80	20.40	20.10	21.10	21.10	21.10
FEO	30.10	30.20	6.72	8.20	25.70	26.30	29.60	31.40	25.20	24.20	25.80
MNO	0.31	0.51	0.15	0.0	0.40	0.09	0.17	0.24	0.07	0.06	0.04
MGO	12.40	11.60	29.77	29.53	15.10	15.40	13.10	11.30	15.00	16.00	15.10
TOTAL	88.61	87.81	86.16	86.65	87.70	89.09	89.57	88.94	89.17	87.66	88.54
ATOMIC RATIOS (O = 28.0)											
SI	5.581	5.562	5.804	5.628	5.511	5.504	5.533	5.551	5.707	5.494	5.520
AL	4.965	5.050	4.458	4.571	5.077	5.092	5.058	5.077	5.105	5.195	5.180
FE	5.383	5.466	1.088	1.333	4.538	4.569	5.208	5.628	4.326	4.228	4.494
MN	0.056	0.093	0.025	0.0	0.072	0.016	0.030	0.044	0.012	0.011	0.007
MG	3.953	3.742	8.592	8.555	4.753	4.769	4.109	3.610	4.590	4.982	4.689
ANALYST	HK	HK	MH	MH	HK	HK	HK	HK	HK	HK	HK
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 5. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF CHLORITES (CONTINUED)

SAMPLE NO	Y-15	Y-34	X-204	X-207	X-05	X-06	X-04	X-03	X-106	23101	X-02
ROCK TYPE	BS	BS	BS	BS	BS	BS	BS	BS	BS	SL	BS
ZONE	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR
GRAIN NO	1	1	1	1	1	1	1	1	1	1	1
POINT NO	1	1	1	1	1	1	1	1	1	1	1
SIO2	25.95	25.62	27.12	27.10	25.74	27.32	26.82	28.51	27.73	28.87	29.03
AL2O3	19.46	19.59	19.13	19.43	19.66	20.22	21.51	18.70	19.14	18.26	18.22
FEO	25.65	25.07	21.13	19.32	22.94	17.31	17.90	21.12	20.68	22.73	18.62
MNO	0.18	0.22	N.D.	N.D.	0.02	0.0	N.D.	N.D.	0.02	N.D.	N.D.
MGO	15.30	18.13	18.90	18.90	17.12	23.41	21.40	19.23	20.18	19.89	21.10
TOTAL	86.54	88.63	86.28	84.75	85.48	88.26	87.63	87.56	87.75	89.75	86.97
ATOMIC RATIOS (O = 28.0)											
SI	5.559	5.351	5.671	5.710	5.503	5.473	5.421	5.852	5.680	5.829	5.920
AL	4.913	4.823	4.714	4.825	4.954	4.774	5.124	4.524	4.621	4.345	4.379
FE	4.595	4.379	3.695	3.405	4.102	2.900	3.025	3.625	3.543	3.838	3.176
MN	0.033	0.039			0.004	0.0			0.003		
MG	4.886	5.645	5.892	5.937	5.457	6.992	6.448	5.884	6.162	5.987	6.415
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH	HH	MH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	X-102	X-01	X-01B	32503	IKADAZU	77031
ROCK TYPE	BS	BS	BS	BS	BS	BS
ZONE	GAR	GAR	GAR	GAR	GAR	CHL
GRAIN NO	1	1	1	1	1	1
POINT NO	1	1	1	1	1	1
SIO2	28.51	26.93	26.81	27.14	26.55	25.92
AL2O3	18.72	20.93	22.02	19.89	19.19	17.53
FEO	21.08	16.80	16.63	17.03	18.76	23.62
MNO	N.D.	N.D.	N.D.	N.D.	0.19	0.34
MGO	19.24	22.10	21.89	22.13	22.67	17.39
TOTAL	87.55	86.76	87.35	86.19	87.36	84.80
ATOMIC RATIOS (O = 28.0)						
SI	5.851	5.470	5.397	5.560	5.439	5.635
AL	4.528	5.010	5.224	4.802	4.634	4.492
FE	3.618	2.854	2.800	2.918	3.214	4.294
MN					0.033	0.063
MG	5.887	6.692	6.569	6.759	6.924	5.636
ANALYST	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU

TABLE 6. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF AMPHIBOLES

SAMPLE NO	FT-07RB					FT-09RB					FSW-01P
ROCK TYPE	BS					BS					PE
ZONE	GAR					GAR					GAR
GRAIN NO	1	2	2	3	4	1	2	3	4	4	1
POINT NO	1	CORE	RIM	1	1	1	1	1	CORE	RIM	1
SIO2	48.30	52.35	51.50	52.17	53.34	46.22	44.74	51.54	44.90	51.21	50.27
TIO2	0.19	0.11	0.09	0.07	0.02	0.25	0.29	0.09	0.28	0.09	0.09
AL2O3	8.67	2.66	3.27	2.10	1.64	10.66	10.81	3.07	10.94	3.06	4.78
FEO	17.54	17.71	15.82	17.61	15.56	18.91	19.56	19.28	19.62	19.10	17.51
MNO	0.17	0.28	0.15	0.24	0.26	0.22	0.28	0.26	0.28	0.26	0.18
MGO	9.87	11.97	12.81	11.83	13.70	8.21	7.57	10.70	7.61	10.73	11.12
CAO	10.36	11.58	11.77	11.86	12.05	8.92	10.16	11.65	10.20	11.60	11.55
NA2O	2.37	0.90	1.07	0.83	0.64	3.45	2.77	0.90	2.73	0.88	1.11
K2O	0.34	0.10	0.12	0.09	0.06	0.34	0.46	0.15	0.46	0.15	0.21
TOTAL	97.81	97.66	96.60	96.80	97.27	97.18	96.64	97.64	97.02	97.08	96.82
ATOMIC RATIOS (O = 23.0)											
SI	7.151	7.728	7.637	7.777	7.822	6.947	6.825	7.678	6.820	7.672	7.504
TI	0.021	0.012	0.010	0.008	0.002	0.028	0.033	0.010	0.032	0.010	0.010
AL	1.513	0.463	0.572	0.369	0.283	1.888	1.944	0.539	1.958	0.540	0.841
FE	2.172	2.186	1.962	2.195	1.908	2.377	2.495	2.402	2.492	2.393	2.186
MN	0.021	0.035	0.019	0.030	0.032	0.028	0.036	0.033	0.036	0.033	0.023
MG	2.178	2.634	2.832	2.629	2.995	1.840	1.722	2.376	1.723	2.396	2.474
CA	1.643	1.832	1.870	1.894	1.893	1.436	1.661	1.860	1.660	1.862	1.847
NA	0.680	0.258	0.308	0.240	0.182	1.005	0.819	0.260	0.804	0.256	0.321
K	0.064	0.019	0.023	0.017	0.011	0.065	0.090	0.029	0.089	0.029	0.040
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	FSW-01P		FSW-04P							2151	
ROCK TYPE	PE		PE							SL	
ZONE	GAR		GAR							GAR	
GRAIN NO	2	3	1	2	2	3	3	4	5	1	1
POINT NO	1	1	1	CORE	RIM	CORE	RIM	1	1	CORE	INTER
SIO2	45.64	46.64	44.85	44.52	51.55	44.27	47.05	44.39	44.10	50.95	54.98
TIO2	0.24	0.26	0.29	0.29	0.0	0.30	0.21	0.35	0.34	0.10	0.12
AL2O3	9.30	9.45	13.78	14.66	2.48	14.08	10.15	14.12	14.03	6.11	3.73
FEO	18.34	18.70	18.55	19.00	19.31	18.53	18.03	18.47	19.40	13.83	16.50
MNO	0.11	0.12	0.04	0.01	0.11	0.02	0.03	0.02	0.13	1.09	1.74
MGO	8.47	8.60	7.13	6.49	10.74	6.95	9.28	6.91	6.42	14.04	11.89
CAO	10.35	10.55	9.10	8.11	11.85	9.03	10.01	8.30	9.27	7.29	2.78
NA2O	2.51	2.51	4.01	3.87	0.55	3.59	2.26	3.28	3.34	4.24	5.77
K2O	0.45	0.50	0.43	0.45	0.15	0.49	0.34	0.44	0.47	0.34	0.04
TOTAL	95.41	97.33	98.18	97.40	96.74	97.26	97.36	96.28	97.50	97.99	97.55
ATOMIC RATIOS (O = 23.0)											
SI	7.001	7.012	6.673	6.662	7.746	6.645	7.007	6.700	6.634	7.398	7.987
TI	0.028	0.029	0.032	0.033	0.0	0.034	0.024	0.040	0.038	0.011	0.013
AL	1.681	1.674	2.416	2.586	0.439	2.491	1.782	2.512	2.488	1.046	0.639
FE	2.353	2.351	2.308	2.378	2.427	2.326	2.246	2.331	2.441	1.679	2.004
MN	0.014	0.015	0.005	0.001	0.014	0.003	0.004	0.003	0.017	0.134	0.214
MG	1.937	1.927	1.581	1.448	2.406	1.555	2.060	1.555	1.440	3.039	2.575
CA	1.701	1.699	1.451	1.300	1.908	1.452	1.597	1.342	1.494	1.134	0.433
NA	0.746	0.732	1.157	1.123	0.160	1.045	0.653	0.960	0.974	1.194	1.625
K	0.088	0.096	0.082	0.086	0.029	0.094	0.065	0.085	0.090	0.063	0.007
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	MH	MH
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	KU	KU

TABLE 6. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF AMPHIBOLES (CONTINUED)

SAMPLE NO	2151	2160	2161	2140			Y-15	32309	32402		Y-19
ROCK TYPE	SL	SL	SL	SL			BS	BS	BS		BS
ZONE	GAR	GAR	GAR	CHL			GAR	GAR	GAR		GAR
GRAIN NO	1	1	1	1	1	1	NA-A	NA-A	NA-A	CA-A	NA-A
POINT NO	RIM	1	1	CORE	INTER	RIM	*	*	*	1	*
SIO2	55.21	49.63	49.97	53.33	55.90	56.12	54.70	54.40	55.87	52.69	56.07
TIO2	0.01	0.08	0.11	0.06	0.06	0.0	N.D.	N.D.	N.D.	0.02	0.07
AL2O3	1.08	8.29	7.97	5.47	4.37	1.27	10.68	8.95	10.17	2.26	9.03
FEO	12.01	8.27	10.05	12.20	11.43	8.62	18.92	16.53	11.84	9.56	15.60
MNO	1.75	0.0	0.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.06
MGO	16.47	17.92	15.65	15.66	16.31	19.32	8.76	7.65	11.50	19.46	8.54
CAO	10.14	8.27	7.83	5.17	3.52	8.93	0.71	0.64	1.23	11.19	0.70
NA2O	1.90	4.42	4.57	5.38	5.87	2.70	6.63	7.31	6.83	1.38	6.41
K2O	0.03	0.45	0.45	0.16	0.11	0.12	N.D.	0.03	N.D.	0.0	0.01
TOTAL	98.60	97.33	96.60	97.43	97.57	97.08	100.40	95.51	97.44	96.56	96.49
ATOMIC RATIOS (O = 23.0)											
SI	7.880	7.086	7.227	7.627	7.887	7.931	7.655	7.937	7.802	7.587	8.010
TI	0.001	0.009	0.012	0.006	0.006	0.0				0.002	0.008
AL	0.182	1.395	1.358	0.922	0.727	0.212	1.762	1.539	1.674	0.384	1.520
FE	1.434	0.987	1.215	1.459	1.349	1.019	2.214	2.017	1.383	1.151	1.864
MN	0.212	0.0	0.0								0.007
MG	3.504	3.814	3.374	3.339	3.430	4.070	1.828	1.664	2.394	4.177	1.819
CA	1.551	1.265	1.213	0.792	0.532	1.352	0.106	0.100	0.184	1.726	0.107
NA	0.526	1.223	1.281	1.492	1.606	0.740	1.799	2.068	1.849	0.385	1.775
K	0.005	0.082	0.083	0.029	0.020	0.022		0.006		0.0	0.002
ANALYST	MH	MH	MH	MH	MH	MH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	Y-34	X-204		X-207	X-05	X-101	X-103	X-06	X-04	X-03	
ROCK TYPE	BS	BS		BS	BS	BS	BS	BS	BS	BS	
ZONE	GAR	GAR		GAR	GAR	GAR	GAR	GAR	GAR	GAR	
GRAIN NO	NA-A	NA-A	CA-A	NA-A	NA-A	NA-A	NA-A	NA-A	NA-A	NA-A	CA-A
POINT NO	*	*	1	*	*	*	*	*	*	*	1
SIO2	56.83	54.59	52.01	54.75	56.85	55.17	54.04	55.33	56.77	57.55	57.32
TIO2	N.D.	0.06	0.03	0.02	0.07	0.03	0.01	0.07	0.03	0.0	0.0
AL2O3	9.65	10.93	4.00	8.43	8.50	9.27	8.86	9.90	11.50	10.21	1.77
FEO	15.34	12.69	12.76	16.00	14.23	13.35	19.19	12.20	10.07	12.62	12.96
MNO	N.D.	N.D.	N.D.	N.D.	N.D.	0.21	0.09	0.0	0.0	0.08	0.0
MGO	9.01	10.13	13.63	10.31	10.13	10.22	8.22	11.77	11.37	10.36	16.27
CAO	0.53	1.02	9.55	0.81	1.80	0.84	0.68	1.67	0.83	0.85	8.96
NA2O	6.90	6.80	2.39	7.15	6.57	6.72	6.81	6.47	7.20	6.73	2.37
K2O	N.D.	0.02	0.15	N.D.	N.D.	0.02	0.0	0.0	0.0	0.0	0.04
TOTAL	98.26	96.24	94.52	97.47	98.15	95.83	97.90	97.41	97.77	98.40	99.69
ATOMIC RATIOS (O = 23.0)											
SI	7.959	7.750	7.729	7.822	7.966	7.892	7.794	7.756	7.811	7.943	8.000
TI		0.006	0.003	0.002	0.007	0.003	0.001	0.007	0.003	0.0	0.0
AL	1.593	1.829	0.701	1.419	1.404	1.563	1.506	1.636	1.865	1.661	0.291
FE	1.797	1.507	1.586	1.912	1.668	1.597	2.315	1.430	1.159	1.457	1.513
MN						0.025	0.011	0.0	0.0	0.009	0.0
MG	1.881	2.144	3.020	2.196	2.116	2.180	1.767	2.460	2.332	2.132	3.385
CA	0.080	0.155	1.521	0.124	0.270	0.129	0.105	0.251	0.122	0.126	1.340
NA	1.873	1.872	0.689	1.981	1.785	1.864	1.904	1.758	1.921	1.801	0.641
K		0.004	0.028			0.004	0.0	0.0	0.0	0.0	0.007
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 6. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF AMPHIBOLES (CONTINUED)

SAMPLE NO	X-113	X-106		23101	23102		X-02				
ROCK TYPE	BS	BS		SL	SL		BS				
ZONE	GAR	GAR		GAR	GAR		GAR				
GRAIN NO	NA-A	NA-A	CA-A	NA-A	NA-A	NA-A	NA-A51	NA-A52	NA-A53	NA-A54	NA-A58
POINT NO	*	*	1	*	CORE	RIM	1	1	1	1	1
SIO2	57.50	56.71	51.67	56.53	55.40	55.57	56.49	55.28	56.68	55.43	56.04
TIO2	0.0	0.0	0.11	0.03	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
AL2O3	10.83	10.13	2.47	8.92	8.18	8.22	9.22	9.29	9.20	9.54	9.17
FEO	9.20	11.07	10.13	14.85	15.37	12.30	13.37	13.21	13.08	12.08	13.02
MNO	0.03	0.05	0.14	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MGO	11.60	10.79	17.74	9.92	10.22	12.94	10.15	10.14	10.10	10.66	11.05
CAO	1.73	1.12	11.27	0.76	1.05	2.20	0.94	1.14	1.12	0.81	1.32
NA2O	6.10	7.33	1.21	7.13	6.98	6.55	6.76	6.87	6.93	6.86	6.61
K2O	0.0	0.03	0.08	0.02	0.05	0.04	N.D.	N.D.	N.D.	N.D.	N.D.
TOTAL	96.99	97.23	94.82	98.16	97.25	97.82	96.93	95.93	97.11	95.38	97.21
ATOMIC RATIOS (O = 23.0)											
SI	7.923	7.903	7.608	7.937	7.901	7.794	7.964	7.896	7.972	7.907	7.885
TI	0.0	0.0	0.012	0.003							
AL	1.759	1.664	0.429	1.476	1.375	1.359	1.532	1.564	1.525	1.604	1.521
FE	1.060	1.290	1.247	1.744	1.833	1.443	1.576	1.578	1.538	1.441	1.532
MN	0.004	0.006	0.017								
MG	2.383	2.242	3.894	2.076	2.173	2.706	2.133	2.159	2.118	2.267	2.318
CA	0.255	0.167	1.778	0.114	0.160	0.331	0.142	0.174	0.169	0.124	0.199
NA	1.630	1.981	0.345	1.941	1.930	1.781	1.848	1.903	1.890	1.897	1.803
K	0.0	0.005	0.015	0.004	0.009	0.007					
ANALYST	HH	HH	HH	MH	MH	MH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	X-02									X-102	X-01
ROCK TYPE	BS									BS	BS
ZONE	GAR									GAR	GAR
GRAIN NO	NA-A59	NA-A60	NA-A61	NA-A62	NA-A63	NA-A64	NA-A65	NA-A56	CA-A	NA-A	NA-A
POINT NO	1	1	1	1	1	1	1	1	1	*	*
SIO2	55.64	54.34	56.71	56.82	56.92	55.67	56.45	55.46	54.39	55.59	55.87
TIO2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.05	0.03	0.0
AL2O3	9.28	9.70	9.40	10.16	9.59	9.60	9.52	7.77	2.39	9.47	8.48
FEO	13.10	13.04	13.42	13.08	13.93	12.85	12.94	13.26	13.46	14.47	12.47
MNO	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.10	0.0
MGO	10.17	9.84	10.40	10.37	10.09	10.70	10.27	11.38	15.95	9.66	11.18
CAO	0.88	0.87	1.05	1.06	1.03	1.12	1.15	2.52	9.23	0.96	1.17
NA2O	7.03	6.90	7.08	6.84	6.90	6.70	6.77	6.27	2.62	7.43	6.80
K2O	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	0.16	0.05
TOTAL	96.10	94.69	98.06	98.33	98.46	96.64	97.10	96.66	98.12	97.87	96.02
ATOMIC RATIOS (O = 23.0)											
SI	7.921	7.859	7.917	7.884	7.921	7.870	7.933	7.899	7.791	7.849	7.947
TI									0.005	0.003	0.0
AL	1.557	1.653	1.547	1.661	1.573	1.599	1.577	1.304	0.403	1.576	1.422
FE	1.560	1.577	1.567	1.518	1.621	1.519	1.521	1.579	1.612	1.709	1.483
MN										0.012	0.0
MG	2.158	2.122	2.164	2.145	2.093	2.255	2.152	2.416	3.406	2.033	2.371
CA	0.134	0.135	0.157	0.158	0.154	0.170	0.173	0.385	1.417	0.145	0.178
NA	1.940	1.935	1.916	1.840	1.862	1.836	1.845	1.731	0.728	2.034	1.875
K									0.005	0.029	0.009
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 6. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF AMPHIBOLES (CONTINUED)

SAMPLE NO	X-01B										
ROCK TYPE	BS										
ZONE	GAR										
GRAIN NO	NA-A01	NA-A02	NA-A03	NA-A04	NA-A05	NA-A06	NA-A07	NA-A08	NA-A10	NA-A11	NA-A12
POINT NO	1	1	1	1	1	1	1	1	1	1	1
SIO2	54.25	55.35	56.83	57.11	57.16	54.76	54.08	56.18	57.26	53.23	55.64
TIO2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
AL2O3	8.11	8.11	8.55	7.73	7.55	8.55	8.90	8.61	8.29	8.20	8.15
FEO	12.99	12.74	13.56	12.77	12.34	12.44	12.46	13.16	13.58	13.18	13.23
MNO	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MGO	11.72	11.40	10.79	11.08	11.04	11.16	11.38	11.74	11.73	11.25	11.07
CAO	2.09	0.86	0.46	0.91	1.34	2.19	0.95	1.42	0.95	1.03	0.79
NA2O	6.25	6.74	6.93	6.63	6.60	6.17	6.80	6.74	6.95	6.76	7.01
K2O	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
TOTAL	95.41	95.20	97.12	96.23	96.03	95.27	94.57	97.85	98.76	93.65	95.89
ATOMIC RATIOS (O = 23.0)											
SI	7.824	7.950	7.999	8.084	8.101	7.872	7.828	7.872	7.944	7.828	7.954
TI											
AL	1.379	1.373	1.418	1.290	1.261	1.449	1.518	1.422	1.356	1.421	1.373
FE	1.567	1.530	1.596	1.512	1.463	1.495	1.508	1.542	1.576	1.621	1.582
MN											
MG	2.520	2.441	2.264	2.338	2.333	2.392	2.456	2.452	2.426	2.466	2.359
CA	0.323	0.132	0.069	0.138	0.203	0.337	0.147	0.213	0.141	0.162	0.121
NA	1.748	1.877	1.891	1.820	1.814	1.720	1.908	1.831	1.870	1.927	1.943
K											
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	X-01B								32502	32503	IKADAZU
ROCK TYPE	BS								BS	BS	BS
ZONE	GAR								GAR	GAR	GAR
GRAIN NO	NA-A13	NA-A15	NA-A16	NA-A17	NA-A18	NA-A19	NA-A20	NA-A22	NA-A	NA-A	NA-A
POINT NO	1	1	1	1	1	1	1	1	*	*	*
SIO2	56.56	55.71	56.72	54.35	55.59	56.79	55.82	54.36	56.53	55.69	55.45
TIO2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	N.D.
AL2O3	8.65	7.76	8.61	8.67	7.67	7.81	8.29	7.85	10.21	8.40	8.90
FEO	13.03	18.37	12.40	13.93	12.87	13.86	13.40	13.55	10.55	13.23	15.16
MNO	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.06
MGO	10.87	11.54	11.00	11.12	10.94	11.33	11.10	11.14	12.35	10.70	11.01
CAO	1.66	1.69	0.80	1.32	0.71	0.80	0.85	0.77	1.79	0.82	1.70
NA2O	6.54	6.57	6.88	6.89	7.27	6.81	6.76	6.81	6.74	7.25	6.91
K2O	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	0.06	0.01
TOTAL	97.31	101.64	96.41	96.28	95.05	97.40	96.22	94.48	98.23	96.15	99.20
ATOMIC RATIOS (O = 23.0)											
SI	7.950	7.724	8.006	7.796	8.010	7.997	7.949	7.915	7.792	7.946	7.762
TI									0.003		
AL	1.433	1.268	1.432	1.466	1.303	1.296	1.391	1.347	1.659	1.413	1.468
FE	1.532	2.130	1.464	1.671	1.551	1.632	1.596	1.650	1.216	1.579	1.775
MN											0.007
MG	2.278	2.385	2.315	2.378	2.350	2.379	2.356	2.418	2.538	2.276	2.298
CA	0.250	0.251	0.121	0.203	0.110	0.121	0.130	0.120	0.264	0.125	0.255
NA	1.782	1.766	1.883	1.916	2.031	1.859	1.866	1.922	1.801	2.006	1.875
K									0.005	0.011	0.002
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 6. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF AMPHIBOLES (CONTINUED)

SAMPLE NO	IKADAZU	77207	77214	77218	77107	SB601	77031	77033
ROCK TYPE	BS	BS	BS	BS	BS	BS	BS	BS
ZONE	GAR	CHL	CHL	CHL	CHL	CHL	CHL	CHL
GRAIN NO	CA-A	NA-A	NA-A	NA-A	NA-A	NA-A	NA-A	NA-A
POINT NO	1	*	*	*	*	*	*	*
SIO2	49.39	55.48	55.13	54.30	54.78	52.58	54.74	54.63
TIO2	0.12	0.04	0.03	0.19	0.03	0.47	0.0	N.D.
AL2O3	7.05	7.06	7.03	7.00	5.65	6.15	4.11	4.52
FEO	16.51	17.68	17.62	17.81	19.20	19.81	20.40	23.36
MNO	0.11	0.10	0.14	0.09	0.10	0.20	0.08	N.D.
MGO	11.91	9.39	9.80	8.42	9.47	9.09	8.75	7.79
CAO	6.84	0.82	1.50	1.34	1.24	2.51	0.95	1.22
NA2O	4.46	7.13	6.77	6.78	6.71	5.33	6.46	6.76
K2O	0.16	0.02	0.04	0.0	0.08	0.09	0.02	N.D.
TOTAL	96.55	97.72	98.06	95.93	97.26	96.23	95.51	98.28
ATOMIC RATIOS (O = 23.0)								
SI	7.337	7.967	7.906	7.965	7.988	7.805	8.164	8.041
TI	0.013	0.004	0.003	0.021	0.003	0.052	0.0	
AL	1.234	1.195	1.188	1.210	0.971	1.076	0.722	0.784
FE	2.051	2.123	2.113	2.185	2.341	2.459	2.544	2.875
MN	0.014	0.012	0.017	0.011	0.012	0.025	0.010	
MG	2.637	2.010	2.095	1.841	2.059	2.012	1.945	1.709
CA	1.089	0.126	0.230	0.211	0.194	0.399	0.152	0.192
NA	1.285	1.985	1.882	1.928	1.897	1.534	1.868	1.929
K	0.030	0.004	0.007	0.0	0.015	0.017	0.004	
ANALYST	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 7. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF GARNETS

SAMPLE NO	FT-09RB				F-10CA						
ROCK TYPE	BS				PE						
ZONE	GAR				GAR						
GRAIN NO	1(N)	1(N)	2(N)	3(N)	1(N)	1(N)	2(N)	2(N)	3(N)	3(N)	3(N)
POINT NO	CORE	RIM	RIM	RIM	RIM	CORE	RIM	CORE	RIM1	RIM2	CORE
SIO2	36.84	36.77	36.82	36.64	37.29	37.29	37.28	36.47	36.95	37.58	36.57
AL2O3	20.62	20.39	20.82	20.70	21.04	21.27	20.74	21.06	20.84	20.95	20.81
FEO	23.60	24.66	25.09	24.91	29.79	27.10	29.46	24.91	29.03	27.54	13.27
MNO	6.35	5.50	5.39	5.35	1.29	3.23	1.58	5.00	2.20	2.57	19.57
MGO	0.69	0.69	0.67	0.67	0.82	0.58	1.26	0.48	0.68	0.63	0.16
CAO	11.18	10.61	10.86	10.80	8.65	10.65	8.75	10.62	9.12	10.06	8.31
TOTAL	99.28	98.62	99.65	99.07	98.88	100.12	99.07	98.54	98.82	99.33	98.69
ATOMIC RATIOS (O = 12.0)											
SI	2.982	2.996	2.973	2.975	3.018	2.986	3.013	2.970	3.003	3.024	2.991
AL	1.967	1.958	1.981	1.981	2.007	2.007	1.976	2.022	1.996	1.987	2.006
FE	1.597	1.680	1.694	1.691	2.016	1.815	1.991	1.697	1.973	1.853	0.908
MN	0.435	0.380	0.369	0.368	0.088	0.219	0.108	0.345	0.151	0.175	1.355
MG	0.083	0.084	0.081	0.081	0.099	0.069	0.152	0.058	0.082	0.076	0.020
CA	0.970	0.926	0.939	0.939	0.750	0.914	0.758	0.927	0.794	0.867	0.728
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

TABLE 7. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF GARNETS (CONTINUED)

SAMPLE NO	F-10CA			F-10CB					FC-01		
ROCK TYPE	PE			PE					PE		
ZONE	GAR			GAR					GAR		
GRAIN NO	4(N)	4(N)	4(N)	1(N)	2(N)	3(N)	4(N)	4(N)	1(N)	2(N)	2(N)
POINT NO	RIM1	RIM2	CORE	RIM	RIM	RIM	RIM	CORE	RIM	RIM	INTER1
SIO2	36.95	37.09	36.39	36.95	37.24	37.02	36.86	37.23	37.58	37.64	37.46
AL2O3	20.79	21.09	20.66	20.82	20.41	20.86	20.74	20.73	21.00	21.06	20.90
FEO	30.66	29.76	13.07	29.47	31.33	31.58	30.75	21.74	28.72	29.36	25.85
MNO	1.09	0.81	20.59	2.73	1.55	0.63	1.46	7.61	2.02	2.25	4.18
MGO	0.87	0.88	0.12	0.68	0.84	0.92	0.76	0.35	1.00	1.12	0.81
CAO	8.64	8.89	7.88	9.76	8.70	9.21	9.67	12.50	9.88	9.31	10.77
TOTAL	99.00	98.52	98.71	100.41	100.07	100.22	100.24	100.16	100.20	100.74	99.97
ATOMIC RATIOS (O = 12.0)											
SI	3.001	3.010	2.985	2.973	3.006	2.979	2.972	2.985	3.005	2.999	3.001
AL	1.990	2.017	1.997	1.974	1.942	1.979	1.971	1.959	1.979	1.978	1.974
FE	2.082	2.020	0.897	1.983	2.115	2.126	2.073	1.458	1.920	1.956	1.732
MN	0.075	0.056	1.431	0.186	0.106	0.043	0.100	0.517	0.137	0.152	0.284
MG	0.105	0.106	0.015	0.082	0.101	0.110	0.091	0.042	0.119	0.133	0.097
CA	0.752	0.773	0.693	0.841	0.752	0.794	0.835	1.074	0.846	0.795	0.925
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	FC-01				FC-02				FC-03		
ROCK TYPE	PE				PE				PE		
ZONE	GAR				GAR				GAR		
GRAIN NO	2(N)	2(N)	3(N)	4(N)	1(N)	1(N)	1(N)	2(N)	1(N)	2(N)	3(N)
POINT NO	INTER2	CORE	RIM	RIM	RIM1	RIM2	CORE	RIM	RIM	RIM	RIM
SIO2	37.52	37.39	37.63	37.44	37.07	37.06	37.13	37.07	37.15	37.18	37.15
AL2O3	20.98	20.96	21.06	20.64	21.00	20.96	20.77	20.96	20.82	20.85	20.83
FEO	26.23	18.45	29.78	28.70	31.32	30.74	18.80	30.43	31.02	31.62	31.32
MNO	5.61	10.05	1.95	2.02	1.41	1.23	14.60	1.79	1.39	1.24	1.29
MGO	0.82	0.45	1.04	1.01	1.03	1.07	0.32	1.00	1.09	1.17	1.11
CAO	9.86	13.22	9.63	9.88	8.84	8.82	9.34	8.39	8.56	8.46	8.89
TOTAL	101.02	100.52	101.09	99.69	100.67	99.88	100.96	99.64	100.03	100.52	100.59
ATOMIC RATIOS (O = 12.0)											
SI	2.990	2.979	2.992	3.012	2.972	2.985	2.979	2.993	2.992	2.984	2.980
AL	1.970	1.968	1.974	1.957	1.985	1.990	1.964	1.994	1.976	1.972	1.969
FE	1.748	1.229	1.980	1.931	2.100	2.071	1.262	2.055	2.089	2.122	2.101
MN	0.379	0.678	0.131	0.138	0.096	0.084	0.992	0.122	0.095	0.084	0.088
MG	0.097	0.053	0.123	0.121	0.123	0.128	0.038	0.120	0.131	0.140	0.133
CA	0.842	1.129	0.820	0.852	0.759	0.761	0.803	0.726	0.739	0.727	0.764
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

TABLE 7. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF GARNETS (CONTINUED)

SAMPLE NO	FC-03	FC-04					FSW-01P				
ROCK TYPE	PE	PE					PE				
ZONE	GAR	GAR					GAR				
GRAIN NO	3(N)	1(N)	2(N)	2(N)	3(N)	3(N)	1(N)	1(N)	2(N)	3(N)	3(N)
POINT NO	CORE	RIM	RIM	CORE	RIM1	RIM2	CORE	RIM	RIM	CORE	RIM
SIO2	36.62	37.05	36.98	36.99	37.11	37.05	36.53	37.38	37.78	36.60	37.52
AL2O3	20.38	20.49	20.45	20.77	20.68	20.69	20.38	20.82	20.69	20.75	20.90
FEO	17.82	30.48	30.91	24.17	31.29	31.14	12.57	27.87	28.28	13.57	29.47
MNO	15.35	1.47	2.01	9.01	1.76	1.17	21.62	3.17	1.95	20.53	2.23
MGO	0.32	1.00	0.97	0.49	1.01	1.13	0.18	0.86	0.91	0.18	0.94
CAO	9.06	9.13	8.44	9.81	8.89	9.07	7.49	9.31	8.76	8.14	8.99
TOTAL	99.55	99.62	99.76	101.24	100.74	100.25	98.77	99.41	98.37	99.77	100.05
ATOMIC RATIOS (O = 12.0)											
SI	2.982	2.997	2.995	2.963	2.979	2.982	2.998	3.014	3.060	2.975	3.011
AL	1.956	1.954	1.952	1.961	1.957	1.962	1.971	1.979	1.975	1.988	1.976
FE	1.214	2.062	2.094	1.619	2.101	2.096	0.863	1.879	1.915	0.923	1.977
MN	1.059	0.101	0.138	0.611	0.120	0.080	1.503	0.217	0.134	1.414	0.152
MG	0.039	0.121	0.117	0.059	0.121	0.136	0.022	0.103	0.110	0.022	0.112
CA	0.790	0.791	0.732	0.842	0.765	0.782	0.659	0.804	0.760	0.709	0.773
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

SAMPLE NO	FSW-01P	FSW-04P									
ROCK TYPE	PE	PE									
ZONE	GAR	GAR									
GRAIN NO	4(N)	1(N)	1(N)	2(N)	2(N)	3(N)	3(N)	3(N)	4(N)	5(N)	5(N)
POINT NO	RIM	RIM	CORE	RIM	INTER	RIM	CORE	INTER	RIM	RIM1	RIM2
SIO2	37.14	38.00	37.72	38.44	38.10	37.92	37.29	37.40	37.18	37.01	37.05
AL2O3	20.74	21.36	21.21	21.42	21.48	21.34	20.89	21.14	20.87	20.99	20.88
FEO	29.23	29.25	13.56	29.55	18.74	30.01	15.80	19.52	28.96	29.66	29.70
MNO	2.57	2.39	18.43	2.11	9.90	2.07	13.84	9.43	2.27	0.88	0.71
MGO	0.89	0.95	0.23	0.96	0.29	0.98	0.23	0.30	0.93	1.02	1.13
CAO	9.02	8.83	10.01	9.17	12.51	8.83	11.59	11.76	8.96	9.25	9.27
TOTAL	99.59	100.78	101.16	101.65	101.02	101.15	99.64	99.55	99.17	98.81	98.74
ATOMIC RATIOS (O = 12.0)											
SI	3.000	3.017	2.999	3.025	3.007	3.007	2.999	3.001	3.007	2.999	3.003
AL	1.974	1.999	1.987	1.986	1.998	1.994	1.980	1.999	1.989	2.004	1.994
FE	1.975	1.942	0.901	1.945	1.237	1.990	1.063	1.310	1.959	2.010	2.013
MN	0.176	0.161	1.241	0.141	0.662	0.139	0.943	0.641	0.155	0.060	0.049
MG	0.107	0.112	0.027	0.113	0.034	0.116	0.028	0.036	0.112	0.123	0.137
CA	0.781	0.751	0.853	0.773	1.058	0.750	0.999	1.011	0.776	0.803	0.805
ANALYST	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
INSTRUMENT	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

TABLE 7. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF GARNETS (CONTINUED)

SAMPLE NO	FS-11R				HK69073107		HK69073101		HK69073014	HK69073004	
ROCK TYPE	PE				PE		PE		PE	PE	
ZONE	GAR				GAR		GAR		BIO	BIO	
GRAIN NO	1(N)	2(N)	3(N)	3(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)
POINT NO	RIM	RIM	RIM	CORE	RIM	CORE	RIM	CORE	RIM	RIM	CORE
SIO2	37.51	37.45	37.35	36.65	36.10	37.40	36.00	35.60	39.30	39.20	39.40
AL2O3	20.77	20.79	20.78	20.30	21.40	21.30	21.70	21.10	21.20	20.20	20.20
FEO	30.62	29.90	28.01	12.13	17.80	8.86	27.80	18.70	31.70	30.90	20.20
MNO	0.98	0.89	3.24	22.29	17.30	24.60	4.51	16.70	0.51	0.46	15.90
MGO	1.14	1.16	0.81	0.16	0.28	0.14	0.86	0.42	1.30	2.34	0.69
CAO	8.88	9.33	9.02	7.75	6.60	7.46	10.90	8.22	9.29	7.14	6.05
TOTAL	99.90	99.52	99.21	99.28	99.48	99.76	101.77	100.74	103.30	100.24	102.44
ATOMIC RATIOS (O = 12.0)											
SI	3.013	3.013	3.019	2.997	2.946	3.014	2.873	2.892	3.044	3.105	3.103
AL	1.966	1.972	1.979	1.956	2.058	2.023	2.041	2.020	1.935	1.886	1.875
FE	2.057	2.012	1.893	0.829	1.215	0.597	1.855	1.270	2.054	2.047	1.330
MN	0.067	0.061	0.222	1.544	1.196	1.679	0.305	1.149	0.033	0.031	1.061
MG	0.137	0.139	0.098	0.020	0.034	0.017	0.102	0.051	0.150	0.276	0.081
CA	0.764	0.804	0.781	0.679	0.577	0.644	0.932	0.715	0.771	0.606	0.510
ANALYST	ME	ME	ME	ME	HK	HK	HK	HK	HK	HK	HK
INSTRUMENT	NU	NU	NU	NU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	HK69073011		HK69072811		HK69072803	HK69072605	HK69072501		HK69072505		HK69072507
ROCK TYPE	PE		PE		PE	PE	PE		PE		PE
ZONE	BIO		BIO		GAR	BIO	BIO		BIO		BIO
GRAIN NO	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)	1(N)
POINT NO	RIM	CORE	RIM	CORE	RIM	RIM	RIM	CORE	RIM	CORE	RIM
SIO2	38.50	35.60	37.60	36.60	38.50	38.40	36.20	36.80	36.50	38.40	39.20
AL2O3	20.90	21.50	21.50	20.60	21.00	21.60	20.70	20.20	21.00	20.50	21.60
FEO	32.00	24.60	31.20	16.90	24.60	29.30	31.40	11.50	30.20	18.40	31.70
MNO	0.45	13.10	0.59	14.90	4.59	1.78	0.61	21.10	0.46	15.80	0.59
MGO	2.49	0.84	2.07	0.41	0.72	1.30	2.77	0.27	2.20	0.28	1.96
CAO	6.09	4.85	7.37	8.04	11.70	9.37	7.55	9.49	8.42	7.23	8.56
TOTAL	100.43	100.49	100.33	97.45	101.11	101.75	99.23	99.36	98.78	100.61	103.61
ATOMIC RATIOS (O = 12.0)											
SI	3.053	2.900	2.992	3.017	3.036	3.012	2.935	2.997	2.958	3.073	3.021
AL	1.953	2.064	2.017	2.001	1.951	1.997	1.978	1.939	2.006	1.933	1.962
FE	2.122	1.676	2.077	1.165	1.622	1.922	2.129	0.783	2.047	1.231	2.043
MN	0.030	0.904	0.040	1.040	0.307	0.118	0.042	1.455	0.032	1.071	0.039
MG	0.294	0.102	0.246	0.050	0.085	0.152	0.335	0.033	0.266	0.033	0.225
CA	0.517	0.423	0.628	0.710	0.988	0.788	0.656	0.828	0.731	0.620	0.707
ANALYST	HK	HK	HK	HK	HK	HK	HK	HK	HK	HK	HK
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

TABLE 7. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF GARNETS (CONTINUED)

SAMPLE NO	Y-15	Y-34	X-05	X-101	23102
ROCK TYPE	BS	BS	BS	BS	SL
ZONE	GAR	GAR	GAR	GAR	GAR
GRAIN NO	1(N)	1(N)	1(N)	1(N)	1(N)
POINT NO	RIM	RIM	RIM	RIM	1
SIO2	37.96	38.22	37.29	37.58	37.39
AL2O3	20.79	21.51	20.85	20.49	20.11
FEO	26.09	27.65	29.25	27.84	13.20
MNO	3.03	2.88	2.86	3.50	21.26
MGO	0.82	1.08	3.06	2.32	2.27
CAO	12.28	10.03	8.01	7.40	5.46
TOTAL	100.97	101.37	101.32	99.13	99.69
ATOMIC RATIOS (O = 12.0)					
SI	3.008	3.010	2.954	3.026	3.019
AL	1.942	1.996	1.947	1.945	1.914
FE	1.729	1.821	1.938	1.875	0.891
MN	0.203	0.192	0.192	0.239	1.454
MG	0.097	0.127	0.361	0.279	0.273
CA	1.043	0.846	0.680	0.638	0.472
ANALYST	HH	HH	HH	HH	MH
INSTRUMENT	KU	KU	KU	KU	KU

TABLE 8. CHEMICAL COMPOSITION AND ATOMIC RATIO OF PYROXENE

SAMPLE NO	2151
ROCK TYPE	SL
ZONE	GAR
GRAIN NO	
POINT NO	
SIO2	53.16
TIO2	0.03
AL2O3	5.39
FEO	13.57
MNO	0.71
MGO	7.26
CAO	11.76
NA2O	7.40
TOTAL	99.28
ATOMIC RATIOS (O = 6.0)	
SI	2.013
TI	0.001
AL	0.241
FE	0.430
MN	0.023
MG	0.410
CA	0.477
NA	0.543
ANALYST	MH
INSTRUMENT	KU

TABLE 9. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF EPIDOTES

SAMPLE NO	FT-07RB			FT-09RB			HK69072803	2160	2161	HK69072605	HK69072501
ROCK TYPE	BS			BS			PE	SL	SL	PE	PE
ZONE	GAR			GAR			GAR	GAR	GAR	BIO	BIO
GRAIN NO	1	2	2	1	2	3	1	1	1	1	1
POINT NO	1	CORE	RIM	1	1	1	1	1	1	1	1
SIO2	37.51	37.96	37.95	38.35	38.19	38.10	39.40	37.44	37.16	39.00	39.90
AL2O3	26.99	27.11	23.70	26.54	27.32	27.34	27.70	23.28	21.81	27.70	26.70
FE2O3	8.37	7.90	12.04	8.98	6.93	6.85	7.73	13.78	14.36	7.16	8.65
MNO	0.17	0.33	0.05	0.76	0.46	0.46	N.D.	0.29	N.D.	0.40	0.05
CAO	24.30	24.33	23.84	23.60	23.92	23.94	23.00	24.12	23.63	22.70	23.30
TOTAL	97.34	97.63	97.58	98.23	96.82	96.69	97.83	98.91	96.96	96.96	98.60
ATOMIC RATIOS (O = 12.5)											
SI	2.961	2.982	3.022	3.002	3.011	3.008	3.056	2.968	3.008	3.052	3.083
AL	2.511	2.510	2.224	2.449	2.539	2.544	2.532	2.175	2.081	2.555	2.431
FE	0.497	0.467	0.721	0.529	0.411	0.407	0.451	0.822	0.875	0.422	0.503
MN	0.011	0.022	0.003	0.050	0.031	0.031		0.019		0.027	0.003
CA	2.055	2.048	2.034	1.979	2.021	2.025	1.912	2.049	2.050	1.904	1.929
ANALYST	ME	ME	ME	ME	ME	ME	HK	MH	MH	HK	HK
INSTRUMENT	NU	NU	NU	NU	NU	NU	KU	KU	KU	KU	KU

TABLE 9. CHEMICAL COMPOSITIONS AND ATOMIC RATIOS OF EPIDOTES (CONTINUED)

SAMPLE NO	2140	32309	32402	Y-19	X-05	X-101	X-103	X-06	X-04	X-03	X-113
ROCK TYPE	SL	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS
ZONE	CHL	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR	GAR
GRAIN NO	1	1	1	1	1	1	1	1	1	1	1
POINT NO	1	*	*	*	*	*	*	*	*	*	*
SIO2	37.56	38.63	38.15	37.71	38.39	36.59	37.50	37.74	39.77	39.47	38.38
AL2O3	21.80	25.50	24.43	23.55	23.02	23.58	22.73	24.42	24.69	26.37	28.16
FE2O3	15.52	11.20	11.41	13.84	14.08	13.80	14.16	12.12	12.13	12.12	6.93
MNO	0.47	N.D.	N.D.	0.13	0.48	N.D.	N.D.	N.D.	N.D.	N.D.	0.03
CAO	23.70	22.49	23.98	22.89	23.29	23.40	23.49	23.90	22.56	23.66	25.09
TOTAL	99.05	97.82	97.97	98.12	99.26	97.37	97.88	98.18	99.15	101.62	98.59
ATOMIC RATIOS (O = 12.5)											
SI	2.991	3.035	3.017	2.996	3.023	2.941	2.998	2.987	3.087	2.998	2.975
AL	2.046	2.362	2.277	2.205	2.137	2.234	2.142	2.278	2.259	2.360	2.572
FE	0.930	0.662	0.679	0.828	0.834	0.835	0.852	0.722	0.708	0.693	0.404
MN	0.032			0.009	0.032						0.002
CA	2.022	1.893	2.032	1.949	1.965	2.015	2.012	2.027	1.876	1.925	2.084
ANALYST	MH	HH	HH	HH	HH	HH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU	KU

SAMPLE NO	23102	X-02	X-102	X-01	X-01B	32502
ROCK TYPE	SL	BS	BS	BS	BS	BS
ZONE	GAR	GAR	GAR	GAR	GAR	GAR
GRAIN NO	1	1	1	1	1	1
POINT NO	1	*	*	*	*	*
SIO2	38.76	37.44	37.77	36.72	38.42	37.98
AL2O3	23.70	24.68	27.97	22.86	23.90	26.42
FE2O3	13.25	13.70	13.85	14.65	13.91	9.31
MNO	0.84	0.04	0.23	0.55	N.D.	0.12
CAO	22.85	23.34	23.33	23.34	22.74	22.07
TOTAL	99.40	99.20	103.15	98.12	98.97	95.90
ATOMIC RATIOS (O = 12.5)						
SI	3.036	2.943	2.847	2.945	3.017	3.025
AL	2.188	2.287	2.485	2.161	2.212	2.480
FE	0.781	0.810	0.786	0.884	0.822	0.558
MN	0.056	0.003	0.015	0.037		0.008
CA	1.918	1.966	1.884	2.006	1.914	1.884
ANALYST	MH	HH	HH	HH	HH	HH
INSTRUMENT	KU	KU	KU	KU	KU	KU

Table 10. Mineral assemblages and correlations between sample Nos used in this paper and those given in the referred papers. Chemical compositions of the minerals marked with ● or star (e.g.pa*) are listed in this paper.

Abbreviations: Pe=pelitic schist, Bs=basic schist, Sl=siliceous schist, Chl=chlorite zone, Gar=garnet zone, Bio=biotite zone, Qz=quartz, Ab=albite, Ms=muscovite, Pa=paragonite, Bt=biotite, Ch=chlorite, Am=amphibole, Hb=hornblende, Px=pyroxene, Ga=garnet, Ep=epidote, Pi=piemontite, Al=allanite, Cc=calcite, To=tourmaline, Ap=apatite, Sp=sphene, Il=ilmenite, Ru=rutile, Hm=hematite, Po=pyrrhotite, Py=pyrite, Cp=chalcopyrite, Cv=covelline, Cm=carbonaceous matter, ○, ●=present, −=absent.

(a) Sazare area

Sample No.	Rock type	Mineral zone	Qz	Ab	Ms	Bi	Ch	Hb	Ga	Ep	Cc	To	Ap	Sp	CM	others	Banno & Kurata (1972)	Kurata (1972)	Kurata & Banno (1974)	Enami (1980)
FT-07RB	Bs	Gar	o	o	●	-	●	●	-	●	o	-	-	o	-	Py,Cp,Cv				
FT-09RB	Bs	Gar	o	●	●	-	●	●	●	●	-	-	-	o	-	Po,Py,Cp				FT-09R
F-10CA	Pe	Gar	o	o	●	-	●	-	●	o	-	o	o	o	o					F-10C
F-10CB	Pe	Gar	o	o	o	-	●	-	●	o	-	o	o	o	o					
FC-01	Pe	Gar	o	o	o	-	●	-	●	o	-	o	o	o	o					FC-01
FC-02	Pe	Gar	o	o	o	-	●	-	●	o	-	o	o	o	o					
FC-03	Pe	Gar	o	o	o	-	●	-	●	o	-	o	o	o	o					
FC-04	Pe	Gar	o	o	o	-	●	-	●	o	-	o	o	o	o	Al				
FSW-01P	Pe	Gar	o	o	●	●	●	●	●	o	-	o	o	o	o					FSW-01P
FSW-04P	Pe	Gar	o	o	o	●	o	●	●	o	-	o	o	o	o					
FS-11R	Pe	Gar	o	o	●	-	●	-	●	o	-	o	o	o	o					
HK69073108	Pe	Chl	o	o	●	-	●	-	-	o	o	o	o	o	o			1	1	
HK69073107	Pe	Gar	o	o	●	-	●	-	●	o	o	o	o	o	o		2	2	2	
HK69073101	Pe	Gar	o	o	●	-	●	-	●	o	o	o	o	o	o		4		4	
HK69073014	Pe	Bio	o	o	●	-	●	-	●	-	-	o	o	o	o			5	5	
HK69073004	Pe	Bio	o	o	●	-	●	-	●	-	-	o	o	o	o		7		7	
HK69073011	Pe	Bio	o	o	●	●	●	o	●	-	-	o	o	o	o		11	11	11	
HK69072811	Pe	Bio	o	o	●	-	●	-	●	o	-	o	o	o	o		13		13	
HK69072803	Pe	Gar	o	o	●	-	●	-	●	●	o	o	o	o	o				17	
2151	Sl	Gar	o	o	o	-	-	●	o	o	o	o	o	o	-	Px*,Pi,Hm				
HK69072610	Pe	Gar	o	o	●	-	●	-	-	o	-	o	o	-	o				19	
2160	Sl	Gar	o	o	o	-	●	●	-	●	o	-	-	-	-	Hm				
2161	Sl	Gar	o	o	o	-	●	●	-	●	o	-	-	o	-	Hm				
HK69072605	Pe	Bio	o	o	●	-	●	-	●	●	-	o	o	-	o				22	
HK69072501	Pe	Bio	o	o	●	-	●	-	●	●	o	o	o	o	o		25	25	25	
HK69072505	Pe	Bio	o	o	o	o	●	-	●	o	o	o	o	o	o		26		26	
HK69072507	Pe	Bio	o	o	●	●	●	-	●	-	-	o	o	-	o		27		27	
2140	Sl	Gar	o	o	●	-	o	●	-	●	o	-	o	o	-	Hm				

(b) Kotu area

Sample No.	Rock type	Mineral zone	Qz	Ab	Ms	Ch	Am	Ga	Ep	Cc	Sp	Ru	Op	others	Hosotani & Banno (in prep.)
Y-15	Bs	Gar	o	o	●	●	●	●	o	-	-	-	o		Y-15
32309	Bs	Gar	o	o	o	o	●	-	●	-	o	-	o		
32402	Bs	Gar	o	o	o	o	●	-	●	-	o	-	o		
Y-19	Bs	Gar	o	o	●	o	●	-	●	-	-	o	o	Hm	
Y-34	Bs	Gar	o	o	o	●	●	●	o	-	-	-	o	Py	Y-34
X-204	Bs	Gar	o	o	o	●	●	-	o	-	o	-	o	Py	X-204
X-207	Bs	Gar	o	o	●	●	●	-	o	o	-	o	o	Hm	
X-05	Bs	Gar	o	o	o	●	●	●	●	-	-	o	o		X-05
X-101	Bs	Gar	o	o	o	o	●	●	●	-	-	o	o		X-101
X-103	Bs	Gar	o	o	o	-	●	o	●	-	-	o	o	Hm,Il	X-103
X-06	Bs	Gar	o	o	o	●	●	-	●	o	o	o	o		X-06
X-04	Bs	Gar	o	o	o	●	●	-	●	-	-	o	o		X-04
X-03	Bs	Gar	o	o	o	●	●	-	●	-	-	o	o		X-03
X-113	Bs	Gar	o	o	o	o	●	-	●	-	o	o	o	Py	X-113
X-106	Bs	Gar	o	o	●	●	●	-	o	-	-	o	o		X-106
23101	Sl	Gar	o	o	o	●	●	o	o	-	o	o	o	To,Ap,Hm	
23102	Sl	Gar	o	o	●	o	●	●	●	-	o	o	o	Pa*,To,Hm	
X-02	Bs	Gar	o	o	o	●	●	-	●	-	o	o	o		X-02
X-102	Bs	Gar	o	o	o	●	●	o	●	-	o	o	o	Hm	X-102
X-01	Bs	Gar	o	o	o	●	●	-	●	o	-	o	o	Hm	X-01
X-01B	Bs	Gar	o	o	o	●	●	-	●	o	-	o	o	Hm	X-01B
32502	Bs	Gar	o	o	o	o	●	-	●	-	-	o	o		32502
32503	Bs	Gar	o	o	o	●	●	-	o	-	-	o	o		32503

(c) Bessi area

Sample No.	Rock type	Mineral zone	Qz	Ab	Ms	Ch	Am	Ep	Cc	Sp	Ru	Hm
IKADAZU	Bs	Gar	o	o	o	●	●	o	-	-	o	o
77207	Bs	Chl	o	o	o	o	●	o	-	-	-	o
77214	Bs	Chl	o	o	o	o	●	o	-	o	-	o
77218	Bs	Chl	o	o	o	o	●	o	o	-	-	o
77107	Bs	Chl	o	o	o	o	●	o	o	o	-	o
SB601	Bs	Chl	o	o	o	o	●	o	o	-	-	o
77031	Bs	Chl	o	o	o	●	●	o	-	o	-	o
77033	Bs	Chl	o	o	o	o	●	o	-	-	-	o