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Article

Modes of occurrence and chemical compositions of amphiboles from the Seba eclogitic basic schists in the Sambagawa metamorphic belt, central Shikoku, Japan

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Abstract

Eclogite in the Seba eclogitic basic schists consists mainly of garnet, clinopyroxene, amphibole, epidote and phengite, along with a small amount of rutile, albite and quartz. Amphiboles in the Seba eclogitic basic schists have a variety of modes of occurrence (Amp 1～11) and a wide range of chemical compositions, i.e. sodic, sodic-calcic and calcic amphiboles. Amphiboles (Amp1) occurring as inclusions in the cores of porphyroblastic garnets are classified as glaucophane, winchite, barroisite, taramite and Mg-taramite. The mantles and rims of the garnets contain inclusions of sodic-calcic amphiboles (Amp1; e.g. barroisite, ferro-barroisite, taramite, Mg-taramite, katophorite and Mg-katophorite). Amphiboles (Amp2) found as inclusions in clinopyroxenes are barroisite, whereas those occurring as inclusions (Amp3) in phengites are barroisite and Mg-katophorite. Amphiboles (Amp4) in the matrix of the eclogites are zoned, with winchite cores, barroisite/Mg-katophorite mantles, and Mg-hornblende rims. Amphiboles (Amp5) occurring as a constituent of aggregates surrounding garnets are barroisite, Mg-katophorite, and Mg-taramite. Amphibole (Amp6) along the cracks of the porphyroblastic garnets is barroisite. Amphiboles (Amp7) as a constituent of symplectite after omphacite, together with aegirine-augite are barroisite, edenite, actinolite, and Mg-hornblende, Mg-hastingsite, and pargasite. Large grains of strongly zoned amphiboles (Amp8) sporadically overgrow the matrix schistosity. These amphiboles have glaucophane cores, barroisite/Mg-katophorite/Mg-taramite mantles, and edenite/Mg-hornblende rims. Their outermost rims are occasionally decomposed into symplectitic aggregates of edenite/Mg-hornblende (Amp9) and albite. The glaucophane cores of the amphiboles (Amp8) contain inclusions of barroisite (Amp10) with resorbed shapes, along with symplectitic aggregates of barroisite/Mg-katophorite/Mg-taramite (Amp11) and albite. The variety of modes of occurrence and chemical compositions of the amphiboles reflects three metamorphic events: a precursor metamorphic event, a first high-pressure eclogitic metamorphic event, and a second high-pressure glaucophane-barroisitic metamorphic event.

Key words: Sambagawa (Sanbagawa) metamorphic belt, Seba (Sebadani) amphibole, glaucophane, barroisite

Introduction

The Sambagawa metamorphic belt is a high-pressure intermediate type metamorphic belt (Miyashiro, 1973) consisting mainly of pelitic and basic schists, and a small volume of siliceous and psammitic schists. Metamorphic grade ranges from the pumpellyite-actinolite facies through the blueschist/greenschist facies to the epidote-amphibolite facies (e.g. Banno, 1964; Higashino, 1990; Enami *et al*., 1994). In the Besshi district in central Shikoku the metamorphism is divided into chlorite, garnet, albite-biotite and oligoclase-biotite zones (Enami, 1983; Higashino, 1990), based on the appearance of index minerals in pelitic schists (Fig. 1). The peak metamorphic conditions of the albite-biotite and oligoclase-biotite zones correspond to the epidote-amphibolite facies metamorphic conditions. Several coarse-grained eclogite-bearing ultramafic and mafic bodies occur within the albite-biotite and oligoclase-biotite zones, such as the Higashi-akaishi peridotite mass, the Western Iratsu mass, Seba eclogitic basic schists, Sebadani metagabbro, the Eastern Iratsu metagabbro mass, and the Tonaru metagabbro mass (Fig. 1; e.g. Takasu 1984, 1989; Kunugiza *et al*., 1986; Aoya, 2001; Kugimiya and Takasu, 2002; Ota *et al*., 2004). These ultramafic-mafic masses underwent extensive recrystallization under epidote-amphibolite facies conditions. However, they locally preserve evidence of eclogite facies metamorphism (e.g. Takasu, 1989; Wallis and Aoya, 2000; Ota *et al*., 2004).

The Sebadani area is located in the central part of the Besshi district, and is mainly composed of the Seba basic schists, with intercalated pelitic and siliceous schists. Eclogites (Seba eclogitic basic schists) are sporadically preserved in the Seba basic schists (Aoya, 2001; Zaw Win Ko *et al*., 2005; Kabir and Takasu, 2009). These eclogites experienced three distinct metamorphic events (Kabir and Takasu, 2010a, b). These are a precursor metamorphic event (amphibolite facies), a first high-pressure metamorphic event (eclogite facies), and a second high-pressure metamorphic event (epidote-amphibolite facies). The Onodani eclogites preserved within the Seba basic schists have a complex metamorphic history, undergoing three different metamorphic episodes during multiple burial and exhumation cycles (Kabir and Takasu, 2010c). These episodes were first and the second high-pressure metamorphic events of the eclogite facies, and a third high-pressure metamorphic event of the epidote-amphibolite facies. Because of this

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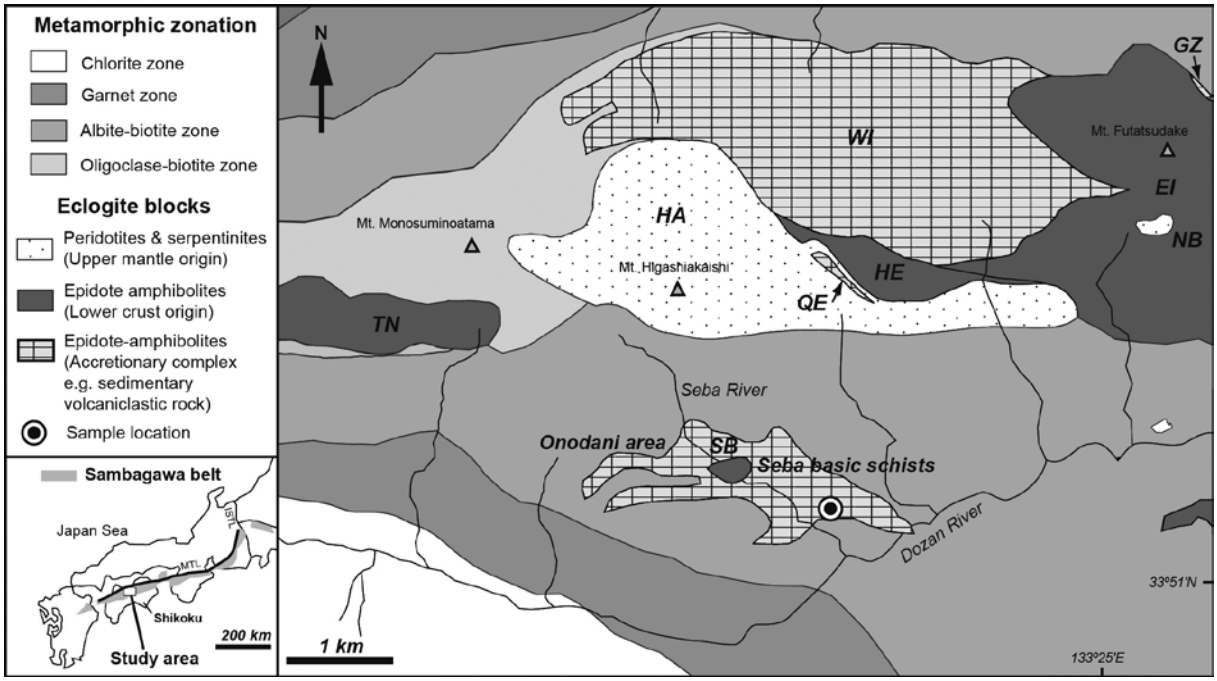

Fig. 1. Geological and metamorphic zonation map of the Sambagawa metamorphic belt in the Besshi district, central Shikoku, Japan (compiled from Takasu and Makino, 1980; Takasu, 1989; Higashino, 1990; Kugimiya and Takasu, 2002; Sakurai and Takasu, 2009). SB, Sebadani metagabbro mass; TN, Tonaru metagabbro mass; WI, Western Iratsu mass; EI, Eastern Iratsu mass; HA, Higashi-akaishi peridotite mass; QE, Quartz eclogite mass; HE, Hornblende eclogite mass; NB, Nikubuchi peridotite mass; GZ, Gazo eclogite mass.

complex metamorphic history, amphiboles in the Seba eclogitic basic schists exhibit a variety of modes of occurrence and variable chemical compositions.

In this paper we describe the diverse textures and variable chemical compositions of the amphiboles from the Seba eclogitic basic schists. The amphibole classification follows Leake *et al*. (1997), and mineral abbreviations used in the text, tables and figures follow Whitney and Evans (2010).

Petrography and the modes of occurrence of amphiboles

The Seba eclogitic basic schists consist mainly of garnet, clinopyroxene (omphacite/aegirine-augite), sodic, sodic-calcic and calcic-amphiboles, epidote and phengite, with a small amount of rutile, titanite, albite, hematite and quartz (Fig. 2a). Chlorite, paragonite and carbonates (calcite and ankerite) occur occasionally. Garnets occur as euhedral to subhedral porphyroblasts up to 5 mm in diameter. The cores of the garnets contain inclusions of sodic and sodic-calcic amphiboles (e.g. glaucophane, winchite, barroisite), epidote (X_{Ps} = 0.24-0.29), paragonite, albite (An < 3), titanite, hematite, chlorite, calcite and quartz. The mantles of the garnets contain inclusions of omphacite (X_{Jd} = 0.25-0.39), sodic-calcic amphiboles (e.g. barroisite, taramite, katophorite), epidote (X_{Ps} = 0.24-0.32), phengite (Si = 6.65-6.81 pfu), rutile, titanite, albite (An < 3), chlorite, and quartz (Kabir and Takasu, 2010a). A schistosity is defined by preferred orientation of phengite, and a lineation on the schistosity is defined by aligned prismatic omphacite and sodic-calcic/calcic-amphibole (Kabir and Takasu, 2010a).

Amphiboles in the Seba eclogitic basic schists display eleven different modes of occurrence (Amp1-11). Amphiboles (Amp1) occur as inclusions in the porphyroblastic garnets. The amphibole inclusions in the cores of the garnets occur as subhedral prismatic crystals up to 2 mm long. They are sodic and sodic-calcic amphiboles (glaucophane, winchite, barroisite, taramite, Mg-taramite) (Fig. 2b,c). The mantles and rims of the garnets contain sodic-calcic amphiboles such as barroisite, ferro-barroisite, taramite, Mg-taramite, katophorite, and Mg-katophorite (Fig. 2a,c). They occur as discrete or polyphase inclusions with omphacite (X_{Jd} = 0.25-0.39), epidote, phengite (Si = 6.65-6.81 pfu), rutile, titanite, albite (An < 3), chlorite, and quartz. Amphibole inclusions also occur within omphacites (Amp2; barroisite) and phengites (Amp3; barroisite, Mg-katophorite).

Amphiboles (Amp4; sodic-calcic and calcic-amphiboles) occur in the matrix as subhedral prismatic grains up to 1.5 mm in length, some of which are zoned from winchite cores through barroisite/Mg-katophorite mantles to Mg-hornblende rims. Porphyroblastic garnets are occasionally surrounded or replaced by aggregates consisting of epidote, albite, phengite, chlorite, quartz, and sodic-calcic amphiboles (Amp5; e.g. barroisite, Mg-katophorite, Mg-taramite). Amphibole (Amp6; barroisite) is also found along the cracks in porphyroblastic garnets. Amp7 is a constituent

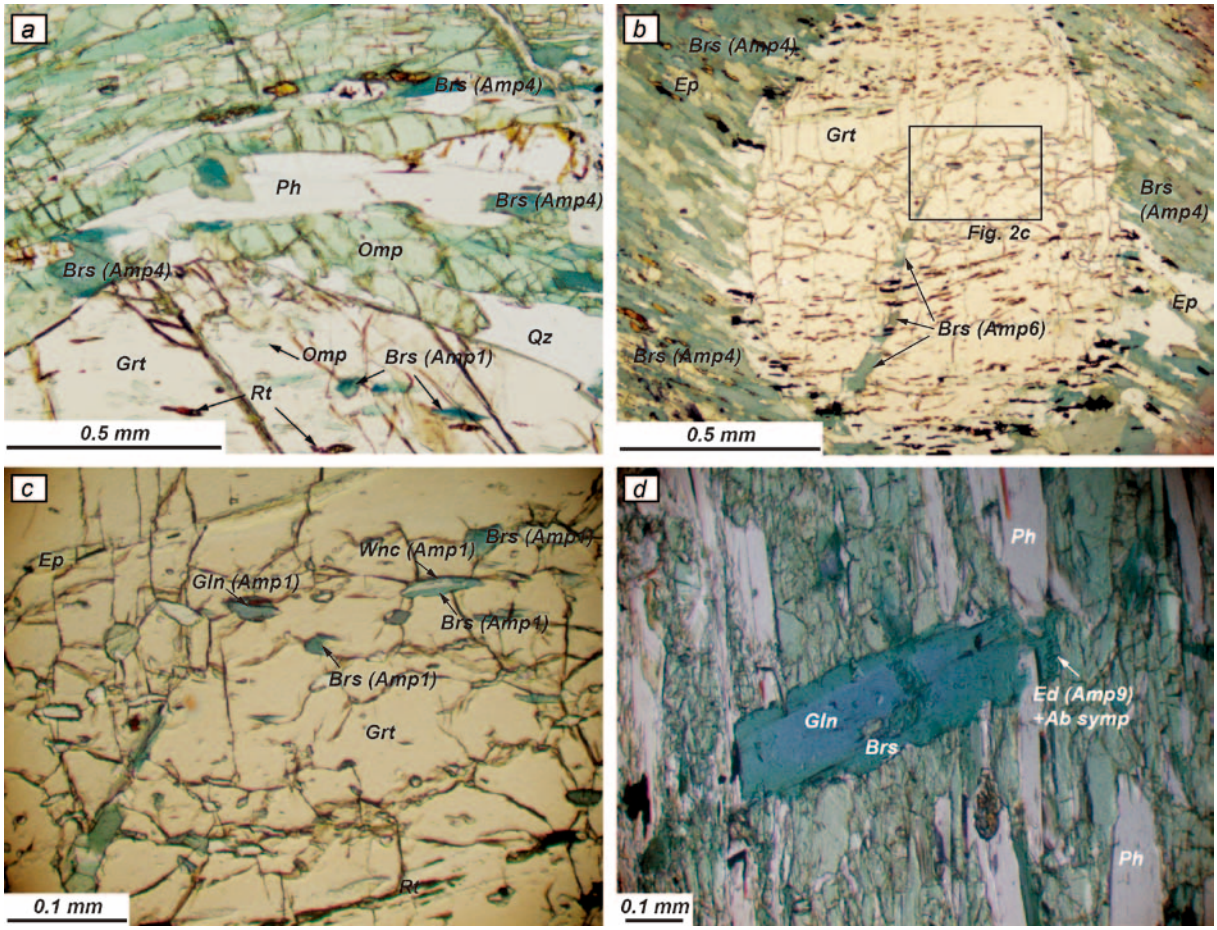

Fig. 2. Photomicrographs of eclogite from the Seba eclogitic basic schists showing: (a) porphyroblastic garnet and schistosity-forming omphacite, barroisitic amphibole (Amp4), phengite, and quartz. The garnet contains inclusions of omphacite, barroisitic amphibole (Amp1), and rutile. (b) Porphyroblastic garnet containing numerous inclusions. Amp6 (barroisite) occurs in a crack in the garnet. (c) Garnet core containing inclusions of sodic- and sodic-calcic amphibole (Amp1; glaucophane, winchite, barroisite), epidote, and rutile. (d) Strongly-zoned amphibole (Amp8) with glaucophane core and barroisite mantle rimmed by edenite/ edenite-albite symplectite (Amp9). Amp8 obliquely overgrows the matrix schistosity.

of symplectite together with amphibole and aegirine-augite (X_{Jd} = 0.10-0.19) after omphacite, occurring as subhedral to anhedral crystals up to 0.2 mm in diameter. Amp7 is classified as barroisite, edenite, actinolite and Mg-hornblende, Mg-hastingsite, and pargasite (Fig. 3a). Large grains of strongly zoned amphibole (Amp8) obliquely overgrow the matrix schistosity (Kabir and Takasu, 2010a). These occur as subhedral to anhedral prismatic grains up to 2.5 mm in length (Fig. 2d), showing distinct optical zoning with purple cores, pale green/bluish green mantles, and pale green to green rims. They are chemically zoned with glaucophane cores, barroisite/Mg-katophorite/Mg-taramite mantles, and edenite/Mg-hornblende rims (Fig. 3b-d). The outermost rims of the amphiboles are occasionally decomposed into symplectitic aggregates of edenite/Mg-hornblende (Amp9) and albite (An < 4) (Fig. 3b-d). Glaucophane cores contain inclusions of barroisite (Amp10), and symplectitic aggregates of barroisite/Mg-katophorite/Mg-taramite (Amp11) and albite (An < 3) (Figs. 3b-d).

Chemical compositions of the amphiboles

Chemical compositions and zoning of the amphiboles in the Seba eclogitic basic schists were investigated using an electron microprobe analyzer (JEOL JXA 8800M) at Shimane University. Analytical conditions used for quantitative analysis were 15 kV accelerating voltage, 20 nA specimen current and 5 μm beam diameter. Data correction was made using the procedure of Bence and Albee (1968), and Fe^{3+} estimation for amphibole used the 13eCNK method (Leake *et al*., 1997).

Analyses of amphiboles from all modes of occurrences are plotted in Figs. 4 and 5. Mn (< 0.02 pfu) and Cr (< 0.01 pfu) contents are negligible. Amphibole (Amp1) inclusions in the cores of the porphyroblastic garnets are classified as sodic and sodic-calcic-amphiboles (Fig. 4a; Table 1). Sodic-amphiboles are classified as glaucophane, with Si = 7.32-7.68 pfu, Na_B = 1.51-1.71 pfu, X_{Mg} (Mg/Mg + Fe^{2+}) = 0.60-0.76, Ti = 0-0.05 pfu and K = 0.01-0.02 pfu (Fig. 4a). Sodic-calcic-amphiboles inclusions in the cores are winchite

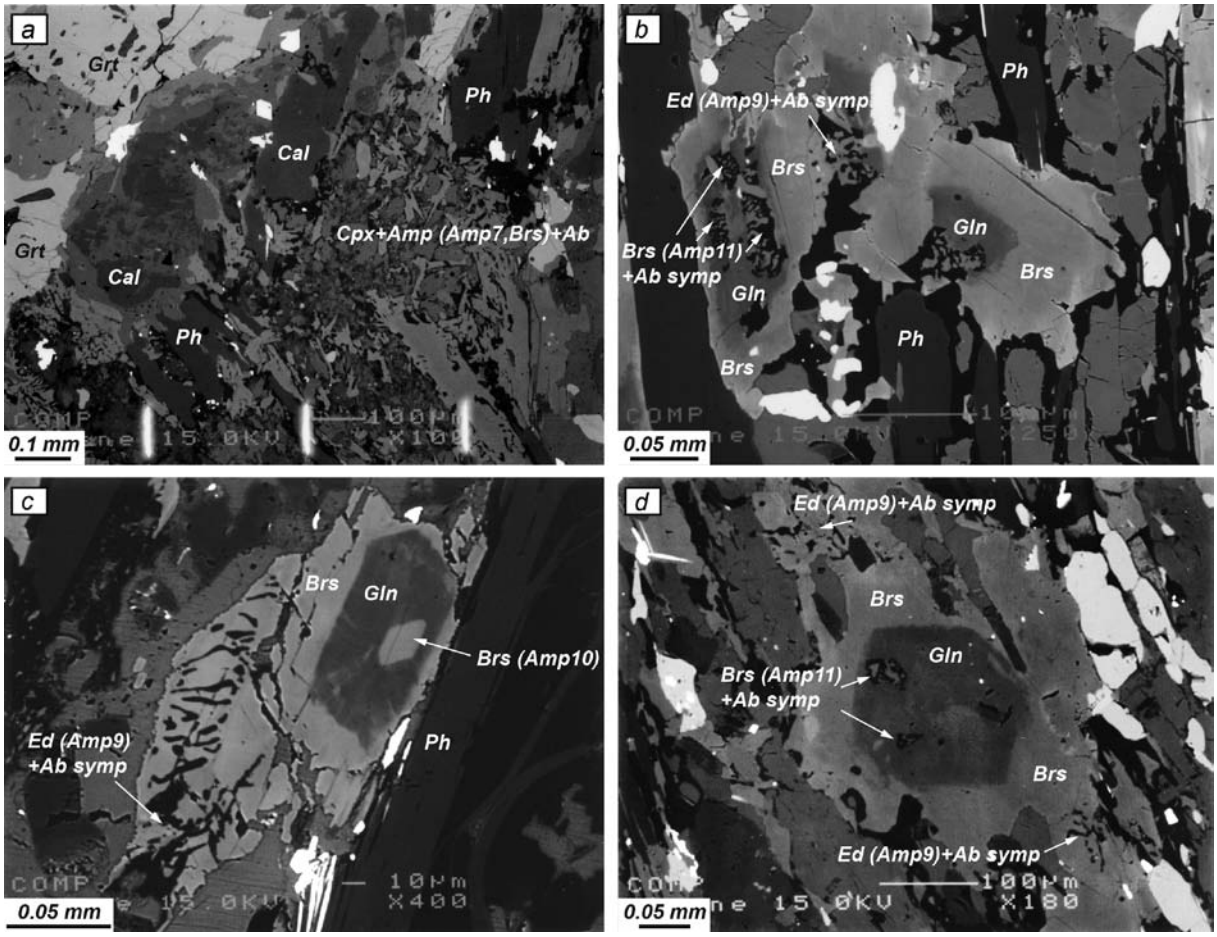

Fig. 3. Backscattered electron images of amphiboles from the Seba eclogitic basic schists. (a) Omphacites replaced by symplectites of jadeite-poor clinopyroxene (X_{Jd} = 0.10-0.19), amphibole (Amp7; barroisite) and albite. (b) Strongly zoned amphiboles (Amp8) with glaucophane core, barroisite mantle, and edenite (Amp9)-albite symplectite at the rim. The core contains inclusions of symplectitic aggregates of barroisite (Amp11) and albite. (c) Amphibole (Amp8) showing zoning with glaucophane core and barroisite mantle, surrounded by symplectitic aggregates of amphibole (Amp9; edenite) and albite at the rim. The core contains an inclusion of barroisite (Amp10). (d) Glaucophane core (Amp8) containing inclusions of symplectitic aggregates of barroisite (Amp11) and albite.

and barroisite with Si = 6.82-7.56 pfu, Na_B = 0.95-1.43 pfu, X_{Mg} = 0.66-0.86, Ti = 0-0.01 pfu and K = 0.01-0.02 pfu. Some relict sodic-calcic amphibole inclusions in garnet cores are classified as taramite and Mg-taramite, and have lower Si (Si = 5.99-6.12 pfu, Na_B = 0.55-0.72 pfu and X_{Mg} = 0.49-0.83), higher Al_2O_3 (< 18 wt.%), Ti (Ti = 0-0.10 pfu; TiO_2 < 0.90 wt.%) and K (0.05-0.15 pfu) contents. Amphibole inclusions in the mantles and rims of the porphyroblastic garnets found as discrete and polyphase inclusions are classified as sodic-calcic amphiboles (e.g. barroisite, ferro-barroisite, taramite, Mg-taramite, katophorite, Mg-katophorite), with compositional ranges of Si = 5.78-7.33 pfu, Na_B = 0.51-1.47 pfu, X_{Mg} = 0.35-0.76, Ti = 0-0.08 pfu and K = 0.01-0.15 pfu. Amphibole (Amp2) inclusions in the matrix clinopyroxenes (X_{Jd} = 0.25-0.48) are barroisite with Si = 7.02-7.08 pfu, Na_B = 0.82-0.93 pfu, X_{Mg} = 0.65-0.73, Ti = 0.03-0.04 pfu and K = 0.06-0.07 pfu. Amp3 in phengites (Si = 6.62-6.88 pfu) are barroisite and Mg-katophorite with Si = 6.68-7.19 pfu, Na_B = 0.75-1.09 pfu, X_{Mg} = 0.61-0.73, Ti = 0.02-0.05 pfu and K = 0.05-0.12 pfu, similar to the compositions of the amphibole inclusions in the garnets.

Amp4 in the matrix is sometimes zoned, with winchite cores to barroisite/Mg-katophorite mantles, decreasing in Si (7.49-6.52 pfu), Na_B (1.30-0.51 pfu) and X_{Mg} (0.74-0.62) and increasing Ti (0.01-0.06 pfu) and K (0.03-0.16 pfu); in the Mg-hornblende rims, Si (from 6.52 to 7.09 pfu) and X_{Mg} (from 0.62 to 0.72) increase, and Ti (from 0.06 to 0.03 pfu), K (from 0.16 to 0.09 pfu) and Na_B (from 0.51 to 0.47 pfu) decrease slightly. Amphiboles surrounding garnets (Amp5) with epidote and albite are barroisite, Mg-katophorite and Mg-taramite (Si = 6.22-6.82 pfu, Na_B = 0.65-0.82 pfu, X_{Mg} = 0.59-0.68, Ti = 0.02-0.04 pfu and K = 0.05-0.10 pfu). Amp6 (barroisite) filling cracks in the garnets have higher Si (6.83-6.95 pfu), Na_B (0.95-1.04 pfu) and X_{Mg} (0.68-0.73) contents, and slightly lower Ti (0.02-0.03 pfu) and K (0.04-0.05 pfu) than the amphiboles (Amp5) surrounding the garnets. Amp7 is a constituent of symplectite together with aegirine-augite (X_{Jd} = 0.10-0.19) and albite after omphacite (X_{Jd} = 0.25-0.48), and is classified as barroisite, edenite, and actinolite with Si = 6.50-7.75 pfu, Na_B = 0.26-1.08 pfu, X_{Mg} = 0.51-0.86, Ti = 0.01-0.07 pfu

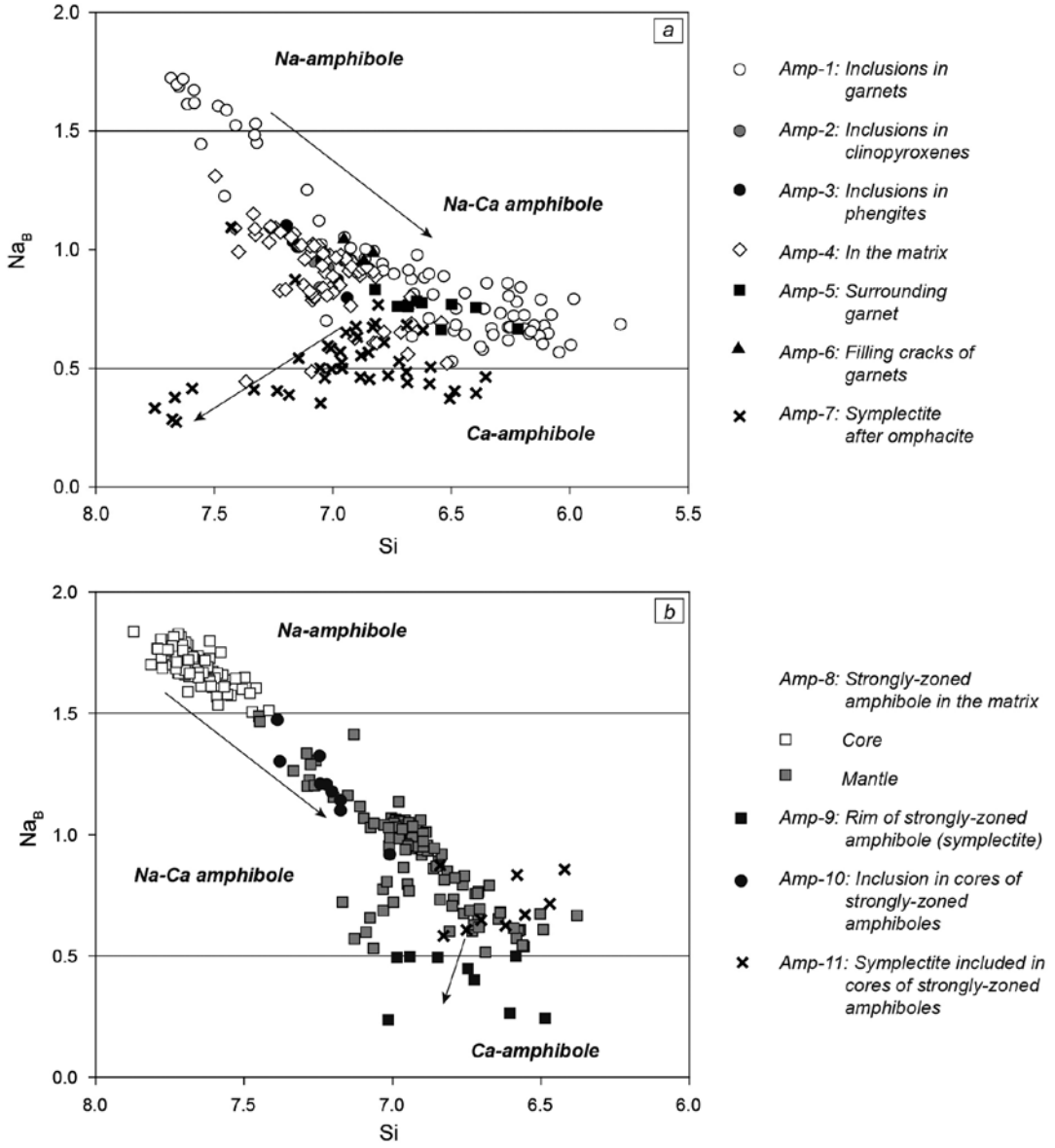

Fig. 4. (a) Chemical compositions of amphiboles in the Seba eclogitic basic schists. Arrows indicate core to rim variations. (b) Chemical compositions of strongly zoned amphiboles (Amp8).

and K = 0.01-0.17 pfu, and Mg-hornblende, Mg-hastingsite and pargasite with Si = 6.35-7.33 pfu, Na_B = 0.34-0.48 pfu, X_{Mg} = 0.55-0.72, Ti = 0.01-0.07 pfu and K = 0.06-0.17 pfu. Amphiboles (Amp7; barroisite, edenite, Mg-hornblende) occurring in symplectites with albite after omphacite have compositions of Si = 6.59-6.90 pfu, Na_B = 0.42-0.75 pfu, X_{Mg} = 0.58-0.70, Ti = 0.02-0.07 pfu and K = 0.07-0.17 pfu, whereas symplectitic amphiboles (Amp10; barroisite, Mg-katophorite and Mg-taramite) within the glaucophane cores of the large amphiboles have similar compositions to the symplectite after omphacite (Si = 6.42-6.84 pfu, Na_B = 0.58-0.88 pfu, X_{Mg} = 0.54-0.70, Ti = 0.02-0.04 pfu and K = 0.10-0.16 pfu). Amphiboles occurring as inclusions in glaucophane in the cores of the strongly zoned amphiboles are barroisite/Mg-katophorites, (Amp10) with Si = 7.01-7.39 pfu, Na_B = 0.92-1.47 pfu, X_{Mg} = 0.60-0.68, Ti = 0.01-0.03 pfu and K = 0.03-0.05 pfu.

The cores of the strongly zoned amphiboles (Amp8) are classified as glaucophane, and have compositions of Si = 7.42-7.87 pfu, Na_B = 1.51-1.84 pfu, X_{Mg} = 0.60-0.73, Ti = 0-0.02 pfu and K = 0.01-0.03 pfu (Figs. 4b, 5a). The barroisite/Mg-katophorite/Mg-taramite mantles have lower Si = 6.38-7.45 pfu, Na_B = 0.52-1.49 pfu, X_{Mg} = 0.51-0.81, Ti = 0.01-0.05 pfu and K = 0.02-0.20 pfu (Fig. 5b-c). The outermost edenite/Mg-hornblende (Amp9) rims have Si = 6.49-7.13 pfu, Na_B = 0.23-0.49 pfu, X_{Mg} = 0.49-0.70, Ti = 0.01-0.03 pfu and K = 0.09-0.19 pfu (Figs. 4b and 5d-e).

Discussion and conclusions

Amphiboles in the Seba eclogitic basic schists exhibit several modes of occurrence (Amp 1~11) and a wide range

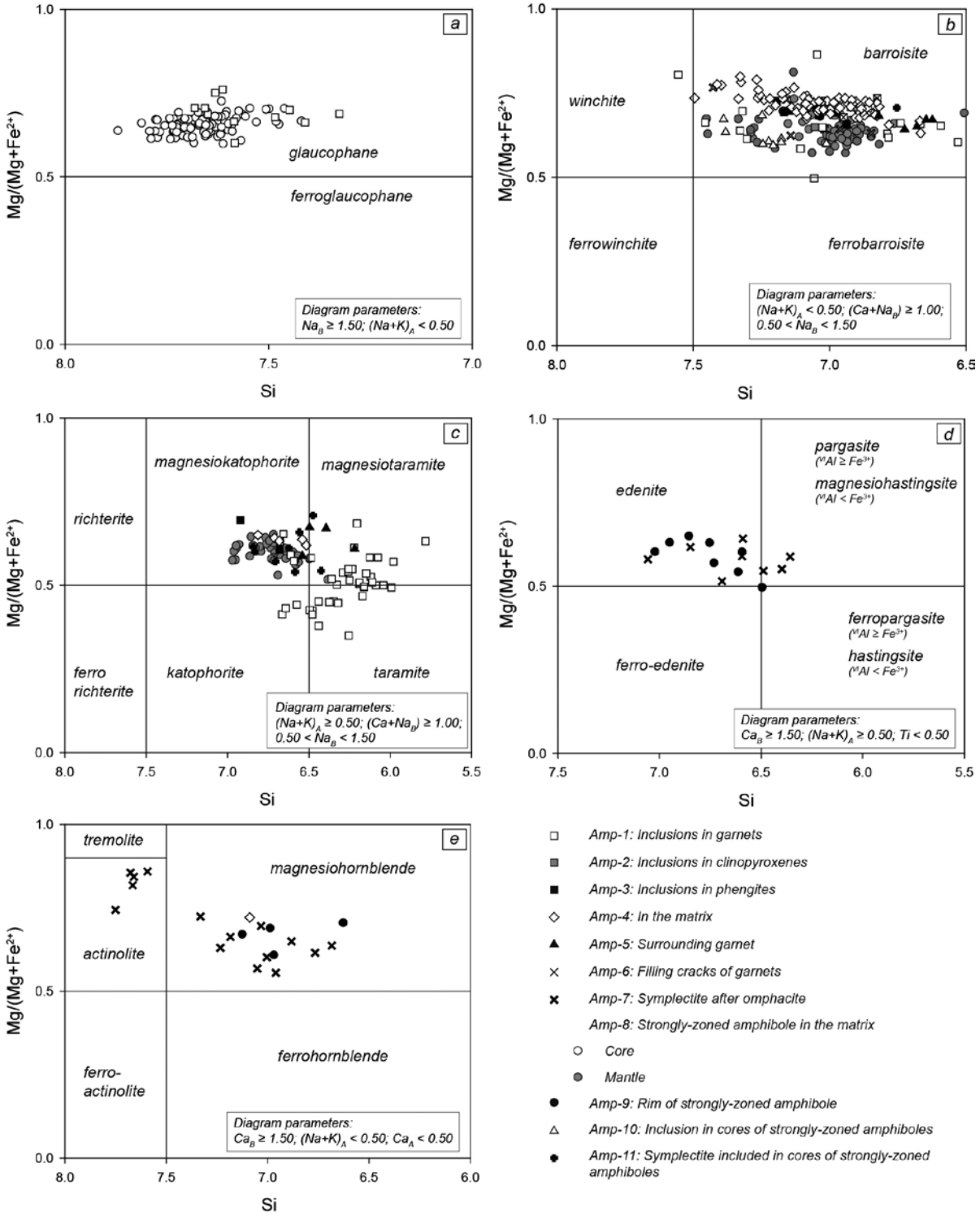

Fig. 5. Chemical compositions of sodic (a), sodic-calcic (b-c), and calcic (d-e) amphiboles from the Seba eclogitic basic schists.

of chemical composition (sodic, sodic-calcic and calcic), suggesting a variety of equilibrium *P-T* conditions.

Relict taramite/Mg-taramite amphibole inclusions (Amp1) in the cores of the porphyroblastic garnets have relatively high Al_2O_3 (< 18 wt.%) and TiO_2 (< 0.90 wt.%) contents, suggesting relatively high-temperature metamorphic conditions such as the amphibolite facies (Kabir and Takasu, 2009; 2010b). The other amphiboles occurring as inclusions in the garnets (Amp1; glaucophane, winchite, barroisite, ferro-barroisite, taramite, Mg-taramite, katophorite, Mg-katophorite), clinopyroxenes (Amp2; barroisite) and phengites (Amp3; barroisite and Mg-katophorite) are the products of the prograde to the peak metamorphism (epidote-blueschist and eclogite facies metamorphic conditions) (Kabir and Takasu, 2010b). Amphiboles in the matrix (Amp4) represent a peak metamorphism of the eclogite

facies (610-640 °C and 12-24 kbar) (Aoya, 2001; Kabir and Takasu, 2010b).

Amphibole occurring as a constituent of aggregates surrounding garnets (Amp5; barroisite, Mg-katophorite, a constituent of symplectites after omphacites (Amp7; barroisite, edenite, actinolite, Mg-hornblende, Mg-hastingsite, pargasite) and inclusions (Amp10; barroisite) in the glaucophane core of the strongly zoned amphibole, and as a constituent of symplectitic aggregates included within the strongly zoned amphibole (Amp11; barroisite/Mg-katophorite/Mg-taramite) all formed in epidote-amphibolite facies conditions during the retrograde stage of the eclogitic metamorphic event (Kabir and Takasu, 2010a). The strongly-zoned amphiboles (Amp8) overgrowing the matrix schistosity having glaucophane cores, barroisite/Mg-katophorite/Mg-taramite mantles and edenite/Mg-hornblende (Amp9) rims suggest a second high-pressure metamorphism from the glaucophane schist facies to the epidote-amphibolite facies at the peak conditions (540-600 °C and 6.5-8 kbar) and subsequent greenschist facies retrograde metamorphism (Kabir and Takasu, 2010a, c).

The amphiboles in the Seba eclogitic basic schists thus occur in various modes of occurrence and show a wide range of compositions. These amphiboles record three distinct metamorphic events, namely a precursor amphibolite facies event, a first high-pressure eclogite facies event, and a second high-pressure epidote-amphibolite facies event.

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References

Aoya, M., 2001, *P-T-D* path of eclogite from the Sambagawa belt deduced from combination of petrological and microstructural analysis. *Journal of Petrology*, **42(7),** 1225-1248.

Banno, S., 1964, Petrological studies of the Sanbagawa crystalline schists in the Bessi-Ino district, central Shikoku, Japan. *Journal of the Faculty of Science, Tokyo University, Section II*, **15**, 203-319.

Bence, A. E. and Albee, A. L., 1968, Empirical correction factors for the electron microanalysis of silicates and oxides. *Journal of Geology*, **76,** 382-403.

Enami, M., 1983, Petrology of pelitic schists in the oligoclase-biotite zone of the Sanbagawa metamorphic terrain, Japan: Phase equilibria in the highest grade zone of a high-pressure intermediate type of metamorphic belt. *Journal of Metamorphic Geology*, **1**, 141-161.

Enami, M., Wallis, S. R. and Banno, Y., 1994, Paragenesis of sodic pyroxene-bearing quartz schist: implications for the *P-T* history of the Sanbagawa belt. *Contributions to Mineralogy and Petrology*, **116,** 182-198.

Higashino, T., 1990, The higher grade metamorphic zonation of the Sambagawa metamorphic belt in central Shikoku, Japan. *Journal of Metamorphic Geology*, **8,** 413-423.

Kabir, M. F. and Takasu, A., 2009, Polyphase metamorphic history of pelitic schists in the Sambagawa metamorphic belt, Sebadani area, central Shikoku, Japan. *Annual Meeting, Geological Society of Japan,* Okayama University of Science, Okayama, Japan, p. 148.

Kabir, M. F. and Takasu, A., 2010a, Glaucophanic amphibole in the Seba eclogitic basic schists, Sambagawa metamorphic belt, central Shikoku, Japan: implications for timing of juxtaposition of the eclogite body with the non-eclogite Sambagawa schists. *Earth Science*, **64,** 183-192.

Kabir, M. F. and Takasu, A., 2010b, Polyphase high-pressure metamorphism of the Sebadani-Onodani eclogites in the Sambagawa metamorphic belt, central Shikoku, Japan: evidence for multiple burial and exhumation cycles of eclogites. *Abstract of Annual Meeting, Japan Association of Mineralogical Sciences*, Shimane University, Japan, p. 205.

Kabir, M. F. and Takasu, A., 2010c, Evidence for multiple burial-partial exhumation cycles from the Onodani eclogites in the Sambagawa metamorphic belt, central Shikoku, Japan. *Journal of Metamorphic Geology*, **28,** 873-893.

Kugimiya, Y. and Takasu, A., 2002, Geology of the Western Iratsu mass within the tectonic mélange zone in the Sambagawa Metamorphic Belt, Besshi district, central Shikoku, Japan. *Journal of the Geological Society of Japan*, **108,** 644-662 (in Japanese with English abstract).

Kunugiza, K., Takasu, A. and Banno, S., 1986, The origin and metamorphic history of the ultramafic and metagabbro bodies in the Sanbagawa metamorphic belt. *Geological Society of America Memoir*, **164,** 375-385.

Leake, B. E., Woolley, A. R., Arps, C. E. S., Birch, W. D., Gilbert, M. C., Grice, J. D., Hawthorne, F. C., Kato, A., Kisch, H. J., Krivovichev, V. G., Linthout, K., Laird, J., Mandarino, J. A., Maresch, W. V., Nickel, E. H., Rock, N. M. S., Schumacher, J. C., Smith, D. C., Stephenson, N. C. N., Ungaretti, L., Whittaker, E. J. W. and Youzhi, G., 1997, Nomenclature of amphiboles: report of the subcommittee on amphiboles of the International Mineralogical Association, Commission on New Minerals and Mineral Names. *The Canadian Mineralogist*, **35,** 219-246.

Miyashiro, A., 1973, Metamorphism and Metamorphic Belts. *George Allen and Unwin, London*.

Ota, T., Terabayashi, M. and Katayama, I., 2004, Thermobaric structure and metamorphic evolution of the eclogite body in the Sanbagawa belt, central Shikoku, Japan. *Lithos*, **73,** 95-126.

Sakurai, T. and Takasu, A., 2009, Geology and metamorphism of the Gazo mass (eclogite-bearing tectonic block) in the Sambagawa metamorphic belt, Besshi district, central Shikoku, Japan. *Journal of the Geological Society of Japan*, **115,** 101-121 (in Japanese with English abstract).

Takasu, A., 1984, Prograde and Retrograde Eclogites in the Sambagawa Metamorphic Belt, Besshi District, Japan. *Journal of Petrology*, **25,** 619-643.

Takasu, A., 1989, *P-T* histories of peridotite and amphibolite tectonic blocks in the Sanbagawa metamorphic belt, Japan. In: *Evolution of metamorphic belts*, Special Publication, (eds Daly, J.S., Cliff, R.A. and Yardley, B.W.D.), **43,** 533-538. Geological Society, London.

Takasu, A. and Makino, K., 1980, Stratigraphy and geologic structure of the Sanbagawa metamorphic belt in the Besshi district, Shikoku, Japan (Reexamination of the recumbent fold structures). *Earth Science*, **34,** 16-26 (in Japanese with English abstract).

Wallis, S. R. and Aoya, M., 2000, A re-evaluation of eclogite facies metamorphism in SW Japan: proposal for an eclogite nappe. *Journal of Metamorphic Geology*, **18,** 653-664.

Whitney, D. L. and Evans, B. W., 2010, Abbreviations for names of rock-forming minerals. *American Mineralogist*, **95,** 185-187.

Zaw Win Ko, Enami, M. and Aoya. M., 2005, Chloritoid and barroisite-bearing pelitic schist from the eclogite unit in the Besshi district, Sanbagawa metamorphic belt. *Lithos*, **81,** 79-100.

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（要　旨）

Takasu, A.・Kabir, Md F., 2011 四国中央部三波川変成帯瀬場エクロジャイト質塩基性片岩中の角閃石の産状と化学組成．島根大学地球資源環境学研究報告，30, 1-15

瀬場エクロジャイト質塩基性片岩中のエクロジャイトには，11 の産状の角閃石 (Amp1-11）が存在する．Amp1 は斑状変晶ざくろ石に包有される角閃石で，そのうち核部に包有される角閃石は藍閃石，ウィンチ閃石，バロワ閃石，タラマ閃石の組成を示し，マントルと縁部に包有される角閃石はバロワ閃石，タラマ閃石，カタフォル閃石などの Na-Ca 角閃岩である．Amp2 は単斜輝石に包有されるバロワ閃石で，Amp3 はフェンジャイトに包有されるバロワ閃石とマグネシオカタフォル閃石である．Amp4 は基質において片理を構成する角閃石で，ウインチ閃石の核部からバロワ閃石またはマグネシオカタフォル閃石のマントル部を経てマグネシオホルンブレンドの縁部に至る累帯構造を示す．Amp5 はざくろ石の縁部を置換する角閃石で，バロワ閃石，マグネシオカタフォル閃石，マグネシオタラマ閃石の組成を示す．Amp6 はざくろ石の割れ目を充填するバロワ閃石である．Amp7 はオンファス輝石の分解に伴って形成されたシンプレクタイトを構成する角閃石でバロワ閃石，エデン閃石，アクチノ閃石及びマグネシオホルンブレンドである．Amp8 は片理と斜行して形成される粗粒の角閃石で，核部は藍閃石，マントル部はバロワ閃石，マグネシオカタフォル閃石またはタラマ閃石，そしてエデン閃石またはマグネシオホルンブレンドの縁部へと顕著な累帯構造を示す．Amp8 の核部の藍閃石は，融食形のバロワ閃石（Amp10）と曹長石と角閃石（Amp-11：バロワ閃石，マグネシオカタフォル閃石またはマグネシオタラマ閃石）のシンプレクタイト状集合体を包有する．このような角閃石の産状と化学組成の多様性は，瀬場エクロジャイト質塩基性片岩の複雑な変成史（先駆的変成イベント，エクロジャイト変成イベント，そして藍閃石 - バロワ閃石変成イベント）に由来する．

Table 1. Representative chemical compositions of amphiboles from the Seba eclogitic basic schists.

Sample	06050701FS06																		
Analysis	3	5	6	7	8	9	10	11	12	13	14	15	16	17	20	21	22	23	24
	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp7	Amp7	Amp7	Amp7	Amp7
	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Brs	Mg-Ktp	Mg-Ktp	Mg-Trm	Mg-Hs	Mg-Hs	Ed	Ed	Ed
SiO_2	46.00	45.02	44.42	45.14	45.63	46.96	44.12	45.49	44.04	44.35	47.57	46.45	44.81	44.01	42.61	41.92	44.57	46.63	44.39
TiO_2	0.22	0.14	0.12	0.34	0.26	0.23	0.27	0.36	0.15	0.16	0.15	0.11	0.25	0.24	0.32	0.34	0.23	0.16	0.12
Al_2O_3	10.04	10.16	10.63	10.63	10.32	9.65	11.01	10.71	10.45	10.68	8.30	9.03	10.93	11.11	12.32	12.67	10.93	8.76	8.14
FeO*	17.65	19.87	19.91	17.79	18.29	17.94	18.84	18.20	19.64	19.16	19.10	18.37	18.41	19.78	18.65	18.52	17.57	16.53	20.50
MnO	0.14	0.11	0.16	0.13	0.10	0.14	0.08	0.10	0.12	0.10	0.12	0.13	0.17	0.09	0.07	0.09	0.07	0.10	0.10
MgO	10.61	9.17	9.40	10.30	10.07	10.46	9.41	9.62	9.55	9.62	9.91	10.57	9.59	9.49	9.53	9.40	10.42	11.74	12.88
CaO	8.35	9.32	8.77	8.54	8.28	8.11	8.73	7.85	9.14	8.96	8.10	8.99	8.32	8.79	9.47	9.52	9.47	9.56	5.71
Na_2O	4.12	3.51	3.88	4.15	4.29	4.14	4.07	4.48	3.66	3.81	3.80	3.68	4.24	3.96	3.71	3.75	3.62	3.42	3.23
K_2O	0.66	0.88	0.94	0.83	0.73	0.66	0.86	0.67	1.00	0.94	0.72	0.80	0.78	0.99	1.23	1.20	0.92	0.67	0.36
Total	97.80	98.17	98.22	97.84	97.97	98.28	97.39	97.48	97.74	97.77	97.76	98.11	97.49	98.47	97.90	97.40	97.80	97.58	95.43
Cations on the basis of 23 oxygens																			
Si	6.864	6.788	6.705	6.758	6.823	6.961	6.684	6.826	6.684	6.702	7.116	6.939	6.751	6.629	6.453	6.387	6.683	6.947	6.840
Ti	0.025	0.016	0.013	0.039	0.029	0.025	0.031	0.041	0.017	0.018	0.017	0.012	0.028	0.027	0.036	0.039	0.026	0.018	0.014
Al	1.765	1.806	1.891	1.875	1.819	1.686	1.966	1.894	1.870	1.903	1.463	1.589	1.940	1.973	2.198	2.276	1.931	1.538	1.478
Fe*	2.202	2.505	2.513	2.227	2.287	2.223	2.386	2.284	2.493	2.421	2.390	2.295	2.320	2.492	2.362	2.360	2.204	2.059	2.642
Mn	0.018	0.014	0.021	0.017	0.013	0.018	0.011	0.012	0.015	0.012	0.015	0.017	0.022	0.012	0.009	0.012	0.009	0.013	0.013
Mg	2.360	2.062	2.115	2.300	2.245	2.311	2.125	2.152	2.162	2.167	2.211	2.353	2.153	2.132	2.150	2.135	2.329	2.607	2.959
Ca	1.335	1.506	1.419	1.369	1.327	1.289	1.417	1.261	1.487	1.451	1.299	1.439	1.343	1.418	1.537	1.555	1.522	1.526	0.942
Na	1.191	1.025	1.134	1.204	1.245	1.189	1.195	1.304	1.076	1.116	1.101	1.067	1.238	1.158	1.088	1.108	1.052	0.989	0.965
K	0.126	0.169	0.181	0.158	0.139	0.124	0.166	0.128	0.193	0.182	0.137	0.152	0.149	0.190	0.238	0.233	0.177	0.127	0.071
Total	15.887	15.891	15.993	15.947	15.927	15.827	15.981	15.902	15.998	15.973	15.748	15.863	15.944	16.030	16.072	16.103	15.934	15.824	15.925

**Total Fe as FeO*

Sample	06050701FS06																		
Analysis	25	26	27	28	29	30	31	32	33	34	37	39	40	43	45	8	9	10	11
	Amp7	Amp7	Amp7	Amp7	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp8	Amp8	Amp8	Amp8
	Ed	Ed	Mg-Hs	Mg-Ktp	Brs	Brs	Brs	Brs	Brs	Brs	Mg-Ktp	Brs	Mg-Ktp	Mg-Trm	Mg-Ktp	Brs	Brs	Mg-Ktp	Brs
																Mantle	←	←	←
SiO_2	47.19	45.84	41.33	44.25	49.99	50.41	52.15	48.06	49.60	50.80	45.41	48.54	47.92	43.13	44.73	47.68	46.45	46.11	45.71
TiO_2	0.12	0.16	0.49	0.36	0.18	0.20	0.13	0.39	0.22	0.16	0.10	0.31	0.23	0.13	0.24	0.08	0.31	0.14	0.27
Al_2O_3	7.39	9.08	12.76	11.16	9.49	9.47	8.66	9.73	9.54	9.70	10.14	10.45	9.05	12.77	12.59	6.96	10.18	10.82	10.30
FeO*	18.14	17.47	19.37	17.91	17.18	17.47	17.25	17.18	17.35	17.41	19.03	16.94	17.69	19.63	18.74	15.92	16.83	19.81	18.09
MnO	0.15	0.10	0.13	0.07	0.10	0.15	0.07	0.14	0.13	0.09	0.05	0.18	0.13	0.16	0.14	0.11	0.10	0.07	0.09
MgO	11.43	11.37	9.21	9.98	9.91	9.56	9.99	9.93	9.54	9.49	9.75	9.75	10.74	8.35	8.55	12.10	9.80	8.32	9.32
CaO	9.53	9.83	9.63	9.15	5.85	5.16	4.60	6.91	5.53	5.16	8.72	6.27	7.92	7.16	7.39	8.79	6.80	8.83	7.20
Na_2O	3.24	3.37	3.72	3.71	5.04	5.41	5.51	4.72	5.16	5.40	3.85	5.18	4.35	5.33	4.94	3.07	4.23	3.41	4.22
K_2O	0.60	0.82	1.29	0.96	0.33	0.28	0.18	0.39	0.30	0.26	0.88	0.40	0.62	0.88	0.78	0.51	0.42	1.04	0.56
Total	97.77	98.04	97.93	97.55	98.07	98.12	98.54	97.43	97.36	98.48	97.91	98.02	98.65	97.53	98.10	95.22	95.12	98.54	95.75
Cations on the basis of 23 oxygens																			
Si	7.061	6.850	6.306	6.664	7.294	7.346	7.516	7.113	7.297	7.361	6.825	7.117	7.056	6.551	6.687	7.216	7.039	6.886	6.949
Ti	0.013	0.018	0.057	0.040	0.020	0.022	0.014	0.043	0.024	0.017	0.011	0.034	0.026	0.015	0.027	0.009	0.035	0.016	0.031
Al	1.304	1.598	2.295	1.981	1.631	1.627	1.471	1.697	1.653	1.657	1.796	1.806	1.571	2.286	2.219	1.242	1.819	1.904	1.846
Fe*	2.270	2.183	2.471	2.255	2.097	2.129	2.080	2.126	2.134	2.111	2.392	2.077	2.178	2.494	2.343	2.015	2.132	2.474	2.300
Mn	0.019	0.012	0.017	0.009	0.012	0.019	0.009	0.017	0.016	0.011	0.006	0.022	0.016	0.021	0.018	0.014	0.013	0.009	0.012
Mg	2.549	2.533	2.094	2.242	2.155	2.077	2.147	2.190	2.091	2.051	2.186	2.131	2.357	1.890	1.907	2.729	2.214	1.853	2.111
Ca	1.528	1.574	1.574	1.476	0.914	0.806	0.710	1.096	0.872	0.802	1.404	0.985	1.250	1.165	1.183	1.425	1.103	1.412	1.172
Na	0.941	0.977	1.099	1.084	1.427	1.529	1.539	1.353	1.470	1.518	1.121	1.472	1.242	1.568	1.432	0.901	1.243	0.988	1.244
K	0.114	0.156	0.251	0.185	0.061	0.053	0.033	0.073	0.056	0.048	0.168	0.076	0.117	0.171	0.149	0.099	0.082	0.198	0.109
Total	15.798	15.900	16.163	15.936	15.611	15.608	15.519	15.709	15.615	15.576	15.909	15.720	15.812	16.160	15.965	15.650	15.679	15.739	15.774

**Total Fe as FeO*

Sample	06050701FS06																		
Analysis	12	13	14	15	21	22	25	26	27	28	29	30	32	33	34	35	37	47	48
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp1	Amp8	Amp8
	Gln	Gln	Gln	Gln	Brs	Gln	Brs	Brs	Brs	Mg-Ktp	Gln	Brs	Brs	Gln	Brs	Mg-Ktp	Trm	Gln	Brs
	←	←	←	Core	Mantle	Core	→	→	→	Mantle	Core	→	Mantle	→	→	Mantle		Core	→
SiO_2	54.29	53.67	54.09	52.79	46.15	52.82	48.26	47.33	45.08	45.32	52.58	47.89	49.61	54.16	47.33	44.49	41.06	53.77	49.72
TiO_2	0.09	0.08	0.05	0.06	0.41	0.09	0.23	0.29	0.25	0.24	0.11	0.29	0.18	0.17	0.27	0.19	0.18	0.10	0.20
Al_2O_3	9.63	9.20	9.19	8.79	9.98	8.79	9.57	9.98	9.68	10.39	9.13	10.02	9.29	8.99	9.91	9.53	13.16	9.48	8.88
FeO*	14.64	15.11	15.17	16.00	16.87	15.63	16.02	16.86	16.95	17.03	15.24	17.08	16.55	15.01	16.66	17.87	21.63	14.73	16.63
MnO	0.07	0.09	0.10	0.08	0.03	0.04	0.09	0.12	0.12	0.11	0.08	0.13	0.13	0.03	0.08	0.10	0.07	0.08	0.14
MgO	9.19	9.27	9.11	9.08	10.07	9.34	10.18	9.93	10.54	10.06	9.25	9.75	9.32	9.17	9.71	10.05	6.51	9.35	9.58
CaO	1.75	2.17	1.65	2.54	7.15	2.56	5.91	6.24	8.24	7.54	2.79	5.94	4.92	2.04	6.58	8.61	8.90	2.15	5.08
Na_2O	6.11	6.02	6.24	5.88	4.19	5.88	4.59	4.59	3.53	4.06	5.71	4.73	5.02	6.13	4.56	3.49	3.83	5.99	4.79
K_2O	0.11	0.12	0.08	0.11	0.54	0.11	0.41	0.44	0.65	0.63	0.16	0.40	0.26	0.10	0.43	0.80	0.09	0.16	0.31
Total	95.87	95.71	95.66	95.33	95.39	95.25	95.24	95.76	95.01	95.38	95.05	96.22	95.28	95.79	95.53	95.12	95.43	95.79	95.34
Cations on the basis of 23 oxygens																			
Si	7.823	7.789	7.837	7.747	6.993	7.746	7.232	7.106	6.899	6.898	7.718	7.149	7.405	7.837	7.121	6.857	6.430	7.778	7.422
Ti	0.009	0.009	0.005	0.007	0.047	0.010	0.026	0.032	0.028	0.028	0.012	0.032	0.020	0.018	0.031	0.021	0.021	0.011	0.023
Al	1.636	1.574	1.569	1.520	1.782	1.519	1.690	1.765	1.746	1.863	1.580	1.763	1.635	1.533	1.757	1.731	2.430	1.616	1.562
Fe*	1.764	1.834	1.838	1.964	2.138	1.917	2.007	2.118	2.169	2.168	1.871	2.133	2.065	1.817	2.096	2.304	2.833	1.782	2.076
Mn	0.008	0.011	0.012	0.010	0.004	0.005	0.012	0.015	0.015	0.014	0.010	0.016	0.017	0.003	0.010	0.013	0.009	0.009	0.017
Mg	1.973	2.005	1.967	1.987	2.275	2.042	2.274	2.223	2.404	2.283	2.024	2.170	2.074	1.977	2.178	2.309	1.519	2.016	2.132
Ca	0.270	0.337	0.256	0.399	1.160	0.402	0.948	1.003	1.350	1.229	0.438	0.950	0.786	0.316	1.061	1.421	1.494	0.333	0.813
Na	1.706	1.694	1.753	1.674	1.230	1.671	1.332	1.335	1.046	1.198	1.625	1.369	1.452	1.720	1.330	1.041	1.164	1.681	1.386
K	0.021	0.021	0.014	0.021	0.104	0.020	0.078	0.085	0.127	0.122	0.031	0.076	0.050	0.018	0.082	0.157	0.018	0.029	0.060
Total	15.212	15.273	15.252	15.328	15.732	15.331	15.598	15.682	15.786	15.803	15.307	15.657	15.505	15.239	15.667	15.855	15.918	15.255	15.491

**Total Fe as FeO.*

Table 1. (continued)

Sample	06050701FS06																		
Analysis	49	50	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8
	Brs	Brs	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Brs	Brs	Brs	Mg-Ktp	Brs	Brs	Brs	Brs	Ed	Brs
	→	Mantle	Core	→	→	→	→	→	→	Mantle	→	→	→	→	→	→	→	Rim	Mantle
SiO_2	47.19	48.36	55.45	55.72	54.31	54.35	54.49	54.91	53.43	48.54	48.48	47.58	46.47	48.17	47.71	48.32	48.96	46.50	48.74
TiO_2	0.37	0.27	0.07	0.01	0.08	0.08	0.07	0.08	0.11	0.24	0.25	0.35	0.32	0.12	0.11	0.11	0.10	0.10	0.08
Al_2O_3	10.50	10.47	9.53	9.56	9.48	9.44	9.61	9.51	9.53	10.08	10.18	10.33	10.20	7.76	7.40	7.61	7.15	6.94	7.12
FeO*	17.01	15.15	15.17	15.50	15.67	15.49	15.15	15.18	15.74	17.30	17.53	17.44	17.82	17.17	17.15	16.73	16.76	15.60	16.13
MnO	0.12	0.13	0.09	0.08	0.13	0.08	0.11	0.09	0.08	0.10	0.15	0.08	0.07	0.09	0.15	0.06	0.11	0.16	0.11
MgO	9.52	10.17	9.35	9.50	9.56	9.67	9.79	9.69	10.04	9.96	9.99	10.17	10.18	11.52	11.63	12.00	12.31	12.18	12.66
CaO	6.68	6.19	1.69	1.47	2.23	2.58	2.36	2.37	3.29	6.53	6.57	6.87	8.08	7.83	7.56	8.41	8.66	10.90	9.45
Na_2O	4.51	4.76	6.65	6.74	6.55	6.48	6.53	6.47	6.25	4.65	4.71	4.54	4.12	3.95	4.22	3.50	3.35	3.18	3.21
K_2O	0.46	0.40	0.11	0.09	0.12	0.13	0.15	0.12	0.18	0.44	0.39	0.46	0.66	0.44	0.39	0.54	0.51	0.48	0.52
Total	96.36	95.89	98.12	98.67	98.12	98.30	98.26	98.43	98.63	97.84	98.26	97.82	97.92	97.04	96.33	97.28	97.91	96.04	98.01
Cations on the basis of 23 oxygens																			
Si	7.055	7.173	7.829	7.827	7.721	7.712	7.718	7.751	7.597	7.136	7.107	7.023	6.910	7.178	7.176	7.172	7.217	7.041	7.175
Ti	0.041	0.030	0.007	0.001	0.009	0.008	0.007	0.008	0.011	0.027	0.028	0.039	0.035	0.014	0.013	0.013	0.011	0.012	0.009
Al	1.849	1.831	1.586	1.583	1.589	1.578	1.604	1.582	1.596	1.747	1.760	1.798	1.787	1.362	1.312	1.332	1.243	1.238	1.236
Fe*	2.127	1.879	1.792	1.820	1.863	1.838	1.795	1.792	1.871	2.128	2.149	2.153	2.217	2.140	2.157	2.077	2.067	1.975	1.986
Mn	0.015	0.016	0.010	0.009	0.016	0.010	0.013	0.011	0.010	0.012	0.018	0.010	0.009	0.012	0.019	0.008	0.013	0.020	0.013
Mg	2.122	2.249	1.969	1.990	2.025	2.045	2.067	2.040	2.127	2.182	2.184	2.238	2.257	2.559	2.608	2.655	2.704	2.751	2.779
Ca	1.070	0.983	0.256	0.221	0.339	0.392	0.358	0.358	0.501	1.029	1.031	1.087	1.287	1.250	1.218	1.338	1.368	1.768	1.490
Na	1.308	1.368	1.821	1.836	1.805	1.784	1.794	1.769	1.723	1.324	1.340	1.299	1.188	1.141	1.230	1.007	0.958	0.934	0.915
K	0.088	0.075	0.019	0.016	0.021	0.024	0.027	0.022	0.032	0.082	0.074	0.087	0.125	0.084	0.075	0.102	0.096	0.092	0.098
Total	15.676	15.603	15.290	15.304	15.388	15.393	15.383	15.334	15.469	15.667	15.691	15.733	15.817	15.739	15.808	15.703	15.677	15.832	15.701

**Total Fe as FeO*

Sample	06050701FS06																		
Analysis	21	26	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17	18
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8
	Mg-Ktp	Mg-Ktp	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Brs	Brs	Brs	Brs	Brs	Brs
	Mantle	Mantle	Core	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
SiO_2	47.054	47.559	54.94	54.28	54.57	54.47	53.71	53.45	53.38	52.87	52.85	52.47	51.91	47.45	46.95	46.74	46.69	46.74	47.76
TiO_2	0.275	0.209	0.08	0.04	0.05	0.05	0.08	0.08	0.09	0.07	0.04	0.04	0.05	0.23	0.26	0.28	0.27	0.32	0.24
Al_2O_3	9.676	8.031	8.85	8.66	8.72	8.92	8.98	8.92	9.12	8.92	8.93	9.74	9.65	10.03	10.24	10.29	10.30	10.41	8.51
FeO*	16.989	17.074	15.93	16.22	15.76	15.07	15.56	15.68	15.43	15.62	15.71	15.17	15.15	16.54	16.65	16.87	16.98	17.71	17.41
MnO	0.18	0.078	0.07	0.12	0.07	0.04	0.07	0.04	0.12	0.04	0.05	0.12	0.09	0.12	0.10	0.11	0.09	0.08	0.10
MgO	10.817	11.817	9.25	9.40	9.22	9.31	9.29	9.52	9.41	9.61	9.48	9.51	9.65	10.20	10.03	10.01	9.81	9.80	11.20
CaO	8.239	9.174	1.59	1.98	1.45	1.37	1.72	2.04	2.04	2.37	2.14	2.29	2.56	5.98	6.17	6.60	6.71	7.06	7.71
Na_2O	3.898	3.387	6.28	6.16	6.49	6.41	5.99	6.02	6.06	6.02	5.97	6.02	5.99	4.66	4.64	4.55	4.47	4.42	4.05
K_2O	0.632	0.709	0.07	0.06	0.10	0.08	0.08	0.09	0.12	0.15	0.12	0.13	0.12	0.36	0.43	0.39	0.43	0.56	0.55
Total	97.76	98.04	97.05	96.91	96.41	95.73	95.48	95.84	95.76	95.65	95.28	95.48	95.19	95.56	95.46	95.82	95.74	97.10	97.52
Cations on the basis of 23 oxygens																			
Si	6.974	7.047	7.864	7.815	7.869	7.876	7.817	7.769	7.761	7.719	7.741	7.657	7.618	7.119	7.070	7.027	7.033	6.978	7.096
Ti	0.031	0.023	0.009	0.004	0.005	0.005	0.008	0.009	0.010	0.007	0.005	0.004	0.006	0.026	0.029	0.032	0.031	0.036	0.026
Al	1.690	1.402	1.494	1.469	1.481	1.520	1.539	1.528	1.564	1.535	1.541	1.676	1.669	1.773	1.818	1.823	1.828	1.832	1.490
Fe*	2.106	2.116	1.907	1.953	1.901	1.823	1.894	1.905	1.877	1.907	1.925	1.851	1.859	2.075	2.097	2.120	2.139	2.211	2.163
Mn	0.023	0.010	0.009	0.014	0.008	0.005	0.008	0.005	0.015	0.005	0.006	0.015	0.012	0.016	0.012	0.013	0.011	0.009	0.013
Mg	2.390	2.610	1.974	2.017	1.982	2.007	2.016	2.062	2.039	2.091	2.070	2.068	2.111	2.281	2.251	2.243	2.203	2.181	2.481
Ca	1.308	1.456	0.243	0.305	0.223	0.213	0.269	0.317	0.317	0.370	0.336	0.358	0.403	0.961	0.996	1.063	1.083	1.129	1.227
Na	1.120	0.973	1.743	1.720	1.815	1.796	1.691	1.697	1.707	1.705	1.695	1.705	1.705	1.356	1.355	1.325	1.305	1.279	1.165
K	0.120	0.134	0.012	0.012	0.017	0.015	0.015	0.017	0.022	0.028	0.021	0.024	0.023	0.069	0.082	0.075	0.083	0.107	0.104
Total	15.762	15.772	15.255	15.310	15.302	15.260	15.258	15.309	15.312	15.366	15.341	15.358	15.406	15.676	15.711	15.722	15.716	15.763	15.767

**Total Fe as FeO*

Sample	06050701FS06																		
Analysis	19	20	21	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Amp8	Amp8	Amp8	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp10	Amp9	Amp9	Amp9	Amp9	Amp9
	Brs	Brs	Gln	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Brs	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Mg-Ktp	Brs	Brs	Brs	Brs	Brs
	→	Mantle	Core																
SiO_2	48.85	49.34	55.52	45.58	45.50	45.17	45.55	45.52	45.68	45.98	45.49	44.93	44.62	44.00	49.54	48.68	48.76	48.71	48.53
TiO_2	0.12	0.18	0.04	0.18	0.19	0.16	0.15	0.19	0.19	0.16	0.19	0.24	0.25	0.21	0.17	0.25	0.20	0.23	0.27
Al_2O_3	6.35	6.61	9.14	10.57	10.71	11.02	11.09	9.85	10.03	9.90	10.38	10.81	10.93	11.16	9.36	9.70	9.60	9.52	9.66
FeO*	15.85	16.53	15.04	18.38	18.58	18.21	18.40	18.28	17.50	17.62	17.99	17.94	18.16	18.05	16.84	16.99	17.30	17.44	17.49
MnO	0.09	0.14	0.08	0.20	0.12	0.20	0.10	0.14	0.12	0.21	0.16	0.17	0.13	0.15	0.17	0.09	0.11	0.15	0.10
MgO	12.96	12.20	9.28	9.49	9.46	9.23	9.59	10.69	10.54	10.32	10.20	10.16	10.37	10.61	9.76	9.54	9.62	9.57	9.77
CaO	9.13	8.20	1.25	8.27	7.86	7.77	7.82	7.99	8.49	8.36	8.34	8.70	8.44	8.14	5.11	5.91	5.87	6.22	6.46
Na_2O	2.70	3.53	6.38	3.83	4.22	4.31	4.20	3.87	3.86	3.92	3.88	3.97	3.78	3.78	5.12	4.83	4.91	4.57	4.53
K_2O	0.51	0.41	0.06	0.79	0.74	0.73	0.78	0.73	0.73	0.73	0.69	0.77	0.79	0.83	0.29	0.34	0.34	0.43	0.43
Total	96.55	97.13	96.77	97.28	97.38	96.81	97.68	97.26	97.14	97.21	97.32	97.70	97.46	96.94	96.36	96.33	96.72	96.83	97.24
Cations on the basis of 23 oxygens																			
Si	7.274	7.307	7.918	6.858	6.843	6.826	6.818	6.850	6.861	6.902	6.831	6.739	6.711	6.658	7.337	7.239	7.237	7.231	7.182
Ti	0.013	0.020	0.004	0.020	0.022	0.018	0.016	0.021	0.021	0.018	0.021	0.027	0.028	0.024	0.019	0.028	0.023	0.026	0.030
Al	1.114	1.153	1.536	1.873	1.897	1.963	1.957	1.747	1.775	1.751	1.837	1.912	1.937	1.989	1.634	1.700	1.679	1.665	1.685
Fe*	1.973	2.048	1.793	2.312	2.336	2.301	2.303	2.300	2.199	2.211	2.260	2.251	2.284	2.284	2.086	2.113	2.147	2.164	2.164
Mn	0.011	0.018	0.009	0.026	0.015	0.025	0.013	0.018	0.015	0.026	0.021	0.022	0.016	0.020	0.021	0.011	0.014	0.019	0.013
Mg	2.876	2.693	1.972	2.128	2.121	2.080	2.140	2.398	2.360	2.310	2.285	2.272	2.325	2.392	2.154	2.116	2.129	2.118	2.155
Ca	1.457	1.301	0.190	1.334	1.266	1.258	1.254	1.287	1.367	1.344	1.341	1.398	1.360	1.320	0.810	0.942	0.934	0.989	1.025
Na	0.780	1.012	1.764	1.117	1.229	1.264	1.219	1.129	1.124	1.141	1.129	1.153	1.101	1.110	1.469	1.394	1.412	1.314	1.300
K	0.097	0.077	0.011	0.152	0.143	0.141	0.148	0.140	0.140	0.141	0.133	0.148	0.151	0.161	0.056	0.064	0.065	0.080	0.081
Total	15.595	15.629	15.197	15.820	15.873	15.877	15.869	15.890	15.862	15.845	15.857	15.923	15.915	15.957	15.585	15.608	15.639	15.607	15.635

**Total Fe as FeO*

Table 1. (continued)

Sample	S0605079																			
Analysis	24	25	26	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	2	
	Amp9	Amp9	Amp9	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	
	Mg-Ktp	Mg-Ktp	Brs	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	
				→	→	→	→	→	→	→	→	→	→	→	→	→	→	Mantle	Mantle	
SiO_2	44.93	46.59	48.54	55.42	54.63	55.47	56.12	55.97	55.68	56.11	55.69	49.15	48.67	48.77	48.69	48.11	48.22	48.47	47.74	
TiO_2	0.14	0.39	0.11	0.10	0.08	0.05	0.08	0.06	0.06	0.06	0.02	0.22	0.28	0.32	0.30	0.32	0.34	0.31	0.25	
Al_2O_3	10.28	10.40	7.95	8.87	8.93	9.36	9.61	9.65	9.62	9.50	9.64	10.18	10.46	10.63	10.53	10.83	10.74	10.55	9.71	
FeO*	18.99	17.43	15.79	15.95	16.71	15.75	15.13	15.40	15.17	14.82	15.20	17.86	17.51	17.71	17.76	17.80	17.46	17.48	17.75	
MnO	0.22	0.20	0.16	0.11	0.09	0.09	0.06	0.08	0.10	0.06	0.08	0.15	0.13	0.13	0.13	0.11	0.14	0.14	0.13	
MgO	9.33	9.81	11.55	9.48	9.34	9.19	9.15	9.20	9.22	9.46	9.53	10.15	9.75	9.53	9.65	9.56	9.70	9.98	9.94	
CaO	8.45	7.15	7.29	2.05	2.41	1.79	1.31	1.48	1.57	1.54	1.69	5.67	6.08	6.13	6.15	6.35	6.49	6.39	6.66	
Na_2O	3.75	4.48	4.09	6.36	6.46	6.72	7.03	7.03	6.70	6.88	6.73	4.96	5.06	4.92	4.94	4.93	4.81	4.87	4.70	
K_2O	0.82	0.55	0.38	0.07	0.11	0.07	0.06	0.07	0.07	0.08	0.11	0.36	0.41	0.45	0.43	0.44	0.45	0.40	0.42	
Total	96.90	97.00	95.86	98.41	98.76	98.49	98.55	98.94	98.20	98.49	98.69	98.72	98.35	98.58	98.59	98.46	98.37	98.59	97.30	
Cations on the basis of 23 oxygens																				
Si	6.825	6.963	7.253	7.833	7.751	7.827	7.873	7.838	7.844	7.868	7.816	7.157	7.120	7.119	7.112	7.048	7.060	7.076	7.093	
Ti	0.016	0.043	0.012	0.011	0.008	0.005	0.008	0.006	0.007	0.007	0.002	0.024	0.031	0.035	0.033	0.035	0.038	0.034	0.028	
Al	1.840	1.832	1.401	1.477	1.493	1.557	1.588	1.594	1.598	1.570	1.595	1.748	1.803	1.829	1.813	1.870	1.853	1.815	1.701	
Fe*	2.412	2.178	1.973	1.885	1.982	1.859	1.775	1.803	1.787	1.738	1.784	2.175	2.142	2.162	2.169	2.181	2.138	2.134	2.205	
Mn	0.028	0.025	0.020	0.013	0.011	0.011	0.007	0.010	0.012	0.007	0.010	0.019	0.016	0.016	0.016	0.014	0.017	0.017	0.017	
Mg	2.113	2.186	2.573	1.997	1.976	1.933	1.912	1.921	1.937	1.978	1.994	2.203	2.126	2.073	2.101	2.089	2.116	2.173	2.201	
Ca	1.375	1.145	1.168	0.310	0.366	0.271	0.197	0.222	0.238	0.231	0.254	0.884	0.953	0.958	0.962	0.996	1.018	1.000	1.061	
Na	1.103	1.299	1.185	1.741	1.776	1.838	1.913	1.909	1.830	1.870	1.832	1.401	1.436	1.391	1.398	1.400	1.366	1.377	1.355	
K	0.159	0.105	0.073	0.012	0.020	0.012	0.011	0.013	0.012	0.013	0.020	0.068	0.076	0.083	0.080	0.083	0.085	0.074	0.079	
Total	15.870	15.777	15.656	15.280	15.384	15.313	15.284	15.316	15.265	15.282	15.307	15.679	15.704	15.667	15.685	15.717	15.692	15.700	15.739	

**Total Fe as FeO*

Sample	S0605079																			
Analysis	3	4	6	8	22	23	30	31	32	33	34	35	36	37	24	34	35	36	39	
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp1	Amp8	Amp8	Amp8	Amp8	
	Brs	Mg-Ktp	Mg-Ktp	Brs	Brs	Mg-Ktp	Gln	Gln	Gln	Brs	Mg-Ktp	Mg-Ktp	Gln	Gln	Gln	Brs	Brs	Gln	Gln	
	Mantle	Mantle	Mantle	Mantle	Mantle	Mantle	Core	→	→	Mantle	←	←	←	Core		Mantle	←	←	Core	
SiO_2	47.24	44.33	45.71	48.30	47.37	45.93	54.20	54.69	54.93	48.07	47.24	45.64	54.61	54.07	54.56	46.41	46.85	52.92	53.11	
TiO_2	0.28	0.43	0.27	0.18	0.27	0.41	0.06	0.08	0.03	0.28	0.27	0.38	0.03	0.06	0.10	0.29	0.26	0.03	0.04	
Al_2O_3	8.92	11.41	9.30	9.17	10.22	11.03	9.75	9.80	9.82	10.30	10.64	11.04	9.28	9.18	9.05	10.43	10.20	9.34	9.03	
FeO*	17.95	18.43	17.57	16.96	17.29	17.64	14.52	13.84	14.50	16.70	16.47	16.70	13.85	14.36	15.56	17.03	17.59	15.38	15.21	
MnO	0.08	0.17	0.06	0.18	0.12	0.11	0.09	0.07	0.11	0.14	0.09	0.06	0.07	0.07	0.03	0.17	0.14	0.05	0.07	
MgO	10.30	9.50	11.01	11.04	10.00	10.14	9.52	9.40	9.61	10.06	9.92	10.32	9.70	9.75	9.38	9.53	9.56	9.32	9.45	
CaO	7.33	7.78	8.39	8.59	6.53	7.65	2.29	1.75	1.84	6.18	6.46	7.83	1.59	1.72	1.46	6.22	5.95	1.62	1.78	
Na_2O	4.36	4.25	3.72	3.71	4.85	4.36	6.49	6.64	6.75	5.05	5.03	4.42	6.56	6.68	6.63	4.88	4.87	6.71	6.46	
K_2O	0.54	0.75	0.91	0.62	0.41	0.67	0.14	0.10	0.09	0.42	0.44	0.75	0.11	0.08	0.06	0.43	0.41	0.09	0.11	
Total	97.00	97.03	96.93	98.75	97.06	97.93	97.05	96.37	97.69	97.20	96.55	97.13	95.78	95.97	96.81	95.38	95.84	95.45	95.26	
Cations on the basis of 23 oxygens																				
Si	7.076	6.702	6.889	7.070	7.046	6.824	7.745	7.820	7.779	7.104	7.036	6.819	7.855	7.801	7.828	7.022	7.062	7.727	7.763	
Ti	0.032	0.049	0.030	0.019	0.030	0.045	0.007	0.008	0.004	0.031	0.031	0.043	0.003	0.006	0.010	0.033	0.030	0.003	0.004	
Al	1.575	2.032	1.652	1.582	1.791	1.931	1.641	1.651	1.639	1.795	1.867	1.943	1.572	1.560	1.530	1.860	1.812	1.607	1.556	
Fe*	2.248	2.330	2.215	2.077	2.150	2.192	1.735	1.655	1.718	2.064	2.052	2.087	1.666	1.733	1.867	2.155	2.218	1.879	1.859	
Mn	0.010	0.021	0.008	0.022	0.015	0.014	0.011	0.009	0.013	0.017	0.011	0.008	0.009	0.008	0.003	0.022	0.018	0.006	0.009	
Mg	2.299	2.141	2.474	2.409	2.217	2.246	2.027	2.003	2.029	2.215	2.203	2.298	2.080	2.097	2.007	2.150	2.149	2.030	2.060	
Ca	1.176	1.259	1.355	1.348	1.041	1.218	0.351	0.267	0.280	0.978	1.030	1.253	0.245	0.266	0.224	1.008	0.961	0.253	0.279	
Na	1.266	1.247	1.087	1.053	1.398	1.255	1.798	1.841	1.854	1.446	1.452	1.279	1.828	1.869	1.845	1.432	1.424	1.898	1.831	
K	0.102	0.145	0.174	0.116	0.079	0.126	0.025	0.019	0.017	0.079	0.084	0.144	0.019	0.014	0.011	0.083	0.079	0.017	0.020	
Total	15.785	15.926	15.885	15.696	15.767	15.852	15.339	15.275	15.331	15.729	15.765	15.872	15.278	15.355	15.325	15.764	15.753	15.420	15.380	

**Total Fe as FeO*

Sample	S0605079																			
Analysis	40	41	42	45	46	47	48	49	50	51	54	55	56	57	58	59	60	61	62	
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	
	Mg-Ktp	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Gln	Brs	Gln	Gln	Brs	Brs	Gln	Brs	Gln	Brs	Brs	
	Mantle	←	←	←	Core	→	→	→	→	Mantle	Core	→	Mantle	Mantle	Core	Mantle	Core	→	→	
SiO_2	45.35	53.21	53.62	53.15	53.67	53.41	54.25	54.74	54.77	46.60	54.23	54.16	51.73	50.05	54.52	49.80	53.57	46.81	46.26	
TiO_2	0.28	0.07	0.03	0.10	0.10	0.07	0.08	0.06	0.04	0.27	0.04	0.06	0.09	0.15	0.06	0.10	0.06	0.26	0.28	
Al_2O_3	10.80	9.16	8.96	8.47	8.83	8.81	9.42	9.58	9.53	10.04	9.00	9.18	9.01	9.36	9.37	9.54	9.17	10.18	10.21	
FeO*	16.98	14.47	14.74	15.56	15.47	15.63	14.21	14.64	14.40	17.10	14.90	14.95	15.83	16.25	14.38	15.81	14.66	16.78	17.53	
MnO	0.12	0.12	0.07	0.09	0.08	0.13	0.06	0.10	0.04	0.13	0.05	0.11	0.11	0.11	0.12	0.07	0.11	0.13	0.13	
MgO	9.79	9.47	9.64	9.57	9.35	9.48	9.33	9.34	9.00	9.64	9.53	9.50	9.72	9.88	9.42	9.76	9.71	9.66	9.85	
CaO	7.31	1.90	1.99	2.52	2.16	2.40	1.62	1.45	1.27	6.41	1.65	1.82	3.31	4.46	1.06	4.53	1.84	5.97	6.82	
Na_2O	4.41	6.52	6.44	6.22	6.50	6.32	6.60	6.88	6.59	4.46	6.50	6.58	5.77	5.31	6.66	5.40	6.59	4.88	4.53	
K_2O	0.58	0.09	0.07	0.12	0.11	0.13	0.07	0.08	0.08	0.46	0.10	0.11	0.09	0.19	0.05	0.30	0.12	0.37	0.50	
Total	95.63	95.00	95.55	95.79	96.27	96.36	95.64	96.87	95.72	95.11	95.99	96.46	95.67	95.76	95.63	95.31	95.82	95.05	96.10	
Cations on the basis of 23 oxygens																				
Si	6.880	7.773	7.790	7.758	7.777	7.745	7.832	7.819	7.886	7.067	7.831	7.795	7.600	7.409	7.862	7.402	7.764	7.085	6.979	
Ti	0.032	0.008	0.003	0.011	0.011	0.008	0.009	0.006	0.004	0.031	0.004	0.007	0.010	0.017	0.006	0.011	0.006	0.030	0.032	
Al	1.931	1.576	1.534	1.457	1.508	1.505	1.602	1.613	1.617	1.795	1.531	1.557	1.561	1.634	1.592	1.671	1.566	1.817	1.815	
Fe*	2.155	1.767	1.791	1.899	1.874	1.895	1.716	1.748	1.734	2.169	1.800	1.799	1.945	2.012	1.735	1.965	1.777	2.123	2.212	
Mn	0.016	0.014	0.008	0.011	0.009	0.016	0.008	0.012	0.005	0.016	0.006	0.014	0.014	0.013	0.014	0.009	0.014	0.016	0.016	
Mg	2.215	2.063	2.087	2.081	2.019	2.048	2.008	1.990	1.932	2.180	2.051	2.037	2.128	2.181	2.026	2.163	2.097	2.180	2.216	
Ca	1.189	0.298	0.310	0.394	0.336	0.373	0.250	0.221	0.196	1.042	0.255	0.280	0.520	0.707	0.163	0.722	0.285	0.968	1.102	
Na	1.296	1.846	1.815	1.761	1.825	1.776	1.847	1.906	1.840	1.312	1.819	1.835	1.645	1.525	1.862	1.556	1.852	1.432	1.326	
K	0.112	0.016	0.012	0.022	0.021	0.023	0.013	0.015	0.014	0.088	0.018	0.021	0.018	0.036	0.010	0.057	0.023	0.071	0.095	
Total	15.826	15.362	15.353	15.394	15.380	15.390	15.285	15.329	15.228	15.701	15.315	15.344	15.441	15.535	15.270	15.557	15.385	15.723	15.792	

**Total Fe as FeO*

Table 1. (continued)

Sample	S0605079																		
Analysis	63	72	73	75	76	77	78	79	81	82	84	85	86	87	88	95	68	69	70
	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp1	Amp1	Amp4	Amp4	Amp4
	Mg-Ktp	Brs	Mg-Ktp	Brs	Gln	Gln	Gln	Gln	Brs	Brs	Gln	Gln	Gln	Brs	Trm	Mg-Trm	Brs	Brs	Brs
	Mantle	←	←	←	←	Core	→	→	→	Mantle	Core	→	→	Mantle			Core	Core	Core
SiO_2	46.15	46.48	45.53	47.37	53.64	52.28	52.57	51.80	48.66	47.11	51.10	53.45	54.12	46.67	42.25	42.89	49.07	49.12	48.10
TiO_2	0.26	0.32	0.38	0.23	0.08	0.07	0.22	0.06	0.18	0.28	0.12	0.04	0.06	0.30	0.23	0.23	0.21	0.24	0.24
Al_2O_3	9.37	10.54	10.60	10.07	8.86	9.20	8.99	9.19	9.12	10.00	9.09	9.40	9.34	10.23	13.66	12.35	9.78	9.43	9.53
FeO*	17.68	17.05	17.13	17.07	14.84	15.72	15.16	15.98	16.70	17.97	16.16	14.95	14.59	17.36	20.51	20.63	17.15	17.38	17.37
MnO	0.18	0.12	0.12	0.08	0.11	0.07	0.09	0.15	0.12	0.17	0.08	0.07	0.08	0.11	0.00	0.06	0.11	0.12	0.11
MgO	10.19	9.44	9.65	9.51	9.52	9.31	10.02	9.29	9.94	9.41	9.44	9.46	9.03	9.63	6.74	7.27	9.27	9.39	9.37
CaO	7.10	6.59	7.37	6.01	1.68	2.30	2.61	2.69	5.31	6.12	3.13	1.13	1.20	6.28	7.48	7.12	5.93	5.90	6.37
Na_2O	4.44	4.65	4.42	4.83	6.25	6.29	6.12	6.02	4.97	4.65	5.81	6.51	6.61	4.70	4.74	4.70	5.04	5.06	4.56
K_2O	0.52	0.43	0.61	0.39	0.11	0.09	0.16	0.11	0.29	0.42	0.19	0.06	0.07	0.41	0.21	0.12	0.33	0.31	0.36
Total	95.89	95.61	95.79	95.54	95.09	95.33	95.93	95.30	95.28	96.12	95.11	95.07	95.08	95.67	95.81	95.36	96.90	96.94	96.00
Cations on the basis of 23 oxygens																			
Si	7.000	7.017	6.901	7.128	7.821	7.676	7.656	7.633	7.300	7.088	7.573	7.789	7.861	7.044	6.525	6.647	7.259	7.274	7.209
Ti	0.030	0.036	0.043	0.026	0.009	0.008	0.024	0.007	0.020	0.032	0.014	0.005	0.006	0.034	0.026	0.026	0.024	0.026	0.026
Al	1.674	1.875	1.893	1.785	1.523	1.592	1.544	1.596	1.612	1.774	1.588	1.615	1.599	1.820	2.486	2.255	1.706	1.646	1.683
Fe*	2.243	2.152	2.171	2.147	1.810	1.930	1.847	1.970	2.095	2.261	2.002	1.822	1.773	2.190	2.649	2.674	2.122	2.152	2.176
Mn	0.024	0.016	0.015	0.011	0.014	0.009	0.010	0.019	0.015	0.022	0.010	0.008	0.010	0.014	0.000	0.008	0.014	0.015	0.014
Mg	2.304	2.125	2.180	2.132	2.070	2.037	2.174	2.040	2.222	2.110	2.084	2.055	1.954	2.165	1.552	1.678	2.044	2.072	2.094
Ca	1.154	1.066	1.196	0.969	0.262	0.362	0.407	0.425	0.854	0.987	0.497	0.176	0.187	1.015	1.237	1.182	0.940	0.937	1.023
Na	1.306	1.360	1.299	1.409	1.767	1.792	1.727	1.721	1.447	1.356	1.668	1.840	1.860	1.374	1.418	1.413	1.446	1.451	1.324
K	0.101	0.082	0.117	0.074	0.020	0.017	0.030	0.021	0.056	0.080	0.035	0.010	0.012	0.078	0.042	0.023	0.062	0.059	0.068
Total	15.836	15.729	15.815	15.681	15.295	15.423	15.420	15.433	15.621	15.711	15.471	15.320	15.262	15.734	15.936	15.907	15.617	15.632	15.619

**Total Fe as FeO*

Sample	S0605079																		
Analysis	71	72	73	74	75	78	79	80	81	82	83	84	85	86	87	88	89	90	91
	Amp4	Amp4	Amp4	Amp4	Amp4	Amp9	Amp9	Amp8	Amp8	Amp8	Amp9	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8
	Brs	Brs	Mg-Trm	Mg-Trm	Mg-Ktp	Brs	Brs	Gln	Gln	Gln	Brs	Gln	Brs	Mg-Ktp	Mg-Ktp	Mg-Ktp	Brs	Brs	Gln
	Core	Core	→	→	Rim			Core	Core	Core		Core	→	→	→	Mantle	Mantle	←	Core
SiO_2	47.11	48.07	42.83	41.99	44.53	49.87	51.01	54.18	53.62	53.98	51.03	53.37	48.00	45.12	45.51	44.53	47.44	48.15	55.05
TiO_2	0.27	0.27	0.39	0.34	0.31	0.18	0.13	0.13	0.12	0.13	0.13	0.08	0.30	0.23	0.35	0.40	0.38	0.25	0.05
Al_2O_3	10.26	9.83	12.67	11.96	10.20	8.92	9.34	8.72	8.96	9.06	8.97	9.21	10.29	9.95	9.99	10.89	10.82	9.90	9.13
FeO*	17.67	17.51	19.20	19.05	19.06	16.85	15.69	15.00	14.75	15.17	15.73	15.04	17.23	16.93	16.83	17.87	17.23	17.61	14.51
MnO	0.09	0.11	0.12	0.15	0.09	0.10	0.07	0.08	0.12	0.05	0.09	0.13	0.12	0.14	0.13	0.11	0.15	0.12	0.04
MgO	9.24	9.42	8.61	8.42	9.08	9.90	9.67	9.55	9.33	9.65	10.40	9.95	9.66	10.75	10.21	9.69	9.60	9.52	9.27
CaO	6.64	6.26	8.34	8.55	7.24	4.33	3.39	1.57	2.00	2.18	4.78	2.77	6.21	8.41	8.07	8.25	6.58	6.13	1.52
Na_2O	4.83	4.86	4.00	4.06	4.52	5.29	5.81	6.52	6.37	6.45	5.22	6.08	4.85	3.78	3.95	4.04	4.88	4.86	6.58
K_2O	0.45	0.39	0.96	1.06	0.60	0.22	0.14	0.09	0.12	0.13	0.24	0.16	0.42	0.85	0.76	0.85	0.45	0.43	0.10
Total	96.55	96.73	97.12	95.57	95.63	95.66	95.26	95.83	95.38	96.81	96.60	96.79	97.06	96.15	95.81	96.62	97.52	96.96	96.23
Cations on the basis of 23 oxygens																			
Si	7.058	7.160	6.521	6.525	6.843	7.419	7.534	7.844	7.805	7.762	7.466	7.689	7.113	6.841	6.904	6.751	7.013	7.156	7.895
Ti	0.031	0.031	0.044	0.040	0.035	0.020	0.014	0.014	0.013	0.014	0.015	0.009	0.034	0.026	0.040	0.046	0.042	0.028	0.005
Al	1.811	1.726	2.274	2.190	1.846	1.563	1.626	1.488	1.538	1.535	1.547	1.563	1.797	1.777	1.787	1.946	1.885	1.733	1.543
Fe*	2.213	2.181	2.445	2.475	2.449	2.096	1.937	1.816	1.795	1.824	1.924	1.812	2.135	2.147	2.135	2.265	2.131	2.189	1.740
Mn	0.012	0.014	0.016	0.020	0.011	0.013	0.009	0.009	0.015	0.006	0.011	0.016	0.015	0.018	0.017	0.014	0.018	0.015	0.004
Mg	2.063	2.093	1.954	1.950	2.080	2.195	2.130	2.060	2.025	2.068	2.268	2.137	2.133	2.429	2.309	2.190	2.116	2.108	1.983
Ca	1.066	0.999	1.361	1.424	1.191	0.690	0.536	0.243	0.312	0.336	0.750	0.428	0.986	1.365	1.312	1.340	1.042	0.975	0.234
Na	1.402	1.404	1.180	1.223	1.347	1.526	1.665	1.829	1.796	1.797	1.482	1.698	1.392	1.110	1.161	1.187	1.398	1.400	1.828
K	0.086	0.074	0.185	0.210	0.118	0.042	0.027	0.017	0.022	0.023	0.044	0.029	0.079	0.164	0.148	0.164	0.084	0.081	0.018
Total	15.740	15.682	15.980	16.057	15.922	15.563	15.478	15.321	15.320	15.367	15.507	15.382	15.684	15.877	15.813	15.902	15.730	15.686	15.251

**Total Fe as FeO*

Sample	SEB-M2																		
Analysis	92	93	13	26	51	54	55	56	57	58	59	61	13	27	28	1	2	3	4
	Amp8	Amp8	Amp8	Amp1	Amp4	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp8	Amp1	Amp8	Amp4	Amp4	Amp4	Amp4	Amp4
	Gln	Brs	Brs	Trm	Mg-Hbl	Brs	Gln	Gln	Gln	Brs	Brs	Gln	Fe-Brs	Gln	Mg-Hbl	Brs	Brs	Mg-Ktp	Brs
	→	Mantle	←			Mantle	←	←	Core	→	Mantle	Core		Core	Rim				
SiO_2	53.84	49.30	51.24	41.37	48.79	47.55	55.28	54.88	55.99	48.05	50.51	55.35	41.96	55.17	48.11	49.35	49.60	45.98	50.02
TiO_2	0.10	0.17	0.10	0.44	0.25	0.30	0.05	0.05	0.03	0.24	0.20	0.04	0.18	0.08	0.29	0.22	0.22	0.40	0.17
Al_2O_3	8.33	9.46	8.82	15.32	8.47	10.97	10.16	10.21	10.93	9.78	6.91	10.29	14.76	9.75	9.60	10.10	9.80	11.91	9.03
FeO*	16.13	17.46	16.46	22.33	12.47	14.05	11.21	11.37	10.49	13.40	11.53	10.98	19.42	12.22	13.14	14.52	13.83	15.32	13.52
MnO	0.13	0.09	0.13	0.04	0.03	0.10	0.08	0.05	0.06	0.06	0.05	0.03	0.04	0.09	0.05	0.04	0.03	0.03	0.03
MgO	9.53	9.20	9.29	5.03	13.47	11.17	11.04	10.92	9.94	12.19	14.44	10.84	6.65	11.04	12.64	11.76	11.81	10.89	12.01
CaO	2.55	5.39	3.42	7.48	9.83	8.05	2.77	2.99	2.33	8.95	10.02	2.64	8.85	3.26	9.67	7.70	7.57	9.35	7.68
Na_2O	6.01	5.19	5.89	5.12	2.80	3.95	5.95	5.72	6.36	3.28	2.49	5.94	4.18	5.90	3.06	3.95	3.99	3.46	3.70
K_2O	0.10	0.30	0.17	0.09	0.46	0.39	0.10	0.11	0.11	0.40	0.34	0.11	0.09	0.09	0.48	0.36	0.34	0.65	0.28
Total	96.72	96.56	95.51	97.22	96.56	96.51	96.63	96.30	96.22	96.35	96.48	96.21	96.11	97.59	97.03	98.02	97.18	98.01	96.43
Cations on the basis of 23 oxygens																			
Si	7.789	7.314	7.581	6.354	7.148	7.004	7.729	7.653	7.698	6.866	7.081	7.484	6.430	7.750	7.042	7.142	7.208	6.754	7.305
Ti	0.011	0.019	0.011	0.051	0.027	0.033	0.005	0.005	0.003	0.025	0.021	0.004	0.021	0.008	0.032	0.024	0.024	0.044	0.018
Al	1.419	1.655	1.538	2.773	1.462	1.904	1.674	1.679	1.771	1.647	1.142	1.639	2.667	1.614	1.656	1.723	1.678	2.062	1.554
Fe*	1.951	2.166	2.036	2.868	1.528	1.731	1.310	1.326	1.206	1.602	1.352	1.242	2.489	1.435	1.608	1.757	1.680	1.882	1.651
Mn	0.015	0.012	0.016	0.005	0.003	0.012	0.009	0.006	0.007	0.007	0.005	0.003	0.005	0.010	0.006	0.005	0.004	0.004	0.003
Mg	2.055	2.035	2.048	1.152	2.941	2.452	2.301	2.270	2.037	2.596	3.017	2.185	1.519	2.313	2.758	2.538	2.559	2.385	2.615
Ca	0.395	0.857	0.543	1.231	1.542	1.270	0.415	0.447	0.342	1.370	1.506	0.383	1.452	0.491	1.517	1.195	1.179	1.472	1.202
Na	1.685	1.493	1.689	1.524	0.796	1.128	1.612	1.545	1.694	0.910	0.677	1.556	1.242	1.606	0.867	1.109	1.123	0.986	1.046
K	0.019	0.056	0.033	0.018	0.086	0.073	0.018	0.019	0.019	0.073	0.061	0.018	0.017	0.016	0.089	0.066	0.062	0.123	0.053
Total	15.340	15.607	15.493	15.977	15.534	15.607	15.074	14.950	14.777	15.096	14.862	14.514	15.842	15.244	15.576	15.560	15.516	15.713	15.447

**Total Fe as FeO*

Table 1. (continued)

Sample	SEB-M2																		
Analysis	5	6	7	8	9	10	11	11	12	13	22	23	31	32	33	35	40	41	52
	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp7	Amp4	Amp4	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1
	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Mg-Ktp	Win	Act	Brs	Mg-Ktp	Ktp	Trm	Trm	Ed	Trm	Ktp	Trm
								Rim	Core										
SiO_2	49.53	49.21	49.17	49.56	48.57	48.74	49.43	47.12	53.86	54.90	50.72	44.75	43.37	43.23	42.48	45.36	42.94	44.22	43.25
TiO_2	0.21	0.24	0.20	0.24	0.27	0.24	0.27	0.29	0.05	0.09	0.17	0.52	0.68	0.46	0.41	0.25	0.58	0.55	0.61
Al_2O_3	9.86	10.06	9.73	9.86	10.62	10.05	9.89	11.30	10.06	2.96	9.19	13.29	12.78	13.72	14.00	11.42	14.10	13.28	14.29
FeO*	13.91	13.89	13.73	13.75	14.17	14.30	13.76	14.37	11.77	10.53	13.44	15.12	20.56	20.22	21.48	18.86	20.24	18.91	21.60
MnO	0.06	0.12	0.05	0.05	0.08	0.04	0.03	0.05	0.07	0.07	0.12	0.07	0.06	0.06	0.03	0.06	0.13	0.12	0.04
MgO	12.05	11.64	12.07	12.07	11.42	11.71	11.88	11.54	11.89	16.60	12.46	10.57	7.11	7.05	6.78	8.94	7.07	6.74	5.81
CaO	7.92	7.86	7.88	7.82	7.75	7.83	7.74	9.10	4.73	11.13	7.78	9.58	9.27	8.61	8.62	9.70	8.97	8.56	7.52
Na_2O	3.75	3.87	3.75	3.65	3.87	3.80	3.86	3.79	5.28	2.02	3.91	3.52	4.04	4.18	4.22	3.64	4.14	4.02	5.12
K_2O	0.33	0.35	0.36	0.35	0.40	0.38	0.37	0.57	0.16	0.14	0.28	0.85	0.08	0.15	0.17	0.08	0.08	0.10	0.13
Total	97.63	97.23	96.93	97.35	97.15	97.08	97.22	98.10	97.88	98.43	98.06	98.27	97.95	97.70	98.19	98.30	98.25	96.50	98.38
Cations on the basis of 23 oxygens																			
Si	7.174	7.162	7.171	7.187	7.090	7.123	7.183	6.873	7.575	7.758	7.284	6.578	6.557	6.527	6.434	6.756	6.458	6.697	6.521
Ti	0.023	0.026	0.022	0.026	0.029	0.026	0.029	0.032	0.005	0.009	0.018	0.058	0.077	0.052	0.047	0.028	0.065	0.063	0.069
Al	1.684	1.725	1.672	1.686	1.827	1.731	1.694	1.942	1.667	0.492	1.555	2.302	2.277	2.442	2.499	2.004	2.499	2.371	2.539
Fe*	1.685	1.690	1.675	1.667	1.730	1.747	1.672	1.752	1.385	1.245	1.615	1.858	2.600	2.553	2.720	2.349	2.545	2.395	2.724
Mn	0.007	0.015	0.006	0.007	0.010	0.005	0.003	0.006	0.009	0.009	0.014	0.009	0.008	0.007	0.003	0.007	0.017	0.016	0.005
Mg	2.602	2.525	2.625	2.609	2.485	2.552	2.573	2.508	2.494	3.496	2.668	2.317	1.602	1.588	1.530	1.985	1.586	1.522	1.307
Ca	1.230	1.226	1.231	1.215	1.212	1.226	1.204	1.422	0.712	1.685	1.197	1.509	1.502	1.393	1.399	1.547	1.445	1.389	1.215
Na	1.053	1.092	1.061	1.026	1.095	1.075	1.088	1.071	1.441	0.553	1.087	1.004	1.183	1.225	1.239	1.050	1.208	1.180	1.498
K	0.061	0.065	0.066	0.065	0.074	0.071	0.069	0.106	0.029	0.025	0.051	0.159	0.016	0.029	0.033	0.015	0.015	0.019	0.024
Total	15.518	15.527	15.530	15.488	15.552	15.557	15.515	15.711	15.317	15.272	15.490	15.793	15.821	15.818	15.905	15.742	15.838	15.651	15.901

**Total Fe as FeO*

Sample	S-9G																		
Analysis	55	56	57	58	64	5	6	7	8	9	11	12	13	14	16	17	18	28	44
	Amp1	Amp1	Amp1	Amp1	Amp1	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp7
	Ktp	Brs	Ktp	Trm	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Mg-Hbl
SiO_2	45.21	48.62	44.38	43.23	48.82	48.52	48.04	49.75	47.65	48.05	51.10	47.91	48.16	46.89	46.16	48.90	49.17	48.78	46.45
TiO_2	0.59	0.86	0.35	0.18	0.17	0.28	0.29	0.28	0.31	0.19	0.09	0.20	0.23	0.31	0.30	0.24	0.21	0.25	0.19
Al_2O_3	13.71	10.11	12.87	11.95	9.11	9.93	10.14	9.22	10.48	8.85	7.00	8.76	10.20	10.34	10.03	9.65	9.43	9.52	6.97
FeO*	20.09	19.91	21.36	23.60	16.14	14.90	14.88	14.27	13.70	15.24	13.12	15.40	14.48	15.29	15.08	14.53	14.65	14.35	18.45
MnO	0.10	0.04	0.14	0.11	0.06	0.20	0.17	0.15	0.23	0.27	0.18	0.23	0.16	0.20	0.29	0.23	0.32	0.27	0.22
MgO	6.56	7.85	6.68	6.35	11.46	11.33	11.35	11.60	11.40	11.73	12.92	11.48	10.94	10.92	11.30	11.31	11.11	11.47	10.21
CaO	6.60	5.75	7.60	8.31	8.54	6.71	6.79	6.17	7.44	7.53	6.60	7.06	6.54	7.15	8.89	6.62	6.42	6.37	10.23
Na_2O	5.33	5.16	4.55	4.24	3.75	4.31	4.26	4.49	4.09	3.88	4.06	4.11	4.47	4.12	3.16	4.28	4.34	4.35	1.99
K_2O	0.23	0.16	0.13	0.28	0.43	0.36	0.41	0.28	0.42	0.35	0.18	0.34	0.36	0.44	0.57	0.31	0.29	0.34	0.57
Total	98.42	98.45	98.07	98.24	98.47	96.53	96.33	96.20	95.72	96.09	95.24	95.49	95.55	95.65	95.77	96.06	95.95	95.72	95.28
Cations on the basis of 23 oxygens																			
Si	6.726	7.166	6.689	6.614	7.120	7.147	7.100	7.302	7.064	7.149	7.523	7.176	7.154	7.017	6.932	7.215	7.264	7.221	7.142
Ti	0.065	0.096	0.040	0.020	0.019	0.031	0.032	0.030	0.035	0.021	0.010	0.022	0.026	0.035	0.033	0.026	0.023	0.028	0.022
Al	2.404	1.757	2.285	2.154	1.566	1.724	1.766	1.595	1.831	1.552	1.215	1.546	1.786	1.823	1.775	1.679	1.643	1.661	1.263
Fe*	2.500	2.454	2.692	3.019	1.969	1.836	1.839	1.751	1.698	1.896	1.616	1.929	1.799	1.914	1.894	1.793	1.810	1.777	2.372
Mn	0.013	0.005	0.018	0.015	0.007	0.024	0.022	0.018	0.029	0.034	0.023	0.030	0.021	0.025	0.037	0.028	0.041	0.034	0.029
Mg	1.456	1.724	1.502	1.447	2.492	2.488	2.500	2.539	2.520	2.603	2.835	2.564	2.423	2.436	2.530	2.488	2.446	2.532	2.340
Ca	1.052	0.908	1.226	1.362	1.334	1.058	1.075	0.970	1.181	1.201	1.042	1.133	1.040	1.146	1.431	1.047	1.016	1.011	1.684
Na	1.537	1.475	1.330	1.259	1.060	1.230	1.221	1.278	1.176	1.118	1.158	1.193	1.287	1.194	0.919	1.224	1.242	1.249	0.593
K	0.044	0.029	0.025	0.054	0.079	0.068	0.077	0.053	0.079	0.067	0.033	0.065	0.068	0.084	0.109	0.059	0.055	0.064	0.113
Total	15.796	15.612	15.807	15.944	15.647	15.608	15.632	15.535	15.613	15.640	15.455	15.658	15.604	15.675	15.659	15.559	15.540	15.577	15.557

**Total Fe as FeO*

Sample	S-9G																		
Analysis	46	70	72	79	91	110	162	163	164	165	166	192	4	5	7	10	12	13	14
	Amp7	Amp4	Amp4	Amp4	Amp7	Amp7	Amp4	Amp4	Amp4	Amp4	Amp4	Amp2	Amp4	Amp4	Amp4	Amp7	Amp4	Amp4	Amp4
	Mg-Hbl	Brs	Brs	Brs	Brs	Mg-Hbl	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs
SiO_2	48.03	48.07	48.76	47.65	48.16	44.88	49.27	49.74	50.07	50.07	50.88	47.65	50.19	46.53	47.34	47.72	49.67	47.03	48.34
TiO_2	0.17	0.28	0.21	0.28	0.10	0.12	0.20	0.20	0.19	0.18	0.14	0.38	0.17	0.23	0.28	0.07	0.23	0.37	0.26
Al_2O_3	5.81	10.17	9.52	10.30	8.47	9.75	9.05	8.87	8.81	8.80	8.48	9.60	7.65	9.93	10.42	9.28	8.89	10.61	9.83
FeO*	16.53	14.27	13.98	14.92	15.31	16.92	14.29	14.19	13.95	13.96	14.33	14.91	13.50	16.25	14.24	15.63	14.22	14.96	14.18
MnO	0.26	0.24	0.19	0.27	0.34	0.33	0.19	0.19	0.12	0.17	0.27	0.21	0.19	0.30	0.19	0.29	0.15	0.22	0.21
MgO	11.57	11.06	11.63	10.91	10.96	10.29	11.56	11.52	11.58	11.61	11.40	10.66	12.73	10.96	11.41	10.97	12.20	11.18	11.47
CaO	9.98	6.78	6.43	6.73	9.27	9.58	6.09	6.05	5.94	5.92	5.60	7.41	6.34	7.05	6.94	9.01	6.48	6.97	6.62
Na_2O	2.05	4.30	4.46	4.33	2.59	2.73	4.33	4.43	4.44	4.37	4.52	3.98	4.31	4.25	4.35	2.94	4.44	4.36	4.47
K_2O	0.43	0.36	0.31	0.37	0.42	0.69	0.26	0.26	0.23	0.24	0.18	0.30	0.21	0.40	0.40	0.40	0.23	0.46	0.33
Total	94.84	95.51	95.48	95.75	95.62	95.28	95.24	95.46	95.31	95.31	95.78	95.11	95.29	95.90	95.57	96.31	96.51	96.17	95.71
Cations on the basis of 23 oxygens																			
Si	7.322	7.140	7.222	7.091	7.212	6.868	7.307	7.350	7.390	7.390	7.470	7.144	7.413	6.992	7.045	7.109	7.275	6.990	7.162
Ti	0.020	0.031	0.024	0.031	0.012	0.013	0.023	0.022	0.021	0.019	0.015	0.043	0.019	0.026	0.031	0.008	0.026	0.042	0.029
Al	1.044	1.780	1.662	1.807	1.495	1.759	1.582	1.546	1.533	1.531	1.467	1.697	1.332	1.758	1.829	1.629	1.534	1.859	1.716
Fe*	2.107	1.772	1.732	1.856	1.917	2.165	1.772	1.753	1.721	1.723	1.759	1.870	1.667	2.042	1.772	1.947	1.741	1.859	1.757
Mn	0.034	0.030	0.023	0.034	0.044	0.043	0.024	0.024	0.015	0.022	0.034	0.027	0.024	0.039	0.024	0.037	0.019	0.028	0.026
Mg	2.629	2.449	2.567	2.420	2.446	2.349	2.557	2.538	2.548	2.554	2.495	2.382	2.802	2.456	2.531	2.437	2.665	2.477	2.534
Ca	1.631	1.079	1.020	1.073	1.488	1.570	0.967	0.958	0.939	0.937	0.881	1.191	1.003	1.134	1.107	1.439	1.016	1.110	1.050
Na	0.605	1.237	1.280	1.250	0.753	0.809	1.246	1.270	1.269	1.252	1.285	1.158	1.233	1.238	1.255	0.848	1.261	1.256	1.285
K	0.084	0.068	0.058	0.070	0.080	0.135	0.049	0.050	0.043	0.045	0.033	0.058	0.040	0.076	0.076	0.077	0.044	0.087	0.063
Total	15.475	15.586	15.588	15.634	15.445	15.711	15.526	15.511	15.479	15.473	15.439	15.569	15.534	15.760	15.671	15.531	15.580	15.708	15.620

**Total Fe as FeO*

Table 1. (continued)

Sample	S-9G																			
Analysis	15	17	22	25	27	29	31	33	34	35	36	38	39	52	53	54	55	56	57	
	Amp4	Amp4	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp7	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	
	Mg-Ktp	Brs	Brs	Mg-Hbl	Brs	Mg-Ktp	Ed	Brs	Brs	Mg-Hbl	Mg-Hbl	Mg-Ktp	Ed	Brs	Brs	Mg-Ktp	Brs	Brs	Brs	
SiO_2	43.66	50.95	46.13	46.33	46.64	44.64	43.57	46.35	47.07	44.55	48.07	44.72	44.00	45.68	48.80	45.22	46.81	47.03	46.33	
TiO_2	0.44	0.12	0.30	0.14	0.17	0.57	0.58	0.27	0.27	0.15	0.11	0.42	0.28	0.31	0.25	0.40	0.29	0.23	0.27	
Al_2O_3	12.03	7.51	10.34	8.85	9.00	10.52	10.49	9.57	10.75	10.38	7.68	11.19	11.26	10.39	9.57	10.94	10.49	9.65	9.24	
FeO*	16.26	13.67	15.21	16.35	15.78	16.66	17.68	16.05	15.75	16.43	15.50	16.73	16.30	15.62	14.40	16.02	14.75	14.61	17.25	
MnO	0.30	0.12	0.29	0.18	0.26	0.29	0.21	0.23	0.22	0.23	0.23	0.27	0.23	0.27	0.21	0.25	0.18	0.23	0.29	
MgO	9.91	12.72	11.03	11.29	11.64	10.17	9.81	10.64	9.41	10.61	12.41	10.34	10.43	10.77	11.50	10.44	11.21	11.59	10.89	
CaO	8.25	6.02	8.38	9.76	9.25	8.31	9.76	8.39	8.98	9.80	9.93	8.54	9.42	8.56	6.43	8.58	6.83	7.94	7.16	
Na_2O	3.97	4.28	3.59	2.66	2.84	3.75	2.72	3.47	2.83	2.65	2.37	3.66	3.04	3.57	4.49	3.56	4.47	3.81	4.26	
K_2O	0.65	0.21	0.45	0.54	0.41	0.64	0.90	0.46	0.69	0.70	0.49	0.61	0.74	0.53	0.33	0.64	0.41	0.40	0.44	
Total	95.46	95.58	95.72	96.09	95.99	95.54	95.70	95.42	95.95	95.51	96.78	96.47	95.69	95.70	95.96	96.04	95.44	95.50	96.11	
Cations on the basis of 23 oxygens																				
Si	6.652	7.484	6.929	6.985	7.005	6.799	6.690	7.007	7.042	6.788	7.143	6.742	6.692	6.886	7.208	6.815	7.004	7.039	6.993	
Ti	0.050	0.013	0.034	0.015	0.019	0.066	0.067	0.031	0.030	0.017	0.012	0.047	0.032	0.036	0.027	0.045	0.033	0.026	0.030	
Al	2.160	1.300	1.830	1.572	1.593	1.888	1.897	1.705	1.895	1.865	1.345	1.987	2.019	1.846	1.665	1.943	1.850	1.703	1.644	
Fe*	2.071	1.679	1.911	2.061	1.982	2.121	2.270	2.029	1.971	2.093	1.926	2.109	2.073	1.970	1.779	2.020	1.846	1.829	2.178	
Mn	0.038	0.015	0.036	0.023	0.033	0.037	0.027	0.030	0.027	0.030	0.029	0.034	0.029	0.035	0.026	0.031	0.023	0.030	0.037	
Mg	2.251	2.785	2.469	2.537	2.606	2.308	2.246	2.398	2.099	2.410	2.750	2.322	2.364	2.420	2.532	2.345	2.500	2.587	2.451	
Ca	1.346	0.947	1.348	1.576	1.489	1.356	1.605	1.360	1.439	1.600	1.581	1.380	1.535	1.383	1.018	1.386	1.095	1.273	1.158	
Na	1.173	1.219	1.046	0.778	0.827	1.107	0.809	1.016	0.822	0.784	0.683	1.070	0.896	1.044	1.285	1.039	1.296	1.105	1.246	
K	0.127	0.039	0.087	0.105	0.079	0.124	0.175	0.089	0.131	0.136	0.092	0.117	0.144	0.102	0.062	0.124	0.078	0.076	0.084	
Total	15.868	15.482	15.689	15.654	15.633	15.807	15.787	15.663	15.457	15.723	15.560	15.809	15.784	15.721	15.602	15.748	15.724	15.667	15.820	

**Total Fe as FeO*

Sample	S-9G																		
Analysis	59	61	64	65	4	6	8	22	23	30	36	37	38	40	44	50	62	63	64
	Amp4	Amp7	Amp7	Amp7	Amp1	Amp1	Amp1	Amp7	Amp7	Amp4	Amp3	Amp3	Amp3	Amp3	Amp3	Amp3	Amp3	Amp3	Amp3
	Mg-Hbl	Brs	Brs	Brs	Mg-Trm	Mg-Trm	Mg-Trm	Mg-Hs	Mg-Hs	Brs	Brs	Mg-Ktp	Brs	Brs	Brs	Brs	Mg-Ktp	Brs	Brs
SiO_2	50.29	46.24	48.91	51.42	42.21	42.36	41.13	42.58	43.05	48.05	49.84	45.39	47.39	49.39	48.52	49.51	47.73	48.34	47.95
TiO_2	0.16	0.21	0.20	0.11	0.68	0.65	0.53	0.54	0.62	0.28	0.19	0.41	0.29	0.33	0.25	0.21	0.34	0.28	0.29
Al_2O_3	5.47	9.13	8.70	7.34	14.32	15.48	15.30	11.40	10.71	9.24	9.00	11.88	10.02	9.17	9.77	9.30	10.42	9.99	10.22
FeO*	15.64	16.46	13.52	13.24	16.66	16.52	18.88	19.19	19.51	15.30	14.48	16.67	15.53	14.59	15.01	14.59	14.78	13.94	14.35
MnO	0.24	0.25	0.26	0.18	0.47	0.36	0.40	0.21	0.20	0.24	0.21	0.23	0.22	0.27	0.25	0.19	0.20	0.23	0.19
MgO	12.48	11.31	12.06	12.48	9.73	8.92	8.27	9.32	9.18	11.48	11.52	9.72	10.87	11.36	11.14	11.27	11.31	11.40	11.37
CaO	10.02	8.49	7.28	5.95	7.46	7.85	8.16	10.07	9.99	7.22	5.91	7.91	7.77	6.48	6.87	6.33	6.82	6.79	7.33
Na_2O	2.13	3.40	3.92	4.32	5.11	4.80	4.91	3.51	3.23	4.33	4.81	4.22	4.02	4.66	4.58	4.70	4.94	4.44	4.28
K_2O	0.23	0.56	0.29	0.21	0.47	0.53	0.27	0.55	0.46	0.40	0.26	0.65	0.52	0.25	0.37	0.32	0.43	0.38	0.44
Total	96.65	96.05	95.14	95.24	97.10	97.47	97.85	97.37	96.94	96.54	96.21	97.09	96.62	96.50	96.76	96.42	96.96	95.79	96.42
Cations on the basis of 23 oxygens																			
Si	7.446	6.971	7.267	7.556	6.352	6.331	6.214	6.492	6.589	7.123	7.324	6.779	7.038	7.260	7.148	7.276	7.030	7.153	7.079
Ti	0.017	0.024	0.022	0.012	0.077	0.074	0.060	0.062	0.072	0.031	0.021	0.046	0.032	0.037	0.028	0.023	0.038	0.031	0.033
Al	0.955	1.623	1.523	1.271	2.539	2.726	2.723	2.049	1.931	1.614	1.559	2.091	1.753	1.588	1.696	1.611	1.809	1.742	1.779
Fe*	1.937	2.075	1.681	1.627	2.097	2.065	2.385	2.447	2.497	1.897	1.780	2.082	1.929	1.793	1.850	1.794	1.820	1.725	1.772
Mn	0.030	0.032	0.032	0.022	0.060	0.045	0.051	0.026	0.025	0.030	0.026	0.029	0.028	0.033	0.032	0.023	0.024	0.029	0.024
Mg	2.755	2.541	2.672	2.734	2.183	1.987	1.862	2.120	2.094	2.536	2.524	2.164	2.407	2.490	2.447	2.470	2.483	2.515	2.501
Ca	1.589	1.371	1.159	0.937	1.203	1.258	1.321	1.646	1.638	1.147	0.930	1.266	1.236	1.021	1.084	0.996	1.076	1.077	1.159
Na	0.612	0.995	1.129	1.230	1.490	1.392	1.439	1.036	0.959	1.245	1.371	1.221	1.158	1.327	1.308	1.340	1.410	1.272	1.225
K	0.043	0.108	0.056	0.039	0.090	0.101	0.052	0.107	0.089	0.076	0.049	0.124	0.099	0.048	0.069	0.060	0.080	0.072	0.083
Total	15.384	15.740	15.541	15.428	16.092	15.979	16.108	15.985	15.895	15.699	15.584	15.803	15.680	15.596	15.662	15.594	15.772	15.617	15.653

**Total Fe as FeO*

Sample	S-9G																		
Analysis	77	91	55	56	57	60	61	62	64	3	4	5	6	7	8	9	10	11	12
	Amp7	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1
	Brs	Brs	Mg-Ktp	Mg-Trm	Brs	Mg-Trm	Mg-Ktp	Brs	Mg-Trm	Mg-Trm	Brs	Brs	Mg-Trm	Mg-Trm	Mg-Trm	Trm	Mg-Trm	Mg-Trm	Mg-Trm
SiO_2	47.00	47.77	45.54	40.55	41.65	39.52	45.88	47.77	40.34	42.73	47.07	46.71	41.59	41.20	40.66	39.94	42.47	42.50	41.65
TiO_2	0.12	0.42	0.28	0.04	0.25	0.40	0.36	0.48	0.62	0.29	0.19	0.17	0.36	0.28	0.19	0.23	0.56	0.45	0.46
Al_2O_3	8.39	9.14	13.39	16.15	16.10	17.70	12.68	10.64	16.18	15.05	12.03	12.35	15.45	16.21	16.66	17.23	15.44	15.48	16.30
FeO*	16.62	15.07	16.89	20.25	19.00	19.34	15.18	15.90	18.39	18.24	16.63	16.14	20.31	18.03	18.09	18.17	17.72	17.84	17.68
MnO	0.28	0.35	0.46	2.12	1.50	1.12	0.22	0.35	0.26	0.38	0.40	0.39	0.33	0.41	0.38	0.40	0.27	0.24	0.25
MgO	11.33	12.01	9.05	6.57	7.20	7.39	10.48	10.90	7.59	8.06	9.73	9.59	7.39	7.38	7.34	7.16	8.12	8.33	7.96
CaO	8.62	7.02	7.29	7.75	8.51	8.49	7.74	6.59	9.03	8.14	6.96	7.10	7.78	8.40	8.54	8.82	8.51	8.24	8.45
Na_2O	3.67	4.50	4.97	4.55	3.53	4.03	4.69	4.88	4.34	4.66	4.84	4.73	4.77	4.64	4.64	4.58	4.18	4.79	4.55
K_2O	0.39	0.23	0.34	0.34	0.54	0.31	0.42	0.29	0.81	0.64	0.32	0.33	0.82	0.78	0.68	0.58	0.70	0.62	0.69
Total	96.41	96.52	98.21	98.30	98.27	98.30	97.63	97.79	97.56	98.19	98.16	97.50	98.80	97.33	97.17	97.11	97.97	98.50	97.99
Cations on the basis of 23 oxygens																			
Si	7.062	7.081	6.713	6.169	6.265	5.968	6.750	7.002	6.123	6.391	6.905	6.886	6.260	6.239	6.172	6.077	6.349	6.329	6.238
Ti	0.013	0.047	0.031	0.004	0.028	0.046	0.039	0.053	0.070	0.033	0.021	0.019	0.040	0.032	0.021	0.026	0.063	0.050	0.052
Al	1.486	1.596	2.326	2.896	2.854	3.151	2.198	1.839	2.894	2.653	2.080	2.146	2.742	2.892	2.981	3.090	2.720	2.717	2.876
Fe*	2.088	1.868	2.082	2.577	2.389	2.442	1.868	1.949	2.334	2.281	2.040	1.989	2.557	2.283	2.296	2.313	2.215	2.222	2.215
Mn	0.035	0.043	0.057	0.273	0.190	0.143	0.028	0.044	0.034	0.048	0.049	0.049	0.042	0.053	0.049	0.051	0.035	0.030	0.032
Mg	2.538	2.653	1.988	1.489	1.614	1.664	2.298	2.381	1.718	1.798	2.128	2.106	1.658	1.665	1.660	1.625	1.809	1.849	1.776
Ca	1.388	1.115	1.151	1.263	1.372	1.374	1.220	1.035	1.469	1.305	1.095	1.121	1.255	1.363	1.388	1.438	1.363	1.315	1.355
Na	1.069	1.294	1.419	1.341	1.029	1.181	1.336	1.386	1.277	1.350	1.376	1.352	1.392	1.362	1.365	1.352	1.212	1.383	1.322
K	0.075	0.044	0.065	0.065	0.103	0.059	0.078	0.054	0.156	0.122	0.060	0.062	0.157	0.151	0.132	0.113	0.133	0.118	0.131
Total	15.754	15.742	15.833	16.077	15.845	16.027	15.815	15.743	16.076	15.981	15.753	15.730	16.103	16.040	16.065	16.083	15.900	16.013	15.997

**Total Fe as FeO*

Table 1. (continued)

Sample	S-9G															S-9R			
Analysis	14	19	20	21	22	24	29	30	32	33	37	38	49	52	61	52	61	76	84
	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1
	Mg-Trm	Mg-Ktp	Trm	Mg-Trm	Mg-Trm	Mg-Trm	Mg-Trm	Brs	Mg-Ktp	Mg-Trm	Mg-Trm	Trm	Mg-Trm	Mg-Trm	Mg-Trm	Mg-Trm	Mg-Trm	Gln	Gln
SiO_2	41.84	44.67	43.01	42.36	42.43	42.36	41.43	46.69	46.14	41.71	42.85	41.11	43.50	40.65	40.50	40.65	40.50	54.45	51.68
TiO_2	0.54	0.58	0.31	0.18	0.46	0.24	0.51	0.45	0.52	0.27	0.31	0.23	0.30	0.46	0.42	0.46	0.42	0.00	0.01
Al_2O_3	16.22	13.80	13.40	14.87	14.99	17.16	15.40	11.48	13.22	15.35	13.78	15.42	13.54	14.42	16.01	14.42	16.01	7.16	8.27
FeO*	17.02	16.16	20.82	18.27	17.74	16.19	18.62	16.87	15.49	19.20	19.79	19.88	16.10	19.78	17.90	19.78	17.90	17.18	19.53
MnO	0.27	0.30	0.34	0.30	0.26	0.37	0.29	0.28	0.21	0.28	0.49	0.44	0.17	0.40	0.24	0.40	0.24	0.20	0.19
MgO	8.70	8.68	6.42	7.70	8.47	7.70	7.54	10.16	9.77	7.59	7.59	6.81	9.31	7.29	7.58	7.29	7.58	10.43	9.26
CaO	8.80	7.08	7.84	8.43	8.85	8.50	8.43	7.23	7.11	8.13	7.96	8.53	8.50	8.38	8.75	8.38	8.75	2.21	3.19
Na_2O	4.57	4.91	4.49	4.50	4.43	4.42	4.72	4.57	4.83	5.12	4.44	4.48	4.16	4.72	4.59	4.72	4.59	5.89	5.67
K_2O	0.27	0.39	0.46	0.56	0.31	0.57	0.31	0.19	0.40	0.33	0.48	0.38	0.73	0.28	0.26	0.28	0.26	0.05	0.07
Total	98.21	96.55	97.09	97.16	97.94	97.51	97.24	97.91	97.69	97.97	97.69	97.28	96.30	96.38	96.23	96.38	96.23	97.57	97.87
Cations on the basis of 23 oxygens																			
Si	6.223	6.675	6.573	6.409	6.347	6.305	6.282	6.877	6.773	6.293	6.487	6.273	6.560	6.274	6.193	6.274	6.193	7.839	7.559
Ti	0.060	0.065	0.035	0.020	0.052	0.027	0.058	0.049	0.057	0.030	0.035	0.027	0.033	0.054	0.048	0.054	0.048	0.000	0.001
Al	2.843	2.430	2.414	2.652	2.644	3.009	2.751	1.993	2.288	2.729	2.458	2.774	2.406	2.624	2.885	2.624	2.885	1.215	1.425
Fe*	2.117	2.019	2.661	2.311	2.220	2.015	2.361	2.077	1.901	2.423	2.506	2.537	2.031	2.554	2.289	2.554	2.289	2.069	2.388
Mn	0.034	0.038	0.044	0.038	0.033	0.047	0.038	0.034	0.026	0.035	0.062	0.056	0.022	0.052	0.030	0.052	0.030	0.025	0.023
Mg	1.930	1.933	1.462	1.736	1.890	1.707	1.703	2.230	2.138	1.707	1.712	1.550	2.092	1.679	1.728	1.679	1.728	2.239	2.020
Ca	1.402	1.133	1.284	1.366	1.418	1.355	1.369	1.141	1.118	1.314	1.291	1.394	1.374	1.387	1.433	1.387	1.433	0.340	0.500
Na	1.318	1.421	1.330	1.318	1.285	1.276	1.387	1.306	1.374	1.497	1.303	1.326	1.216	1.412	1.361	1.412	1.361	1.645	1.607
K	0.051	0.075	0.089	0.108	0.058	0.108	0.059	0.035	0.075	0.064	0.093	0.074	0.140	0.054	0.051	0.054	0.051	0.008	0.013
Total	15.977	15.789	15.892	15.958	15.947	15.850	16.008	15.745	15.751	16.092	15.947	16.013	15.875	16.089	16.020	16.089	16.020	15.380	15.537

**Total Fe as FeO*

Sample	S-9R																		
Analysis	85	86	89	90	91	93	22	28	29	32	33	64	76	79	92	93	98	99	100
	Amp1	Amp1	Amp1	Amp6	Amp6	Amp6	Amp1	Amp5	Amp5	Amp5	Amp5	Amp1	Amp1	Amp1	Amp5	Amp5	Amp4	Amp4	Amp4
	Win	Brs	Brs	Brs	Brs	Brs	Brs	Mg-Trm	Mg-Ktp	Brs	Brs	Gln	Brs	Brs	Brs	Brs	Brs	Brs	Brs
SiO_2	53.26	51.58	52.85	46.79	47.51	48.13	50.69	42.23	44.40	45.79	45.44	55.12	47.37	44.97	46.29	45.34	48.24	48.07	48.42
TiO_2	0.00	0.01	0.10	0.26	0.24	0.23	0.06	0.25	0.30	0.33	0.26	0.03	0.23	0.73	0.24	0.27	0.23	0.24	0.22
Al_2O_3	7.39	9.20	9.51	11.11	11.22	10.55	12.06	15.00	12.94	11.78	12.16	9.13	10.84	12.26	10.60	11.42	11.10	11.20	10.53
FeO*	16.39	17.31	15.29	15.09	16.13	16.81	19.40	17.89	17.21	16.50	16.40	14.55	14.73	16.03	16.05	16.24	14.38	14.14	14.80
MnO	0.12	0.12	0.14	0.09	0.18	0.14	0.53	0.12	0.10	0.23	0.17	0.04	0.14	0.08	0.12	0.16	0.14	0.06	0.15
MgO	10.64	9.80	10.14	10.96	10.36	10.15	7.97	8.79	9.32	10.18	10.30	10.60	10.85	10.20	10.55	10.01	11.40	11.41	11.31
CaO	2.67	3.72	5.09	6.54	6.81	6.23	3.04	8.55	8.57	8.04	7.94	1.92	6.45	8.32	7.49	7.89	6.56	6.36	6.18
Na_2O	5.20	5.53	4.42	4.60	4.27	4.62	3.73	4.01	4.02	4.05	4.09	6.35	4.69	3.89	4.00	3.96	4.47	4.70	4.74
K_2O	0.08	0.10	0.12	0.27	0.28	0.23	0.05	0.52	0.38	0.31	0.37	0.06	0.34	0.17	0.28	0.33	0.31	0.33	0.27
Total	95.74	97.36	97.66	95.70	97.00	97.09	97.53	97.35	97.24	97.20	97.13	97.78	95.64	96.64	95.63	95.61	96.83	96.50	96.62
Cations on the basis of 23 oxygens																			
Si	7.792	7.508	7.574	6.974	7.009	7.102	7.366	6.351	6.639	6.803	6.756	7.794	7.049	6.707	6.957	6.842	7.061	7.052	7.114
Ti	0.000	0.001	0.010	0.029	0.026	0.025	0.006	0.029	0.034	0.037	0.029	0.003	0.025	0.082	0.028	0.030	0.025	0.026	0.025
Al	1.275	1.578	1.605	1.951	1.950	1.835	2.066	2.658	2.280	2.063	2.131	1.521	1.901	2.155	1.877	2.032	1.914	1.937	1.823
Fe*	2.005	2.107	1.833	1.881	1.990	2.074	2.358	2.250	2.152	2.050	2.039	1.720	1.833	1.999	2.017	2.049	1.760	1.734	1.819
Mn	0.015	0.015	0.017	0.011	0.022	0.017	0.065	0.015	0.013	0.028	0.022	0.004	0.018	0.010	0.015	0.020	0.017	0.008	0.018
Mg	2.321	2.126	2.167	2.435	2.279	2.233	1.726	1.971	2.078	2.255	2.282	2.235	2.408	2.267	2.364	2.252	2.487	2.496	2.477
Ca	0.418	0.580	0.781	1.045	1.077	0.985	0.473	1.377	1.373	1.279	1.265	0.291	1.028	1.329	1.206	1.276	1.029	1.000	0.972
Na	1.474	1.560	1.229	1.331	1.222	1.323	1.051	1.170	1.166	1.166	1.178	1.740	1.352	1.123	1.166	1.158	1.269	1.335	1.349
K	0.015	0.018	0.022	0.052	0.052	0.042	0.009	0.099	0.072	0.059	0.070	0.010	0.065	0.032	0.054	0.064	0.058	0.061	0.051
Total	15.315	15.492	15.238	15.709	15.627	15.638	15.121	15.920	15.806	15.741	15.771	15.318	15.679	15.704	15.685	15.723	15.620	15.649	15.649

**Total Fe as FeO*

Sample	S-9R									S-9C									
Analysis	1	6	7	9	11	13	17	22	23	44	57	18	19	20	21	22	23	24	28
	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp1	Amp5	Amp5	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4	Amp4
	Gln	Gln	Trm	Gln	Gln	Brs	Gln	Gln	Gln	Mg-Trm	Mg-Trm	Brs	Brs	Brs	Brs	Brs	Brs	Brs	Brs
SiO_2	54.32	51.71	41.50	52.53	53.08	48.43	51.75	53.42	54.46	43.98	43.14	49.15	48.37	49.74	50.27	47.15	46.95	44.74	47.20
TiO_2	0.50	0.05	0.12	0.10	0.05	0.02	0.06	0.06	0.02	0.26	0.31	0.20	0.35	0.28	0.24	0.37	0.38	0.39	0.30
Al_2O_3	9.01	9.09	13.55	8.30	9.38	10.41	9.45	9.17	9.09	12.28	13.32	10.26	11.42	10.75	10.87	12.14	12.25	12.25	10.30
FeO*	14.00	16.23	21.35	17.39	16.11	18.17	16.21	15.60	14.07	17.06	16.84	15.52	14.78	14.42	13.94	14.61	14.37	17.18	15.70
MnO	0.07	0.38	0.27	0.12	0.12	0.13	0.11	0.12	0.09	0.14	0.16	0.23	0.18	0.24	0.14	0.09	0.09	0.24	0.28
MgO	10.14	9.33	6.26	8.72	9.69	8.42	9.53	9.47	10.15	10.05	9.67	10.30	10.52	10.86	10.98	10.72	10.92	9.20	10.37
CaO	2.08	2.77	7.06	2.57	2.72	4.86	3.21	2.26	1.93	7.87	7.93	5.78	5.89	5.43	4.84	6.46	6.58	7.99	7.43
Na_2O	6.15	5.68	4.94	6.20	6.20	5.27	5.99	6.32	6.42	4.29	4.15	4.20	4.56	4.58	4.99	4.50	4.41	3.58	3.59
K_2O	0.05	0.07	0.28	0.08	0.07	0.15	0.12	0.06	0.05	0.34	0.36	0.21	0.29	0.22	0.21	0.32	0.38	0.32	0.25
Total	96.31	95.31	95.34	96.01	97.41	95.86	96.42	96.50	96.27	96.25	95.87	95.84	96.35	96.53	96.48	96.34	96.33	95.90	95.41
Cations on the basis of 23 oxygens																			
Si	7.785	7.629	6.489	7.726	7.638	7.253	7.558	7.726	7.813	6.645	6.542	7.262	7.106	7.251	7.298	6.949	6.920	6.759	7.073
Ti	0.054	0.006	0.014	0.011	0.006	0.002	0.007	0.006	0.003	0.029	0.035	0.022	0.039	0.031	0.027	0.041	0.042	0.045	0.033
Al	1.521	1.581	2.498	1.439	1.590	1.838	1.627	1.564	1.537	2.186	2.380	1.786	1.977	1.847	1.860	2.109	2.128	2.181	1.819
Fe*	1.678	2.003	2.792	2.140	1.939	2.275	1.980	1.887	1.688	2.155	2.136	1.918	1.815	1.758	1.693	1.800	1.771	2.171	1.968
Mn	0.008	0.047	0.036	0.015	0.015	0.017	0.014	0.015	0.011	0.018	0.020	0.029	0.022	0.030	0.017	0.011	0.011	0.030	0.035
Mg	2.167	2.052	1.460	1.912	2.078	1.880	2.075	2.042	2.170	2.265	2.186	2.269	2.303	2.361	2.376	2.354	2.399	2.073	2.317
Ca	0.319	0.438	1.183	0.405	0.419	0.780	0.502	0.350	0.297	1.274	1.289	0.915	0.927	0.848	0.753	1.019	1.039	1.293	1.193
Na	1.709	1.626	1.498	1.769	1.729	1.530	1.696	1.773	1.785	1.255	1.220	1.204	1.298	1.295	1.403	1.287	1.260	1.047	1.042
K	0.010	0.013	0.056	0.014	0.013	0.028	0.022	0.011	0.009	0.065	0.069	0.039	0.055	0.042	0.039	0.060	0.071	0.062	0.047
Total	15.252	15.394	16.026	15.431	15.428	15.602	15.479	15.375	15.312	15.893	15.877	15.444	15.541	15.463	15.466	15.629	15.640	15.660	15.528

**Total Fe as FeO*