Mem. Fac. Sci. Eng. Shimane Univ.
Series A
34, pp. 1-12 (2000)

Mineral paragenesis and chemical compositions of the constituent minerals of jadeitites from the Osayama area in the Sangun metamorphic belt, southwest Japan

Takasu, A.[1)], Sakamoto, S.[2)] and Kashiwabara, Y.[1)]

[1)]*Dept. of Geoscience, Faculty of Science and Engineering, Shimane University*
[2)]*Dept. of Geology and Mineralogy, Kyoto University*

Abstract

Jadeitites (OsaJd and OsaJd2) from the serpentinites of the Osayama ultramafic body in the Sangun metamorphic belt (Suo belt) are petrographically described. Wollastonite and albite are newly found in the jadeitite of OsaJd associated with jadeite, pectolite, grossular and analcite. Magnesiokatophorite has been found from the jadeitite of OsaJd2, and it is associated with jadeite, omphacite, diopside, phlogopite, rutile and titanite. The clinopyroxenes from the jadeitite (OsaJd2) are classified into jadeite, omphacite and diopside. The compositional gaps between jadeite and omphacite and omphacite and diopside have been revealed. Based on the textural relationship a successive formation of clinopyroxenes from jadeite through omphacite and up to diopside is recognized.

Ca–rich minerals such as diopside, wollastonite, pectolite and grossular occur along the cracks within the matrix of jadeites, suggesting later stage Ca–rich fluid infiltration and subsequent participation of such Ca–rich minerals.

Key word: Sangun, Renge, Osayama, serpentinite melange, tectonic block, jadeite, omphacite, diopside, wollastonite, katophorite

Introduction

Jadeitites often occur as block or enclave within serpentinite body or serpentinite melange. In the Renge belt of the Sangun high–P metamorphic belt (Nishimura, 1998), jadeitite blocks within the serpentinite bodies have been described from the Omi–Renge, Oya, Wakasa and Osayama areas.

The Osayama ultramafic body (Fig. 1) is emplaced into the low-grade schists of the Suo belt (Nishimura, 1998) , and it consists mainly of harzburgite with small amounts of dunite and metagabbro, but major parts of the ultramafic rocks are serpentinized (Kobayashi et al., 1987; Nozaka and Shibata, 1994, 1995). A Cretaceous granitic body gave a contact metamorphism in the southwestern parts of the Osayama ultramafic body. The Osayama ultramafic body contains

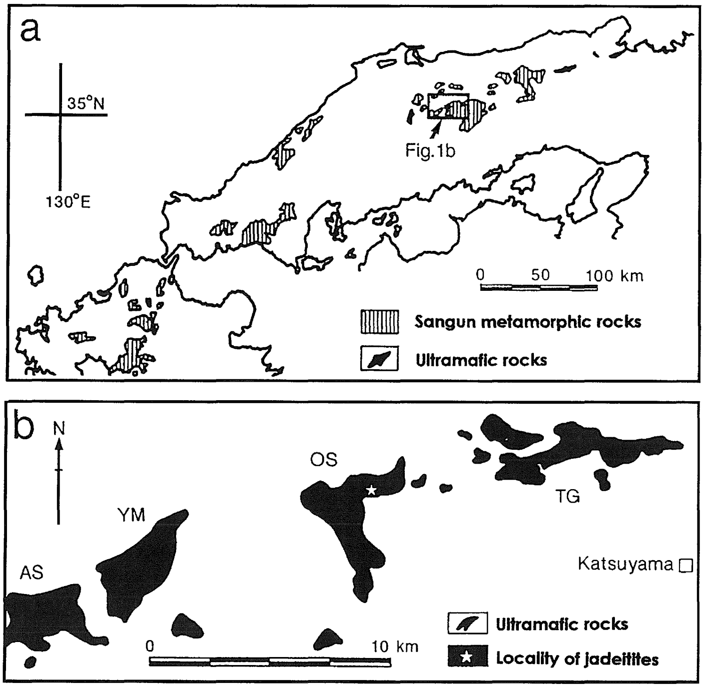

Fig. 1. Location of the Osayama ultramafic body (after Shibata and Nishimura, 1989; Matsumoto and Sugita, 1980; Matsumoto et al., 1995). AS: Ashidachi body; YM: Yanomine body; OS: Osayama body; TG: Taguchi body.

tectonic blocks with diverse lithologies and sizes (10 cm–1.5 km across). The tectonic blocks within the serpentinite matrix include lawsonite-glaucophane schists, garnet glaucophane schists, pelitic schists, metagabbros, metadiabases, metadolerites and metasomatic rocks such as rodingite, albitite, omphacitite, tremolite rock and jadeitite (Watanabe, 1984; Watanabe et al., 1987; Kobayashi et al., 1987; Tsujimori and Takasu, 1994; Sakamoto and Takasu, 1996; Takasu and Sakamoto, 1996).

A vein-like jadeitite block with several meters in width within the serpentinites was discovered from the northeastern part of the Osayama ultramafic body (Fig. 2; Kobayashi et al., 1987). Rodingites also occur as veins and lenses in the serpentinites close to the jadeitite block. The jadeitites show milky white, light green and light blue in color. The jadeitites occurring in the interior parts of the vein-like block consist mainly of jadeite with minor grossular, analcite, prehnite, vesuvianite, natrolite, thomsonite, zircon, deweylite and stronalsite. The marginal parts of the block consist of grossular, chlorite, diopside and zircon (Kobayashi et al., 1987). Nozaka, T. of Okayama University (1988: personal communication) found pectolite from a loosed block of jadeitite close to the outcrop of jadeitite block described by Kobayashi et al. (1987). Tsujimori (1998) petrographically studied some loosed blocks of jadeitites, and

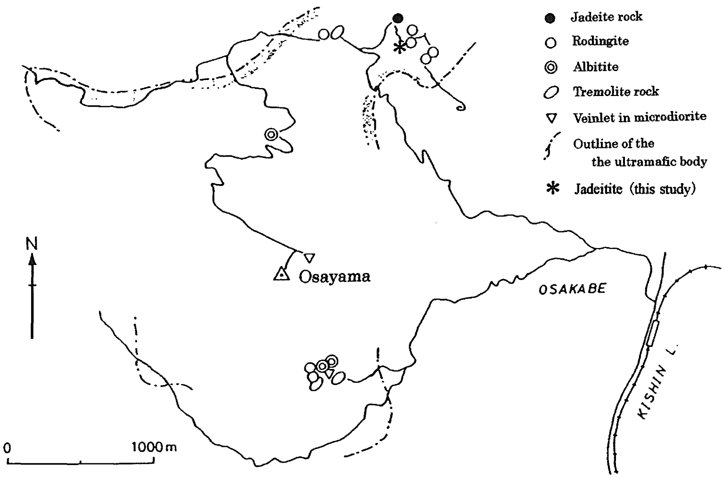

Fig. 2. Sample locality of the jadeitite blocks (after Kobayashi et al., 1987).

described omphacite, phlogopite and rutile in the jadeitites. Omphacite, analcite and phlogopite were regarded as secondary minerals.

In this paper, we describe jadeitites which were collected as loosed blocks occurring close to the original locality of jadeitite in the Osayama area (Fig. 2). Wollastonite, amphibole of the sodic-calcic group (Leake et al., 1997) and albite in jadeitites are newly described in this paper. We also show the chemical compositions of the constituent minerals of the jadeitite such as clinopyroxene, pectolite, wollastonite, phlogopite and sodic-calcic amphibole, and discuss the mineral paragenesis of the jadeitites in the Osayama ultramafic body.

Petrography of jadeitites from the Osayama area

Two jadeitite loosed blocks (OsaJd and OsaJd2) were collected close to the original locality of the jadeitite described by Kobayashi et al. (1987), and are petrographically described below.

1. OsaJd

The jadeitite (OsaJd) is massive, and it consists mainly of jadeite with subordinate pectolite, wollastonite, grossular, analcite and albite.

Jadeite has no preferred orientation, and it is of subhedral to euhedral prismatic crystal with maximum length of c. 3 mm. The grain size of jadeite is different in different domains within the sample. Pectolite, grossular, analcite and albite occur along cracks and at the intestices of jadeite crystals. Wollastonite is participated along irregular cracks in the pectolite crystals (Fig. 3).

2. OsaJd2

The jadeitite (OsaJd2) is massive, and it consists mainly of jadeite and subordinate

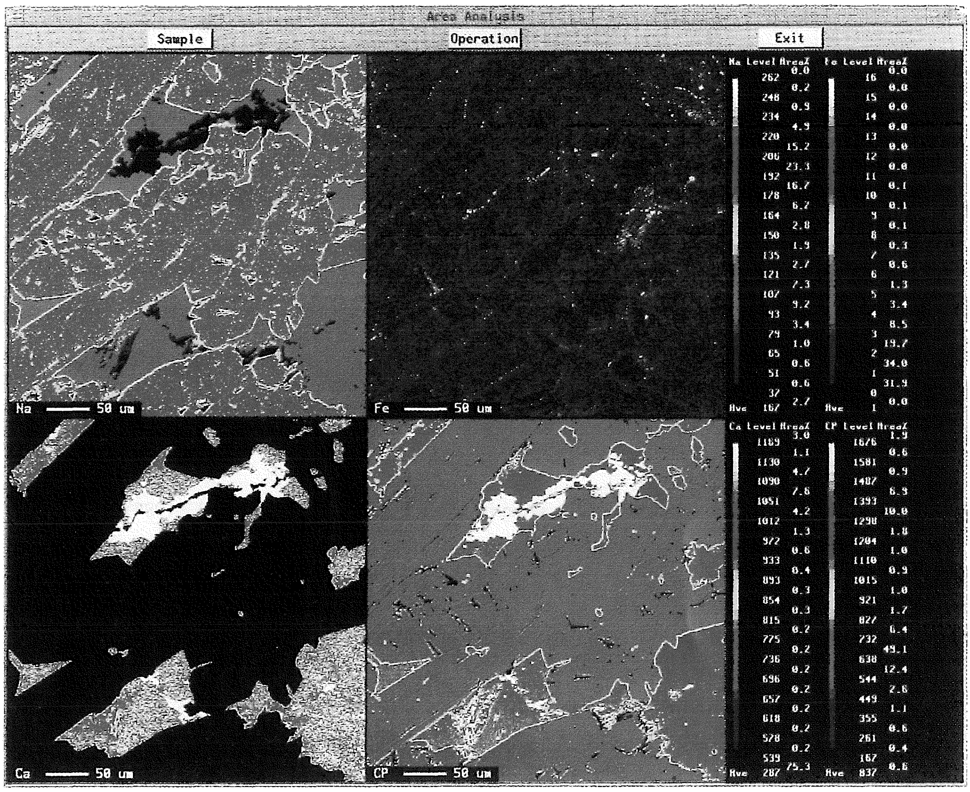

Fig. 3. Elemental color map photo of Na, Fe, Ca and BEI. In the Ca map, wollastonite (white) occurs along the cracks through the pectolite grains (pink). Black parts consist of aggregate of jadeites.

amounts of omphacite and diopside, with accessory phlogopite, sodic-calcic amphibole, rutile and titanite. Diopside and sodic-calcic amphibole occur along the cracks in the matrix consisting mainly of jadeites.

Jadeite has no preferred orientation, and it is of subhedral to euhedral prismatic crystal with maximum length of c. 1 mm. Omphacite occurs at the interstice of jadeite grains and as inclusion in diopside. Diopside has two modes of occurrence, one being of subhedral to anhedral prismatic crystal (max. 2–3 mm in length) and the other being euhedral prismatic crystal (max. 0.7 mm in length) with no preferred orientation overgrowing on the matrix jadeites. Phlogopite is of subhedral to anhedral tiny crystal occurring along the cracks together with diopside and sodic-calcic amphibole. Rutile occurs as porphyroblast of subhedral to anhedral prismatic crystal (max. 5 mm in length). It is rimmed by aggregate of titanites.

Chemistry of the constitute minerals in jadeitites

Chemical compositions of minerals have been analysed by EPMA (JEOL JXA-8800M) in the Research Center for Coastal Lagoon Environments, Shimane University. The analyses were performed at 15 kV of accelerating voltage, 2×10^{-8} A of specimen current, and 3–5 μm of probe diameter, following the correction method of Bence and Albee (1968). The chemical composition of the minerals are shown in Tables 1 and 2.

1. clinopyroxenes

Clinopyroxenes in the sample of OsaJd are classified into jadeite composition ranging from $Jd_{94.5}$ to $Jd_{99.6}$. There is a compositional gap between $Jd_{95.1}$ and $Jd_{98.9}$ (Fig. 4). Aegirine and kosmochlor molecules are negligible.

Clinopyroxenes in the sample of OsaJd2 are chemically classified into three, i.e. jadeite, omphacite and diopside (Fig. 5). The jadeite group clinopyroxenes contain very low aegirine molecules (<0.5 mol.%), and the lower the jadeite molecule, the higher the aegirine molecule. Diopsidic clinopyroxenes have relatively high aegirine molecule up to c. 10 mol.%. Jadeitic clinopyroxenes have a compositional gap between $Jd_{94.5}$ and $Jd_{86.6}$. There are also compositional gaps between jadeites and omphacites ($Jd_{47.8-80.0}$) and omphacites and diopsides ($Jd_{12.2-27.9}$). Clinapyroxenes in OsaJd2 contain negligible amounts of kosmochlor molecule.

Table 1 Chemical compositions of clinopyroxenes from the jadeitites.

Sample	OsaJd 717				719				823		
No.	1	3	4	5	2	10	11	13	1	2	4
SiO_2	59.06	58.73	58.40	58.95	59.29	59.48	59.24	59.40	59.54	59.19	59.14
TiO_2	0.02	0.06	0.14	0.00	0.01	0.01	0.00	0.03	0.00	0.00	0.00
Al_2O_3	25.41	23.90	23.47	24.98	25.00	25.14	25.03	24.90	25.39	25.06	25.22
FeO*	0.09	0.65	0.57	0.04	0.06	0.11	0.05	0.11	0.18	0.04	0.14
MnO	0.00	0.00	0.03	0.00	0.01	0.04	0.00	0.04	0.01	0.00	0.02
MgO	0.03	0.71	1.21	0.00	0.09	0.00	0.00	0.01	0.01	0.00	0.02
CaO	0.12	1.16	0.81	0.15	0.32	0.20	0.10	0.17	0.22	0.09	0.15
Na_2O	14.65	14.30	14.05	14.45	15.15	15.04	15.22	15.14	15.38	14.70	14.95
K_2O	0.06	0.04	0.37	0.03	0.01	0.04	0.04	0.04	0.03	0.04	0.04
Cr_2O_3	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01
Total	99.45	99.55	99.05	98.60	99.94	100.06	99.68	99.87	100.76	99.13	99.69
Si	1.996	1.996	1.996	2.007	1.999	2.001	2.001	2.003	1.993	2.006	1.997
Ti	0.001	0.002	0.004	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Al	1.012	0.957	0.945	1.002	0.993	0.997	0.996	0.990	1.001	1.000	1.003
Fe	0.003	0.018	0.016	0.001	0.002	0.003	0.001	0.003	0.005	0.001	0.004
Mn	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.001
Mg	0.002	0.036	0.062	0.000	0.005	0.000	0.000	0.001	0.000	0.000	0.001
Ca	0.004	0.042	0.030	0.005	0.012	0.007	0.004	0.006	0.008	0.003	0.005
Na	0.959	0.942	0.931	0.953	0.990	0.980	0.996	0.989	0.998	0.965	0.978
K	0.003	0.002	0.016	0.001	0.000	0.002	0.002	0.002	0.001	0.002	0.002
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Total	3.980	3.995	4.001	3.969	4.001	3.991	4.000	3.997	4.006	3.977	3.991
Jd	99.52	95.12	94.50	99.43	98.85	99.27	99.64	99.30	98.87	99.65	99.42
Aeg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00
Ko	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.02
Aug	0.45	4.88	5.50	0.57	1.15	0.73	0.36	0.62	0.77	0.35	0.56

* Total Fe as FeO

Jd: jadeite; Aeg; aegirine; Ko: kosmochlor; Aug: augite.

Table 1 (Continued)

Sample	OsaJd	OsaJd2									
	823	717									
No.	14	2	3	4	7	10	11	12	13	14	15
SiO_2	59.14	58.10	57.94	57.90	53.72	53.59	54.20	54.17	53.97	57.43	57.64
TiO_2	0.00	0.12	0.11	0.20	0.26	0.30	0.11	0.31	0.36	0.04	0.10
Al_2O_3	24.76	24.24	21.05	20.78	0.61	1.08	0.79	1.28	1.16	20.38	19.89
FeO*	0.16	0.30	0.65	0.89	4.52	5.14	5.58	5.55	5.81	0.99	0.75
MnO	0.00	0.00	0.00	0.02	0.15	0.16	0.15	0.10	0.11	0.02	0.00
MgO	0.19	0.69	2.68	2.72	14.93	14.89	14.46	13.63	13.84	3.38	3.70
CaO	0.62	0.69	3.64	3.70	22.95	21.93	22.73	22.01	22.03	4.27	4.99
Na_2O	15.19	14.17	12.86	12.59	1.37	1.76	1.20	1.90	1.61	12.22	11.93
K_2O	0.06	0.19	0.05	0.03	0.07	0.29	0.06	0.04	0.05	0.27	0.05
Cr_2O_3	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.27	0.03	0.00	0.02
Total	100.12	98.50	98.99	98.83	98.58	99.14	99.31	99.26	98.97	99.00	99.07
Si	1.995	1.991	1.996	1.999	2.002	1.991	2.009	2.008	2.007	1.987	1.991
Ti	0.000	0.003	0.003	0.005	0.007	0.008	0.003	0.009	0.010	0.001	0.003
Al	0.984	0.979	0.854	0.845	0.027	0.047	0.035	0.056	0.051	0.831	0.810
Fe	0.005	0.009	0.019	0.026	0.141	0.160	0.173	0.172	0.181	0.029	0.022
Mn	0.000	0.000	0.000	0.001	0.005	0.005	0.005	0.003	0.003	0.001	0.000
Mg	0.009	0.035	0.138	0.140	0.829	0.824	0.798	0.753	0.767	0.174	0.190
Ca	0.022	0.025	0.134	0.137	0.916	0.872	0.902	0.874	0.878	0.158	0.185
Na	0.993	0.941	0.858	0.842	0.099	0.127	0.086	0.136	0.116	0.819	0.799
K	0.002	0.008	0.002	0.001	0.003	0.014	0.003	0.002	0.002	0.012	0.002
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.001	0.000	0.001
Total	4.010	3.991	4.004	3.996	4.029	4.048	4.015	4.021	4.016	4.012	4.003
Jd	97.34	96.46	85.05	84.76	2.64	3.74	3.45	5.53	5.09	81.84	80.05
Aeg	0.45	0.00	0.79	0.00	7.11	8.77	5.08	7.19	6.44	0.13	0.00
Ko	0.00	0.00	0.03	0.00	0.00	0.00	0.09	0.78	0.09	0.00	0.05
Aug	2.21	3.54	14.13	15.24	90.25	87.49	91.38	86.49	88.37	18.03	19.89

Sample	OsaJd2										
	717										
No.	16	17	18	19	22	23	24	25	26	27	28
SiO_2	53.93	54.81	54.06	53.84	53.73	53.93	54.90	55.28	53.97	55.44	54.28
TiO_2	0.37	0.33	0.52	0.40	0.47	0.40	0.36	0.25	0.41	0.25	0.19
Al_2O_3	2.17	11.15	1.18	1.12	1.16	1.21	10.28	10.38	0.67	8.50	7.27
FeO*	4.66	2.12	4.77	4.80	4.13	4.46	2.37	2.29	4.75	2.60	2.96
MnO	0.08	0.07	0.15	0.04	0.13	0.09	0.02	0.04	0.12	0.09	0.09
MgO	13.97	10.12	14.32	14.76	14.96	14.66	10.53	10.19	14.87	11.30	12.55
CaO	21.08	13.27	21.91	21.70	22.25	22.19	13.80	14.72	22.82	16.28	16.98
Na_2O	2.16	6.35	1.89	1.85	1.82	1.83	6.04	6.24	1.45	4.92	3.96
K_2O	0.16	0.45	0.10	0.17	0.03	0.05	0.48	0.10	0.03	0.25	0.56
Cr_2O_3	0.00	0.00	0.03	0.01	0.01	0.02	0.05	0.01	0.03	0.00	0.03
Total	98.58	98.67	98.93	98.69	98.69	98.84	98.83	99.50	99.12	99.63	98.87
Si	2.000	1.965	2.004	2.001	1.994	1.999	1.970	1.971	2.001	1.983	1.970
Ti	0.010	0.009	0.014	0.011	0.013	0.011	0.010	0.007	0.011	0.007	0.005
Al	0.095	0.471	0.052	0.049	0.051	0.053	0.435	0.436	0.029	0.358	0.311
Fe	0.144	0.064	0.148	0.149	0.128	0.138	0.071	0.068	0.147	0.078	0.090
Mn	0.003	0.002	0.005	0.001	0.004	0.003	0.001	0.001	0.004	0.003	0.003
Mg	0.772	0.540	0.791	0.817	0.827	0.810	0.563	0.541	0.821	0.602	0.678
Ca	0.837	0.509	0.870	0.864	0.884	0.881	0.530	0.562	0.906	0.624	0.660
Na	0.155	0.441	0.136	0.133	0.131	0.131	0.420	0.431	0.104	0.341	0.278
K	0.008	0.021	0.005	0.008	0.001	0.002	0.022	0.005	0.001	0.011	0.026
Cr	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.001
Total	4.024	4.022	4.026	4.033	4.033	4.029	4.023	4.022	4.026	4.007	4.022
Jd	9.45	43.74	5.13	4.87	4.39	5.16	40.67	40.47	2.90	34.30	27.93
Aeg	6.03	0.54	8.29	8.33	8.47	7.76	1.38	2.38	7.33	0.00	0.00
Ko	0.00	0.00	0.09	0.03	0.03	0.06	0.14	0.03	0.09	0.00	0.09
Aug	84.52	55.72	86.50	86.77	87.11	87.02	57.82	57.13	89.69	65.70	71.98

* Total Fe as FeO

Table 1 (Continued)

Sample No.	OsaJd2 717 29	31	32	40	41	42	43	44	45	47	48
SiO_2	53.61	57.78	53.97	53.86	55.94	54.33	54.84	54.84	55.57	55.58	55.01
TiO_2	0.65	0.19	0.63	0.65	0.16	0.32	0.20	0.20	0.26	0.28	0.30
Al_2O_3	1.21	21.44	1.63	0.87	8.87	1.33	8.54	8.54	10.83	8.14	8.22
FeO*	5.48	0.69	4.96	5.03	2.54	4.26	2.52	2.52	2.23	2.22	2.44
MnO	0.09	0.00	0.16	0.10	0.03	0.10	0.09	0.09	0.00	0.05	0.06
MgO	14.13	2.82	13.93	14.39	10.89	15.22	12.56	12.56	10.33	11.94	12.50
CaO	21.19	3.22	20.94	22.21	16.17	22.36	15.79	15.79	14.03	16.65	16.19
Na_2O	2.37	12.56	2.30	1.81	5.53	1.92	4.43	4.43	5.99	4.88	4.69
K_2O	0.05	0.32	0.07	0.06	0.07	0.08	0.83	0.83	0.34	0.28	0.51
Cr_2O_3	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Total	98.82	99.02	98.59	98.98	100.20	99.92	99.80	99.80	99.58	100.03	99.92
Si	1.997	1.989	2.005	2.001	1.987	1.992	1.962	1.962	1.973	1.980	1.966
Ti	0.018	0.005	0.018	0.018	0.004	0.009	0.005	0.005	0.007	0.007	0.008
Al	0.053	0.869	0.071	0.038	0.371	0.057	0.360	0.360	0.453	0.342	0.346
Fe	0.171	0.020	0.154	0.156	0.075	0.131	0.075	0.075	0.066	0.066	0.073
Mn	0.003	0.000	0.005	0.003	0.001	0.003	0.003	0.003	0.000	0.002	0.002
Mg	0.784	0.145	0.771	0.796	0.576	0.831	0.669	0.669	0.546	0.634	0.665
Ca	0.845	0.119	0.833	0.883	0.615	0.878	0.605	0.605	0.534	0.635	0.620
Na	0.171	0.838	0.166	0.130	0.381	0.136	0.307	0.307	0.412	0.337	0.325
K	0.002	0.014	0.003	0.003	0.003	0.004	0.038	0.038	0.015	0.013	0.023
Cr	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	4.045	3.999	4.026	4.028	4.013	4.041	4.024	4.024	4.006	4.016	4.028
Jd	4.88	85.54	7.14	3.76	35.74	4.85	31.23	31.23	41.83	32.27	31.23
Aeg	11.83	0.00	9.42	9.09	2.19	8.60	0.00	0.00	0.00	1.47	1.31
Ko	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Aug	83.17	14.46	83.44	87.15	62.07	86.55	68.77	68.77	58.17	66.24	67.46

Sample No.	OsaJd2 717 49	51	52	53	54	55	56	58	59	60
SiO_2	53.85	55.27	55.13	55.45	54.32	54.11	54.92	58.63	58.97	58.85
TiO_2	0.38	0.27	0.16	0.17	0.72	0.43	0.13	0.05	0.00	0.00
Al_2O_3	1.39	9.83	10.99	11.65	2.87	1.04	7.95	24.84	25.07	25.06
FeO*	6.42	2.01	2.26	2.47	4.25	4.79	2.47	0.14	0.10	0.08
MnO	0.15	0.07	0.06	0.07	0.12	0.18	0.08	0.00	0.00	0.04
MgO	13.66	10.47	9.73	9.42	13.64	14.42	11.64	0.24	0.01	0.02
CaO	21.06	15.25	14.07	13.50	19.98	22.38	16.88	0.43	0.28	0.20
Na_2O	2.12	5.74	6.26	6.98	3.01	1.60	4.43	14.33	14.62	14.76
K_2O	0.10	0.15	0.23	0.27	0.11	0.07	0.34	0.02	0.06	0.05
Cr_2O_3	0.04	0.02	0.01	0.00	0.00	0.07	0.00	0.00	0.01	0.00
Total	99.17	99.08	98.90	99.98	99.02	99.09	98.84	98.68	99.12	99.06
Si	2.003	1.978	1.973	1.965	1.998	2.004	1.983	1.998	2.001	1.999
Ti	0.011	0.007	0.004	0.005	0.020	0.012	0.004	0.001	0.000	0.000
Al	0.061	0.414	0.463	0.487	0.124	0.045	0.338	0.997	1.002	1.003
Fe	0.200	0.060	0.068	0.073	0.131	0.148	0.075	0.004	0.003	0.002
Mn	0.005	0.002	0.002	0.002	0.004	0.006	0.002	0.000	0.000	0.001
Mg	0.757	0.558	0.519	0.497	0.747	0.796	0.626	0.012	0.001	0.001
Ca	0.839	0.584	0.539	0.512	0.787	0.888	0.653	0.016	0.010	0.007
Na	0.153	0.398	0.434	0.479	0.214	0.115	0.310	0.946	0.961	0.971
K	0.005	0.007	0.010	0.012	0.005	0.003	0.016	0.001	0.003	0.002
Cr	0.001	0.001	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Total	4.034	4.009	4.012	4.032	4.030	4.019	4.007	3.975	3.981	3.986
Jd	6.05	39.32	43.48	44.81	12.17	4.53	31.38	98.34	98.92	99.26
Aeg	9.00	0.51	0.00	2.74	9.23	6.72	0.00	0.00	0.00	0.00
Ko	0.12	0.06	0.03	0.00	0.00	0.20	0.00	0.00	0.03	0.00
Aug	84.83	60.11	56.49	52.45	78.60	88.55	68.62	1.66	1.05	0.74

* Total Fe as FeO

Table 2 Chemical compositions of pectolite, wollastonite, phlogopite and amphibole.

mineral	OsaJd pectolite						wo				
No.	8	9	10	11	12	16	17	18	19	20	21
SiO_2	54.30	53.98	53.77	54.43	54.05	54.24	51.16	51.75	51.35	52.65	51.16
TiO_2	0.01	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.00	0.00	0.01
Al_2O_3	0.02	0.00	0.00	0.68	0.01	0.03	0.62	0.01	0.02	1.88	0.01
FeO*	0.03	0.07	0.05	0.11	0.06	0.09	0.03	0.09	0.05	0.14	0.24
MnO	0.06	0.08	0.00	0.08	0.10	0.00	0.05	0.02	0.04	0.10	0.08
MgO	0.04	0.04	0.00	0.04	0.01	0.05	0.04	0.02	0.04	0.05	0.02
CaO	33.90	33.84	33.83	33.10	33.89	33.76	46.67	48.21	48.12	44.00	47.57
Na_2O	9.23	8.95	9.14	9.55	9.36	9.34	0.05	0.01	0.01	0.47	0.10
K_2O	0.03	0.04	0.01	0.04	0.05	0.01	0.03	0.06	0.04	0.83	0.05
Cr_2O_3	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Total	97.62	97.02	96.80	98.03	97.51	97.54	98.66	100.19	99.67	100.12	99.27
O=	8.5	8.5	8.5	8.5	8.5	8.5	6	6	6	6	6
Si	2.996	2.997	2.994	2.985	2.990	2.995	1.998	1.999	1.995	2.012	1.997
Ti	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000
Al	0.002	0.000	0.000	0.044	0.000	0.002	0.028	0.000	0.001	0.085	0.000
Fe	0.001	0.003	0.002	0.005	0.003	0.004	0.001	0.003	0.002	0.004	0.008
Mn	0.003	0.004	0.000	0.004	0.005	0.000	0.002	0.001	0.001	0.003	0.003
Mg	0.003	0.003	0.000	0.003	0.000	0.004	0.003	0.001	0.002	0.003	0.001
Ca	2.003	2.012	2.017	1.944	2.008	1.997	1.952	1.994	2.002	1.801	1.988
Na	0.987	0.963	0.986	1.015	1.003	0.999	0.003	0.001	0.000	0.034	0.008
K	0.002	0.003	0.001	0.003	0.003	0.001	0.002	0.003	0.002	0.041	0.003
Cr	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Total	5.997	5.986	6.000	6.003	6.012	6.003	3.989	4.003	4.005	3.983	4.009

	OsaJd2 phlogopite 717		amp 717	
No.	36	39	38	46
SiO_2	42.76	41.33	52.59	53.40
TiO_2	0.08	0.00	0.25	0.25
Al_2O_3	12.88	14.06	7.52	7.80
FeO*	3.53	2.74	3.07	2.63
MnO	0.02	0.00	0.00	0.04
MgO	24.43	25.54	19.87	17.11
CaO	0.65	0.12	6.59	9.09
Na_2O	1.22	0.89	7.23	5.79
K_2O	9.16	9.85	0.50	0.75
Cr_2O_3	0.00	0.00	0.00	0.00
Total	94.73	94.53	97.62	96.86
O=	22	22	23	23
Si	6.050	5.862	7.313	7.466
Ti	0.009	0.000	0.026	0.026
Al	2.147	2.350	1.232	1.285
Fe	0.418	0.325	0.357	0.307
Mn	0.002	0.000	0.000	0.005
Mg	5.149	5.396	4.116	3.563
Ca	0.098	0.018	0.981	1.361
Na	0.334	0.254	1.948	1.569
K	1.653	1.781	0.089	0.134
Cr	0.000	0.000	0.000	0.000
Total	15.860	15.986	16.062	15.716

* Total Fe as FeO

Wo: wollastonite; amp: amphibole.

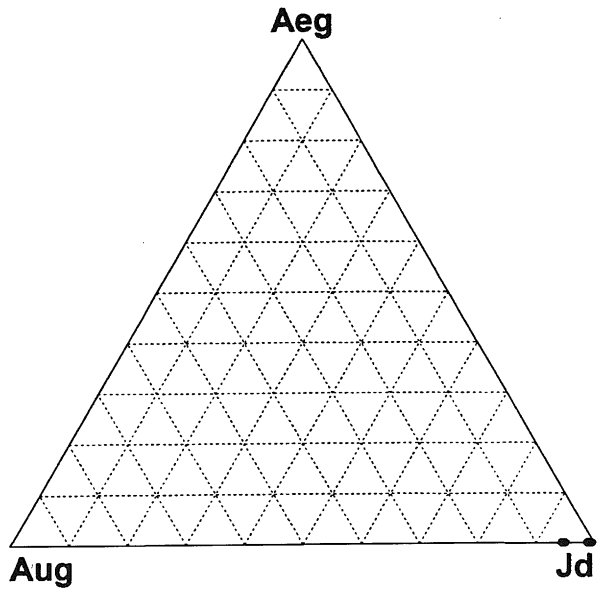

Fig. 4. Chemical composition of clinopyroxenes from the jadeitite (OsaJd). Aeg.: aegirine; Aug: augite; Jd: jadeite.

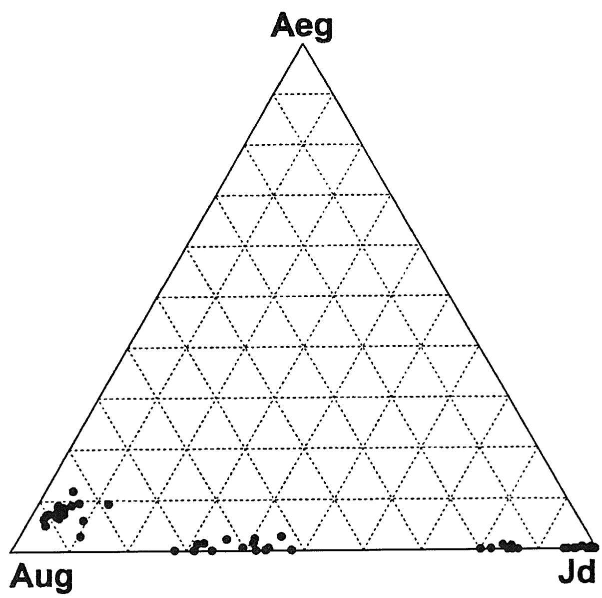

Fig. 5. Chemical composition of clinopyroxenes from the jadeitite (OsaJd2). Aeg.: aegirine; Aug: augite; Jd: jadeite.

2. Pectolite

Pectolites in the jadeitite, OsaJd, show the chemical composition close to the ideal composition, $Ca_2NaH[SiO_3]_3$ (Table 2). Al, Fe, Mn and Mg in the pectolites are negligible.

3. Wollastonite

Wollastonites in the jadeitite, OsaJd, show the chemical composition of the ideal formula of wollastonite. They contain very low Fe and Mn (Table 2).

4. Phlogopite

Phlogopites in the jadeitite, OsaJd2, range in Mg/(Mg+Fe) between 0.92 and 0.94. Na/(Na+K) is 0.12–0.17 (Table 2).

5. Sodic-calcic amphibole

Sodic-calcic amphiboles occur in the jadeitite of OsaJd2, and they are classified into magnesiokatophorite (Leake et al., 1997). Mg/(Mg+Fe) is high with 0.92, and Ca ranges from 0.98 to 1.36 (O=23).

Conclusions

(1) Two loosed blocks of jadeitite form the Osayama area in the Sangun metamorphic belt have been described. Wollastonite and albite are newly described in the jadeitite (OsaJd) associated with jadeite, pectolite, grossular, and analcite. Magnesiokatophorite has been described from the jadeitite (OsaJd2), and it is associated with jadeite, omphacite, diopside, phlogopite, rutile and titanite.

(2) The clinopyroxenes from the jadeitite (OsaJd) are classified into jadeite, omphacite and diopside. The compositional ranges of the gaps between jadeite and omphacite and omphacite and diopside have been revealed. Based on the textural relationship a successive formation of clinopyroxenes from jadeite through omphacite and up to diopside is recognized.

(3) Relatively Ca–rich minerals such as diopside, wollastonite, pectolite and grossular occur along the cracks within the matrix consisting mainly of jadeites, suggesting later stage Ca–rich fluid infiltration and subsequent participation of such Ca–rich minerals.

Acknowledgements

Thanks are due to Dr. T. Nozaka of Okayama University for his providing us valuable information on the geology of the Osayama area and the petrography of jadeitites and their related rocks in the serpentinites.

References

Bence, A. E. and Albee, A. L., 1968, Empirical correction factors for electron micro analysis of silicates and oxides. Jour. Geol., **76**, 382–403.

Kobayashi, S., Miyake, H. and Shoji, T., 1987, A jadeite rock from Oosa-cho, Okayama Prefecture, Southwest Japan. Mineral. Jour., **13**, 314–327.

Leake, B. E., Woolley, A. R., Arps, C. E. S., Birch, W. D., Gilbert, M. C., Grice, J. D., Hoethorne, F. C., Kato, A., Kisch, H. J., Krivovichev, V. G., Linthout, K., Laird, J. and Mandarino, J., 1997, Nomenclature of amphiboles: report of the Subcommittee on Amphiboles of the International Mineralogical Association Commission on New Minerals and Mineral Names. Mineral. Mag., **61**, 295–321.

Matsumoto, I., Arai, S., Muraoka, H. and Yamauchi, H., 1995, Petrological characteristics of the dunite-harzburgite-chromitite complexes of the Sangun zone, Southwest Japan. Jour. Mineral. Petrol. Economic Geol., **90**, 13–236.

Mitsuno, C. and Sugita, M., 1980, Geological map of Okayama Prefecture, Japan. 1 : 100,000. Naigaichizu.

Nishimura, Y., 1998, Geotectonic subdivision and areal extent of the Sangun belt, Inner Zone of Southwest Japan. J. Metamorphic Geol., **16**, 129–140.

Nozaka, T. and Shibata, T., 1994, Petrography of primary peridotites from the Ohsa-yama area, Okayama Prefecture. Okayama Univ. Earth Sci. Rep., 1, 1–8.

Nozaka, T. and Shibata, T., 1995, Mineral paragenesis in thermally metamorphosed serpentinites, Ohsa-yama, Okayama Prefecture. Okayama Univ. Earth Sci. Rep., 2, 1–11.

Sakamoto, S. and Takasu, A., 1995, Discovery of kosmochlor from the Osayama ultramafic body in the Sangun metamorphic belt, northern Okayama Prefecture, southwest Japan. Proc. Kansai Branch, Geol. Soc. Japan, No. 120, 4–6.

Sakamoto, S. and Takasu, A., 1996, Kosmochlor from the Osayama ultramafic body in the Sangun metamorphic belt, Southwest Japan. J. Geol. Soc. Japan, 102, 49–52.

Shibata, K. and Nishimura, Y., 1989, Isotope age s of the Sangun crystalline schists , Southwest Japan. Mem. Geol. Soc. Japan, No. 33, 317–341.

Takasu and Sakamoto, 1996, Kosmochlor discovered from the Osayama ultramafic body in the Sangun high-P metamorphic belt, Japan. Earth Science **50**, 1–8.

Tsujimori, T., 1998, Geology of Osayama serpentinite melange in the central Chugoku Mountains, southwestern Japan: 320 Ma blueschist-bearing serpentinite melange beneath the Oeyama ophiolite. Jour. Geol. Soc. Japan, **104**, 213–231.

Tsujimori, T. and Takasu, A., 1994, High-P/T tectonic blocks associated with Osayama ultramafic body in the Sangun metamorphic belt, northwestern Okayama Prefecture. Abst. 101st Ann. Meet. Geol. Soc. Japan, 245.

Watanabe, T., 1984, Glaucophane and ferroglaucophane in the Sangun metamorphic terrane of the Oosa district, Okayama Prefecture, Japan. Mem. Fac. Sci. Shimane Univ., No. 18, 69–74.

Watanabe, T., Tokuoka, T. and Naka, T., 1987, Complex fragmentation of Permo-Triassic and Jurassic accreted terranes in the Chugoku region, Southwest Japan and the formation of the Sangun metamorphic rocks. In Leitch, E.C. and Scheibner, E. eds. Terrane Accretion and Orogenic Belt, Geodynamic Series Vol. 18, Amer. Geophys. Union, 275–289.

日本語要旨

三郡変成帯大佐山地域産ひすい輝石岩の構成鉱物の共生関係と化学組成

高須　晃[1)]・阪本志津枝[2)]・柏原由芙子[1)]
[1)]島根大学総合理工学部地球資源環境学教室
[2)]京都大学大学院理学研究科地球惑星科学専攻

三郡変成帯（周防帯）中の大佐山超苦鉄質岩体に由来すると考えられるひすい輝石岩転石（OsaJd と OsaJd2）の記載岩石学的研究と，構成鉱物の化学組成の分析を行った．OsaJd のひすい輝石岩からは珪灰石と曹長石がひすい輝石，ペクトライト，グロシュラー，方フッ石とともに見いだされた．OsaJd2 からはマグネシオカタフォライトがひすい輝石，オンファス輝石，透輝石，金雲母，ルチル，チタナイトとともに共生するのが見つかった．OsaJd2 の単斜輝石はひすい輝石，オンファス輝石，透輝石で，それぞれの間の組成はギャップとなっている．組織より，ひすい輝石が最初で，その後オンファス輝石，最後に透輝石が形成されたことがわかる．

透輝石，珪灰石，ペクトライト，グロシュラーなどのカルシウムに富む鉱物は，ひすい輝石集合体からなるマトリックス中の割れ目に沿って形成されており，ひすい輝石岩が形成された後のカルシウムに富む流体の浸透によって，これらの鉱物が形成されたと考えられる．