島根大学地質学研究報告　13．13～21ページ（1994年11月）
Geol. Rept. Shimane Univ., 13. p.13～21 (1994)

Electron microprobe analyses of rock–forming minerals from the eastern Iratsu epidote amphibolite mass in the Sambagawa metamorphic belt, central Shikoku, Japan

Chu Tanaka*

Abstract

The eastern Iratsu epidote amphibolite mass occurs as a tectonic block in the Sambagawa metamorphic belt, central Shikoku, Japan. The eastern Iratsu mass has a complex metamorphic and tectonic history. Chemical compositions of rock–forming minerals from granulite and eclogite in the eastern Iratsu mass are tabulated along with brief description in this paper.

Key words: Sambagawa metamorphic belt, eastern Iratsu mass,eclogite, grnulite, chemical composition, omphacite, garnet, glaucophane.

Geologic outline

The Sambagawa metamorphic belt is high–pressure intermediate type metamorphic belt, extending longitudinally for about 800km through the central portion of the Japanese island arc on the Pacific Ocean side (Outer zone of southwest Japan). The highest grade rocks (epidote–amphibolite facies) of the belt occur in the Besshi district of central Shikoku, which locally contains higher grade masses of coarse–grained basic, pelitic and ultrabasic lithologies (Kunugiza et al., 1986 Takasu, 1989). These masses have been regarded as tectonic blocks in a melange zone which formed at the initial stage of the exhumation of the Sambagawa belt (Takasu, 1984; 1989; Kunugiza et al., 1986)(Fig, 1).

The Iratsu epidote amphibolite mass (which is one of the tectonic blocks) consists mainly of garnet–epidote amphibolites accompanied by eclogite, granulite and minor marble. Takasu and Kohsaka (1987) argued that the Iratsu mass is devided into a western and eastern part, each with a different protolith and metamorphic history. The formation history of the western part of Iratsu mass (the western Iratsu mass) is as follows: basic volcaniclastic rocks with minor pelitic and siliceous rocks → prograde metamorphism via under epidote-amphibolite to eclogite facies → retrograde metamorphism under epidote–amphibolite facies conditions (Takasu, 1989). The original rocks of eastern part of Iratsu mass (the eastern Iratsu mass) are layered gabbros (Banno et al, 1976). The metamorphic history of this mass is as follows: layered gabbro → granulite–facies metamorphism → high–temperature eclogite–facies metamorphism → hydration under glaucophane–schist facies → low–temperature eclogite–facies metamorphism → Sambagawa epidote–amphibolite–facies metamorphism (Takasu, 1989). The metamorphic conditions for low–temperature eclogite facies are similar to those of prograde metamorphism forming eclogite in the western Iratsu mass (Takasu, 1989). Omphacites, both in the secondary eclogite of the eastern Iratsu mass and in the western Iratsu mass, show a north–south lineation (Kohsaka, 1985). These facts suggest that the eastern and western Iratsu masses amalgamated to form a single mass at the time of eclogite–facies metamorphism (Takasu, 1989).

Outline of petrography

The eastern Iratsu mass consists of melanocratic and leucocratic layers. This banding is derived from the layered structure of gabbro. Granulite and eclogite are distributed randomly in the eastern Iratsu

* Department of Geology, Shimane University, Matsue 690, Japan
Present address: Department of Geology and Mineralogy, Faculty of Science, Kyoto University, Kyoto 606, Japan

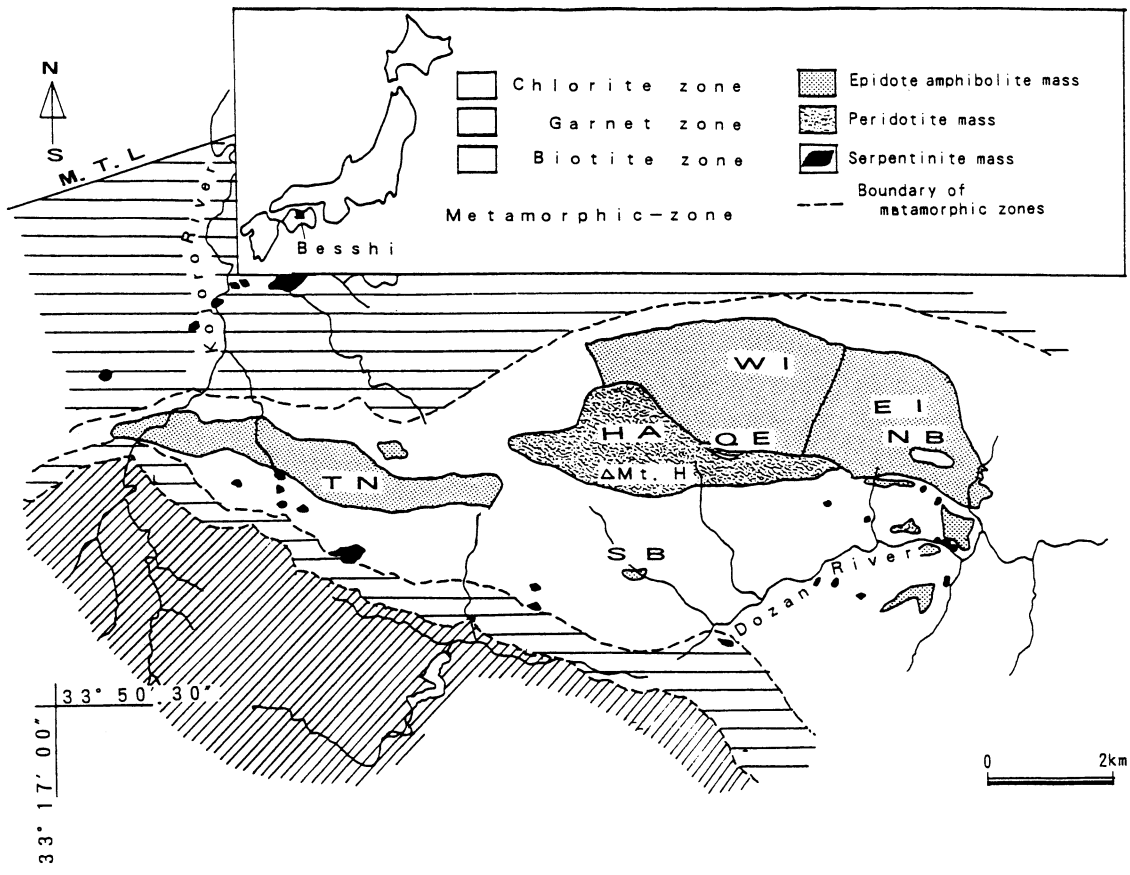

Fig. 1 Geologic and metamorphiczone map of the Besshi district, slightly modified from Takasu (1989). TN and SB = Tonaru and Sebadani metagabbro masses, respectively; WI and EI= western Iratsu and eastern Iratsu epidote–amphibolite masses, respectively; HA and NB= Higashiakaisi and Nikubuchi peridotite masses, respectively; QE= Quartz Eclogite mass; Mt, H= Mt, Higashiakaisi; M.T.L = Median Tectonic Line

mass. Granulite shows granoblastic texture, and is composed mainly of clinopyroxene, orthopyroxene, garnet, plagioclase, brown–hornblende and spinel. In some samples, brown–hornblende, spinel and plagioclase are absent. In the granulites, clinopyroxene, orthopyroxene and plagioclase occur as constituent minerals, showing granoblastic texture, with garnet occuring on the grain boundarles of constituent minerals. Spinel occurs as inclusions in clinopyroxene, orthopyroxene and garnet. Plagioclase is usually altered to saussurite. Granulites are sometimes identified only by granoblatic texture, and constituent minerals are replaced by epidote–amphibolite facies mineral assemblages. Eclogites are composed mainly of garnet, omphacite, hornblende, glaucophane, epidote, white–mica, quartz and plagioclase, with subordinate rutile, chlorite, calcite and opaque minerals. In some samples, glauciphane, apatite, chlorite and calcite are absent. Omphacite, hornblende, glaucophane, epidote and white–mica usually show a preferred orientation. Epidote–amphibolites are composed mainly of hornblende, epidote, garnet, white–mica, plagioclase, quartz and chlorite, with subordinate apatite, calcite, sphene and rutile. Hornblende, epidote and white–mica usually show a preferred orientation.

Analytical Procedure

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

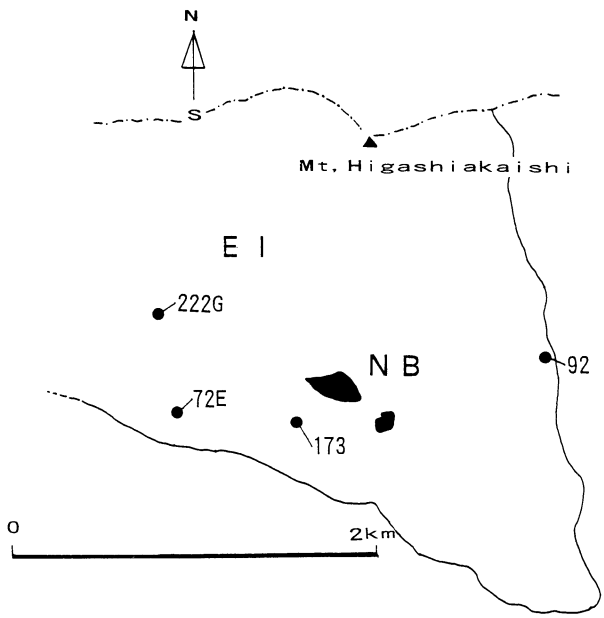

Fig. 2 Sample localities in the eastern Ilatsu epidote amphibolite mass. EI= eastern Iratsu epidote–amphibolite mass; NB= Nikubuchi peridotite mass.

Brief description of individual specimens

1. Granulite (specimen No. 222G)

This specimen is from Nikubuchi valley (Fig. 2), and shows typical granoblastic texture. The granulite facies mineral assemblage is preserved. The specimen is composed mainly of clinopyroxene, orthopyroxene and garnet, with subordinate amounts of brown–hornlende and plagioclase (Table 1). The chemical composition of clinopyroxene and garnet are shown in Tables 2 and 3. In this specimen, the chemical compositions of clinopyroxene and garnet are homogeneous (Tables 2 and 3).

2. Eclogite (specimen Nos, 72E, 92 and 173)

These specimens were collected from Nikubuchi valley, east Nikubuchi valley and Ooki valley, respectively (Fig. 2). The mineral assembeage of each specimen is shown in Table 1. The chemical compositions of garnet, omphacite and glaucophane are shown in Tables 4, 5 and 6, garnet from specimen Nos, 92 and 173 are divided into core and rim, In contrast, the chemical compositions of garnet from specimen No, 72E are generally homogeneous, and are similar to those of the rim of garnets from specimen Nos, 92 and 173 (Table 4). The chemical compositions of omphacites are generally homogeneous (Table 5), as are the chemical compositions of glaucophane (Table 6).

Acknowledgements

The author would like to thank Dr. A. Takasu for his discussion and critical reading of the manuscriot.

Table 1. Mineral assembleges of specimens

A. Mineral assembleges of eclogites

Specimen No	Chl	Ms	Ep	Hb	Rt	Sph	Opq	Ap	Ab	Qz	Cc	Gt	Gl	Omp
72E	++	+	++	++	+	+	+	—	—	+	—	++		+
92	+	+	++	++	+	—	+		—	+	+	++	+	+
173	+	+	++	++	+	+	+	—	+	—		++	+	+

B. Mineral assembleges of granulite

Specimen No	Cpx	Opx	Gt	BHb	Pl	Opq
222G	++	++	+	—	+	—

Abbreviations: Chl=chlorite, Ms=muscovite, Ep=epidote, Hb=hornblende, Rt=rutile, Sph=sphene, Opq=Opaque minerals, Ap=apatite, Ab=albite, Qz=quartz, Cc=calcite, Gt=garnet, Gl=glaucophane, Omp=omphacite, Cpx=clinopyroxene, Opx=orthopyroxene, BHb=brown–hornblende, Pl=plagioclase. ++= a large quantity of present, += present, –= a small quantity of present

Table 2. Chemical compositions of clinopyroxenes in granulite

Specimen, No	222G	222G	222G	222G	222G	222G	222G	222G	222G	222G
Point, No	13	14	15	19	20	21	22	23	26	37
SiO_2	49.92	51.42	51.38	51.24	50.41	50.60	50.83	52.52	51.29	51.74
TiO_2	0.26	0.24	0.25	0.25	0.32	0.30	0.30	0.22	0.28	0.26
Al_2O_3	6.16	5.74	5.91	5.65	6.52	6.84	6.62	5.79	5.30	4.95
FeO※	4.44	4.23	4.34	3.83	4.48	4.40	4.28	4.10	3.88	3.25
MnO	0.04	0.07	0.01	0.08	0.02	0.05	0.13	0.00	0.07	0.02
MgO	13.80	14.60	14.38	14.48	14.04	13.83	14.16	14.62	14.55	15.04
CaO	22.65	23.25	22.87	23.27	22.50	22.66	22.63	22.94	23.09	23.53
Na_2O	1.12	1.10	1.08	1.00	1.11	1.08	1.02	1.07	0.92	1.04
Total	98.39	100.65	100.22	99.80	99.40	99.76	99.97	101.26	99.38	99.83
Atomic ratio (O=6)										
Si	1.862	1.873	1.877	1.879	1.859	1.857	1.861	1.893	1.888	1.893
Ti	0.007	0.007	0.007	0.007	0.009	0.008	0.008	0.006	0.008	0.008
Al	0.271	0.247	0.254	0.244	0.283	0.296	0.286	0.246	0.230	0.213
Fe	0.139	0.129	0.133	0.117	0.138	0.135	0.131	0.124	0.120	0.099
Mn	0.001	0.002	0.000	0.002	0.001	0.002	0.004	0.000	0.002	0.001
Mg	0.767	0.793	0.783	0.792	0.772	0.757	0.773	0.785	0.798	0.820
Ca	0.905	0.907	0.895	0.914	0.889	0.891	0.888	0.886	0.911	0.922
Na	0.081	0.077	0.077	0.071	0.080	0.077	0.073	0.075	0.066	0.074
Total	4.033	4.035	4.026	4.026	4.031	4.023	4.024	4.015	4.023	4.030

※ Total Fe as FeO

13= rim. 14, 15= rim. 19–23= rim–core–rim. 26, 37= rim

Table 3. Chemical compositions of gaenets in granulite

Specimen, No	222G	222G	222G	222G	222G	222G	222G	222G
Point, No	8	9	10	12	24	25	34	35
SiO_2	40.76	40.78	40.38	41.23	41.05	41.36	41.10	40.54
TiO_2	0.03	0.00	0.00	0.03	0.02	0.00	0.00	0.03
Al_2O_3	22.43	22.61	22.48	22.83	22.68	23.14	22.61	22.77
FeO※	15.34	15.06	16.20	14.87	14.61	15.02	15.68	15.28
MnO	0.34	0.36	0.33	0.28	0.27	0.32	0.24	0.34
MgO	14.89	14.52	13.82	15.06	14.89	14.97	13.99	14.83
CaO	5.96	6.06	6.19	5.93	6.19	6.20	5.71	5.76
Total	99.75	99.39	99.40	100.23	99.71	101.01	99.35	99.55
Atomic ratio (O=12)								
Si	3.001	3.008	2.998	3.010	3.012	2.999	3.035	2.990
Ti	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.001
Al	1.947	1.966	1.967	1.965	1.962	1.978	1.968	1.979
Fe	0.945	0.929	1.006	0.908	0.896	0.911	0.968	0.942
Mn	0.021	0.023	0.021	0.018	0.017	0.020	0.015	0.021
Mg	1.634	1.596	1.530	1.639	1.629	1.619	1.540	1.630
Ca	0.470	0.479	0.493	0.464	0.487	0.482	0.451	0.455
Total	8.020	8.001	8.015	8.005	8.004	8.009	7.977	8.018

※ Total Fe as FeO

8–10=core–rim. 12= rim. 24, 25= rim. 34, 35= rim–core

Table 4. Chemical compositions of garnets in eclogite

Specimen, No	72E	72E	72E	72E	72E	72E	72E	72E	72E	92	92	92
Point, No	1	4	6	12	14	15	23	24	26	2	3	6
SiO_2	38.88	38.34	38.60	39.11	38.29	38.45	38.23	38.30	38.82	39.69	38.74	39.28
TiO_2	0.02	0.02	0.04	0.01	0.02	0.08	0.05	0.04	0.05	0.08	0.03	0.08
Al_2O_3	21.03	21.22	21.02	21.39	21.12	21.07	21.06	20.64	21.49	21.48	21.32	21.10
FeO※	25.96	25.59	26.38	24.79	25.36	26.36	25.55	25.37	25.70	23.93	27.76	23.54
MnO	0.72	0.74	0.83	0.73	0.56	0.84	0.71	0.82	0.65	0.77	0.67	0.73
MgO	5.03	5.23	5.20	5.07	5.35	5.19	5.19	5.54	5.39	8.20	3.49	8.10
CaO	8.51	8.18	8.14	9.21	8.43	7.71	8.86	7.82	8.59	6.49	8.44	6.69
Total	100.15	99.32	100.21	100.31	99.13	99.70	99.65	98.53	100.69	100.64	100.45	99.52
Atomic ratio (O=12)												
Si	3.030	3.010	3.014	3.029	3.008	3.012	2.998	3.028	3.004	3.026	3.031	3.029
Ti	0.002	0.001	0.002	0.000	0.001	0.005	0.003	0.003	0.003	0.005	0.002	0.004
Al	1.932	1.963	1.934	1.953	1.956	1.945	1.947	1.923	1.960	1.930	1.966	1.918
Fe	1.692	1.680	1.723	1.606	1.666	1.727	1.676	1.678	1.663	1.525	1.816	1.518
Mn	0.047	0.049	0.055	0.048	0.037	0.056	0.047	0.055	0.043	0.050	0.044	0.048
Mg	0.584	0.613	0.605	0.586	0.626	0.605	0.606	0.652	0.622	0.932	0.407	0.931
Ca	0.711	0.688	0.681	0.764	0.710	0.647	0.745	0.662	0.712	0.530	0.708	0.553
Total	7.998	8.004	8.014	7.986	8.004	7.998	8.022	8.001	8.007	7.998	7.974	8.001

Specimen, No	92	92	92	92	92	92	92	92	92	92	92	92
Point, No	7	8	9	10	11	12	14	20	21	22	23	24
SiO_2	39.57	39.42	39.16	37.84	38.18	38.73	38.56	38.71	38.38	38.80	38.70	38.07
TiO_2	0.06	0.09	0.07	0.11	0.00	0.07	0.07	0.03	0.10	0.06	0.08	0.02
Al_2O_3	21.34	21.70	21.51	20.88	20.82	21.03	20.84	21.28	20.93	21.05	21.18	20.74
FeO※	23.59	24.17	23.73	26.34	26.88	27.31	26.85	23.11	23.66	23.20	24.28	28.29
MnO	0.70	0.78	0.75	0.74	0.98	0.70	0.75	0.87	0.97	0.98	0.88	0.43
MgO	8.14	7.87	8.03	3.68	4.04	3.77	5.61	7.98	7.88	7.91	8.05	4.03
CaO	6.73	6.85	6.84	9.31	8.62	8.41	6.81	6.60	6.48	6.56	6.76	7.83
Total	100.13	100.88	100.09	98.90	99.52	100.02	99.49	98.58	98.40	98.56	99.93	99.41
Atomic ratio (O=12)												
Si	3.029	3.004	3.006	3.007	3.018	3.039	3.025	3.011	3.003	3.022	2.989	3.019
Ti	0.004	0.005	0.004	0.007	0.000	0.004	0.004	0.002	0.006	0.003	0.005	0.001
Al	1.926	1.949	1.946	1.956	1.940	1.945	1.927	1.951	1.931	1.932	1.928	1.938
Fe	1.510	1.540	1.524	1.751	1.777	1.792	1.761	1.503	1.548	1.511	1.568	1.876
Mn	0.045	0.050	0.049	0.050	0.066	0.047	0.050	0.057	0.064	0.065	0.058	0.029
Mg	0.929	0.894	0.919	0.436	0.476	0.441	0.655	0.925	0.919	0.918	0.927	0.476
Ca	0.552	0.559	0.562	0.793	0.730	0.707	0.572	0.550	0.543	0.547	0.559	0.665
Total	7.995	8.001	8.010	8.000	8.007	7.975	7.994	7.999	8.014	7.998	8.034	8.004

Specimen, No	92	92	92	92	92	92	92	92	173	173	173	173
Point, No	30	31	32	37	38	39	40	41	1	2	3	4
SiO_2	37.81	37.56	39.00	39.73	39.42	38.70	38.47	38.71	38.05	39.07	38.75	38.69
TiO_2	0.05	0.04	0.06	0.09	0.08	0.03	0.07	0.08	0.09	0.07	0.06	0.04
Al_2O_3	20.96	20.52	21.36	21.39	21.35	20.82	21.05	21.13	20.39	20.96	20.75	20.66
FeO※	28.07	27.95	23.67	23.49	24.22	30.07	27.35	25.78	25.86	24.39	24.83	25.75
MnO	0.64	0.71	0.85	0.97	0.89	0.79	0.74	0.78	0.54	0.63	0.54	0.75
MgO	3.83	3.79	8.01	8.22	8.32	3.74	3.98	6.79	6.30	6.57	6.36	5.49
CaO	8.07	8.38	6.73	6.42	6.35	6.33	8.80	6.72	7.71	8.32	8.30	8.18
Total	99.43	98.95	99.63	100.31	100.63	100.48	100.46	99.99	98.94	100.01	99.59	99.56
Atomic ratio (O=12)												
Si	3.000	3.001	3.008	3.035	3.013	3.045	3.013	3.004	3.002	3.024	3.020	3.032
Ti	0.003	0.002	0.003	0.005	0.005	0.002	0.004	0.005	0.006	0.004	0.004	0.002
Al	1.961	1.933	1.941	1.926	1.923	1.931	1.944	1.933	1.896	1.912	1.906	1.908
Fe	1.862	1.868	1.527	1.501	1.548	1.979	1.792	1.673	1.706	1.579	1.619	1.687
Mn	0.043	0.048	0.056	0.063	0.057	0.052	0.049	0.051	0.036	0.042	0.036	0.050
Mg	0.453	0.452	0.921	0.936	0.948	0.438	0.465	0.786	0.741	0.758	0.739	0.641
Ca	0.686	0.717	0.556	0.525	0.520	0.534	0.738	0.559	0.652	0.690	0.693	0.687
Total	8.008	8.021	8.011	7.991	8.014	7.981	8.005	8.011	8.039	8.009	8.017	8.007

Electron microprobe analyses of rock-forming minerals from eastern Iratsu epidote amophibolite mass in the Sambagawa metamorphic belt, central Shikoku, Japan

Specimen, No	173	173	173	173	173	173	173	173	173	173	173	173
Point, No	5	6	7	8	11	12	13	14	24	25	26	27
SiO_2	38.16	38.00	37.61	38.73	38.67	39.00	38.23	37.85	38.88	38.46	39.18	39.71
TiO_2	0.06	0.07	0.02	0.06	0.03	0.10	0.03	0.04	0.01	0.07	0.07	0.03
Al_2O_3	20.64	20.75	20.88	20.90	21.40	20.98	21.17	20.35	21.22	20.74	21.01	21.26
FeO※	25.65	26.14	25.65	25.68	24.00	24.18	25.33	25.58	24.42	24.31	23.92	23.47
MnO	0.71	0.69	0.63	0.67	0.61	0.59	0.53	0.63	0.56	0.45	0.46	0.46
MgO	5.81	5.87	6.24	6.08	4.78	7.01	4.83	5.87	5.24	6.53	7.47	7.52
CaO	8.24	8.25	8.24	8.33	10.44	8.15	9.81	8.22	9.46	8.36	7.98	7.99
Total	99.27	99.77	99.27	100.45	99.93	100.01	99.93	98.54	99.78	98.92	100.09	100.44
Atomic ratio (O=12)												
Si	3.002	2.983	2.962	3.007	3.009	3.015	2.993	3.002	3.026	3.013	3.018	3.036
Ti	0.003	0.004	0.001	0.003	0.002	0.006	0.002	0.002	0.000	0.004	0.004	0.002
Al	1.914	1.920	1.938	1.912	1.963	1.912	1.953	1.902	1.946	1.915	1.907	1.916
Fe	1.688	1.716	1.689	1.667	1.562	1.564	1.658	1.697	1.590	1.593	1.541	1.501
Mn	0.047	0.046	0.042	0.044	0.040	0.039	0.035	0.042	0.037	0.030	0.030	0.030
Mg	0.681	0.687	0.732	0.703	0.555	0.808	0.563	0.693	0.608	0.763	0.858	0.857
Ca	0.695	0.694	0.695	0.693	0.871	0.675	0.823	0.699	0.789	0.702	0.659	0.654
Total	8.030	8.050	8.059	8.029	8.002	8.019	8.027	8.037	7.996	8.020	8.016	7.996

Specimen, No	173	173	173	173	173	173	173	173	173	173	173	173
Point, No	32	33	34	35	36	37	38	39	40	53	56	57
SiO_2	37.95	38.28	38.53	38.37	38.73	39.06	38.97	38.98	38.66	38.39	38.89	38.91
TiO_2	0.08	0.11	0.09	0.04	0.07	0.09	0.10	0.11	0.09	0.07	0.10	0.09
Al_2O_3	21.05	20.89	20.59	20.58	20.91	20.99	20.77	20.64	20.73	20.32	21.03	21.20
FeO※	24.61	25.35	26.27	25.71	25.24	24.38	24.34	24.12	26.38	26.42	23.76	24.11
MnO	0.52	0.67	0.78	0.64	0.64	0.60	0.62	0.50	0.57	0.84	0.54	0.51
MgO	5.03	6.55	5.15	6.48	6.75	7.46	7.37	7.05	5.60	5.42	7.69	7.81
CaO	9.72	7.93	8.11	7.84	7.48	7.51	7.53	7.71	8.44	8.27	7.87	7.47
Total	98.96	99.78	99.52	99.66	99.82	100.09	99.70	99.11	100.47	99.73	99.88	100.10
Atomic ratio (O=12)												
Si	2.991	2.988	3.028	3.001	3.012	3.015	3.020	3.037	3.010	3.018	3.003	2.998
Ti	0.004	0.007	0.006	0.002	0.004	0.005	0.006	0.006	0.006	0.004	0.006	0.005
Al	1.956	1.922	1.907	1.896	1.916	1.909	1.897	1.895	1.903	1.884	1.914	1.925
Fe	1.622	1.655	1.726	1.682	1.642	1.574	1.578	1.571	1.718	1.737	1.535	1.554
Mn	0.035	0.044	0.052	0.042	0.042	0.039	0.041	0.033	0.037	0.056	0.035	0.033
Mg	0.591	0.762	0.603	0.756	0.782	0.858	0.852	0.818	0.650	0.635	0.886	0.897
Ca	0.821	0.663	0.683	0.657	0.623	0.621	0.626	0.643	0.704	0.697	0.651	0.617
Total	8.020	8.041	8.005	8.036	8.021	8.021	8.020	8.003	8.028	8.031	8.030	8.029

※Total Fe as FeO

72E:1,4,6=rim. 12,14,15=core. 23,24,26=rim. 92:2=core. 3=rim. 6–9=core. 10–12=rim. 14=rim. 20–23=core. 24=rim. 30–31=rim, 32,37,38=core. 39–41=rim. 173:1–11=rim. 12=core. 13,14=rim. 24,25=rim. 26,27=core. 32–36=rim. 37–39=core. 40,53=rim. 56,57=core.

Table 5. Chemical compositions of omphacites in eclogite

Specimen, No	72E	72E	72E	72E	72E	72E	72E	72E	72E	72E	72E	72E
Point, No	2	3	7	8	9	11	13	16	19	20	21	22
SiO_2	56.07	55.51	54.63	55.28	55.66	54.72	53.95	55.37	55.22	55.70	55.49	55.94
TiO_2	0.16	0.14	0.06	0.13	0.06	0.12	0.17	0.13	0.07	0.08	0.19	0.18
Al_2O_3	12.79	12.12	11.43	11.10	10.52	11.28	11.38	10.66	10.03	10.01	12.44	12.28
FeO*	7.15	7.78	6.42	6.38	6.11	6.47	6.51	6.64	6.37	6.52	6.07	6.27
MnO	0.00	0.01	0.00	0.01	0.03	0.05	0.01	0.00	0.02	0.00	0.03	0.06
MgO	5.62	5.76	7.23	7.54	7.87	7.33	7.09	7.28	7.83	7.92	6.43	6.70
CaO	9.89	9.94	11.85	12.35	12.47	12.15	11.80	12.53	12.70	12.82	10.77	11.19
Na_2O	9.12	9.18	8.15	7.86	7.85	7.83	8.23	7.50	7.92	7.81	8.76	8.75
Total	100.80	100.44	99.77	100.65	100.57	99.95	99.14	100.11	100.16	100.86	100.18	101.37
Atomic ratio (O=6)												
Si	1.993	1.990	1.971	1.976	1.989	1.971	1.963	1.990	1.989	1.992	1.982	1.979
Ti	0.004	0.004	0.002	0.004	0.002	0.003	0.005	0.004	0.002	0.002	0.005	0.005
Al	0.536	0.512	0.486	0.468	0.443	0.479	0.488	0.452	0.426	0.422	0.524	0.512
Fe	0.212	0.233	0.194	0.191	0.183	0.195	0.198	0.200	0.192	0.195	0.181	0.185
Mn	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.002
Mg	0.298	0.308	0.389	0.402	0.419	0.394	0.384	0.390	0.420	0.422	0.342	0.353
Ca	0.377	0.382	0.458	0.473	0.478	0.469	0.460	0.483	0.490	0.491	0.412	0.424
Na	0.629	0.638	0.570	0.545	0.544	0.547	0.580	0.523	0.553	0.541	0.607	0.600
Total	4.049	4.067	4.070	4.059	4.059	4.059	4.078	4.042	4.073	4.065	4.054	4.060

Specimen, No	72E	92	92	92	92	92	92	92	92	92	92	92
Point, No	25	1	4	13	15	18	19	28	29	33	34	35
SiO_2	55.63	55.97	55.49	56.53	55.06	56.19	55.26	55.57	55.88	55.84	55.76	54.94
TiO_2	0.12	0.05	0.06	0.03	0.04	0.06	0.04	0.00	0.05	0.03	0.06	0.07
Al_2O_3	11.16	9.63	8.51	9.35	9.39	8.76	9.57	8.67	8.83	8.24	8.84	8.59
FeO*	6.20	6.54	7.66	7.34	7.19	6.81	6.24	7.35	7.78	7.54	7.81	7.95
MnO	0.01	0.01	0.00	0.02	0.04	0.07	0.04	0.02	0.00	0.03	0.00	0.03
MgO	7.34	8.16	8.30	7.61	7.84	8.25	8.09	7.79	7.62	8.20	7.99	8.15
CaO	12.32	12.73	13.25	12.48	12.36	13.38	12.67	12.88	12.36	13.15	13.02	13.35
Na_2O	8.06	7.72	6.95	7.86	7.82	7.30	7.67	7.34	7.71	7.27	7.38	7.39
Total	100.84	100.81	100.22	101.22	99.74	100.82	99.58	99.62	100.23	100.30	100.86	100.47
Atomic ratio (O=6)												
Si	1.983	2.001	2.008	2.017	1.997	2.014	1.999	2.018	2.019	2.019	2.006	1.992
Ti	0.003	0.001	0.002	0.001	0.001	0.002	0.001	0.000	0.001	0.001	0.002	0.002
Al	0.469	0.406	0.363	0.393	0.402	0.370	0.408	0.371	0.376	0.351	0.375	0.367
Fe	0.185	0.195	0.232	0.219	0.218	0.204	0.189	0.223	0.235	0.228	0.235	0.241
Mn	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.001	0.000	0.001	0.000	0.001
Mg	0.390	0.435	0.448	0.405	0.424	0.441	0.436	0.422	0.410	0.442	0.428	0.440
Ca	0.470	0.488	0.514	0.477	0.480	0.514	0.491	0.501	0.479	0.509	0.502	0.519
Na	0.557	0.535	0.487	0.544	0.550	0.507	0.538	0.517	0.540	0.509	0.515	0.520
Total	4.057	4.061	4.054	4.057	4.073	4.054	4.063	4.053	4.060	4.060	4.063	4.082

Specimen, No	92	92	92	92	173	173	173	173	173	173	173	173
Point, No	36	43	44	45	9	10	15	16	17	18	28	29
SiO_2	54.90	55.61	55.01	55.52	55.70	53.47	53.81	54.77	55.66	54.46	55.66	54.24
TiO_2	0.06	0.04	0.00	0.09	0.04	0.10	0.15	0.13	0.12	0.14	0.16	0.15
Al_2O_3	9.56	8.60	8.13	8.91	8.99	9.68	10.34	9.89	10.40	9.04	11.69	11.19
FeO*	7.52	6.44	7.02	6.95	7.05	8.38	6.88	6.47	6.50	7.22	5.81	5.88
MnO	0.06	0.00	0.02	0.02	0.02	0.05	0.07	0.01	0.05	0.07	0.00	0.00
MgO	7.62	8.41	8.47	8.14	7.86	9.08	7.55	7.90	7.72	8.65	7.19	7.36
CaO	12.38	13.66	13.77	13.04	12.66	11.09	12.79	12.94	12.17	14.19	12.11	11.97
Na_2O	7.93	7.05	7.06	7.61	7.71	6.91	7.48	7.52	7.55	6.40	7.79	7.87
Total	100.03	99.81	99.49	100.28	100.05	98.76	99.07	99.63	100.17	100.17	100.40	98.66
Atomic ratio (O=6)												
Si	1.991	2.001	2.006	2.004	2.013	1.963	1.967	1.985	1.997	1.974	1.984	1.974
Ti	0.002	0.001	0.000	0.003	0.001	0.003	0.004	0.004	0.003	0.004	0.004	0.004
Al	0.408	0.367	0.350	0.379	0.383	0.419	0.445	0.422	0.440	0.386	0.491	0.480
Fe	0.228	0.195	0.214	0.210	0.213	0.257	0.210	0.196	0.195	0.219	0.173	0.179
Mn	0.002	0.000	0.001	0.001	0.001	0.002	0.002	0.000	0.002	0.002	0.000	0.000
Mg	0.412	0.454	0.460	0.438	0.423	0.497	0.412	0.427	0.413	0.467	0.382	0.399
Ca	0.481	0.529	0.538	0.504	0.490	0.436	0.501	0.503	0.468	0.551	0.462	0.467
Na	0.557	0.494	0.499	0.532	0.540	0.492	0.530	0.528	0.525	0.450	0.538	0.555
Total	4.081	4.051	4.068	4.071	4.064	4.069	4.071	4.065	4.043	4.053	4.034	4.058

Specimen, No	92	92	92	173	173	173	173	173	173
Point, No	31	41	42	43	48A	48B	50	51	52
SiO_2	54.54	54.65	54.35	55.66	53.72	53.88	54.35	53.74	54.52
TiO_2	0.14	0.14	0.14	0.03	0.14	0.14	0.10	0.18	0.08
Al_2O_3	11.28	10.96	9.66	9.82	9.68	9.65	9.15	9.40	10.65
FeO※	5.65	6.02	7.02	6.80	6.41	6.46	6.83	6.90	6.33
MnO	0.00	0.07	0.05	0.00	0.03	0.02	0.03	0.04	0.06
MgO	7.59	7.52	8.13	7.30	8.30	8.19	8.77	8.71	7.79
CaO	12.12	12.23	14.12	11.90	13.51	13.66	14.61	14.30	12.97
Na_2O	8.06	7.93	6.69	8.19	6.91	7.08	6.47	6.76	7.20
Total	99.38	99.52	100.16	99.70	98.70	99.08	100.31	100.03	99.60
Atomic ratio (O=6)									
Si	1.970	1.975	1.968	2.012	1.968	1.969	1.967	1.954	1.972
Ti	0.004	0.004	0.004	0.001	0.004	0.004	0.003	0.005	0.002
Al	0.480	0.467	0.412	0.418	0.418	0.416	0.390	0.403	0.454
Fe	0.171	0.182	0.213	0.206	0.196	0.198	0.207	0.210	0.192
Mn	0.000	0.002	0.001	0.000	0.001	0.001	0.001	0.001	0.002
Mg	0.409	0.405	0.439	0.393	0.453	0.446	0.473	0.472	0.420
Ca	0.469	0.474	0.548	0.461	0.530	0.535	0.566	0.557	0.503
Na	0.565	0.556	0.470	0.574	0.491	0.502	0.454	0.477	0.505
Total	4.068	4.065	4.055	4.065	4.061	4.071	4.061	4.077	4.050

※Total Fe as FeO

72E: 2, 3, 7=rim. 8, 9=core. 11, 13=rim. 16, 19, 20=rim. 21, 22, 25=core. 92: 1, 4=core. 13, 15=rim. 18, 19=rim. 28, 29=rim. 33=rim. 34–36=core. 43–45=rim–core–rim. 173: 9, 10=rim. 15, 16=rim. 17, 18=core. 28, 29=core. 31=rim. 41=rim. 42=core. 43=rim. 48A, 48B, 50=rim–core. 51, 52=rim.

Table 6. Chemical compositions of glaucophanes in eclogite

Specimen, No	92	92	92	173	173	173	173	173	173	173	173	173
Point, No	5	16	17	19	20	21	22	23	44	45	46	47
SiO_2	57.18	55.94	56.53	56.95	57.34	57.09	56.64	57.20	55.79	57.82	55.79	58.27
TiO_2	0.06	0.02	0.03	0.01	0.01	0.06	0.00	0.04	0.01	0.01	0.00	0.03
Al_2O_3	11.00	10.59	10.46	10.92	10.49	11.08	10.89	11.03	10.96	10.96	10.83	11.00
FeO※	9.18	9.97	10.07	8.13	7.82	7.89	8.25	8.39	9.21	7.90	8.82	7.42
MnO	0.07	0.02	0.05	0.06	0.00	0.08	0.00	0.00	0.03	0.03	0.00	0.08
MgO	11.79	11.48	11.80	12.28	12.40	12.40	12.07	11.82	11.94	12.15	12.18	12.49
CaO	1.55	2.04	1.87	1.37	0.89	1.12	1.08	1.15	1.30	0.76	1.33	1.12
Na_2O	7.12	6.80	6.98	7.08	7.48	7.24	7.17	7.30	7.33	7.45	7.20	7.39
Total	98.04	96.86	97.79	96.80	96.43	96.96	96.10	96.93	96.57	97.08	96.15	97.80
Atomic ratio (O=23)												
Si	7.831	7.801	7.810	7.853	7.920	7.850	7.867	7.879	7.775	7.923	7.791	7.914
Ti	0.006	0.002	0.003	0.001	0.001	0.006	0.000	0.004	0.001	0.001	0.000	0.003
Al	1.776	1.740	1.703	1.775	1.708	1.796	1.782	1.791	1.800	1.770	1.782	1.761
Fe	1.051	1.163	1.163	0.938	0.904	0.907	0.959	0.967	1.073	0.905	1.030	0.843
Mn	0.008	0.002	0.006	0.007	0.000	0.009	0.000	0.001	0.003	0.004	0.000	0.009
Mg	2.406	2.387	2.430	2.524	2.554	2.541	2.499	2.427	2.480	2.482	2.535	2.530
Ca	0.227	0.304	0.276	0.202	0.131	0.166	0.160	0.170	0.194	0.112	0.198	0.162
Na	1.914	1.840	1.871	1.893	2.003	1.930	1.931	1.950	1.981	1.979	1.949	1.947
Total	15.219	15.239	15.262	15.193	15.221	15.203	15.198	15.189	15.307	15.176	15.285	15.169

※Total Fe as FeO

92: 5=rim. 16=core. 17=rim. 173: 19, 20=rim. 21–23=core. 44–45=rim–core. 46=rim. 47=core

References

Banno, S., Yokoyama, K., Iwata, O. and Terashima, S. 1976: Genesis of epidote amphibolite masses in the Sanbagawa metamorphic belt of central Shikoku. Jour. Geol. Soc. Japan, **82**, 199–210*.

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

Kohsaka, Y. 1985: Deformation of eclogite masses in the axis of the Sambagawa metamorphic belt, Shikoku. Abstract of the 92nd Annual Meeting of the Geological Society of Japan, p. 380**.

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

Takasu, A. 1984: Prograde and retrograde eclogites in the Sambagawa metamorphic belt. Besshi district, Japan. Jour. Petrol., **25**, 619–643.

Takasu, A. and Kohsaka, Y. 1987: Eclogites from the Iratsu epidote amphibolite mass in the Sambagawa metamorphic belt, Besshi district, Japan. Jour. Geol. Soc. Japan. **93**, 517–520*.

Takasu, A. 1989: P–T histories of peridotite and amphibolite tectonic blocks in the Sanbagawa metamorphic belt, Japan. Geological Society Special Publication No. **43**, 533–538.

* In Japanese with English abstract.

** In Japanese.

（要　旨）

田中　宙, 1994, 四国中央部三波川帯中の五良津東部緑れん石角閃岩体構成鉱物の化学組成. 島根大学地質学研究報告, 13, 13 − 21.

四国中央部三波川変成帯中のラクトニック・ブロック岩体の一つである五良津東部緑れん石角閃岩体は複雑な変成史をもっている. 原岩は層状はんれい岩体で, 高温のエクロジャイト相の変成作用を受けた後, グラニュライト相の変成作用, その後藍閃片岩相の後退変成作用を受けた後, 再びエクロジャイト相の累進変成作用を受けた. この後, 変成作用が進行している三波川変成帯の現位置へ固体貫入し, 周囲の三波川結晶片岩と同じ緑れん石角閃岩相の変成作用を受けた. この岩体中のグラニュライト及びエクロジャイトを構成する単斜輝石, ざくろ石及び藍閃石のX線マイクロアナライザー分析による化学組成を示すとともに, これらの岩石の記載をおこなった.