**Fumiko SHIDO*: Notes on Rock-Forming Minerals (9) Hornblende-bearing Eclogite
from Gongen-yama of Higasi-Akai in the Bessi District, Sikoku**

Hornblende-bearing eclogite occurs in association with ordinary eclogite within a big mass of dunite at Gongen-yama of Higasi-Akai in the Bessi district of the Sanbagawa-Mikabu glaucophanitic metamorphic belt. This paper is concerned with the mineralogy of the hornblende-bearing eclogite.

I. Mode of Occurrence

The Sanbagawa-Mikabu belt of glaucophanitic regional metamorphism lies east and west in Sikoku (MIYASHIRO and BANNO, 1958). Within the belt, small ultrabasic masses, most of which are serpentinized, are exposed sporadically. The dunite mass of Higasi-Akai in the Bessi district is the largest among them (3km in maximum diameter) and has long been widely known because of its freshness as well as its association with eclogite.

BANNO divided the regional metamorphic terrain of the Bessi district into zones I, II and III in the order of rising temperature; Most of zone I belongs to the epidote-glaucophane subfacies, and the lower-grade part of zone II belongs to the actinolite-greenschist facies and zone III belongs to the epidote-amphibolite facies (MIYASHIRO and BANNO, 1958; MIYASHIRO and SEKI, 1958).

The dunite mass is situated within zone III. In parts of the mass, eclogite occurs as lenses or subparallel bands intercalated with dunite. Descriptions of the modes of occurrence and petrographic characters of the dunite and associated eclogite were given by HORIKOSHI (1937) and BAMBA (1953).

They observed that dunite (olivine: For_{95-93}) layers alternate with pyroxenite layers, usually exclusively composed of clinopyroxene and rarely mixed with some orthopyroxene ($\gamma = 1.672$: En_{95-92}). Some pyroxenite layers carry large pools or lenses mostly or exclusively composed of garnet. In some layers, however, pyroxene is mixed with a smaller or larger amount of garnet, resulting in the formation of eclogite. The boundary between the eclogite and dunite is sharp. Eclogite is often amphibolitized from the marginal part of the mass.

HORIKOSHI (1937) states that in the southern slope of Gongen-yama, hornblende-bearing eclogites are exposed as bands alternating with dunite. These eclogites contain larger amounts of hornblende and epidote and a smaller amount of clinopyroxene than the ordinary part of eclogite. The modes of occurrence and structural features of the hornblende-bearing eclogites are very similar to those of the ordinary part of eclogite.

II. Chemical Compositions of Constituent Minerals

The hornblende-bearing eclogite under investigation (collected by HORIKOSHI) is composed mainly of garnet, hornblende, clinopyroxene and epidote with much smaller amounts of rutile and sphene. The garnet occupies a half of the rock in volume and the hornblende, epidote and clinopyroxene, in nearly equal amounts, jointly occupies the remaining half.

The epidote has the composition of $Fe^{+3}/(Al + Fe^{+3}) = 0.1$, judging from its optical constants ($\gamma_D = 1.736$, $2V = 90^\circ$).

The clinopyroxene, garnet and hornblende were separated and purified completely enough for chemical analysis with repeated use of the isodynamic separator and Clerici solution. Their chemical compositions are shown in Table 1.

III. Discussions

Chemical analyses of the clinopyroxene and garnet from an ordinary part of the eclogite were shown by MIYASHIRO and SEKI (1958). The chemical data of garnet from a garnet-clinzoisite-amphibolite of zone III of the Bessi district is also available (HORIKOSHI, 1937). These data are presented in Table 2. for comparison with the present new analyses.

The clinopyroxene from an ordinary part of the eclogite is diopside extremely poor in Na_2O in spite of the existence of available Na and Al judging from the character of the

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Table 1. Clinopyroxene, hornblende and garnet from a hornblende-bearing eclogite (Specimen No. HK48091603) of Gongen-yama in the Bessi district.

	1	2	3
SiO ₂	50.78	46.59	37.69
Al ₂ O ₃	7.24	11.75	22.87
TiO ₂	0.23	0.18	0.08
Fe ₂ O ₃	2.96	2.46	2.27
FeO	3.35	8.40	17.78
MnO	0.03	0.07	0.35
MgO	11.92	14.27	7.02
CaO	20.12	11.58	12.32
Na ₂ O	2.84	2.18	0.10
K ₂ O	0.06	0.29	tr.
H ₂ O+	0.66	1.98	tr.
H ₂ O-	0.00	0.11	0.08
P ₂ O ₅	0.02	0.05	tr.
Total	100.21	99.91	100.56

All analysed by H. HARAMURA.

- 1: Clinopyroxene. $2V_Z=62^\circ$, $c\wedge Z=48^\circ$, $\alpha=1.677$ and $\gamma=1.705$ for Na-light. X=nearly colorless, Y=very pale green and Z=very pale green. $Mg/(Mg+Fe^{+2})=0.86$. ($Na_{0.20}Ca_{0.79}Mg_{0.63}Fe^{+2}_{0.10}Fe^{+3}_{0.08}Ti_{0.01}Al^{VI}_{0.18}Si_{1.87}Al^{IV}_{0.13}$)_{2.00}.
- 2: Hornblende. $2V_x=86^\circ$, $c\wedge Z=19^\circ$, $\alpha=1.636$ and $\gamma=1.663$ for Na-light. Dispersion $r>v$; distinct. X=nearly colorless, Y=light green with bluish tinge and Z=light bluish green. ($K_{0.05}Na_{0.61}Ca_{1.78}Mg_{3.06}Mn_{0.01}Fe^{+2}_{1.01}Fe^{+3}_{0.27}Ti_{0.02}Al^{IV}_{0.69}Si_{6.70}$)_{8.01} in atomic ratios (0=23).
- 3: Garnet. $n=1.770$ for Na-light. $a_0=11.63$ A. $Mg/(Mg+Fe^{+2})=41.3$. Alm_{26.9} Py_{38.3} Sp_{0.7} Gr_{27.4} And_{6.6}.

associated hornblende. (The optical properties of the associated hornblende, determined by MIYASHIRO, closely resemble those of the hornblende, rich in Na, in the hornblende-bearing eclogite.) On the other hand, the clinopyroxene from the hornblende-bearing eclogite is omphacite containing 2.84 per cent Na₂O by weight. The atomic ratio of Na in this pyroxene is much larger than that of Fe⁺³, and therefore a considerable amount of jadeite molecule must be contained.

The abundance of jadeite and aegirin molecules in this pyroxene would suggest that the temperature of crystallization (or recrystallization) was lower than that of the ordinary part of the eclogite.

The garnet from the ordinary part of the eclogite has $Mg/(Mg+Fe^{+2})$ ratio=0.68, whereas in the garnet from the hornblende-bearing

Table 2. Analyses of a clinopyroxene and garnets from the Bessi district quoted from literature.

	A	B	C
SiO ₂	51.86	39.68	48.88
Al ₂ O ₃	1.02	22.05	17.22
TiO ₂	0.20	0.98	0.58
Fe ₂ O ₃	0.99	4.10	3.45
FeO	1.73	11.33	17.48
MnO	0.02	1.57	1.41
MgO	17.09	13.63	3.90
CaO	25.24	6.75	6.44
Na ₂ O	0.08	0.19	0.51
K ₂ O	0.06	0.04	0.14
H ₂ O	2.13	0.28	0.36
Total	100.42	100.60	100.37

A: Clinopyroxene from an eclogite of Gongen-yama in the Bessi district. Analysed by H. HARAMURA. $2V_Z=60^\circ$, $c\wedge Z=43^\circ$, $\alpha=1.676$ $\beta=1.684$, and $\gamma=1.703$ for Na-light. Ca : Mg : Fe⁺² = 50 : 47 : 3. $Mg/(Mg+Fe^{+2})=0.94$. (MIYASHIRO and SEKI, 1958).

B: Garnet from the same eclogite specimen of Gongen-yama. Analysed by H. HARAMURA. $a_0=11.555\pm0.010$ A and $n_D=1.756$. Alm 24.7, Py 53.0, Sp 3.4, Gr 6.8, And 12.1 mol. %. $Mg/(Mg+Fe^{+2})=0.68$. (MIYASHIRO and SEKI, 1958).

C: Garnet from garnet-clinzoisite-amphibolite of zone III in Doi-mati, Uma-gun, in the Bessi district. Analysed by Z. KURIYAMA. $n_D=1.790$ as determined by S. OKA. $Mg/(Mg+Fe^{+2})=0.28$. (HORIKOSHI, 1937).

eclogite, the ratio is 0.41. The composition field of pyralspite garnet enlarges toward higher Mg content with rising temperature (MIYASHIRO, 1953). Thus, the chemical behavior of garnet in these rocks is consistent with the above consideration.

The pyralspite garnet from a garnet-amphibolite of zone III has $Mg/(Mg+Fe^{+2})=0.28$. This value is lower than the corresponding value of the garnet from the hornblende-bearing eclogite.

Thus, the hornblende-bearing eclogite may be regarded as representing an intermediate member in the physical conditions of formation between the associated garnet-amphibolites and ordinary part of the eclogites.

The analysed hornblende has a high content of Na as is usually the case in the hornblende produced by glaucophanitic metamorphism. Probably, high rock-pressure as well as low

degree of silica saturation, prevailing during the formation, would be responsible for the high alkali content.

IV. Acknowledgements

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種子田定勝*・松本 征夫**：霧島火山新燃岳 1959 年 2 月の爆発

新燃岳は霧島火山の新期火山群に属するホマーテ型火丘の一つで、頂上には直径約 750m の火口があり、最高所の標高 1420.8m、火口底との比高 187m、火口底のほぼ中央に直径 150m 位の池があり、また火口底の南東部に直径 30~50m の小火口跡がある。有史時代にもしばしば活動し、近くは文政 4 年 (1821) に噴火している。その後昭和 9 年に火口底の池の異変が報告されたほか***、この火丘は平穏であつたが、昭和 34 年 (1959) 2 月 17 日 14 時 30 分頃爆発した。これは霧島火山としては大規模のものに属し、殊に東側 (宮崎県側) の被害は大きかつた。

小林営林署大幡事業所 (新燃岳東北東約 6km) では 14 時 30 分頃ドロドロという音が 4・5 分間続き、夕

A 火口の下より C, D 火口の噴煙を望む
手前は噴出岩塊と被害を受けた森林帯
(昭和 34 年 2 月 27 日)

韓国岳より新燃岳の噴煙を望む

左方: 高千穂の峰 中央部: 新燃岳

A: A 火口, B: B 火口 1: C, D 両火口の噴煙
2: E, F 両火口の噴煙 (昭和 34 年 2 月 27 日)

立雲のように白煙がもくもくと起り、ついで真黒な雲が天にひろがり (14 時 50 分頃)、青灰色の小豆大の火山灰の塊りが降り、硫黄臭が鼻をつき始めた (桜島が大爆発したのか? と考えたという)。火山灰は 5 分間位降つて一応やみ、上空が真黒になれば又降るという状態が約 40 分間続き、飲料水・河川の水は灰色に変わった。灰は湿つてベトベトで歩行困難であつたが、16 時以後は乾燥した灰が降つた。降灰状況は次の通りであつた。すなわち、

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*** 霧島火山全体としてみると、最近では昭和 33 年 11 月大浪付近の旧地割れから蒸気が出、また付近に新しい地割れ (孔) を生じている。
地質学雑誌 第 65 巻 第 770 号 1959 年 11 月