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# Glaucophane and Ferroglaucophane in the Sangun Metamorphic Terrane of the Oosa District, Okayama Prefecture, Japan

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## Introduction

The Sangun metamorphic terrane, which is situated in the inner side of southwest Japan, is one of the glaucophanitic metamorphic terranes of high-pressure intermediate type in late Paleozoic — early Mesozoic. It is characterized by widespread occurrences of pumpellyite-bearing assemblages and sodic amphibole-bearing assemblages in mafic schists. Sodic amphibole in the Sangun terrane is mainly crossite — magnesioriebeckite with b=Z (Hashimoto, 1968a & b; Nishimura, 1971; Okamura et al., 1975; Kobayashi, 1979) whereas glaucophane with b=Y shows relatively minor occurrence as described from Zone II in the Katsuyama district (Hashimoto, 1968a) and Goutsu (=Gozu) district (Sengan et al., 1983). As suggested by Hashimoto (1968a, page 140), composition of sodic amphibole may reflect different physical conditions of metamorphism. Chemical composition of sodic amphibole is important for fully understanding the physical conditions of the Sangun metamorphism. The author briefly descibes glaucophane and ferroglaucophane, the latter of which is first reported in the Sangun terrane, in the Oosa district.

## Petrography

Glaucophane described here occurs as dark spots (maximum size 1 mm × 1 mm) in grayish quartz-mica schists. The schists were collected from an outcrop on the road, 1.3 km NNW from the summit of Mt. Oosayama (Fig. 1). The schists occur in a xenolithic block of 10 m × 10 m included in the Oosayama ultramafic body. Mineral assemblage carrying the glaucophane is albite — quartz — glaucophane — phengite with minor chlorite, epidote, sphene, apatite and opaque minerals. Garnet is found with sodic amphibole and white mica from one of the schists. The glaucophane is weakly zoned and thin outer rim has slightly strong pleochroism (core part: X′= colourless, Z′=faint blue, rim part: X′=faint yellow, Z′=pale blue). 2V over x is about 40° in the core part. Chemical composition obtained by EPMA analysis is listed in Table 1 and plotted in Fig. 2 (Miyashiro's diagram). The glaucophane, especially

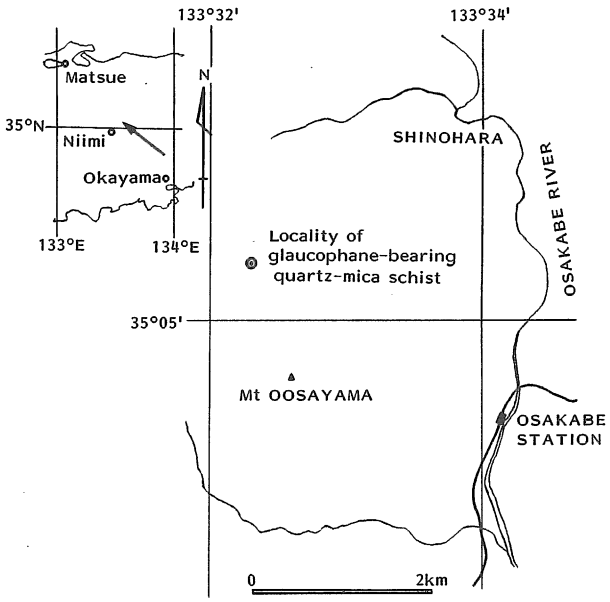


Fig. 1. Map showing locality of glaucophane-bearing quartz-mica schist near the summit of Mt Oosayama.

in the core part, is magnesian in harmony with its very weak pleochroism. Fig. 3a shows the mode of occurrence of glaucophane. Chemical composition of a phengite coexisting with the glaucophane is also listed in Table 1.

Ferroglaucophane is found from a sample catalogued in the National Science Museum, Tokyo (Registered number of the sample is 108979 in Catalogue of Rock Specimens-(2) Sangun metamorphic rocks. The sample (greenstone) is collected by Professor M. Hashimoto from Shinohara in the Oosa district.). According to the catalogue, mineral assemblage is quartz — albite — chlorite — tremolite — alkali amphibole — stilpnomelane — pumpellyite — lawsonite. The ferroglaucophane here analysed occurs in a vein with quartz and stilpnomelane. It is needle-shaped showing clear pleochroism (X′=colourless, Z′=blue). Its chemical composition is also listed in Table 1 and the mode of occurrence is shown in Fig. 3b. As shown in the mineral formula in Table 1, ferrous iron/(magnesium+manganese+ferrous iron) is approximately 0.65 and ferric iron/(aluminium+ferric iron) is almost 0.70. This plots on the boundary between ferroglaucophane and crossite by Miyashiro's classification (Miyashiro, 1957). However, the plotted point is not so rigid, as ferric iron is estimated by calculation on the basis of the mineral formula. The author use a term of ferroglaucophane to stress characteristics of the chemical composition of analysed sodic amphibole, i.e., the amphibole contains considerablly high ferrous iron. Occurrence of ferroglaucophane has not been reported from other Sangun metamorphic terrane.

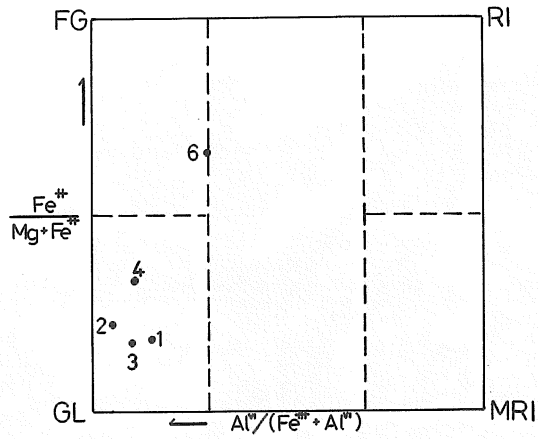


Fig. 2. Chemical compositions of glaucophane and ferroglaucophane in the Oosa district. Abbreviations are as follows: GL; glaucophane, FG; ferroglaucophane, MRI; magnesioriebeckite, RI; riebeckite. Numbers correspond to those in Table 1.

Table 1. Chemical compositions of glaucophane (1–3: core part, 4: rim), phengite (5) and ferroglaucophane (6) in the Oosa district. (EPMA analysis. Ferric iron contents are estimated on the basis of mineral formula for amphibole, i.e., Si+Al+Ti+Fe(3+)+Fe(2+)+Mn+Mg=13.000). About 2% $H_2O$ is expected for amphibole and about 4% $H_2O$ for phengite.

| | glaucophane | | | | phengite | ferroglaucophane |
|---|---|---|---|---|---|---|
| | 1 | 2 core part | 3 | 4 rim | 5 | 6 |
| $SiO_2$ | 57.41 | 58.93 | 57.85 | 57.37 | 51.60 | 55.82 |
| $TiO_2$ | 0.02 | 0.01 | 0.00 | 0.00 | 0.16 | n.d. |
| $Al_3O_2$ | 11.44 | 11.29 | 11.67 | 10.55 | 27.18 | 7.55 |
| $Fe_3O_2$ | 2.81 | 0.89 | 1.86 | 1.98 | 2.02 | 5.05 |
| FeO | 5.08 | 6.05 | 4.87 | 8.92 | 0.00 | 17.23 |
| MnO | 0.02 | 0.00 | 0.00 | 0.09 | 0.02 | 0.22 |
| MgO | 12.56 | 11.93 | 12.64 | 9.94 | 3.47 | 5.10 |
| CaO | 1.98 | 0.72 | 1.38 | 0.74 | 0.01 | 1.05 |
| $Na_2O$ | 6.68 | 7.17 | 7.07 | 7.13 | 0.47 | 6.68 |
| $K_2O$ | 0.04 | 0.01 | 0.05 | 0.00 | 10.56 | 0.01 |
| Total | 98.04 | 97.00 | 97.39 | 96.67 | 95.47 | 98.71 |
| Si | 7.774 | 8.001 | 7.840 | 7.964 | 6.832 | 7.999 |
| Al | 1.826 | 1.806 | 1.864 | 1.726 | 4.241 | 1.275 |
| Ti | 0.002 | 0.001 | 0.000 | 0.000 | 0.016 | 0.000 |
| $Fe^{3+}$ | 0.286 | 0.091 | 0.190 | 0.207 | 0.201 | 0.545 |
| $Fe^{2+}$ | 0.575 | 0.687 | 0.552 | 1.036 | — | 2.065 |
| Mn | 0.002 | 0.000 | 0.000 | 0.010 | 0.002 | 0.027 |
| Mg | 2.535 | 2.414 | 2.554 | 2.057 | 0.685 | 1.090 |
| Ca | 0.287 | 0.105 | 0.200 | 0.110 | 0.001 | 0.161 |
| Na | 1.754 | 1.887 | 1.858 | 1.919 | 0.121 | 1.856 |
| K | 0.007 | 0.002 | 0.009 | 0.000 | 1.784 | 0.002 |
| | 0=23 | 0=23 | 0=23 | 0=23 | 0=22 | 0=23 |

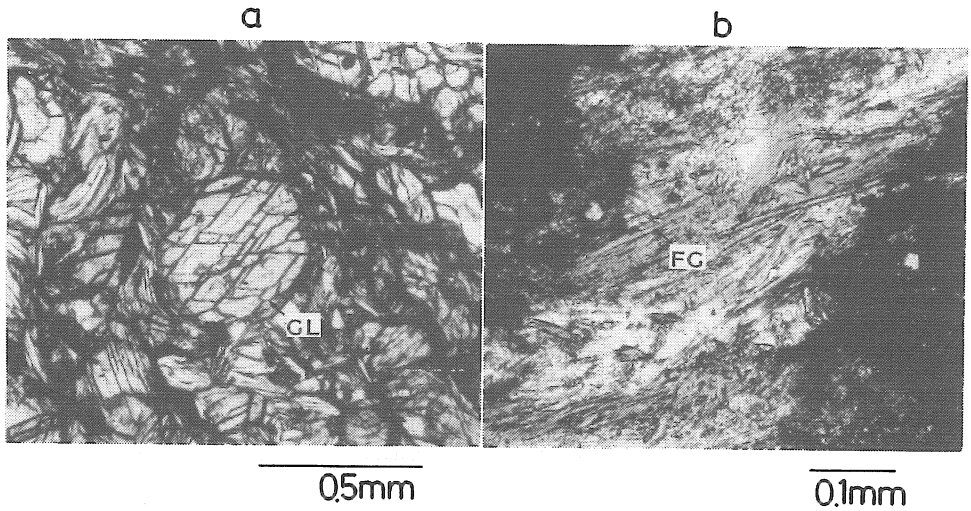


Fig. 3. Photomicrograph showing occurrence of glaucophane (a) and ferroglaucophane (b) in the Oosa district.

## Discussion

Hashimoto (1968a) described occurrence of two kinds of blue amphibole, i.e., parallel-symmetric (b=Y) and normal-symmetric (b=Z) blue amphibloes, in zone II and zone II′ of the Katsuyama district. In zone II, parallel-symmetric variety occurs in an equal proportion to normal-symmetric one, whereas the observed sodic amphboles in zone II′ are normal symmetric. On the basis of the different occurrence of sodic amphibole, he suggested the difference between physical conditions of zone II and zone II′ during the metamorphism. Miyashiro and Banno (1958) have already shown that formation of sodic amphiboles with lower ferric iron contents are related to higher pressure conditions. Similar discussion on sodic amphibole coexisted with albite, quartz and chlorite has been mentioned by de Roever et al., (1976). Nakajima et al. (1978) has described ferroglaucophane from greenstones of the Ino Formation, Kochi prefecture and suggested high P/T metamorphism as compared with the Sanbagawa metamorphism. They also noticed occurrences of pumpellyite — sodic amphibole assemblages in the Ino Formation. Pumpellyite — sodic amphibole assemblages are commonly found in higher P/T metamorphic terranes, such as Franciscan, as described by Brown (1977), Ernst at al., (1970) and Seki (1969).

As summarized above, occurrences of glaucophane and/or ferroglaucophane together with pumpellyite — sodic amphibole assemblages ARE considered to be effective for subdivision among so-called high P/T metamorphic terranes and for discrimination of a higher P/T metamorphic terrane. Hashimoto and Igi (1970) reported the first occurrence of lawsonite — sodic amphibole schists from the Sangun metamorphic terrane in

the Oosa district and at the same time payed attention to occurrence of pumpellyite — sodic amphibole assemblages in mafic schists. In this paper, the author reported occurrences of glaucophane and ferroglaucophane in the same district. These descriptions of metamorphic minerals in the Oosa district seems to prepare an estimation that metamorphic condition in some part of the Oosa district was high P/T one as compared with other district of the Sangun metamorphic terrane. The rocks suffered higher P/T metamorphism may have emplaced in relation to the Oosa ultramafic body because the glaucophane-bearing quartz-mica schist described in this paper occurs as an xenolith in the ultramafic body.

## Summary

Glaucophane and ferroglaucophane in the Oosa district are briefly described. Judging from the occurrences of glaucophane, ferroglaucophane, lawsonite — sodic amphibole assemblages and pumpellyite — sodic amphibole assemblages, some part of the Sangun metamorphic terrane in the Oosa district is estimated to show relatively high P/T metamorphic conditions as compared with other districts in the Sangun metamorphic terrane.

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