METAMORPHIC ARAGONITE FROM THE YAEYAMA METAMORPHIC ROCKS ON ISHIGAKI-JIMA, SOUTHWEST RYUKYU ISLANDS

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Introduction

The Yaeyama metamorphic rocks are scattered on southwest Ryukyu Islands, typically on Ishigaki-jima (-island) (Fig. 1). Since FOSTER (1965) described the general geology

and petrography of the Yaeyama metamorphic rocks, many studies on its metamorphic nature have been done (for a review, see FUJII & KIZAKI, 1983 ; NISHIMURA *et al.*, 1983). These studies revealed that the Yaeyama metamorphic rocks include alkali amphibole, alkali

Fig. 1. Geological sketch map of Ishigaki-jima(modified from FOSTER, 1965 and FUJII & KIZAKI, 1983). The inset shows the location of the Ryukyu Islands, in which the thin arrow points to Ishigaki-jima.

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Fig. 2. Localities of aragonite, calcite and lawsonite in the Yaeyama metamorphic rocks on Ishigaki-jima. ISJ-05, -09 and -13 indicate aragonite-bearing samples treated in this paper. Zonal mapping is after NISHIMURA *et al.* (1983).

pyroxene and lawsonite, and belong to the high-pressure type of metamorphism. Metamorphic zonal mapping has been attempted by NISHIMURA *et al.* (1983). On the other hand, the muscovites from the Yaeyama metamorphic rocks were dated by the K-Ar method to be 178 Ma (SHIBATA *et al.*, 1968; 1979) and 159, 161, 167 and 179 Ma (NISHIMURA *et al.*, 1983), and by the Rb-Sr method to be 202 Ma (SHIBATA *et al.*, 1972; 1979).

In the course of the geological work on the Yaeyama metamorphic rocks, we have newly

found metamorphic aragonite in Ishigaki-jima. The following is a petrographical description on the newly found aragonite-bearing rocks, along with a brief discussion on its significance in the metamorphic petrology of the Yaeyama metamorphic rocks.

Geological outline

The Yaeyama metamorphic rocks on Ishigaki-jima are divided into the Fusaki Formation and the Tomuru Formation (FOSTER, 1965) (Fig. 1). Structurally, the Tomuru Formation thrusts up onto the Fusaki Formation (FUJII & KIZAKI, 1983). The metamorphic zonal mapping of NISHIMURA *et al.* (1983) assigned the Fusaki Formation to Zone I, and the Tomuru Formation to Zones II, III and IV, respectively.

The present study deals with a part of the Tomuru Formation in the eastern to north-eastern Ishigaki-jima (Fig. 2). This area corresponds to Zones II, III and IV of NISHIMURA *et al.* (1983). The metamorphic rocks in the area are mainly composed of pelitic and basic schists with minor intercalations of psammitic and siliceous schists. Serpentinite and metabasite also occur as blocks or lenses in the pelitic and sometimes basic schists. The basic schist sometimes preserves the pillow and hyaloclastite structures, but its majority lack original structure. The schistosity generally strikes NW-SE and dips gently (30° – 60°) to NE.

Petrography

Staining of carbonate minerals on uncovered thin section by Feigl's solution was used for identification of aragonite and calcite in the present study. The 23 carbonate mineral-bearing rocks are examined here, of which three samples (Samples ISJ-05, ISJ-09, ISJ-13) contained aragonite. The localities of aragonite and calcite are shown in Fig. 2, in which those of lawsonite are also shown for comparison.

All of the aragonite-bearing samples are basic schists, of which one (Sample ISJ-09) retains the pillow structure, whereas the neighbouring carbonate mineral-bearing pelitic schists contain only calcite but no

Fig. 3. Photomicrograph of carbonate-rich vein in metabasites (Sample No. = ISJ-09). Note that aragonite occurs within calcite, as dark particles due to staining by Feigl's solution. The scale bar is 0.2 mm. Abbreviations are Ar=aragonite, Ca=calcite, La=lawsonite, M=muscovite and Q=quartz.

aragonite. The aragonite occurs only in vein and amygdale in the basic schists, and it is fine-grained and scattered within host calcite grain (Fig. 3). The optical orientation of individual aragonite differs from grain by grain, but the host calcite possess an identical optical orientation. These aragonite-bearing vein and amygdale also include chlorite with or without lawsonite, epidote, pumpellyite, albite and quartz, but are devoid of alkali amphibole and alkali pyroxene that occur in the matrix; the mineral assemblages of the aragonite-bearing samples are listed in Table 1.

Comparing with the zonal mapping of NISHIMURA *et al.* (1983), the aragonite-bearing samples belong to the low- to medium-grade part of Zone II (Fig. 2) which is characterized

Table 1. Mineral assemblages of aragonite-bearing metabasites from the Yaeyama metamorphic rocks on Ishigaki-jima.

Sample No.	ISJ-05	ISJ-09	ISJ-13
Aragonite	V	V	A
Calcite	V	V	A
Lawsonite	/	V	A
Na-Amphibole	M	M	/
Na-Pyroxene	/	/	M
Epidote	VM	/	/
Pumpellyite	/	V	/
Muscovite	/	VM	/
Chlorite	VM	VM	AM
Albite	M	VM	M
Quartz	VM	M	/

V:vein, A:amygdale, M:matrix, /:absent

by the mineral assemblages of L+P+Gl, L+Ep, P+Gl+Act, P+Gl+Ep, P+Act+Ep and Gl+Act+Ep (L=lawsonite, P=pumpellyite, Gl=glaucofane, Ep=epidote, Act=actinolite); all including chlorite with or without quartz and albite (for detail, see Table 1 of NISHIMURA *et al.*, 1983).

Concluding remarks

Although the experimental results reviewed by CARLSON (1983) show that aragonite represents a higher-pressure polymorph of calcite, its stability in prograde or retrograde metamorphism is not well known. In this connection, it is noteworthy that (1) the mode of occurrence of the Yaeyama aragonite indicates that the aragonite was converted from a part of the host calcite (Fig. 3), and (2) the aragonite occurs in the area where lawsonite is widespread (Fig. 2). These allow the interpretation of the Yaeyama aragonite as a high-pressure metamorphic mineral, probably converted from calcite during the prograde increase in pressure. Hence, the presence of aragonite provides an additional constraint to the P-T conditions of the Yaeyama metamorphism, which is estimated to be higher than 5–6 kb at 200 °C and 8–9 kb at 400 °C (CARLSON, 1983).

A further study on the regional distribution of aragonite is in progress by one of us (HI).

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- * : in Japanese with English abstract

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Ishigaki-jima……………石垣島

Ryukyu……………琉球

Yaeyama……………八重山