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Epidote Porphyroblasts in Sambagawa Schists of Central Shikoku, Japan

By

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with 6 Text-figures and 1 Plate

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Abstract: Epidote grains are commonly found as inclusions in plagioclase porphyroblasts of the schists in the biotite zone of the Sambagawa belt of Central Shikoku, Japan. Two types of fabrics of inclusion epidotes are observed: Type I) though the growth of plagioclase porphyroblasts occurred under non-deformational condition (cf. Takagi and Hara, 1979; Maeda and Hara, 1983a and b), the epidote grains show preferred lattice and dimenssional orientation, in individual plagioclase porphyroblasts forming a single set of schistosity and of lineation. And Type II) the epidote grains occur with random lattice and dimensional orientation in individual plagioclase porphyroblasts, developing as porphyroblasts which contain other metamorphic minerals as inclusions. Only in the schists in which inclusion epidote has the fabric of Type II, matrix epidote appears to develop as porphyroblasts. The appearance of the epidote grains as porphyroblasts under non-deformational condition appears to have begun earlier to some extent than that of plagioclase porphyroblasts.

Contents

I. Introduction

Plagioclase of schists in the biotite zone of the Sambagawa belt of Central Shikoku, Japan, develops commonly as porphyroblasts which contain other metamorphic minerals as inclusions. The plagioclase porphyroblasts show commonly zonal variation of inclusions defined by inclusion-free mantles and inclusion-rich cores (Hara *et al.*, 1977; Takagi and Hara 1979; Hosotani, 1980; Hara *et al.*, 1980; Hara *et al.*, 1983; Hara *et al.*, 1983). The cores of plagioclase porphyroblasts appear to have grown under non-deformational condition and progressive increase of metamorphic temperature (Takagi and Hara, 1979; Maeda and Hara, 1983a and b; Hara *et al.*, 1983). Hara *et al.* (1983) has clarified that hornblende porphyroblasts grew during growth of the inner zones of mantles of plagioclase porphyroblasts, though most of them were recrystallized as fine-grained hornblendes by a deformation during growth of the outer zones of mantles of plagioclase porphyroblasts. Maeda and Hara's (1983a) data would indicate that the mantles (with low MnO content and high FeO and MgO contents) of garnet porphyroblasts grew during growth of the cores and inner zones of mantles of plagioclase porphyroblasts. But, it has not yet become so clear how other metamorphic minerals had grown during growth of the plagioclase porphyroblasts. This problem should be partially solved by analysis of microtextures of inclusion minerals in the plagioclase cores. This is because the microtextures of inclusion minerals must be what they had during growth of the plagioclase cores but immediately before they had been included into the plagioclase cores. Microtextures of epidote grains in plagioclase porphyroblasts of schists in the biotite zone of the Sambagawa belt of Central Shikoku (Fig. 1) have been observed on a few hundred thin sections, recognizing two modes of their growth during growth of the plagioclase porphyroblasts. The two modes, Type I and Type II, will be described in this paper.

II. TWO TYPES OF EPIDOTE FABRICS

Type I: TAKAGI and HARA (1979) described fabric of epidote grains in the cores of plagioclase porphyroblasts of a basic schist, which was collected from an outcrop (outcrop A in Fig. 1) in the biotite zone of the Sambagawa belt of Central Shikoku. This is a typical one of the epidote fabrics of Type I: The epidote grains in the cores of plagioclase porphyroblasts, as well as other inclusion minerals, are fine-grained and show preferred dimensional orientation forming a single set of schistosity (S_1) and of lineation (L_1). The direction of preferred orientation of principal vibration axes Y for the epidote grains coincides with L_1. TAKAGI and HARA also clarified that the cores of plagioclase

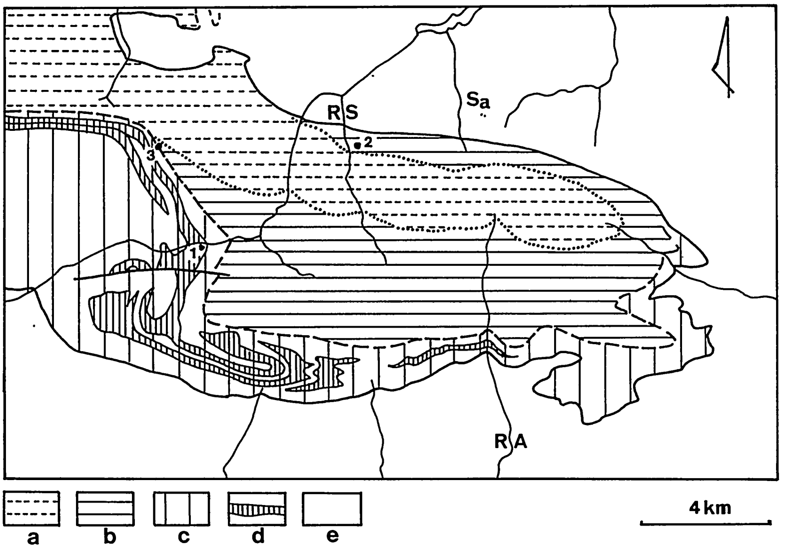


FIG. 1. Diagram showing the localities of the analysed specimens in the Sambagawa belt of Central Shikoku.

a, b, c and d: Saruta nappe [a and b: Saruta nappe II (a: garnet zone, b: biotite zone), c and d: Saruta nappe I (c: biotite zone, d: Shirataki hornblende-schist and associated quartz-schist)], e: Nagahama nappe [map after HARA, HIDE and MAEDA (1983)]. Sa: Sazara, RS: River Saruta, RA: River Asemi, 1: outcrop A, 2: outcrop B, 3: outcrop C.

porphyroblasts had grown under non-deformational condition. Thus, it would be said that the epidote grains had been included into plagioclase porphyroblasts well preserving their lattice and dimensional fabrics produced by a deformation which occurred before the appearance of plagioclase porphyroblasts, and that they had hardly grown during growth of plagioclase grains as porphyroblasts. Another example of the epidote fabrics of Type I, which is from the outcrop B in Fig. 1, will be briefly described in the following paragraphs.

In the basic schist from the outcrop B occurs only plagioclase as porphyroblasts. The inclusion minerals in plagioclase porphyroblasts all show preferred dimensional orientation forming a single set of S_1 (Plate 12–a and b). In the inclusion minerals are found epidote and amphibole together with white mica and opaque minerals.

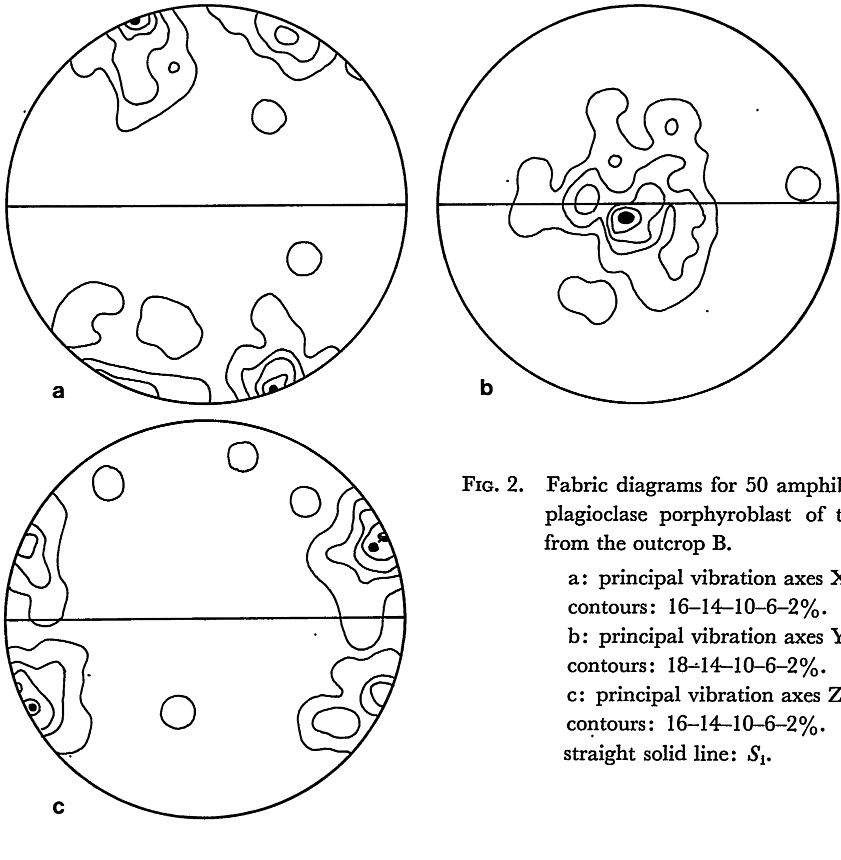


Fig. 2. Fabric diagrams for 50 amphibole grains in a plagioclase porphyroblast of the basic schist from the outcrop B.
a: principal vibration axes X, contours: 16–14–10–6–2%.
b: principal vibration axes Y, contours: 18–14–10–6–2%.
c: principal vibration axes Z, contours: 16–14–10–6–2%.
straight solid line: S_1.

Fig. 2 illustrates a lattice fabric of amphibole grains in a plagioclase porphyroblast on a thin section (XY-section) for the basic schist. From the fabric pattern of Fig. 2 it can be said that the c axes of amphibole grains are preferentially oriented along a direction on S_1 forming a single set of lineation L_1 and their (100) planes are preferentially oriented parallel to S_1. This fabric pattern is referred to the Type I of amphibole fabric after Hara *et al.* (1983) and comparable with that of amphibole grains in plagioclase porphyroblast of the Sambagawa schist described by HARA *et al.* (1980).

Fig. 3 illustrates preferred dimensional orientation of epidote grains in the plagioclase porphyroblast (on the XY-section), in which the amphibole fabric (Fig. 2) has been analysed. While Fig. 4 illustrates elongation degree (GE=length of longest axis/length of its normal) for the same epidote grains, showing that it is between 1.5 and 16.6 with mean value of 6.1. Thus, it can be said that the epidote grains are strongly elongated parallel to S_1 and to L_1 (Plate 12–a and b).

Lattice fabric for the epidote grains, from which the data of Figs. 3 and 4 has been obtained, has been also analysed. The result is shown in Fig. 5. Principal vibration axes Y and Z are preferentially oriented parallel to S_1, while principal vibration axes X normal to S_1. The orientation direction of Y axes coincides with L_1. This fabric pattern of epidote grains is comparable with that in the Sambagawa schist described by KOJIMA and HIDE (1965). Thus, it would be said that the epidote grains in the basic schist of the outcrop B had hardly grown during growth of the plagioclase porphyroblasts and so been included into them well preserving lattice and dimensional fabrics produced by a deformation which occurred before their appearance, like in the case of the basic schist described by TAKAGI and HARA (1979). In the schists, in which inclusion epidotes have the fabric of Type I, can not be commonly found epidote grains as porphyroblasts.

Type II: The fabric of epidote grains in plagioclase porphyroblasts in a basic schist,

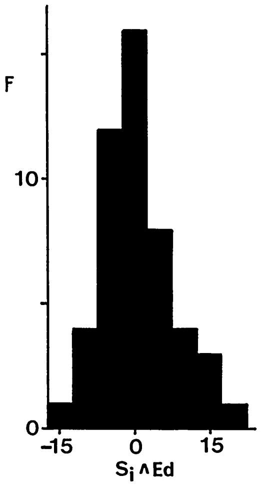


FIG. 3. Diagram showing the dimensional orientation of epidote grains in the plagioclase porphyroblast of Fig. 2.

S_1: schistosity S_1, Ed: direction of longest axis of epidote grain.

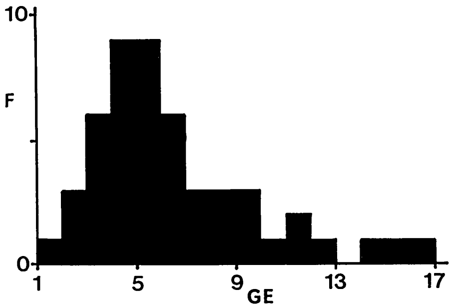
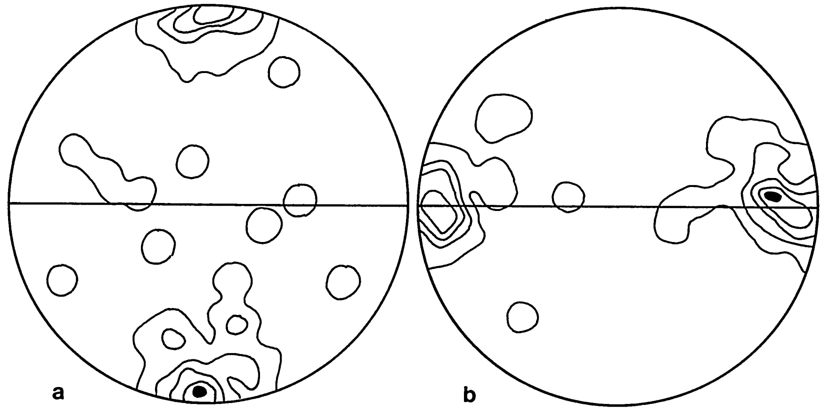


FIG. 4. Diagram showing the variation of elongation degree (GE) of epidote grains in the plagioclase porphyroblast of Fig. 2.



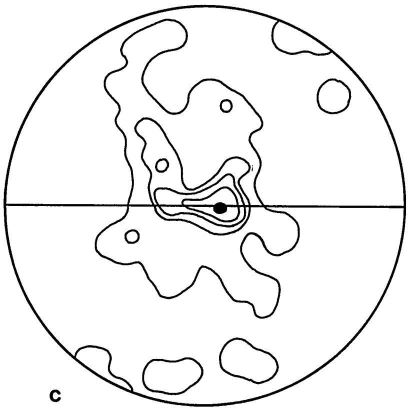


FIG. 5. Fabric diagrams for 50 epidote grains in the plagioclase porphyroblast of Fig. 2.
a: principal vibration axes X,
contours: 18–14–10–6–2%.
b: principal vibration axes Y,
contours: 18–14–10–6–2%.
c: principal vibration axes Z,
contours: 12–10–8–6–2%.

which has been collected from the outcrop C in Fig. 1, is of Type II. In the basic schist occurs epidote, as well as plagioclase, as porphyroblasts which contain other metamorphic minerals as inclusions. All of inclusion minerals in epidote porphyroblasts show preferred dimensional orientation forming a single set of schistosity S_i, and they in plagioclase porphyroblasts, except for epidote grains, do also it (Plate 12–c and d). S_i in individual epidote porphyroblasts and plagioclase porphyroblasts is commonly approximately straight.

Epidote grains in plagioclase porphyroblasts are much larger in size than other inclusion minerals. And they contain other metamorphic minerals as inclusions which show preferred dimensional orientation forming a single set of schistosity (S_{i-e}) (Plate 12–c and d). S_{i-e} is always approximately straight and parallel to S_i in matrix plagioclase porphyroblasts. Namely, S_{i-e} continues into S_i (Plate 12–c and d).

The longest axes of epidote grains are randomly oriented in individual plagioclase porphyroblasts, though S_{i-e} is parallel to each other throughout all of them and to S_i, (Plate 12–c and d). Fig. 6 illustrates the lattice fabric of epidote grains in plagioclase porphyroblasts. It can be said that the epidote grains do not have a preferred lattice orientation, as well as preferred dimensional orientation, unlike in the case of the epidote fabric of Type I.

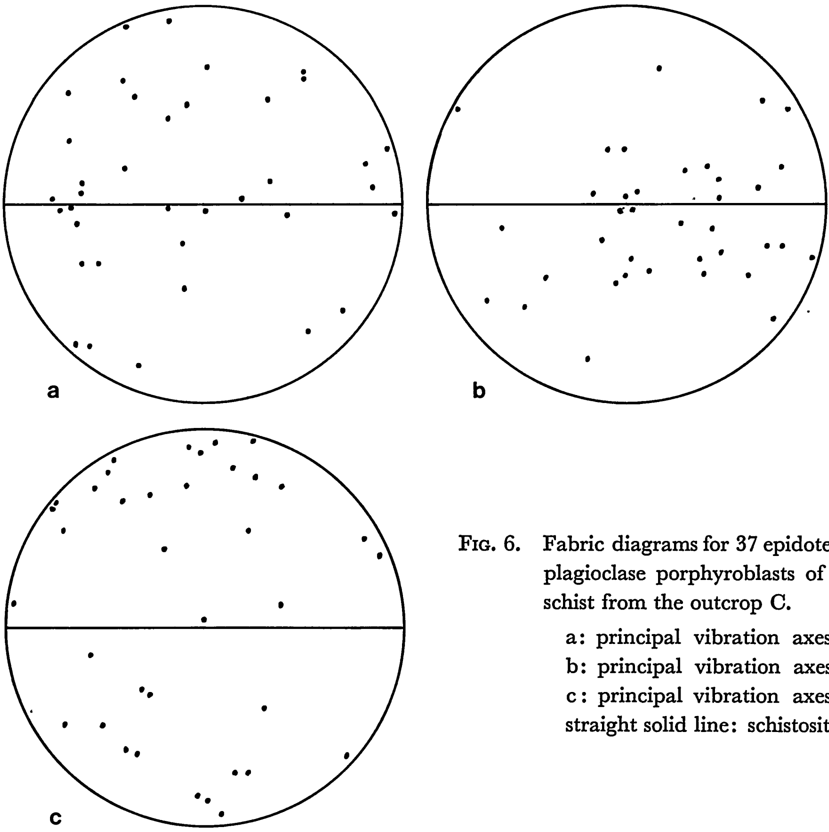


FIG. 6. Fabric diagrams for 37 epidote grains in plagioclase porphyroblasts of the basic schist from the outcrop C.
a: principal vibration axes X,
b: principal vibration axes Y,
c: principal vibration axes Z,
straight solid line: schistosity S_1.

On the basis of the above-described evidences it could be concluded that the epidote grains in the basis schist from the outcrop C (=in the case of the epidote fabric of Type II) had been remarkably grown as porphyroblasts under non-deformational condition after the deformation related to the formation of S_1 and then some of them had been included into plagioclase porphyroblasts. The appearance of epidote grains as porphyroblasts appear to have begun earlier to some extent than the growth of plagioclase grains as porphyroblasts. Epidote porphyroblasts are as coarse-grained as plagioclase porphyroblasts. Therefore, it can be pointed out that epidote grains, which had not been included into plagioclase porphyroblasts, had also remarkably grown during their growth.

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EXPLANATION OF PLATE XII

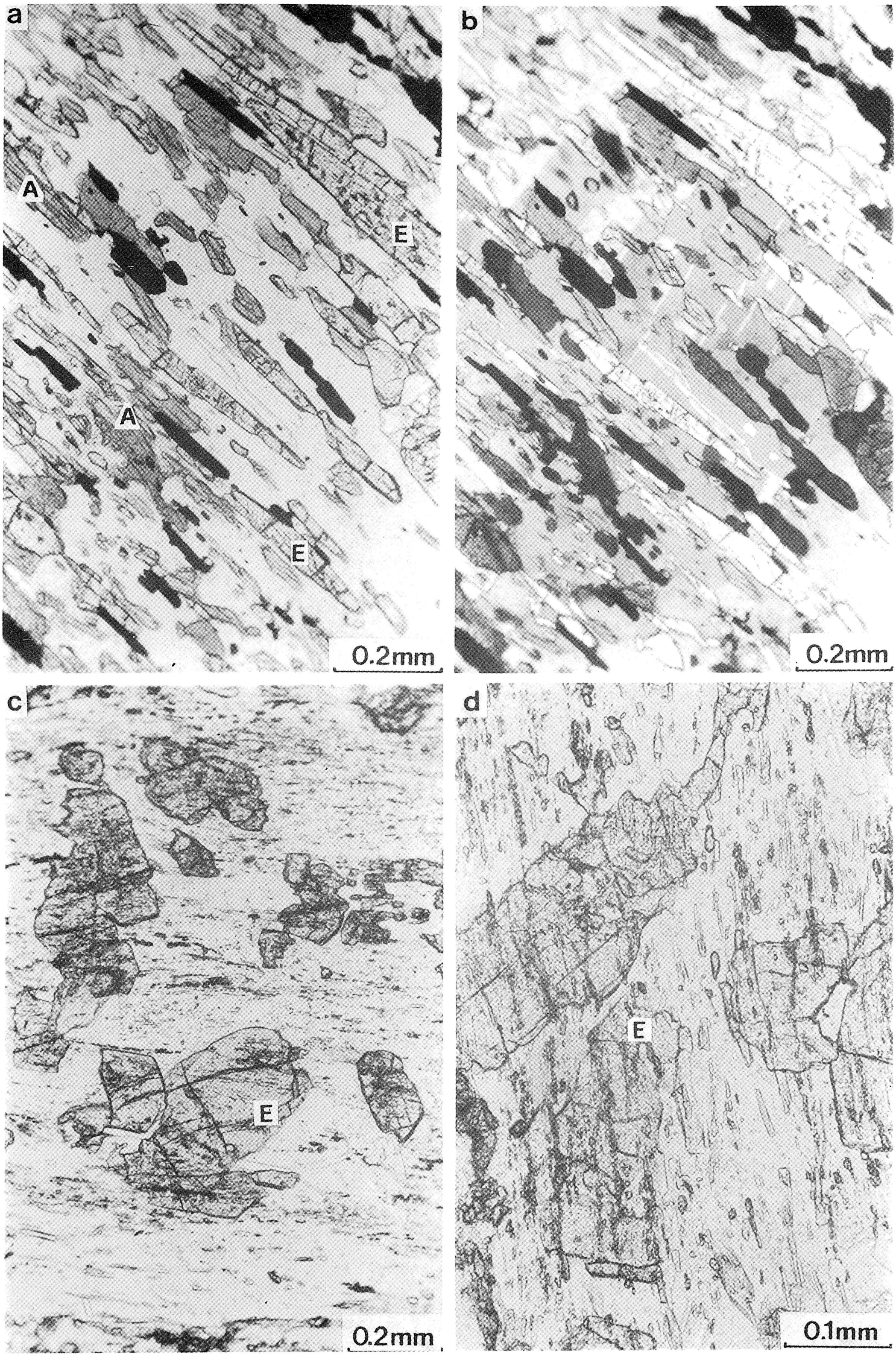
a: Microphotograph of inclusion minerals in a plagioclase porphyroblast of the basic schist from the outcrop B. Lower nicol only.

b: Microphotograph of inclusion minerals in a plagioclase porphyroblast of the basic schist from the outcrop B. Crossed nicols.

c: Microphotograph of inclusion minerals in a plagioclase porphyroblast of the basic schist from the outcrop C. Lower nicol only.

d: Microphotograph of inclusion minerals in a plagioclase porphyroblast of the basic schist from the outcrop C. Lower nicol only.

E: epidote, A: amphibole.


a
A
E
A
E
0.2mm
b
0.2mm
c
E
0.2mm
d
E
0.1mm