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Citation	Geological report of the Hiroshima University , 14 : 233 - 238
Issue Date	1965-02-22
DOI	
Self DOI	10.15027/52852
URL	https://ir.lib.hiroshima-u.ac.jp/00052852
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Orientation of an Epidote with a Unique Crystal Habit in a Quartz-Schist from Besshi

By

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with 2 Text-figures and 1 Plate

(Received September 28, 1964)

ABSTRACT: Epidote crystals characterized by the development of the crystallographic plane ($\bar{1}02$) have been found in a quartz-schist from Besshi, Ehime Pref. The crystallographic axis b of the epidote coincides with fabric axis *b* of the rock, and the plane ($\bar{1}02$) is oriented parallel to the fabric plane (*ab*).

CONTENTS

I. INTRODUCTION

It has long been established that, in the tectonite, epidote is oriented with the crystallographic axis b parallel to the fabric axis *b* of the rock (FAIRBAIRN, 1949; SANDER, 1950; LADURNER 1951; CRAMPTON, 1957). As to the preferred orientation of respective planes of crystallography with respect to the fabric plane (*ab*), however, any unequivocal fabric diagrams have not yet been published. LADURNER suggests that the faces (100), ($\bar{1}01$), and (001) are parallel as well as normal to (*ab*), and that, in particular, (001) tends to be oriented parallel to (*ab*), but the pattern of his diagrams does not seem to us so clear as he insists. The situation is quite the same through our work on the preferred orientation of epidote in crystalline schists in Japan except one case, on which we are going to report here.

The rock in question is a quartz-schist collected from the hanging wall of the Besshi ore bed (the specimen number GK55XI17-1). From the standpoint of structural geometry, the rock is a remarkable triclinic tectonite with a characteristic pattern of quartz fabric diagram, on which we reported in a previous paper (1958). Already in that paper, we touched on the peculier crystal habit and the orientation of the epidote (p. 203, foot-note), but detailed description has been left to a future paper.

II. PETROGRAPHIC FEATURES

The specimen was collected from the horizon of quartz-schist, just the upper of the ore bed of Besshi. The horizon of the beds in question including the ore bed represents the transitional zone between the non-spotted (without porphyroblasts of albitic feldspar) anticlinorium to the south and the spotted synclinorium to the north, namely, a zone of flexure characterized by intense shear movement (about the geologic setting see our previous paper, 1958). The rock is light-greenish in colour, showing fine laminated structure. The quartzose layer consists of quartz almost exclusively, accompanied by muscovite, epidote, and hematite, while the micaceous layer contains quartz, porphyroblastic albitic feldspar, muscovite, chlorite, epidote, hematite, apatite, and also garnet in some layers. The grain-size of the main constituents is as follows: quartz 0.1–0.3mm, muscovite 0.2–0.5mm, and feldspar porphyroblast ca. 2mm.

The planar structure of the rock was analysed in the previous paper (1958). The surfaces of the laminated structure represents the most distinct schistosity, designated S_{1-2}. There are developed other s-surfaces of later formation, being classified into the first transversal schistosity surfaces, S_3 and S_4, and the second transversal schistosity surfaces, S_5 to S_{10} (*cf.* Fig. 5 and Table 1 of the paper, 1958). The former relates to the elongation in the axis *a*, while the latter to the elongation in *b*.

On the principal schistosity surface S_{1-2} are found distinct parallel grooves or striations, which correspond to the axis of isoclinal fold of original lamination as well as to the intersection of S_{1-2} and S_3 or S_4, the direction being taken as the fabric axis *b* of the rock. When carefully observed, fine striations are traceable other than the principal lineation on S_{1-2}, which can be identified with the intersection of S_{1-2} and the transversal s-surfaces, S_5 to S_{10}. Furthermore, in addition to these striations, a kind of faint furrows of micro-corrugation is perceptible on S_{1-2}, which is cut across by the above rectilinear striations. This lineation is designated L_0, representing an older lineation than the principal one. We have assigned L_0 to the earlier lineation formed at the stage of non-spotted metamorphism, and the spotted metamorphism of higher metamorphic grade has been interpreted as overlapped on the non-spotted schists.

III. CRYSTAL HABIT OF EPIDOTE

Most crystals of epidote in metamorphic tectonites are short prismatic with hexagonal cross-section, owing to equally balanced development of crystal faces, such as (100), ($\bar{1}$01), and (001). Crystals of the epidote of the rock are mostly long prismatic with flat rhomboidal cross-section. The (010) cross-section of the crystal is drawn schematically in Fig. 1. The rhomboidal outline is marked by

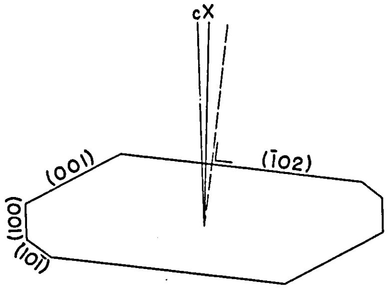


FIG. 1 Schematic cross-section of epidote crystal.
The section is cut parallel to (010). Dashed line is the normal to the face (̄102).

the development of (̄102) and (001), and the sharp tip of the wedge is cut by (100) and (̄101). Tiny rhomboids of the mineral are observed on the (*ac*)-section (Plate). While, on the (*ab*)-section, elongated crystals of epidote are found. Terminal faces of the crystal are rarely developed. On the (*ab*)-section, the prisms are cut across by several fractures, that run almost perpendicular to the long edge of the prism, and, not infrequently, parts of a single prism are separated from each other at the fractures. These features can be interpreted as developed at the stage of the elongation in *b* relating to the formation of the second transversal schistosity surfaces. Accordingly, it can be inferred that the epidote had ceased its crystallization before that stage.

The long diameter of the rhomboid on the (*ac*)-section is 0.05mm, and the length of the prism on the (*ab*)-section is 0.15mm on the average.

IV. Orientation of Epidote

We have measured the angles between the crystal faces and the optic elasticity axis X with the following results:

Pole of (̄102)^X 7° (the mean of 8 measurements)
Pole of (001)^X 28° (the mean of 10 measurements)

By applying the value 9° of the angle between the pole of (̄102) and the axis c to the former value, the angle c^X is calculated as 2°. These angular relations are shown in Fig. 1.

The orientation of three optic elasticity axes of the epidote was measured for 150 grains without selection on the (*ab*)-section, and the result is shown in separate diagrams of Fig. 2. As read from Fig. 2, b, the crystallographic axis b coincides strictly with the fabric axis *b*, that is the principal lineation on the schistosity surface S_{1-2}, having a sharp maximum (22%). There can be traced a tendency of the points to disperse towards the earlier lineation, L_0. This sug-

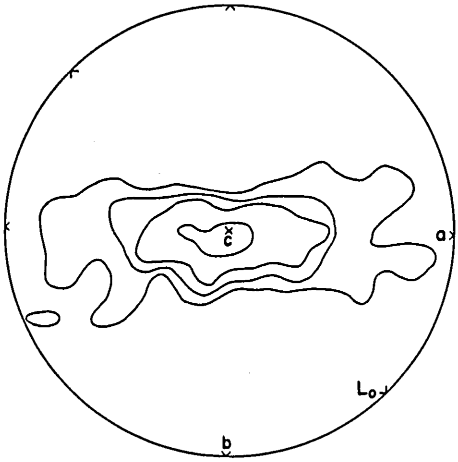
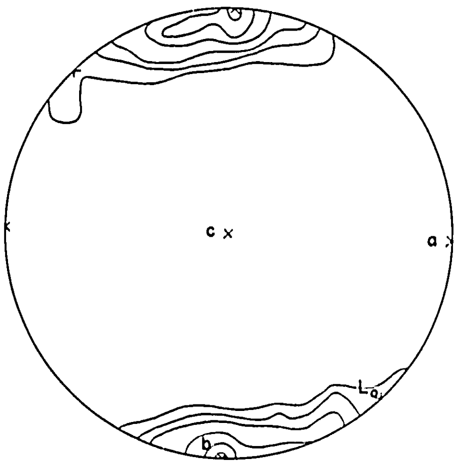


FIG. 2 Fabric diagrams of three optic elasticity axes of epidote.
a. 150 X axes. Max. 13%. Contours 10-5-3-1%.

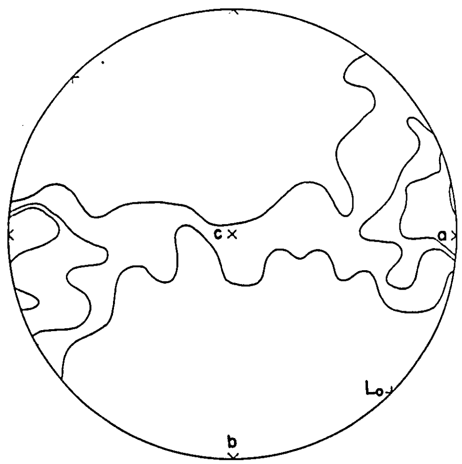


b. 150 Y axes. Max. 22%. Contours 20-15-10-5-3-2%.

gests that the epidote had already been formed at the stage of non-spotted metamorphism, and that, entering on the stage of spotted metamorphism, the mineral was rearranged according to the renewed stress plan.

The unique habit and the preferred orientation of the mineral are distinctly represented by the pattern of the diagram, Fig. 2, a. The diagram has a single maximum at *c*. The incomplete girdle reflects slight rotation around the axis *b*. As inferable from the small angle between the pole of ($\bar{1}02$) and X, the pattern evidences that the epidote is oriented statistically with the plane ($\bar{1}02$) parallel to the schistosity surface, S_{1-2}. The effect of L_0 is also traceable in the presence of a weak subordinate girdle.

The pattern of the diagram, Fig. 2, c, can also be explained as above. The



c. 150 Z axes. Max. 9%. Contours 5-3-1%.

effect of L_0 is traceable.

V. Concluding Remarks

In this paper, an epidote with spindle-shaped cross-section found in a quartz-schist has been reported, especially, with respect to its orientation in the tectonite. The unique outline of the cross-section is ruled with ($\bar{1}$02) and (001) as well. The coincidence of the crystallographic axis b with the fabric *b* is quite distinct. In addition, the planar orientation of the mineral parallel to the schistosity plane is also distinct, and the pattern of the fabric diagrams suggests that the face ($\bar{1}$02) tends to be oriented parallel to the schistosity plane.

In relation to the cyrstal habit and the orientation of epidote, we have examined about one hundred thin sections of crystalline schists, mainly quartz-schists, in the Besshi-Shirataki district. Most crystals of the mineral have prismatic forms elongated in the crystallographic axis b. On the cross-section, the faces (001), (100), and ($\bar{1}$02) are commonly observed. Among these faces, (001) is the most common. Epidote crystals having the face ($\bar{1}$02) can be found rather ubiquitously in quartz-schists in the district, irrespective of metamorphic grade. However, the spindle-shaped crystals are mingled with the crystals having other outlines of cross-section, such as rounded forms, polygons, squares, and so on. The quartz-schists, in which are contained abundantly such crystals with spindle-shaped cross-section as reported in this paper, have been collected from only a few localities, that is, the hanging wall of the ore bed of Besshi, a quartz-schist bed near Bôundô to the south of Hadeba, and a piedmontite-quartz-schist bed east of the Ikadatsu mine.

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Explanation of Plate XX

Fig. 1 Photomicrograph of quartz-schist, showing flat rhomboids of epidote. The faces (001), ($\bar{1}$02), and (100) are observable. The thin section was cut parallel to the fabric plane (*ac*) from the specimen of quartz-schist, forming the hanging wall of the Besshi ore bed. The specimen number: GK55XI17-1. ×413

Fig. 2 ibid. ×422

Fig. 3 Photomicrograph of a thin section cut parallel to the fabric plane (*ab*) from the same specimen as in Fig. 1. A prism of epidote is cut across by fractures, and parts of the crystal are separated from each other at the fractures. ×413

Fig. 4 Photomicrograph of a thin section cut parallel to the fabric plane (*ac*) from a specimen of piedmontite-quartz-schist, collected to the east of the Ikadatsu mine. The specimen number: HK511019. The faces, (001) and (100), along with cleavage traces parallel to these faces, and the face ($\bar{1}$02) can be traced on a flat piedmontite crystal, just to the right of the center. ×146

FIG. 1

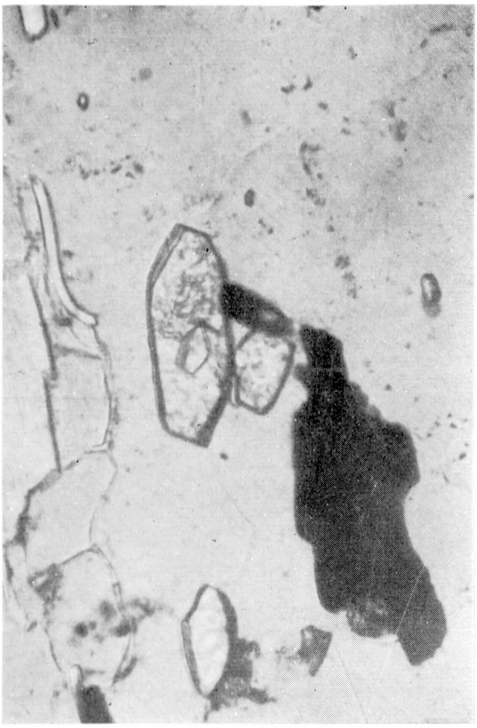

FIG. 2

FIG. 3

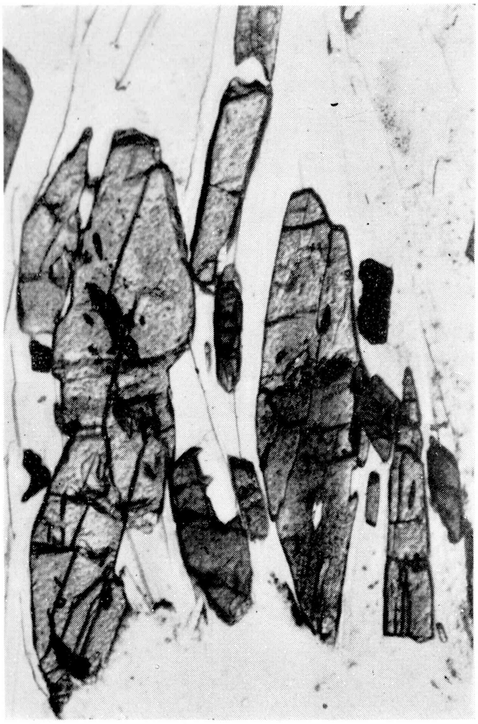

FIG. 4