Notes on the Preferred Orientation of Calcite Porphyroblasts

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with 6 Text-figures

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ABSTRACT: In a calcareous gneiss showing porphyroblastic texture, (0001) poles of calcite porphyroblasts concentrate more than those of matrix calcite. In a green schist and a quartz-calcite layer of green schist, having porphyroblasts of calcite, the (0001) pole figures of calcite porphyroblasts show random or weak preferred orientation. The former case can be interpreted to be the result of secondary recrystallization.

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I. INTRODUCTION

The term 'porphyroblast' is defined by H. WILLIAMS *et al.* (1953) as follows: 'In many metamorphic rocks large crystals (porphyroblast) of one or more minerals are associated with much smaller grains of other minerals'. Porphyroblasts are naturally developed in various metamorphic minerals show the tendency to become porphyroblast; e.g. lawsonite, albite, epidote, calcite, dolomite, muscovite, pyrite, garnet, biotite, hornblende, corundum, staurolite, andalusite, microcline and so on. The author does not agree with H. WILLIAMS *et al.*, when they restrict the usage of the term 'porphyroblast' within the case where large crystals are embedded in a matrix consisting of other minerals, as defined above. The author is now going to examine the specimen in which porphyroblasts of calcite occur in matrices that contain much smaller crystals of calcite or other minerals.

D.T. GRIGGS *et al.* (1960) reported the formation of calcite porphyroblasts by recrystallization of calcite material. In their experiments, porphyroblasts were developed when the initial material had moistened, compressed and heated in the squeezer to 1000°C, under the pressure of 4kb, for 30 minutes. The groundmass is composed of fine grains, forming granoblastic texture. They have shown that the (0001) pole diagram of the matrix calcite shows generally a pattern affected by the initial fabric and is essentially random, while, that the orientation of calcite porphyroblasts is characterized by the prominent c-axis maximum, which is parallel to the axis of compression of the squeezer and normal to the piston face.

Features of annealing recrystallization have been clarified in the metallographical field, such as the cases of Si–Fe and Cu, and it has become clear that annealing recrystallization at various temperetures shows various stages of development of the fabric pattern. For example, J. E. MAY and D. TURNBULL (1957) have experimentally examined the fabric of copper at the secondary recrystallization and they have shown that the percent of (110) (001) texture increases when the grains become suddenly large.

In this paper, the author reports the fabric of calcite porphyroblasts which have been formed under different metamorphic conditions and discusses the similarity between the 'mechanism of porphyroblast formation' defined petrologically and the 'secondary recrystallization' defined in the metallography.

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II. DESCRIPTION OF CALCITE FABRIC

Specimen 1 is a calcareous gneiss which shows porphyroblastic texture (K. HASHIKAWA, 1969). The specimen consists of calcite grains, the size of which is 0.1 to 0.2 mm in the matrix, while the calcite porphyroblasts attain 0.8 to 1 mm. Mechanical twins of calcite are developed both in the matrix and the porphyroblasts, but, because their development is weak, they do not seem to affect the (0001) pole figures. (0001) pole diagrams of the matrix and the porphyroblast are shown in Figs. 1 and 2, respectively. The (0001) pole figure of the porphyroblast is roughly characterized by the point maxima. The maximum of the concentration attains 8 percent and the poles concentrate in a small circle area with the angular radius of 20°. The (0001) pole figure of the porphyroblast differs from that of the matrix in the degree of concentration as well as in its pattern.

Specimen 2 is a green schist, consisting of calcite porphyroblasts and the matrix of epidote-chlorite-albite-calcite. The grain size of calcite porphyroblasts is 0.8 to 1 mm. Fig. 3 shows the (0001) pole diagram of the calcite porphyroblasts. The diagram is characterized by random orientation.

Specimen 3 is a calcite-quartz layer in a spotted green schist consisting of calcite porphyroblasts and the matrix of fine grains of quartz and calcite. In this specimen, calcite occurs in two types; namely, matrix and porphyroblast. Mechanical twins in the calcite porphyroblast are markedly developed, while that of the matrix is not so marked. The grain size of calcite porphyroblast is 0.8 to 1 mm. Fig. 4 shows the (0001) pole figure of calcite porphyroblasts. The diagram shows weak concentration

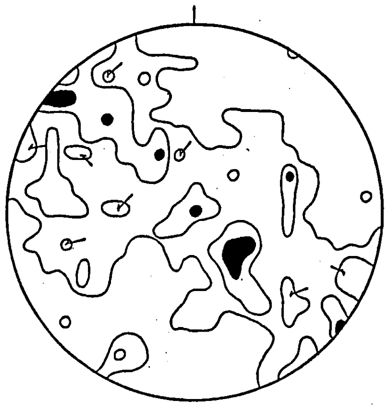

FIG. 1. (0001) pole diagram of matrix calcite in the specimen 1. contours: 4-2-1%

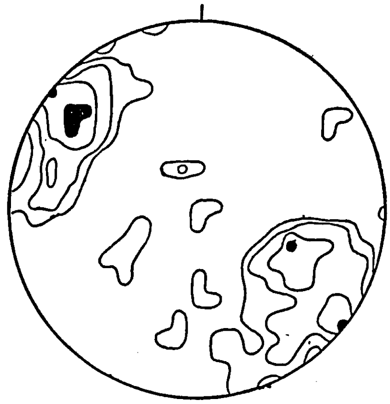

FIG. 2. (0001) pole diagram of calcite porphyroblast in the specimen 1. contours: 8-4-2-1%

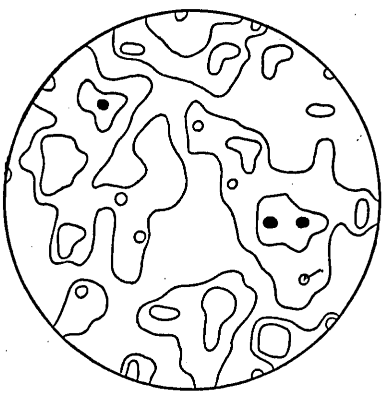

FIG. 3. (0001) pole diagram of calcite porphyroblast in the specimen 2. contours: 4-2-1%

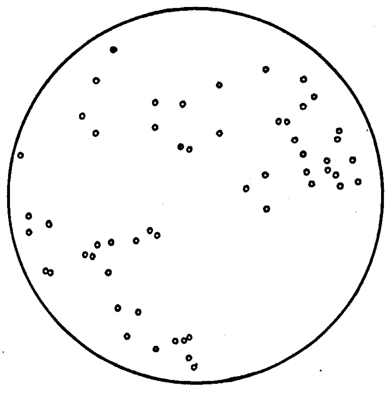

FIG. 4. (0001) pole diagram of calcite porphyroblast in the specimen 3.

of c-axis.

Specimen 4 is a calcareous gneiss which occurs in the Kôsadake district. This specimen shows porphyroblastic texture and consists of calcite porphyroblasts and calcite matrix. The grain size of calcite porphyroblast is 0.8 to 1 mm and that of the calcite matrix is 0.1 to 0.2 mm. The c-axis diagram of them are shown in Figs. 5 and 6. As shown in the diagrams, the c-axis of the calcite porphyroblasts concentrates more than that of the calcite matrix; the maximum concentration of the calcite porphyroblast being 8 percent and that of the calcite matrix being 4 percent.

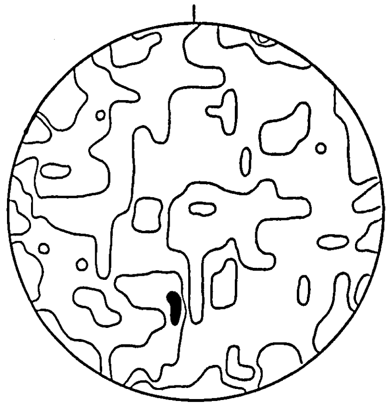

FIG. 5. c-axis of matrix calcite in the specimen 4. contours: 2/3-2-4%

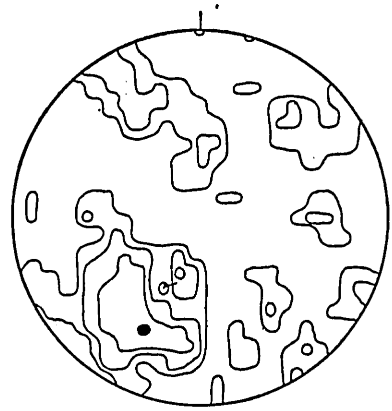

FIG. 6. c-axis diagram of calcite porphyroblast in the specimen 4. contours: 1-2-4-8%

III. DISCUSSION

M.L. KRONBERG and F.H. WILSON (1949) defined the 'secondary recrystallization' as follows: 'The low temperature recrystallization of very heavily rolled copper produces a fine grained structure with a high degree of preferred orientation. Additional heating to within a few hundred degrees of the melting point may induce an abrupt and pronounced increase in the grain size, with the resulting crystals having new orientation. This behavior at high temperature is commonly termed 'secondary recrystallization''. J.E. MAY and D. TURNBULL (1957) studied the secondary recrystallization in Si–Fe. They have shown that recrystallization in high purity Si–Fe (fine grains) shows weaker (110) (001) texture than that in Si–Fe with Mn–S (large grains).

In the calcareous gneisses of specimens 1 and 4 coexist fine (0.1–0.2 mm) and large grains (0.8–1 mm) of calcite. Based upon the change of fabric along with the grain growth of these calcareous gneisses, as described above, this texture may not necessarily be interpreted as formed by two separate phases of recrystallization (K. HASHIKAWA, 1969), but it would suggest the discontinuous grain growth during a single phase of progressive metamorphism. The grain growth which shows the discontinuity as these, is metallographically expressed as the secondary recrystallization. In the same way, feature of these calcareous gneisses as above point out can be interpreted to be resulted from the secondary recrystallization.

The change of fabric, observed on the specimens 1 and 2, suggests that the c-axis of calcite tend to concentrate toward the pole of the layering with the progress of grain growth. The mechanism of this process must be studied in future.

In the specimens 2 and 3, which consists of several mineral species with calcite porphyroblast, preferred orientation of the porphyroblast is either indistinct or lacking. In these cases, the mechanism of grain growth of calcite may be affected by some other factors as compared with the monomineralic assemblage.

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