SPHALERITE-DOLOMITE ORIENTATION RELATIONS AT THE RENFREW ZINC PROSPECT, ONTARIO

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ABSTRACT

The orientation of dolomite and metasomatic sphalerite in slightly foliated, coarsely crystalline dolomite from the Renfrew Zinc Prospect, Ontario, shows the following features: The crystallographic axes C_v of dolomite are normal to the foliation. There is a remarkable development of $(02\bar{2}1)$ twin doublets which, with the crystal axis orientation, fixes the position of the grains. The orientation pattern supports Fairbairn's assumption of a direction-sense of twinning in dolomite which is the reverse of that known for calcite, and also the hypothesis that the chief stress acted approximately normal to the foliation. Measurement of the dodecahedral cleavage planes of scattered sphalerite grains reveals a high degree of orientation of their isometric axes, one being parallel to the S-surface, the other two inclined at 45 degrees on either side of the S-surface. The sphalerite is, in part, elongated parallel to the foliation as a result of movement along cleavage planes. The marked symmetrical relations between the dolomite and later sphalerite suggests an inherited orientation modified by deformation.

INTRODUCTION

Dark brown sphalerite grains are disseminated throughout coarsely crystalline dolomite at the Renfrew Zinc Prospect in Ontario. The dolomite shows inconspicuous S-surfaces in which the dark sphalerite plays a conspicuous role in emphasizing this megascopic structural feature.

By the use of especially thin rock slices and intense illumination, it was possible to transmit light through the sphalerite grains, and measure the cleavage planes by routine petrofabric methods. The dolomite exhibited twinning, the orientation of which served to fix the position of the dolomite crystals in space.

By correlating the petrofabric data of the sphalerite, which showed a high degree of orientation, with the dolomite, a new field of ore mineral—country rock fabric relations has been initiated (1). This study represents statistical data on these relations, only. That there is a definite mutual orientation relation is established.

DESCRIPTION OF SPECIMENS

The sphalerite at the Renfrew Zinc Prospect occurs in small, dark brown, sub-metallic, slightly elongated, disseminated grains from 0.5 to 2 mm. in diameter in a massive, coarsely crystalline, slightly foliated dolomite. The dolomite grains range from two to five mm. The hand specimens show a fairly distinct banding due to the concentration of small deformed sphalerite grains in planes which were tentatively designated *S*-surfaces. Evidence of foliation due to dimensional relations of the dolomite grains themselves is very inconspicuous. What evidence there is, plus the indication that the sphalerite was formed by replacement of the dolomite, suggest that the *S*-surface is actually in the position designated. In some specimens, there was not sufficient evidence to determine the *S*-plane megascopically.

Due to the large size of the dolomite grains, it was not possible to get the orientation relations on as large a number of individual grains as is usually thought necessary. On the other hand, the orientation proved to be so marked that a relatively small number of grains clearly indicate the relations. Determination of the position of low angle cleavage or twin planes is relatively more difficult the flatter the cleavage. Measurements from 90 to 30 degrees are possible, but below that point these are not obtainable on the universal stage. Sections cut at right angles to the *S*-surface were employed in one instance to furnish the desired data on the low angle cleavage planes in sphalerite.

Petrofabric Analysis

Standard universal stage techniques were employed to measure the crystal axes and deformation twins in the dolomite and the cleavage planes in the sphalerite. These data were plotted on an equal area net using the lower hemisphere projection (2).

The dolomite hand specimen *R* 13—2 in which the sphalerite orientation appeared most noticeably, was given the greatest amount of attention. Figure 1 represents the orientation of the crystallographic *c* axes for the grains which have twin doublets. The axes are essentially normal to the foliation. Figure 2 shows the position of the $(02\bar{2}1)$ twin poles for the same dolomite grains. The distribution of the maxima does not fix the position of the dolomite grains in space as well as might have been expected. The theoretical positions which were substantiated by the work of Fairbairn and Hawkes (3) are shown in Fig. 3 at the *T* positions. These positions were much more nearly reproduced in Fig. 9 which represents an additional diagram of dolomite from the same locality. Figure 4 is constructed from the data in Figs. 1 and 2, and shows the orientation of the assumed glide line for the formation of the dolomite twins. The ideal position of these glide lines is shown in Fig. 3 by the dashed line and the *G* points. The maxima in Fig. 4 do not correspond too closely to the theoretical positions, but indicate a definite tendency to lie on the small circle indicated. The erratic orientation of the twin poles is probably responsible for the erratic results.

The sphalerite orientation is indicated in Fig. 5, which is a composite diagram derived from two thin sections cut at right angles to each other

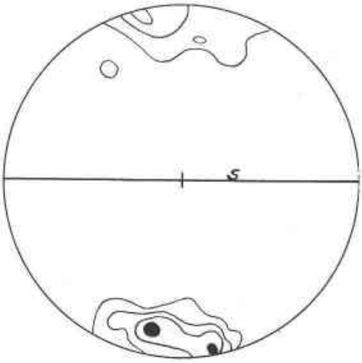

Fig. 1

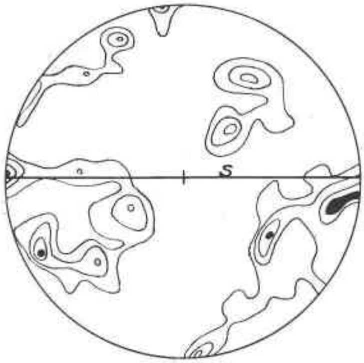

Fig. 2

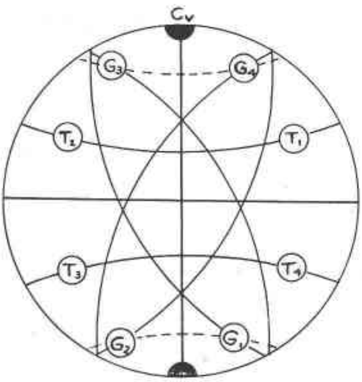

Fig. 3

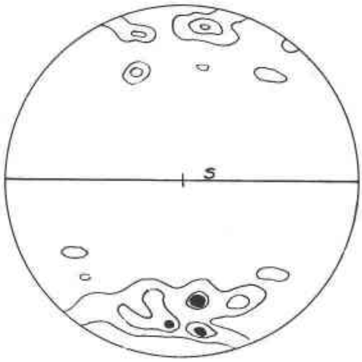

Fig. 4

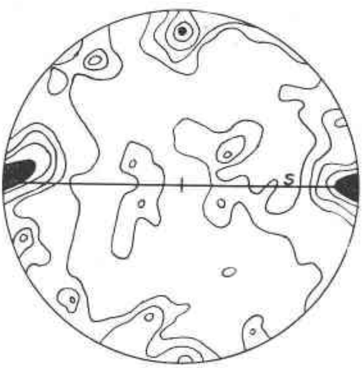

Fig. 5

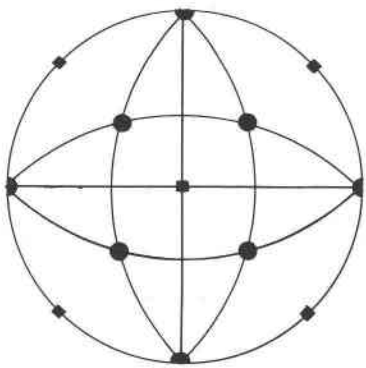

Fig. 6

Plate I

so that the concentrations in the center of the diagram could be indicated. The orientation of the sphalerite with respect to the rock fabric is indicated in Fig. 6. The squares are the crystallographic axes, whereas the dodecahedral cleavage poles are indicated by circles. The strongest maxima are on the periphery of the diagram and removed from each other by 90 degrees. They show a remarkable degree of orientation, especially when it is considered that there are six possible positions for each grain. The lineation of the sphalerite grains is due to elongation in the *b* direction by fracture along the cleavage planes on the circumference of the diagram. No account was taken of the relative development of a given set of cleavage planes in the individual grains, but it is clear, from a purely statistical analysis, that the maximum deformation took place along these best developed planes.

In specimen *R* 15-4, there were very few sphalerite grains, but the *S*-surface in the dolomite was fairly well indicated. Fig. 7 shows the vertical crystallographic axes of the dolomite grains showing twin doublets. The maxima are slightly inclined to the *S*-surface, presumably more so than could be accounted for in cutting the section. (See also Fig. 10.) Figure 8 shows the position of the poles of the twin planes. These maxima agree rather closely with the *T* positions in Fig. 3. Figure 9 was compiled from Figs. 7 and 8 to show the position of the assumed "glide" line of the dolomite deformation twins. These data correspond rather closely to the *G* positions in Fig. 3.

Specimen *R* 15-5 contained an appreciable amount of sphalerite, but the *S*-surface was not readily distinguishable. The vertical axes are shown in Fig. 10 and the twin plane poles are shown in Fig. 12. Figure 11 shows the orientation of the sphalerite cleavage poles. The cleavage poles of the sphalerite indicate a marked girdle around the periphery of the diagram, the whole tilted with respect to the horizontal plane of the lower hemisphere by about 10 degrees. The relations of the fixed positions of dolomite

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FIG. 1. Dolomite from Renfrew Zinc Prospect, Ontario. *R* 13—2. 75 crystallographic axes of dolomite having twin doublets. *S*=foliation. 8, 6, 4, 2, 0%.

FIG. 2. The same. 125 Dolomite twin doublet poles. 4, 3, 2, 1, 0%.

FIG. 3. Schematic diagram to illustrate dolomite orientations. C_v=vertical crystallographic axis. T_1, T_2, T_3, T_4 are the twin pole positions. G_1, G_2, G_3, G_4 are the corresponding dolomite "glide" lines of the Figure after Fairbairn and Hawkes Plate I, Fig. 6. (2).

FIG. 4. The same. Dolomite "glide" lines of the doublet twins. Constructed from Fig. 2. 4, 3, 2, 0%.

FIG. 5. The same. 194 sphalerite dodecahedral cleavage poles. Composite diagram from two thin sections cut at right angles to each other.

FIG. 6. Schematic diagram to illustrate sphalerite orientation. Squares=crystallographic axes, circles=dodecahedral cleavage poles.

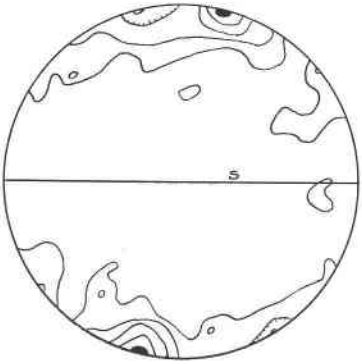

FIG. 7

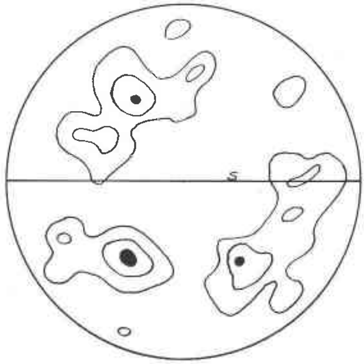

FIG. 8

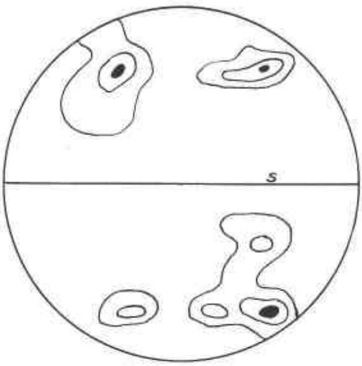

FIG. 9

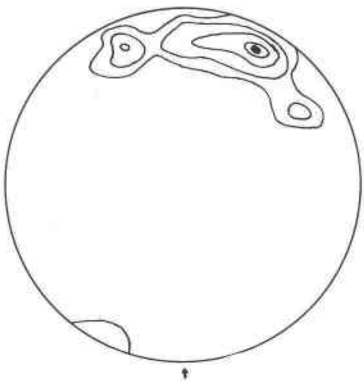

FIG. 10

FIG. 11

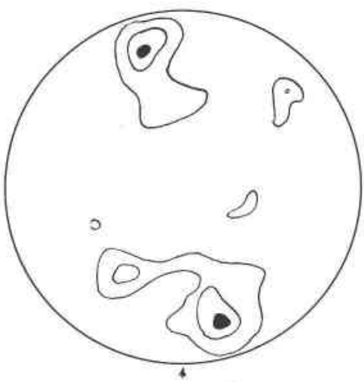

FIG. 12

PLATE II

and sphalerite are not so clear in these off-centered diagrams (which could not be positively related to an *S*-surface); however, the geometry is very nearly the same. Significantly, the sphalerite is well oriented. The true *S*-surface is not delimited by the planar arrangement of sphalerite grains, but at about 45 degrees from the horizon of the diagram.

Discussion

These data indicate distinct preferred arrangement in space for the dolomite and the sphalerite grains. The hand specimens were not oriented in the field so that no correlation with field relations can be attempted. The emphasis is placed on the fact that mutual orientation relations exist, a conclusion heretofore not demonstrated for these two minerals. It appears clear that the sphalerite was introduced into the dolomite as a hypogene mineral by metasomatic replacement of the dolomite. The replacement was controlled, to a large degree, by the pre-existing fabric of the dolomite country rock. The "ore" has been subsequently deformed to a slight extent. In the deformation, the dolomite twins and the elongation of the sphalerite grains occurred, both phenomena serving to fix the spacial relations of the two minerals.

These data on dolomite deformation, and the assumed "glide" lines, serve to further substantiate the work of Fairbairn and Hawkes (2) in establishing that the direction-sense of the "glide" lines, which produce the dolomite twin, is fundamentally different from the direction-sense for the formation of similar twins in calcite.

Conclusions

1. The orientation pattern of the deformation twin doublets of dolomite adds further evidence in support of Fairbairn and Hawkes' assumption that the direction-sense for producing the twins is the reverse of the direction-sense for calcite. In other words, the chief stress acted approximately normal to the foliation.

2. The sphalerite grains in the dolomite are well oriented, based on the measurement of the dodecahedral cleavage planes. The axes are thought to be oriented; one parallel to the *S*-surface and the other two inclined at 45 degrees on either side of the *S*-surface.

Fig. 7. Dolomite, Renfrew Zinc Prospect, Ontario. *R* 15-4. 75 crystallographic axes having twin doublets. *S*=foliation. 10, 8, 6, 4, 2, 0%.

Fig. 8. The same. 72 dolomite twin doublet poles. 4.5, 3, 1.5, 0%.

Fig. 9. The same. Dolomite "glide" lines constructed from Fig. 8.

Fig. 10. The same. *R* 15-5. 85 crystallographic axes having twin doublets. 7, 5, 3, 1, 0%.

Fig. 11. The same. 67 sphalerite dodecahedral cleavage poles. 13, 10, 7, 4, 0%.

Fig. 12. The same. 100 dolomite twin doublet poles. 5, 3, 1, 0%.

3. The sphalerite is, in part, elongated parallel to the foliation as a result of movement along cleavage planes.

4. The marked symmetrical relations between the dolomite and sphalerite suggest that the sphalerite was introduced after the dolomite had formed (probably by metasomatic replacement of the dolomite) and inherited its orientation from the dolomite country rock. The rock was subsequently subjected to minor deformations at which time the dolomite twins were formed and the elongation of the sphalerite grains took place.

Acknowledgments

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