NOTES AND NEWS

REPLACEMENT IN FILLED FISSURE VEINS

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Metasomatic processes have been described at length in numerous papers[1] on the subject, but these deal with the replacement processes in practically solid rock, or along shear planes.

When fractures or other cavities containing mineral matter showing a crustified structure are referred to or described, it is usually either intimated or stated that the several crusts or bands have been deposited one on the other, no suggestion being made that the minerals of a later crust may to any extent replace those of an earlier one.

If a fracture after being filled with vein matter has been reopened the material deposited later is likewise commonly spoken of as *filling* the fracture.

In either case there seems no valid reason why some of the minerals of one crust should not in part replace those of an earlier crust since in many cases metasomatic relationships are found to exist between similar minerals under other conditions.

It is possible that the idea of replacement under the conditions mentioned does not suggest itself because the contact between adjoining bands often appears quite sharp when examined megascopically.

The writer has had occasion to examine a number of banded, brecciated and massive vein specimens from America and foreign localities, all of them being in the Cornell University collection. In the study of thin and polished sections it was interesting to find in how many cases there was undoubted evidence of replacement along the boundary line between two bands or between minerals succeeding each other in time of crystallization.

Fig. 1 represents a vein in the black dolomitic limestone from Austinville, Va. Megascopically the walls of the fracture appear quite sharp. Next to the walls there are white bands of dolomite,

[1] Lindgren, Waldemar, Metasomatic Processes in Fissure-veins: *A.I.M.E., Trans.*, vol. **30**, pp. 578–692, 1900.

Irving, J. D., Replacement Ore-bodies and the Criteria for their Recognition: *Econ. Geol.*, vol. **6**, pp. 527–561, 1911.

Lindgren, Waldemar, Mineral Deposits, 3rd Edition, p. 196, **1928**, McGraw-Hill Book Co., New York.

these are followed by darker irregular bands of sphalerite and pyrite deposited in the order named, while in the center there is sometimes

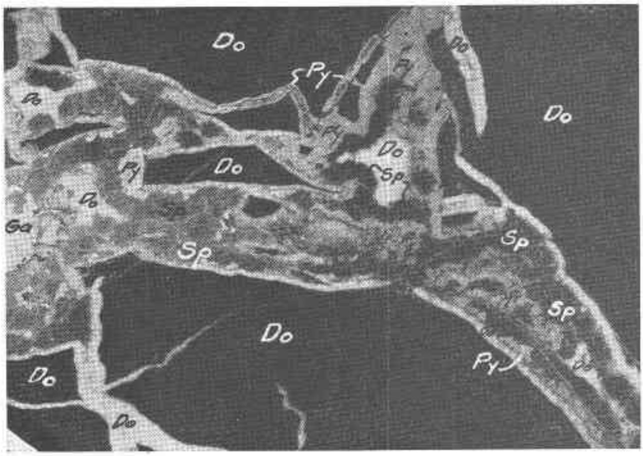
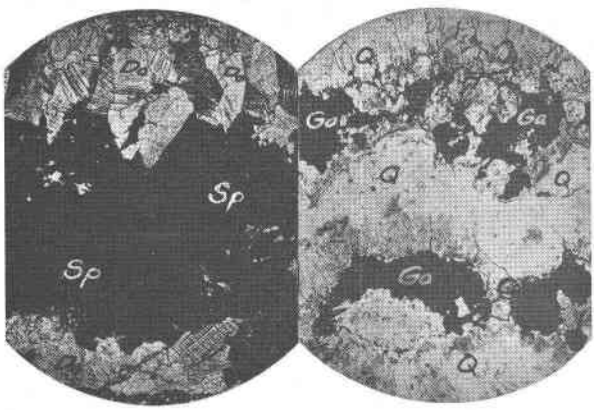


FIG. 1. Black dolomitic limestone (Do) from Austinville, Va., showing irregular banded veins of dolomite (Do), sphalerite (Sp), pyrite (Py) and galena (Ga). $X=0.8$

another band of dolomite. A thin section of one of these veins (Fig. 2A) shows the dolomite on the borders with the sphalerite



2A 2B

FIG. 2A. Photomicrograph across a vein of Fig. 1 showing metasomatic relation between the dolomite (Do) and sphalerite (Sp). $X=12$.

FIG. 2B. Photmicrograph showing some quartz (Q) and galena (Ga) bands of Fig. 3. in which the galena has replaced some of the quartz. $X=12$.

and pyrite in the center. It is not only clear that the dolomite has been replaced by the sulphides, but the residual areas of the carbonate shown within the sulphides indicate that the replacement has been more extensive than a megascopic examination indicates.

The beautifully banded ores from Clausthal, Germany, are quite well known and a specimen of one of these is shown in Fig. 3. This consists of bands of quartz, sphalerite and galena. The width and distinctiveness of the bands decrease toward the center of the vein.

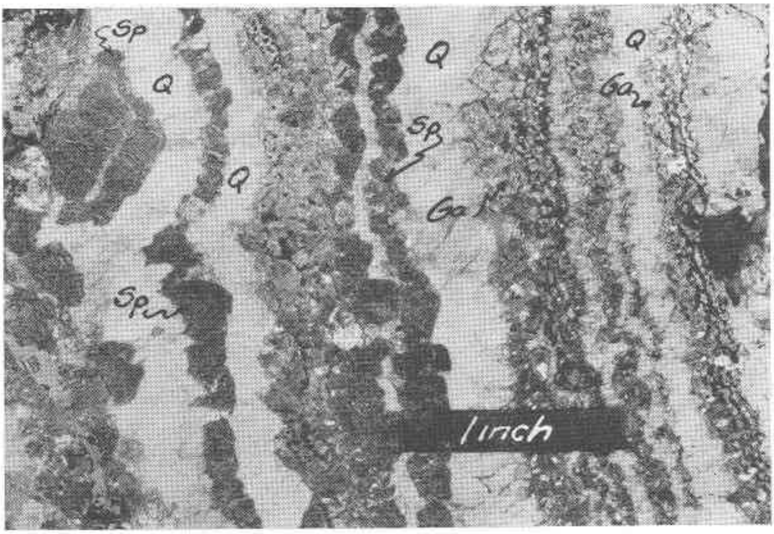


FIG. 3. Banded specimen of quartz (Q), sphalerite (Sp) and galena (Ga) from Clausthal, Germany.

Fig. 2B shows a photomicrograph of two bands of galena and parts of three bands of quartz and it seems evident from these that the galena has in part replaced the quartz.

It appears to the writer that the relationship between the bands of this specimen may be explained on the basis that the banding is the result of rhythmic fractional crystallization[2] and the accompanying physico-chemical changes. In the phase where the process changes from the crystallization of one band to the deposition of another, the supersaturation of the mineral of the first band has

[2] Shaub, B. M., The Cause of Banding in Fissure Veins: *Am. Mineral.*, vol. **19**, pp. 398–399, 1934.

been reduced close to the saturation point where the solid phase of the mineral and the solution are close to a state of equilibrium.

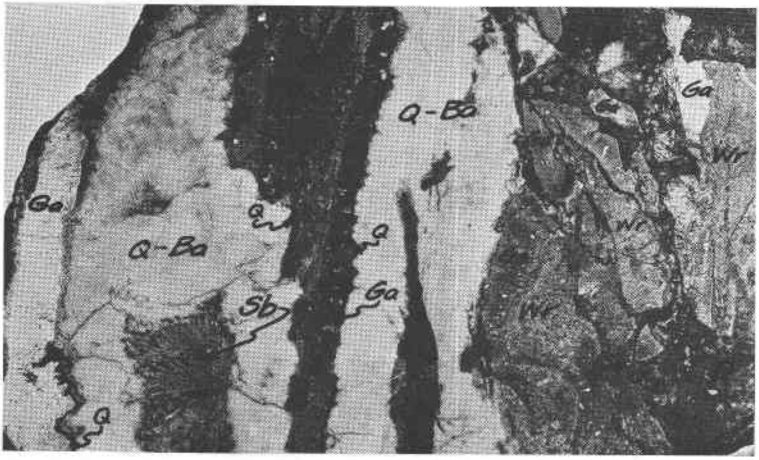
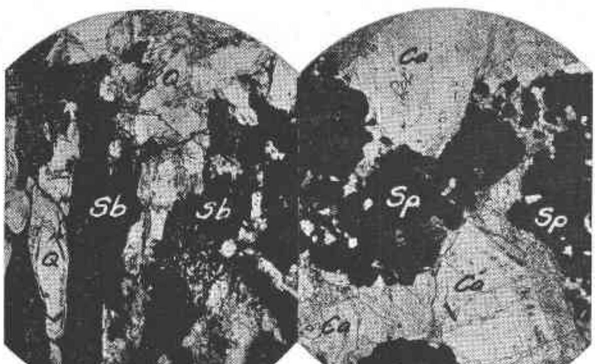


FIG. 4. Brecciated vein specimen from Przibram, Czechoslovakia, showing fragments of galena (Ga) and wallrock (Wr) cemented by quartz (Q) and a slush-like intergrowth of quartz and barite (Q-Ba). Stibnite (Sb). $X=0.35$.



5A 5B

FIG. 5A. Photomicrograph from specimen of Fig. 4. showing metasomatic relation between stibnite (Sb) and quartz (Q). $X=12$.

FIG. 5B. Photomicrograph from specimen of Fig. 6 showing metasomatic relation between sphalerite (Sp) band and carbonate (Ca).

When the solute which crystallizes to form the succeeding band becomes sufficiently supersaturated to cause it to crystallize, its deposition follows rapidly causing a liberation of heat and changes in the composition of the solution. These together with other physico-chemical changes occurring at or near the contact of the crusts introduces a metastable condition conducive to replacement at the junction of the bands.

An interesting specimen from Przibram, Czechoslovakia (Fig. 4), is a brecciated vein consisting chiefly of galena, quartz, barite and stibnite. Among the last minerals to crystallize were quartz and stibnite near the center of the irregular bands of quartz and barite which have a slush-like textured intergrowth. The radial stibnite clearly replaces some of the quartz as is shown in Fig. 5A where it can be seen that the zoned crystals of quartz have been dissolved to unequal depths.

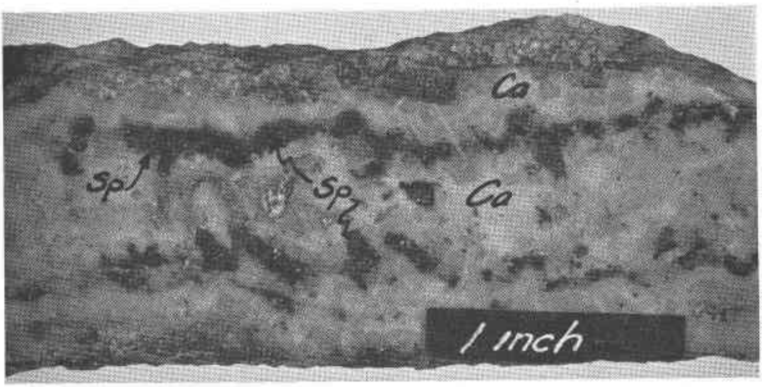


FIG. 6. Small carbonate (Ca) vein from Brad, Transylvania showing, two irregular although symmetrical bands of sulphides, chiefly sphalerite (Sp).

A specimen from Brad, Transylvania (Fig. 6), shows irregular bands of sulphides symmetrically arranged in a carbonate gangue. The first carbonate to crystallize shows fine bands of white colloid-like inclusions immediately preceding the sulphides which have replaced the carbonates along both contacts leaving many residua of replacement in the sulphide areas (Fig. 5B) which do not appear to follow shear zones.

The cause of the metasomatic relationships of the minerals in the specimens from Austinville, Przibram and Brad is believed to be more or less analogous to that described above for the Clausthal specimen with the exception that in the latter the physico-chemical conditions were favorable for rhythmic banding.

Additional examples with their variations might be quoted, but it would seem that the foregoing are sufficient to bring out the point mentioned in the beginning of this paper.

While the process described was noticed chiefly in specimens from mesothermal deposits, it was also observed, but to a far lesser extent and degree, in deposits formed in shallower zones where the solutions are less concentrated.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to professor Heinrich Ries for many valuable suggestions and criticisms.

CRYSTAL CAVITIES IN LAVAS FROM THE HAWAIIAN ISLANDS

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In the *American Mineralogist*, volume **18**, 1933, pages 369–385, there appeared an article by the writer, bearing the above title, and setting forth the results of a mineralogical and paragenetic study of material collected by the late Professor A. S. Eakle. During 1934 this article was the subject of some correspondence from Dr. H. T. Stearns of the United States Geological Survey, who is stationed on Maui, in the Hawaiian Islands. Dr. Stearns has been able to supply valuable information bearing on the field relations of the lavas in which the cavities occur. With his permission, extracts from his letters are quoted below.

Material from three principal localities was studied: Moiliili Quarry, Honolulu, Oahu; Alexander Dam, Kauai; and the Lanikai Hills, whose locality should have been stated as Oahu and not Hawaii. Some of the Lanikai material was erroneously labeled as "near railroad station"; this should have been "near radio station."

Dr. Stearns agrees with the writer's conclusion that the minerals at the first of these localities originated from the nepheline-melilite basalt flow in which they are found, and writes as follows: "The Moiliili Quarry is in the terminal margin of the Sugar Loaf lava flow, probably the youngest on Oahu. This lava was erupted after the dissection of the Koolau dome, and at the quarry rests on emerged reef limestone. The basal water table lies most of the time just below the basalt, which is about 50 feet thick at this point, but in wet weather the water table rises into the lower part of the