NOTE ON SLIPPING-PLANES AND LAMELLAR TWINNING IN GALENA.

BY WHITMAN CROSS.

The common mineral galena is distinguished for its softness, brittleness and perfect cleavage. It cannot be fractured without the development of the cubical cleavage, for any apparently transverse fracture plane will be found on examination to be rough through elevations and depressions bounded by brilliant cleavage faces. Yet this most brittle and perfectly cleavable mineral is capable of fractureless changes of form and of molecular constitution of the most pronounced kind, when the conditions are favorable. Specimens which I have recently received from the "Minnie Moore" mine, Bellevue, Idaho, exhibit the phenomena referred to in a perfection and variety probably far beyond any previously described occurrence,* and I will attempt to describe some features of this material though I cannot do full justice to it.

According to Sadebeck the first description of a striation on the cubical faces of galena was given by Count Bournon in 1813. In 1874 Frenzel described galena from several mines near Freiberg, in Saxony, on which a striation was developed caused by laminæ inserted parallel to a face of a triakisoctahedron. Sadebeck issued a monograph on the crystallography of galena in 1874, determining the law of twinning according to which the laminæ were intergrown in certain galenas studied by him. According to him the composition face is 4O, the axis the normal thereto. A further instance of twin laminæ has been mentioned by von Zepharovich, the icositetrahedron 3O3 being in this case the twinning plane.

* For assistance in securing this material I am indebted to Mr. J. B. Farish, Dr. J. P. Welch, and, especially, to Mr. John M. Kinnear, Supt. of the "Minnie Moore" mine.

As to the slipping planes of galena but little is known. In 1882 Bauer produced fracture-figures on galena, which were formed by a slipping parallel to the rhombic dodecahedron plane and he also alludes to the twinning described by Sadebeck, = 4O, as probably produced by pressure. All efforts to produce these twin laminæ by artificial means, as in calcite, proved futile. An attempt by Mügge was likewise unsuccessful.

The galena from the Minnie Moore mine occurs in considerable masses of very coarse granular texture. Some of the individuals are two or three inches in diameter. Mixed with the galena in the specimens I have seen are occasional particles and small masses of chalcopyrite, and a mineral I suppose to be tetrahedrite. All specimens of this galena that have been examined show a more or less distinct lamellar structure, or a striation on certain cubical cleavage planes, which is found to be identical in character with the lamination. The regularity of this structure is not evident on many pieces, but appears very distinctly on others, and by means of numerous transition stages all forms of banding are seen to be developed according to determinable laws, and to represent one of the two phenomena to be described.

The first form of structure to which I wish to call attention is where a banding appears on a cleavage face, which is seen to result from a series of undulations parallel to one diagonal of the cube. The reflection is seen to be simultaneous in alternate bands and to be continuous from one position to the other, for the surface is simply folded. Tracing the bands over to other faces of the cleavage cube they are seen to run *parallel* to the cleavage lines, not diagonal. They are thus seen to be parallel to ∞O. Bauer found in his experiment that a motion or slipping was produced parallel to ∞O, and this is clearly an instance of the same movement.

Another structure, more sharply defined than the last, is caused by an alternation of laminæ with definite formal relations to each other. These are sometimes thin, appearing as mere striations, but may have a thickness of ¼ inch or more. These laminæ do not always occupy the same position and are inserted parallel to several different crystal planes, but all conform in general to the law I have fully determined. The law of twinning represented by many of these laminæ is: Twinning plane 3O; axis the normal to the twinning plane.

The multiplicity of changes produced in this galena is so great that much more study is necessary to reach a knowledge of the entire subject. I am sure that several planes of twinning are present and that they all lie in the zone ∞O∞—∞O and probably several planes of *m*O serve as twinning planes. 4O was mentioned as twinning plane by Sadebeck, and 3O3 by von Zepharovich.

Another twinning which I have seen on some small fragments is where the laminæ are inserted parallel to the octahedron face O.

By careful examination of many of these specimens striations are seen running at regular angles with the lines of cubical cleavage. By measuring these inclinations under the microscope the faces according to which the laminæ causing the striations are inserted may be determined.

This structure which I have described is certainly secondary, and from what we now know of similar phenomena in other minerals it is very natural to suppose the cause of it all to be *pressure*, the pressure which has caused our mountains to rise, and which still exists in many places to-day. Mr. Kinnear, the Superintendent of the mine, wrote me that he believed the structure to result from pressure, and among the specimens exhibited is one which certainly demonstrates the former existence of pressure in this mass of galena.

To anyone who can examine these specimens the evidences of pressure are very plain. The distorted forms of the masses which are included by cleavage planes are sometimes very striking. These should be cubes but are in fact rhombs or bodies with unsymmetrical shape. Faces which are not regularly disturbed by the slipping = ∞O are often curved and show indistinct development of one or the other of the twinning forms. It seems that the pressure manifested itself in accordance with the position in which a given individual lay with regard to the pressure. Sometimes the force could be all applied to the production of one form of twinning; sometimes it was resolved into several elements of pressures, each availing itself of the plane of weakness most suitable for its manifestation, and hence we see the different twinnings and slipping all developed in one piece. In many places, probably in the greater part of the mass of ore, the galena has been simply crushed, as seen in the specimen with the slickenside surface. Again a very thin or fine lamination has been produced with much fracturing combined so that the law of the structure is obscured.

This note is intended merely as a preliminary one. I hope to present a complete paper on the subject at some future time.

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