REMARKS ON "TWINNING OF CRYOLITE" BY DOROTHY WRINCH

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Abstract

By selecting a sub-multiple cell, rather than a multiple cell, of the cryolite lattice to define the twin lattice, Dr. Wrinch succeeds in giving the twin lattice a physical significance. The generalization of the validity of this observation will require numerous additional examples.

In the preceding paper Dr. Wrinch establishes relationships between the twinning of cryolite and the crystal structure of this mineral. It is her implied hope that she will be able to predict some structural features of a crystal from its observed twin laws, by relating pseudo-symmetry to twinning and twinning to structure.

She starts with a lattice based on morphological elements—axial ratios and angle β. The pseudo-symmetry of this lattice leads her to choose a "companion cell," which is identical in shape with the "double cell" used by J.D.H.D. The two cells under consideration differ only by a scale factor: the edges of the "companion cell" are equal to A/2, B/2, C/2; those of the "double cell" being A, B, C. Since it is the pseudo-symmetry—not the size—of the "companion cell" that is used to predict the twin laws. Dr. Wrinch's predictions are identical with those of J.D.H.D. No less, no more.

The transformation "Náray-Szabó to Wrinch" is $\frac{1}{2}\frac{\bar{1}}{2}0/\frac{1}{2}\frac{1}{2}0/00\frac{1}{2}$. It amounts to centering the C-face of the cryolite cell and halving its c-axis. This is precisely the transformation which G. Friedel (1905), on the strength of the Law of Bravais, applied to the Krenner elements to find the lattice of cryolite. He states that the lattice thus obtained may be not the true crystal lattice but rather the "material lattice" (*réseau matériel*), meaning thereby that its nodes are occupied by atoms.

As to the relations of twinning to structure, Dr. Wrinch looks for a physical interpretation of the "companion cell" in the known crystal structure of the mineral. She finds that Na^{+} and Al^{+++} ions play pseudo-equivalent roles at the nodes of the pseudo-cubic twin lattice, which—quite unexpectedly—turns out to be body-centered. Will atoms that are restored by twinning, in all cases, have to occupy nodes of the twin lattice, as they do in cryolite? The answer to this question should be sought in the remark that a twin operation, according to definition, is essentially a point-group operation, so that no operation involving a translation can be a twin operation. Returning to cryolite, it is hard to see how one would have gone about making predictions, had the crystal structure been unknown.

The term "twin lattice" is here used to designate the lattice which pervades the whole twinned edifice and governs the repetition of part of the crystal structure. Its cell is defined by the vectors $\boldsymbol{A}$, $\boldsymbol{B}$, $\boldsymbol{C}$, in the first paper; it is defined by $\boldsymbol{A}/2$, $\boldsymbol{B}/2$, $\boldsymbol{C}/2$, in the second paper. In the case of Dr. Wrinch's treatment, the twin lattice acquires a physical meaning: it is the pseudo-cubic body-centered lattice, the nodes of which are occupied by Na^+ and Al^{+++} ions. It is remarkable that these should be the small ions. One could have expected the large ions instead, since it is the packing of large ions that usually controls the crystal structure.

There is no reason for the privileged position given by Dr. Wrinch to the "cubicity" of the crystal. In fact the twin lattice based on her submultiple cell need not be pseudo-cubic at all. Any twin lattice resulting from the pseudo-perpendicularity of a net and a row will do just as well for the purpose. Many crystalline species are known in which twins are controlled by a cell that approximates a rectangular parallelepiped.

In summary, the outstanding point of interest in Dr. Wrinch's paper is the physical meaning given the twin lattice. Whereas the twin lattice used to be considered as a multiple lattice of the crystal lattice, Dr. Wrinch now makes the crystal lattice a multiple of the twin lattice. Part of the atoms of the motif can then be repeated by the twin lattice. Is this remarkable discovery limited to a few isolated cases, or does it have general validity? Since it is not accompanied by any theoretical explanation, it will have to be established by numerous examples before it can be accepted as a law of observation.

Manuscript received Sept. 24, 1951