SOME RESULTS

OF THE

CRYSTALLOGRAPHIC STUDY OF DANBURITE.

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[Communicated by the President.]

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EVERY student of crystals is aware how frequently they fall short of the ideal perfection which theory ascribes to them. With regard to the development of the simple forms, the irregularities are most prominent on the crystals which are subject to certain laws of symmetry. In consequence of the differences of size presented on the same crystal by planes belonging to the same form, the most manifold distortions ensue, resulting at one time in the imitation of forms of a lower degree of symmetry, at another in the complete absence of symmetry. Moreover, as long as the faces constituting the distorted form remain the same, *i.e.* as long as the cause of the distortion is without influence on the development of the combination, so long will the angles of inclination of the circumscribing elements of the individual remain the same, and thus the degree of symmetry can be determined by measurement of the crystal notwithstanding the distortion. This is generally the case, and is characterised as the constancy of the angles of inclination. Exceptions to this law will be alluded to further on.

The physical state of the faces themselves may cause great difficulty in the exact determination of the angles of inclination, for the faces are rarely plane and smooth, being as a rule either curved, or plane but dull, or finally, even when good reflectors, are reticulated or broken up into a number of distinct fields. Unorganised bodies naturally bounded by curved faces can scarcely lay claim to the designation of crystals, but are rather, at most, to be characterised as crystalline individuals, when endowed with a definite homogeneous internal structure. On crystals with plane but dull faces, one may conceive that the outermost molecules of the planes which constitute the boundary surface are homogeneously distributed, though they are not present in sufficient number to correspond with the internal network. Finally, when the faces of a crystal are smooth and bright, but appear broken up into several fields, the following cases may be distinguished :—either the molecules in the different fields are differently arranged towards one another—a point which a simple optical examination will decide—and the crystal is then only apparently homogeneous, but is in reality a group built up of subordinate individuals in almost parallel position, or in twinned juxtaposition, a case that occurs more frequently in mimetic crystals. Or, again, it is found that all the fields can be referred as bounding elements to one and the same crystallographic individual.

It appears to be an essential character of crystals that they are bounded by a limited number of faces which are parallel to internal molecular planes, more particularly to such planes as may be said to possess the greatest molecular density; the occurrence, therefore, of faces with highly complex indices strikes the observer as being abnormal, and the question arises whether such faces are subject to the same laws, and are as characteristic of the substance on which they occur, as the simple typical faces which they replace.

Whilst engaged upon the crystallographic investigation of the mineral danburite, recently found at Mount Scopi, in Switzerland, the author was in a position to study such elementary planes very completely, and with some unexpected results, which have been given in detail in a paper published elsewhere.*

Among the faces with complex indices, in addition to those which appear as occasional and local developments, and which, as a rule, belong to that class of secondary planes known as "vicinal" planes, others were observed which are characterised by the peculiarity that they almost coincide with the simple typical faces in conjunction with which they are found; so much so, that the inclination frequently amounts to only a few minutes of arc. These faces have a real and probably a genetic relationship to the principal faces.

At present it is desired to draw attention to two of the most marked characteristics of these planes, for which the designation of "transitional faces" has been proposed.

That these planes are genuine, although they often almost defy detection and observation, is proved by the fact that they in the great majority of cases lie in zones well defined by typical planes, and that they occupy in these zones definite positions recurring in many different crystals; further, they frequently appear in exactly the number and distribution corresponding with the symmetrical disposition of those primary faces to which they stand in the relation of vicinal planes.

These faces are, however, in their occurrence much more variable than

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* *Tschermak's mineralogische und petrographische Mittheilungen*, Vol. V. p. 397, and Vol. VI. p. 301.

are the faces with simpler indices; and it is a remarkable fact that they are much more susceptible to the influences which give rise to distortion. Whilst planes with simple indices are either diminished or increased in size by distortion, without being actually obliterated, it frequently happens that under such circumstances existing "transitional faces" are replaced by new ones, of which the disposition may be proved to correspond with the irregular development of the form.

This fact may become exceedingly valuable for the study of the phenomena of crystal-growth, for it affords a means of recognising, not only the exact part of the growing crystal where a disturbance in the uniform development commenced, but also of gaining a clue to the measurable amount of the divergence.

More remarkable yet are the numerical relations between the indices of the various transitional planes and the corresponding simple faces. Such relations are the simplest in the case of pinakoids, and can be briefly expressed thus: the intercepts of the vicinal faces on the axes lying in any pinakoid appear as multiples of a definite factor (which is the same for all the parametral axes) in such a manner that all the indices of the transitional faces in question would be simple, if only the factor were made equal to unity.

It was fully demonstrated in the paper quoted above, that the same factor is similarly related to the indices of transitional faces which appear in conjunction with prismatic and pyramidal faces, though the relationship cannot be expressed so simply as above. As this factor is the same for all the principal planes, without exception, we are led to infer that it represents a particular state of the fluid which surrounded the crystal during the growth of the vicinal faces.

The further circumstance that such planes of highly complex indices resolve into those of simple indices upon the elimination of this factor, seems to indicate that such simple planes at any rate tend to be present.

It would appear, therefore, that the transitional faces, in the case of danburite, spring from the same cause as the inequality in the development of faces of a form. They would thus have to be regarded as the result of the action of two sets of forces; one acting in connection with the arrival of newly deposited molecules and their state, the other emanating from and connected with the so far completed faces of the crystal; in other words, these planes are induced by the tendency towards the formation of a new plane over one already completed.

It would be out of place to enter further, on this occasion, upon the subject of the paper already quoted, viz. the deduction, discussion, and closer confirmation of the above theorems, and the theoretical and practical results which would seem to accrue for the crystallographer. The object of this note will have been fulfilled if the author has succeeded in attracting the attention of students to these remarkable elementary faces, and has convinced them that the study of such subordinate features is not as hopeless as might at first sight appear; but that a prospect is opened up that these complicated features (which to a German *savant* seemed so wonderful that he compared them with those of the living plant) may yet be made amenable to mathematical laws which doubtless underlie them.