

## PART II. PHYSICAL MINERALOGY

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274. The PHYSICAL CHARACTERS of minerals fall under the following heads:

I. Characters depending upon *Cohesion* and *Elasticity*—viz., cleavage, fracture, tenacity, hardness, elasticity, etc.

II. *Specific Gravity*, or the *Density* compared with that of water.

III. Characters depending upon *Light*—viz., color, luster, degree of transparency, special optical properties, etc.

IV. Characters depending upon *Heat*—viz., heat-conductivity, change of form and of optical characters with change of temperature, fusibility, etc.

V. Characters depending upon *Electricity* and *Magnetism*.

VI. Characters depending upon the action of the senses—viz., taste, odor, feel.

275. **General Relation of Physical Characters to Molecular Structure.**—

It has been stated on pp. 7, 8 that the geometrical form of a crystallized mineral is the external evidence of the internal molecular structure. A full knowledge in regard to this structure, however, can only be obtained by the study of the various physical characters included in the classes enumerated above.

Of these characters, the specific gravity merely gives indication of the atomic mass of the elements present, and further, of the state of molecular aggregation. The first of these points is illustrated by the high specific gravity of compounds of lead; the second, by the distinction observed, for example, between carbon in the form of the diamond, with a specific gravity of 3.5, and the same chemical substance as the mineral graphite, with a specific gravity of only 2.

All the other characters (except the relatively unimportant ones of Class VI) in general vary according to the direction in the crystal; in other words they have a definite orientation. For all of them it is true that *directions which are crystallographically identical have like physical characters*.

In regard to the converse proposition—viz., *that in all directions crystallographically dissimilar there may be a variation in the physical characters*, an important distinction is to be made. This proposition holds true for all crystals, so far as the characters of Class I are concerned; that is, those depending upon the cohesion and elasticity, as shown in the cleavage, hardness, the planes of molecular gliding, the etching-figures, etc. It is also true in the case of pyro-electricity and piezo-electricity.

It does *not* apply in the same way with respect to the characters which involve the propagation of light (and radiant heat), the change of volume with change of temperature; further, electric radiation, magnetic induction, etc.

Thus, although it will be shown that the optical characters of crystals are in agreement in general with the symmetry of their form, they do not show all the variations in this symmetry. It is true, for example, that all directions are optically similar in a crystal belonging to any class under the isometric system; but this is obviously not true of its molecular cohesion, as may be shown by the cleavage. Again, all directions in a tetragonal crystal at right angles to the vertical axis are optically similar; but this again is not true of the cohesion. These points are further elucidated under the description of the special characters of each group.

## I. CHARACTERS DEPENDING UPON COHESION AND ELASTICITY

**276. Cohesion, Elasticity.** — The name *cohesion* is given to the force of attraction existing between the molecules of one and the same body, in consequence of which they offer resistance to any influence tending to separate them, as in the breaking of a solid body or the scratching of its surface.

*Elasticity* is the force which tends to restore the molecules of a body back into their original position, from which they have been disturbed, as when a body has suffered change of shape or of volume under pressure.

The varying degrees of cohesion and elasticity for crystals of different minerals, or for different directions in the same crystal, are shown in the prominent characters: cleavage, fracture, tenacity, hardness; also in the gliding-planes, percussion-figures or pressure-figures, and the etching-figures.

**277. Cleavage.** — Cleavage is the tendency of a crystallized mineral to break in certain definite directions, yielding more or less smooth surfaces. It obviously indicates a minimum value of cohesion in the direction of easy fracture — that is, normal to the cleavage-plane itself. The cleavage parallel to the cubic faces of a crystal of galena is a familiar illustration. An amorphous body (p. 8) necessarily can show no cleavage.

As stated in Art. 31, the consideration of the molecular structure of crystals shows that a cleavage-plane must be a direction in which the molecules are closely aggregated together; while normal to this the distance between successive layers of molecules must be relatively large, and hence this last is the direction of easy separation. It further follows that cleavage can exist only parallel to some possible face of a crystal, and, further, that this must be one of the common fundamental forms. Hence in cases where the choice in the position of the axes is more or less arbitrary the presence of cleavage is properly regarded as showing which planes should be made fundamental. Still again, cleavage is the same in all directions in a crystal which are crystallographically identical.

Cleavage is defined, (1) according to its direction, as cubic, octahedral, rhombohedral, basal, prismatic, etc. Also, (2) according to the ease with which it is obtained, and the smoothness of the surface yielded. It is said to be *perfect* or *eminent* when it is obtained with great ease, affording smooth, lustrous surfaces, as in mica, topaz, calcite. Inferior degrees of cleavage are spoken of as distinct, indistinct or imperfect, interrupted, in traces, difficult. These terms are sufficiently intelligible without further explanation. It may be noticed that the cleavage of a species is sometimes better developed in some of its varieties than in others.