

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.

278. Cleavage in the Different Systems. — (1) In the ISOMETRIC SYSTEM, cleavage is *cubic*, when parallel to the faces of the cube; this is the common case, as illustrated by galena and halite. It is also often *octahedral* — that is, parallel to the octahedral faces, as with fluorite and the diamond. Less frequently it is *dodecahedral*, or parallel to the faces of the rhombic dodecahedron, as with sphalerite.

In the TETRAGONAL SYSTEM, cleavage is often *basal*, or parallel to the basal plane, as with apophyllite; also *prismatic*, or parallel to one (or both) of the square prisms, as with rutile and wernerite; less frequently it is *pyramidal*, or parallel to the faces of the square pyramid, as with scheelite.

In the HEXAGONAL SYSTEM, cleavage is usually either *basal*, as with beryl, or *prismatic*, parallel to one of the six-sided prisms, as with nephelite; *pyramidal* cleavage, as with pyromorphite, is rare and imperfect.

In the RHOMBOHEDRAL DIVISION, besides the basal and prismatic cleavages, *rhomboidal* cleavage, parallel to the faces of a rhombohedron, is also common, as with calcite and the allied species.

In the ORTHORHOMBIC SYSTEM, cleavage parallel to one or more of the pinacoids is common. Thus it is *basal* with topaz, and in all three pinacoidal directions with anhydrite. *Prismatic* cleavage is also common, as with barite; in this case the arbitrary position assumed in describing the crystal may make this cleavage parallel to a "horizontal prism," or dome.

In the MONOCLINIC SYSTEM, cleavage parallel to the clinopinacoid, is common, as with orthoclase, gypsum, heulandite and euclase; also *basal*, as with the micas and orthoclase, or parallel to the orthopinacoid; also *prismatic*, as with amphibole. Less frequently cleavage is parallel to a hemi-pyramid, as with gypsum.

In the TRICLINIC SYSTEM, it is usual and proper to so select the fundamental form as to make the cleavage directions correspond with the pinacoids.

279. In some cases cleavage which is ordinarily not observed may be developed by a sharp blow or by sudden change of temperature. Thus, quartz is usually conspicuously free from cleavage, but a quartz crystal heated and plunged into cold water often shows planes of separation * parallel to both the + and - rhombohedrons and to the prism as well. Similarly, the prismatic cleavage of pyroxene is observed with great distinctness in thin sections, made by grinding, while not so readily noted in large crystals.

When the cleavage is parallel to a closed form — that is, when it is cubic, octahedral, dodecahedral, or rhombohedral (also pyramidal in the tetragonal, hexagonal, and orthorhombic systems) — solids resembling crystals may often be broken out from a single crystalline individual, and all the fragments have the same angles. It is, in general, easy to distinguish such a cleavage form, as a cleavage octahedron of fluorite, from a true crystal by the splintery character of the faces of the former.

280. Cleavage and Luster. — The face of a crystal parallel to which there is perfect cleavage often shows a pearly luster (see p. 249), due to the partial separation of the crystal into parallel plates. This is illustrated by the basal plane of apophyllite, the clinopinacoid of stilbite and heulandite. An iridescent play of colors is also often seen, as with calcite, when the separation has been sufficient to produce the prismatic colors by interference.

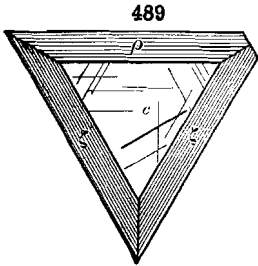
281. Gliding-planes. — Closely related to the cleavage directions in their connection with the cohesion of the molecules of a crystal are the *gliding-planes*, or directions parallel to which a slipping of the molecules may take place under the application of mechanical force, as by pressure.

This may have the result of simply producing a separation into layers in the given direction, or, on the other hand, and more commonly, there may be a revolution of the molecules into a new twinning-position, so that *secondary twinning-lamellæ* are formed.

Thus, if a crystal of halite, or rock salt, be subjected to gradual pressure in the direction of a dodecahedral face, a plane of separation is developed normal to this and hence in the direction of another face of the same form. There are six such directions of molecular slipping and separation in a crystal of this substance. Certain kinds of mica of the biotite class often show

* Lehmann (Zs. Kr., 11, 608, 1886) and Judd (Min. Mag., 8, 7, 1888) regard these as gliding-planes (see Art. 281).

pseudo-crystalline faces, which are undoubtedly secondary in origin — that is, have been developed by pressure exerted subsequently to the growth of the crystal (cf. Fig. 489).

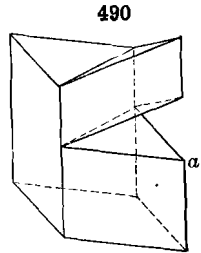


Biotite

of the molecules into a new twinning-position (see p. 160 *et seq.*), is well illustrated by calcite. Pressure upon a cleavage-fragment may result in the formation of a number of thin lamellæ in twinning-position to the parent mass, the twinning-plane being the obtuse negative rhombohedron, $e(01\bar{1}2)$. Secondary twinning-lamellæ similar to these are often observed in natural cleavage-masses of calcite, and particularly in the grains of a crystalline limestone, as observed in thin sections under the microscope.

Secondary twinning-lamellæ may also be produced (and are often noted in nature) in the case of the triclinic feldspars, pyroxene, barite, etc. A secondary lamellar structure in quartz has been observed by Judd, in which the lamellæ consisted of right-handed and left-handed portions.

By the proper means a complete calcite twin may be artificially produced by pressure. Thus, if a cleavage-fragment of prismatic form, say 6–8 mm. in length and 3–6 mm. in breadth, be placed with the obtuse edge on a firm horizontal support, and pressed by the blade of an ordinary tableknife on the other obtuse edge (at a , Fig. 490), the result is that a portion of the crystal is reversed in position, as if twinned parallel to the plane $(01\bar{1}2)$ which in the figure lies in a vertical position. If skillfully done, the twinning surface is perfectly smooth, and the re-entrant angle corresponds exactly with that required by theory.

Artificial Twinning
in Calcite

283. Parting. — The secondary twinning-planes described are often directions of an easy separation — conveniently called *parting* — which may be mistaken for cleavage.* The basal parting of pyroxene is a common example of such pseudo-cleavage; it was long mistaken for cleavage. The basal and rhombohedral $(10\bar{1}1)$ and the less distinct prismatic $(11\bar{2}0)$ parting of corundum; the octahedral parting of magnetite (cf. Fig. 474, p. 176), are other examples.

An important distinction between cleavage and parting is this: parting can exist only in certain definite planes — that is, on the surface of a twinning-lamella — while the cleavage may take place in *any* plane having the given direction.

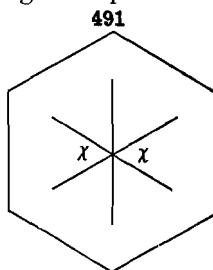
284. Percussion-figures. — Immediately connected with the gliding-planes are the figures — called *percussion-figures* † — produced upon a crystal

* The lamellar structure of a massive mineral, without twinning, may also be the cause of a fracture which can be mistaken for cleavage.

† The percussion-figures are best obtained if the crystal plate under investigation be supported upon a hard cushion and a blow be struck with a light hammer upon a steel rod the slightly rounded point of which is held firmly against the surface.

section by a blow or pressure with a suitable point. In such cases, the method described serves to develop more or less well-defined cracks whose orientation varies with the crystallographic direction of the surface. Thus upon the cubic face of a crystal of halite a four-rayed, star-shaped figure is produced with arms parallel to the diagonals — that is, parallel to the dodecahedral faces. On an octahedral face a three-rayed star is obtained.

The percussion-figures in the case of the micas have been often investigated, and, as remarked later, they form a means of fixing the true orientation of a cleavage-plate having no crystalline outlines. The figure (Fig. 491) is here a six-rayed star one of whose branches is parallel to the clinopinacoid (*b*), the others approximately parallel to the intersection edges of the prism (*m*) and base (*c*).*



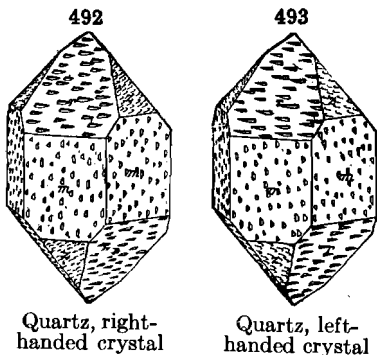
Pressure upon a mica plate produces a less distinct six-rayed star, diagonal to that just named; this is called a *pressure-figure*.

285. Solution-planes. — In the case of many crystals, it is possible to prove the existence of certain directions, or structure-planes, in which chemical action takes place most readily — for example, when a crystal is under great pressure. These directions of chemical weakness have been called *solution-planes*. They often manifest themselves by the presence of a multitude of oriented cavities of crystalline outline (so-called negative crystals) in the given direction.

These solution-planes in certain cases, as shown by Judd, are the same as the directions of secondary lamellar twinning, as is illustrated by calcite. Connected with this is the *schillerization* (see Art. 369), observed in certain minerals in rocks (as diallage, schillerspar).

286. Etching-figures. — Intimately connected with the general subjects here considered, of cohesion in relation to crystals, are the figures produced by etching on crystalline faces; these are often called *etching-figures*. This method of investigation, developed particularly by Baumhauer, is of high importance as revealing the molecular structure of the crystal faces under examination, and therefore the symmetry of the crystal itself.

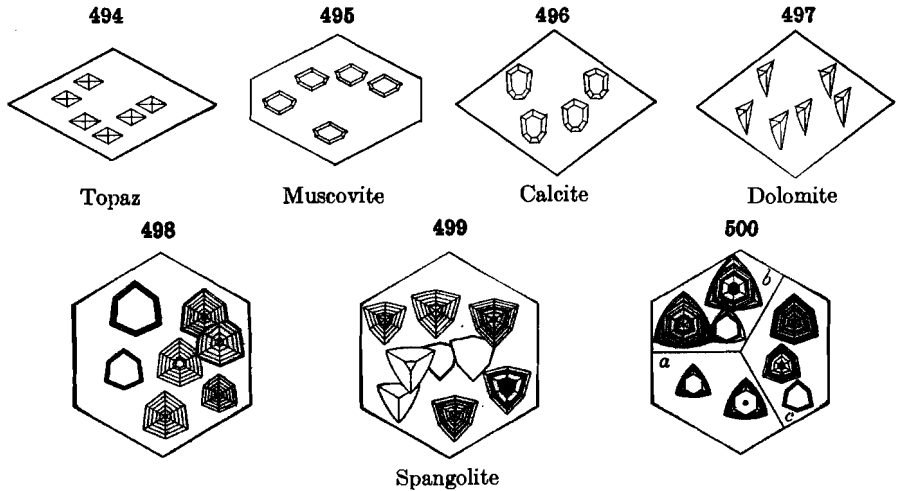
The etching is performed mostly by solvents, as by water in some cases, more generally the ordinary mineral acids, or caustic alkalies, also by steam at a high pressure and hydrofluoric acid; the last is especially powerful in its action, and is used frequently with the silicates. The figures produced are in the majority of cases angular depressions, such as low triangular or quadrilateral pyramids, whose outlines may run parallel to some of the crystalline edges. In some cases the planes produced can be referred to occurring crystallographic faces. They appear alike on similar faces of crystals, and hence serve to distinguish different forms, perhaps in appearance identical, as the two sets of faces in the ordinary double pyramid of quartz; so, too, they reveal the compound twinning-structure common on some crystals, as quartz and aragonite.



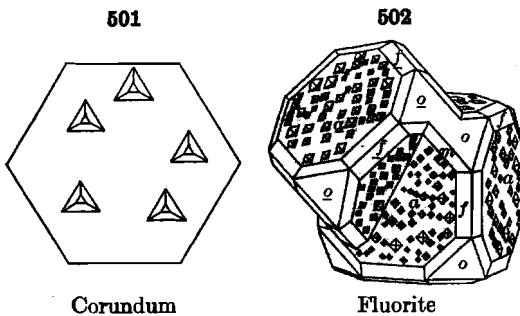
* Cf. Walker, *Am. J. Sc.*, **2**, 5, 1896, and G. Friedel, *Bull. Soc. Min.*, **19**, 18, 1896. Walker found the angle opposite *b*(010) (χ in Fig. 491) to be 53° to 56° for muscovite, 59° for lepidolite, 60° for biotite, and 61° to 63° for phlogopite.

Further, their form in general corresponds to the symmetry of the group to which the given crystal belongs. They thus reveal the trapezohedral symmetry of quartz and the difference between a right-handed and left-handed crystal (Figs. 492, 493); the distinction between calcite and dolomite (Figs. 496, 497); the distinctive character of apatite, pyromorphite, etc.; the hemimorphic symmetry of calamine and nephelite (cf. Fig. 237, p. 102), etc.; they also prove by their form the monoclinic crystallization of muscovite and other micas (Fig. 495).

Fig. 494 shows the etching-figures formed on a basal plane (cleavage) of topaz by fused caustic potash; Fig. 495, those on a cleavage-plate of muscovite by hydrofluoric acid; Fig. 496, upon a rhombohedral face of calcite, and Fig. 497, on one of dolomite by dilute hydrochloric acid.



The shape of the etching-figures may vary with the same crystal with the nature of the solvent employed, though their symmetry remains constant. For example, Fig. 498 shows the figures obtained with spangolite by the action of sulphuric acid, Fig. 499 by the same diluted, and Fig. 500 by hydrochloric acid of different degrees of concentration.



Of the same nature as the etching-figures artificially produced, in their relation to the symmetry of the crystal, are the markings often observed on the natural faces of crystals. These are sometimes secondary, caused by a natural etching process, but are more

often an irregularity in the crystalline development of the crystal. The inverted triangular depressions often seen on the octahedral faces of diamond crystals are an example. Fig. 501 shows natural depressions, rhombohedral in character, observed on corundum crystals from Montana (Pratt). Fig. 502 shows a twin crystal of fluorite with natural etching-figures (Pirsson);

these are minute pyramidal depressions whose sides are parallel to the faces of the trapezohedron (311).

287. Corrosion Forms. — If the etching process spoken of in the preceding article — whether natural or artificial — is continued, the result may be to destroy the original crystalline surface and to substitute for it perhaps a multitude of minute elevations, more or less distinct; or, further, new faces may be developed, the crystallographic position of which can often be determined, though the symbols may be complex. The mere loss of water in some cases produces certain corrosive forms.

Penfield subjected a sphere of quartz (from a simple right-handed individual) to the prolonged action of hydrofluoric acid. It was found that it was attacked rapidly in the direction of the vertical axis, but barely at all at the + extremities of the horizontal axes. Figs. 503, 504 show the form remaining after the sphere had been etched for seven weeks; Fig. 503 is a basal view; Fig. 504, a front view; the circle shows the original form of the sphere, the dotted hexagon the position of the axes.

288. Fracture. — The term *fracture* is used to define the form or kind of surface obtained by breaking in a direction other than that of cleavage in crystallized minerals, and in any direction in massive minerals. When the cleavage is highly perfect in several directions, as the rhombohedral cleavage of calcite, fracture is often not readily obtainable.

Fracture is defined as:

(a) *Conchoidal*; when a mineral breaks with curved concavities, more or less deep. It is so called from the resemblance of the concavity to the valve of a shell, from *concha*, a *shell*.

This is well illustrated by obsidian, also by flint. If the resulting forms are small, the fracture is said to be *small-conchoidal*; if only partially distinct, it is *subconchoidal*.

(b) *Even*; when the surface of fracture, though rough with numerous small elevations and depressions, still approximates to a plane surface.

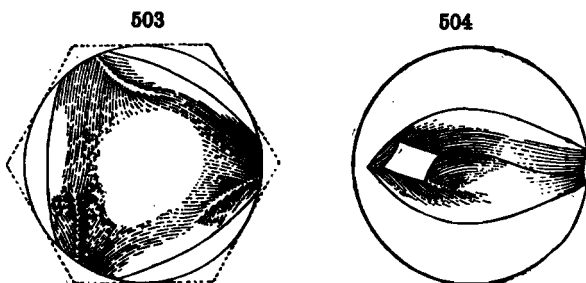
(c) *Uneven*; when the surface is rough and entirely irregular; this is true of most minerals.

(d) *Hackly*; when the elevations are sharp or jagged; broken iron.

Other terms also employed are *earthy*, *splintery*, etc.

289. Hardness. — The *hardness* of a mineral is measured by the resistance which a smooth surface offers to abrasion. The degree of hardness is determined by observing the comparative ease or difficulty with which one mineral is scratched by another, or by a file or knife.

In minerals there are all grades of hardness, from that of talc, impressible by the finger-nail, to that of the diamond. To give precision to the use of this character, a *scale of hardness* was introduced by Mohs.* It is as follows:



Etched Sphere of Quartz

* The interval between 2 and 3, and 5 and 6, in the scale of Mohs, being a little greater than between the other numbers, Breithaupt proposed a scale of *twelve* minerals; but the scale of Mohs is now universally accepted.

- | | |
|---------------------|-----------------------|
| 1. <i>Talc.</i> | 6. <i>Orthoclase.</i> |
| 2. <i>Gypsum</i> | 7. <i>Quartz.</i> |
| 3. <i>Calcite.</i> | 8. <i>Topaz.</i> |
| 4. <i>Fluorite.</i> | 9. <i>Corundum.</i> |
| 5. <i>Apatite.</i> | 10. <i>Diamond.</i> |

Crystalline varieties with smooth surfaces should be taken so far as possible.

If the mineral under examination is scratched by the knife-blade as easily as calcite its hardness is said to be 3; if less easily than calcite and more so than fluorite its hardness is 3.5. In the latter case the mineral in question would be scratched by fluorite but would itself scratch calcite. It need hardly be added that great accuracy is not attainable by the above methods, though, indeed, for purposes of the determination of minerals, exactness is quite unnecessary.

It should be noted that minerals of grade 1 have a greasy feel to the hand; those of grade 2 are easily scratched by the finger-nail; those of grade 3 are rather readily cut, as by a knife; of grade 4, scratched rather easily by the knife; grade 5, scratched with some difficulty; grade 6, barely scratched by a knife, but distinctly by a file — moreover, they also scratch ordinary glass. Minerals as hard as quartz ($H. = 7$), or harder, scratch glass readily but are little touched by a file; the few species belonging here are enumerated in Appendix B; they include all the gems.

290. Sclerometer. — Accurate determinations of the hardness of minerals can be made in various ways, one of the best being by use of an instrument called a *sclerometer*. The mineral is placed on a movable carriage, with the surface to be experimented upon horizontal; this is brought in contact with a steel point (or diamond point), fixed on a support above; the weight is then determined which is just sufficient to move the carriage and produce a scratch on the surface of the mineral.

By means of such an instrument the hardness of the different faces of a given crystal has been determined in a variety of cases. It has been found that different faces of a crystal (*e.g.*, cyanite) differ in hardness, and the same face may differ as it is scratched in different directions. In general, differences in hardness are noted only with crystals which show distinct cleavage; the hardest face is that which is intersected by the plane of most complete cleavage. Further, of a single face, which is intersected by cleavage-planes, the direction perpendicular to the cleavage-direction is the softer, those parallel to it the harder.

This subject has been investigated by Exner (p. 194), who has given the form of the *curves of hardness* for the different faces of many crystals. These curves are obtained as follows: the least weight required to scratch a crystalline surface in different directions, for each 10° or 15°, from 0° to 180°, is determined with the sclerometer; these directions are laid off as radii from a center, and the length of each is made proportional to the weight fixed by experiment — that is, to the hardness thus determined; the line connecting the extremities of these radii is the curve of hardness for the given face.

The following table gives the results obtained* (see literature) in comparing the hardness of the minerals of the scale from corundum, No. 9, taken as 1000, to gypsum, No. 2. Pfaff used the method of boring with a standard point, the hardness being determined by the number of rotations; Rosiwal used a standard powder to grind the surface, Jaggard employed his micro-sclerometer, the method being essentially a modification of that of

* The numbers are here given as tabulated by Jaggard.

Pfaff. By means of this instrument he is able to test the hardness of the minerals present in a thin section under the microscope. Measurements of absolute hardness have also been made by Auerbach. Holmquist has recently made many hardness tests by the grinding method. His results with regard to the minerals of the scale of hardness agree fairly well with those of Rosiwal given below but show considerable discrepancies with the results obtained by the other methods. He, like Rosiwal, finds that topaz is lower in the scale than quartz.

	Pfaff, 1884	Rosiwal, 1892	Jaggar, 1897
9. Corundum.....	1000	1000	1000
8. Topaz.....	459	138	152
7. Quartz.....	254	149	40
6. Orthoclase.....	191	28·7	25
5. Apatite.....	53·5	6·20	1·23
4. Fluorite.....	37·3	4·70	·75
3. Calcite.....	15·3	2·68	·26
2. Gypsum.....	12·03	·34	·04

291. Relation of Hardness to Chemical Composition. — Some general facts of importance can be stated * in regard to the connection between the hardness of a mineral and its chemical composition.

1. Compounds of the heavy metals, as silver, copper, mercury, lead, etc., are *soft*, their hardness seldom exceeding 2·5 to 3.

Among the compounds of the common metals, the sulphides (arsenides) and oxides of iron (also of nickel and cobalt) are relatively *hard* (*e.g.*, for pyrite H. = 6 to 6·5; for hematite H. = 6, etc.); here belong also columbite, iron niobate; tantalite, iron tantalate; wolframite, iron tungstate.

2. The sulphides are mostly relatively soft (except as noted in 1), also most of the carbonates, sulphates, and phosphates.

3. Hydrous salts are relatively soft. This is most distinctly shown among the silicates — *e.g.*, compare the feldspars and zeolites.

4. The conspicuously hard minerals are found chiefly among the oxides and silicates; many of them are compounds containing aluminium — *e.g.*, corundum, diaspore, chrysoberyl, and many alumino-silicates. Outside of these the borate, boracite, is hard (H. = 7); also iridosmine.

On the relation of hardness to specific gravity, see Art. 302.

292. Practical Suggestions. — Several points should be regarded in the trials of hardness:

(1) If the mineral is slightly altered, as is often the case with corundum, garnet, etc., the surface may be readily scratched when this would be impossible with the mineral itself; a trial with an edge of the latter will often give a correct result in such a case.

(2) A mineral with a granular surface often appears to be scratched when the grains have been only torn apart or crushed.

(3) A relatively soft mineral may leave a faint white ridge on a surface, as of glass, which can be mistaken for a scratch if carelessly observed.

(4) A crystal, as of quartz, is often slightly scratched by the edge of another of the same species and like hardness.

(5) The scratch should be made in such a way as to disfigure the specimen as little as possible.

293. Tenacity. — Minerals may be either brittle, sectile, malleable, or flexible.

(a) *Brittle*; when parts of a mineral separate in powder or grains on attempting to cut it, as calcite.

(b) *Sectile*; when pieces may be cut off with a knife without falling to powder, but still the mineral pulverizes under a hammer. This character is intermediate between brittle and malleable, as gypsum.

(c) *Malleable*; when slices may be cut off, and these slices flattened out under a hammer; native gold, native silver.

* See further in Appendix B.

(d) *Flexible*; when the mineral will bend without breaking, and remain bent after the bending force is removed, as talc.

The tenacity of a substance is properly a consequence of its elasticity.

294. Elasticity. — The elasticity of a solid body expresses at once the resistance which it makes to a change in shape or volume, and also its tendency to return to its original shape when the deforming force ceases to act. If the *limit of elasticity* is not passed, the change in molecular position is proportional to the force acting, and the former shape of volume is exactly resumed; if this limit is exceeded, the deformation becomes permanent, a new position of molecular equilibrium having been assumed; this is shown in the phenomena of gliding-planes and secondary twinning, already discussed. The magnitude of the elasticity of a given substance is measured by the *coefficient of elasticity*, or, better, the coefficient of restitution. This is defined as the relation, for example, between the elongation of a bar of unit section to the force acting to produce this effect; similarly of the bending or twisting of a bar. The subject was early investigated acoustically by Savart; in recent years, Voigt and others have made accurate measures of the elasticity of many substances and of the crystals of the same substance in different directions. The elasticity of an amorphous body is the same in all directions, but it changes in value with change of crystallographic direction in all crystals.

The distinction between *elastic* and *inelastic* is often made between the species of the mica group and allied minerals. Muscovite, for example, is described as "highly elastic," while phlogopite is much less so. In this case it is not true in the physical sense that muscovite has a high value for the coefficient of elasticity; its peculiarity lies rather in the fact that its elasticity is displayed through unusually wide limits.

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II. SPECIFIC GRAVITY OR RELATIVE DENSITY

295. Definition of Specific Gravity. — The specific gravity of a mineral is the ratio of its density * to that of water at 4° C. (39·2° F.). This relative density may be learned in any case by comparing the ratio of the weight of a certain volume of the given substance to that of an equal volume of water; hence the specific gravity is often defined as: *the weight of the body divided by the weight of an equal volume of water.*

The statement that the specific gravity of graphite is 2, of corundum 4, of galena 7·5, etc., means that the densities of the minerals named are 2, 4, and 7·5, etc., times that of water; in other words, as familiarly expressed, any volume of them, a cubic inch for example, weighs 2 times, 4 times, 7·5 times, etc., as much as a like volume, a cubic inch, of water.

Strictly speaking, since the density of water varies with its expansion or contraction under change of temperature, the comparison should be made with water at a fixed temperature, namely 4° C. (39·2° F.), at which it has its maximum density. If made at a higher temperature, a suitable correction should be introduced by calculation. Practically, however, since a high degree of accuracy is not often called for, and, indeed, in many cases is impracticable to attain in consequence of the nature of the material at hand, in the ordinary work of obtaining the specific gravity of minerals the temperature at which the observation is made can safely be neglected. Common variations of temperature would seldom affect the value of the specific gravity to the extent of one unit in the third decimal place.

* The *density* of a body is strictly *the mass of the unit volume*. Thus if a cubic centimeter of water (at its maximum density, 4° C. or 39·2° F.) is taken as the unit of mass, the density of any body — as gold — is given by the number of grams of mass (about 19) in a cubic centimeter; in this case the same number, 19, gives the relative density or specific gravity. If, however, a pound is taken as the unit of mass, and the cubic foot as the unit of volume, the mass of a cubic foot of water is 62·5 lbs., that of gold about 1188 lbs., and the specific gravity is the ratio of the second to the first, or, again, 19.