Prismatic cleavage and steep rhombohedral form in α-quartz.

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(1) An example of α-quartz showing good prismatic cleavages.

As is well known, quartz rarely shows well-defined cleavages. Kenngott has shown that quartz that has suddenly been cooled, after strong heating, has a tendency to break up in the directions of rhombohedron faces. Breithaupt (cf. Hintze, Min., 1904, vol. 1, p. 1273) mentions 'cleavage following the primary rhombohedron and the prism, rarely well defined, often passing into conchoidal fracture'.

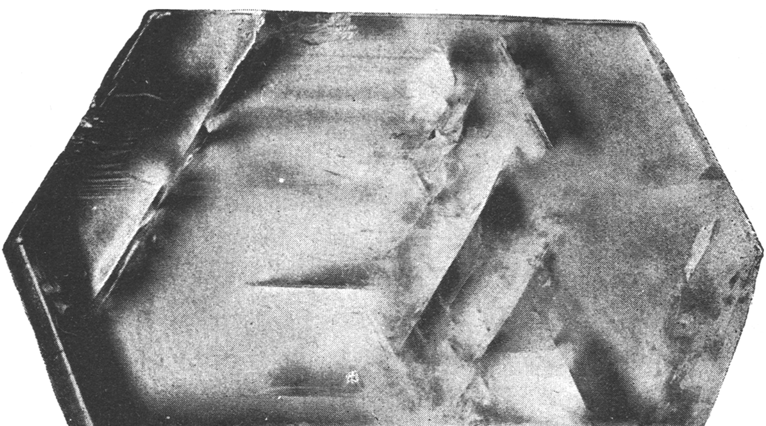


Fig. 1. Polished slice of α-quartz cut perpendicular to the c-axis, showing prismatic cleavages.

It may be useful to put on record an example of clear rock-crystal in which cleavage is developed in all three 60° directions of the prism faces. The specimen was originally in the Daimeries collection, in Brussels, having been bought years ago at Idar, near Oberstein on the Nahe, by A. Daimeries. I obtained it from Mr. A. G. F. Gregory, who had bought the Daimeries collection. The locality from which it came is, unfortunately, unknown.

The specimen (fig. 1) is a slice, 2 cm. thick, cut normally to the c-axis through a large crystal of clear rock-crystal. It measures 17 cm. along the longest diagonal with a width of 9 cm. The cleavage cracks continue right through the thickness of the slice and extend, in one case for a length of over 7 cm., in others for several centimetres in parallel orientation to one or other of the three prism faces. In some there is a tendency for the ends of the cracks to curve round, in two cases at least resuming a straight course following another of the three 60° directions. These must, then, be true cleavages, otherwise there would not be this tendency to resume a direction parallel to another prism face. This cleavage is, however, not an easy one.

Unfortunately nothing is known of the cause that produced the cleavages in this specimen. They may have been already present in the specimen when it was found or may have been developed by some intense mechanical action during the process of cutting and polishing. The surfaces of the cleavages reflect light strongly when placed in a suitable position, and they are seen to be fairly flat and smooth. One or two show a 'hackly' surface, being formed of flat bands elongated horizontally, and all show striations in the same horizontal direction. The flatter parts of these hackly fractures are joined by irregular curved parts. Neither in these nor in any of the other fractures in the slice is any orientation along a rhombohedron face discernible. Cleavage is observed in the prism directions alone, and none in the direction of the primitive rhombohedron. Other cracks show the usual curved, somewhat conchoidal forms that often occur in quartz.

Beside these cleavages and fractures in the thickness of the slice there are surface fractures that also show definite orientations, in each case along the main diagonal of the slice and parallel to one prism face. The most distinct are a set of deep troughs with curved sides, but all elongated in this same direction; then a series of close-packed surface-grooves continuing the troughs on one face of the slice. Finally, two well-defined conchoidal fractures can be observed on the main prism edge, each caused by a sharp blow on the edge.

A photograph (fig. 1) of the slice, somewhat reduced in size, shows the cleavages and surface fractures fairly satisfactorily, though an examination of the specimen itself can alone bring out all the details.

The absence of information as to the origin of these cleavages makes it difficult to decide whether these are really true cleavages or whether they may be in relation to twinning. Twinning would, I imagine, be more likely to develop rhombohedral parting, and no trace of this appears on the specimen. I would therefore regard it as being definitely in the nature of true cleavage.

(2) AN EXAMPLE OF α-QUARTZ CRYSTALS WITH A STEEP RHOMBOHEDRON AS THE PREDOMINANT FORM.

The list of known crystal-forms on α-quartz is a long one. Yet the main habit of this mineral is, as every one knows, an extremely constant one. There are few occurrences in which the association of the prism with the two unit rhombohedra is not the dominant one, the positive rhombohedron being sometimes more important than the negative one. The other forms occur as modifications on the edges and corners of this combination. Sometimes one or other of these other forms become more prominent and we obtain, for instance, quartz crystals with acute pyramidal terminations through the predominance of a steeper rhombohedron. A. Lacroix[1] figures crystals from Bourg-d'Oisans, Isère, in which the acute rhombohedron $(0.11.\overline{11}.1)$ is sometimes so important as to become the predominant form. But other crystals of the same occurrence show intermediate stages, and the acute rhombohedron cannot be considered the essential one of the combination.

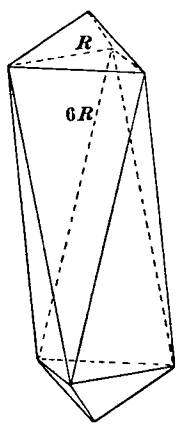
C. Palache[2] has described an occurrence, however, in which an acute rhombohedron is present as an independent form, only occasionally modified by the two unit rhombohedra. These were found in a cavity in the Franklin Furnace (New Jersey) ore, embedded in a felted mass of the finest crocidolite. They ranged in size from minute sharp spicules to rods 3 cm. long and 3 mm. in diameter, some with needle-sharp triangular terminations, others blunted by faces of the two unit rhombohedra. The faces not being very brilliant, measurements were not sufficiently precise to determine whether the acute rhombohedron was Y $(0.18.\overline{18}.1)$ or $(0.17.\overline{17}.1)$, and no sure means were available to ascertain which of the two unit rhombohedra was the positive one. Palache shows, in his drawing, the first $(0.18.\overline{18}.1)$ of these steep rhombohedra. But the larger development of the unit rhombohedron, that becomes the negative one on this assumption, suggests that, perhaps, the steep rhombohedron $(0.17.\overline{17}.1)$ may be the true one. So far as I can discover, this occurrence is the only one recorded in which a steep rhombohedron is present as a really independent or predominant form.

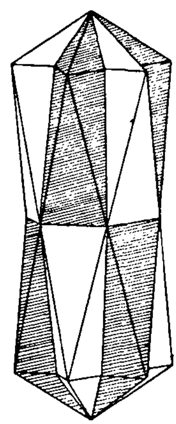
Another such case has come to my notice while examining, with a binocular microscope, minute quartz crystals occurring on a specimen of stibnite from Kisbánya, Romania, that I had obtained from Mr. E. P. Bottley last June. The fine, bladed crystals of stibnite occur in closely packed sheaths on crusts formed of minute rhombohedra of chalybite

[1] A. Lacroix, Min. France, 1901, vol. 3, p. 86, fig. 56; p. 81, figs. 51 and 52.
[2] C. Palache, Amer. Min., 1928, vol. 13, p. 319, pl. VIII, fig. 23.

associated with more obtuse rhombohedra of calcite. One side of these crusts is in many places coated with a layer of very minute, closely intergrown, doubly terminated quartz crystals. These quartzes all show the same habit, and that a very unusual one, as we have just seen, of an acute rhombohedron modified by one very subordinate unit rhombohedron, which we may assume to be the primitive $+R$ $(10\bar{1}1)$. The steep rhombohedron is of the same sign as the unit one and would, on the above assumption, be also positive.

Some of these crystals are of ideal symmetry (fig. 2). Most of them are, however, complicated by twinning about the vertical axis, the most symmetric being interpenetration twins of two such simple crystals (fig. 3). Most of the crystals are, however, complicated by frequent





α-Quartz, combination of R and $6R$, from Kisbánya, Romania.

FIG. 2. Simple, untwinned crystal. FIG. 3. Interpenetration twin about the vertical axis.

repetitions of the same law of twinning and the juxtaposition of the numerous elements in parallel position to each other, producing the appearance of true sixfold symmetry. The edge between the two rhombohedra is more or less rounded, but no other form is present than these two. The acute rhombohedron is here, as in the occurrence described by Palache, a truly independent and predominant form.

The surface of the steep rhombohedron is somewhat rough and, in spite of good reflections from the primitive rhombohedron, no accurate readings could be obtained on the goniometer. Rough measurements on the microscope stage of the angle between adjacent faces, together with the measurement of the acute angle at the apex of each rhombohedron face and of the ratio of the side to the short diagonal, give sufficient ground for taking the indices of this face to be either $(60\bar{6}1)$ or $(70\bar{7}1)$. They agree slightly better with the first of these, and the drawings have in consequence been based on a rhombohedron $6R$ $(60\bar{6}1)$. The following table gives the results of these rough measurements:

	Measured.	Calculated value for $6R$.	Calculated value for $7R$.
Angle between adjacent faces	$58° \pm 2°$	$59° 29'$	$59° 19'$
Acute angle of the rhombohedron face	$24° \pm 2°$	$25° 20'$	$22° 0'$
Ratio of side to short diagonal	$2–2\frac{1}{2}$	2·28	2·62

The symmetrical development of these crystals points to their having been formed in suspension in a homogeneous solution. They seem to have settled from this on to the carbonate crusts, occurring on these as an irregular mass of crystals, some of which are easily detached without damage. They are, however, too minute to be mounted conveniently for the goniometer. They form very suitable material for study with the binocular microscope. This is, in fact, a good example of the use that can be made of 'micro-mounts' in the study of minute crystals that would otherwise pass unnoticed. For the complex intergrowths produced by repeated twinning are not easily elucidated, even by careful examination with an ordinary single-tube microscope.