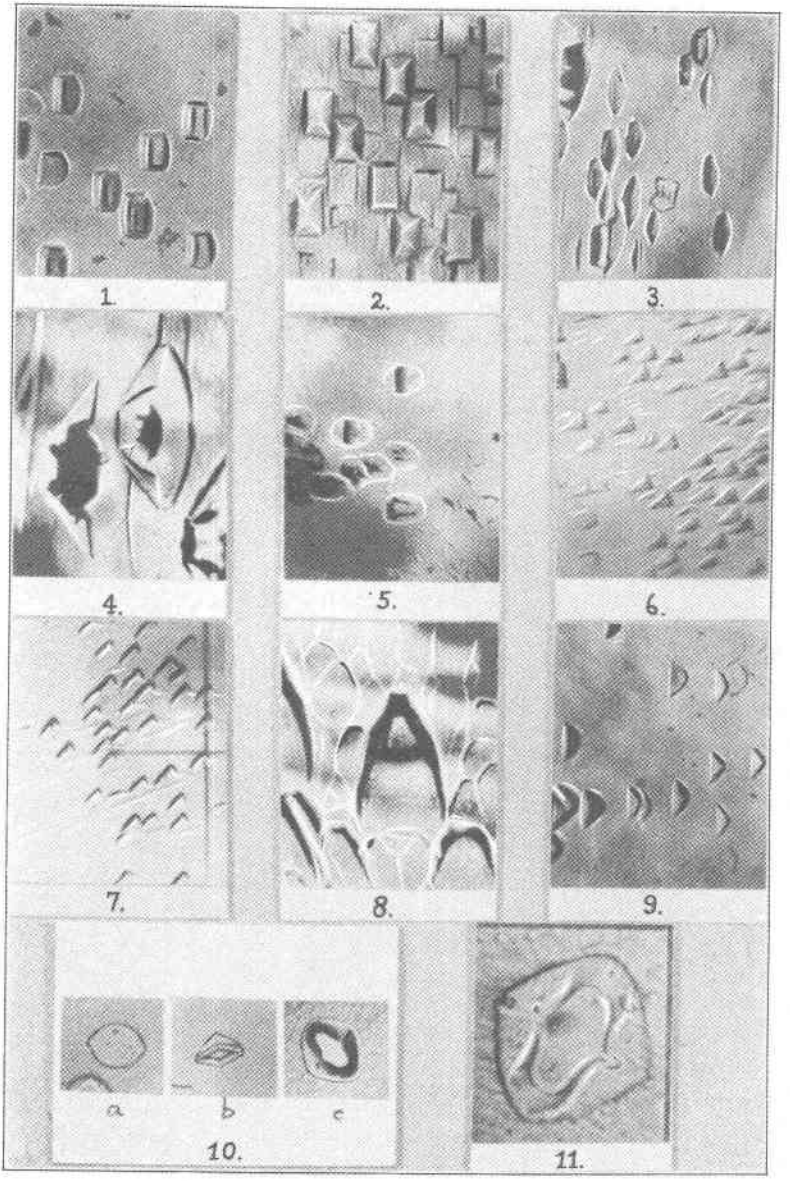
PLATE 3.



Photographs by Arthur P. Honess

ETCHING FIGURES OF TOPAZ.

Nos. 1, 2, 4, 5, 6, 8, 9, and 10, are ×180; 3 and 7, ×120; 11, ×310.

THE AMERICAN MINERALOGIST
JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA
VOL. 6 APRIL, 1921 No. 4

THE ETCHING FIGURES OF TOPAZ

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In view of the fact that a detailed study of the etching figures of topaz has not been attempted, and in consequence of doubt expressed by certain authors as to the holohedral character of this mineral, the results of a careful examination of the etchings of the fundamental forms may be of interest. Baumhauer[1] was able to obtain distinct figures on the base and unit prism of Brazilian topaz, by means of potassium hydroxide. The base figures are rhombic and oriented with the sides parallel to the edge 001/110. They are usually composed of four faces so placed as to be divisible by two symmetry planes, which accords with the holohedral class. The prism faces are marked by many quadrilateral depressions, elongated in the direction of the *c* axis, and divisible by an equatorial plane of symmetry (also indicating holohedrism).

E. S. Fedorov[2] described natural etchings occurring on topaz crystals from Alabaschka and Urulga, the description being illustrated by seven large photographs. He observed the following: a constancy of the type of etch figures occurring on equivalent faces; the presence of two kinds of figures, that is, a formation of etch figures on faces, which have arisen thru etching; and a very noticeable difference in the etchings of different crystal forms. References to work on the etching of topaz, by Goldschmidt and Rosicky, have been seen, but the original article has not been accessible to the writer.

Owing to the abundance of suitable material obtained from the Thomas Mountain locality, in Utah, little difficulty was experienced in selecting clear brownish crystals which were very satisfactory for the purpose of etching. Altho six fundamen-

[1] *Neues Jahrb. Min. Geol.*, **1876**, 5.

[2] *Ann. Inst. Mines* **1**, 1908.

tal forms are common in this locality, the seventh, the macropinacoid, (100), is apparently always wanting; the extreme rarity of this form was not really appreciated, until a diligent search thru the Princeton Museum specimens, coming from a variety of localities, failed to reveal a single crystal bearing this face.

Topaz, being a very insoluble mineral, is little attacked by acids; consequently, fusions similar to those which have been used for etching tourmaline were employed for the investigation of the topaz etching figures. Potassium hydroxide, if concentrated, was found to corrode the crystal, so that a more dilute fusion was prepared by adding a little water; as this solution becomes more and more concentrated the crystal is attacked quite readily, the six forms revealing figures as seen in diagram A, where the holohedral symmetry of the orthorhombic system is demonstrated.

Unit Prism (110)

Several minutes immersion in the potassium hydroxide fusion produces distinct etchings on this form. (See Fig. 1.) They are for the most part composed of five faces in the mature stage of development and are slightly elongated parallel to the prism edges. The primitive figures are usually semi-circular but have very little relief; consequently, if there are lateral faces present at this stage of growth, they are microscopic.

The mature figures are generally quadrilateral in outline, altho either of the two longer boundaries may be modified at the ends by two short straight lines. These longer boundaries may be curved or straight. The ends of the figures are similarly developed, being limited by a short straight line inclined to the prism edge at an angle of approximately 85°; thus the figures are symmetrical to an equatorial plane.

If a red-hot fusion of potassium bisulfate and powdered fluorite, mixed in a proportion of three to one, is allowed to act upon topaz for a period of forty minutes, the unit prism presents an appearance not unlike that of the potassium hydroxide fusion. The figures, however, are more rectangular in outline, and composed of four or five faces accordingly as the figures are mature or primitive. (See Fig. 2). In the mature etchings, the four bounding faces are usually triangular and meet at a point well to one side of the figure. Like the figures previously described, the two larger planes lie in the prism zone, hence the etchings

are elongated parallel to the prism edges, and altho the contour at first appears symmetrical in two directions, closer examination reveals two faces lying in the prism zone which are not of the same intercept. The ends of the figure above and below are similarly developed; consequently, the etchings indicate an equatorial plane of symmetry.

Prism (120)

This form is usually more or less striated, so that the etching is very apt to proceed too rapidly, unless precautions are used. Nevertheless, the two solvents used for the previous etchings gave equally as good results upon the prism *l*. The etch-figures produced by immersion of four minutes in a dilute fusion of potassium hydroxide are represented in fig. 3. They are oval figures, acute at either end and elongated parallel to the prism edges. Of the two longer contours, the one adjacent to edge 110/120 is more sharply curved, indicating an absence of a vertical plane of symmetry. As solution continues the ends of the figures become modified thru the continuation of the larger face as a pointed appendage. This may be seen in diagram A, which, in the most mature stage of development, marks the intersection of a small triangular face with the surface of the crystal. It is surprising what a change from simplicity to complexity takes place in the evolution of the etch figures as solution goes on; but never at any stage does the etching fail to meet the symmetry requirement of the prism face, which in this case consists of an equatorial plane of symmetry.

Figure 4 represents the etchings produced on the prism, (120) after immersion in the potassium bisulfate and fluorite fusion for forty minutes. These figures are very similar to those just described in the mature stage, but in the earlier stages of development the pointed appendages, so prominent on the KOH figures, do not appear to be present. These etchings are fan-shaped, with three distinct faces grouped about one side of the central portion of the figures. Opposite these there lies a large face which descends gradually from the crystal surface to the deeper portion of the figures, and the contour of which is a symmetrical curve. The figures, altho very complex, are symmetrical above and below the equatorial plane.

Brachypinacoid (010)

Altho the brachypinacoid is frequently present on the Thomas Mts. crystals, the face is usually small and reveals only a few well defined etchings. (See Fig. 5). The figures are simple elliptical forms with the elongation parallel to the *a* axis; they are usually composed of four faces symmetrically arranged in pairs, with a groove running thru the center of the figures, parallel to the short axis of the ellipse. In accordance with the type they indicate two planes of symmetry, one passing thru the b and c axes, the other the equatorial plane. Hence, the various etchings of the prism zone are alike, in that they are all symmetrical to an equatorial plane.

Pyramids

The pyramids (221) and (111) are well developed and yield very fine etchings after only a brief immersion in the potassium hydroxide fusion. (See diagram A.) The figures occurring on (221) are simple triangular pits, usually composed of three faces, asymmetrically arranged. The figures are elongated in a direction inclined to the edge 221/110, with the acute end turned toward the macrodome. The base of the triangles is often continued, producing a pointed appendage at the larger angle of the figures. (See Fig. 6). The etchings by their positions on adjacent faces indicate two vertical planes of symmetry in the crystal, but the pyramid faces, as indicated by the form of the etchings, possess a molecular configuration which is asymmetrical.

The unit pyramid behaves very similarly to the (221) form and the figures are only slightly different. (See diagram A, and Fig. 7.) They have a similar orientation and are asymmetrical; they are also much more elongated, possessing curved boundaries, and being rounded at the acute angle. Like the etchings of (221), their position on adjacent pyramid faces indicates the presence of two symmetry planes.

Domes

Of the two domes present, (201) and (041), the brachydome is usually better developed and is acted upon by the alkali fusion more rapidly than the other form. Immersion in dilute potassium hydroxide fusion for a time sufficient to corrode the brachy-

dome, produced only a few small etch pits on the macro form. This difference of solubility is not so marked in the case of the potassium bisulfate-fluorite fusion. It is to be observed, however, that such a comparison of the relative solubilities of the two forms can be made only when both faces are of like perfection, for often a more insoluble form is very readily attacked by solvents, because of an imperfect or rough surface. The great necessity of a perfect crystal surface for the investigation of artificial etchings cannot be over-emphasized.

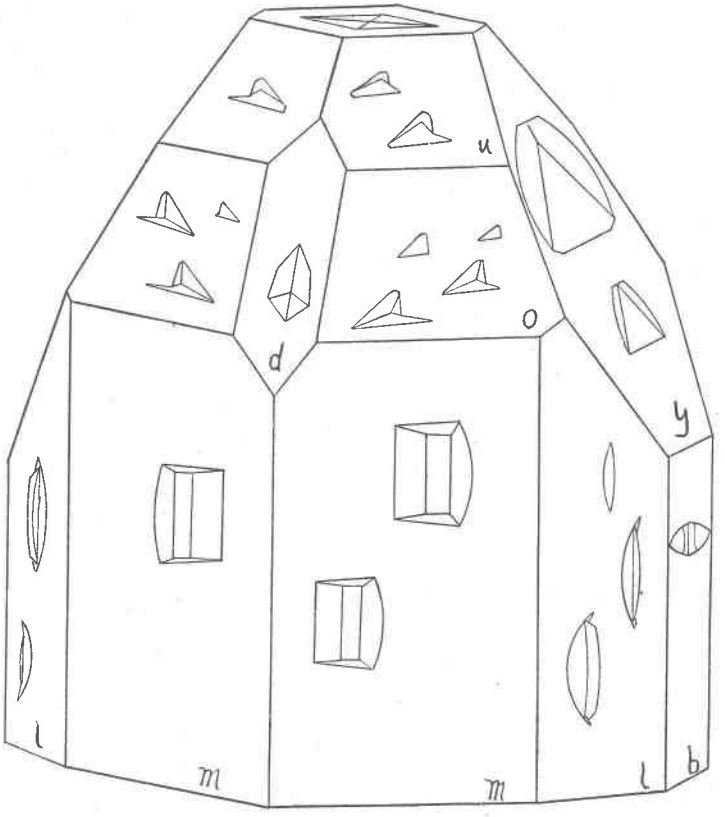

DIAGRAM A. ETCHING FIGURES ON TOPAZ

Well defined etchings were obtained on the macrodome after several minutes immersion in a dilute fusion of potassium hydroxide. The figures, altho small, appear as illustrated in

diagram A, Form d. They are composed of three or four faces, and are usually hexagonal, broader at the lower end and elongated vertically. The figures are symmetrical to a vertical plane.

The brachydome etches with great ease if immersed in either of the two fusions. The figures produced by potassium hydroxide are illustrated in diagram A, Form y. There are present three faces, the largest of which is triangular and lies in the zone of the brachydome and base. At either side there is a narrow curved face which extends the entire length of the figures and these meeting form the acute apex of the triangular etching figure. (See Fig. 8.) The figures have curved contours and are oriented symmetrically, with the apex turned upward. Different etchings were obtained with the potassium bisulfate-fluorite fusion; a longer immersion even to the extent of thirty minutes being necessary, but the figures produced are usually distinct (see Fig. 9), and are of two kinds, triangular and semi-circular; the former may appear flattened, due to the truncation of the apex by a small face lying in the zone of the brachydome. Occasional figures are marked by faces lying at the bottom, but this represents a particular stage in the development. The contour forming the base of the figures is straight and extends parallel to the intersection 041/010. The other boundary lines are curved, but are symmetrical, revealing a vertical plane of symmetry thru the face. Hence the dome faces, as represented by their etching figures, are also in accordance with the holohedral symmetry of the orthorhombic system.

Base (001)

This form etches very rapidly with the potassium hydroxide fusion and, as the etchings produced do not differ from those described by Baumhauer, either in form or orientation, no further description is required. If a crystal is immersed in a red-hot fusion of potassium bisulfate and powdered fluorite for about twenty minutes, the figures resulting are quite unlike any hitherto described on topaz. The figures as they first appear are to a considerable degree circular, with a very slight elongation parallel to *b*. (See Fig. 10, *a*.) As solution continues the figures become deeper and angular (see Fig. 10 *b*); they become rhombic forms, the diagonals of which appear to be approximately of the same length; the contour is still rounded to a small degree

and remains so, the continued development being one of complexity, and confined to the inner portion of the pit. (See Fig. 10 *c*.) This development as observed under greater magnification includes the formation of a long rhombic pit within the primitive figures and elongated parallel to *a*; each side of this rhombic form is subdivided into two faces, as the mature stage approaches, producing as the ultimate form, Fig. 11, an etching bearing the primitive outline inset with an elongated octagonal pit, extending parallel to the brachy-axis and divisible by two symmetry planes. This manner of growth, while involving a great many changes, never alters the figure to a form other than one which accurately indicates the symmetry of the basal pinacoid.

Topaz is, therefore, according to the etchings of six fundamental crystal forms, divisible by three symmetry planes at right angles, which accords with the holohedral symmetry of the orthorhombic system of crystals.

SOME CRYSTAL LOCALITIES IN ST. LAWRENCE COUNTY, NEW YORK[1]

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St. Lawrence county, New York, has long been famous for numerous localities from which fine mineral specimens representing many species have been obtained. Specimens from this region have found their way into many of the mineral cabinets of the world. During the prosecution of the detailed geological survey of the Russell quadrangle, in the middle of the county, a number of mineral localities (mostly new ones) of considerable interest were found by the writer. At most of these places good crystals and groups of crystals of tremolite, diopside, and hornblende may be obtained with the aid of a geologist's hammer, but much better material would doubtless be found by blasting open the ledges.

[1] Published by permission of the State Geologist of New York. [The famous mineral localities of St. Lawrence County have not been treated in this series of articles heretofore; but we are glad to report that in addition to the present description of several new localities, we have on hand a manuscript in which all of the older ones are described in great detail; this will be published when space permits, in the course of the next 3 or 4 months. ED.]