Tear-Figures on Certain Minerals. II.

By

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In the first paper[1] upon this subject, published in *Octobar*, 1916, the tear-figures on stibnite, galena, sphalerite, pyrite, vivianite and enargite were described; and in the following the author desires to explain the characteristics of those on calcite, gypsum, and barite.

Calcite.

Hexagonal system; H-3; cleavage perfect rhombohedral, being parallel to (R); very brittle.

The specimen taken for examination was a cleavage piece {R} in which a face (R) and a section parallel to a basal pinacoid were polished. Its tear-figures were made with pressure of a needle-point against those sections.

On the rhombohedral face, the tear-figures are of two types, one being a parallelogram with sides parallel to the edges of the rhomb (Fig. 11, a; Fig. 1, a, Pl. IX), the other an obtuse-angled isosceles triangle whose apial angle is equal to the obtuse angle of the rhomb, having the two equal sides parallel to the edges (Fig. 11, b; Fig. 1, b, Pl. IX). An isosceles triangle with apical angle equal to the acute angle of the rhomb has not been produced.

1) Mikio Kuhara, "Tear-figures on certain minerals. I.", Memoirs of the Kiōto Imperia University, pp. 267–74, Vol. I, No. 8, 1916.

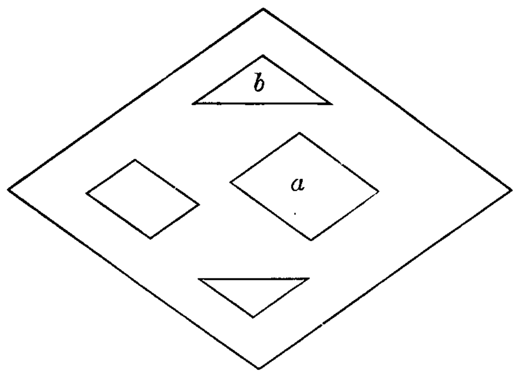


Fig. 11.

On a basal section, triangular (upright and inverted equilateral), trapezoidal and parallelogrammic figures, each with sides parallel to (R), have been produced (Fig. 12; Figs. 1 a, b, c and 2, Pl. X).

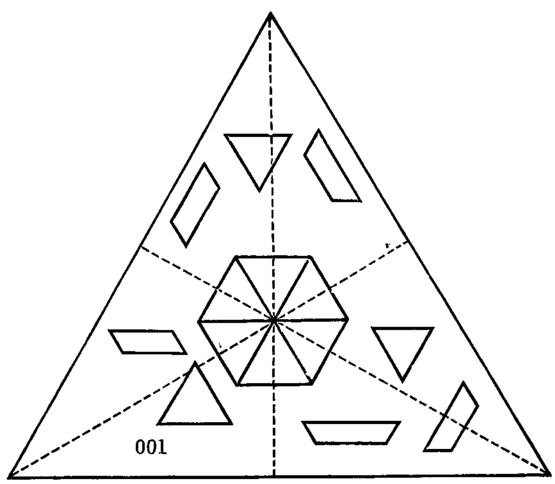
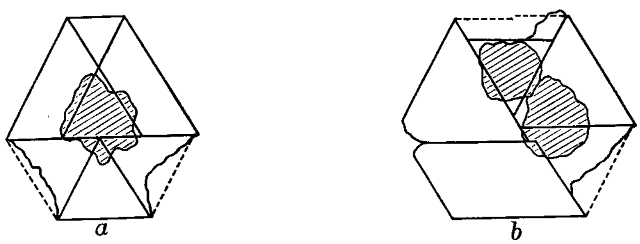


Fig. 12.

Where several figures of one or different types, triangular, trapezoidal and parallelogrammic, lay close together, a hexagonal figure with sides parallel to the basal edges of the hexagonal pyramid of the first order has been found to have been formed (Fig. 12; Fig. 13; Fig. 2, Pl. IX). Figs. 12 and 13a show a hexagonal figure composed of six triangles.

Fig. 13a is a diagrammatic figure corresponding to a in Fig. 2, Pl. IX. Fig. 13b, being a diagrammatic figure corresponding to b in Fig. 2, Pl. IX, shows a hexagonal figure composed of four triangles and one parallelogram.

On the basel section, an acute-angled (30° at apex) isosceles triangular figure[1], such as Samojloff considers to have been formed during polishing, has never been produced in the author's experiments, either by polishing with emery powder on a glass plate or by polishing in a metallographical method. But, instead of Samojloff's triangle, the author has observed equilateral-triangular pits, actually produced during preliminary polishing (Fig. 1, d, Pl. X), which possess exactly the same character as a triangular figure produced by a needle-point.



Hatched areas are the pits of a need-point.

Fig. 13.

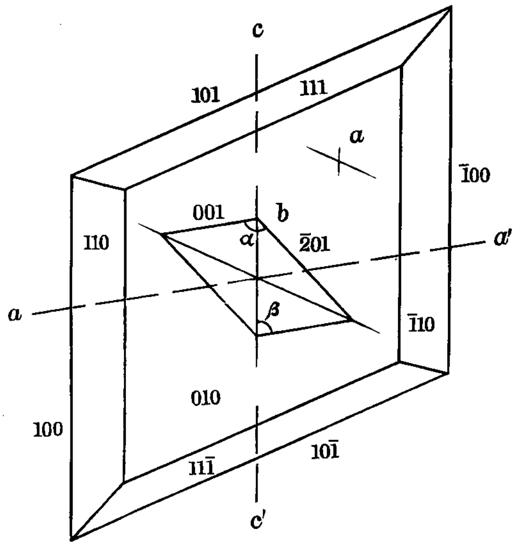
Interpreting the facts so far observed, the author has been led to believe that of four types of tear-figures on a basal section the most perfect and complicated form is hexagonal, in harmony with the base of the holohedral hexagonal pyramid of the first order.

Gypsum.

The specimen was a transparent, well-defined, tabular crystal distinctly exhibiting faces {110} and {010}, together with a negative unit pyramid. H-1, to 2; cleavage very perfect clino-pinacoidal and fair ortho-pinacoidal, and also fair parallel to a positive unit pyramid; very flexible; monoclinic system.

1) J. Samojloff, Zeit. für cyst. und Miner. pp, 19–22, Vol. XXXIX, 1914.

A very light pressure on the face (010) with a sharp needle-point has been found to produce a four-rayed figure consisting of two cracks intersecting at an angle of 66° 9′, the longer one being parallel to ($\bar{1}$10) and the shorter to (100), the direction of the two coinsiding with those of the fair cleavages (Fig. 14a; Fig. 1, Pl. XI). On applying a stronger pressure or impact, however, a parallelogrammic figure with the cracks as diagonals has been formed (Fig. 14b; Fig. 1 and 2, Pl. XI). Two sides of such a parallelogrammic figure are parallel to the base of the crystal, and the other sides[1] probably to face ($\bar{2}$01) which usually does not exist in a natural crystal.



$\alpha = 124° 30'$ appr. $\beta = 80° 40'$ appr.

Fig. 14.

The difference in the length of the cracks may indicate the grade of the cleavage in the two directions, while the sides of the parallelogrammic figure, associated with the cracks, may be wholly independent of the cleavage directions[2].

The four-rayed figure is undoubtedly a pressure-figure in character highly resembling a pressure-figure on the basal pinacoid of micas, while the parallelogram is a tear-figure which has evidently been formed by stripping off a minute portion of the gypsum.

By a pin's point on face {111}, cracks intersecting at right angle have been produced, as shown in Fig. 15, the longer crack being parallel to

1) By caluculation from the plane angle (α) these sides have been found to be parallel to ($\bar{2}$01). See Fig. 14.

2) According to Dana (System of mineralogy, sixth edition, pp. 933), Gypsum has cleavage in directions parallel to (010), (100), (101), ($\bar{3}$01) and ($\bar{5}$09).

{010}, and the shorter radiating toward (010) on (111) and toward (0$\bar{1}$0) on (1$\bar{1}$1).

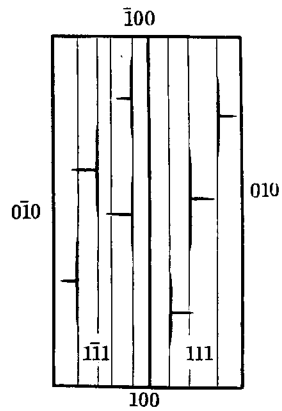


Fig. 15.

On the faces perpendicular to the axial plane containing c- and a-axis, only a single crack parallel to the cleavage direction (010) has been observed (Fig. 16).

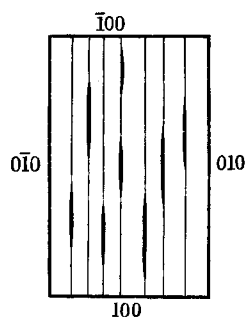


Fig. 16.

Barite.

The specimen was of rhombic tabular form, flattened parallel to the base and exhibiting the basal pinacoid and prism. H-2,5 to 3,5; cleavage perfect basal and fair prismatic; brittle; rhombic system.

The tear-figures on faces (001) and (110) were examined, each face having been polished and pressure applied with a needle-point.

On a basal pinacoid, a starlike figure with many rays of cracks was produced (Fig. 17; Figs. 1, 2, Pl. XII), but a slight polishing effaced the irregular cracks and disclosed a six-rayed figure composed of three cracks, one being longer and parallel to the shorter diagonal of the basal rhomb, and the other two shorter and parallel to the prisms or the directions of the fair cleavages (Fig. 17; Fig. 1, Pl. XIII). The three cracks may, therefore, be the main ones neccessary to form the figure and the others only shallow cracks produced irregularly by a lateral pressure of the pin's point without any close relation to the crystal construction. A lath-shaped rectangular figure, elongated along the longer crack, has always been found to exist at the centre of the six-rayed figure (Fig. 17; Fig. 2, Pl. XII; Fig. 2, Pl. XIII). Two groups of isosceles triangles, the one group being rotated 180° from the other, have rarely been produced on the basal pinacoid. Each triangle has the two short cracks as its equal sides and its base parallel to face (010) (Fig. 17b).

The rectangled and the starlike figures stand in accord with the two planes of symmetry, while the triangle with only one plane of symmetry which is parallel to the longer diagonal of the rhomb.

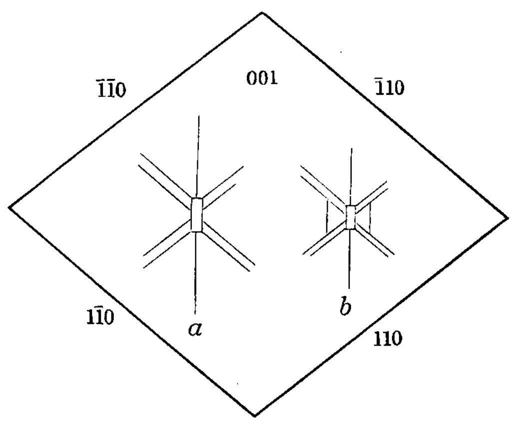


Fig. 17.

Samojloff[1] has observed a natural tear-figure on a basal pinacoid of a

1) J. Samojloff, Verhandl. d. russ. mineral. Geselsch. 1900, XXXVIII, pp. 343 and Bull. d. Natur. de Moscou, XVI, pp. 233.

barite crystal from Berge Gr. Bogdo, and Valentin[1] on that from Kronthal in Elsas. These tear-figures have been found to be isosceles triangles, being concordant with only one plane of symmetry, but all these triangles were oriented in two directions, one group of them being rotated 180° from the other group. Valentin regards such a figure as a naturally etched figure, while Samojloff assumes it to be a kind of natural "Abreissungs-figur" produced by the rubbing of wind-blown sands whose occurance is most usual in that locality. Taking into consideration the similarity between the Valentin-Samojloff's figure and the author's triangle, we may say that Samojloff's assumption with regard to the genesis of the figure may be correct.

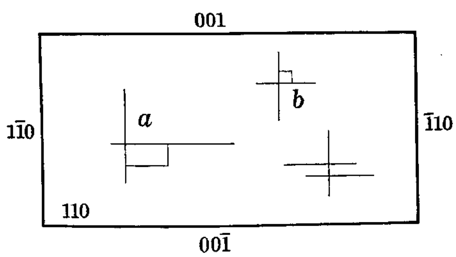


Fig. 18.

On a prism two kinds of cracks crossing each other at right angle and parallel to the base and a prism have been formed (Fig. 18; Fig. 1, Pl. XIV).

Further, a square and a rectangle, each possessing similar cracks for their sides have been found (Fig. 18 a, b; Fig. 1 a, Pl. XIV).

From the evidence brought forward in the present article it may be concluded, that a tear-figure sometimes may possess more sides than the number of edges bounding its host crystal face, and that some of them may be parallel to a face which exists in a more complicated crystal form. For example, a perfect tear-figure on the basal section of a rhombohedron of calcite is six-sided with sides parallel to the edges of the base of a hexagonal pyramid of the first order, while the base of the rhombohedron has a triangular form. In such a case as calcite, we can ascertain the shape

1) J. Valentin, Zeit. für Kryst. und Mineral 1889, XV, pp. 576.

of the basal section of the holohedral crystal by the tear-figure produced on the base of the hemihedral form.

Sometimes the existence of a face which has never been observed even in the most complicated crystal form may be shown by the side of a tear-figure. For example, gypsum usually does not possess face ($\bar{2}01$); but the tear-figure on face (010) shows a side which is parallel to a face corresponding to face ($\bar{2}01$).

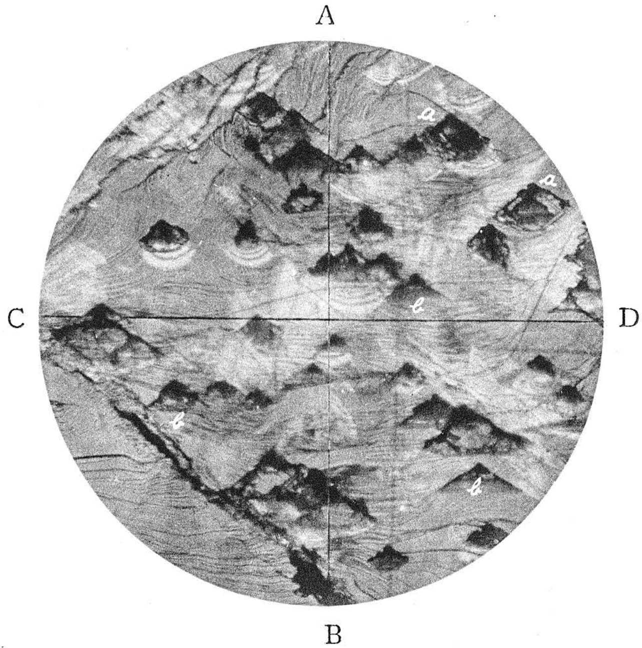


Fig. 1. Rhombic (a) and triangular (b) figures on a rhombohedral face of calcite.
AB and CD indicate the directions of the shorter and the longer diagonals of the rhomb respectively.
Vert. illum. Mag. 16 dia.

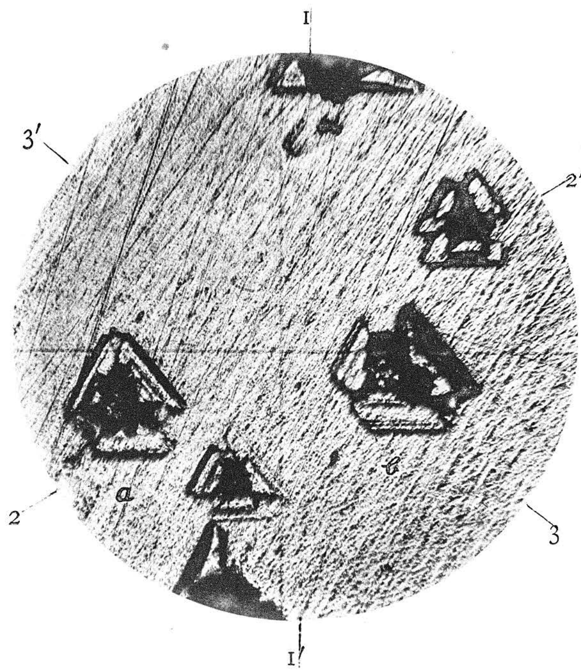


Fig. 2. Six-sided tear-figures on a basal section of calcite.
a......a figures composed of six triangles, (See Fig. 13).
b......a figure composed of probably four triangles and one parallelogram, (See Fig. 13).
Irregular spots at the centre of each figure are pits of a needle-point.
11′, 22′ and 33′......directions of the planes of symmetry.
Vert. illum. Mag. 60 dia.

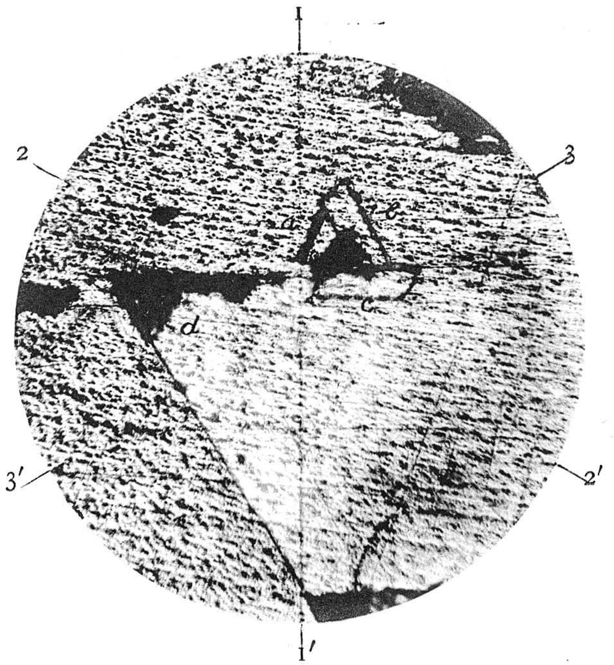


Fig. 1. Trapezoidal (b), parallelogrammic (c), and triangular (a) figures on a basal section of calcite. (d) is an equilateral triangular pit produced during preliminary polishing.
Irregular sport at the centre of the figure is a pit of a needle-point.
11′, 22′ and 33′......directions of the planes of symmetry.
Vert. illum. Mag. 60 dia.

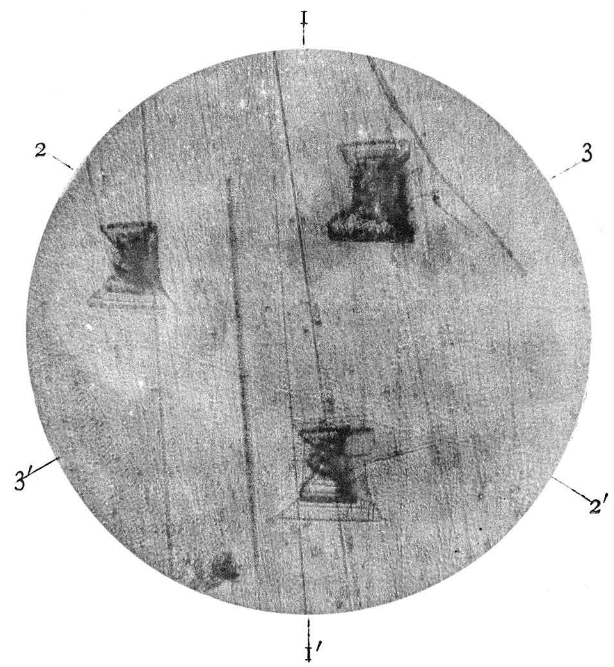


Fig. 2. Upright and inverted triangular figures approximately equilateral, on the section approximately parallel to a base of calcite.
11′, 22′ and 33′......directions of the planes of symmetry.
Vert. illum. Mag. 50 dia.

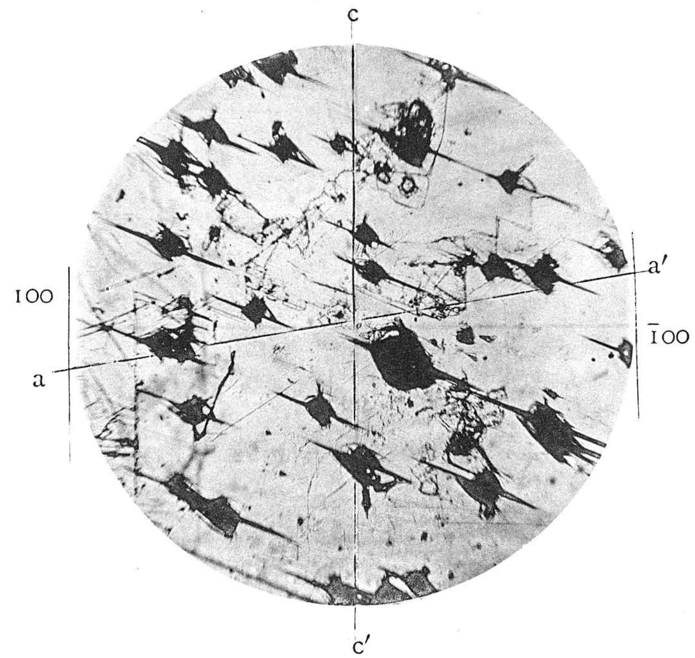


Fig. 1. Tear-figures on the clinopinacoid of gypsum. Obliquely intersecting cracks and the associating parallelogrammic figures are shown. The longer and the shorter cracks are parallel to a positive unit pyramid and the face (100) respectively.

aa′......clino-axis.

cc′......ortho-axis.

Transmitted light. Mag. 16 dia.

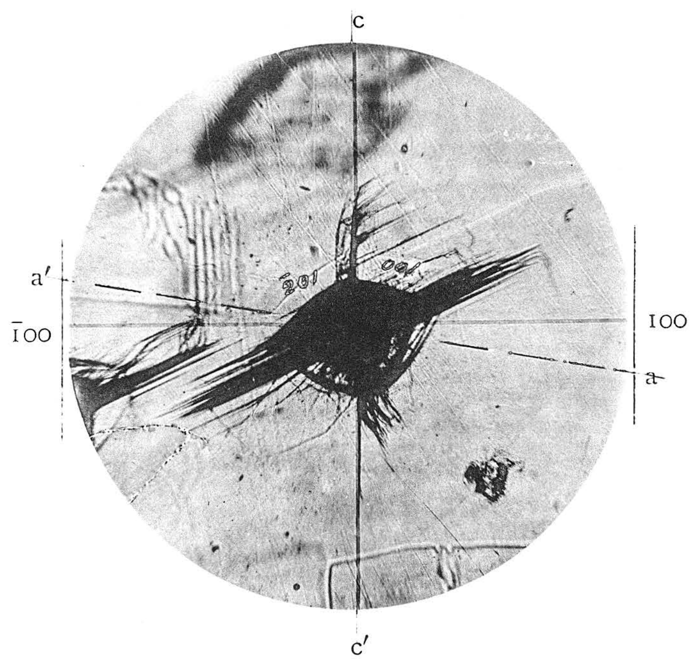


Fig. 2. A part of Fig. 1 highly magnified. For photographic convenience, the specimen was rotated 180° on c-c′. The parallelogramic sides parallel to (001) and probably ($\bar{2}01$), are shown.

aa′......clino-axis.

cc′......ortho-axis.

Transmitted light. Mag. 50 dia.

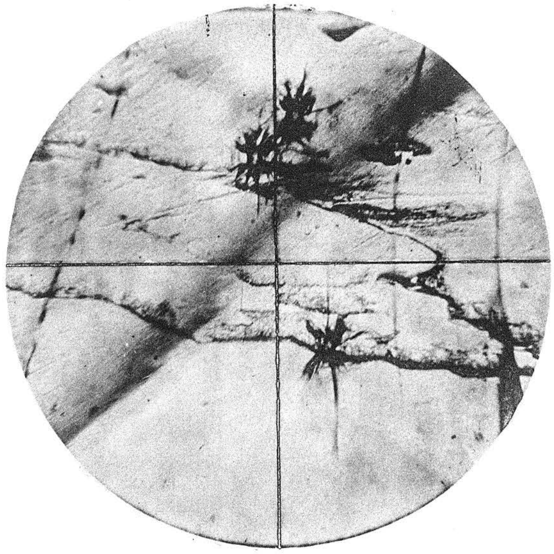


Fig. 1. The starlike figures on (001) of barite with a needle-point. North-south line indicates the direction of the shorter diagonal of the base.
Transmitted light. Mag. 50 dia.

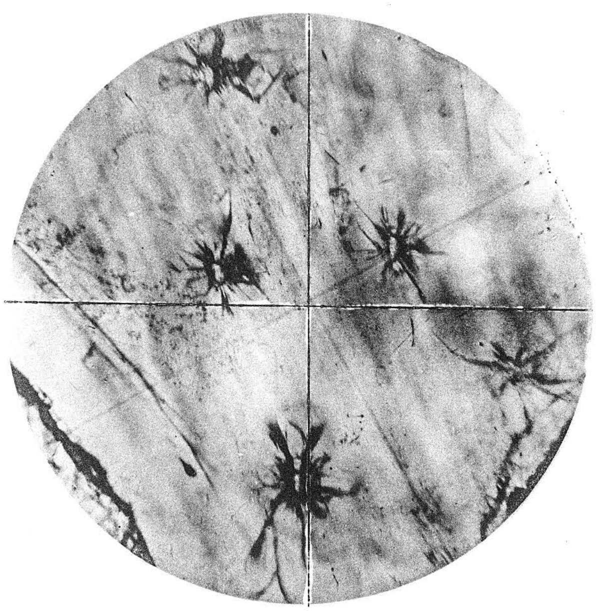


Fig. 2. Same as Fig. 1.
At the centres of the starlike figures, rectangles are seen.
Transmitted light. Mag. 60 dia.

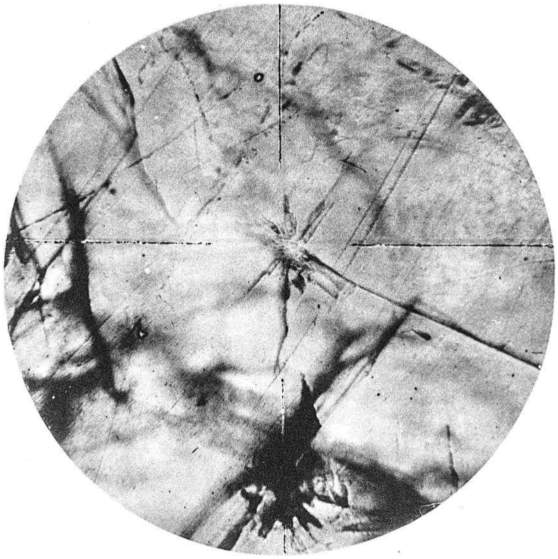


Fig. 1. The six-rayed figure on the basal pinacoid of barite produced by a needle-point and by polishing to eliminate the irregular cracks.
North-south crack is parallel to the shorter diagonal of the basal rhomb, and the two other cracks are parallel to the cleavage directions (110).
Transmitted light. Mag. 80 dia.

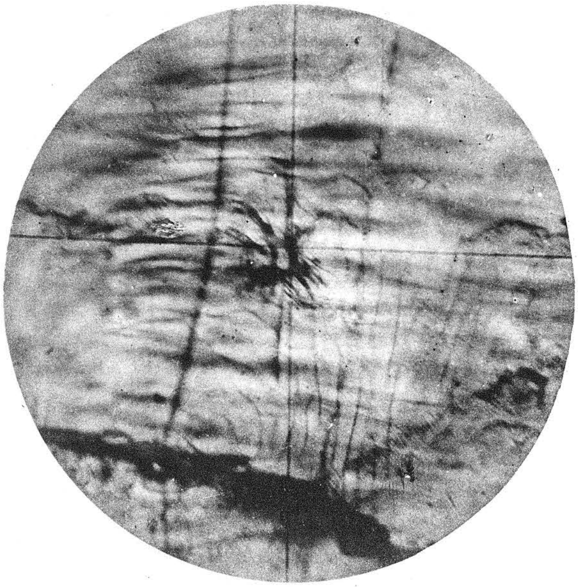


Fig. 2. The starlike figure on the base of barite, highly magnified to show the central rectangle distinctly.
Transmitted light. Mag. 100 dia.

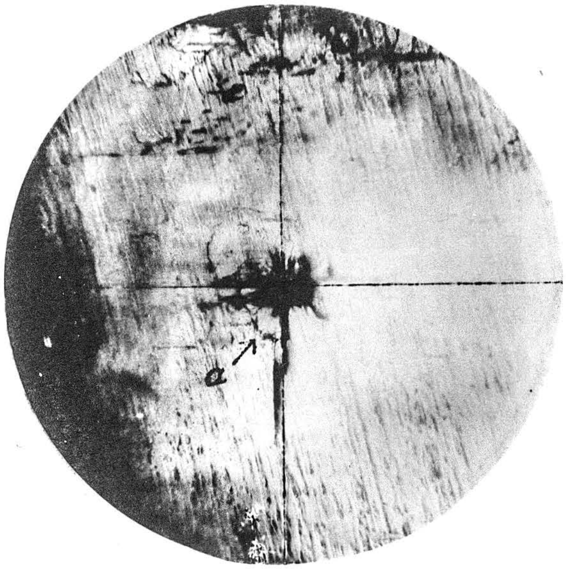


Fig. 1. The crossed cracks and the associating square figure (a) on the section parallel to (110) of barite. North-south line indicates the direction parallel to adjacent prisms, and east-west line parallel to the base. Transmitted light. Mag. 80 dia.