specimen ring in place is machined so that when it is slipped into the rotating device the sample surface comes into the exact center of the goniometer. This fulfills the basic requirement that the center of the sample must coincide with the axis of the goniometer.

This modified holder has been very successfully used in the investigation of clay minerals such as montmorillonites, kaolinites, and illites.

NOTES ON A SIX-RAYED DIFFRACTION STAR PRODUCED BY MAGNETITE ENCLOSED IN MUSCOVITE

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Description of the magnetite by B. M. Shaub

During the autumn of 1954, Frank L. Leggett of Meredith, New Hampshire, brought to the writer's attention a small rectangular piece of asteriated magnetite $7\frac{1}{2} \times 9\frac{1}{2}$ mm. in size enclosed in a clear amber-colored piece of good quality muscovite 4×6 in. in size. The thickness of the piece of enclosed magnetite was not determined, however, it is probably very thin although it is distinctly opaque. The specimen came from a quarry operated in 1944 by Leslie Smith of Campton, New Hampshire, and Percy Leggett of Gorham, New Hampshire, on property owned by Mr. Carr of Thornton, New Hampshire. The mine was operated for mica and located in a pegmatite about $\frac{3}{4}$ of a mile from Mr. Carr's farm. The writer wishes to extend his thanks and appreciation to Mr. Frank L. Leggett for supplying the material and data for this paper.

A microscopic examination of the magnetite showed it to be divided into numerous small pieces bounded by a series of very fine open linear spaces which are located at 120° to each other. These microscopic spaces are seldom of any linear extent but are soon offset by joining one or both of the lines in the other two 120° directions. The shapes and sizes of the separate pieces are extremely variable although they form a perfect mosaic of closely fitting units separated from each other by the extremely narrow slits or cracks, Fig. 1. When a point of light is viewed through the trigonal network of minute cracks a distinct six-rayed star is clearly visible, Fig. 2.

The orientation of the rays of this star is such that the rays are normal to the system of three slits or cracks in the magnetite. The relationship is shown in Figs. 1 and 2, respectively. The vertical ray is normal to the horizontal line-openings, and the N.E.–S.W. ray is normal to the N.W.–S.E. ray and in a like manner for the third ray.

The cause of the development of the trigonally arranged linear openings in the magnetite may be due to one of three possible causes. (1) A differential contraction between the muscovite and the magnetite, during cooling, may have produced such a system, of fractures, providing the magnetite has a larger coefficient of expansion than the muscovite. This could cause the magnetite to separate along planes of minimum cohesion during cooling. (2) Each unit could represent a distorted magnetite crystal of minute size in parallel position and oriented with an octahedron face parallel to the cleavage plane of the mica. The trigonal lines representing open spaces between the crystal boundaries which may have been enlarged by 1 above or 3 below. (3) In the mining operations the flexing of the muscovite could have fractured the thin piece of magnetite along the octahedral directions and thereby divided the large flat grain of magnetite oriented with an octahedron face parallel to the cleavage, into many small pieces along the "parting" planes. If this were the correct answer one would expect a preponderance of cracks in one of the three particular directions as well as fractures extending across in irregular directions. It is quite likely that a combination of two or all of these factors may have contributed to development of the slits now present in the magnetite.

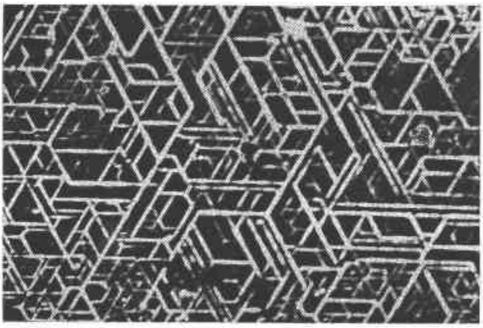

FIG. 1. Photomicrograph of trigonal lines, minute linear spaces, in a small piece of magnetite enclosed in muscovite. X=11.6

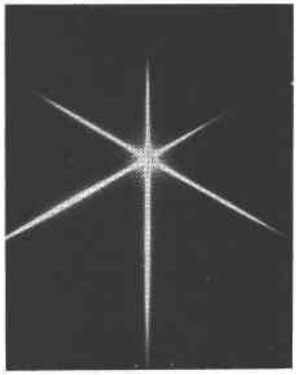

FIG. 2. Six-rayed star produced by a beam of light passing through the fractures of the magnetite shown in Fig. 1. The rays are perpendicular to the linear openings in the magnetite.

In examining Fig. 1, one will notice that many nodes occur along most of the white lines, which represent the cracks on the magnetite. This appears to be a phenomenon associated with the diffracted beams of light in passing through the narrow slits. The lines in the photograph are proportionally wider than the actual openings in the specimen due to the diffraction of the light beam in passing through the narrow openings during the exposure of the photographic film.

In order to be certain that the material in the muscovite was magnetite, the muscovite specimen was supsended on a very long fine thread and when the torsional effect, inherent in the thread, was released after being suspended for some time, one could cause a rotation of the specimen in either direction by bringing a small alnico magnet in the proximity of the inclusion within the muscovite. The black and opaque nature of the inclusions together with its magnetic properties proved it to be magnetite.

A note on the cause of the asterism, by Dorothy Wrinch

In Figs. 1 and 2 above we have (1) a highly complex distribution which is preferentially arranged with respect to three directions which form

FIG. 3. Diffraction pattern of a triangular aperture.

a trigonal set of axes, and (2) a centered distribution in which strong intensities radiate in the six directions at right angles to the set of axes. It is of interest to study these figures in the light of the diagram shown in Fig. 3 which is taken from the works of a well known astronomer of the nineteenth century (Bridge 1858).

In the era of Airy and Bridge, the diffraction patterns of eyepieces of various shapes were matters of considerable interest to astronomers and the diffraction patterns of square and rectangular eyepieces and eyepieces of triangular and circular form were well known, both geometrically and analytically. The effect on the diffraction pattern of repeating such shapes in regular arrays was also studied in the classical investigations of circular holes arranged on a triangle, and square holes arranged in a square, etc. (Airy 1834, Bridge 1858). Nowadays the relation between $g(xyz)$, a distribution of atoms, or more generally an electron density distribution, and $G(XYZ)$, its structure factor or Fourier transform (Hettich 1935, Wrinch 1946, Glaser and Wrinch 1953), is much used in crystal structure analysis and we recognize the analysis of the diffraction pattern of repetitions of various shapes on a lattice in the works of the astronomers in its modern form in which, for a distribution g, repeated on a lattice L, the structure factor is G, sampled at the reciprocal lattice L^*.

In Figs. 1 and 2 above, we have an illustration of the type of relation between a non-periodic distribution g and the square of its structure factor $[G]^2$. We may compare the edges of the small triangle in Fig. 3 forming a trigonal set of directions, with the preferential directions in the distribution, Fig. 1, and the direction of the rays of the star lying at right angles to these axes, in Fig. 3, with the preferential direction of the rays in the star of Fig. 2. Further analysis of cases of this kind, with special reference to such issues as the "spacing" between the parallel distributions in Fig. 1 and the detailed geometry of the star in Fig. 2 can be carried out in terms of the general relations (Wrinch 1946) between a distribution g and its Fourier transform G.

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HYDROTHERMAL GROWTH OF ALUMINUM ARSENATE CRYSTALS

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The growth of aluminum orthoarsenate crystals of sufficient size and quality for evaluation of their piezoelectric properties was undertaken because previous studies had shown that its crystal structure was