to remain on the turntable. As they are carried in front of the ejector, an air jet blows them into the discard receptacle. White or black paper is glued to the top of the turntable to facilitate identification of the desired grains.

As the assemblage of grains is brought into the field of the microscope, the operator picks the desired grains with the vacuum picker shown in the figure. This consists of a glass tube drawn out to a fine opening at one end and connected to a water filter pump at the other end. Close to the vacuum end of the glass tube is a sintered glass disk. As the grains are sucked up, they collect in the tube just in front of this disk. To remove the grains, the tube is made in two parts connected by a ground glass joint secured with small springs (not shown in diagram).

The apparatus is built on a 5″×6″×9″ metal box. The turntable motor is geared to revolve at 3½ turns per minute at 110 volts, and its speed is further reduced to about ¼ turns per minute by reducing the voltage with a Variac control. The distribution drum motor is also geared down and controlled by a Variac. Its speed will vary with the size of hole used. In this case 100 to 200 turns per minute was found to be a convenient speed. The discard receptacle is made from a plastic box cover cut to fit close to the turntable. It might be pointed out that the distribution drum should not be made of plastic material. The electrostatic charges built up on such a drum tend to clog the orifice restricting the flow of particles.

Where this type of work is to be conducted over an extended period of time, eye strain on the operator may be reduced by projecting the field on a small screen with a prism. To do this, however, requires stronger illumination than can be obtained with an ordinary microscope lamp.

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UNIT CELL OF SCHAIRERITE

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Schairerite ($Na_2SO_4 \cdot Na(F_{.814}Cl_{.186})$) was discovered in the Searles Lake complex of salts by Foshag and described by him in 1931. The mineral occurs with a pronounced trigonal habit with the suggestion of rhombohedral symmetry. Artificial crystals of the same substance had previously been synthesized by Schairer (1930) of the Geophysical Laboratory for whom the mineral was named. Dr. Clifford Frondel of Harvard in a paper on *Habit Variations of Sodium Fluoride* (1940) gave *x*-ray data obtained from a natural crystal of schairerite. In this paper he suggested that the elements he obtained "gave a hexagonal cell inconsistent with the morphology." He suggested a rhombohedral interpretation with a tripling of his value for c_0.

Crystals of the natural mineral came to the attention of the senior author, and it was decided to investigate the discrepancy between the morphological and x-ray values. Results of that investigation follow.

Morphology.—Foshag noted four forms: $c\{0001\}$, $m\{10\bar{1}0\}$, $r\{10\bar{1}1\}$, and $e\{01\bar{1}2\}$. The authors examined six crystals and did not observe any additional forms. It should be noted, however, that although the forms r and e apparently show a rhombohedral development which conforms to the rhombohedral centering rule of $h+i+l=3n$, the development of the prism $\{10\bar{1}0\}$ is not at all typically rhombohedral. The typical and expectable prism in rhombohedral minerals is $\{11\bar{2}0\}$. On morphological grounds alone, then, a rhombohedral symmetry for schairerite is to be questioned. A trigonal symmetry, however, is obvious. Reproductions of Foshag's figures 3 and 4 are shown, Figures 1 and 2, to demonstrate the apparently non-rhombohedral symmetry of the mineral. Foshag gives 2.764 as an average value for c/a from 24 measurements of r faces; from 8 measurements of e faces he obtained 2.749. Our best average value is 2.752. Foshag gives as his preferred value 2.7634 which is not appreciably different.

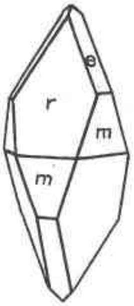

FIG. 1. Schairerite. (Figure 3 of Foshag.)

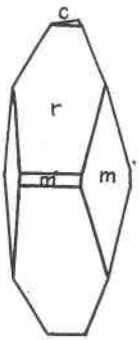

FIG. 2. Schairerite. (Figure 4 of Foshag.)

X-Ray Data.—Rotation, 0, 1st, and 7th layer line photographs were taken about the c axis. There was no hint in the rotation picture of the possible tripling of the c axis which was suggested by Dr. Frondel. Since c_0 was of the order of 19kX units and since Cu radiation was used, there was doubt in the authors' minds that the 0 or 2nd layer line spots could be screened adequately while taking the 1st layer line. For this reason, a

7th layer line picture was obtained upon which any rhombohedral distribution of lattice planes could be noted. None was observed. Photographs about the c axis gave the following data:

Non-rhombohedral symmetry
No systematic omissions
$c_0 = 19$ kX ca.
$a_0 = 7.05 \pm 0.02$ kX units
$m_0 = 12.22 \pm 0.03$ kX units

Since Frondel had given a_0 equal to 12.12 and c_0 equal to 19.19, it seemed desirable to check the chosen a_0 by rotations around the a and m axes. Rotation and 0-layer line photographs were taken about each of these axes and the results showed unequivocally that Frondel's a_0 was actually m_0 of the lattice. A value for c_0 was obtained from the 0-layer line picture about the m axis $[10\bar{1}0]$. Interpretation of these pictures gives the following data:

Non-rhombohedral symmetry (all orders of (0001) were present, not just $3n$ orders).
$c_0 = 19.33$ kX units.

Crystal class.—The trigonal symmetry of the crystals restricts the crystal class to the following:

$3, \bar{3}, 3m, 32, \bar{3}2/m, \bar{6}, \bar{6}m2$

An examination of the crystals on our own part and of those drawn by Foshag seems to indicate that four of these may be eliminated for the following reasons:

Class 3 is not proper since there is no center of symmetry in that class and a center of symmetry seems to be present on most crystals. Foshag's figure 4 (our figure 2), however, does not indicate a center of symmetry. The major part of the evidence indicates, however, a higher symmetry operation than is present in class 3.

Class $3m$ is unlikely because it does not account for the typical symmetrical relationship of the bottom faces to the top faces, or of the generally equal development of the six faces of $\{10\bar{1}0\}$.

Class $\bar{6}$ is eliminated because of the presence of equal development of six faces of the prism $\{10\bar{1}0\}$ and because there is no hint of an horizontal plane of symmetry on most crystals.

Class $\bar{6}m2$ is eliminated because of the absence of a horizontal symmetry plane on the crystals.

X-ray Weissenberg layer line photographs of class $\bar{3}$ minerals would not show planes of symmetry, but on the 0 and 7th layer line pictures around [0001], symmetry planes are noted in each 60° position; therefore, class $\bar{3}$ is eliminated as a possibility.

The trigonal trapezohedral class 3 2 and the hexagonal scalenohedral class $\bar{3}\ 2/m$ remain as possibilities, and these cannot be distinguished on the basis of x-rays. The distinction between these classes must be based on morphology, and morphological data is inadequate for the determination. A piezoelectric determination might also serve to establish the 3 2 symmetry, but equipment for this test is not available to the authors.

Space Group.—No systematic omissions were noted for any of the planes of reflection. If the symmetry class be 3 2 the space group would be $C312$; if it is $\bar{3}\ 2/m$ the space group would be $C\bar{3}1m$.

Cell Contents.—If we assume the composition of the schairerite to be $Na_2SO_4 \cdot Na(F_{.814}Cl_{.186})$ as given by Foshag's analysis and accept Foshag's specific gravity of 2.612, the contents of the unit cell may be established, using our cell volume of 832.0 kX^3. We find that there would be 7 of the simplest molecules in the unit cell. Frondel obtained 21, but his cell volume is approximately 3 times ours because he used m_0 for a_0. The cell contents, then, are $Na_{14}(SO_4)_7Na_7(F_{5.70}Cl_{1.30})$. Foshag has indicated the probable isomorphous relationship of the fluorine-chlorine in the composition, and the non-rational quantities of these elements in the unit cell bear out his conclusion.

The calculated specific gravity obtained from this cell is 2.60 which is in close agreement with the 2.612 specific gravity obtained in heavy liquids by Foshag. We made a specific gravity determination by using 10 small crystals on the Berman Balance and obtained 2.63. Foshag's measurement is in closer agreement with the calculated value.

Conclusions.

Lattice Mode: Hexagonal—P (not rhombohedral).
Crystal class: 3 2 or $\bar{3}\ 2/m$.
Space Group: $C\ 312$ or $C\ \bar{3}1m$.
Lattice periods: a_0 7.05, c_0 19.33. $c_0/a_0 = 2.742$.
Cell contents: $7[Na_2SO_4 \cdot Na(F \cdot Cl)]$.
Specific gravity: 2.60 calc.; 2.612, 2.63 meas.
Morphological linear ratio:
  $c = 2.7634$, Foshag
  $c = 2.752$, Wolfe and Caras

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