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SCHAIRERITE, A NEW MINERAL FROM SEARLES LAKE, CALIFORNIA

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The mineral deposit of Searles is a remarkable body of salts contained in a playa "lake." The central portion of this playa is occupied by a body of solid salts covering an area of more than twelve square miles, and exceeding 100 feet in thickness. About this central salt core is a peripheral band of saline muds, in many places rich in minerals. In various parts of this deposit have been found crystals of uncommon character. Six new minerals, all double or triple salts, have been found, some of them in considerable abundance. There is reason to believe that these species are present in considerable quantity in certain parts of the deposit but since most of them have been recovered by deep drilling, only small quantities are usually available to the mineralogist. Hanksite crystals can be recovered from the muds of the playa in large numbers and pirssonite is sufficiently abundant to form thin strata in the deeper layers. Northupite is fairly abundant in some well samples. Tychite once known only as the original three crystals, seems to characterize a particular thin band rich in gaylussite. Sulfohalite is probably one of the rarest of the minerals from Searles Lake.

In the examination of drill samples from a well obtained by the U. S. Geological Survey in 1912, a seventh new species was found. This well, drilled in the central part of the salt crusts, penetrated the salt body for a depth of 125 feet. The material obtained from these samples consists of rather pure salts with but little contamination of muds and sand. Unfortunately the sample yielding the new mineral was without any information as to depth, although judging from its chemical character it was one of the deeper samples, the deeper layers being more calcareous than the intermediate or upper ones. For this new species, a sulfate and fluoride of soda, the name

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schairerite is proposed in honor of Dr. J. F. Schairer of the Geophysical Laboratory of the Carnegie Institution, who studied[1] the quarternary system Na_2SO_4-NaF-NaCl-H_2O, in which this compound plays a prominent part. A considerable quantity of the salts containing schairerite (U. S. N. M. 90685) was available but the mineral is present in such small amount that only three-fourths of a gram of material was recovered (U. S. N. M. 96437). This was obtained by concentrating the mineral with heavy solutions and picking out the crystals of schairerite by hand.

For analysis three portions were taken, one of 2000 milligrams was used to determine all constituents except chlorine and fluorine. A second portion of 1500 milligrams was used for chlorine and a third of 900 milligrams was used for fluorine. Due to the paucity of material, magnesia and carbon dioxide, known to be present as extraneous material, could not be determined and the summation of the analysis is consequently low. The sample used for analysis consisted of small crystals that had been washed to remove the easily soluble extraneous coating on some of the crystals. The sample so prepared was examined under the microscope and found to contain small amounts of hanksite, gaylussite and tychite. The crystals of schairerite also contained small included crystals, the crystal outline of some suggesting hanksite with others of unknown character. The total amount of extraneous matter, however, did not exceed 1 per cent. The results of the analysis is given in the following table.

Analysis and Ratios of Schairerite

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	Analysis	Ratios			Theoretical composition
Ign. loss	0.90				
Insol.	0.20				
$(Fe, Al)_2O_3$	0.15				
CaO	0.30	.0033			
Na	35.77	1.5777	1.5810	3.019	37.5
K	0.13	.0033			
SO_4	50.01	.5205		1.000	52.2
Cl	3.44	.0972	.5224	.997	10.3
F	8.08	.4252			
Total	98.98				

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[1] A. W. Foote and J. F. Schairer, *Am. Jour. Sci.*, **52**, pp. 4202–4217, 1930.

The determination of fluorine, made by the Berzelius method, was checked by the conversion of CaF_2 to $CaSO_4$, the calculated percentage of fluorine by this method being 8.0 per cent. The presence of fluorine in the original precipitate was further checked by the etching test.

The ratios derived from the above analysis gives schairerite the formula $Na_2SO_4 . Na(F,Cl)$, requiring for the pure fluorine salt the theoretical composition given in column three. That the chlorine is isomorphous with the fluorine is indicated, first, by the absence of any impurities to which this amount of chlorine can be ascribed and second, the simplicity of the ratios when it is so considered. Schairer found that chlorine enters into the composition of the salt to a limited extent, the greatest percentage of Cl found in his prepared sample being 3.8 per cent. The natural mineral seems therefore, to show the maximum degree of miscibility.

Schairerite is slowly but completely soluble in water. The solution gives the usual reactions for sulfates and chlorides. It fuses easily to a white porcelainous mass, coloring the flame an intense yellow. Hardness $= 3\frac{1}{2}$. G. (by floating in heavy solution) $= 2.612$.

The crystals of schairerite seldom exceed a millimeter in length, the largest measuring less than two millimeters. Some are sharp and perfectly formed, others are rather distorted. They appear as steep trigonal rhombs. A number of crystals were mounted and provisionally examined but only ten were completely measured. These measurements completely confirm the trigonal nature of the crystals.

The few forms present on the crystals are: $c(0001)$, $m(10\bar{1}0)$, $r(10\bar{1}1)$, $e(01\bar{1}2)$.

c. Usually present as a small truncating face and often developed on one end of the crystal only. Rarely prominent and then only on one end. Dull and etched.

m. The prism varies from a narrow line face to a size sufficient to give the mineral a decided prismatic habit. Often absent. Reflections usually poor.

r. This form is the most prominent and important one of the crystals. It is always present and is usually sharp and smooth. Signals are usually excellent. This face was used entirely for orienting the crystal on the goniometer and the crystallographical constants are based upon measurements from this face.

e. This form is usually present as a narrow and truncating face. Rarely it approaches *r* in size. It is sometimes coarsely striated or offset by oscillation with the prism. Usually dull with poor reflections.

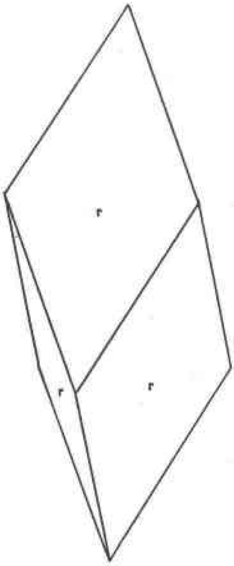

FIG. 1. Simple crystal of schairerite, Searles Lake.

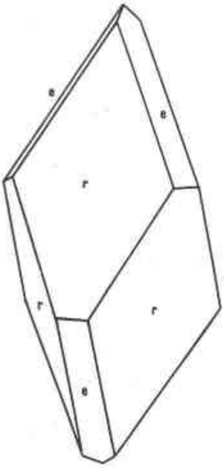

FIG. 2. Schairerite, Searles Lake.

The simplest crystal habit is a steep rhomb consisting of the faces *r*, usually sharp and well formed. This habit is shown in Fig. 1. This may be modified by *e* as narrow truncating faces, approaching, with an increase in the size of *e*, a simple hexagonal pyramid (Fig. 2). The faces of *r* can be easily distinguished from *e* by the striations and offsets commonly present. The addition of the prisms gives crystals somewhat narrower and elongated, assuming a shape shown in Fig. 3. A curious habit perhaps the result of twinning on the plane *c* is shown by crystal 7 (Fig. 4). Here the lower faces of *r* are directly below those of the upper *r* and separated by narrow faces of the prism. The artificial mineral prepared and described by Schairer is of a totally different habit. These crystals are flat, tabular in habit, with modifying faces of $(02\bar{2}3)$ and $(10\bar{1}3)$ (Fig. 5) .

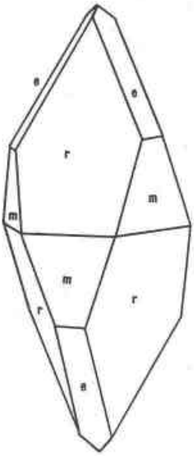

FIG. 3. Prismatic crystal of schairerite, Searles Lake.

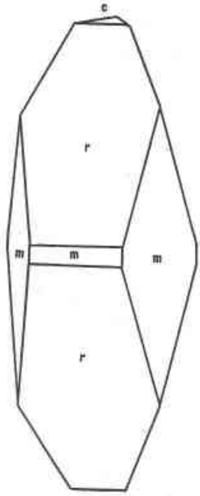

FIG. 4. Twin (?) crystal of schairerite, Searles Lake.

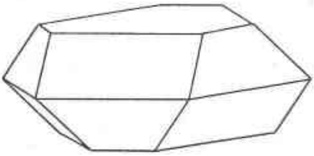

FIG. 5. Schairerite, artificial.

The ten crystals measured gave twenty-four satisfactory measurements of the ρ angle for the face r as follows:

	72° 30′	(3)
	34	(6)
	35	(3)
	38	(3)
	40	(3)
	41	(6)
Average	72° 36′	

For the face e, eight measurements were as follows:

	57° 42′	57° 50′
	43	52
	47	54
	48	
Average	57° 47′	

From the value of ρ for $(10\bar{1}1)$ the following constants were calculated for the position G_2:

$$c = 2.7634 \qquad p_0 = 1.8422$$

or for the position G_1:

$$c = 4.7662 \qquad p_0 = 3.1775.$$

From these elements the calculated angle for the face e is 57° 55′.

The orientation here adopted differs from that of Schairer for the artificial crystals. Here the large and well formed rhombohedron r is taken as the unit form and as is customary in rhombohedral crystals assigned the G_2 orientation. This, therefore, becomes the $(10\bar{1}1)$ face. Schairer's orientation is in the G_1 position with respect to the one here adopted and the unit rhombohedron assigned the indices $(03\bar{3}2)$. It is felt that, in view of the sharp and constant development of r on the natural crystals, the adoption of the bright rhombohedron as the unit form is preferable. With this new orientation Schairer's forms are:

$$(03\bar{3}2) = (10\bar{1}1)$$
$$(10\bar{1}1) = (02\bar{2}3)$$
$$(01\bar{1}2) = (10\bar{1}3).$$

In its purest state schairerite is colorless with a clear limpidity. It is also faintly milky or flecked with minute cloudlike masses of inclosed mud. Its lustre is vitreous. The mineral is brittle with conchoidal fractures. No trace of cleavage could be detected.

Examined under the petrographic microscope the mineral is characterized by a low index of refraction and an extremely low birefringence. The indices of refraction determined by the immersion method were found to be as follows: $\omega = 1.440$, $\epsilon = 1.445$. Schairer has found for the pure fluoride member $\omega = 1.436$, $\epsilon = 1.439$. In order to compare the indices of refraction of the Searles Lake mineral with that prepared by Schairer the two crystals were examined in the same oil and the natural mineral was found to be somewhat higher, as one might expect from its content of chlorine. The birefringence of the mineral is very weak, small grains appearing isotropic between crossed nicols, only the largest fragments show colors as high as light gray of the first order. The mineral is distinctly optically positive. Twinning noted by Schairer on the artificial material was not found on the natural mineral.

Schairerite was found in small quantity in a sample of a well drilled in the central salt crust and presumably came from a depth somewhere near the bottom of the salt crust. Associated with it are abundant clear and well formed crystals of gaylussite (U. S. N. M. 96440); small, clear, colorless to bluish octahedrons and cubo-octahedrons of tychite (U. S. N. M. 96436); clear, tabular crystals of pirssonite (U. S. N. M. 96441); etched laths and rods of thenardite (U. S. N. M. 96442); small amounts of trona; an occasional small crystal of hanksite; and rarely ivory colored opaque rhombohedrons of calcite. Only tychite was found attached directly to the schairerite crystals. Many of the crystals were partly coated with a fine, tenacious mud suggesting that schairerite occurs as single individuals embedded in a thin clayey stratum.

Inclusions within the schairerite crystals consist of small octahedrons of tychite, flat crystals of pirssonite (?), and thin laths of thenardite (?). While most of the salts are in the form of loose crystals a few samples were found in which the minerals are still in their original association. A few small fragments of aggregated salts consisting of thinly laminated, fine, sandy gaylussite were found. This material included abundant small octahedrons of tychite and an occasional crystal of schairerite. Other associated minerals are a few large, dark, northupite crystals, a few bladed crystals of thenardite and a single crystal of halite. This presumably represents the original association of the schairerite.