SEARLESITE FROM ESMERALDA COUNTY, NEVADA[1]

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INTRODUCTION

The mineral searlesite was first described by Esper S. Larsen and W. B. Hicks[2] from well boring samples from Searles Lake, California. It occurred in the muds of this deposit of salts as nearly white spherulites of minute size, made up of radiating fibers, intimately mixed with calcite, sand and other impurities. Material much better suited for investigation, was later found in the Silver Peak Range, Esmeralda County, Nevada. This was studied by Austin F. Rogers,[3] who determined the essential crystallographic constants and more accurate optical properties of this mineral. The writer visited the locality in company with Mr. Forest Gonyer, in the summer of 1929 and collected a quantity of material sufficient for a more thorough study of the mineral, including a complete chemical analysis of the satisfactorily pure mineral.

CHEMICAL PROPERTIES

Material for analysis was obtained by scraping the clear glassy crystals from their matrix and removing hyalite and barite by means of heavy solutions. The sample thus obtained consisted of broken fragments of clear crystals without visible admixture of other substances when examined under the petrographic microscope. The boron was determined by titration with standard

ANALYSIS OF SEARLESITE, CAVE SPRINGS WASH, NEVADA

W. F. Foshag, analyst

		Theoretical Composition
$(Fe, Al)_2O_3$	0.44	
CaO	0.32	
Na_2O	14.60	15.20
K_2O	0.17	
B_2O_3	17.28	17.15
SiO_2	58.80	58.82
H_2O	8.90	8.83
	100.51	

[1] Published with the permission of the Secretary of the Smithsonian Institution.

[2] *Am. Jour. Sci.*, vol. **38,** pp. 437–440, 1914.

[3] *Am. Jour. Sci.*, vol. **7,** pp. 498–502, 1924.

sodium hydroxide solution, after removal of the silica by evaporation to dryness. The bases were determined in the usual manner after removal of boric acid by volatilization with hydrochloric acid and methyl alcohol. The results are given in the above table.

The analysis agrees closely with that required for the formula: $Na_2O \cdot B_2O_3 \cdot 4SiO_2 \cdot 2H_2O$, the formula proposed by Larsen and Hicks from their analysis of the impure mineral.

The mineral is easily soluble in hydrochloric acid, which solution gives the usual reaction for boric acid and silica. Before the blowpipe, the mineral whitens, intumesces and finally fuses to a colorless glass. It gives a strong sodium flame.

Crystallography

The crystals of searlesite are small, seldom exceeding 3 millimeters in length. They are all prismatic and quite simple in their forms. A number of crystals have undergone partial resolution with the development of several faces more or less vicinal in character. No twins were observed.

The crystals, although appearing to the eye to be eminently suitable for measurement were found to give rather poor signals so that the measured angles are not of the best quality. The domal faces while small gave satisfactory readings but the prism zone usually showed blurred images. Seventeen crystals were measured on the two circle goniometer and a number of others mounted for examination but discarded without complete measurement. Five well defined forms and two solution forms were noted.

Elements. The angles used in the calculation of the elements of crystallization were those of the forms $m(110)$, $r(101)$ and $s(\bar{1}01)$. For the angle ϕ of the prism only those measurements marked "good" in the notebook were used. These ranged from $\phi = 41°21'$ to $42°12'$, average of all was $41°49'$. For the dome faces all measurements were used, the good faces were given twice the value of the poor ones in the general average. The ρ angles varied for $s(\bar{1}01)$ from $34°19'$ to $34°48'$, average of $34°28'$; for $r(101)$ from $49°4'$ to $49°42'$, average $49°25'$. From these measurements the following constants were calculated:

$e = .2338$;	$p_0 = .9012$;	$q_0 = 1.0126$;	$h = .9723$
$a = 1.1503$;	$c = 1.0367$.	$\mu = 76°29'$	

Rogers has determined the following constants from the measure-

ment of two crystals: $a=1.148$, $c=1.034$, with which the above values are in fair agreement.

Forms and Angles. Five definite forms and two solution forms were found on the searlesite crystals. These are the two domes $r(101)$, and $s(\bar{1}01)$; the prism $m(110)$; and the pinacoids $a(100)$ and $b(010)$. The solution forms have approximately the indices 7.12.4 and $\bar{4}05$.

MEASURED AND CALCULATED ANGLES, SEARLESITE

Lt	Symbol	No. of crystals	No. of faces	Measured		Calculated	
				ϕ	ρ	ϕ	ρ
a	100	17	34	90° 00′	90° 00′	90° 00′	90° 00′
b	010	2	4	0 00	90 00	0 00	90 00
m	110	17	68	41 49	90 00	41 49	90 00
r	101	10	10	90 00	49 25	90 00	49 25
s	$\bar{1}01$	11	11	90 00	−34 28	90 00	−34 28
	7.12.4 (?)	3	5	25 32	72 40	23 59	75 25
	$\bar{4}$ 0 5 (?)	2	2	90 00	−28 45	90 00	−26 48

$a(100)$. The width of the orthopinacoid varies and was observed on all the crystals. It is sometimes deeply striated.

$b(010)$. This form is usually absent but may be found on some of the larger crystals as a very narrow to line face.

$m(110)$. The unit prism is always present and has always about the same relative size. The faces are smooth and without striations but the reflections are often blurred.

$r(101)$. The front orthodome is always present and is the largest terminal face on the crystals. It often reduces the rear orthodome to a very small face or suppresses it entirely.

$s(\bar{1}01)$. The rear orthodome is usually present but is sometimes absent or too small to measure. Both the orthodomes are sharp faces and if large enough give satisfactory signals.

The form 7.12.4 results from the etching and partial solution of the crystals and is seen on large crystals. It is often large enough to give the crystals a tapering termination. The face is somewhat rounded and etched so that satisfactory measurements were not obtained. A second solution face, lying in the zone of the orthodomes, was noted on several crystals but signals from these faces were very faint and blurred. It has approximately the indices $\bar{4}05$.

HABITS

The habits of the crystals depend largely upon the presence or absence of the orthopinacoid and its relative size. When this face is broad the crystals are lathe-like as shown in fig. 1. If narrow, the

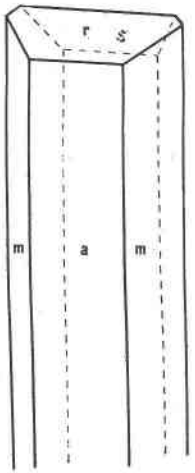

FIG. 1.

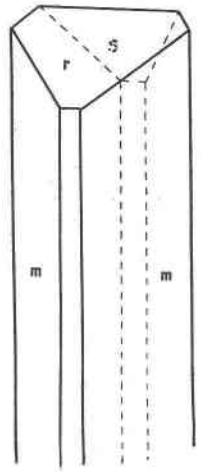

FIG. 2.

FIGS. 1 and 2. Common crystal habits from Cave Springs Wash, Esmeralda Co., Nevada.

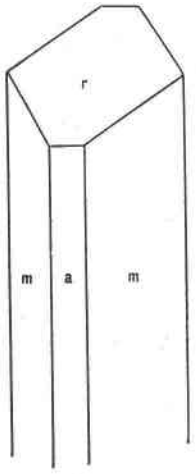

FIG. 3.

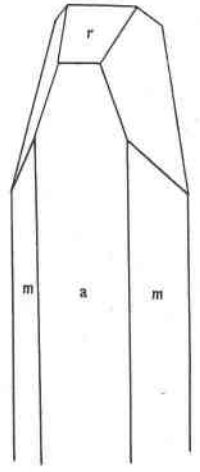

FIG. 4.

FIG. 3. Crystal habit of searlesite with prominent orthodome.

FIG. 4. Crystal habit of searlesite showing prominent solution face.

the crystals are more nearly rectangular prismatic as in fig. 2. The other variations in habit are brought about by the relative size of the front orthodome. Usually this face is somewhat larger than the rear orthodome, but a number of crystals show this face very much larger than the corresponding rear face or even forming the entire crystal termination. This latter habit is illustrated in fig. 3. Another variation of the habit is brought about by the prominent development of the steep 7.12.4 face, then the crystals have a tapering termination as shown in fig. 4.

Physical and Optical Properties

The crystals of searlesite are entirely colorless. The luster is glassy or slightly pearly on the cleavage surface. A perfect cleavage follows the orthopinacoid (100). Hd. 3.5, G. 2.44.

The indices of refraction, as measured by oil immersion method are: $\alpha = 1.515$, $\beta = 1.533$, $\gamma = 1.535$. The indices are practically the same as those given by Rogers but differ from those given by Larsen and Hicks for the original Searles Lake material. This latter material however, was hardly suitable for accurate determinations of the optical constants, being in minute pellets and intimately mixed with extraneous material. The plane of the optic axis is normal to the orthopinacoid (100), with the orientation $b = \gamma$, $\alpha \wedge c = 34°$. This extinction angle is slightly larger than that found by Rogers; 30°15′.

Occurrence

The searlesite is found in a series of thinly bedded marls that form a part of a somewhat boraciferous series of shales and sandstones flanking the Silver Peak Range on the northwest. These beds are probably a continuation of the sedimentary beds exposed along the northern end of the Silver Peak Range, believed to be of Miocene age and named by H. W. Turner,[4] the Esmeralda Formation. This formation carries in places thin beds of coal and in others abundant remains of fish. Nearby beds, presumably a part of this same series, carries a sparse vertebrate fauna indicative of an upper Miocene or Lower Pliocene age. At a few places in the boraciferous series are small bodies of ulexite of no commercial importance.

[4] The Esmeralda Formation, a Fresh-water Lake Deposit: *U. S. Geol. Survey, 21st. Ann. Rept.*, pt. 2, pp. 191–208, 1899–1900.

To reach the searlesite locality one follows the Coaldale-Almondale road through Fish Lake valley to a point about 2 miles south of a small hill that rises out of the valley at the south end of the saline playa in Fish Lake valley. At this point an old road leads to the east and follows up Cave Springs Wash as far as Cave Springs. About a mile below Cave Springs the road cuts across the belt of boraciferous beds, which can be easily recognized by their light color and thin fissile character. To the north of the wash on the east slope of a low ridge are a few short adits driven into the deposit to prospect the marls for borax ore.

A large part of the marls exposed in the vicinity carry some boron, the material being an intimate mixture of searlesite with carbonates of lime and magnesia and opal. An analysis of a pure white, porcelaneous marl gave the following analysis:

ANALYSIS OF BORACIFEROUS MARL, CAVE SPRINGS WASH, NEVADA

W. F. Foshag, analyst

Al_2O_3	1.10
CaO	12.04
MgO	7.47
Na_2O	9.84
K_2O	0.09
B_2O_3	8.51
SiO_2	39.80
CO_2	14.48
H_2O	7.40
Total	100.73

The crystals of searlesite are found in a banded white to pale buff or pale grayish blue marl in which the only conspicuous mineral, even with a hand lens, is a pale brown mica. There are also minute pockets of crystals and massive granular searlesite embedded in the matrix. The best crystals, however, form pockets or crusts in the transverse cracks of the marl. These crystals are seldom more than 2 millimeters in length, are clear and glassy and might easily be mistaken for gypsum crystals. Unlike gypsum, however, they are brittle and cannot be bent as small gypsum crystals can. Occasionally the crystals are not glassy but have a superficial milky coating and carry small attached beads of clear glassy hyalite.

The most common associated mineral is the hyalite already re-

ferred to. In some specimens these small beads of opal are fairly abundant. In some of the cracks there are radiating groups of small honey brown crystals of barite that are later than the searlesite. Rarely do the cracks contain an amber yellow calcite filling, and small fern-like splotches of manganese oxide are not uncommon.

Origin

The Esmeralda Formation carries a curious and varied assemblage of sedimentary rocks, including beds of organic origin (coal beds), lacustrine deposits (marls containing fish remains), subaerial deposits (sandstones with vertebrate fossils, and fan-glomerates), abundant volcanic products (tuffs, etc.), as well as playa beds (boraciferous shales and marls). Some of the latter show silicified bands with a retention of the original bedding. This, together with the occurrence of hyalite, suggests that the original material contained a fair content of volcanic ash. It is here suggested that the action of boraciferous water of a playa on the soluble silica of volcanic ash would yield a deposit of the nature of the Cave Springs searlesite marl.