Art. XXXV.—*Searlesite, a new mineral;* by Esper S. Larsen and W. B. Hicks.*

Introduction.

In the course of the microscopical study of a number of samples from the old Searles deep well at Searles Lake, San Bernardino County, California, by Mr. Larsen, several minerals were found which could not be determined optically. A chemical analysis of one of these showed it to be a hydrous borosilicate of sodium, and the name *Searlesite* is proposed for the new mineral after Mr. John W. Searles, the pioneer who put down the deep well from which the specimen came. The authors wish to express their thanks to Mr. Hoyt S. Gale, of the United States Geological Survey, for his generosity in furnishing the material for this study.

Occurrence and association.—A sample washed from the clay at a depth of 540 feet, according to the label, was made up almost entirely of nearly white spherulites about a millimeter in diameter. From a microscopic examination these were found to be made up chiefly of the new mineral, searlesite, in minute, fairly well-formed, radiating fibers. Small grains of sand were enclosed in some of the spherulites and nearly all contained much calcite in minute grains or crystals. In addition, a little halite was recognized. The sand grains consisted of quartz, orthoclase, microcline, plagioclase, chlorite, and green hornblende. Searlesite was also recognized in a specimen marked 540′ "runnings". This specimen is in massive fragments several centimeters across and is made up chiefly of pirssonite, with some halite, trona, searlesite, sand grains, clay-like material, etc.

Physical properties and pyrognostics.—The physical properties of searlesite could not be determined accurately on account of the character of the material. It is known, however, that the mineral is rather soft and fuses below red heat to a nearly clear glass. It is readily decomposed by hydrochloric acid and is appreciably soluble in water apparently without decomposition. Its specific gravity could not be determined.

Optical properties.—The optical properties were measured with some difficulty and the following results are only approximate:

$\alpha = 1{\cdot}520$, $\gamma = 1{\cdot}528$. Optically — (?) $2E$ = very large

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The extinction angles vary from zero to very large. The elongation is positive for fibers showing zero or small extinction angles. The mineral is probably monoclinic in crystal symmetry.

An attempt to dissolve out the calcite with dilute acids revealed the fact that the optical properties of searlesite gradually change on treatment with acids. The indices of refraction decrease, the birefringence remains about the same, the extinction becomes sensibly parallel, and the axial angle smaller. A specimen treated with cold, dilute hydrochloric acid for several hours showed the following optical properties:

$$\beta = 1{\cdot}465 \qquad \gamma - \alpha = {\cdot}01$$

Extinction parallel and elongation +.

Another specimen treated for a shorter time showed:

$\gamma = 1{\cdot}480$ $\alpha = 1{\cdot}470$ Optically −. $2E$ = rather large

Extinction parallel and elongation+. A specimen treated with acetic acid shows $\beta = 1{\cdot}50$–$1{\cdot}51$.

Chemical properties.—A sample of nearly 1·5 grams of the spherulitic material was washed with 75^{cc} of water to remove the admixed chlorides, dried at 100° C. and preserved for analysis. Inasmuch as the sample contained large quantities of calcite and considerable quartz and feldspar, besides smaller amounts of other impurities, a method of analysis which would eliminate as much of these impurities as possible was planned. The carbon dioxide was determined on a half gram sample by the usual gravimetric method. The material from this determination was digested on the steam bath with strong hydrochloric acid, filtered through a Munroe crucible, and the residue thoroughly washed with water. The amorphous silica was then extracted from the residue by hot ten per cent sodium carbonate solution. The residue still remaining was acidified, thoroughly washed with water, dried at 100° C., and weighed. By microscopic examination this insoluble matter was found to be composed largely of plagioclase with some microcline, chlorite, quartz, hornblende, and clay. After ignition the residue was weighed and reported as insoluble matter. The silica was recovered from both the hydrochloric acid and the sodium carbonate extracts and determined in the usual way. After removing boric acid the rest of the analysis was accomplished by well-known methods, boric acid being determined in a separate portion by distillation with methyl alcohol and titration with standard sodium hydroxide in the presence of mannitol.

The results of the quantitative analysis are as follows (W. B. Hicks, analyst):

	Per cent
Residue insoluble in HCl	11·88
CO_2	12·84
SiO_2	34·00
B_2O_3	9·80
Na_2O	7·70
K_2O	0·60
CaO	12·10
MgO	4·20
FeO*	1·14
H_2O below 105° C	0·78
H_2O above 105° C	5·72
Al_2O_3	0·22
Cl	none
SO_3	none
	100·98

* The state of oxidation of the iron was not determined.

Since it has been shown by microscopic examination that the material as analyzed contained large amounts of calcite and considerable quartz, feldspar, and chlorite, we are justified in removing these constituents from the analysis before attempting to calculate the formula for searlesite. Since the index of refraction of the carbonate was found to be that of nearly pure calcite ($\omega = 1{\cdot}658$), all of the calcium has been calculated as carbonate and the excess of carbon dioxide allotted to magnesium. Determined in this way, the extraneous matter in the sample is as follows:

Composition of extraneous matter.

	Per cent
Residue insoluble in HCl	11·88
$CaCO_3$	21·63
$MgCO_3$	6·41
H_2O below 105° C	0·78
	40·70

By removing this foreign matter from the analysis, and calculating the remaining constituents to 100 per cent, the following data are obtained:

Analysis and ratios.

	Original analysis	Calculated to 100 per cent	Ratios			Calculated for $Na_2O.B_2O_3.4SiO_2.2H_2O$
SiO_2	34·00	56·41	·940	3·72	4×0·93	58·82
B_2O_3	9·80	16·26	·232	0·91	1×0·91	17·15
Na_2O	7·70	12·78	·206			15·20
K_2O	0·60	1·00	·011	1·14	1×1·14	
MgO	1·10	1·82	·045			
FeO	1·14	1·89	·026			
Al_2O_3	0·22	0·37	·004			
H_2O	5·72	9·47	·525	2·08	2×1·04	8·83
	60·28	100·00				100·00

The ratios correspond approximately to the following formula: $Na_2O.B_2O_3.4SiO_2.2H_2O$, or $NaB(SiO_3)_2.H_2O$, in which a portion of the sodium is replaced by magnesium, iron, and potassium. It seems probable, however, that the iron, magnesium, and alumina in the analysis have been derived from the associated gangue as a result of the solvent action of hydrochloric acid on the chlorite and other silicates known to have been present in the sample, rather than as having been constituents of searlesite itself. The presence of the large amount of foreign minerals makes an analysis of purer material highly desirable, but the optical study has enabled us to correct for calcite and the material insoluble in hydrochloric acid with some confidence. Searlesite differs from most other borosilicates in that it is a derivative of metasilicic acid. Its formula shows a striking analogy to that of analcite:

Searlesite ..... $NaB(SiO_3)_2.H_2O$
Analcite ..... $NaAl(SiO_3)_2.H_2O$