SHORTITE, A NEW CARBONATE OF SODIUM AND CALCIUM[1]

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Abstract

Crystals of shortite, named after Professor M. N. Short of the University of Arizona, were found in cores of clay shale from Sweetwater County, Wyoming, at depths between 1258 and 1805 feet. The crystals, several millimeters thick, are orthorhombic, hemimorphic, with the axial ratio $a:b:c=0.455:1:0.648$. The indices of refraction are: $\alpha=1.531$, $\beta=1.555$, $\gamma=1.570$, $2V$ is negative, 75°. Axial plane is {100} with the c axis the acute bisectrix. Analyses of two types of crystals give the formula, $Na_2O \cdot 2CaO \cdot 3CO_2$.

Introduction

The mineral described in this paper, a double carbonate of sodium and calcium, $Na_2CO_3 \cdot 2CaCO_3$, was found in a drill core from the test well John Hay Jr. No. 1, located on Government land in the SE $\frac{1}{4}$ of the NW $\frac{1}{4}$, sec. 2 (1920 feet from N line and 2120 feet from the W line), T. 18 N., R. 110 W., about 20 miles west of the city of Green River, Sweetwater County, Wyoming. The well was drilled by the Mountain Fuel Supply Co. of Findlay, Ohio, operator, and made available to the U. S. Geological Survey for study by Mr. W. F. Nightingale, geologist, Mountain Fuel Supply Co. Drilling was started on Oct. 29, 1937, and completed on Jan. 3, 1938, at a depth of 5323 feet. The elevation is 6355 feet. Two samples from the core at depths of 1594 and 1600 feet, respectively, were sent to Mr. H. I. Smith, Chief, Mining Division, Conservation Branch, U. S. Geological Survey, in January, 1938, and shown on chemical analysis by R. C. Wells, of the Survey, to be nearly pure trona, $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$. Later other portions of the core, about 30 feet in all, were selected and sent to Washington by Mr. Smith for further study, which the writer began in May, 1939. In the course of this investigation numerous crystals of the new mineral shortite were discovered at several places in the core between the depths 1258 and 1805 feet.

Shortite is named in honor of Dr. Maxwell N. Short, Professor of optical mineralogy at the University of Arizona, President of the Mineralogical Society of America, and widely known for his contributions to the study of opaque minerals.

The writer wishes to express his thanks to Mr. M. L. Jefferson of the Bureau of Chemistry and Soils, Department of Agriculture, who determined that the crystals are pyroelectric, and to Dr. W. T. Schaller of

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the Geological Survey who has contributed the section on crystallography.

Occurrence and Association

The first appearance of shortite in the core is at a depth of 1258 feet. It occurs intermittently down to 1805 feet, which is the lowest section of the core sent to Washington. The matrix is a greenish-gray clay of the montmorillonite type which grades into oil shale. The clay and oil shale contain pyrite and carbonates of calcium and magnesium, the latter too fine-grained to determine whether the mineral is dolomite, or calcite and magnesite, or mixtures. Crystals of calcite up to two millimeters in diameter are abundant in places in the core. Massive trona is present at depths of 1325 feet and 1587½ feet, but is not found associated with the new mineral. At the lower depth shortite is present in the clay that overlies the massive trona. The material is from the Green River formation of Eocene age. The nearly equant crystals of shortite are from 1 to 3 millimeters in size, while the tabular crystals are larger, up to 15 millimeters across and 2 to 3 millimeters thick.

Crystallography

Shortite occurs in individual crystals, orthorhombic, hemimorphic, and simple in habit, being bounded essentially by only five faces, $a(100)$, $a'(\bar{1}00)$, $c(00\bar{1})$, $e(011)$, and $e'(0\bar{1}1)$ (Figs. 1 and 2). Narrow striated faces of $o\{01\bar{1}\}$, in oscillatory combination with the base $c\{00\bar{1}\}$, are usually present and line faces of $p\{111\}$ were measured on one crystal.

All the faces gave poor reflections. Measurements of $e \wedge e'$ averaged 65°53′, hence $c=0.648$. The average measurements of four faces of $p\{111\}$, with the crystal set in polar position, gave $\phi=65°57'$, $\rho=57°21'$. The axial ratio is $a:b:c=0.455:1:0.648$, $p_0=1.425$.

The calculated angles are:

	ϕ	ρ
$c\{00\bar{1}\}$	0°00′	90°00′
$a\{100\}$	90 00	90 00
$e\{011\}$	0 00	32 57
$o\{01\bar{1}\}$	0 00	32 57
$p\{111\}$	65 33	57 26

Two general habits were observed: (1) Nearly equant to short prismatic with elongation parallel to the a-axis (Fig. 1) and tabular parallel to the macropinacoid $a\{100\}$ (Fig. 2).

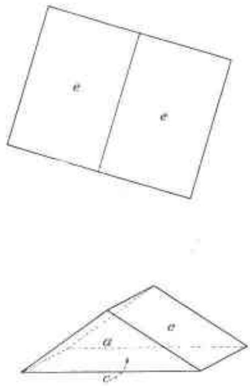

FIG. 1. Nearly equant crystal of shortite. Forms: $c\{00\bar{1}\}$, $a\{100\}$, $e\{011\}$.

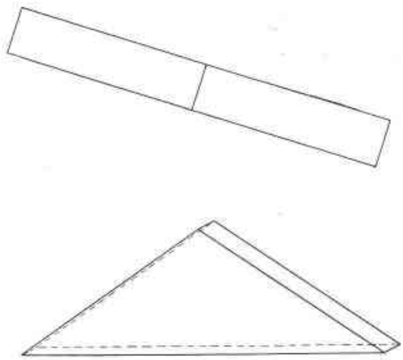

FIG. 2. Tabular crystal of shortite.

PHYSICAL PROPERTIES

The specific gravity of shortite, obtained by the pycnometer method at 25°C., is 2.629. There is a distinct cleavage parallel to the brachypinacoid *b*{010}, which has not been observed as a crystal form. It has a conchoidal fracture and vitreous luster. The hardness is 3. The crystals are strongly pyroelectric as determined by Mr. Jefferson using Martin's method.

Inversion takes place at about 200°C. accompanied by violent decrepitation. The resulting product appears to be a single compound rather than a mixture, though it is too fine-grained to permit such a conclusion definitely to be made. Incongruent melting takes place at about 600°C. The compound in the solid phase in this melt is probably calcium carbonate, with sodium carbonate, or the one to one sodium calcium carbonate, or a mixture of the two in the liquid phase. When cooled the melt was so fine-grained that identification of the component parts by means of the petrographic microscope was not possible.

Optical Properties

The color of shortite varies from colorless to a pale yellow in reflected light. In thin section the mineral is colorless. It fluoresces a light amber color in the ultra violet light from a high intensity mercury vapor lamp.

The indices of refraction at 25°C. are:

$$\left.\begin{array}{l}\alpha = 1.531\\ \beta = 1.555\\ \gamma = 1.570\end{array}\right\} \pm 0.002$$

Computed from the indices of refraction the 2V angle (−) is 75°. The crystals are orthorhombic, with the optic axial plane parallel to the macropinacoid and the acute bisectrix normal to the base.

The optical orientation is:

X,α (acute bisectrix) = c axis
Y,β = a axis
Z,γ (obtuse bisectrix) = b axis

The dispersion is moderate $r<v$.

Chemical Properties

Samples of shortite from depths of 1649 feet and 1729 feet were freed from the matrix by hand picking. At 1649 feet the matrix is oil shale. The crystals of shortite at this depth are predominantly equant to short prismatic in habit. Many of these crystals have small inclusions of pyrite. The matrix at 1729 feet is a clay of the montmorillonite type. Most of the crystals of shortite from this depth are thick tabular, parallel to the macropinacoid in habit. No pyrite was noticed in these crystals but a small quantity of clay was present.

The analyses of these two samples of shortite yield the formula: $Na_2O \cdot 2CaO \cdot 3CO_2$ or $Na_2CO_3 \cdot 2CaCO_3$.

Analysis of Shortite from Depth of 1649 Feet.

	Per cent	Molecular ratios	
CaO	36.34	0.6480	0.6490=2.002
MgO	0.04	0.0010	
Na_2O	19.91	0.3212	0.3212=0.991
CO_2	42.90	0.9750	0.9750=3.007
Insol.	0.66		
	99.85		

ANALYSIS OF SHORTITE FROM DEPTH OF 1729 FEET

	Per cent	Molecular ratios	
CaO	36.38	0.6487	0.6497 = 2.003
MgO	0.04	0.0010	
Na_2O	20.07	0.3238	0.3238 = 0.998
CO_2	42.78	0.9723	0.9723 = 2.998
Insol.	0.68		
	99.95		

The insoluble material was determined by filtration on a sintered glass filter, drying at 105°C. for two hours and weighing.

Both samples were examined for the following components with negative results:

SO_3, Cl, F, SiO_2, metals of the R_2O_3 group, SrO, BaO, K_2O, Rb_2O, Cs_2O, Li_2O.

A sample composed of fragments of crystals of shortite that were free from traces of clay and pyrite was tested in a closed tube for water. None was present.

Shortite is slowly decomposed by cold water and more rapidly by boiling water. The sodium carbonate goes into solution and the calcium carbonate remains quantitatively in the solid phase.

The chemical synthesis of an anhydrous soda-lime carbonate with the composition of shortite has never been reported, though the compound $Na_2O \cdot CaO \cdot 2CO_2$ is known. The writer hopes to study the paragenesis of the minerals found in this core. Such work may do much to reveal the conditions that prevailed during and since the deposition of these sediments.