NOTES AND NEWS

BOUSSINGAULTITE FROM RESIDUE OF FIRE IN ANTHRACITE REFUSE BANK[1]

(*Contribution from the Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.*)

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Introduction

This paper contains a description of the occurrence of boussingaultite, $(NH_4)_2Mg(SO_4)_2 \cdot 6H_2O$, following a fire[3] in a bank of minus-eight-inch anthracite breaker refuse two miles west of Mahanoy City, Schuylkill County, Pennsylvania, in the Western Middle anthracite field.

A series of 17 holes was drilled into the refuse to locate the fire. The hole (No. 3) around which the boussingaultite was discovered was drilled until hot vapors were enountered at a depth of 158 feet. The temperature at the bottom of this hole was 370°C., while that in the other holes did not exceed 100°C. About 30,000 pounds of limestone dust in a 1 to 1 aqueous suspension was poured down this hole No. 3 to aid in extinguishing the fire. The dust was found, upon excavation of the burning refuse, to have spread 6 to 8 feet radially from the holes not in the hottest zone and to have traveled to the outer limits of the fire and deposited as a chalk-like mass from the holes in the hottest zone.

Discovery of the Boussingaultite

Pinkish crystals of boussingaultite were found, upon excavation of the burned refuse, filling cavities in the refuse near the edges of the deposits of the limestone dust. Refuse material (consisting of unburned, high-grade anthracite, bone coal, and slate) was found cemented together by some of the crystals. The presence of the unburned coal, which has an ignition temperature of 470°C.,[4] indicates that the sample was not heated higher than this temperature, even though the refuse reportedly[5] burned to ashes. The boussingaultite evidently formed after the hot refuse cooled

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[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

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[3] Leitch, R. D., Some information on extinguishing an anthracite refuse-bank fire near Mahanoy City, Pa.: *Bureau of Mines, Inf. Circ.* **7104,** 16 pp. (1940).

[4] Jones, G. W., and Scott, G. S., Chemical considerations relating to fires in anthracite refuse: *Bureau of Mines, Rept. of Investigations* **3468,** 5 (1939).

[5] Leitch, R. D., Work cited in footnote 3, page 15.

as ammonium-magnesium sulfate hexahydrate loses 86 to 87 per cent of its water at 120°C. and becomes anhydrous at 132°C., according to Mellor.[6] Boussingaultite crystallizes, without decomposition, from an aqueous solution.[7] Thus the formation of boussingaultite from components in solution would be expected upon evaporation or cooling of the solution.

IDENTIFICATION OF THE BOUSSINGAULTITE

The crystals varied in color from colorless to a yellowish-pink and were about 1 mm. in diameter. Some had small faces. Most of the crystal fragments revealed, under the mircoscope, a centered optic normal interference figure due to the $\{010\}$ cleavage. The material was biaxial positive with $\alpha = 1.471 \pm 0.002$ and $\gamma = 1.479 \pm 0.002$, and had a moderate $2\ V$ and a birefringence of 0.008. An extinction angle was not measured.

The material was soluble in water and yielded water upon heating in a closed tube. Ammonia[8] and sulfate[9] were found by chemical microscopy.

Considerable magnesium, a few tenths of one per cent of iron and manganese, and traces of calcium and silicon were found by spectroscopic analysis.[10] The iron and manganese probably replaced some of the magnesium.

PROBABLE ORIGIN OF THE BOUSSINGAULTITE

Ammonical compounds in the refuse probably supplied the ammonia for the boussingaultite. Leitch[11] noted a faint odor of ammonia during the pouring of the limestone suspension. Liberation of ammonia was attributed to the action of free lime from the limestone on ammonical compounds in the refuse. The formation of an ammonium-calcium sulfate might be expected in the presence of the quantity of calcium carbonate present in the drill hole. An ammonium syngenite has been reported[12] but it is stable only in strong ammonium sulfate solutions.

Magnesium in the limestone, in ankerite in the coal, and in the water of the limestone suspension probably supplied the magnesium. The lime-

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[6] Mellor, J. W., *A Comprehensive Treatise on Inorganic and Theoretical Chemistry:* Longmans, Green & Co., London, **4**, 342–343 (1923).

[7] Weston, A., The quaternary system potassium sulfate—magnesium sulfate—ammonium sulfate—water: *Jour. Chem. Soc.*, **121**, 1223–1237 (1922).

[8] Add sodium hydroxide to solution and warm. Odor of ammonia was obtained upon heating the solution to which sodium hydroxide was added.

[9] Gypsum crystals were formed upon addition of calcium acetate to the solution.

[10] Analysis by H. I. Oshry, former assistant physicist, Gas and Dust Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

[11] Leitch, R. D., Work cited in footnote 3, page 3.

[12] Hill, A. E., and Yanick, N. S., Ternary systems. XX. Calcium sulfate, ammonium sulfate, and water: *Jour. Am. Chem. Soc.*, **57**, 645–651 (1935).

stone, judging from analysis[13] of samples from the vicinity of its origin[14] (Bellefonte, Centre County, Pennsylvania), probably contained about 0.5 per cent $MgCO_3$. Thirty thousand pounds of limestone with 0.5 per cent $MgCO_3$ would contain 150 pounds of $MgCO_3$,which is equivalent to 640 pounds of boussingaultite. Some of the bone coal from the vicinity of the boussingaultite was found to contain a few per cent of ankerite. The water, judging from analysis of water from a nearby well[15] and from the Susquehanna River[16] (into which the region drains), contained only a few parts per million of magnesium, so the water was not an important source of the magnesium. Lansfordite and nesquehonite, the type locality of which is about 20 miles away,[17] may have contributed some magnesium but none of these minerals were found in the samples of boussingaultite.

Sulfur compounds in the refuse probably supplied the sulfur for the sulfate. From 0.2 to 4.3 per cent sulfur was found[18] in similar refuse.

[13] Miller, B. L., Limestones of Pennsylvania: *Pa. Geol. Sur.*, 4th Series, *Bull.* **M20,** 281–291 (1934).

[14] Personal communication, George E. McElroy, senior mining engineer, Health Division, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.

[15] Lohman, S. W., Ground water in northeastern Pennsylvania: *Pa. Geol. Sur.*, 4th Series, *Bull.* **W4,** 244 (1937).

[16] Dole, R. B., The quality of surface waters in the United States: *U. S. Geol. Sur., Water-Supply Paper* **236,** 104 (1909).

[17] Ford, W. E., *Dana's Textbook of Mineralogy:* John Wiley & Sons, New York (**1932**), pp. 529–531.

[18] Jones, G. W., and Scott, G. S., Work cited in footnote 4, page 5.

NOMINATIONS FOR OFFICERS OF THE MINERALOGICAL SOCIETY OF AMERICA FOR 1945

The Council has nominated the following for officers of the Mineralogical Society of America for the year 1945:

PRESIDENT: K. K. Landes, University of Michigan, Ann Arbor, Michigan.
VICE-PRESIDENT: George Tunell, Geophysical Laboratory, Washington, D. C.
SECRETARY: C. S. Hurlbut, Jr., Harvard University, Cambridge, Mass.
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COUNCILOR (1945–1948): R. E. Grim, Illinois Geological Survey, Urbana, Illinois.

Following the decision of the Geological Society of America, there will be no meeting for the presentation of papers of the Mineralogical Society of America during 1944. Members of the Society may submit abstracts of scientific papers to be published in the March-April issue of the *American Mineralogist.*

The ballots for officers of the Society and for candidates for fellowship will be sent out from the Secretary's office early in October.

C. S. HURLBUT, JR., *Secretary.*