BLACK BARITE DEPOSITS IN UPPER EAST TENNESSEE[1]

ROBERT A. LAURENCE

Associate Geologist, Tennessee Valley Authority

INTRODUCTION

The occurrence of a dark, fetid, crystalline variety of barite in Upper East Tennessee has long been known, but apparently this rather unusual occurrence has escaped more than mere mention in the geologic literature. These deposits are found in a long, narrow belt trending northeast through Greene, Washington, and Sullivan Counties (Fig. 1). The area is usually known as the Fall Branch District, after the small town of that name located at the corner of the three counties, where most attention has been directed to the deposits.

These deposits were noted by Safford (1869) who refers to an occurrence "near the Greeneville and Chimney Top road (of) a vein of the fetid crystalline variety." Other reports on barite (Gordon, 1920) and zinc deposits (Secrist, 1924) in this area do not mention the occurrence of this variety. The present paper is the result of various investigations made between 1934 and 1937. A brief description of the area, by the present writer, is included in a recent paper on Tennessee Valley barite (Rankin, 1938).

The writer is greatly indebted to Benjamin Gildersleeve, Assistant Geologist, Tennessee Valley Authority, who spent several months in this area in 1935, in connection with prospecting of the deposits and who has contributed many valuable suggestions, and to Edward C. Houston, Assistant Chemist, who made the analyses and contributed many ideas regarding the chemistry of the deposits.

The geology of the Fall Branch area is shown on the Greeneville Folio (Keith, 1905). The area is part of the Appalachian Valley and Ridge physiographic province, consisting of parallel ridges and valleys with trellised drainage. The upper Knox dolomite ("Post-Nittany") has been overthrust upon the Athens shale of Horse Creek and Lick Creek valleys. Locally, at least, the Knox dolomite has been overturned near the fault, and brecciation is fairly common throughout this belt of Knox. There are small outcrops of Athens shale, apparently infolded in the Knox dolomite. To the southeast, the Knox dolomite passes, with normal contact, beneath a syncline of Athens shale. There are three erosion surfaces in the area: the peneplain at 2,100-2,200 feet, on Bays Mountain; the younger peneplain at 1,700-

[1]Published with permission of the Tennessee Valley Authority.

1,900 feet which is represented by the lower ridges, and the valleys of Lick and Horse Creeks at 1,300-1,500 feet.

The Fall Branch area has not been an important producer of barite because of the relatively small reserves and the scattered nature of the deposits. However, the purity of the ground barite is sufficiently high to command a premium of fifty cents to one dollar per ton over other Tennessee barites. Some barite was mined here in the late 1890's and in the World War period, but it was only the white, as the black was then thought to be less pure. In 1935, the Tennessee Valley Associated Cooperatives washed, crushed, and shipped about 170 tons of barite, most of which was of the black variety, from ten properties in the Fall Branch area. Since then, there has been no recorded production.

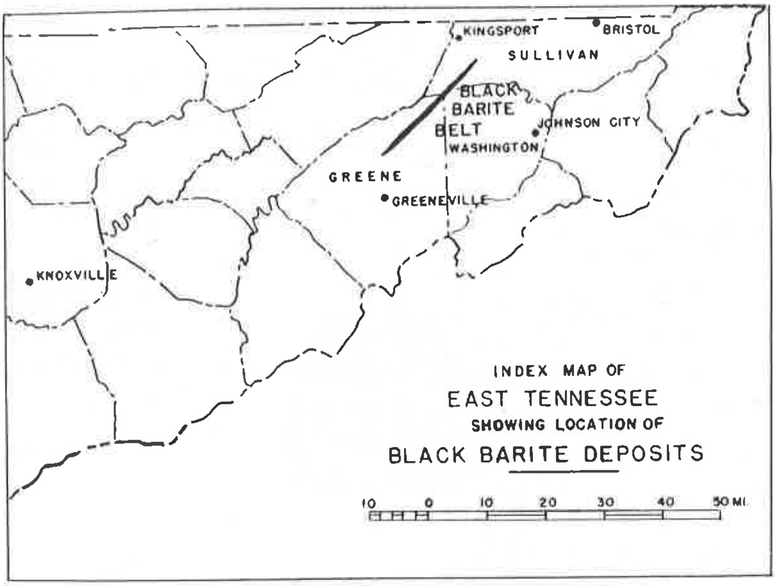

Fig. 1. Index map of East Tennessee showing location of the Black Barite deposits.

Occurrence and Description of the Barite

Barite is found in this area in the upper Knox ("Post-Nittany") dolomite, near to and above the thrust fault. It usually occurs 750 to 1,000 feet below the top of the Knox dolomite. Gildersleeve[2] reports one occurrence of barite in the Athens shale. The deposits, presumably derived from veins in the underlying bedrock, are found in residual clays developed upon the younger peneplain (1,700-1,900 feet). There are associated deposits of white barite which are found

[2]Gildersleeve, Benjamin. Oral communication.

not only in the residuum, but also in veins and breccia zones in the dolomite, with sphalerite and galena, but the black variety apparently occurs only in the residuum.

The black barite has four distinctive features which may be described separately:

Form. The black barite nearly always occurs in large, perfectly crystalline masses, with three perfectly developed cleavages. Fracture planes are also common, approximately bisecting the angles between the cleavage planes and occurring in closely spaced series, but they are seldom prominent enough to cause a piece to break along these directions. Some of the white barite also has this perfect crystalline form, although most of it occurs as lumps and crystal aggregates (Fig. 2). Frequently, the cleavage planes are slightly warped, a condition which may be due to folding or movement subsequent to the formation of the deposits.

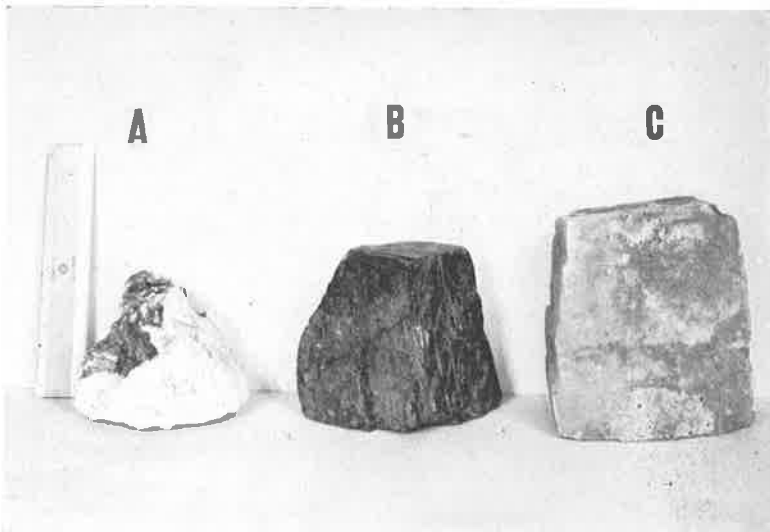

Fig. 2. Tennessee barite. A., Typical Sweetwater lump barite. B., Fall Branch black barite. C., Fall Branch white barite.

Color. The most distinctive feature of the black barite is its dark color, which ranges through many shades from bluish black to dark black. A thin flake is transparent and almost colorless, and when ground, the powder appears to be white, although by comparison with white barite, it is distinctly an off-color variety. The dark color is not distributed evenly through the barite, but is concentrated along cleavage and fracture planes, as one can easily see by miscroscopic examination (Fig. 3). This accounts for the lack of color in thin pieces. The dark matter appears to be organic, and it resembles the carbonaceous matter seen in many thin sections of limestones. Houston found that this variety does not respond favorably to bleaching tests, and that when burned, it becomes light canary yellow instead of white, as one would expect if carbon is the coloring matter.

Fetid odor. When broken in any manner, or heated, the black barite gives off a strong fetid odor, apparently that of hydrogen sulphide. This is usually attributed to the presence of organic matter, though it might be produced by the reaction of moisture in the air with barium sulphide or ferrous sulphide. This odor is noticeable when even the smallest cleavage flakes are broken with the fingers, and a fine powder will give off the odor when ground again.

Decrepitation. Although the black barite is quite stable while enclosed in the residual clay, very little heat is required to decrepitate it

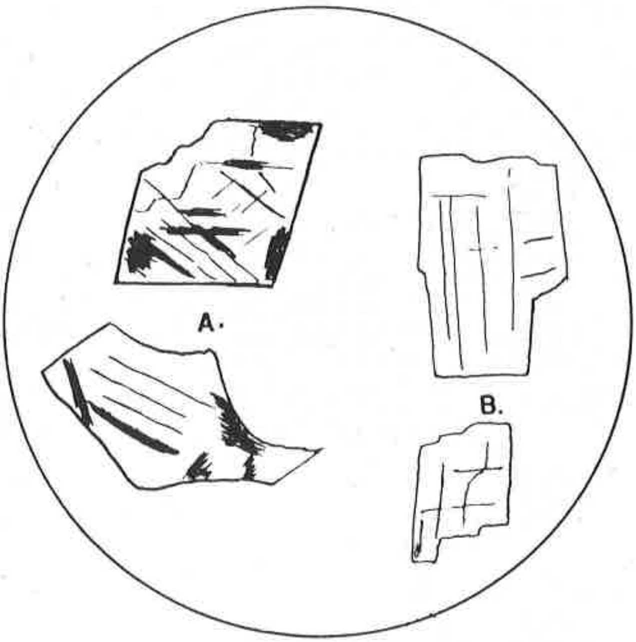

Fig. 3. Cleavage fragments of Fall Branch black and white barite as seen under the microscope. A., Black barite showing black matter along fracture and cleavage planes. B., white barite.

after it is mined. When this material was being worked a few years ago, stock piles exposed to summer sunshine had to be covered with canvas to protect the barite. If not so protected, it will disintegrate almost to powder in a short time, and the decrepitation is so rapid that a crackling sound, like a light shower falling on dry leaves may be heard at a distance of several yards. The fetid odor is also given off during this decrepitation and is strongly noticeable at some distance. Decrepitation of small fragments follows for several seconds after a large piece is struck with a hammer. On the other hand, white barite from this same area will decrepitate only slightly when subjected to heat up to 1,000° C. The rapid decrepitation of the black variety is probably due to the well-developed cleavage and fracture planes, the warping of some of the cleavage planes, and the presence of either organic matter or some sulphide on the cleavage planes.

Analyses of the Barite

Chemical. The Fall Branch black barite is the purest barite in Tennessee. Representative analyses are:

Sample No.	$BaSO_4$	SiO_2	Fe_2O_3	F	Total
297	98.98	0.82	0.20	neg.	100.0
298	99.56	0.24	0.16	neg.	99.96

(Analyses by E. C. Houston, T.V.A. Minerals Testing Labortary)

The amount of carbon present is only 0.045 per cent, according to an analysis by C. D. Susano, of the T.V.A. Materials Testing Laboratory.

Because this small amount of carbonaceous matter seemed insufficient to account for the dark color and strong odor, the possibility of barium sulphide being present was considered, since the color and odor are similar to those of barium sulphide, and the instability of the latter might account for the unusually rapid decrepitation. However, chemical analyses failed to detect any sulphide, and the failure to "burn" white is as unfavorable to this theory as to the presence of carbonaceous matter. It is not likely that barium sulphide could be produced contemporaneously with the decrepitation, as continued high temperatures are required to reduce barium sulphate to the sulphide.

Spectroscopic. Samples of the Fall Branch black barite were sent to Dr. L. C. Robinson, of the Department of Geology, University of Kentucky, for spectroscopic analysis. The spectrograph shows lines for barium, sulphur, oxygen, and carbon. Dr. Robinson interprets the presence of the carbon lines as the result of organic matter which he considers is responsible for the color and odor.

Petrographic. As described above, examination of the black barite under the petrographic microscope shows no impurities except dark matter, probably organic, on cleavage and fracture planes. This is the strongest evidence in favor of carbonaceous matter as the agent responsible for the dark color of large pieces.

Summary

The color and fetid odor of the black barite are evidently due to the presence of small amounts of carbonaceous (organic) matter on cleavage and fracture planes. It is worthy of note that such a small amount of carbon as 0.045 per cent is apparently responsible for the dark color of the barite.

The black barite decrepitates readily, probably because of its perfect crystallinity with three cleavages and two or three fractures, with warping of some of the cleavage planes, and the presence of organic matter on the cleavage planes.

The theory that the color and odor might be due to the presence of barium sulphide is rejected, temporarily at least, for lack of supporting evidence, although the color, odor, ready decrepitation and almost complete absence of carbon seem more than a coincidence. The failure to detect any sulphide by chemical analysis, the failure of the material to "burn" or bleach white, and the lack of an effective reducing agent to produce barium sulphide, all argue against the presence of barium sulphide in this barite.

The exceptional purity of these deposits gives them special commercial interest, but their limited extent and scattered nature preclude any likelihood of large scale development.

Bibliography

Gordon, C. H. 1920. Barite Deposits in Upper East Tennessee. *Tenn. Geol. Surv.*, Bull. 23.

Houston, E. C. *A. I. M. E.*, Tech. Pub. 880.

Keith, Arthur. 1905. Greeneville Quadrangle. *U. S. Geol. Surv.*, Folio No. 118.

Rankin, H. S., *et al.* 1938. Concentration Tests on Tennessee Valley Barite. *A. I. M. E.*, Tech. Pub. 880.

Safford, J M. 1869. *Geology of Tennessee.*

Secrist, M. H. 1924. Zinc Deposits of East Tennessee. *Tenn. Div. Geol.*, Bull. 31.

Received March 3, 1938.