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THE BARITE DEPOSITS

OF THE

SOUTHERN APPALACHIAN STATES

A THESIS

PRESENTED TO THE ACADEMIC FACULTY

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BY

James Dabney Burfoot, Jr.

INTRODUCTION

This thesis entitled The Barite Deposits of the Southern Appalachian States is based on a critical study and digest of the extensive literature related to the study of the deposits. The area embraced is a large one, including a part of each of eight states, which, named in order geographically, are Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, and Alabama. The attempt has been made to cover all the essential points in the geology of the deposits taking them as a whole, with special emphasis being placed on the distribution, the occurrence, the associated rocks, the associated minerals, the grade of ore, and the genesis of the deposits. Necessarily much material had to be omitted, but it is believed that this discussion is reasonably complete.

GENERAL DISCUSSION

The Mineral

Physical Character.- Barite, known commercially as baryte, barytes, or heavy spar, is a white, opaque to transluscent, crystalline mineral, having a hardness of 2.5 to 3.5 and a specific gravity of 4.3 to 4.6. Barite crystallizes in the orthorhombic system, the crystals usually being the combination of the unit prism and the basal pinacoid. Well formed crystals, however, are not the common occurrence. The mineral usually occurs as aggregates of straight, or slightly curved, cleavable plates, or in granular, fibrous, earthy, stalactitic, or nodular masses. The plates are commonly united by their broad sides in crested, divergent groups. The cleavage is orthorhombic, with c(001) perfect, m(110) perfect, and b(101) imperfect. The mineral is brittle, breaking with an uneven or conchoidal fracture; and, when unaltered, has a vitreous to pearly luster. It becomes a dull, earthy white, however, on weathering. The color is typically white, varying to shades of yellow, brown, gray, red, or blue. The streak is white. Before the blowpipe, it decrepitates readily, fuses at about 3, and colors the flame yellowish green.

Chemical Character.- Barite is the sulphate of barium ($BaSO_4$); and contains, when pure, 65.7 per cent of baryta (BaO) and 34.3 per cent sulphur trioxide (SO_3). In nature, it practically always

contains other substances, of which the most common are silica (SiO_2), lime (CaO), magnesia (MgO), hydrocarbons, and the oxides of aluminium, iron, and manganese. Sometimes strontium is present, the Kentucky deposits showing up to 11 per cent of this substance.

Distinguishing Characteristics.- Barite is easily distinguished from other non-metallic minerals by its high specific gravity, its cleavage, its insolubility in cold hydrochloric (muriatic) acid and its apple green coloration of the blowpipe flame.

Occurrence

Barite is a common mineral, having a wide geologic and geographic distribution. It is formed in rocks of igneous, sedimentary, and metamorphic origin, in nearly all cases formed by deposition from aqueous solutions. The mineral is not found as an original constituent of igneous rocks, nor is it found in contact metamorphic zones, pegmatite dikes, nor as a product of dynamic metamorphism. It is common gangue mineral in metallic ore veins; but, as such, is not of commercial value. Travertine deposits containing varying amounts of barite are also known. Commercially important deposits of barite, however, may include the following types:

1. Veins, formed by the filling of fissures, by replacement, or by cementing of fault breccias, the wall rock being limestone, quartzite, sandstone, schist, gneiss, or volcanic rocks of different occurrences.
2. Bedded deposits, formed by the replacement of beds of limestone or pyrite.

3. Irregular masses, formed by the replacement of limestone, by the filling of the interstices of brecciated masses, or by the filling of solution caves.
4. Lumps in residual clays, formed by the weathering of any of the occurrences named above.

Associated Rocks

From the mode of occurrence discussed above, it is seen that the mineral has a wide range as to the kind of rock in which it is found. These rocks include each of the three major groups,- igneous, sedimentary, and metamorphic.

Of the sedimentary rocks, limestones and sandstones and their residual clays, especially limestones, are the usual ones with which the mineral occurs associated. In one locality, however, Prince William County, Virginia, barite is associated with Triassic red shales and impure limestones as veins. Occurrences of the mineral in limestone or its residual clays are noted in each of the larger physiographic divisions of the Appalachian States.

The known deposits of barite in igneous and metamorphic rocks in the Appalachian States are limited to the Piedmont Plateau, where the mineral occurs as veins and replacements chiefly in schists and crystalline limestone, occasionally granite.

Associated Minerals

The minerals most commonly associated with barite are calcite, fluorite, sphalerite, galena, and less frequently but locally of importance, quartz, strontianite, pyrite, limonite, chalcopyrite,

smithsonite, and manganese oxide. These associated minerals vary with the individual deposit. The vein and replacement types often carry metallic sulphides, especially galena, sometimes sphalerite, chalcopyrite, and pyrite. Quartz, calcite, and fluorite are also at times abundant. The residual deposits especially may carry considerable iron and mangnese oxides, as well as quartz.

Weathering of Barite

Barite is very sparingly soluble in surface waters, and it is because of this fact that it is very slowly dissolved and carried off. The effect of weathering on barite is to soften and accentuate its fibrous, reticulated structure and to break it into small masses, or gravel, which are found in the clay above the unweathered deposits. Because of its fibrous structure,however, barite is not readily reduced to gravel. Accompaying these changes, it loses its luster and becomes duller, whiter, and more chalky in character and is frequently discolored by iron oxide. Much of the weathered mineral is honeycombed from the leaching out of the more soluble constituents intimately associated with it. It is because of its sparing solubility that barite is found in the residual clays above the unweathered deposits, the more soluble rocks and minerals associated with it having disintegrated and been carried away. These residual deposits are always of greater areal extent than the unweathered deposits occurring below. In some instances, lumps of barite are carried for considerable distances away from the unweathered deposits whence they were derived.

Origin

Barium is by no means a rare element in the rocks of the earth. Clarke, in computing the average composition of the lithosphere, found that barium made up 0.08 per cent of the known rocks of the earth; that is, it ranks with manganese in holding the fifteenth place in the relative abundance of chemical elements. Igneous rocks, particularly those rich in feldspar and micas high in potash, contain appreciable percentages of the element. It will be remembered in this connection, that the feldspars and the micas carry varying amounts of barium. It is also found in soils, in plants, in spring water, in mine water, and in sea water.

It is generally agreed that barite is deposited from solutions, both hot and cold, that have derived their barium content from the rocks through which they have passed, whether these rocks be igneous, sedimentary, or metamorphic. The ultimate source of the barium, however, is the barium bearing feldspars and micas of crystalline rocks, from which it has been dissolved out by the ordinary processes of weathering. The barium may be carried in solution as the chloride, the carbonate, or even the sulphate, from which it may be precipitated as a direct deposit from the waters as a deposit when these waters commingle with certain others, or, as C. W. Dickson has shown, by a reaction between barium bicarbonate and gypsum, or between barium bicarbonate and oxidizing pyrite. In the latter reaction, the oxidizing pyrite is first instrumental in transforming calcium carbonate to calcium sulphate, and this then undergoes double decomposition with the percolating barium solutions.

These reactions might be looked upon as an explanation for the frequent occurrence of barite in limestone.

Since barite is found as a common gangue mineral in metallic ore veins, it is assumed, in such cases, to be deposited from hot, ascending solutions of magmatic origin. In this connection, Hull[1] writes, "From the authorities previously referred to (Hillebrand, Clarke, Emmons, Failyer, and others) it may be seen that barytes has formed at the surface of the earth and at depth; that it has been deposited as a gangue mineral in the unoxidized and the oxidized zones of ore lodes; that it occurs as a primary and a secondary mineral; and that it is deposited from cold descending waters and from hot ascending waters."

The origin of the individual deposits will be taken up under the detailed description of the areas.

Geologic Distribution

Geologically, the barite deposits of the Southern Appalachian States are associated with rocks which range from pre-Cambrian to Triassic in age. The exact age of the deposits themselves, however, is not known.

The age of the rocks in which barite deposits are found may be tabulated in the following manner:

1. Triassic: Virginia.
2. Carboniferous (Mississippian): Western Kentucky.

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1. Hull, J. P. D.; Barytes Deposits of Georgia, Georgia Geological Survey Bulletin No. 36, Page 2, 1920.

3. Cambro-Ordovician: Central Kentucky, Tennessee, Appalachian Valley region of Virginia, Georgia, and Alabama.

4. Pre-Cambrian and Cambrian: Piedmont Province of Virginia, North Carolina, including the Madison County deposits, and South Carolina.

Geographic Distribution

The Southern Appalachian States include Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Tennessee, Georgia, and Alabama. Barite occurs in each of these states, with the exception of West Virginia. Deposits are known in (1) the Piedmont Plateau, (2) the Appalachian Mountains, (3) the Appalachian Valley, (4) the Cumberland Plateaus, and (5) the Interior Lowlands.

Description by States

A detailed description of the individual areas will now be taken up by states.

VIRGINIA

Barite is found in a large number of counties of the state, but the industry has been confined to only a few of them. The counties in which barite is found are (1) Bedford, Campbell, Pittsylvainia, Nelson, Buckingham, Amherst, Orange, Louisa, and Prince William lying east of the Blue Ridge in the crystalline area, or Piedmont Province, and (2) Tazewell, Russell, Bland, Wythe, Washington, Scott, Smyth, Montgomery, Botetourt, Rockbridge, Warren, and Frederick lying west of the Blue Ridge in the Paleozoic sediments

of the Valley Region. Of these, Bedford, Campbell, Louisa, Pittsylvania, and Prince William Counties of the Piedmont Province, and Smyth, Tazewell, Russell, and Montgomery Counties of the Valley Region have been the chief producers of the State.

Geologically, the barite deposits of Virginia are grouped into three unlike areas,-(1) those deposits in the red shale-sandstone series of Triassic age, (2) those in the crystalline metamorphic rocks of pre-Cambrian and Cambrian age, and (3) those in the Valley Region of folded and faulted Cambrian and Ordovician limestones. (1) and (2) compose the Piedmont Province which stretches from the Blue Ridge eastward to the fall belt, or western margin of the Coastal Plain sediments.

The Triassic Area

The Triassic rocks of Virginia comprise a number of belts, having a northeast-southwest trend and extending in general through the central part of the Piedmont Province. The particular belt in which the barite deposits occur crosses the Potomac River west of Washington and terminates abruptly south of Culpeper. Barite occurs in the eastern margin of this area about four miles southeast of Catlett Station, in Prince William County. This deposit was worked as early as 1845 and is probably the oldest barite mine in Virginia.

The rocks of this region, in general, consist of a red shale-sandstone series of Triassic age. Those of the immediate barite

locality are ferruginous, red, sandy shales and a light-colored crystalline limestone. The dip taken at numerous places west of the mine measured 10° to 15° west of northwest. The strike is in a northeast southwest direction.

The barite is of good, white quality, finely to coarsely crystalline, massive, and largely free from most of the common impurities. It occurs as a filling or cement of crushed and fractured impure limestones and red shales. The widest of these barite filled fractures are reported to be 4 to 8 feet. The barite also occurs as thin, tabular, cleavable masses in the limestone.

The Piedmont Plateau Region

Barite is reported to be found in the following counties of the Piedmont Region east of the Blue Ridge: Campbell, Bedford, Pittsylvania, Nelson, Buckingham, Amherst, Louisa, and Orange. It is also found near Marshall and Upperville in the crystalline rocks of Fauquier County, west of the Triassic area described above. Of the counties named, Campbell, Bedford, and Pittsylvania have been the chief producers.

The Campbell-Pittsylvania Area

Beginning in the middle western portion of Campbell County, a few miles east of Evington, a station on the Southern Railway, a belt of barite deposits is traced southwestward to 3 or more miles south of Sandy Level in the northwestern part of Pittsylvania County, a distance of about 30 miles. Numerous openings have been

made at different points on the belt, many of which have been extensively worked and have produced large quantities of excellent ore. This belt, being near the Southern Railway throughout its entire distance, has abundant facilities for shipping the ore. At every point opened, the barite is reported to have outcropped on the surface.

Associated Rocks.- The principal rocks of the barite belt in Campbell and Pittsylvania Counties are crystalline schists with intercalated thin beds of coarsely crystalline limestone. Of the former, two district types are differentiated; namely, mica schists and quartz schists. The immediate rocks with which the barite is associated are marked by an essential absence of feldspar. The schists are composed of mica with minimum quartz. They otherwise bear all the indications of altered sediments.

The limestone, with which the barite is found associated, is a coarsely crystalline, calcareous marble of considerable purity in places. The color is generally white, occasionally pink, and sometimes greenish. It contains ferro-magnesian silicate minerals, especially biotite and tremolite, and frequently chalcopyrite and pyrite. Manganese and iron oxides are also noted in places. This limestone widens and narrows alternately, forming lenses with a maximum thickness of 60 feet. It conforms to the dip and strike of the enclosing schists.

On either side of these limestone lenses are found schists.

In the northeastern portion of the belt, a fine-grained, quartzite schist of considerable purity, containing small, brightly reflecting scales of white mica underlies the limestone; whereas a variable mica schist of fine texture and thin foliation overlies the limestone. Variation is from a moderately fine-grained muscovite-biotite schist at the Saunders-Phillips Mines to a very fine-grained lustrous, sericite schist at the Hewitt Mine. A fine textured mica schist, heavily charged with minute grains and crystals of black magnetite, forms additional facies of schist at the Hewitt Mine. The mica schists are composed essentially of mica without feldspar. Those mines of the southwestern portion of the belt indicate an enclosure of the limestone by a much coarser textured, biotite-muscowite schist on the two sides. Feldspar is only scantily developed in the rock, but thin stringers of quartz are interleaved at times with the schist and small dike like bodies of a coarse crystallization of pink feldspar and quartz frequently cut across the foliation of the schist.

The third important type of rock, intimately associated with the limestone, is a black, usually foliated, manganiferous and ferruginous clay, locally known as "umber". This clay, whose fresh equivalent is a limestone schist, is believed to represent a transition between the well-defined and differentiated limestone on one hand and the mica schist on the other. Near the outcrop, this clay occupies the entire space between the schist walls.

When followed down the dip, however, the limestone appears as a thin wedge about the center of the thickness of the clay. This wedge of limestone expands as we continue to follow down the dip, until finally we reach a point where the clay disappears and the limestone assumes the entire space between the schist walls.

Structure.- These rocks all preserve a general northeast strike, which varies from N. 30° E. to N.55° E. Greater variations in dip are observed. At the northern end of the area about a mile east of Evington at the Saunders-Phillips Mines, the schists dip N. 60°--65° W. At the Hewitt Mine, which is about two miles S. 70° W. from the Saunders-Phillips Mines, the dip is to the southeast and quite steep, affording a distinct synclinal structure. The southern end of the belt shows a variable dip to the southeast, averaging about 20°.

As indicated in these measurements, the folding has not been of uniform intensity throughout the belt; but, in the northeastern end, the folding is steeper and of a somewhat closed type, while in the southwestern end, it is flatter and of a more open type.

Mode of occurrence.- Two characteristic occurrences of the barite are observed in this belt, always in association and equally as strongly emphasized in one part as in the other. The first and principal occurrence is in intimate association with the crystalline limestone as irregular, lenticular bodies or pockets replacing the limestone. These bodies measure 100 to 200 feet or more in width and generally lie between the footwall of schist

and the overlying limestone and black clay. Occurrences have been reported where the barite pockets are entirely enclosed by limestone. The ore observes the same coarsely crystalline, massive structure as characterizes the limestone, and in several places, gradation of the ore into the limestone has been observed. The second occurrence of barite in this belt is as lumps and nodules of large and small size distributed in an irregular fashion through the black, manganiferous and ferruginous clay. Occasionally barite stringers of slight thickness are formed along the foliation planes of the clay.

Barite and Associated Minerals.- The barite is, for the most part, massive granular, moderately coarsely crystalline, and of good white quality.

Calcite in the form of the coarsely crystalline marble, with which the barite occurs, is much the most abundant associate of the barite. Pyrite and chalcopyrite are frequently present as thin stringers and as disseminated small grains and crystals in some of the ore, but more especially in the associated limestone. These minerals are usually intermingled; and, in several instances, a green staining of malachite has been observed from the alteration of the chalcopyrite. Manganese and iron oxides are frequent associates; but, as a rule, they are not noticeable in the best grade of the ore. These oxides are more abundant and, therefore, more troublesome in the ore mined from near the surface. A small

amount of the ore of the Hewitt Mine, in Campbell County, is reported to have been highly charged with manganese oxide. Tremolite has been observed in both the black clay and the marble; and, in places, much biotite accompanies the tremolite in the limestone.

The Louisa County Area.

The barite deposits of this county are located on the Walker place, three-quarters of a mile south of Mechanicsville and 3 miles southeast of Lindsay.

The rocks are metamorphic, crystalline schists probably of sedimentary origin. They are very thinly foliated micaceous schists, considerably altered, the foliation planes of which are so regular and closely spaced as to be called locally, "slates". The strike is in a general northeast-southwest direction, and observes a southeast dip, which probably averages about 45°. Exposures of the rock are rare because of the considerable depth of residual decay which is chiefly in the form of gray and red clays. Quartz fragments, both large and small, frequently litter the surface, indicating quartz veins or vein-like masses interleaved with and cutting across the foliation of the schists. No limestone is known to occur in this area.

The ore is a moderately white grade of coarsely crystalline barite, remarkably free from impurities other than the usual discoloration from the red iron oxide. Several lumps showed cavities filled with nearly perfect quartz crystals. Drused surfaces of large, tabular, barite crystals are abundant. The ore, as far as

observed, has a general but variable southeast dip. It is reported to be pockety in mode of occurrence, widening and narrowing sharply and frequently and having a thickness of about 3 feet. The ore probably represents a filling of an irregular fracture in the crystalline schists, the barium salt being probably derived from some mineral or minerals composing the surrounding rocks.

The Bedford County Area.

Barite occurs at a number of different localities in Bedford County. Several mines near the Campbell County line have yielded large quantities of the mineral. In the western part of the county, between Bedford City and Roanoke, about 3 miles northwest of Thaxton, there is an interesting occurrence of the mineral. The barite occurs in a completely schistose, coarse-grained granite filling a fracture. Some distance away from the fracture, the granite is entirely massive and porphyritic, the feldspar phenocrysts being of large dimensions. The fracture appears to have a N.10°-20°E. coarse and dips about 60° southeast. The granite in the vicinity of the fracture is deeply decayed. The barite is crystalline and varies in color from white to deep blue-gray. In places, much galena in small grains and occasionally sphalerite are disseminated through the barite. It is quite probable that the source of the barium has been the feldspar of the granite. The associated galena and sphalerite indicate that they were deposited contemporaneously with the barite. There is no evidence to indicate whether they were introduced as soluble sulphides and deposited as such or whether they were introduced as sulphates and subsequently reduced to the sulphide form.

The Valley Region of Southwest Virginia.

The Virginia Valley Region lies west of the Blue Ridge Mountains and comprises a vast thickness of Paleozoic sediments, the principal member of which is the Valley, or Shenandoah, limestone. This limestone is separable into several divisions of Cambrian and Ordovician ages. Barite is found in a number of counties in the middle and northern parts of the Valley, but mining in this province has been confined largely to Russell, Smyth, and Tazewell Counties in southwest Virginia. Within recent years, mining operations have been confined chiefly to Russell and Tazewell Counties.

General Mode of Occurrence.

Wherever commercial deposits of barite have been opened in the Valley Province, they have been found in association with the Shenandoah limestone or its residual decay. These deposits observe certain minor variations of occurrence from place to place. They fill in part at least, fractures in the limestone; and, in part, they replace the limestone.

Wythe County

In the southern part of the county, near the eastern margin of the Shenandoah limestone, barite is found in association with the metallic ores in some of the zinc and iron mines. No attention has been given to the mining barite in this locality: therefore little is known as to its extent or occurrence.

In several of the brown-iron-ore pits at Ivanhoe, barite has been observed in some of the limestone pinnacles as protruding, irregular, porous or cellular masses, intimately associated at times with pyrite, sphalerite, and galena. These latter minerals, sulphides, were noted in several instances as enclosures in the barite. The barite in part replaces the limestone. Northwest of Ivanhoe at the Bertha zinc mines, which have been operated for iron ore, barite is found in places embedded in the red clay resulting from the decay of the limestone. About a half mile northeast of the Bertha Mine at the Barren Springs iron-ore pits, barite is found again similarly occurring.

The mode of occurrence and the associations of the barite in the above localities suggest the introduction of the barium salt along fractures in the limestone and the partial replacement of the limestone by barite.

Smyth County

Barite occurs both on the east and the west sides of Marion, the county seat of Smyth County. The chief mining operations, however, have been confined to the west side of the town. The barite has been found here both in the fresh, hard Shenandoah limestone and as lumps and nodules embedded in the residual red clays derived from the limestone. The barite nodules are often found mixed with cherty masses and with broken or detached pieces of limestone. Gradation from the barite into the limestone has been

observed. The exposures of limestone, in some places, showed more or less barite mixed with it.

Russell-Tazewell Counties Area

The occurrence of barite in this area is limited chiefly to the southern slope of Kent Ridge and its prolongation both northeastward and southwestward along the valley of the Clinch River, extending from near North Tazewell on the northeast to near Lebanon on the southwest, a distance of more than 30 miles.

The barite occurs as small and large lumps of irregular shapes assembled in the residual clay of the Knox dolomite, and in pocket form and vein-like bodies filling spaces in the limestone itself. The barite, in part, replaces the limestone. The limestone of this area is badly faulted and folded, numerous thrust faults occurring in the vicinity of the barite. The ore is crystalline, of good, white quality, and in most places quite free from impurities. Iron oxide is the commonest impurity, fluorite, chert, and manganese oxide occurring in small quantities at places.

This locality has been a large producer of the mineral.

Genesis of the Virginia Barite Deposits

Judging from the field character and relations of the Virginia barite deposits, it seems reasonable to assume that the source of the barium was largely, if not entirely, the rocks in which the deposits are now found. There is no evidence in support of a deep circulation.

The barium of the Valley deposits is believed to have been derived from the Shenandoah limestone, the rock in which the deposit

is found. Of those deposits east of the Blue Ridge in the Piedmont, it is not possible to say whether the barium was derived from the crystalline schists or from the associated limestone masses, or from both. It is reasonably certain, however, that the source of the barium in the deposit near Thaxton, Bedford County, was the silicate minerals of the granite, probably the feldspar. In all cases, the barium was probably liberated and carried in solution as the soluble bicarbonate when, under proper conditions, it was precipitated as the insoluble sulphate. The presence of pyrite in the Virginia rocks may suggest the possibility of its connection as a precipitating agent in the formation of barite deposits, but lack of sufficient data renders it impossible at this time to state the conditions under which the precipitation of the barium sulphate took place and the agents involved.

Conclusion

In discussing the Virginia barite deposits, Watson[1] makes the following conslusions:

"1. With two exceptions, the barite-deposits are associated with limestone or its residual decay. These exceptions show the occurrence of the barite in crystalline, siliceous rocks more or less remote from limestone masses.

"2. The occurrence of the barite in the limestone is partly as a replacement and partly as vein-like masses filling fractures,

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[1]Watson, Thos. L., Geology of the Virginia Barite-Deposits, Trans. A. I. M. E. , Vol. XXXVIII, p. 733, 1908.

and in the residual clays as loose, nodular masses, irregularly assembled and of different sizes and shapes. In each of these occurrences, the barite is crystalline in texture and is the result of solution and deposition.

"3. The barite and associated minerals suggest deposition from reasonably shallow circulations. The barite is believed to have been largely, if not entirely, derived, in most cases, from the rocks in which the concentrations are now found."

WEST VIRGINIA

So far as is known at the present time, no appreciable deposits of barite occur in this state. The same formation, the Shenandoah limestone (Knox dolomite), which carries deposits of barite in Virginia and Tennessee outcrops in sections of West Virginia, but no deposits of barite have been found in association with it here.[1]

KENTUCKY

Barite deposits are known to occur in five districts in Kentucky; namely,

1. The Central Kentucky District, comprising Anderson, Bourbon, Boyle, Clark, Fayette, Franklin, Garrard, Harrison, Henry, Jessamine, Lincoln, Madison, Mercer, Owen, Scott, and Woodford Counties.

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[1]By personal correspondance from Mr. David B. Reger, Asst. Geologist of the W. Va. Geol. Surv., April 8, 1925.

2. The Western Kentucky District, comprising Russell, Cumberland, Caldwell, Christian, Crittenden, Livingston, Lyon, and Trigg Counties.
3. Union County.
4. Casey County.
5. Geode occurrences in Clinton, Grant, Estill, and Lincoln Counties.

The Central Kentucky District has been by far the most productive district of the state, Boyle, Fayette, and Garrard Counties, in order named, being the principal producers. The Western District and Union County follow in the order named. Casey County and the geode occurrences of Clinton, Grant, Estill, and Lincoln Counties are, at this time, of no commercial importance.

The vein deposits of the first three districts named occur respectively in Ordovician, Mississippian, and Carboniferous rocks, the barite occurring most abundantly in the lowest of these strata divisions and decreasing in each succeeding higher one. The Casey County occurrence is in Devonian shale; while the geode occurrences range through the whole stratigraphic series of Kentucky.

Just as the commercial barite of Kentucky occurs in three of the more important stratigraphic divisions of the state, so is it connected with the three greatest earth movements, or disturbances, in the rocks of the state; namely, the Cincinnati Geanticline affecting the Ordovician rocks, the Crittenden Fan-fold-monocline affecting the Mississippian rocks, and the Rough Creek Anticline

affecting the Carboniferous and Mississippian rocks of west- central Kentucky. In each instance, these disturbances present great domal, modified domal, or uplift conditions.

Central Kentucky

The rocks exposed in central Kentucky range from lower Mississippian to lower Ordovician inclusive in age. Lower Mississippian, Devonian, and Silurian rocks cap small outliers, these rocks having been lowered by faulting to the level of the Ordovician rocks which cover the major portion of the region. The barite deposits are confined to the Ordovician, and are more prominently developed in the lower, or Mohawkian, than in the upper, or Cincinnatian, series of this division.

The workable deposits really begin at the top of the Cynthiana (Winchester) limestone, the lowest member of the Cincinnatian division of the Ordivician. Rather massive limestones carrying small crinoid stems, together with blue and gray knotty limestones, clay, and clay-shale constitute these upper beds.

The Lexington (Trenton) limestone, the upper Mohawkian beds, embraces five members of which the Bigby and the Wilmore beds, aggregating about 150 feet, offer the best barite deposits. The uppermost bed of the Lexington is a course cross-bedded limestone. The Perryville (upper Birdseye), which is usually fractured, is compact and dove-colored with glassy calcite grains disseminated throughout. This formation does not carry workable deposits of barite. The Bigby is a coarse grained, heavy-bedded, calcitic limestone with very little shale interbedded. The upper 40 feet

is highly phosphatic, and the extreme top very cherty. The Bigby carries the widest fissures and, consequently, the best barite deposits. The Wilmore member is a coarsely crystalline, somewhat argillaceous limestone interbedded with shale. It carries deposits next in value to those of the Bigby, but the deposits are usually narrower and the lower beds are apt to carry breccias. The Logana member is fine-grained, well-bedded, and inclined to be shaly. This member gives rise chiefly to breccias. The Curdsville is a crystalline limestone, cherty chiefly in the upper 20 feet; occassionally the upper 15 feet is coarse and massive. This member contains mixed breccia and narrow fissure deposits.

The Tyrone limestone, while similar in composition to the Lexington limestone, differs physically in its fine, compact, birds-eye texture and in its brittleness, making it liable to be easily broken into small angular fragments. These properties account for the breccias common to this formation; the compactness, at the same time, accounting for its being almost impermiable to water and to its slight solubility. There is, therefore, an absence of either marked fissure or replacement deposits in this limestone. The underlying Oregon member is a gray to cream-colored magnesian marble, which weathers yellow and has a thickness of 10 to 40, usually 25, feet. The Camp Nelson limestone, the lowest geological horizon outcropping in Kentucky, has an exposed thickness of 285 feet. Owing both to its being slightly magnesian and to its coarser, more open texture, it is more readily soluble than even the Lexington

limestone. The deposits are again fissure-filling, and crustification is common with flourite, barite, and calcite in alternating bands. The Camp Nelson member carries occassionally thin beds of white shale, which apparently do not effect the character of the deposits.

Structure.- The principal structure feature of the district is the Cincinnati Geanticline, which trends a little east of north through central Kentucky, crossing the Ohio River east of Moscow and extending thence to the latitude of middle Ohio. The Jessamine Dome is one of the two larger domal culminations of this structure. Following the axis of the Cincinnati Geanticline, north and south from the apex of the Jessamine Dome, the strata dips are very gentle, while the greatest dips are those east and west of the apex, along the eastern flank of the geanticline. The regularity of the dip is, of course, broken by faults and fault zones, which were necessary corollaries to the folding of such rigid strata as heavy limestone beds.

Attendant upon the uplift and broad, gentle folding, was the formation of the following fault zone: the Frankfort, the Elkhorn West Hickman, the Kentucky Anticlinal, and the Barrett Knob Fault zones. The Frankfort and the Kentucky Anticlinal Fault Zones form a "V" starting immediately south of the apex of the Jessamine Dome, the former striking northwest and the latter striking northeast. With minor exceptions, the barite district lies almost wholly within this "V". These fault zones represent minor folds modifying the regularity of the geanticline. Each fault zone represents a broadly shattered strip, varying locally from a few feet to a mile in

width and from five to seventy miles in length. Usually a number of faults and fractures make up each zone. The faults are of two types,- the normal fault with vertical or nearly vertical displacement of one wall, and the shift fault, in which one wall has shifted past the other in the direction of the strike of the fault. The former type is common to the major fault zones; the latter is predominant along the Frankfort Zone and in areas intermediate between the fault zones. While the strike of many of the faults varies from 5° to 10° east or west of north, there are many exceptions in which the strike more nearly approaches east and west. Shearing is common between the major fault zones. The strike of a single fault is often found to vary from east to west of north, the length of the faults varying from 1000 feet to 5 miles. The displacement of the normal faults is usually less than 100 feet, while the movement of the shift faults is seldom more than a few feet. The faults may reach depths of from 100 to more than 2,000 feet from the present surface; and, in many instances, 600 feet or more has been eroded from their tops. More than 200 faults have been mapped and a large number remain to be found. The distance between parallel veins varies greatly, but usually parallels are to be expected within ¼ mile of the central fault. The lack of joints, except in proximity to the veins, is quite marked, and the lack of calcite or barite seaming, ever more so.

Barite and Associated Minerals.- The barite of Kentucky is usually white, rarely bluish-gray, and even black. Crystals

occur rarely and, when found, are small and always a combination of the unit prism and the basal pinacoid. Analyses of Kentucky barite show a varying percentage of strontium sulphate, ranging from 0.37 to 21.32 percent; but, for all ordinary purposes, the mixed barium-strontium sulphate mineral or compounds prepared from it will serve as well as the straight barium sulphate mineral or compounds prepared from it. The chief exception to this is the use of barite in the preparation of barium peroxide.

The principal minerals found associated with barite in Kentucky are calcite, fluorite, galena, sphalerite, celestite, limonite (massive, in scales, as thin stains, or mixed with clay), and some manganese dioxide. Limestone and hydrocarbon stains are also found frequently associated. Quartz and strontianite as incrustations are associated to a lesser extent. The calcite, fluorite, galena, and sphalerite occur intergrown in all combinations. The celestite appears intimately blended with barite. The limestone is usually in the form of angular fragments, which are cemented together by the minerals. The limestone, calcite, and sphalerite are frequently partly decomposed, otherwise they are leached.

Mode of Occurrence.- The barite and associated minerals occur in three forms of deposits,-veins, bed-veins, and geodes. Only the first of these occurrences is economically important, although a bed-vein may occasionally prove to be of some value.

The veins are vertical or slightly inclined deposits, which pinch and swell both vertically and horizontally. They may reach a depth of over 1200 feet, a length of 4 or 5 miles, and a width of 16 feet. The average depth of the known deposits is 600 feet,

at least half of which carries a commercial product. The average width of the veins varies from 2 to 4 feet. The deposits fill three types of fissures,- simple fissures, shift faults, and normal faults. Those of the first type are rare. The most important deposits occur in the shift faults, and good deposits occur more frequently in normal faults of small displacement than in those of great displacement. The veins, although sinuous, maintain a fairly regular general strike. They are sometimes short and arranged in step fashion;sometimes they are linked.

The bed-veins are formed by the cementation of brecciated limestone. This brecciation results from the crushing of a limestone bed which has either been altered through leaching or else shrunk by being changed to magnesian limestone (dolomitization). The crushing results from the weight of overlying beds.

Geodes have been found notably in the Cynthiana limestone, in some of the upper Cincinnatian limestones, in the Keokuk limestone, and in the Waverly sandstone.

The deposits are either of the fissure type, the breccia type, the replacement type, or a combination of two or all of them.

The fissure type is characterized by the arrangement of the minerals in alternate bands (crustification). These bands consist either of one mineral or of two or more minerals in all possible combinations. Much of the barite and fluorite belong to this type. The order of abundance of the principal minerals is barite, calcite, fluorite, sphalerite, and galena. Angular or partly altered frag-

ments of country rock are occasionally enclosed in the veins.

The breccia type occurs both along shift and along normal faults. These deposits are least common along faults of great vertical displacement. Deposits of this kind are found in all veins, but most frequently where the vein cuts compact, brittle rocks such as the Tyrone limestone. Breccias seem to favor the deposition of flourspar and calcite somewhat more than the deposition of barite.

Replacement deposits of barite are found only occasionally in this district, but, when they are found, they usually form arborescent masses with unreplaced limestone between the fibers. Such barite is usually grayish to bluish in color.

Vertical Distribution Minerals.- The best barite deposits occur in the Bigby-Flanagan beds of the Lexington limestone. Flourite is not confined to any specific geologic horizon, but ranges through the whole stratigraphic series. Calcite and flourspar-calcite seem to occur most abundantly in the Highbridge limestones. In general, prospecting for these deposits in rocks younger than the Greendale limestone is not advised.

Western Kentucky

The barite district of western Kentucky comprised the following eight counties: Caldwell, Christian, Crittenden, Cumberland, Livingston, Lyon, Russell, and Trigg, the most important deposits being found in Caldwell, Crittenden, and Livingston Counties. This area forms the well-known flourspar district of western Kentucky,

and the barite deposits are incidental to the flourspar in this area just as the flourspar deposits are incidental to the barite in the Central Kentucky District.

Stratigraphy.- The rocks of this region range from upper Devonian (Chemung) through lower Pennsylvanian (Pottsville) in age, the barite deposits being found in the Meramec and Chester groups of the Mississippian.

The Meramec groups comprises the Warsaw formation, the Spergen limestone, and the St. Louis limestone, the Warsaw formation being as yet not definitely identified in this area. The Spergen limestone generally comprises massive, oolitic beds of light or dark gray, buff, or drab limestone, interbedded with thinner layers of various kinds of limestone and occasionally with thin seams of yellowish shale. It averages around 100 feet in thickness in this area. The St. Louis limestone in this region consists of at least 300 feet of chiefly dark-gray, rather heavy-bedded, highly siliceous limestone, interbedded, principally in the lower half, with purer, gray, crinoidal, subcrystalline layers and exhibiting a tendancy to become shaly in the lower fourth.

The Chester group consists of a variable series of limestone, sandstone, and shales, which is separated into four main divisions,- the Ste. Genevieve limestone, the Cypress sandstone, the Tribune limestone, and the Birdsville formation. The Ste. Genevieve limestone consists of a lower member of chiefly white, oolitic limestone, interbedded with blue oolite, thin bands of sub-crystalline, crinoidal limestones, and here and there a seam of green clay shale

or a bed of fine-grained, argillaceous limestone; a middle member of light, greenish-gray, very finely arenaceous usually massive limestone, which weathers to a light red or reddish brown, laminated, soft, porous, more or less calcareous sandstone; and a top member of variable, thin, fine-grained, earthy limestone, interbedded with soft, greenish, calcareous, clayey shales. The Ste. Genevieve limestone is about 300 feet thick in this district. The Cypress sandstone consists usually of a light brown, massive, fine to medium-grained(rarely coarse) quartzone sandstone. The Tribune limestone comprises thin to thick bedded, fine-to coarse-grained, generally light-gray limestones, more or less abundantly interbedded with thin seams of calcareous, clayey shale, a nd occasionally with thin beds of sandstone. The Birdsville formation is an extremely variable series of sandstones, shales, and limestones. The veins carrying barite occur especially in the Ste. Genevieve and St. Louis limestones.

Structure.- In a broad way, the Western Kentucky District, the rocks of which extend into Illinois, represent two truncated, stratigraphic domes. The northern one centers in Hardin County, Illinois, and is the sharper, more complete one of the two. The southern dome is so badly broken up and eroded that its center cannot now be definitely fixed, but it was probably somewhere along the Tennessee River not far from the town of Grand Rivers. Both domes are irregularly circled on the north and east by an escarpment formed by the Mansfield sandstone. On the southwest, the district is bounded by the remains of an ancient and often submerged anticlinal fold, against and over which deposits were

piled from both sides. It is an elevation on this anticlinal fold that is supposed to be the center of the southern dome. From here to the Mansfield Escarpment, the Mississippian formations occur in successive but very much interrupted bands. To the southwest, the Cretaceous and Tertiary clays overlap the slope to, and in places across, the Tennessee River.

The barite district contains a large number of normal faults, striking in many directions, chiefly northeast, northwest, and east named in order of importance. Their maxium displacement ranges from 300 to over 1400 feet. The planes of these faults divide the area into a large number of very unequal, but always sharp-sided polygons. As a rule, the lines of faulting are practically straight.

Very little local folding occurs in this region, but, in Crittenden County, dikes and sheets of mica-peridotite are to be found. The dikes, for the most part, have a northwest trend, are from 2 to 25 feet in width, and probably have great length.

Minerals of the Ore Deposits.- The minerals forming ore deposits and associated with them in this district are barite, galena, cerussite, pyromorphite, sulphur, sphalerite, smithsonite, hydrozincite, calamine, greenockite, pyrite, marcasite, limonite, chalcopyrite, malachite, fluorite, calcite, quartz, kaolinite, and ankerite, In addition to these, small quantities of some of the hydrocarbon compounds are occasionally found in the veins. Of these minerals, only fluorite, barite, galena, sphalerite, and smithsonite are known to be of economic importance within the district.

Barite is usually found in massive, fine-grained aggregates, although it is occasionally noted as crystals, especially in small cavities in the partially weathered, more massive forms. The individuals of the massive barite are generally thin and platy and are frequently grouped in arborescent forms.

Mode of Occurrence.- The barite of western Kentucky is found chiefly as a vein mineral in flourspar deposits, which occur as (1) vein deposits filling fissures caused by faulting, (2) ores cementing breccias of country rock which has been thoroughly shattered by differential movements, and (3) metasomatic replacements mainly of the country rock or of rock fragments in deposits of the other two classes. The three types are frequently associated, and the first two may grade into each other. Fluorite, barite, some galena, and some sphalerite are found in fissure veins, which are by far the most important occurrence. The same ores occur as a cement to breccias, while those found as metasomatic replacements include mainly sphalerite below the influence of surface oxidation and smithsonite within that zone.

The width of the veins varies considerably, the maximum width thus far recorded being 19 feet. The most important veins, however, do not exceed 6 or 8 feet in width. The veins have been too little exploited however, to make it possible to state with any degree of certainty that the individual ore bodies are continuous for more than one-fourth of a mile. The veins are not perfectly straight, either horizontally or vertically, both dip and strike changing

from point to point usually in accordance with the dip and strike of the fault plane. The dip of the veins is always high, generally 60° or more.

Barite is common in some of the veins, although in many, if not most of them, it is not found at all. Taking the district as a whole, however, it is probably next in abundance to calcite as a vein mineral. In many cases where it occurs it forms only a small proportion of the vein, although occasionally it is the chief constituent. Seams is brecciated rocks and narrow veins sometimes consist wholly of this mineral.

Barite occurs in all the rocks in which fluorite is found. Where seen only in small amounts it was, as a rule, along the margin of the vein, never distributed through it. When occurring with fluorite in seams, it sometimes shows symmetrical banding. This banding ~~banding~~ is the most pronounced structural feature of the veins and is shown to a greater or less extent by most of them.

Origin.- The various writers who have studied the western Kentucky vein deposits are generally agreed that they were formed from solution, and that the source of the materials has been the limestones of the region. It is not impossible however, that the source of some of the minerals at least, may have been the magma from which the peridotite dikes were derived. Smith[1] says, " It is not probable, however, that the dikes themselves are the source of the fluorite, chiefly on account of the total volume of the fluorite veins as compared with that of the igneous dikes and the very small fluorine content of the peridotite." It has also been sug-

gested that meteoric waters circulating in dolomitized limestone at a level below the Carboniferous formations were heated by the intrusion of the dikes, producing convectional currents and precipitation from solution at higher levels along the lines of faulting.

NORTH CAROLINA

North Carolina is one of the important barite-producing states in the Southern Appalachian region. The deposits occur in two areas of rocks,-(1) in Madison County in the western or mountainous part of the state, and (2) in Gaston, Cleveland, and Orange Counties in the Piedmont region.

Madison County

Barite is found in large quantities in the region along the French Broad River, northwestward from a line drawn approximately northeast and southwest through Barnard. Little prospecting has been done beyond a few miles from the French Broad River and the Southern Railway along its banks, because of the transportation difficulties encountered in the rough mountain country. There is no reason to believe, however, that the barite is confined to the strip along the railway; in fact, it is known that the reverse is the case.

Rock Types.- The rocks of this region comprise igeous, ancient

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[1] Ulrich, E. O. and Smith, W. S. T., The Lead, Zinc, and Flourspar Deposits of Western Kentucky, U. S. Geol. Surv. Professional Paper No. 36, P. 151, 1905.

metamorphic, and sedimentary bodies,all more or less altered since their materials were brought together. Some of them are very ancient, going back to the earliest known period. They consist of two groups of widely different age and character,- (1) the igneous and metamorphic rocks, including gneiss, schist, granite, diorite, and similar formations, and (2) sedimentary strata of lower Cambrian age, including conglomerate, sandstone, shale, limestone, and their metamorphic equivalents. Ordovician rocks are found in a small and unimportant area. The older of these groups occupies the greatest area; the younger, the least.

The barite is found in a rock type of each of the above named groups, the Max Patch Granite of the older groups and the Snowbird Formation of the younger group.

The Max Patch granite consists almost entirely of coarse granite, in places porphyritic, in places of uniform grain. The principal minerals of this rock are orthoclase and plagioclase feldspar, quartz, biotite, and a little muscovite; the accessary minerals are magnetite, pyrite, and epidote, the latter being, for the most part, in secondary veins and patches. The color of the rock ranges from light gray to dull white to ~~a~~ red.

The Snowbird formation is composed mainly of fine and coarse quartzite, interbedded with conglomerate and arkose, and subordinate layers of gray and black state. Most of the beds are light colored, white or gray but there is considerable variation in this respect, dark bluish gray and reddish beds having been observed.

Structure.- The rocks of this area have undergone many alterations, having been bent, broken, and metamorphosed to a high degree. The structures thus resulting trend in a general northeast-southwest direction, there being much less regularity, however, than is usual in the Appalachians. The folds are large and intricate, and are broken by immense thrust faults, both the folds and faults varying widely in the direction of their strike. The barite areas occur in a belt near and parallel to one of the principal thrust faults of the region.

Barite and Associated Minerals.- The barite is usually of high purity. Some specimens show a yellowish color, an oily luster, a nearly transparent diaphaniety, and a structure inclined to be columnar with long pores somewhat like stick candy. These specimens are homogeneous in nature. Other specimens are clear, soft, and crystalline with exceptional brilliance and whiteness. The chief associated minerals are fluorite and silica. Pyrite, and manganese, iron, and aluminum oxides are also sometimes found associated.

Mode of Occurrence.- The deposits are in veins of the fissure and brecciated types, occurring in the Max Patch granite and, to a less extent, in the Snowbird formation, which lies unconformably thereon. They usually occur near the contact of these two rock types, and are, according to Watkins[1], sometimes associated with

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[1] Watkins, Joel, Watson and Grasty, Barite of the Appalachian States, Trans. A. I. M. E., Vol. LI, p.533, 1906.

limestone. The barite areas occur in a northeast-southwest belt near and parallel to one of the principal thrust faults of the region. Pratt[1] states that the veins vary from 3 to 10 feet in thickness and that the barite is practically free from impurities; whereas Keith[2] states that the barite occupies irregular veins and gashes in the country rock and that these veins are rarely over a foot in thickness, usually several inches. One vein located near Sandy Bottom Station on the Southern Railway is described by Mr. Betts, a mining engineer of Ashville, N. C. He states that the vein strikes north 10° east for a distance of a mile and dips 30 to 60 degrees.

Origin.- According to Keith, the barite was deposited from aqueous solutions subsequent to the metamorphism of the inclosing rocks. The ultimate source of the material is probably the great mass of granite within which it is now found. These conclusions are based on the arrangement of the barite and the fact that it occurs in large crystals and crystalline masses which have not been deformed, as have the minerals of the inclosing rocks.

The Piedmont Region

Barite occurs in Gaston, Cleveland, and Orange Counties of the Piedmont Region of North Carolina.

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[1] Pratt, J. H., Economic Paper No. 6, N. C. Geol. Surv., pp. 62 to 65, 1902.

[2] Keith, Arthur, Ashville Folio, N. C.-Tenn., No.116, U. S. G. S. pp.9, 1904.

In Orange County, barite of good quartz is found 3 1/2 miles southeast of Hillsboro, near the Chapel Hill Road. Some development of this occurrence was in progress in 1901.

The barite in Gaston and Cleveland Counties occurs in a belt, known as the Kings Mountain Belt, which extends several miles in a southwest direction from Bessemer City.

The country rocks are, for the most part, crystalline schists and gneisses, the former being micaceous, chloritic, argillaceous, and sometimes graphitic, the latter, micaceous. The strike of these rocks is in a general northeast-southwest direction, and the dip is generally to the west at very steep angles. Occasionally lenticular bodies of siliceous, magnesian limestone have been observed. Quartzite forms the higher ledges of the mountains of the region. This whole region has been subjected to faulting and folding.

The barite is granular, sometimes coarsely crystalline; and, in some places, cleavable surfaces two inches across are noted. The quality of the barite, as a whole, is good, and, by giving some care to its selection, barite of the first quality can be obtained. The associated minerals are quartz, galena, sphalerite, pyromorphite, and stains of iron and manganese oxides.

The barite occurs in lenticular veins in a pyrite-bearing sericite schist. The veins strike N. 15°-40°E. and dip at high angles, usually toward the west. The dip and strike of the veins conform to the cleavage of the schists. The fissures and crevices,

now occupied by the barite, were very probably formed by the faulting and the tearing of the schists apart, the veins themselves being formed partly by replacement of the pyritiferous schist and partly by the filling of open fractures. These veins range in thickness from 2 1/2 to 6 or more feet and are 400 or more feet in length. Cyanite schist outcrops near the veins on the west side; and lenses of magnesian limestone occur in the region, but, so far as observed, are not found in association with the barite.

SOUTH CAROLINA

Barite has been found in South Carolina along the Kings Mountain Range in the Abbeville-York Zone. Specimens of the mineral have been obtained from the vicinity of Kings Creek, a station in Cherokee County on the Blacksburg-Yorkville branch of the Southern Railway and from a locality near Rossville in Chester County. The former locality is about thirteen miles southwest of the Lawson Mine in Gaston County, North Carolina.

The barite appears to have been deposited from solution in fissures of hard mica schists, now weathered above the valley lines to the unctuous hydro-mica form. The country rock has been greatly foliated and more or less deformed.

In the deposits in the vicinity of Kings Creek Station, the barite occurs in quartz-sericite schist as lenticular veins. This schist strikes northeastward and dips southeastward at an angle of about 43°. Thus far, limestone has not been observed in association with the barite deposits. The barite is of good quality, massive

granular in texture, and varies from pure white to pink in color, the white predominating. There is apparently no difference in quality in the differently colored minerals. Some parts of the veins are very pure, being singularly free from associated minerals, but other parts contain a little galena and less fine-grained quartz. Occasional inclusions of pyrite cause local areas of stain. The veins have a general strike of about N.25° E. and a dip of about 40° to 45° southeast. The greatest thickness observed was 6 feet of massive, white barite; while one outcrop is conspicuous for more than 500 feet in length. The veins conform roughly to the structure of the inclosing schists, and sharp contacts between the vein and the country rock are usually shown, although small inclusions of the schist are incorporated in the barite in places. Branching veinlets, which fill fractures that cross the structure of the schists, are given off from the main veins. The field evidence indicates that the veins have had a similar genesis to those farther northeast in Gaston County, North Carolina.

The sample obtained from the Rossville area was of good grade, but the locality has not been examined.

TENNESSEE

Barite is found in many localities in Tennessee, but the more important deposits occur in the eastern part of the State. The chief localities are (1) the Sweetwater District, centered about the town of Sweetwater and including parts of Loudon, McMinn, and Monroe Counties, and (2) the French Broad District, which in-

cludes parts of Cocke and Sevier Counties on the North Carolina line. Barite is also found in Green County about twelve miles from Greeneville, in Davidson County near Haysborough, and in Bradley, Jefferson, Smith, and Washington Counties.

The Sweetwater District

The Sweetwater District is the largest and most important barite district in Tennessee. The area lies near the middle of that part of the Great, or Appalachian, Valley included within the limits of the State of Tennessee. It includes those parts of Loudon, McMinn, and Monroe Counties centered within a radius of 20 miles about Sweetwater, a town on the Southern Railway 42 miles southwest of Knoxville.

Stratigraphy.- With the exception of a small area in the northwestern part of the district, the rocks all belong to the Cambrian and Ordovician Systems, the outcropping formations occurring in belts extending from northeast to southwest. The Cambrian is represented by eight narrow bands of shales and sandstones. Alternating with these bands of Cambrian formations are wide bands of limestones and dolomite most of which belong to the Ordovician. Chief among these is the great Knox dolomite formation, which underlies the greater part of the district and in which the barite deposits occur. This formation is a massively bedded, dolomitic limestone, containing in places a large amount of chert. The chert occurs as nodules and masses in the strata sometimes in such amount as to almost constitute beds. Because of their ability to

resist erosion, the chert beds stand out more or less prominently as ridges. Accompanying the Knox are higher formations of shales, limestones, and ferruginous sandstones of the same age. In the northwestern part of the district is a small area underlain by formations of Silurian, Devonian, and Mississippian age.

Structure.- The rocks of this region have been greatly faulted and folded, Seven great thrust faults occur within the district as mapped, in addition to which are many minor breaks ans slips. The planes of all these faults strike in the general northeast-southwest trend of the region. The beds, in general, dip from 10 to 40 degrees southeast, more commonly 20 to 30 degrees, and strike northeast and southwest. Some beds, however, dip to the northwest. In some cases, especially in the immediate vicinity of faults, the dip may approach vertical.

Barite and Associated Minerals.- In its unaltered condition, the ore of this district is a crystalline, massive, gray or grayish white barite with a vitreous luster and sometimes stained pink or brown by iron oxide. When subjected to weathering conditions, the mineral assumes a dull, lusterless, white appearance and ultimately crumbles to a white powder. The surficial portions of the residual deposits are, therefore, likely to be reduced to a fragmental condition, known as "gravel" ore.

The minerals associated with barite in this district are fluorite, chert, iron oxide in the form of limonite, sphalerite, galena, anglesite, calcite, and manganese oxide. Fluorite is of frequent occurrence, being usually confined to certain parts of the

vein and absent in others; chert is present in a greater or less amount in all the deposits; iron oxide, in varying amounts; while sphalerite, galena, anglesite and manganese oxide occur in small amounts in places. In addition to these minerals, inclusions of the country rock are associated with the barite in brecciated deposits.

Mode of Occurrence.- The barite of the Sweetwater District occurs in two forms of deposits,-(1) as bedded veins or shattered zones in the Knox solomite, and (2) as lumps and masses in the overlying residual clays derived from the decay of the dolomite. Only the latter form of deposit is of commercial importance at present.

Three separate veins or belts are reconized, although these may be one and the same repeated by faulting. They are the Howard Vein, the Garrison Vein, and the Culveyhouse Vein. These veins all occur in the Knox dolomite at nearly the same horizon in the formation; that is, about one-third its thickness below the top of the formation, or at about the top of the Copper Ridge Chert. A few small deposits appear to lie outside the limits of these veins, but they are apparently local and of little importance. The veins strike in a general northeast-southwest direction, and extend in length entirely across the area. The width of one of the veins, as shown by the outcroppings in the bed of a dry weather branch, is about 600 feet. The thickness of the overlying barite-bearing clay which results from the weathering of the dolomite, may be

100 feet or more in places; but the average thickness is much less this.

Origin.- In their original form the ores were deposited from solutions carrying barium sulphate, which circulated through the brecciated zones in the Knox dolomite. These depositions more or less completely filled the cavities and cemented the breccia together. Indications of deposition in irregular spaces is seen by the banded and crested structure of the ore, while, in places, deposition appears to have ceased before the cavity was completely filled, leaving vacant spaces, or "vugs", lined with projecting crystals of barite. The ultinate source of the barium was evidently the dolomite and the associated limestones, analyses of these rocks showing an appreciable percentage of barium.

The French Broad District

The French Broad District includes parts of Cocke and Sevier Counties, located on the North Carolina line in the mountainous region of the State, south and a little east of Knoxville.

The rocks of the region, in the main, consist of sandstones, conglomerates, and shales, which have been metamorphosed to quartzites and slates. The strike is in a general northeast-southwest direction, and the dip is usually to the southeast at a high angle. These rocks have been greatly faulted and folded.

The barite, which is at places bluish in color and crystalline, occurs as masses and stringers in clay-filled veins which tend to parallel the dip and strike of the inclosing rocks. Several open-

ings show the width of the veins to range from one to ten feet. Associated with the barite in the veins, has been found, in addition to the filling of clay, white quartz and iron ore; but the deposits are, as a whole, very free from impurities.

Green County

The barite deposits of this county have been worked at four localities; namely, about four miles northeast of Greenville, in the vicinity of Jearoldstown, five miles south of Midway, and near Morristown.

These deposits, like those of the Sweetwater District, occur in veins in the Knox dolomite and in the residual clays overlying this formation. The veins appear to be several feet in width and to follow the bedding of the country rock in dip and strike. The dip taken at one locality was found to be 60°, N. 40°W. Sphalerite has been observed associated with the barite.

GEORGIA

The barite deposits of Georgia are situated in the northwestern part of the state both in the Appalachian Valley Province and in the Piedmont Province. The physiographic boundary between these two great provinces is the escarpment of the Cartersville Fault. This fault, likewise , is the line of separation between the Paleozoic sediments of the Valley and the Paleozoic and pre-Paleozoic metamorphosed rocks of the Plateau.

In the Piedmont Plateau, the rocks in which deposits of barite occur are, beginning with the oldest, the Corbin granite, the Pine-

log conglomerate, and the Wilhite slate; in the Appalachian Valley, they are the Weisner quartzite, the Shady limestone, the Cartersville shale, the Conasauga formation, and the Knox dolomite. These rocks, ranging from igneous Archean types to sedimentary Paleozoic types, will be described in the districts in which they occur.

Types and Deposits

The barite deposits of Georgia may be classified into six types according to their modes of occurrence; namely, (1) vein deposits, (2) replacement deposits, (3) breccia deposits, (4) residual deposits, (5) colluvial deposits, and (6) alluvial deposits. The first three types occur in hard rock, or consolidated formations; the last three, in unconsolidated material. Only the residual and colluvial deposits are of commercial importance, although a few deposits of the vein type have been worked on a small scale.

With the deposits of the vein type may be grouped fracture-filling. Much of the breccia ore is also a fractured phase of vein-filling. Veins and fractures filled with barite are not common in the known rocks of Georgia; but there are several occurrences sufficient to indicate that the large, fragmental ore deposits accumulated by the weathering of veins. Most of the veins occur in limestone with their exposures generally ill-defined as regards attitude and extent of the ore body. The observations made, however, indicate that they vary from a few inches to three feet in

thickness. It is not always clear whether they represent true veins or replacements.

Many of the ore bodies of the residual type have accumulated from fragments weathered out of deposits that formed in veins and as replacements in limestone. Ore fragments are found showing barite occupying portions of finely-granular but somewhat porous, siliceous material from which the calcium carbonate has apparently been removed. In such instances the barite has replaced the more calcareous portions of the rock.

The breccia type of deposit forms a large number of the barite ore bodies of Georgia. Much of the brecciated ore is found in the residual deposits, where some of the brecciated masses consist of angular limestone fragments cemented together by barite, and others, of barite fragments cemented by ferruginous material of both ocherous and limonitic character.

Residual deposits as here defined form, at present, the only profitably workable deposits in Georgia. The term "residual", as here used, is not restricted to those ore bodies that have been left behind in place, but it is intended to embrace also those other fragmental accumulations that have been added to the strictly residual deposits and have thus been concentrated in unconsolidated material by long continued weathering agencies such as frost action, hillside creep, and gully wash. The term "residual" is applied to these accumulations, because they are generally in the red and yellow soil mass that overlies or represents the ore-bearing rock, which is, as a rule, limestone. Residual deposits may have

been formed from any or all of the three consolidated types,- vein, replacement, or breccia.

All the large deposits of Georgia may be described as colluvial deposits; that is, they are unconsolidated accumulations formed by the wearing away of hillsides, and they still occupy hillside positions. Since the colluvial deposit is a gradual accumulation from strictly residual ore, the ore in place slowly passing by means of hillside creep into a strictly secondary position, it cannot be definitely separated from the residual deposit. The principal deposits are, therefore, both residual and colluvial in nature; and, for this reason, Hull[1] has called them "secondary-residual" or "residual-hillside" deposits.

Although alluvial, or water-borne, accumulations of barite are not recognized as distinct and separate ore bodies, they do form a part of several important deposits. The close and common associations of stream and beach gravel with the ore deposits, the rounded pebbly appearance of some of the barite itself, and the distinct and almost horizontal stratification of some of the unconsolidated material are all good evidences that water transportation has contributed in a small way to the secondary deposition of the ore.

Types of Ore

The principal types of ore found in Georgia may be classified as (1) crystalline and (2) granular. The crystalline ore is both coarse and fine in texture, transluscent in thin fragments, and

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[1] Op. cit.

generally slightly bluish-white in color. The granular ore is finely granular, opaque, and dull white. Different phases of the two types are caused by iron, manganese, quartz, limestone, and other impurities. There seems to be little, if any, difference in the chemical composition of the two types, although the opaque, granular ore is the weathered and thus the somewhat altered and softer product. Both types occur as irregularly shaped fragments, some angular, some with smoothly worn surfaces, ranging in size from mere grains to masses several feet thick.

Origin of Deposits

The barium, originally in the feldspars and micas of the crystalline rocks, was removed in solution by circulating meteoric and thermal waters and carried from uncertain depths upward through channels made by faulting and fracturing in the earth's crust to limestone formations where favorable precipitating reactions caused the deposition of the barium sulphate, barite. It is not thought that the sulphate was formed by the reaction between barium carbonate, or witherite, and calcium sulphate, or gypsum, as has been suggested for the origin of some deposits, because neither of these minerals has been found associated with any of the deposits studied.

It has been observed that the larger ore bodies are near the great Cartersville Fault and that the smaller deposits are near minor faults or near the contact of one formation with another.

The ore bodies were deposited in Archean and early Paleozoic rocks about the end of the Paleozoic Period when the Appalachian deformation was in progress and the structure of the Piedmont Plateau and the Appalachian Valley was complicated in a most confusing manner by folding, fracturing, and faulting. Faults and fissures formed by this shattering became the channels for many different mineral-bearing solutions from which barite was one of the most important ores deposited. During subsequent periods of weathering and degradation of the mountains found at that time, the original deposits of barite have been exposed and the enclosing rocks have been greatly worn away, leaving the more resistant and less changeable ore behind as residual-hillside accumulations.

Distribution of Deposits

The barite deposits are almost wholly in the Appalachian Valley division of the northwestern part of Georgia, occurring principally in the vicinity of Cartersville, Bartow County, about 40 miles northwest of Atlanta, and in minor quantities and isolated localities from the Alabama line near Esom Hill northeastward to the deposits near Ruralvale, 6 miles south of the Tennessee line. This area including these scattered deposits is 75 miles long and 25 miles wide at its greatest width near its center. The following seven counties named in order from the Alabama line northeast to the Tennessee line contain deposits: Polk(?), Floyd, Bartow, Cherokee, Gordon, Murray, and Whitfield.

All the large deposits and all that were being worked in 1919 are in the Cartersville mining district in the south-eastern part of Bartow County. A smaller and inactive district includes the old mines near Eton in central Murray County. In addition to these, seven other districts will be described or mentioned in this paper; namely, (1) near Bass Ferry, eastern Floyd County, (2) south of Plainville, northeastern Floyd County, (3) southwest of Stilesboro, southwestern Bartow County, (4) north of Kingston, western Bartow County, (5) southwest of Waleska, western Cherokee County, (6) north of Plainville, southwestern Gordon County, and (7) near Ruralvale, eastern Whitfield County. The occurrence reported near Esom Hill, Polk County, is doubtfully in Georgia.

The Cartersville District

The Cartersville District comprised an area in the south-eastern part of Bartow County 18 miles long, from the vicinity of Emerson at the south end to the vicinity of Pinelog and Martin's Hill at the north end. Its greatest width, in the vicinity of Cassville and Rowland Spring, is 7 miles. Thus limited, it lies wholly within the Appalachian Valley just west of the Cartersville Fault.

The principal barite deposits are confined to the southern part of this district, comprising an area about 6 miles long and 3 miles wide, extending northward from Pumpkinvine Creek on the southside of EtowahRiver to the mines northwest of Pine Mountain on the north side of the same river.

Rock Types.- Including in the Cartersville barite district the isolated deposit at Iron Hill in the Piedmont Plateau, 6 miles east of Cartersville, we find that the stratigraphic sequence of the rocks begins with the Archean and ends with the upper Cambrian formations. The ancient crystalline rocks of the Piedmont Plateau east of the great fault are included in this discussion, because some of them contain feldspars that are probably significant as the ultimate source of the barium. The following formations are those with which barite is more or less associated in the Cartersville District.

Cambrian

Conasauga shale and limestone

Cartersville shale, slate, and sandstone

Shady limestone

Weisner quartzite

Ocoee

Cambrian (?) or Algonkian (?)

Wilhite slate and limestone lentils

Pinelog conglomerate

Archean

Corbin granite

The Corbin granite is a massive, coarse-grained rock, containing large porphyritic crystals of feldspar (microcline) in a ground-mass of plagioclase feldspar, muscovite, and blue quartz. Some parts of the rock have undergone considerable alteration,

having been converted into an augengneiss. Since the largest barite deposits of the State occur in sedimentary rocks near this granite mass, whose silicate minerals contain barium, it seems probable that they owe their origin in part at least to it. A chemical analysis by H. N. Stokes shows 0.30 percent of barium oxide. This rock constitutes the hills of the Piedmont Plateau east of Pinelog, Brushy Knob, Pine, and Signal Mountains.

The Pinelog conglomerate borders the granite area on all sides but the southeast. It forms many of the hills and smaller mountains of the region and lies along the eastern flank of Brushy Knob and Signal Mountains. This is a rather heterogeneous formation composed of conglomerate, arkose, quartzite, siliceous phyllite, and graphitic slate, all much sheared and largely altered to sericite schist and gneiss. It seems to be an altered phase of the granite, and its border, or peripheral, character, is shown in its areal distribution.

The Wilhite slate likewise surrounds the Corbin granite area by narrow borders 1/8 to one mile wide. It comprises slate and schist, characterized by carbonaceous, or graphitic, material and contains limestone lenses that have probably afforded favorable conditions for the deposition of barite by replacement.

The Weisner quartzite, correlated with the Erwin quartzite of Virginia and Tennessee, with the overlying Shady limestone is one of the most important formations of the barite district in its relation to the occurrence of the barite deposits. It extends along the western side of the Cartersville Fault from Pumpkinvine

Creek north-northeastward about 18 miles, the length of the whole Cartersville District, to Pinelog Creek. In the barite district proper, it occupies the foothills, or ore bearing area, and is 2 to 3 miles wide. Although the area thus described has been mapped as and is almost all quartzite, no small part of it is underlain by Shady limestone. This formation, as associated with the barite deposits, strikes north-northeast and north-northwest and dips 45° to 50° southeast to northeast.

The Weisner quartzite consists chiefly of vitreous quartzite, although it also contains some beds of fine conglomerate and probably considerable beds of siliceous shales. The thickness of the formation is probably 2,000 to 3,000 feet, but may be considerably more. All analyses that have been made of this rock show an appreciable percentage of barium; in fact, a higher percentage than is shown by any other rock associated with the deposits. Specimens collected by the late Dr. Thomas L. Watson[1] show 4.46 percent barium sulphate; whereas samples collected by Hull[2] of the Georgia Survey show 0.40 and 0.15 percent barium oxide.

The Shady limestone, including the unconsolidated products of its decomposition, is the formation that contains the barite deposits of the district. It overlies the Weisner Quartzite and occupies an area paralleling that formation on the west. It ranges in width from 1/8 to 1 1/4 miles, and is evidenced by low-lying

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[1] Watson, Thos. L. and Grasty, J. S., Barite of the Appalachian States, Trans. A. I. M. E., Vol. LI , 1915.
[2] Op. cit.

gently rolling hills. This formation was formerly called the Beaver Limestone; but, since it does not occur at Beaver Ridge, Tennessee, and since it has been correlated with the Shady limestone of Virginia and Tennessee, the old name has been abandoned by Hull[1] and the name "Shady limestone" adopted. It consists of gray, dolomitic limestone, generally rather sandy and, in places, clayey. The principal characteristics of the weathered phase are the chert like masses of siliceous and ferruginous rock and the residium of red clay soil. The thickness of the formation, as estimated by Hayes[2] ranges from 800 to 1200 feet. Analyses of specimens collected show that the content of barium in the limestone itself is neither large nor widespread, only one of five specimens showing any barium content. This specimen showed 0.55 percent barium sulphate.

The Cartersville formation occupies a narrow belt just west of and parallel to the Shady limestone. This formation is a potash-bearing series of slates, shales, and felspathic sandstones, ranging in thickness from 600 to 700 feet. Barium is not known in this rock, although no determination has been made for it. Only a few barite deposits are found associated with this formation.

The Conasauga shales and limestones underlies a broad area west of the Cartersville formation; yet they form only a small part of the barite district proper. It is with the dolomitic limestones of this formation that the barite is associated when present at all, although it is very seldom found present.

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[1] Op. cit, p. 26
[2] Hayes, C. W., Geological Relations of the Iron Ores of the Cartersville District, Ga., Trans. A. I. M. E. Vol. xxx, p. 404 1901.

The strike and dip of the beds of this formation are generally north-northeast and east-southeast, respectively. Hayes[1] estimates its thickness to be between 1500 and 2000 feet. Barite is not known definitely to occur in this formation in the Cartersville District, although fragmental barite does occur near its contact with the Cartersville Formation.

Structure.- The rocks of this area have been subjected to intense folding, faulting, and metamorphism. In the vicinity of Cartersville, the rocks strike from north-northeast through north to northwest, forming a crescent bending around the east side of Cartersville. They dip in corresponding easterly directions. The folds usually observed in this district are as a whole of the closed, overturned, anticlinal type; while the faults are of the overthrust type. The axes of the folds strike in a general northeast-southwest direction, and the traces of most of the fault planes tend to parallel this strike, the pressure having come from the southeast. Some of the fault traces, however, cut across the formations very obliquely. In the areas between the major faults and folds of the region, may be seen many minor faults and folds of the same types as the major ones.

Mode of Occurrence.- The barite deposits of the Cartersville District are so closely associated with yellow ocher, limonite, and manganese ores that a discussion of their origin and occurrence almost of necessity involves a discussion of all these ores.

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[1] Hayes, C. W., Hull, J. P. D., Op. cit, p. 28.

All the commercial deposits of barite are of the residual-colluvial types, wholly or in part, although the ocher deposits belong more strictly to the replacement type. They occur in the unconsolidated residual and colluvial clayey accumulations decomposed from the Shady limestone and, to some extent, from the Weisner quartzite. These accumulations, carrying the yellow ocher and limonite, manganese, and barite, overlies a steeply dipping foot wall of Weisner quartzite. Each of the four minerals commonly occurs in the same open-cut, but only one generally forms the workable deposit for that particular opening. Furthermore, the same sequence holds in a general way topographically. First below the quartzite outcrops, down the hillslope, occur limonite and ocher mixed in the clay; farther down the slope, appear the manganese deposits; and still farther down, the barite deposits. The deposits, however, are not sharply marked off from one another; for the limonite and ocher deposits grade into the maganese deposits, and the manganese deposits in turn grade into the barite deposits. The position of these ores is the result, in a large measure, of the tilting of the ore-bearing beds and the gradual selective concentration of the ores by gravity, the minerals having a higher specific gravity being carried farther down the slope than those having a relatively lower gravity.

These deposits of the residual-colluvial type have undoubtedly accumulated from deposits of the vein, breccia, and replacement types, occuring principally in limestone but partly in quartzite.

Aside from the secondary deposits, however, barite occurs rather sparingly in the district.

Origin.- Since the mass of Corbin Granite just east of the district is characterized by feldspars and contains a marked percentage of barium, it is, at least, suggestive that this igneous rock type was a contributing source of barium. Also, analyses of the Shady limestone and of the Weisner quartzite have shown them to contain barium; but, since these analyses have shown that the barium is much more widespread and in much higher percentages in the quartzite than in the limestone,- the limestone in places showing no barium at all,- it has been concluded that the source of the barium was from rocks below the limestone and that the barium was carried by solutions ascending through the shattered quartzite to the equally disturbed limestone where the barite was deposited under conditions more favorable for its chemical precipitation than those encountered in the siliceous rocks. The action of hot springs, which Hayes and Phalen[1] suggest once characterized this region, was probably instrumental in the deposition. The presence of pyrite, oxidizing and producing alkaline sulphates in the rocks passed through, may also have aided in the deposition of barium sulphate. If barium sulphate (barite) were formed from the interaction between barium carbonate (witherite) and calcium sulphate (gypsum), such an origin is not indicated by the presence of either witherite or gypsum. Pyrite, however, is present in the barite ore, together

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[1] Hayes, C. W., and Phalen, W. C., A Commercial Occurrence of Barite near Cartersville, Ga., U. S. G. S. Bull, No. 340, pp. 458 to 462, 1908.

with limonite pseudomorphs after pyrite.

Other Localities in Bartow County

There are three other occurrences of barite in Bartow County which deserve mention, although they are of no commercial importance. The Brandon and McCormick properties are located near Stilesboro in the southern part of the county, where the barite is associated with Ordovician limestone of the Chickamauga formation. Some of the barite found was moderately clean, while some was dirty, porous, and intimately mixed with iron oxide. All the barite found in the loose, reddish-yellow soil overlying the limestone, but there are indications that it occupies irregularities and erosional cavities in the limestone below. The Holcombe property is located near Kingston in the western part of the county. The barite occurs as massive, crystalline fragments or as crystal groups mixed with a yellow soil derived from the weathering of the underlying Knox dolomite of Cambro-Ordovician age. Manganese and brown iron oxide have also been found on the property.

Eton District of Murray County

The known deposits of barite of this area occur in a belt two and three-quarter miles long, extending south-southwest from Eton to lot 157, 9th district, 3rd section. The ore of the southwestern part of the district is of variable grade, often associated with siliceous impurities, pyrite, and iron oxide. All the barite observed occurs in the red-clay soil derived from the weathering of the Knox dolomite. The barite of the northeastern part of the area

is generally of good grade with both crystalline and granular texture and is associated with pyrite and iron oxide. It occurs as vein-fillings and breccia cement in Cambrian limestone probably belonging to the Conasauga formation and as loose fragments in the yellow soil derived from this limestone.

Whitfield County

Barite deposits are known to occur in this county in an area lying about ten miles northeast of Ruralvale. Irregular fragments of heavy, white, crystalline barite have been found in a yellow and reddish-yellow clay loam containing a few cherty fragments representing the Knox dolomite formation. A few masses of the ore as large as three feet in thickness have been unearthed in plowing. Several excellent specimens of transparent and translucent, tabular crystals arranged in crested form and held in an ocherous, cherty matrix have been collected from the Morgan property and are now in the State Museum at the Capitol.

Gordon County

Barite occurs in the southwestern part of this county 1 1/2 miles north of Plainville. Barite of high grade occurs as veins in a fine-to medium-grained, probably mangnesian limestone, belonging to the Conasauga formation, and as fragments, ranging in thickness from a fraction of an inch to 6 inches in the loose, brown soil derived from this limestone.

Floyd County

There are two localities of barite in this county worthy of mention, one in the northeastern and one in the eastern part of the county.

The area in the northeastern part of the county is situated about two miles south to two miles south-southwest of Plainville. The barite, which is clean, white, crystalline, and of good grade, occurs as veins and fracture-fillings in limestone and as fragments in the thin soil that overlies it. The rock represents the limestone member of the Conasauga formation of the Cambrian. One vein of the ore, as exposed in a stream, is three feet wide and enclosed within fairly definite limestone walls. The strike and the dip could not be determined,however.

The other area is in the eastern part of the county about one-half a mile south of Baas Ferry on Etowah River. Barite fragments of good quality occur in the dark red soil which overlies the Knox dolomite, the country rock of the vicinity. These fragments have doubtlessly weathered out of veins or fracture-fillings in the dolomite.

Cherokee County

Barite has been found in the western part of this county about 8 or 9 miles by road northwest of Canton, a station on the Louisville and Nashville Railroad. One vein of barite about a foot thick, occuring between walls of light gray to yellowish gray quartzite of finely

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granular texture and sheared structure, has been observed in this area. Other smaller veins 1 to 2 inches thick, occurring in quartzite and schist, have also been found in the area. The veins all strike parallel to the foliation planes of the enclosing rocks. The rock containing the ore deposits has been tentatively mapped as the Wilhite slate of the Ocoee series (Algonkian??), which, except for the quartzite enclosing some of the barite, is composed of a dark, somewhat foliated slate and schist, containing lenses of limestone with sandy phases. Barite occurs as fragments scattered locally through the soil of this formation. It is significant to note, in connection with the origin of the deposit, that marble and light gray, sandy limestone form extensive outcrops not far distant from the deposits and that, east and west of the Wilhite formation, there are large masses of Corbin granite. Since the barite occurs in the sheared quartzite and banded schist as layers parallel to the schistosity of the rock, it has been suggested that the ore has replaced certain calcareous beds or layers.

ALABAMA

Barite deposits are known to occur in the following counties of Alabama: Bibb, Calhoun, Etowah, Jefferson, Shelby, and St. Clair. These counties are located in the central and northeastern part of the State and are underlain, in part or wholly, by sedimentary rocks of lower Paleozoic age.

The formations with which the barite is associated are the Knox dolomite of Cambro-Ordovician age and the Pelham, or Trenton

(Chickamauga), limestone of Ordovician age. The Knox dolomite is a massively-bedded, light gray, mangnesian limestone, with cherty layers characteristic of the upper five sixths of its thickness. The Pelham limestone, which is stratigraphically above the Knox dolomite, is a thin-bedded, bluish to dove-colored limestone, ranging in thickness from 200 to 500 feet. These formations outcrops in narrow, northeastward-trending bands, whose position is determined by the folding and faulting that formed the Appalachian Mountains.

The barite occurs as veins and probably as replacements in these formations, and as lumps, nodules, and irregular masses imbedded in the clays derived from them by weathering. The deposits seem to be localized along lines of folding and faulting, the more important ones being found near the contact of the two formations, although some deposits are found entirely within the limits of the residual clays of the Knox dolomite.

The mineral is generally of good quality, usually pure and white, sometimes grayish or bluish in color, and stained with iron oxide. In some cases the barite is associated with or occurs near limonite deposits, and at times carries more or less galena. Chert is also a frequent associate.

Notwithstanding the good quality of barite in most of the localities of Alabama, developments have thus far been slight; and, so far as is known, little or none of the mineral has been put on the market.

Bibb County

Barite occurs at many localities in Bibb County, the most

important being near Maguire Shoals on the Little Cahaba River, at the "Sinks" on Six Mile Creek, and near Pratt's Ferry. Concerning the occurrence of barite in this county, Smith[1] says, " Barite, or heavy spar, is of frequent occurrence in the Quebec (Knox) dolomite. Maguire's Shoals on the Little Cahaba and the "Sinks" on Six Mile Creek may be mentioned as localities, but barite is found in veins in many other places."

Calhoun County

Several deposits of barite have been reported as occurring in Calhoun County, the more promising being found in the following townships: T. 15, R. 5 E., T. 13, R. 8 E., and T. 14 R. E. All three of these occurrences are found in the residual clay of the upper member of the Knox dolomite. The two deposits in townships 13 and 14 are but a few miles apart and are situated near Tampa, a station on the Southern Railway. Other deposits are found near Tampa, some of which are said to contain considerable ore. All these deposits near Tampa have limonite occurring near them.

The barite found in this county is, for the most part, of good quality, although some of it is stained a dark color. Galena is found associated with it in some instances; and, at one deposit, 10 feet of good kaolin is reported as occurring.

Shelby County

Barite is reported from a number of localities in this county; namely, just south of Calera, in Section 30, T. 19, R. 2 E., near Wilsonville. All these deposits occur in the clay of the upper

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[1] Smith, E. A., Report of Progress for 1875, G. S. of Ala., p.95 1876.

member of the Knox dolomite. The first two deposits are in areas that exhibit folding, here and there accompanied by faulting. The deposit south of Calera is a small limonite deposit with fragments of barite intimately mixed through it.

High grade barite has been produced at these localities, and indications at a number of places point to larger bodies than those already found.

St. Clair County

The best-known barite deposit of this county is on the Montevallo Road about 1/2 mile west of Greensport. This deposit was operated in 1906; but, since then, it has produced no barite.

Jefferson County

A barite deposit near Leeds, Jefferson County, was under development in 1918. The ore here occurs in the red residual clay overlying the upper member of the Knox dolomite. High grade barite has been produced from this development, and indications are that larger bodies will be found.

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