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BARITE IN THE SOUTHERN ILLINOIS FLUORSPAR DISTRICT

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CIRCULAR 265 1959

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ABSTRACT

Barite occurs in association with fluorspar in the Hardin-Pope County mining district of extreme southern Illinois. It usually has been considered a gangue mineral, but recent interest in the possibility that commercial concentrations may be present has prompted this investigation. The barite occurs in places throughout the entire mining district and is found in both the vein and bedded replacement types of fluorspar deposits. However, its distribution is spotty and its concentrations are of such size as to appear to be of possible commercial significance in only a few areas. Such occurrences are described and suggestions are made for prospecting. Chemical analyses of barite and barite "ores" from various parts of the district are given.

INTRODUCTION

The presence of barite in the fluorspar deposits of southern Illinois has been known for many years. Its occurrence is so sporadic, however, that few attempts have been made to mine and sell the barite, and generally it has been regarded as a nuisance in the fluorspar ores.

The increasing use of barite in recent years, chiefly because it is used in deep exploratory drilling for oil, has stimulated a search for new deposits, and many companies have inquired regarding commercial possibilities of barite in the Illinois fluorspar district. In response to such inquiries, this report summarizes facts concerning the occurrence of barite in the district and briefly describes known deposits.

Description and Properties of Barite

Barite, known also as barytes, heavy spar, and tiff (in Missouri), is a non-metallic mineral of high specific gravity (4.5). It is a fairly soft mineral, for it can be easily scratched with a knife blade. Barite may be found in tabular crystals or in massive form and is white, light shades of blue, yellow, or red, or may be colorless.

In the Illinois fluorspar district, the barite is chiefly white, fine- to medium-grained, and massive. It is usually lamellar or fibrous, but it may also be finely granular, resembling sugar. Its distinguishing characteristics are its white color, often stained yellowish brown by iron oxide in weathered exposures, and its heaviness. In small amounts it may be difficult to distinguish from calcite, but the fine granular or fibrous habit of barite ordinarily distinguishes it from the usual coarsely crystalline habit of calcite. A simple diagnostic test can be made if hydrochloric or some other strong acid is available. A few drops of acid will cause vigorous effervescence on calcite but will not affect barite.

Uses and Specifications

The chief use of barite in 1956, representing about 85 percent of total consumption, was in well-drilling mud. The manufacture of barium chemicals accounted for 8 percent, and the remainder went into lithopone, glass, fillers, and other uses (Schreck and Foley, 1958).

Drilling Mud

To make a drilling mud the barite is combined with bentonite which keeps the barite in suspension and makes a heavy fluid that carries the drill cuttings to the surface, plasters the walls of the hole to prevent caving of the sides of the hole, contamination of the oil sands, and loss of fluid, and also restrains gas and oil pressures. The properties that make barite the universally accepted weighting agent for drilling muds are its high specific gravity, low cost, cleanness, freedom from detrimental impurities, and inertness. This use of barite is expected to increase because of the necessity of drilling deeper wells in exploration for oil.

The specifications for barite to be used in drilling muds are relatively simple. The product must have a specific gravity of 4.2 or higher, be ground to a fineness such that 90 to 95 percent will pass a 325-mesh screen, and be free of soluble salts. Most grinders of barite for well-drilling mud try to maintain a grade of 92 percent barite, but the important thing is the 4.2 specific gravity (Harness and Barsigian, 1946). Several percent of iron is not objectionable.

Barium Chemicals

Barium chemicals, which are manufactured from barite, find a number of uses. To mention a few, barium sulfate,or blanc fixe,($BaSO_4$) is used in pigment and as a filler; barium chloride ($BaCl_2$) is used for case hardening, for treating leather and cloth, and as a source of barium metal; barium carbonate ($BaCO_3$) is used in the ceramic industry in the manufacture of glass and other products; and barium hydroxide ($Ba(OH)_2$) is used in recovering sugar from molasses, in preventing scumming of ceramics, and in lubricating oils. Barium metal is used as a deoxidizer of copper and in alloys for spark plugs and emission elements in electron tubes.

Barite to be used in the manufacture of barium chemicals is usually required to contain a minimum of 94 percent $BaSO_4$, not more than 1 percent iron oxide as Fe_2O_3, and no more than a trace of fluorine (Arundale, 1956). Manufacturers of barium nitrate for use in green signal flares require that strontium sulfate ($SrSO_4$) should not exceed 1 percent because strontium tends to impart a red color to the flame. This, however, is a minor use, except in time of war, and strontium is not normally mentioned in specifications (Harness and Barsigian, 1946). Another occasional limitation is a maximum of 0.1 percent calcium oxide (CaO), but most specifications contain no reference to calcium. Chemical manufacturers usually desire a jig concentrate. They cannot use ground barite because of dust loss in the rotary kiln process.

Lithopone

Lithopone, an intimate mixture of the coprecipitated salts zinc sulfite and barium sulfate, is used as a white pigment. Its consumption has been decreasing steadily in recent years owing to the increasing use of titanium dioxide (TiO_2),

which has about three times the hiding power of lithopone (Harness and Barsigian, 1946). Lithopone continues in use, however, because of the comparatively high cost of titanium dioxide.

Specifications, both chemical and physical, for barite by lithopone makers are essentially the same as those for the manufacture of barium chemicals.

Glass

In glass manufacturing, barite serves several purposes. It acts as a flux, as an oxidizer and decolorizer, makes the glass more workable, and increases brilliance in the finished product (Harness and Barsigian, 1946).

Barite for use in making glass is required to be of a higher purity than that for other purposes. A typical analysis of glass-grade barite is 98 percent $BaSO_4$, 1.5 percent SiO_2, 0.15 percent Al_2O_3, and 0.15 percent Fe_2O_3 (Arundale, 1956). As fluorine is a constituent of many glasses, a limited market is found for a barite-fluorspar mixture that has the trade name "fluorbarite."

New Uses

Heavy concrete, employing barite aggregate as the weighting agent, is used as a coating around pipelines in swamps and river crossings. Another potential use of heavy concrete is in shielding for atomic reactors, wherein the barite has the property of stopping harmful radiation.

A mixture of finely ground barite and synthetic rubber powder has been found to be beneficial when added to hot-mix asphalt in construction of highways, airports, and parking areas (Arundale, 1956). This use may provide an important future outlet for barite.

Prices and Grades

Prices as of April 30, 1958, as listed in Engineering and Mining Journal for May 1958, were as follows: Georgia crude, f.o.b. cars, $18 per ton; Missouri 94 percent $BaSO_4$, $16 to $18 per ton; crude, oil well grade, minimum 4.3 specific gravity, $18 per ton. Oil, Paint and Drug Reporter for May 12, 1958, listed these additional prices, as of May 9: Georgia beneficiated, in bags, $25 per ton; water-ground and bleached, St. Louis, $55 per ton.

The first three grade designations all refer to "crude" barite, which is commonly a log-washer product. As Georgia and Missouri barites occur in residual deposits, that is, barite concentrations formed by the removal of the host rock by weathering, the "ore" is essentially a barite-clay mixture from which a fairly high-grade product may be obtained merely by washing. "Beneficiated" is the product obtained from crushing and jigging the washed barite to remove any included rock. The term "bleached" refers to a process in which ground barite is treated with sulfuric acid to remove impurities, which are ordinarily lead sulfide and the oxides, sulfides, and silicates of iron and manganese.

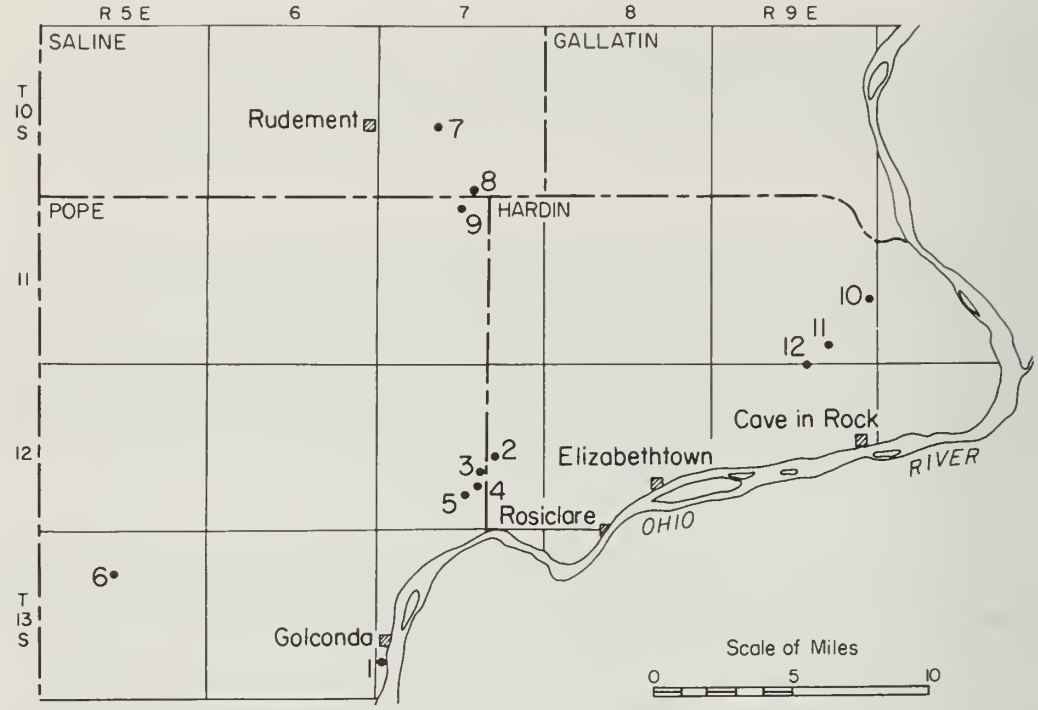

Fig. 1. - Barite occurrences in the southern Illinois fluorspar district. The Little Jean is the only mine that has been operated only for barite. One of the Austin mines (East Green pit) has produced both barite and fluorspar. Production from the other mines, so far as known, has been fluorspar only.

Key to mines and prospects

1. Little Jean mine
2. Jefferson mine
3. Sam Parkinson prospect
4. Sebastian Rotes prospect
5. Rotes prospect
6. Lake Glendale prospect
7. King prospect
8. Vein outcrop, sec. 34
9. Float and narrow vein outcrop, secs. 3 and 4
10. Minerva No. 1 mine
11. West Green mine
12. Victory and Austin mines

DISTRIBUTION OF BARITE IN THE FLUORSPAR DISTRICT

General Statement

In the Illinois fluorspar district, barite occurs primarily as an accessory mineral in the fluorspar deposits. It is found in places throughout the district and in all parts of the stratigraphic column that contain deposits of fluorite, but its chief characteristic is its spotty distribution. Because of this, notable concentrations of barite are known in only a few areas (fig. 1).

The commercial possibilities of barite in southern Illinois are difficult to evaluate. Very little recorded data exist with regard to dimensions and grade of mineral. In general, however, the evidence gathered during this study suggests that the barite deposits are small as compared to the fluorspar deposits and that

the best chance for mining barite profitably is to produce it as a by-product or co-product of a fluorspar operation. A discussion of the economics of barite recovery from mixed ores involves questions of milling methods beyond the scope of this paper.

Barite in Vein Deposits

In the fluorspar vein deposits barite usually occurs in finely crystalline masses in the central parts of the veins or in narrow fissures contiguous to the fluorspar veins. It also may occur as small tabular crystals coating fluorite cubes in vugs, but this type of occurrence has little economic potential except as a source of specimens for mineral collectors. Rarely barite has been found as the predominant vein mineral with subordinate or minor amounts of fluorspar.

The dimensions of barite occurrences are difficult to define because data are scarce. As barite is normally considered a gangue mineral, highly baritic fluorspar veins or portions of veins are generally considered not worth mining. As a result, little is known concerning barite occurrences aside from the fact that certain veins are known to be baritic.

Some data on widths of barite deposits are available, as this dimension is easily seen in a working face. Barite veins may range from a streak a fraction of an inch wide to a mass 5 feet or more across. The Little Jean mine at the south edge of Golconda, the only mine on record that was worked solely for barite in the Illinois fluorspar district, is said to have had a maximum vein width of 5 feet of barite. Bastin (1931) mentions barite 3 to 4 feet wide in the Hillside vein.

Very little of a definite nature is known concerning the length of deposits. The little Jean barite mine was reportedly worked for a length of 75 feet, but there are no recorded lengths of barite occurrences in fluorspar veins.

Barite is a late mineral in relation to the other minerals of the fluorspar deposits in both vein and bedded replacement deposits. It appears to occupy a marginal position with respect to vein fluorspar in that barite is found chiefly at the top and bottom of the fluorspar bodies. On the southwestward extension of the Stewart vein system, barite is found at numerous places in the Bethel Sandstone, which is the surface formation, but, according to E. A. Brecke, Ozark-Mahoning geologist, drill holes in the area have failed to encounter any barite at depth.

The Lake Glendale area poses a similar situation, where barite has been excavated from shallow pits, but an inclined drill hole showed no barite at a depth of 60 feet under one of the pits. Bastin (1931) stated that the barite in the Hillside vein occurred within 60 feet of the surface but that he did not see the mineral "in any of the ores from the deeper portions of the veins." The Little Jean barite mine was also relatively shallow, with the workings reportedly at a depth of 60-75 feet. In the Jefferson mine of Minerva Oil Company barite is encountered in the upper levels of the mine and has been found in drill cores from the bottom part of the deposit.

Barite in Bedded Deposits

In the bedded fluorspar deposits, as in the vein deposits, barite occurs in finely crystalline masses. According to Grogan (in Weller et al., 1952), the barite replaces limestone, calcite, and fluorite. One of its most common occurrences is in ore with alternating bands of fluorite. This type of occurrence is found at the margins of many of the bedded deposits where the thickness of the ore has decreased to one foot or less. Banded barite-fluorite ore is also common in the lower

levels of the Lead mine in the Spar Mountain group of mines. In other places the barite may be massive where it has filled cavities or replaced limestone or fluorite, as in one of the orebodies of Minerva No. 1 mine. Smaller masses, of the order of 1 to 2 feet in diameter, occur in one part of the Carlos orebody in the Victory mine. The massive barite generally has more or less fluorite mixed with it.

The baritic portions of the bedded fluorspar deposits are extremely variable in extent. Massive barite segregations may range from the 1- to 2-foot scattered pods of the Carlos orebody to the barite deposit of apparently considerable extent in Minerva No. 1 mine. Banded barite-fluorspar ore ranges from marginal occurrences one foot or less thick to the baritic levels of the Lead mine where the banded ore occurs in narrow linear bodies typical of many of the fluorspar deposits of that area. The linear extent of the banded barite-fluorspar bodies is not known but may be as much as several hundred feet.

As has been mentioned, barite is a late primary mineral in the bedded deposits. According to Grogan(in Weller et al.,1952), barite "appears to have been deposited principally along the top, bottom, and margins of the deposits."

DESCRIPTIONS OF OCCURRENCES

Vein Deposits

Little Jean Barite Mine

The Little Jean mine is in the SW 1/4, NE 1/4, SW 1/4 sec. 30, T. 13 S., R. 7 E., Pope County, near the south edge of Golconda, approximately 1,000 feet south of the concrete apron at Lock and Dam No. 51. The mine is said to have had commercial production of barite in 1918-22. Mineral Resources of the United States, 1919 (1922) states that the crude ore ran 65 percent barite and 35 percent fluorite, and that,by jigging, a concentrate was produced that tested about 96 percent barite. A sample of crude barite collected by the writer from the dump of the farther south of two shafts tested 85 percent barite and 3 percent fluorite.

The vein was entered by two shafts, one at the top of the slope above the Ohio River and the other about 150 feet S. 60° W. from the first. The locations of the shafts can still be detected as caved areas surrounded by dumps containing considerable barite. The strike of the vein was reported to be slightly south of west. The southernmost of the two shafts is said to be 60 feet deep. From the bottom of the shaft a crosscut to the north is said to have intersected the vein at 60 feet, at which point a winze was sunk to a depth of 60 feet. Little or no drifting was done on the vein. The other shaft is said to be 75 to 80 feet deep, from which the vein was mined for a length of 75 feet.

The vein, which contained barite with minor fluorite and traces of galena (lead sulfide), was reportedly as much as 5 feet wide. Mining ceased when the vein pinched out.

Stewart Fault

Barite has been noted at several places along the Stewart Fault zone from the Jefferson mine southwestward to Big Grand Pierre Creek. The Stewart Fault as shown on the last-published geologic map (Weller et al., 1952) is offset along a fault that strikes N. 15° W. in sec. 22, T. 12 S., R. 7 E., but more recent drilling by Ozark-Mahoning Company indicates that the Stewart Fault should be mapped as a continuous line (Palmer, 1956).

Barite is not generally abundant in the Jefferson mine, occurring primarily near the top and bottom of the ore. In the upper levels, where the wall rock is the Bethel Sandstone, barite has been encountered in stringers and lenses up to 3 feet wide and 15 feet high, but, according to J. J. Daly, Minerva mining engineer, it has never been present in large enough amounts to cause difficulty in maintaining grade of fluorspar ore. Barite has also been encountered in drill holes through the bottom part of the orebody, where the wall rock is the St. Louis Limestone. As these holes were nearly vertical, no conclusions could be drawn regarding the width of the barite occurrences.

Ozark-Mahoning geologists report that they have encountered barite at several places during prospecting activities along the Stewart Fault in the area south of Route 146. Their drilling has indicated, however, that the barite occurs in only the upper parts of the veins and does not persist in depth.

Field notes in Survey files describe three prospects which show barite on or near the Stewart Fault southwest from Route 146. The northernmost is the Sam Parkinson prospect in the NE 1/4, SE 1/4, SE 1/4 sec. 22, T. 12 S., R. 7 E. The workings are described as an old shaft, said to be 25 to 35 feet deep, and a 3-foot wide open cut, 2 to 3 feet deep and 50 feet long. The deposit is in a nearly vertical fracture with N. 20° E. strike. The vein itself was apparently concealed at the time of examination. Barite was the only mineral seen on the dump and is described as "exceedingly abundant in lumps up to 6 inches thick."

The next prospect south is the Sebastian Rotes or Blackjack, in the NE 1/4, SW 1/4, NE 1/4 sec. 27, T. 12 S., R. 7 E. This also is a vein deposit, now inaccessible, and was worked from a shaft said to be about 20 feet deep. The minerals showing on the dump are described as "barite, calcite, abundant sphalerite (zinc sulfide), minor fluorite." No mention is made of amount of barite on the dump.

The third prospect is referred to as the Rotes. It is located beside Big Grand Pierre Creek in the NE 1/4, SW 1/4, SW 1/4 sec. 27, T. 12 S., R. 7 E. A vertical vein strikes N. 20-25° E. and is 3 feet wide at the bottom of the shaft, which is 40 feet deep. According to the notes, barite and sphalerite are abundant with fluorite minor. Galena is abundant in the upper half of the shaft. In 1958 the shaft collar was no longer evident, having been buried by caving of the steep bank above it. The only signs of prospecting activity were scattered pieces of barite and sphalerite at the top of the bank.

Lake Glendale Area

The Lake Glendale fluorspar-barite prospect is in the eastern half of sec. 9, T. 13 S., R. 5 E., Pope County, about half a mile south of Lake Glendale. The geology in the vicinity of the prospect and results of diamond drilling have been described by Tippie (1944).

The Lake Glendale area lies within a half-mile wide fault zone which constitutes the western border of the Dixon Springs graben. Weller and Krey (1939, pl. 1) mapped the formations within the fault zone as belonging to the upper part of the Chester Series, but Tippie (1944) found the host rocks of the fluorspar-barite mineralization to be the Ste. Genevieve Limestone. Other Survey staff members, including the writer, have substantiated Tippie's correlation.

The barite, admixed with minor fluorspar, has been found in prospect pits and in an exploration trench as weathered residual ore overlying a fracture zone in

Table 1. - Chemical Analyses of Barite and Barite Ores*

Sample	Frac. sec.	Sec.-T-R	$BaSO_4$	CaF_2	SiO_2	Al_2O_3	Fe_2O_3	Pb[1]	Zn[1]	Total[2]
F-597	SW SE NE	9-13S-5E	80.54	11.85	2.01	0.06	0.06	0.050	N.D.	94.57
F-599	NW SE SW	30-13S-7E	84.95	3.47	1.12	0.05	0.05	N.D.	N.D.	89.64
F-603	SE NW NW	3-12S-9E	99.04	0.38	0.91	0.09	0.06	N.D.	N.D.	100.48
F-603B	SE NW NW	3-12S-9E	54.33	28.78	2.96	0.15	0.21	0.005	1.1	87.54
F-604-1	NW NE NE	3-12S-9E	84.03	12.05	1.85	0.22	0.21	0.008	N.D.	98.37
F-604-2	NW NE NE	3-12S-9E	79.52	13.05	2.15	0.73	0.17	0.056	N.D.	95.68
F-605	NW NW NE	35-11S-9E	91.76	3.02	0.92	0.00	0.09	N.D.	N.D.	95.79
F-607	NE SE SW	34-10S-7E	98.09	0.33	0.80	0.00	0.16	0.074	N.D.	99.45
F-607B	NE SE SW	34-10S-7E	78.50	16.60	1.01	0.06	0.09	0.10	N.D.	96.36
F-608	NW SW	21-10S-7E	89.33	6.49	2.10	0.31	0.17	0.029	N.D.	98.43

*Chemical analyses by L. D. McVicker; spectrochemical analyses by N. F. Shimp.

1/ Pb and Zn determined spectrographically. N.D. equals not detected. Limits of detection: Pb - 0.004 percent; Zn - 0.1 percent.

2/ Analyses do not include $CaCO_3$, which accounts for the low totals.

Source of Samples

F-597: Barite-fluorspar ore from stockpile at prospect pit, ½ mile south of Lake Glendale, Pope County.

F-599: Barite, pieces from dump, Little Jean mine, Golconda, Pope County.

F-603: Barite, hand-picked from wall of sublevel haulage adit, Lead mine, near Cave in Rock, Hardin County.

F-603B: Barite-fluorspar ore, channel sample from wall of adit, same location as F-603.

F-604-1: Barite-fluorspar ore from top layer, 6" to 3' thick, East Green pit, near Cave in Rock, Hardin County.

F-604-2: Barite-fluorspar-rock breccia from second layer, 6" to 3' thick, East Green pit.

F-605: Barite pieces from large barite body in West Green mine near Cave in Rock.

F-607: Barite, hand-picked from 15" vein in Saline County, near Herod.

F-607B: Barite-fluorspar ore representing entire 15" vein of sample F-607.

F-608: Barite, hand-picked from mineralized fracture zone, King property, near Somerset, Saline County.

the Fredonia Member about 200 feet southeast of a major fault. One inclined diamond drill hole (No. 1) undercut the line of prospect pits but found only calcite veinlets with traces of fluorspar. Other borings in the immediate vicinity also were unproductive of barite. Exposures of faults in the area showed no mineralization other than calcite.

Tippie (1944) reached the conclusions that "mineralization appears to be limited to small fractures in the limestone on the southeast side of the major fault. The apparent concentration of spar and barite in the shallow pits near diamond drill hole No. 1 may be a result of concentration by weathering." The writer agrees with both these conclusions, but feels that this does not necessarily eliminate the area from further consideration. It is possible that drilling in the fault zone either northeast or southwest of the rather localized area of prospecting described above might reveal barite deposits of considerably greater extent.

A sample (table 1) was collected from pieces of barite that had been excavated from a pit in the south wall of the exploration trench.

King Property

The prospect on the King property lies in the NW 1/4, SW 1/4, sec. 21, T. 10 S., R. 7 E., Saline County, a little more than two miles east of Rudement. Barite and fluorspar occur in narrow veins and veinlets with minor galena in an intensely fractured zone associated with a southwestward-trending branch of the Shawneetown Fault zone. The host rocks are limestones and sandstones of the upper part of the Chester Series.

This is the vicinity of the old King and Ferguson mine described by Bain (1905, p. 60). Recent operations have consisted chiefly of trenching and some test pitting. The analysis in table 1 is of barite vein material that was hand-picked,partly from narrow veins in place in the wall of the northernmost open cut, but mostly from excavated material lying loose below the wall.

Sec. 34, T. 10 S., R. 7 E., Saline County

A vein, 15 inches wide, that contains barite and fluorite, crops out in the east bank of a north-flowing stream in the NE 1/4, SE 1/4, SW 1/4 sec. 34. The vein also is exposed in the wall of a shallow shaft on the bank above the outcrop. The strike of the vein is N. 30° E.; the dip is 55° SE.

The vein occurs in a wide,shattered zone in sandstone of Pennsylvanian age. The width of the broken zone is unknown, as it occupies the whole of the 50-foot length of outcrop along the stream. Veinlets and small irregular areas of breccia occur throughout the fracture zone. Galena and sphalerite occur sporadically in the areas of breccia but were not seen in the 15-inch vein.

As exposed in the north wall of the shaft, the vein is composed of massive barite in the half next to the footwall and of fluorspar containing isolated masses of barite in the half next to the hanging wall. In the outcrop the vein appeared to contain a higher proportion of barite. A sample of barite-fluorspar was collected from excavated material with an attempt at maintaining the ratio of barite to fluorspar as shown by the exposure of the vein in the shaft wall.

A second prospect shaft is located about 25 feet south of the first, but exposes only veinlets in its walls.

Secs. 3 and 4, T. 11 S., R. 7 E., Hardin County

Numerous pieces of barite occur for about 50 feet along the bed of a west-flowing stream in the SW 1/4, SW 1/4, NW 1/4 sec. 3. Only a few ledges crop out in the stream bed in the immediate vicinity and no veins are exposed. Some of the pieces are as much as 3 inches in diameter, so it is felt that the parent vein is not far from the placer concentration. The barite gradually disappears, both upstream and downstream.

About 300 feet downstream from the placer concentration is a strong nearly vertical fracture that trends N. 38° E. in the rock floor of the stream and in the north bank. Barite up to 3 inches wide forms a discontinuous vein along the fracture. No slickensides were recognized on the fracture walls. This occurrence is probably across the section line from the placer concentration and near the center of the E 1/2 E 1/2 sec. 4.

Bedded Deposits

Minerva No. 1 Mine

Barite is irregularly distributed throughout the ore of Minerva No. 1 mine. In general, it is found most abundantly at the margins of the ore where the ore thickness has decreased to about 1 foot and also locally elsewhere in the orebodies. According to Gill Montgomery, vice-president and general manager of Minerva Oil Company, Fluorspar Division, the ore from No. 1 mine averages about 2 percent barite. The mineralized horizon is the upper part of the Renault Formation, with the Bethel Sandstone forming the roof of the workings.

The Third orebody of No. 1 mine contains an abnormally high content of barite but has not been mined because of the presence of the mineral witherite, barium carbonate ($BaCO_3$). Witherite, which accompanies the barite in small amounts, causes trouble during the milling process in that it hinders the depressing of the barite in the flotation cells. Because of this, the barite floats with the fluorspar and prevents making a high-grade fluorspar product.

The barite content of the Third orebody averages 15-20 percent, but limited portions of the deposit are considerably richer. For example, two drill holes showed, respectively, 10 feet of 100 percent barite and 20 feet of 70 percent barite.

Ozark-Mahoning Company

More or less barite has occurred throughout the A. L. Davis and West Green orebodies of Ozark-Mahoning Company in the Cave in Rock district. It is unevenly distributed in the orebodies, occurring chiefly along the margins or at the top or bottom, and may be abundant in some places. On the whole, however, the barite content is low; the ore from the A. L. Davis orebody is said to have averaged 2 percent. Figures on amounts and grades of barite, even in the more baritic portions of the orebodies, are difficult to obtain because barite is generally regarded as only another gangue mineral, but notes in Survey files state that in the West Green deposit barite ranged from a fraction of 1 percent to more than 10 percent in various headings. The A. L. Davis orebody is described as "strongly baritic" in places, but no percentages are mentioned.

The barite apparently shows no preference for any particular stratigraphic horizon in the Ozark-Mahoning group of deposits. The A. L. Davis orebody is in

the top of the Renault Formation and the West Green orebody is in the Ste. Genevieve Limestone at the top of the Fredonia Member.

An abnormally large segregation of barite ore, roughly 100 feet wide and 200 feet long, was observed in the West Green mine. The ore consisted of massive barite containing unreplaced islands of rock. At its thickest part, the barite body was about 10 feet thick, thinning in all directions towards its periphery. A drift along the northwest margin of the occurrence showed 3 to 5 feet of rich barite ore. By visual estimate, the barite segregation averaged about 50 percent barite with some faces as high as 70 to 80 percent barite. According to E. A. Brecke, drilling indicates that moderately baritic ore extends another 200 feet in length and averages 5 to 10 percent barite.

At the present time, the rich barite ore is being undercut to mine fluorspar beneath it. The underlying fluorspar ore contains streaks and pockets of barite visually estimated in the amount of 10 percent.

An analysis of a sample of the massive barite is shown in table 1.

Austin Mines

The Austin mines, formerly known as the Benzon group, lie on the southeast slope of Spar Mountain, a topographic ridge which borders the Fredonia-St. Louis plain along its northwest side. With the orebodies of the Victory mine, one of the important producers in the history of the Cave in Rock district, the Austin mines form a concentrated group of fluorspar orebodies near the southwest end of the main ore belt of the Cave in Rock district. These deposits are now largely worked out.

Fluorspar has been produced chiefly from four horizons, all within the Fredonia Limestone. The main producing level has been the top 10 feet of the Fredonia, directly below the Rosiclare Sandstone Member. The next lower level has its top 15 to 20 feet below the Rosiclare. The third is 25 to 30 feet below the Rosiclare, and the fourth is the 10 feet above and below the Spar Mountain Sandstone Bed, which has been found to occur 50 to 65 feet below the Rosiclare Sandstone on the Austin tract.

Barite has been found at all the mineralized horizons but appears to be more abundant in the lower ones. In the upper level it has been noted at only a few places, and the content of barite at any one place is apparently not particularly high. The next lower level, the top of which is 15 to 20 feet below the Rosiclare, was found to contain 4 to 5 feet of "highly baritic ore" at one place in the Lead mine, according to field notes. The extent of this ore body is not known. At the third level, 25 to 30 feet below the Rosiclare, workings below the Cleveland mine contained "3 to 4 feet of highly baritic ore" and an adit near the east end of the Lead mine showed 5 feet of "intermittent baritic ore" below 3 feet of good banded fluorspar.

The lowest level, which includes ore both above and below the Spar Mountain Bed, contains abundant barite at three places, 1) in workings below the Cleveland mine, 2) in drilling below the lowest level of the Lead mine, and 3) in the first 150 feet of a long sublevel haulage drift into the Lead mine at its east end. Workings below the Cleveland mine consisted of two separate drifts, one above and one below the Spar Mountain Bed. Field notes state that the one above contained "4 1/2 feet of baritic massive and banded ore." The one below, referred to locally as the Barite drift, was apparently inaccessible at the time of the investigation (1944). The drilling below the Lead mine, done recently by the Minerva

Oil Company, encountered up to 4 1/2 feet of banded fluorspar-barite ore just above the Spar Mountain Bed. Assays by Minerva showed 20 to 25 percent barite in the ore. The banded fluorspar-barite ore in the walls of thesublevel haulage drift ranged from 18 inches to 4 feet in thickness and extended from the entrance to a point about 150 feet along the drift. The rest of the drift, including the portion under the main Lead mine workings, was barren. The haulage drift ends in two raises under the mine, and there has apparently been no stoping at this level in the mine.

Two samples from the sublevel haulage drift were analyzed (table 1). Sample F-603B was a channel sample from a 4-foot face of banded barite-fluorspar ore exposed in the drift, and the other, Sample F-603, was a hand-picked sample of the barite in the ore.

An additional high-barite orebody, a little more than a quarter of a mile east of the Victory group, is the East Green mine, also a part of the Austin holdings. Here barite and spar of the typical bedded replacement type are exposed in an open cut immediately below the Spar Mountain Bed. As seen in the north wall of the pit, the top layer of ore is massive barite containing veinlets and small irregular masses of fluorspar and occasional slabs of rock. Its thickness ranges from 6 inches to 3 feet. The second layer consists of a breccia of sandstone and shale fragments cemented by barite and fluorspar and is comparable in thickness to the first layer. Underneath the breccia layer is fluorspar, both disseminated in the limestone and as imperfectly banded ore. This layer extends into the floor and is mostly covered, so that its full thickness cannot be observed. The analyses of material from the East Green mine in table 1 are of the massive barite bed, F-604-1, and the breccia layer, F-604-2.

Omar Austin, operator of the East Green pit, reports that a jig concentrate made from the barite-fluorspar ore has assayed nearly equal parts of barite and fluorspar and has run 42 to 47 percent each on various shipments. The remainder of the concentrate generally is chiefly silica. The barite-fluorspar concentrate is reportedly blended into a product called "fluorbarite," used by certain glass manufacturers.

Victory Mine

Low-grade baritic fluorspar ore exists between the two high-grade fluorspar orebodies in the area served by the Carlos shaft. The barite occurs in streaks and pockets and does not appear to compose a very high percentage of the total volume of rock present. The Victory orebodies occur in the top part of the Fredonia Limestone, immediately below the Rosiclare Sandstone.

SUGGESTIONS FOR PROSPECTING

Residual Deposits

Any area directly underlain by limestone which is known to contain barite may be considered a favorable locale for the existance of residual barite deposits. Under conditions of weathering, limestone (a relatively soluble rock) is leached away, leaving a residual concentration of barite, together with any other insoluble material, such as clay, which may have been in the limestone. Because of this concentrating action, minable residual deposits may develop from uneconomic primary deposits.

Among the areas described in this report, the Lake Glendale prospect and the vicinity of the Austin mines appear to offer the best possibilities for residual barite.

Vein Deposits

As the Little Jean is the only mine in the fluorspar district that is known to have produced barite as its chief product, the immediate vicinity of this mine must be regarded as a favorable locality for prospecting. If the length of the workings is only 75 feet, as reported, it is possible that there are minable widths of barite on the westward extension of the vein.

The potential of the 15-inch wide barite-fluorspar vein in sec. 34, T. 10 S., R. 7 E., Saline County, is totally unknown. As it is exposed only in a creek bank outcrop and in the wall of a prospect shaft 15 feet away, little can be predicted regarding lateral extent or its behavior in depth. The fact that it occurs in a wide, heavily fractured zone suggests, by analogy with known occurrences of this type, that the vein may not have great persistence or continuity. Due to the large number of fractures in a heavily broken zone of this type, individual veins tend to pinch, swell, and terminate abruptly. Locally, however, a single vein may posses the extent and continuity necessary to support a mining operation, as at the Rock Candy Mountain fluorspar mine in the intensely fractured fault zone along Lusk Creek in Pope County.

The mineralized zone, in which the 15-inch vein occurs, may possess considerable length if the barite occurrences in secs. 3 and 4, T. 11 S., R. 7 E., three-fourths of a mile southwest of the outcrop of the 15-inch vein, are associated with the same fracture zone.

Mining operations and prospecting on the Stewart Fault zone, in southwestern Hardin County and southeastern Pope County, suggest that the barite occurs in relatively small scattered pods, chiefly in the upper part of the vein. Although this does not preclude the possibility of finding a minable deposit of barite, either alone or with fluorspar, zinc, or lead, it does decrease the attractiveness of the area as a barite prospect. The southwest end of the fault zone, which includes the Rotes barite-zinc-lead prospect, has not been systematically prospected, so far as the recorded information shows, and may contain barite in minable concentrations.

The Lake Glendale prospect presents much the same situation as the Stewart Fault - barite close to the surface of the ground, but, according to drill logs, little or none at depth. In the Lake Glendale area, however, only one drill hole adequately tested the known mineralized zone, as represented by shallow prospect pits. A second boring initiated from the opposite side of the zone, did not penetrate far enough to give conclusive evidence. Other drill holes in the area were not directed at the known mineralized zone. Although the available information on the Lake Glendale prospect suggests that it is not a major mineralized area, there is not sufficient evidence to discount the possibility of minable barite deposits.

The King prospect, near Rudement in Saline County, has been the site of surface prospecting from time to time. Trenching and test pitting have uncovered many small veins and pods of mixed barite and fluorspar but no commercial concentrations. This is another area of intense fracturing and widespread mineralization in which persistent veins of minable width are difficult to find. A combination of surface prospecting and core drilling is probably necessary to prospect adequately an area such as this.

Bedded Deposits

On the whole, the occurrence of barite in the bedded deposits is unpredictable. Barite does not appear to be concentrated in any one part of the Cave in Rock district. It is found in various fluorspar orebodies from the Minerva mine at the northeast end of the district to the Austin mines near the southwest end and may occur at any of the stratigraphic positions at which fluorspar is found. Consequently, it is extremely difficult to explore solely or even chiefly for barite.

Except for the chance encounter with a minable body of barite in prospecting for or mining fluorspar in the Cave in Rock district, probably the best possibilities for finding a source of barite lie in the Austin area. As has been pointed out, the best concentrations of barite in the Austin mines were found in the Fredonia Limestone, just above or just below the Spar Mountain Bed. It seems probable that the highly baritic ores were not mined in this now inactive area, presumably because of a lack of facilities for separating the barite and fluorspar. There is no mention in notes, made when the mines were active, of the size of the baritic bodies, but from the frequency with which barite was noted in the lower horizons, the area may warrant investigation as a source of barite.

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Illinois State Geological Survey Circular 265
14 p., 1 fig., 1 table, 1959

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