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LEAD-ZINC DEPOSITS OF THE BEETOWN AREA,

GRANT COUNTY, WISCONSIN

by

Allen V. Heyl, Jr., 1918- Erwin J. Lyons,

and John J. Theiler

Contents

ILLUSTRATIONS

Lead-Zinc Deposits of the Beetown Area, Grant County, Wisconsin

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Introduction

The Beetown area, in Grant County, Wisconsin, in the Northwestern part of the Upper Mississippi Valley zinc-lead district, lies in the western part of T. 4 N., R. 4 W., and the eastern part of T. 4 N., R. 5 W. The village of Beetown is at about its center.

Recent geologic investigations in the area by the U. S. Geological Survey, in cooperation with the Wisconsin Geological and Natural History Survey, indicate that further prospecting for both lead and zinc ore is justified. This brief preliminary paper discusses geologic features of the lead and the zinc deposits. It is one of several areas within the district chosen for detailed geologic study because surface indications and past production suggest that the area may contain undiscovered lead and zinc deposits. This report is based on field work that began in July 1947 and continued at intervals until September 1949. The members of the field party consisted of E. J. Lyons, A. V. Heyl, Jr., and J. J. Theiler, assisted by A. E. Flint, A. F. Agnew, J. H. Moor, C. W. Tandy, Maxine L. Heyl, and R. P. Crumpton. We wish to acknowledge the excellent cooperation given by members

Page 1a follows

of the Wisconsin State Highway Commission at Lancaster, Wis., who provided bench marks for vertical control, and William and Freeman Clauer, Raleigh Jameson, and James Franklind, local residents, who provided valuable information on the abandoned mines.

History and Production

Lead mining in the Beetown area was important from 1830 to 1870. About one-eighth of the total Wisconsin production of 6, 877 tons of lead concentrates in 1870 was produced in this area, (Strong, pp. 744,749). Lead Production from the area decreased markedly after 1870, and in recent years the only production has been from small-scale, sporadic mining. Zinc has never been an important product, but some small-scale zinc mining was done between 1870 and 1910, (Strong, p. 696, Bain, p. 117), and indications of other zinc ore bodies are present.

The easily accessible ore bodies, i. e., those in which the lead ore was at shallow depths, have been thoroughly prospected and mined. Zinc prospecting and mining have been limited to a few places where the ore bodies cropped out. The ore bodies found to date have been rich but relatively small.

Geology

The Beetown lead-zinc area comprises the southwestern part of a local center of mineralization within the northwestern part of the larger mining district. This center of more concentrated mineralization extends northeastward from the Beetown area to within 2 miles of Lancaster, and is marked by many old lead mines and a few zinc prospects. About 15 miles northeast of the Beetown area is the northwestward-trending western part of a major anticline that lies between the Beetown area and the main north part of the mining district. Toward the Southeast, but separated from the Beetown area by an unmineralized belt, is the old Potosi mining area, (Heyl et al). Shallow folds, which have diverse trends, numerous well-defined lead-bearing joints and small faults are similar to the structures found in other parts of the mining district. The zinc ore bodies, however, appear to be smaller than generally present elsewhere in the district and are restricted to a small part of the Beetown center of mineralization.

The stratigraphic units that crop out in the Beetown area comprise, in descending order, the Galena dolomite, the Decorah formation of dolomite, limestone, and shale; the Platteville formation of shaly limestone, dolomite, and sandy shales; and the St. Peter sandstone. They are all of Middle Ordovician age. These Slightly folded but essentially horizontal beds are exposed throughout the entire area. Beneath these strata lies the shaly, sandy dolomite of the Lower Ordovician Shakopee dolomite of the Prairie du Chien group.

Table 1 presents descriptions of the exposed strata in the Bee-town area, commencing with the topmost beds.

Table 1

Formation	Member	Local name	Description	Thickness Feet
	Dubuque shaly member	Yellow sandy	Dolomitic limestone, yellow, thin-bedded, shaly.	20±
Galena dolomite	Stewartville massive member		Dolomite, buff, slightly calcareous, coarse-grained, thick-bedded.	80
	Prosser cherty member	Drab	Dolomite, light gray-buff, slightly calcareous, coarse-grained, thick-bedded, cherty.	110
Total thickness				210

Formation	Member	Local name	Description	Thickness Feet
Decorah formation	Ion dolomite member	Gray	Dolomitic limestone, light gray, somewhat mottled, coarse-grained, becoming more calcareous near base, medium-bedded, contains layers of greenish shale; more shaly and thins to 9 feet where mineralized.	14
		Blue	Dolomitic limestone and limestone, darker gray, more mottled and shaly than above, medium-to coarse-grained, medium-to thin-bedded, contains some rounded quartz sand grains near base. Where mineralized, becomes a dolomitic green shale and thins to 6 feet.	7
	Guttenberg limestone member	Oil rock	Limestone, light pinkish buff, very fine-to medium-grained; in wavy beds separated by thin chocolate brown carbonaceous shales; the basal bed contains minute, black phosphatic pebbles and fossils. Where mineralized, becomes a brown carbonaceous shale with complete or partial solution of the limestone beds and thins to a minimum thickness of 4 feet.	15

Formation	Member	Local name	Description	Thickness Feet
Decorah formation	Spechts Ferry shale member	Clay bed	Shale, apple green, with interbedded, fine-grained, dense limestone, very fossiliferous; minute black phosphate nodules near top; white or yellow, sticky bentonite ("pipe clay") near base. The "clay bed" is entirely shale where mineralized.	7
Total thickness				43
	Quimbys Mill Member	Glass rock	Limestone, salmon pink, very fine-to medium-grained, very hard and brittle; medium to thin beds bounded by dark-brown carbonaceous shale layers above and below.	0.5
	McGregor limestone member	Trenton	Limestone, light pinkish gray, fine-grained, somewhat mottled; in thin wavy beds, between which are thin beds of brownish-gray shale; slightly thicker in the western part of the area.	28-25
Platteville formation	Pecatonica dolomite member	Trenton or quarry beds	Dolomite, brownish gray, mostly thick-bedded; very argillaceous near the top, contains many quartz sand grains and numerous phosphate nodules near the base; becomes thinner in the western part of the area.	18-23

Formation	Member	Local name	Description	Thickness Feet
Platteville formation	Glenwood shale member	Glenwood or lower pipe clay	Shale, gray-brown, beneath which lies sandy shale, green to gray green; contains well rounded, colorless to white quartz sand grains; grades downward into sandstone.	7
Total thickness				53.5-55.5
St. Peter sandstone		St. Peter	Sandstone, white, yellow or brown; poorly bedded, sometimes cross-bedded on a large scale; the frosted sand grains are of clear, colorless quartz, well-rounded and sorted, fairly coarse-grained; becomes finer-grained and more poorly sorted near base. At base is a shale, green, sandy, with local chert nodules and siliceous oolites.	32-52
Total thickness				32-52
Major unconformity beneath which lies the Prairie du Chien group of lower Ordovician age				
Group	Formation	Local name	Description	
Prairie du Chien group	Shakopee dolomite	Lower Magnesium	Dolomite, gray to pink, coarse grained, irregular, wavy beds of varying thickness; locally sandy, with green glauconitic shale layers or lenses; siliceous ooliths or white chert nodules present.	10+
Total exposed thickness				10+

The Galena dolomite underlies the surface in the northern and northwestern parts of the area and caps all the higher hills in the dissected terrane of the southern and eastern parts. All the gash-vein, joint-controlled lead deposits are confined to the Galena dolomite, which also contains a few joint-controlled zinc deposits. The Galena dolomite has an average thickness of 220 feet elsewhere in the mining district, as for example the area near Hazel Green, Wis. (Agnew et al., p.2). Because of erosion, the uppermost beds are missing in the Beetown area, and the maximum remaining thickness of this formation is about 210 feet on the crest of the high hill west of Beetown village.

The Decorah formation is exposed in the valleys and along the sides of the hills in the eastern and southern parts of the area. Zinc deposits of the pitch-and-flat type, described later, are confined to this formation in the Beetown area. On the map accompanying this report the Decorah formation has not been distinguished from the Galena dolomite. Separate mapping would have added the complication of another formation boundary without adding materially to the economic value of the map. No ore bodies are known to exist in any of the strata beneath the Decorah formation in the Beetown area.

The Platteville formation is exposed in the same parts of the area as the Decorah formation. The most distinctive local feature of the Platteville formation is the extreme thinness of the Quimbys Mill member, here only one-half foot thick, whereas toward the east this member thickens up to 15 feet and is an important ore-bearing zone (Agnew et al., p.3).

The St. Peter sandstone is underlain by an erosional unconformity. The sandstone fills the valleys and covers more thinly the ridges of the former erosion surface at the top of the Prairie du Chien group, hence the marked changes in thickness of the St. Peter sandstone in different parts of the area.

The upper part of the Prairie du Chien group consists of dolomite, a few sandy dolomite and sandstone beds, and thin, green, glauconitic shale layers or lenses; the lower part is alternating dolomite and sandstone strata. Only the uppermost few feet of this group is exposed in the southeastern part of the Beetown area, in the floors of the deepest valleys.

Structure

The strata of the area have been deformed into broad, open anticlines and synclines. The folds are of greater amplitude, tighter, and more closely spaced in the southern and southeastern parts of the area. The folds trend in several directions, the most important of which is about N. 70° E., as represented by the prominent syncline that crosses the area from the southwest corner to the center of the east edge. This syncline is bounded on the south by a parallel, complex, anticlinal area. The south limb of the syncline is generally the steeper. Less prominent folds trend northeast, east, and northwest to form a complex cross-fold pattern. The deforming forces were apparently compressional. Small faults and well-developed joints produced by the general deformation of the region are characteristic of the district and are present in the Beetown area. Most of these faults show a displacement of less than 10 feet. A few faults, notably those along the axis of the prominent northeast-trending syncline that crosses the area (see map), have probable displacements of about 30 feet. The exact nature of these larger faults could not be determined. The smaller faults located on the flanks of the smaller folds are generally bedding-plane faults and associated reverse faults, which in plan are either parallel linear bands or arcuate belts. These fault zones in the Decorah formation generally control the zinc ore bodies.

All the rock formations are characterized by well-developed vertical and, in some places, inclined joints. The strike of the vertical joints is remarkably straight over considerable distances. The strikes of these joints fall into three groups: (1) N. 70°-80° W., (2) N. 40°-60° E., and (3) N. 10°-40° W. The joints striking N. 70°-80° E. W. are generally more open than those of the other two groups, and where present in the Galena dolomite they most commonly contain the joint-controlled lead ore deposits.

Ore deposits

Composition of the ores. As elsewhere in the Upper Mississippi Valley district the ores are mineralogically relatively simple. The metallic and gangue minerals of the ore deposits are listed in table 2.

Table 2

	Mineral Name	Chemical Composition	Local Terms
Ore and associated metallic minerals	Galena	Lead sulfide	Lead or mineral.
	Sphalerite	Zinc sulfide	Jack or black jack
	Smithsonite	Zinc carbonate	Bone or drybone.
	Pyrite	Iron sulfide	Sulfur.
	Marcasite	Iron sulfide	Sulfur.
	Chalcopyrite	Copper iron sulfide	Copper.
	Chalcocite	Cuprous sulfide	Copper.
	Azurite	Basic copper carbonate	Copper.
	Malachite	Basic copper carbonate	Copper.
Gangue minerals	Calcite	Calcium carbonate	Tiff.
	Dolomite	Calcium magnesium carbonate	
	Quartz (chert)	Silicon dioxide	Flint.
	Limonite	Hydroxide of iron	Ocher.
	Barite	Barium sulfate	Barytes.

Galena is the only lead mineral of commercial importance. Sphalerite is the only zinc mineral of economic value in recent years, although smithsonite was formerly recovered. These two zinc minerals when intimately mixed have little value because of difficulties in ore separation and smelting. The iron sulfides are sometimes recovered as a byproduct. Barite and the copper minerals are not known to occur in economic quantities in the area. Barite is present at the Beetown mine (no. 29), and the copper minerals are minor constituents of the ore body at the Black Jack mine (no. 30).

General occurrence of the ores. Although lead and zinc deposits occur in vertically adjacent formations, they do not directly underlie one another in this area. The lead deposits are prevalent in the northern two-thirds of the area, north of the axis of the prominent northeast-trending syncline that crosses the southern part. The southeastern part of the area south of the synclinal axis is the only part in which probably commercial zinc deposits are known or are likely to be discovered. The gash-vein lead deposits are limited to several stratigraphic horizons within the "drab" or Prosser cherty member of the Galena dolomite. Very locally, as at the Eberle mine (no. 27), zinc also has been deposited in these beds, accompanying the galena. The known zinc deposits of workable size are of the arcuate, pitch-and-flat type and are confined to the Decorah formation. The ore occurs as veins along small faults; it also replaces and impregnates the wall rock. Although sphalerite is generally the predominant ore, galena is also present in sufficient quantities to make a valuable byproduct. The limestone and calcareous dolomite strata of the Decorah formation in which the arcuate ore deposits occur are generally partly altered to a shaly residue within and surrounding the ore bodies. For example, the oil rock, which is a thin-bedded shaly limestone in barren area, is thinned and altered to a brown shale residue in the ore deposits.

Lead deposits. Most of the lead ore occurs as gash-veins in long, regular, vertical joints, along some of which minor movement has taken place. The galena is associated with iron sulfides or limonite, calcite, and rarely zinc minerals; it lines the walls of the joints, lies loosely within the joints, or is deposited in brecciated and partly dissolved porous zones in favorable beds bordering the joints. Such zones are known as "openings." These pod-shaped zones are horizontal, linear ore bodies whose long dimension parallels the strike of the joints. The openings may be open caves, caves filled with clay, or loose or partly dissolved vuggy rock, and any of them may contain ore. The ore is distributed irregularly along the length of the openings to form a series of podlike masses in a line along the joint, or it is deposited in a pinching and swelling gash-vein within the joint fracture. Several openings may be present above each other along the same joint at separate favorable stratigraphic horizons. Mineralized ground may continue vertically between the several openings, but only occasionally are these intervening areas known to have contained deposits rich enough to be mined at a profit. The openings range from 4 to about 20 feet in width, 5 to 20 feet in height, and generally several hundred feet in length. Such openings occur in several recognized stratigraphic zones in the "drab" or Prosser cherty member of the Galena dolomite in the Beetown area. They are:

Name	Average depth in feet below top of Prosser cherty member		
	Top of opening		Floor of opening
1st or 12-foot opening (roof at about the top of the highest chert)	0	to	12
2d or 32-foot or false opening (not often lead bearing)	44	to	52
3d or 65-foot opening	77	to	95
4th opening (just above the base of the Prosser).	105	to	110

In the central and eastern part of the Beetown area the 1st or 12-foot opening was the largest producer of lead in the past, but in some places in this locality ore was found also in the other three openings. However, these deeper openings (2d, 3d, and 4th) have been prospected only slightly. In the western part of the area, along Rattlesnake Creek, lead ore was successfully mined in all four openings, but the 65-foot opening was by far the largest, the most often mineralized, and the most commonly mined. The 1st or 12-foot opening was also important, but the 2d or 32-foot opening was not commonly mineralized and the 4th opening was rarely prospected.

Almost all of the gash-vein deposits in the Beetown area are north of the significant northeast-trending syncline. The most important mineralized joints strike N. 70°-88° W. These and the less prevalent joints that strike N. 40°-60° W. control the more productive openings described above. Lead-bearing joints that trend northwest, north, north-northeast, and east-northeast are locally common, but these usually contain only a thin vertical gash-vein of ore, without openings. At some junctions of mineralized joints the ore forms vertical "chimneys" along the zone of intersection. Many of the lead-producing joints may be traced along the surface by a line of old pits, shafts, and mine dumps; the more prominent of these are locally called "ranges."

Zinc deposits. The zinc ore deposits in the Decorah formation occur in brecciated zones bordering minor faults, in veins along fractures (pitches), in veins along bedding-plane fractures (flats), and in disseminations in favorable beds, especially those that are somewhat shaly. Sphalerite is the predominant ore mineral and galena is of minor importance.

The pitches dip at angles of about 45°; the flats are approximately horizontal. The pitches and their associated flats are generally found along the flanks of folds. Most of the pitches are reverse faults of small displacement that dip toward the structurally high areas. They are directly related to the folds and tend to form at the noses or along the limbs of both the major and the minor folds. The pitches apparently are best developed where the dip of the beds on the flanks of the folds is the steepest and the tendency of the rocks to fracture is the greatest. The flats, apparently formed by tension and faulting along the bedding planes, extend laterally from the pitches.

Types of zinc ore bodies. The few known zinc ore bodies in the Beetown area are of two general types: (1) the horseshoe or arcuate pitch-and-flat deposits and (2) the gash-vein, joint-controlled deposits.

The arcuate ore body is the more common type in the area, particularly in the southeastern part. Typical ore bodies occur on the limbs of local folds, have arcuate outlines, and wrap around the nose of the fold. Pitches on opposite limbs may be several hundred feet apart, and the area between the pitches is relatively lean or barren of ore. The complete form is elliptical, but is rarely found. The only known arcuate ore bodies in the Beetown area lie on the flanks of an anticline as, for example, the Black Jack mine (no. 30) and Yellow Jacket mine (no. 28), but probably such ore bodies are also present on the flanks of synclines.

All of the known horseshoe or arcuate zinc ore bodies lie south of the prominent syncline of N. 70° W. trend. The ore bodies of this type are probably limited to the flanks of this syncline and to the area south of it.

The gash-vein, joint-controlled deposits are of very minor importance. Those known to date have not been large enough to be mined successfully for zinc. They are in all respects similar to the gash-vein lead deposits previously described, except sphalerite rather than galena is the predominant mineral present. The Eberle mine (no. 27) is an example of this type of deposit; other examples are known in the area north and east of Beetown.

Suggestions and Possibilities for Prospecting

Lead deposits. Probably the best method for finding additional joint-controlled lead deposits in the Beetown area is to prospect on the ends of known lead-bearing joints beyond the point of previous prospecting and mining. This method might be used with success not only on the extensions of known lead-bearing joints but also in the unprospected areas between the Beetown, the Nip and Tuck, and the Muscalunge diggings. The high nearly level areas between valleys are particularly favorable.

A second possibility for finding lead deposits is to prospect for openings below those already mined. Inasmuch as large quantities of lead were found in the 3d or 65-foot opening in the western part of the Beetown area, ore may be present also in the eastern part, at horizons equivalent to the 2d, 3d, and 4th openings that have never been thoroughly prospected. Lead mining in nearly all places was limited to the beds above the ground-water level; it is probable that large quantities of lead still remain beneath the water table, especially under the higher hills. Pumping or drainage by long adits would be necessary in the recovery of this lead ore. Because of the type of occurrence of these lead deposits, prospecting methods appear to be confined either to shaft sinking along the lead-bearing joints or to churn drilling of holes very carefully located directly on the fracture. This type of drilling is expensive in many cases, because of the difficulty of placing the holes directly in the narrow joints and the mechanical problems of drilling in in the soft rock along the joints. Diamond drilling is generally not successful because the soft broken rock yields practically no core or sludge.

In the nineteenth century individual companies mined successfully on a fairly large scale in the Muscalunge Diggings along Rattlesnake Creek. The mining of large numbers of closely spaced mineralized joints was facilitated by the use of a series of drainage adits, pumps, and exploration and haulage cross-drifts. A modification of this method might again make lead mining possible in the Beetown and other areas on a fairly large scale.

Most of the gash-vein lead deposits known are limited to the area north of the major syncline, and thus lead prospecting along this fold and south of it does not appear advisable.

Zinc deposits. In view of the structural control of the zinc mineralization already described, the first step in prospecting for the larger, arcuate zinc deposits should be to consider sites that are structurally favorable. Only the area along and south of the major syncline appears to contain the type and size of folds necessary to produce the controlling pitch-and-flat fractures that localize these zinc deposits. Therefore the surface lead deposits do not appear useful here as a guide to deeper ore. The most favorable structure in this area is the local anticline along which lie the Balck Jack (no. 30) and Yellow Jacket (no. 28) mines. Additional ore might be found along the flanks of this fold between these two mines. The limbs of the large syncline in the southern part of the area and the minor folds related to it also appear of potential interest. A number of outcrops show the residual shale phase of the Decorah formation plus intense iron sulfide mineralization typical of the arcuate zinc deposits. In some places numerous small galena crystals are found with this assemblage, but zinc minerals have not been noted, probably because of surface weathering and leaching. The deeper valleys are not good places for exploration because they cut below the favorable ore zone in the Decorah formation. Successful prospecting for zinc is possible only on the higher hills where the Decorah formation and overlying beds remain uneroded and unweathered.

In order to explore adequately the Decorah formation by drilling, the holes should penetrate at least 10 feet into the Platteville formation. The depth to the "clay bed" is rarely more than 200 feet and generally ranges between 0 and 150 feet. Drilling in areas of exposed Platteville formation and underlying beds does not appear advisable unless marked mineralization is found at the surface. The structure contours on the map indicate the altitude above sea level of the top of the "clay bed" at the base of the Decorah formation. The probable depth of drilling necessary to explore through the "clay bed" at any given point on the surface may be obtained by subtracting the altitude indicated by the structure contours from the surface altitude at that point, and adding to this figure about 15 feet, the combined thickness of the "clay bed" and uppermost part of the Platteville formation.

Drilling should yield the most information if the first line of holes put down in each locality is laid out at right angles to the probable trend of the ore body. The holes should not be more than 100 feet apart. If no indication of ore is found, it would be advisable to move several hundred feet farther along the trend and again drill a line of holes at right angles to the trend. This procedure may be repeated until favorable indications are obtained or until the area is deemed sufficiently prospected. An alternate method is to begin drilling in a grid pattern, placing the holes about 600 feet apart, until the structure is sufficiently defined to permit more local drilling. Then use the drilling method previously described to delimit the ore bodies. Old dumps that contain zinc and lead ores are an indication that justifies prospecting on a small scale, particularly if these dumps show ore from the beds of the Decorah and Platteville formations.

Because the known ore bodies in the Beetown area are small, large prospecting and development expenditures would not be justified.

Technical Features

The zinc ore is generally concentrated by flotation methods or a combination of jigs, float cells, and tables. These facilities are not available in the Beetown area, and successful mining in the vicinity will require the erection of mills for concentration. Railroad shipping points for concentrates are only a few miles distant -- Lancaster to the northeast and Cassville to the southwest.

Most of the area is so deeply dissected that unwatering of mines should be a minor problem. In many places drainage adits may be successfully driven into the mine from a nearby valley to take care of the water encountered.

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REPORT ON THE LEAD-ZINC DEPOSITS OF THE BEETOWN AREA, WISCONSIN, RELEASED

Secretary of the Interior Oscar L. Chapman today announced completion of a report on the lead and zinc deposits of the Beetown area, Grant County, Wisconsin, accompanied by a geologic map of the area. This was done under the direction of the U. S. Geological Survey in cooperation with the Wisconsin Geological and Natural History Survey.

The Beetown area is in the northwestern part of the Upper Mississippi Valley zinc-lead district. At one time it was an important producer of lead, but in recent years mining has been sporadic and on a small scale. Zinc was never an important product, although a number of small but rich ore bodies were mined. The present investigation indicates that further prospecting is justified.

The report, prepared by Allen V. Heyl, Jr., Erwin J. Lyons, and John Theiler, describes the general geology of the area and the manner of occurrence of the lead and zinc deposits, and has a brief discussion of the factors involved in prospecting and beneficiation of the ores. Included is a list of the more important mines and their location.

Director of the Geological Survey, W. E. Wrather, announces that the report, which will soon be published as a chapter of a Survey bulletin, is now on open file for public inspection at the U. S. Geological Survey, Room 1033 (Library), General Services Building, Washington, D. C.; at the U. S. Geological Survey office, Wisconsin Institute of Technology, Platteville, Wisconsin; and at the office of Mr. E. F. Bean, State Geologist, Science Hall, University of Wisconsin, Madison, Wisconsin.

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P.N. 79595

Interior--Duplicating Section, Washington, D. C.

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