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ZINC DEPOSITS OF THE MIFFLIN-COKERVILLE AREA

OF THE WISCONSIN LEAD-ZINC DISTRICT

by

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The Mifflin-Cokerville area is in the north-central part of the Wisconsin lead-zinc district, about 14 miles north of Platteville, Wis. The lead deposits in this area, particularly those in the vicinity of Mifflin, were among the largest and most extensively worked in the district, and the old Penitentiary mine was among the first from which zinc was recovered in quantity. From about 1900 to 1928 the Mifflin-Cokerville area was one of the most active in Wisconsin, and the Cokerville group of mines included some of the largest zinc mines in the State. At present only three mines--the New Dale Rundell, the Defense, and the Okay--are being worked, and the operations are on a small scale. A large flotation mill is being erected by the Defense Plant Corporation to rework the Coker No. 1 and No. 2 jig tailing piles. Churn drilling, moreover, has revealed large reserves of zinc ore near by, and recent investigations by geologists of the Geological Survey, U. S. Department of the Interior, indicate strongly that further prospecting for zinc ore is justified. This brief preliminary paper deals chiefly with the zinc deposits, the lead ores being touched upon only incidentally.

Both the zinc ores and the lead ore occur in the Galena dolomite and Platteville limestone, both of Ordovician age.

The Galena consists in general of cherty dolomite, but it becomes less cherty and more calcareous near its base. Elsewhere in this district it has an average total thickness of 235 feet; because of erosion, however, the uppermost member of this unit is not exposed in the Mifflin-Cokerville area. The formation may be divided into the following lithologic members, the popular terms for which are given in quotation marks below:

	Feet	
"Yellow sandy"--Limestone, medium-grained, moderately dolomitic	Up to 115	
"Drab"--Cherty dolomite, coarse-grained, dense	85	
"Gray"--Limestone, granular, coarse-grained, somewhat mottled; chert rare; contains layers of green shale	10	
"Blue"--Limestone, granular, bluish gray, coarse-grained, strongly mottled; contains layers of green shale	10	
"Oil Rock"--1. Limestone, pink, fine-grained, thin-bedded, mostly very calcareous but locally dolomitic and coarsely granular; layers of chocolate-brown oil shale	10	15
2. Chocolate-brown shale, with layers of very thin bedded, pink, highly calcareous limestone	5	
	Up to 235 feet.	

The Platteville, which has an average thickness of 60 feet, consists mainly of limestone (locally dolomitized) with a thin bed of green shale at the top and another at the bottom. It may be divided into the following members:

	Feet
"Clay bed"—Apple-green shale, with metabentonite beds, thin beds of shaly limestone, and phosphate nodules..	2
"Glass rock"—Limestone, salmon pink, fine- to medium-grained, mostly calcareous but locally dolomitic, very dense, with striking conchoidal fracture....................................	5
"Magnolia"—Limestone, greenish-gray, partly thin-bedded and partly thick-bedded, fine-grained, dense, mostly very calcareous but locally dolomitic.....	15
"Mifflin"—Limestone in thin wavy beds, light-gray, very fine grained and dense; layers of chocolate-brown oil shale....................................	17
"Pecatonica"—Dolomite, thick-bedded, greenish-gray, fine-grained..................................	19
"Glenwood"—Apple-green to gray-green sandy shale with abundant phosphate nodules......................	2

Beneath the Platteville lies the St. Peter sandstone. This formation varies in thickness between 60 and 100 feet, but only the upper 40 feet is exposed in the Mifflin-Cokerville area. The St. Peter is composed of thick-bedded, white reddish-brown sandstone cemented with silica and iron oxides. The sand grains are very well rounded, clear and glassy, and the formation is characterized by large-scale cross bedding.

Both the Galena dolomite and the Platteville limestone locally contain deposits of lead and zinc ores. In the Mifflin-Cokerville area lead ore has a greater stratigraphic range than zinc ore. It has a vertical range of 115 feet; it may be found at any horizon from the top of the "Pecatonica" member of the Platteville limestone upward into the "drab" member of the Galena dolomite. Zinc deposits of workable size are found in the following parts of the section; near the base of the Galena dolomite, either in the lowermost part of the "drab" or in the "gray," "blue," and "oil rock" members; and in the upper two members of the Platteville limestone—the apple-green "clay bed" and the "glass rock."

The ores of the Wisconsin district are very simple in composition, containing only a few minerals that need be mentioned. The only lead mineral forming an appreciable part of the ores is galena (lead sulfide, locally known as "lead"); the zinc is found commercially in two minerals, sphalerite (zinc sulfide, widely known as "jack" or "blackjack"), and the weathering product smithsonite (zinc carbonate, locally known as "drybone" or "bone"). The associated metallic minerals are pyrite and marcasite (iron sulfides, the local term for which is "sulfur"); the gangue minerals are calcite (calcium carbonate, known in this district as "tiff") and barite (barium sulfate, known locally as "barytes"). Some of the zinc deposits contain high percentages of iron sulfide.

Most of the lead ore is found in long, regular, nearly vertical joints or minor fault fissures, either lining the walls or lying loose. Some of the galena, however, in the lower part of the mineralized zone is associated with sphalerite in pitches (deposits along inclined fissures) and flats (deposits along bedding planes). Galena occurs also as individual crystals disseminated in favorable beds, either alone or accompanying sphalerite crystals. Many of the lead-bearing joints may be traced along the surface by linear series of old pits, shafts, and dumps. The principal ones in the Mifflin-Cokerville area strike N. 30°-45° W. A less important group of joints trends east and west.

Some of the zinc ore bodies--those, for example, of the Old Squirrel, Old Slack, Penitentiary, and Defense mines--tend to follow these same trends. The main zinc deposits, however, are of two distinct types, both having easterly trends, yet differing strikingly as to the nature of openings that contain the ore.

One type is illustrated in the Cokerville mines, in which there are three roughly parallel ranges. From north to south these are the Bickford-Coker No. 1-Biddick range, the Coker No. 2-Yewdall range, and the Senator-Coker No. 3-New Dale Rundell range. As may be seen on the accompanying map, these ore bodies are of great linear extent; each of those in the Coker No. 1 and Coker No. 2 has a length of 1½ miles. The thickness of the ore bodies ranges from 12 to 40 feet and the width from 40 to 120 feet. The structure contours indicate that the ore bodies occur on the limbs of large, open elliptical domes and basins. The Coker No. 2 ore body outlines a dome completely, while the Coker No. 1 and No. 3 ore bodies partly outline two other domes.

On the map, lines and arrows within the ore bodies indicate the position and the strikes and dips of the small inclined faults known locally as pitches. In each ore body the ore is localized along these pitches and their accompanying fracture zones. It will be noted that in this part of the area all the pitches dip toward the anticlines, which indicates that the pitches are reverse faults. These pitches dip at angles approximating 45°. Several similar structures as yet unprospected, or apparently accompanied by ore bodies only partly prospected, can be seen in the vicinity. These structures especially warrant the most concentrated prospecting in the area.

The second major type of zinc ore body is exemplified by the Okay-Slack-Squirrel range. Here again the major trend is nearly east, but the features controlling mineralization differ from those of the first type, already described. The pitches are normal faults dipping toward the syncline at steep angles (80°), and they are tight and contain little or no ore. Some of the ore is found in the fracture zone between the several parallel pitches, but more of it consists of crystals disseminated along certain shaly beds. Like the Coker Nos. 1 and 2 ore bodies, the Okay-Slack-Squirrel range has a total length of about 1½ miles and a width of 40 to 120 feet; its thickness probably varies from 4 to 20 feet. The range borders the south limb of a large anticlinal nose and is in this way similar to the Cokerville type.

Some light on the relations of the ore-bearing fractures to the general structure of the area can be gained from a study of the geologic map. It will there be seen that the rocks of the Galena dolomite and Platteville limestone have been deformed by compressional forces, probably originating from the south, into broad, open ellipsoidal synclines and anticlines, which trend about N. 50° E. and have their steeper limbs on the north sides of the anticlines. The two major kinds of ore-bearing fractures border these folds, upon which are superimposed two sets of subsidiary structures. One of these sets of subsidiary structures includes the prominent series of faults and joints, trending N. 30°-50° W., mentioned previously, which are locally mineralized, especially with lead sulfides. Associated with these are folds of the same trend. These features appear to indicate the direction of shear caused by the compressional forces from the south. One of the cross folds, about 1 mile north of Mifflin (sec. 22), is accompanied by a fault with a vertical displacement of at least 60 feet; a number of loose boulders of St. Peter sandstone found in the faultline valley suggest that the vertical displacement may be even larger. The horizontal displacement on this fault has not been definitely measured but is probably well over 1,000 feet. The Old Slack mine is on a continuation of this cross structure, and the Old Squirrel and Penitentiary mines are on similar but less prominent ones. The other set of subsidiary structures consists of minor domes and basins similar to the larger ones in every respect but size. An example is to be seen at the Old Gruno mine, just west of Mifflin, which is situated in one of these small basins.

The detailed discussion of the structural features of the region will be reserved for a later and longer report.

In general the zinc deposits tend to occur at the ends or along the limbs of major and minor folds, and along cross structures, being localized in both cases on those parts of the structures where the dip is steepest and the tendency to fracture greatest. The first step in prospecting for zinc should therefore be to locate sites that are structurally favorable as indicated on the map. Surface diggings in the lead deposits of this area indicate only one type of deposit and in general, the one that has been the smallest producer of zinc. Any old dumps on the favorable structure should be examined for traces of zinc ore. If any were found, it would be a promising indication, and the property should then be drilled with the churn drill commonly used in the district. The holes should be drilled to the base of the "glass rock," whose distance from the surface would rarely be more than 150 feet and in most places much less. As the structure contours on the map indicate the altitude above sea level of the top of the "clay bed," which immediately overlies the "glass rock," the probable depth of drilling necessary at any given point may be obtained by subtracting the altitude indicated by the structure contours from that of the surface at that point and adding to the figure thus obtained 7 feet, which is the combined thickness of the "clay bed" and the "glass rock." Drilling might yield the best returns if the first holes put down at each locality were alined at right angles to the probable trend of the ore body. If no ore were found in such a cross section the existence of a deposit near the line of drill holes would be improbable whereas a line of holes parallel to the probable trend might barely miss an ore body lying alongside the line. The holes along a cross line should not be more than 40 or 50 feet apart.

The ores mined in this area were being shipped, at the end of 1943, to the custom flotation mill at Cuba City, Wis., some 30 miles to the south, and thus had to absorb a high transportation charge. Under those conditions, it might have been more profitable to ship a smaller tonnage of higher-grade ore; but if that were done, some of the zinc so urgently needed for war purposes would be lost.

In the eastern half of the area, much of the ore is disseminated in beds of shale, which becomes tenacious clay when wet. This necessitates some special adaptations in milling to yield a maximum recovery of the mineral. Ore from the pitches and flats in the western part of the area, on the other hand, is amenable to orthodox zinc milling procedures, such as diaphragm jigging, slime tabling, and flotation.