Proceedings of the Iowa Academy of Science

Volume 53 | Annual Issue Article 27

1946

Recent Developments in The Wisconsin-Illinois-Iowa Lead-Zinc District

Allen F. Agnew
Iowa Geological Survey

Allen V. Heyl Jr.
Iowa Geological Survey

RECENT DEVELOPMENTS IN THE WISCONSIN-ILLINOIS-IOWA LEAD-ZINC DISTRICT-[1]

ALLEN F. AGNEW AND ALLEN V. HEYL, JR.

One of the oldest mining districts in the United States, and one from which lead and zinc ores were mined in substantial quantity during the last five years or so is situated in the upper area of drainage of the Mississippi River. The district lies in the geologic province that has been known for several decades as the "Driftless Area," and is characterized by gently-rolling topography, which extends from the nearly-level uplands to the well-dissected areas bordering the major rivers. The Mississippi on the west, the Wisconsin River on the north, and the Rock River on the east virtually bound the district. The area of major mining activity includes roughly some 2500 square miles, most of which lies in Wisconsin. The land is fairly well wooded, particularly where greatly dissected, while the uplands and bottomlands contain acreage valuable for farming. The district is characterized by dairy farms and industries based upon dairy products. The area involved has a temperate climate with moderate precipitation. Its secondary roads are well kept, the road metal being both from tailings piles of mining operations as well as from quarries

The sedimentary rocks of the area are principally Ordovician, the greater part of which are of Chazy (?) and Mohawkian age. They include, in ascending order, the St. Peter sandstone, the limestone, dolomite and shale beds of the Platteville limestone, the shale, limestone and dolomite beds of the Decorah shale, and the dolomite and chert of the Galena dolomite. The Maquoketa group and overlying dolomite of Silurian age are found to a thickness of some 350 feet in the Illinois and Iowa parts of the district, not because of superior altitude but because of the regional dip of the strata to the southwest.

The main zones of ore occurrence are in the lower Galena dolomite and upper dolomite beds of the Decorah shale, and also in the upper Platteville limestone or "glass rock" beds. The "oil rock" and "clay bed" units of the Decorah contain deposits of less extent and value. The ores are localized mainly as veins in zones of folding and faulting, but some ore is disseminated, principally in the shaly parts of the Decorah. The folds and faults, though of relatively small amplitude, have surprising linear extent and continuity. Although the structures are generally simple folds and faults, they locally show plastic flow and solution with much associated brecciation. The important ore minerals are the zinc and lead sulfides, sphalerite and galena, associated with the iron sulfides (pyrite and marcasite), and calcite. Of interest but of negligible economic importance today are barite and various copper minerals.

It might be interesting to note a few characteristics of a typical

[1] Published by permission of the Director, U. S. Geological Survey.

mine in the Upper Mississippi Valley lead-zinc district. This mine would be situated under good farmland (the farmers often exact damages for the piles of waste rock which cover some of their arable acreages), and would be reached by a shaft about 180 feet in depth. Descent to the workings would be in a "can" (a cast-iron bucket estimated to hold 1000 lbs. of ore) controlled by a hoist mounted some 30 feet above the surface. At the base of the shaft an opening 100 feet in width would extend for perhaps 1500 feet longitudinally. The roof would be 20 to 30 feet above; from fractures in it small intermittent or flowing streams would be descending. The mine would be electrically lighted and would "make" perhaps 800 gallons of water per minute. The temperature in the mine is approximately the same as the mean annual temperature of the region, and the humidity is extreme. The floor of the mine is kept at a grade suitable for easy mine haulage, and this allows the water to drain to the low point, where a sump is located, from which the water is pumped to the surface.

The mining is usually carried on at one level, benches being resorted to if necessary, and an incline or winze may be driven to reach ore at a lower level. Mechanical loaders and locomotives for tramming are in use underground. Normally the stope or mine opening is "mucked out" in the early part of the shift, and then the drillers take over, drilling the faces with the new rounds of holes, which are loaded and fired as the last operation of the day's work.

As a rule the dolomite roof stands well and thus the "back" is supported only by rock and ore pillars 10 feet or so in diameter, located about 50 feet apart. Where the roof is formed by the thin-bedded limestones of the middle Decorah shale it is often necessary to resort to timbering to control its slabbing-off.

After the ore is hoisted to the surface it is rough-sorted over a "grizzly" and then "wet-milled" (by jigging and tabling) or sent directly to the custom flotation mill by truck. The ore may contain 4% zinc as mined, 6 to 7% after "cobbing" (hand-sorting), and as high as 25% after jigging. The flotation mill brings its grade up to 60% zinc with less than 1% iron; this is the product that is shipped out of the district for smelting. The lead concentrate contains about 80% metallic lead.

The Upper Mississippi Valley lead-zinc district was studied rather thoroughly by government survey parties until about 1916. The first work was conducted by Owen in 1839 and 1852 for the federal government; Whitney in the 1850s performed private consulting work as well as investigations for the federal government, and Percival in 1854 and 1855 completed surveys for the State of Wisconsin. Chamberlin and Strong in the 1870s carried on a masterful study of the region for the State of Wisconsin. In the 1890s and 1900s the Iowa Geological Survey (headed by Calvin) and the Wisconsin Geological Survey (under the direction of Grant) conducted thorough investigations of their respective portions of the district and by 1906 there had been published by the U. S. Geological Survey (under Bain's

leadership) a general volume covering the whole mining district, a U. S. Geological Survey volume dealing solely with Illinois having appeared slightly earlier. Two later reports, published by the Illinois survey in 1914 and 1916, contained the results of work in Illinois completed by Cox, and by Trowbridge and Shaw.

Since 1916 the geological investigations have been less intense; they were carried out by company geologists until most of the major companies abandoned the district in the late 1920s. From that date until 1942 the only geological activity in the district was that carried on by professors and their students from several universities, principally Northwestern University.

The past production of the district has been very large. The lead mines in the Dubuque area were among the earliest worked by white men, beginning in 1788 with Dubuque's concession. The production of galena increased rapidly in the 1820s, when settlers first began to flow into the region in numbers; it reached its peak in the 1840s, when the district was contributing a great part of the output of the United States.

Zinc production did not get under way until the 1860s, as prior to that time there was no market for zinc ore. A quantity of this ore, half carbonate ("drybone"), was mined before 1880, when production was curtailed by the great depression. The rejuvenation about 1900 suddenly caused the mining of zinc to boom; it increased to a maximum during the first World War, but dropped to practically nothing in 1930. Relatively less zinc than lead has been produced in Iowa, though substantial tonnages of zinc have been obtained from the Durango drybone opencut and small near-surface mines within the city of Dubuque.

Recent activity in the mining district has been striking. The completion of a custom flotation mill about 10 years ago gave the district a new lease on life, as it made possible the winning of much ore whose extraction had heretofore been uneconomical. Production, principally zinc, increased slowly until the demands of World War II caused a sudden spurt in the amount of ore mined.

In the summer of 1942 the U. S. Geological Survey and the U. S. Bureau of Mines, represented by C. H. Behre, Jr., and Alvin M. Cummings respectively, proposed that both federal bureaus engage actively in aiding the district to attain greater production during the war. In October of that year the Federal Geological Survey sent a geologist to the mining field, with headquarters in Platteville, Wisconsin, and the ground work of general geology, particularly stratigraphy, plus the gathering of pertinent data, was begun.

The Bureau of Mines' exploration party arrived early in 1943 and began drilling for ore late in January. Arrangements were worked out with the geological surveys of the three states involved whereby the work of both federal agencies could be carried out with the least amount of red tape. The Illinois State Geological Survey, because of its large staff, was able in the spring of 1944 to set up a field party in Galena, Illinois; this party restricted its specific activities to that

state. The geological surveys of the other two states, Iowa and Wisconsin, entered only modestly into the program, but took a more active part in the discussions and planning of the work, particularly in their respective states. At the present time the Wisconsin Geological Survey is aiding the work financially.

The geological work of the U. S. Geological Survey, both in cooperation with and independently of the U. S. Bureau of Mines, contributed to the greatly increased output of the district, principally in the following ways:

1) By recommending the prospecting for and the mining of ore in the "glass rock" unit and lower beds. As they are situated below the "clay bed," which was previously thought to dam the descending solutions, these beds had been considered to be unfavorable as hosts.

2) By calling attention to commercial zinc deposits geographically outside the borders of the productive area of the district.

3) By recommending locations for drilling.

4) By recommending exploration for extensions of ore from the underground workings.

Although very important for the future of the district, the results of No. 1 and No. 2 cannot be estimated very accurately. However, referring to No. 1 it is known that as much as one-fourth of the total output of the district during certain months came from the "glass rock" and lower beds. With regard to No. 2, the impetus given by the discoveries of commercial zinc deposits in two outlying areas (the Gray-Bautsch orebodies in Illinois, and the Tennyson deposit in Wisconsin) is already a major factor in the healthy outlook for the district. No. 3 resulted in the discovery of more than two and one-half million tons of ore averaging in excess of 5% metallic zinc and lead. During the war 3% zinc was arbitrarily considered the basal economic limit of ore for mining, although a few mines were able to operate on ore that contained less zinc that that. No. 4 contributed substantially to the output of the district. In the later part of the work (1944-1945) the Illinois State Geological Survey made notable contributions, particularly with respect to No. 3 of the items mentioned above.

The work of the U. S. Geological Survey consisted principally in structural mapping, both at the surface and in detail in the individual mines. It was found that the ore was controlled by faults and associated folds in certain favorable beds, and that these structures, though they had very small vertical components, were surprisingly continuous lineally. The smallness of the structures (the faults, reverse in movement, usually have displacements of less than 5 feet vertically) demanded a precise stratigraphic determination of the beds. This was possible because of the numerous units of small thickness that were distinguished for use as datum beds for the structural mapping. The structural picture, which is new, and the revised

stratigraphy of the district, are being described fully in the detailed report that is being prepared for publication.

The district boomed also because the mining fever gripped men in many of the other occupations, particularly farming. Coupled with this was the fact that many of the mining men in the district had kept in secluded corners far back in their minds the memory of some property or prospect that had "looked good," and might be worth exploiting in a time of higher prices.

Principally because of the favorable results gained by the drilling of the U. S. Bureau of Mines, the interest of mining companies operating in other districts was directed toward the Upper Mississippi Valley district, to the extent that several of the major zinc producers of the United States who had given up in Wisconsin-Illinois-Iowa in the late 1920s sent representatives back for another look. In addition, the following new blood has been introduced:

1) Tri-State Zinc, Inc., which in late 1944 came up from the Missouri-Oklahoma-Kansas zinc-lead district, is now mining one of the largest bodies of zinc ore discovered in the United States during the war—the direct result of work by the U. S. Geological Survey, U. S. Bureau of Mines, and Illinois State Geological Survey.

2) The Eagle-Picher Mining and Smelting Co., the major zinc producer of the Tri-State district, had a reconnaissance party in the Wisconsin-Illinois-Iowa field in the spring of 1946.

3) The W. B. Baggaley enterprises developed and mined several ore bodies in Illinois and Wisconsin.

With the end of the war the U. S. Bureau of Mines closed all operations, but in February, 1946, began drilling again, this time in Illinois.

Production during the war period was at a substantial increase over the 1930s, though it fell short of the last operations before the grand shutdown of the late 1920s. During World War I production attained a peak of more than 60,000 tons of metallic zinc annually, and throughout the 1920s it ranged from 15,000-30,000 tons per year. The year 1945 of the present boom saw an output of more than 19,000 tons of recovered zinc metal and more than 2200 tons of lead metal.

This output was made possible mainly by the payment of subsidies to the operators by the government. These subsidies raised the price of zinc from its base rate of 8.25 cents per lb. to more than 13 cents in the Upper Mississippi Valley field as well as in the Tri-State district. Likewise, the base price of lead was raised by subsidies from its 6.5 cents per lb. base, so that the average price in the two districts mentioned before was in excess of 9 cents.

This tremendous incentive to production not only contributed directly to the winning of the war (for brass and other zinc alloys, as well as lead products were in great demand for military purposes), but it also contributed to the material reduction of known ore re-

serves in the district, as many "lean" bodies were mined that had been held in reserve for years.

The part that Iowa played in the recent output of the district was necessarily small. Likewise, less work by the U. S. Geological Survey and the U. S. Bureau of Mines was carried on in Iowa. The reasons are well known: most of the recent mining had been in the other two states, particularly Wisconsin, and the custom mills were located there; furthermore, the geological structures were more clearly exposed and could therefore be mapped there with more confidence, and with more promise of immediate war-time production than in Iowa. Clearly a major consideration in all this planning was the fact that the production was needed immediately.

Iowa did, however, receive attention in the following ways:

1) The U. S. Geological Survey, associated in several projects with the Iowa Geological Survey, carried out structural mapping of certain areas in Iowa, and in addition examined promising prospects.

2) This work resulted in the drilling by the U. S. Bureau of Mines of two of the properties, known as the Pikes Peak "ranges" and the Timber range. The latter contains the famous Durango drybone opencut of the 1890s. In each case mineralized ground was found, but the zinc content was not of ore grade.

The authors believe that the future of the district as a whole appears favorable. With the new theory of structural control supplemented by useful stratigraphic units it is felt that many workable deposits of zinc and lead ore can be found in future work. Only those areas that are near lines of transportation to mills have been prospected. Of necessity the most mining has been done in those areas that are generally well-dissected, as mining operations have been started from ore outcrops and traces of ore in the overburden and float ore found in stream beds. There are extensive areas of tableland that have remained unprospected because of farming. In addition, the areas where deeper drilling will be necessary to reach the ore horizons have so far been relatively untouched.

All of these points are favorable as far as the possibility of ore occurrence in the district is concerned and are particularly applicable to the Iowa part of the field. In Iowa the ore-bearing beds are less commonly exposed; present milling facilities are far away; deeper and thus more expensive drilling will be required; and the region is less favorable for geologic study and prospecting. Specifically with regard to the Iowa part of the district there is the possibility of further finds of ore, because the lower beds of the Galena dolomite have been unprospected, particularly in the Dubuque area. These beds constitute the main producing zone of the major part of the mining district, to the east.

A further factor that should be mentioned is the possible occurrence of ore in beds of the Prairie du Chien group, below the St.

Peter sandstone. The theory of ascending solutions supports this idea, at least theoretically; furthermore, several of the deposits mined have been situated in those beds, known in the miners' terminology as the "lower magnesian lime."

GEOLOGICAL SURVEY,
Geology Annex,
Iowa City, Iowa.