# Exploratory Drilling for Evidence of Zinc and Lead Ore in Dubuque County, Iowa

*By* ARTHUR E. FLINT *and* C. ERVIN BROWN

A CONTRIBUTION TO ECONOMIC GEOLOGY

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# A CONTRIBUTION TO ECONOMIC GEOLOGY

## EXPLORATORY DRILLING FOR EVIDENCE OF ZINC AND LEAD ORE IN DUBUQUE COUNTY, IOWA

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### ABSTRACT

The U. S. Geological Survey, in cooperation with the Iowa Geological Survey, made a study of the Galena and Decorah formations in the Iowa part of the upper Mississippi Valley zinc-lead district, to investigate structures that appear favorable for the concentration of zinc and lead minerals in the Decorah formation and in the lower part of the Galena formation, both of Ordovician age, and to determine by drilling whether these structures may be delineated by mapping the principal outcrops, which are 50–200 feet higher in the stratigraphic section. Rocks of the Decorah formation and lower part of the Galena formation are the principal host for major zinc-lead ore bodies in the Wisconsin and Illinois parts of the mining district, but these strata have been explored by drilling in only a few places in Iowa.

A total of 2,870 feet in 13 holes was drilled in four localities. Zinc mineralized rock was intersected in the Decorah formation at three of the four localities, and drilling verified the fact that the existence of favorable structures at depth can be inferred from a study of maps of outcrops. Folds or small warps in the Decorah formation are reflected at the surface and generally coincide with structures that are inferred by mapping outcrops.

### INTRODUCTION

#### PURPOSE

The twofold objective of the drilling project in the Dubuque subdistrict in Iowa (fig. 62) was to test drill structures delineated by mapping outcrops that appear favorable for the concentration of zinc and lead ore and to determine whether the minor downwarped structures commonly associated with ore emplacement in the Decorah formation and the lower part of the Galena dolomite are reflected upward into outcropping strata 50–200 feet higher in the stratigraphic section, where they may be delineated by mapping the surface.

#### SUMMARY OF PRINCIPAL RESULTS

Results of this study in the Dubuque subdistrict indicate that commercial zinc deposits may occur in strata of the Decorah formation and lower part of the Galena dolomite, and that structures favorable for ore concentration may be located by mapping the surface. In bluff areas, however, superficial structures due to mass slumpage may be misinterpreted as favorable for finding ore concentrations.

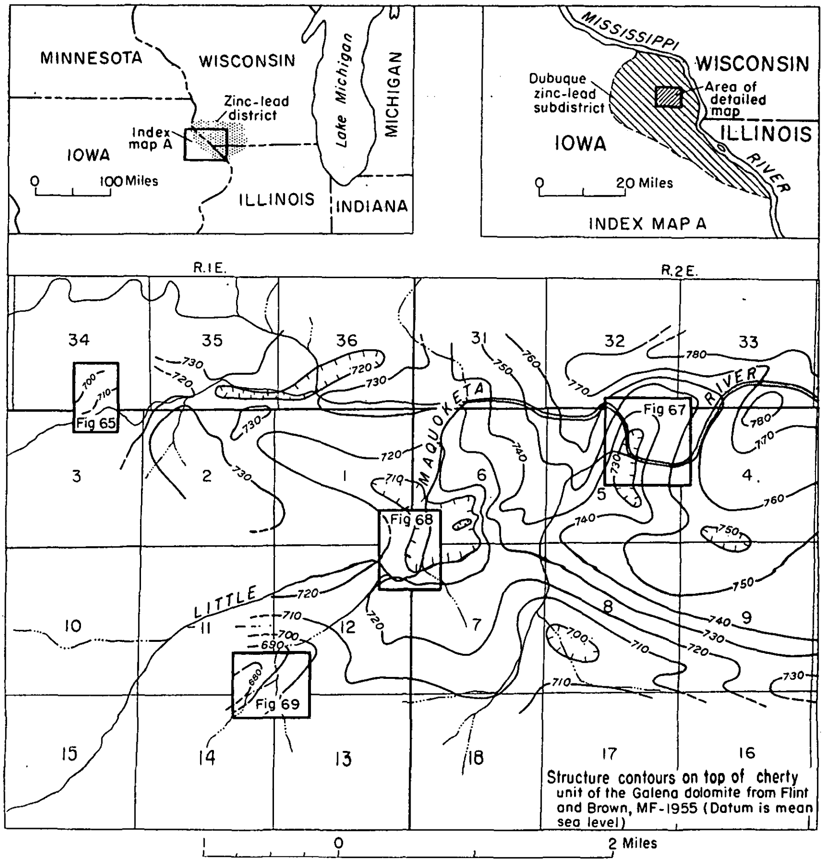


FIGURE 62.—Index maps showing the location of the upper Mississippi Valley zinc-lead district, the Dubuque subdistrict, and the areas shown by detailed maps in this report.

## HISTORY

Mining in the Dubuque subdistrict of the upper Mississippi Valley zinc-lead district began about 1788, although small amounts of lead had been dug by the Indians before that time. Only lead ore was mined until about 1870 when zinc ore also was recovered. From 1833 to 1854 lead production was high throughout the entire upper Mississippi Valley mining district. Statistics for the year 1852 indicate that the district produced 87 percent of the total domestic lead (33,760,000 pounds), and a large part was obtained from the Dubuque subdistrict. In Iowa, only an occasional increase in mining activity interrupted the downward trend in the production of lead from 1858 to 1910, when the last of the important mines in the vicinity of Dubuque was shut down. Since 1910, lead production has been sporadic and of little consequence. Although complete production data are not available, Iowa zinc production, almost entirely as zinc carbonate, appears to have been significant from about 1890 to 1910.

Both the lead and zinc ore came from small, mostly shallow deposits in the middle and upper parts of the Galena dolomite, in contrast with the larger, stratigraphically lower, zinc and lead deposits that have been exploited in the Wisconsin and Illinois parts of the mining district since the late 1800's.

Detailed geologic mapping in Iowa by the U. S. Geological Survey in cooperation with the Iowa Geological Survey was begun in 1951 to determine whether major zinc and lead deposits occur in Iowa similar to those in the Decorah formation and the lower part of the Galena formation of Wisconsin and Illinois. The exploratory program is a part of this larger project.

## ACKNOWLEDGMENTS

The authors acknowledge the fine cooperation of Martin Behnke, Clarence Dietz, C. H. Parker, Frank Krug, Leo Schromen, and Burton Wallis who granted permission to have drilling done on their properties.

## GEOLOGY

The Dubuque subdistrict of the upper Mississippi Valley zinc-lead district is partly in the Driftless Area, an area surrounded but not covered by glacial ice during Pleistocene time. The western boundary of the known mineralized district coincides roughly with the western boundary of that area. Adjacent to the Mississippi River and its large tributaries, maximum local relief is about 300 feet. Valley walls are steep to vertical, and topography is youthful. Away from these streams the upland is an undulating plain of moderate to low relief.

### STRATIGRAPHY

Rocks exposed in the area range in age from Middle Ordovician to Middle Silurian. Figure 63 shows the sequence of the stratigraphic units pertinent to this report.

The oldest exposed beds are gray limestone of the McGregor limestone member of the Platteville formation that crops out in only a few places along the Little Maquoketa and Mississippi Rivers. These strata are generally fine-grained and locally are sublithographic.

Where present in Dubuque County, the Quimbys Mill member of the same formation is a dark-brown sublithographic limestone that contains thin dark-brown shale partings. Some zinc and lead deposits occur in the upper beds of the McGregor member and in the Quimbys Mill member elsewhere in the mineralized district but are not known in the Dubuque subdistrict.

Overlying the Platteville formation are the limestone and shale of the Decorah formation; like the Platteville, the Decorah outcrops are limited to the areas of deepest dissection.

| Formation | Member | Units of local usage | | Description | Thickness (feet) |
|---|---|---|---|---|---|
| Maquoketa shale. | | "Slate." | | Shale, blue-green and brown, and argillaceous dolomite. Phosphatic fossil zone at base. | 100+ |
| Total thickness | | | | | 100+ |
| Galena dolomite. | Dubuque shaly member. | Noncherty unit (117 feet). | Yellow sandy. | Dolomite, yellow-buff, fine-grained, even-bedded, shaly; brown and gray shale partings. | 37 |
| | Stewartville massive member. | | | Dolomite, buff, crystalline, massive. | 34 |
| | Prosser cherty member. | Cherty unit (118 feet). | Drab. | Dolomite, gray-brown, crystalline, mainly thick bedded; cherty in lower 118 feet. | 164 |
| Total thickness | | | | | 235 |
| Decorah formation. | Ion dolomite member. | Gray. | | Limestone and dolomitic limestone, light-brown-gray, mottled, argillaceous; green shale partings. | 14 |
| | | Blue. | | Limestone, medium-gray, very argillaceous; green shale partings; thins to gray-green shale in mineralized areas. | 6-7 |
| | Guttenberg limestone member. | Oil rock. | | Limestone, light-tan, very fine grained; dark-brown shale partings; may thin to as little as 3.5 feet of calcareous brown shale in mineralized areas. | 17 |
| | Spechts Ferry shale member. | Clay bed. | | Shale, gray and green, and gray fine-grained limestone; contains thin bentonite beds. | 7 |
| Total thickness | | | | | 44-45 |
| Platteville formation. | Quimbys Mill member. | Glass rock. | | Limestone, dark-brown, very fine grained; dark-brown shale partings. | 0-1 |
| | McGregor limestone member. | "Trenton." | | Limestone, gray, fine-grained; partly dolomitic. | 22+ |
| Total exposed thickness | | | | | 22+ |

FIGURE 63.—Generalized stratigraphic section of part of the Middle and Upper Ordovician series in the Dubuque subdistrict of the upper Mississippi Valley zinc-lead district.

The Spechts Ferry, the lowest member of the Decorah formation, is composed of shale and fine-grained gray limestone; it contains, locally, sparse disseminated sphalerite and galena, but it is not known to be a host rock for zinc and lead ore in the mining district.

The Guttenberg limestone member of the same formation overlies the Spechts Ferry shale member and is a limestone in the Dubuque subdistrict except where it has been altered by solutions to dolomite. This limestone member is commonly leached and thinned, in and surrounding the mineralized areas. The unit may be thinned by solution from its normal thickness of 17 feet to as little as 3.5 feet. Carbonaceous material is dispersed throughout the Guttenberg and concentrated along bedding planes as brown shale partings; in its leached phase the Guttenberg is little more than a residual carbonaceous shale. Locally, this shale will burn and is called "oil rock" by the miners. The Guttenberg has been an important host rock for zinc and lead ore in the Wisconsin and Illinois part of the mining district but has not been appreciably explored in Iowa.

Above the Guttenberg limestone member is the Ion, the uppermost member of the Decorah formation. Like the Guttenberg, the Ion dolomite member is a limestone in the Dubuque subdistrict except where solutions have altered it to dolomite. The Ion, throughout the mining district, has been divided into two units, the "blue beds" below and the "gray beds" above. The subdivision is based on the amount of argillaceous material in the limestone; clay impurities are more common in the blue beds than in the gray beds. The Ion has been leached and thinned in and near ore bodies. The leached phase is a gray-green shale that is commonly not as well leached or compacted as the underlying member. The Ion strata are very important host rocks for zinc and lead ore in the district but have been tested in only a few places in Iowa.

The Galena dolomite, which overlies the Decorah formation, is composed of three dolomite members, the Prosser, Stewartville, and Dubuque, in ascending order.

The Prosser member is a gray-brown hard crystalline dolomite that contains abundant bedded chert throughout the lower 118 feet. The contact between the cherty and noncherty parts of this member is abrupt, and it is found consistently at the same stratigraphic position. Locally in the Dubuque subdistrict the lower 15 to 20 feet of this member may be limestone.

The Stewartville member is a buff crystalline massive noncherty dolomite.

The Dubuque member is a yellow-buff even-bedded fine-grained argillaceous dolomite. Strata of this member contain many thin brown and gray shale partings.

The Galena dolomite has been an important host rock for deposits of zinc and lead ore, but zinc deposits have been important only in its lower beds in the mining district. In Iowa the lower beds have been tested in only a few places.

Overlying the Galena dolomite is the Maquoketa shale, which is represented topographically by long, gentle slopes between the overlying Silurian scarp and the Galena bluffs. Although the formation contains some zinc and lead sulfides, it is not considered a probable

353799—56——2

host rock for commercial ore bodies. As much as 100 feet of Maquoketa shale is exposed in the area.

Silurian rocks are not present in the area of this study.

### STRUCTURE

The beds in the vicinity of Dubuque have an average dip south-southwestward of 17 feet per mile. Superposed on the regional dip are local undulations with dips substantially more than the average. The structural relief of these local undulations is probably no more than 100 feet in the Dubuque subdistrict. Faults have not been observed in the vicinity of Dubuque, but both faults and shear zones occur elsewhere in the district.

## SULFIDE DEPOSITS IN THE DECORAH AND GALENA FORMATIONS

### CONTROLLING STRUCTURES

Zinc-lead deposits in these formations can be classified on the basis of the structural features that were the primary control of the mineral emplacement. Vertical fractures have controlled ore concentration throughout the Galena dolomite; these fractures are locally called crevices.

Crevice deposits, if their geologic history is interpreted correctly, are in joints that resulted from lateral compressive forces and were developed as tension joints and shear-couple fractures in the dolomite. The most consistent joint trend in the Dubuque subdistrict ranges a few degrees from a due east direction. These joints are parallel to the axes of the large folds that cross the district and appear to be related to them. Less prominent joints trend northeastward. The fractures were conduits through which circulating ground water removed the carbonate material by solution from more soluble beds, widening the joints and forming voids in the rock. Zinc and lead minerals, mainly the latter, were concentrated in the open spaces along the joints; and, although these deposits are nearly all sphalerite and galena, they are small. Most of them contain about 40 to 100 tons of ore. The deposits in the joints widened by solution are confined to the Galena dolomite.

Small synclines or elongate basins and associated inclined fractures in the strata appear to have controlled the localization of the ore in the upper part of the Platteville formation, in the Decorah formation, and locally in the lower part of the Galena dolomite. In most places these fractures occur on the flanks of the downwarped areas and have offset bedding a few inches to a few feet. The fractures, where mineralized, are known throughout the mining district as "pitches," and the associated ore concentrations along bedding planes intersecting them are called "flats" (fig. 64). A pitch may be an uninter-

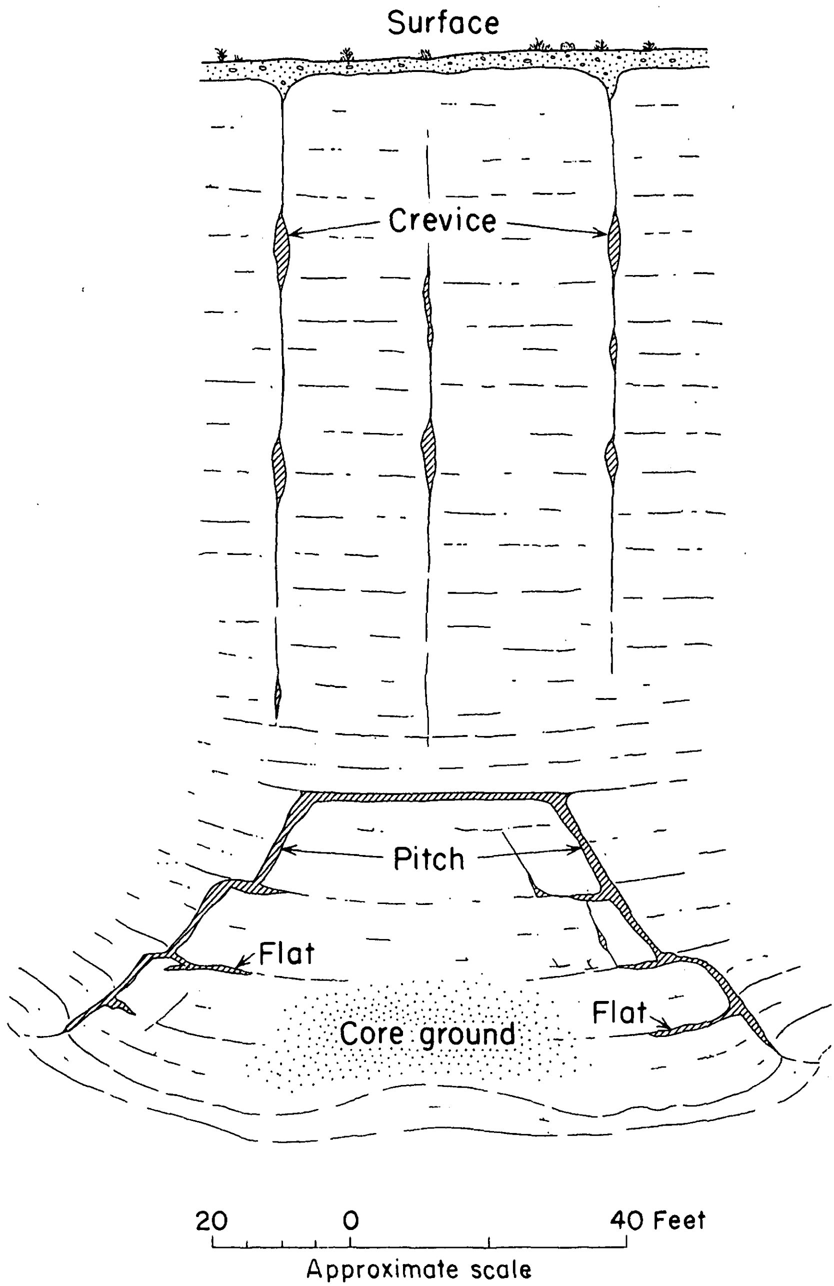


FIGURE 64.—Diagrammatic section showing the characteristic forms of crevice and "pitch-and-flat" ore deposits.

rupted mineralized fracture or it may be offset horizontally at stratification to acquire a steplike appearance. These fractures and intersecting bedding planes evidently have been the channels along which ore solutions traveled and removed a part of the host rock, creating voids in which the ore minerals were deposited. The voids have been enlarged by differential compaction of the argillaceous residues from the leached carbonate rock, particularly in the Guttenberg limestone member, where the strata may be thinned by solution and compaction from their maximum thickness of 17 feet to 3.5 feet. Commonly, two opposing main pitches and several parallel subsidiary pitches are present in an ore body (fig. 64); and the area between them, called "core ground," is generally mineralized. The ore bodies controlled by pitches and flats are primarily zinc-bearing. In Wisconsin and Illinois these deposits are much larger than the ore concentrations in vertical joints in the Galena dolomite. Typical pitch-and-flat deposits are not known in the Dubuque subdistrict, but very little prospecting has been done for them.

## ORE MINERALS AND ASSOCIATED MINERALS

The principal ore minerals are galena (lead sulfide) and sphalerite (zinc sulfide). Other minerals that have been mined in the upper Mississippi Valley zinc-lead district include smithsonite (zinc carbonate), barite (barium sulfate), chalcopyrite (copper-iron sulfide), chalcocite (cuprous sulfide), azurite and malachite (basic copper carbonates), and marcasite-pyrite (iron sulfide), the latter having been roasted to provide sulfur dioxide for the manufacture of sulfuric acid. None of these, except galena and sphalerite, were being recovered in 1953.

Galena, in crevice deposits, occurs mainly as veins along thin open joints or as vug fillings; minor amounts replace the enclosing dolomite. As a rule, the galena in veins or in large vugs has been released from its original position by postmineralization solution of the host rock, which has permitted the galena to fall or slump into clay that is abundant in most crevices.

Associated with galena in crevice deposits are marcasite and pyrite or their oxidation products, calcite, and varying amounts of sphalerite, which has been altered to smithsonite in the oxidized zone. Locally, barite and gypsum are also present.

The sphalerite in pitch-and-flat deposits occurs mainly as veins in the pitch fractures and bedding-plane openings, and commonly is disseminated as small crystals, lining or filling solution vugs in the core ground. A minor amount replaces the enclosing carbonate rock.

Associated with the sphalerite in pitch-and-flat deposits are marcasite and pyrite, varying amounts of galena and calcite, and, locally, barite, chalcopyrite, and very rarely millerite (nickel sulfide).

### ALTERATION OF HOST ROCK

Limestone into which the ore has been introduced is nearly everywhere partly or completely altered to dolomite, and both the limestone and dolomite host rocks are locally silicified. Evidence of dolomitization, silicification, and leaching commonly extend peripherally beyond the ore concentrations—an important aid to prospecting.

## EXPLORATION

### PROCEDURE

Geologic mapping [1] to delineate favorable structures was the first stage of exploration in the program. In this phase of the investigation, outcrops that contained key stratigraphic horizons were surveyed with telescopic alidade and plane table. The altitudes of those key horizons were reduced to a common datum plane, the top of the cherty unit of the Galena. Available subsurface data also were used to compile the preliminary structure maps. In places, contours could be established for only a small part of a particular structure owing to sparseness of outcrops. Stage two involved the locating and drilling of exploratory holes. It was decided to test, with a minimum of holes, several favorable-appearing structures for evidence of mineralization rather than to concentrate the drilling on one structure. Consequently, the limited drilling on each syncline was expected to show no more than the presence or absence of mineralized areas. A great many more test holes would be required to adequately prospect the four structures drilled. Drill-hole locations were spaced 100 to 550 feet apart, depending on the width and relief of the structure, and were alined normal to the axes of the synclines being tested. In one place where surface data were insufficient to define the orientation of the syncline, additional holes were drilled for this purpose.

Exploration was done with cable-tool solid-bit drills. At the end of each 5 feet (in a few places 2½ feet) of drilling the tools were removed and the hole bailed clean, that is, all recoverable cuttings were brought to the surface. A representative sample from each 5-foot interval of drilling was studied under a binocular microscope at 10–30 power magnification, and the descriptive logs that are a part of this report were prepared from these drill cuttings. Samples from significantly mineralized rock were taken from the cuttings for assaying; the grade of other samples was estimated.

[1] Flint, A. E., and Brown, C. E., 1955 Geology and zinc-lead deposits in the Durango area, Dubuque County, Iowa: U. S. Geol. Survey Mineral Investigations Field Studies Map MF 33.

## RESULTS

Four different areas (fig. 62) were drilled during the investigation. No structure was tested with more than five holes, and some were investigated with only two. In three of the four areas, zinc-mineralized strata were penetrated. In addition, marked thinning by solution of Decorah strata, evidence of dolomitization and silicification, and abundant iron sulfide—all considered favorable indicators of nearby zinc-mineralized rock—were found in one or more of the synclines tested. The structures as mapped from outcrops in the middle and upper part of the Galena dolomite were found to reflect structures in the underlying Decorah formation. The magnitude of structural relief, however, and in one locality (see Behnke-Krug area) the orientation of the structure as well, depends on the datum plane used.

### BEHNKE-KRUG AREA

Five exploratory holes were drilled in the Behnke-Krug area in T. 90 N., R. 1 E., 2.5 miles west of Durango, Iowa (fig. 65). The structure to be investigated appeared to trend westward, but because the beds of only the south limb of the fold crop out, its size and orientation could not be determined by surface mapping. For this reason the first three drill holes were located about 150 feet apart at the apices of a triangle to furnish a three-dimensional "view" of the bedding attitude in the favorable stratigraphic zone. Data from the drill holes seem to indicate a northwestward-trending downwarp at the top of the Spechts Ferry shale member but defined also a northeasterly-trending fold at the top of the cherty unit of the Galena, 140 feet higher stratigraphically. Because zinc-mineralized Guttenberg strata were penetrated in the drilling, the lower datum plane was considered to reflect the controlling structure, and hole 4 was located approximately in line with holes 1 and 2 to provide data across the lower syncline. Data from hole 4 indicates that the axis of the syncline is north of that hole. Hole 5 was drilled approximately in line with holes 2 and 3 for data to further clarify the structure.

Two geologic sections, constructed from the drilling information, show the thinned and downwarped nature of the Decorah formation (fig. 66). The drilling data as interpreted show a syncline in the Decorah strata plunging westward. This small-scale structure appears to be caused mostly by thinning by solution in the carbonate beds of the Guttenberg and Ion members of the Decorah formation. It cuts across northwestward-dipping strata indicated by structure contours drawn on the top of the cherty unit of the Galena dolomite. The downwarp produced by the thinned and compacted Guttenberg and Ion members is transmitted upward through the cherty unit, as shown by the inflection in the contours constructed on the top of chert horizon (fig. 65).

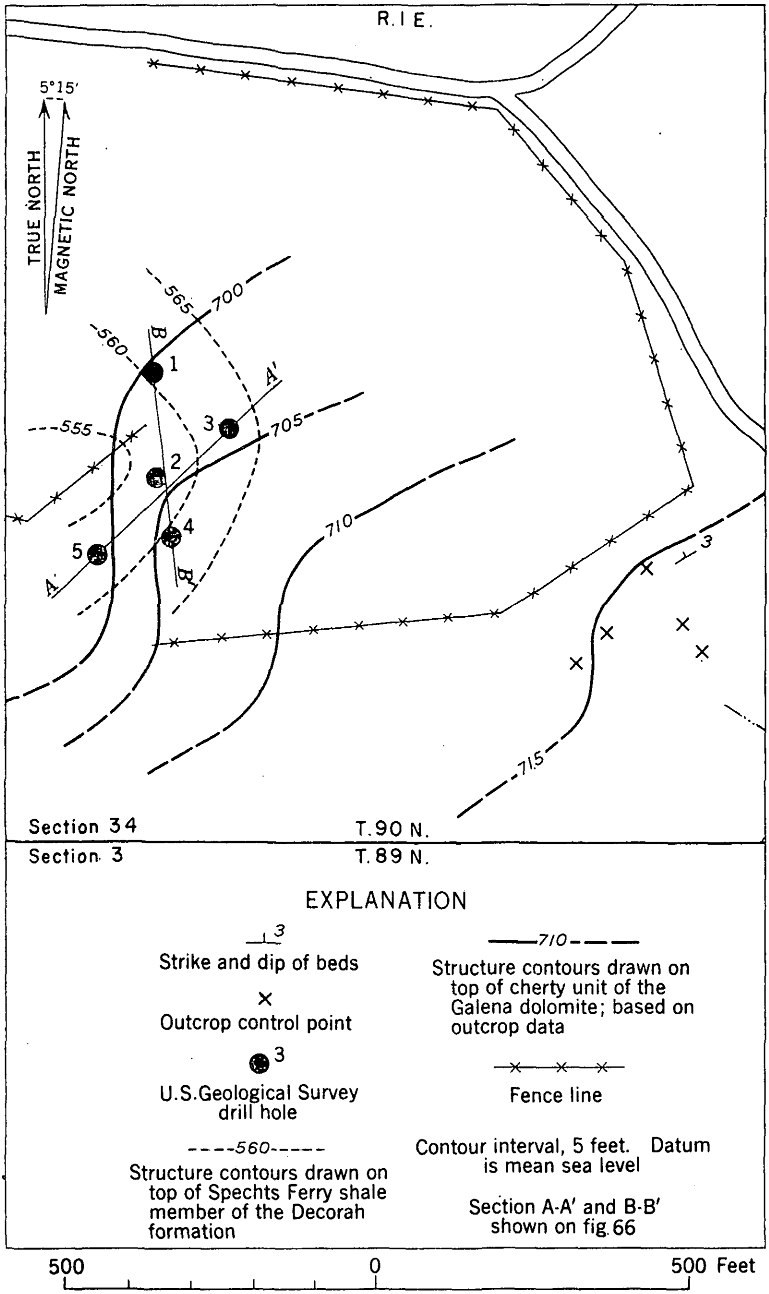


FIGURE 65.—Geologic map showing structure and location of drill holes at the Behnke-Krug area, 2.5 miles west of Durango, Iowa.

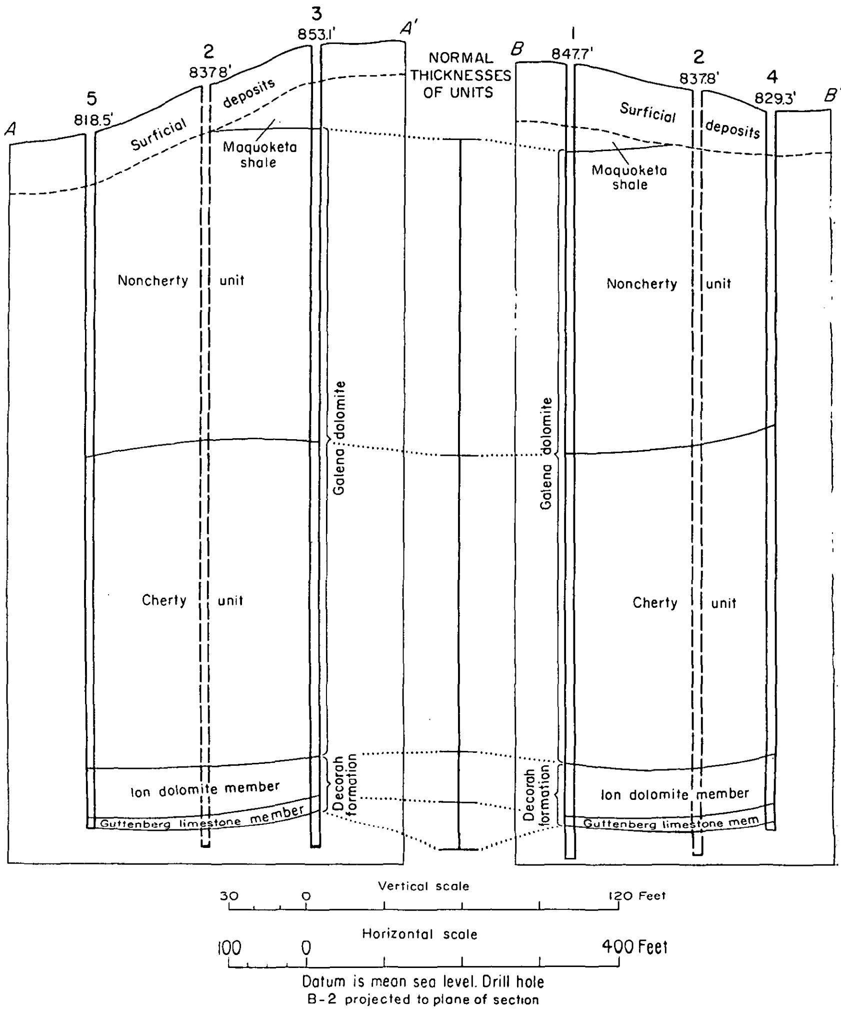


FIGURE 66.—Cross sections of drill holes at the Behnke-Krug area 2.5 miles west of Durango, Iowa. Location of sections *A-A'* and *B-B'* shown on figure 65.

All five exploratory holes were drilled through zinc-mineralized zones in the Decorah formation, and hole 5 also passed through a zinc-mineralized zone extending from 26 to 67 feet above the base of the Galena. Samples from holes 2 and 4 contained the most zinc and ranged in grade from 1.56 to 2.2 percent zinc metal through 5 feet or more of beds. Ore of this grade, although submarginal, is, nevertheless, significant.

The drill samples from the Krug and Behnke holes revealed complete dolomitization of the Guttenberg and Ion members, and considerable silicification and extreme thinning by solution (from a normal thickness of 17 feet to as little as 4 feet) of the Guttenberg limestone member (fig. 66).

### WALLIS AREA

The area termed "the Wallis area" in this report lies 1.4 miles east of Durango, Iowa. Across the area, as interpreted from outcrops, a broad, gentle, arcuate syncline trends northeastward (fig. 67). Mapping indicates that the syncline extends more than a mile southwestward and southward from the Wallis area, but its northeastward extension is not known because of scarce outcrops in the area. Three holes, alined normal to the trend of the structure and spaced 500 to 550 feet apart, were drilled to investigate the syncline.

Wallis 2 was the only hole that was drilled into zinc- and lead-mineralized strata. Drill samples from the Guttenberg limestone

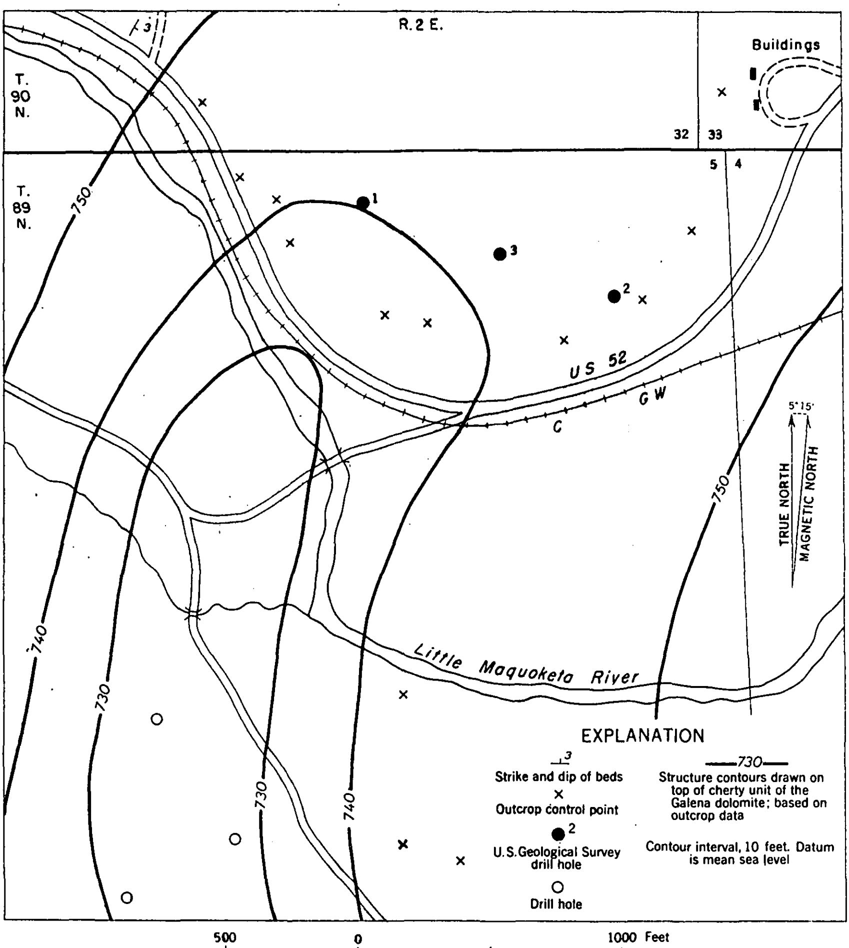


FIGURE 67.—Geologic structure map and location of drill holes at the Wallis area, 1.4 miles east of Durango, Iowa.

member of the Decorah formation were estimated to contain a trace to 1 percent of combined zinc and lead. In all three holes, however, the Guttenberg contains iron sulfide, is substantially thinned, and, in two of the three holes, is partly or completely dolomitized. The common occurrence of calcite-filled vugs and small fractures in the Decorah strata is also considered favorable. The sphalerite in the Guttenberg samples is in the form of very dark small crystals that probably lined vugs in the rock.

Data from the drilling in general verified the structure as interpreted by surface mapping.

### PARKER AREA

A syncline trending N. 75° E. across the "Parker area," 1.2 miles southwest of Durango, (fig. 68) was mapped from nearby bluff exposures; the area is almost entirely in the flood plain of the South Fork of the Little Maquoketa River. Drilling here was intended, first, to test for evidence of zinc and lead mineralization; second, to determine if favorable beds had been removed by stream erosion below the valley fill; and third, to determine if mapped surface structures are due to undetected large-block slumpage in the nearly vertical bluff outcrops. Three drill holes were spaced about 300 feet apart in a line nearly normal to the trend of mapped structure. The upper half of the Ion dolomite member is dolomitized, and thinning in the Guttenberg limestone member is not notable, although the latter was reduced in thickness by as much as 3 feet. Traces of sphalerite are present in the Guttenberg strata in Parker hole 3, and minor amounts of marcasite occur in cuttings of the Guttenberg from Parker holes 1 and 3.

Figure 68 shows the adjustment in structure contours required by the subsurface data. The orientation of the syncline was slightly changed; its structural relief was reduced. The latter is regarded as evidence of subsidence of large blocks in the nearly vertical bluff walls, owing probably to undercutting by stream action.

### DIETZ-SCHROMEN AREA

In the Dietz-Schromen area, 2.4 miles southwest of Durango, two exploratory holes (fig. 69) were located in a line normal to the axis of a northeasterly-trending syncline to explore the southeast limb. Neither hole revealed significant evidence of zinc mineralization. Moreover, the Guttenberg and Ion members of the Decorah formation show little solution effect, are limestone rather than dolomite, and are not silicified. Considerable amounts of iron sulfide occur in the Galena dolomite penetrated in both holes, and the cherty unit of the Galena dolomite appears to be thinned from 118 feet to 88 feet.

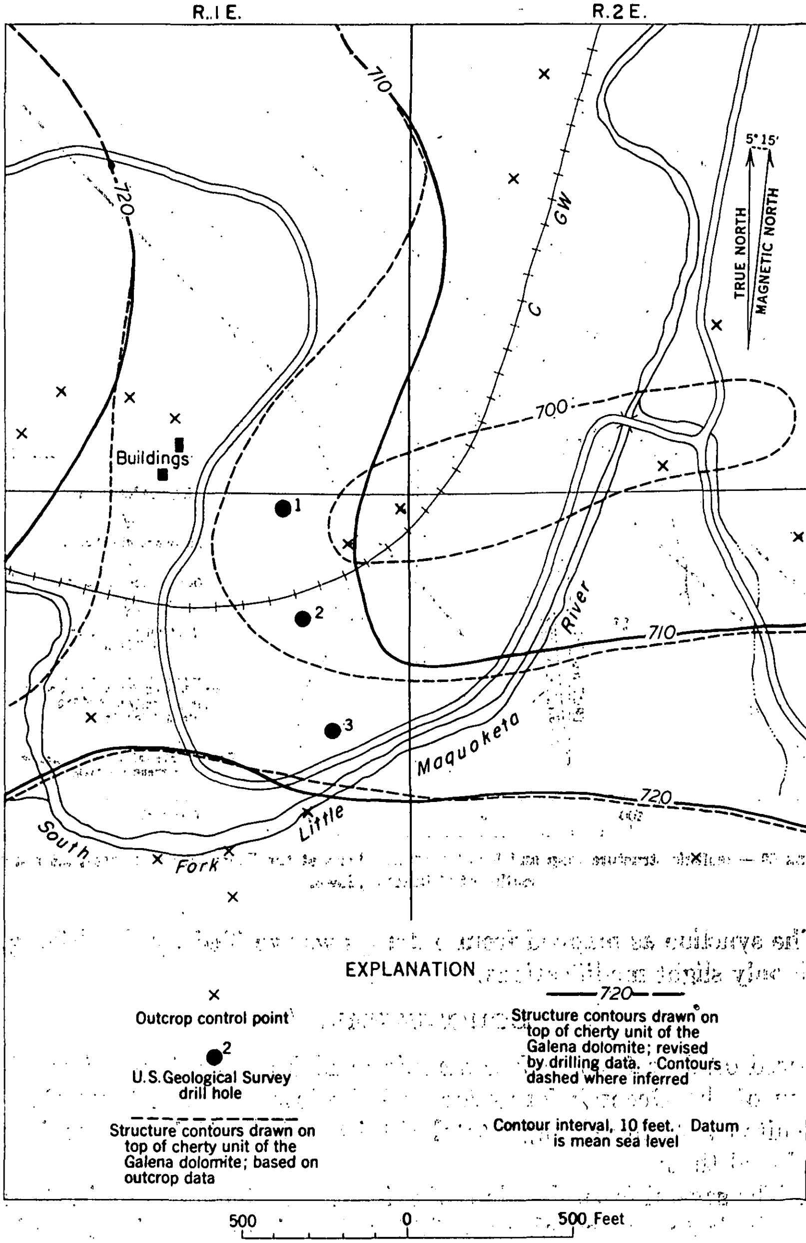


FIGURE 68.—Geologic structure map and location of drill holes at Parker area, 1.2 miles southwest of Durango, Iowa.

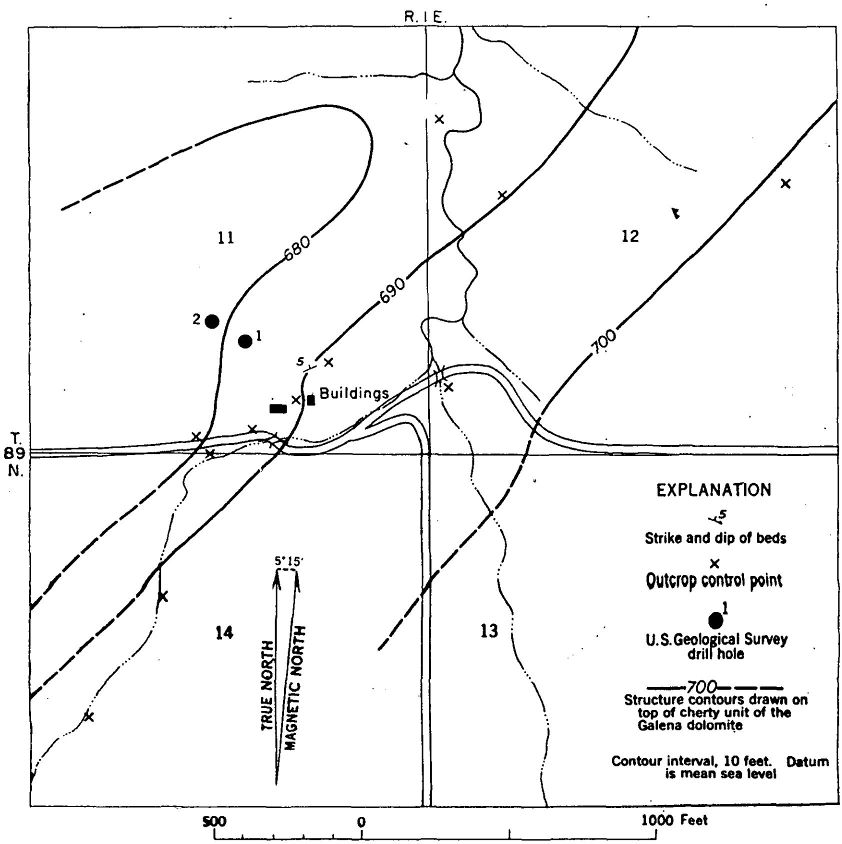


FIGURE 69.—Geologic structure map and location of drill holes at the Dietz-Schromen area, 2.4 miles southwest of Durango, Iowa.

The syncline as mapped from outcrops was verified by the drilling, with only slight modifications.

## CONCLUSIONS

Based on data from surface mapping and from the limited investigation of the Decorah formation and the lower part of the Galena dolomite by churn-drilling, a total of thirteen holes in four areas, it is concluded that:

1. The several favorable lines of evidence of mineralization in these strata indicate a reasonable possibility that zinc ore bodies occur in these stratigraphic units in the Dubuque subdistrict, in Iowa.

2. Structures favorable for ore concentration can generally be delineated by mapping outcrops from 50 to 200 feet higher in the stratigraphic section than the principal ore zone.

3. Because of mass slumpage along bluff outcrops, favorable-appearing structures may be mapped that are not reflected below in

the principal ore zone, and for this reason a syncline interpreted from this type of data should be verified before drilling, if possible, by outcrops or subsurface information in areas away from the bluff outcrops.

## RECORDS OF DRILL HOLES.

*Behnke-Krug area, drill hole 1*

Location: 730 feet north and 10 feet east of the southwest corner of the SE¼ sec. 34, T. 90 N., R. 1 E., Iowa.
Driller: H. Landgraf (0–190 ft) 10/29/52–11/6/52; E. Dietz (190–300 ft) 1/5/53–1/7/53.

| | |
|---|---|
| Collar elevation | 847.7 ft |
| Total depth | 300 ft |
| Depth to water | 95 ft |

Sample study and logging: C. E. Brown.

| | *Depth (feet)* |
|---|---|
| Surficial: Soil, loess, brown shale residuum | 0–24 |
| Maquoketa shale ("slate"): Shale, dolomitic, dark-brown; abundant depauperate fossils lower 2 feet | 24–32 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, gray and buff, medium-grained, argillaceous | 32–35 |
| Dolomite, yellow-buff, argillaceous | 35–70 |
| Dolomite, buff, medium crystalline, partly limonite stained | 70–125 |
| Dolomite, drab and tan, medium crystalline, vuggy; speckled with minute pyrite crystals | 125–147 |
| Cherty unit (drab): | |
| Dolomite, light-brown, slightly disintegrated; leached-white, gray, and drab chert is common | 147–155 |
| Dolomite, tan, medium crystalline, moderately hard; drab to gray chert partly decomposed; disseminated pyrite in the chert | 155–160 |
| Dolomite, medium crystalline, tan; mottled drab, gray, and white chert with very fine disseminated crystals of pyrite | 160–185 |
| Dolomite, light-gray, recrystallized, speckled with pyrite; white-gray chert is sparse | 185–200 |
| Dolomite, gray to tan; trace of green-blue shale partings; gray chert is common | 200–215 |
| Dolomite, tan, medium crystalline; leached-white, gray, and drab chert is common | 215–260 |
| Dolomite as above; chert is sparse | 260–263 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, medium crystalline, vuggy, argillaceous with dark-gray specks; green shale common in lower 5 ft | 263–274 |
| Limestone, dolomitic, gray-blue, medium-grained, argillaceous; calcite is common | 274–284 |
| Guttenberg limestone member (oil rock): Limestone, dolomitic, gray to flesh-colored, medium-grained, silicified in part; much drab to tan argillaceous residuum | 284–288 |
| Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous, and dense gray limestone; phosphatic nodules | 288–295 |
| Platteville formation: McGregor limestone member ("Trenton") Limestone, mottled gray, sugary, fine-grained, fossiliferous | 295–300 |

*Estimated zinc, lead, and iron content in percent*

| Depth | Zinc | Lead | Iron |
|---|---|---|---|
| 185–190 | | | ½–1 |
| 190–215 | | | ½ |
| 275–280 | | | 2 |
| 280–282½ | Trace | | 3 |
| 285–290 | Trace | Trace | 2 |
| 295–300 | | | ½ |

*Behnke–Krug area, drill hole 2*

Location: 20 feet east and 580 feet north of the southwest corner of the SE¼ sec. 34, T. 90 N., R. 1 E., Iowa.
Driller: H. Landgraf, 11/7/52–11/24/52.

Collar elevation ... 837.5 ft
Total depth ... 288 ft
Depth to water ... 90 ft

Sample study and logging: C. E. Brown.

| | *Depth (feet)* |
|---|---|
| Surficial: Soil, loess, and residuum | 0–20 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff, fine-grained, argillaceous | 20–38 |
| Dolomite, yellow-buff, fine-grained, argillaceous; lower 5 ft medium crystalline | 38–55 |
| Dolomite, medium crystalline, buff with limonite-staining | 55–65 |
| Dolomite, buff, medium crystalline | 65–80 |
| Dolomite, buff, hard, finely crystalline; slight limonite-staining in lower 15 ft | 80–115 |
| Dolomite, drab; minute crystals of disseminated pyrite are common | 115–134 |
| Cherty unit (drab): | |
| Dolomite, drab, hard; white to tan chert is sparse | 134–140 |
| Dolomite as above; white to tan chert is common | 140–170 |
| Dolomite, tan to drab, hard; light-gray chert is common; disseminated pyrite in chert | 170–180 |
| Dolomite, light-gray, hard; light-gray chert is sparse | 180–190 |
| Dolomite, tan, hard; gray to white chert is sparse | 190–225 |
| Dolomite as above; drab to gray chert is common | 225–240 |
| Dolomite, light-brown; white chert is abundant | 240–250 |
| Dolomite, buff, medium crystalline; chert is sparse | 250–256 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, gray-drab, argillaceous, medium-grained; green shale partings | 256–268 |
| Dolomite, gray-blue, argillaceous, medium-grained; blue-green shale is common | 268–275 |
| Guttenberg limestone member (oil rock): Dolomite, tan, fine-grained, siliceous; drab clay is abundant | 275–282 |
| Spechts Ferry shale member (clay bed): Shale, blue-green and dense gray limestone | 282–287 |
| Platteville formation: McGregor limestone member ("Trenton"): Limestone, gray, argillaceous | 287–288 |

*Zinc and iron content*

| Depth | Estimated percent | | Assayed percent | |
| --- | --- | --- | --- | --- |
| | Zinc | Iron | Zinc | Iron |
| 140–180 | | ½–1 | | |
| 180–190 | | 1–2 | | |
| 195–205 | | 2 | | |
| 205–210 | | 3 | | |
| 210–225 | | 1 | | |
| 225–235 | | 3 | | |
| 235–265 | | ½–1 | | |
| 265–270 | | 3 | | |
| 270–275 | | 5 | | |
| 275–280 | 1–2 | 5 | 2.20 | 5.50 |
| 280–285 | ½ | 3 | | |
| 285–288 | [1] Trace–½ | 2 | | |

[1] Caved?

*Behnke-Krug area, drill hole 3*

Location: 620 feet north and 135 feet east of the southwest corner of the SE¼ sec. 34, T. 90 N., R. 1 E., Iowa.
Driller: E. Dietz, 1/8/53–1/15/53.
Collar elevation ........ 853.1 ft
Total depth ........ 302 ft
Depth to water ........ 67 ft
Sample study and logging: A. E. Flint.

| | *Depth (feet)* |
| --- | --- |
| Surficial: Soil and loess | 0–13 |
| Maquoketa shale ("slate"): Shale, mainly dark brown and gray, slightly calcareous siltstone | 13–32 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff and gray, mainly fine grained, partly argillaceous; limonite is sparse | 32–55 |
| Dolomite, buff, fine-grained and crystalline; crevice clay is sparse | 55–60 |
| Crevice clay, red-brown; much limonite staining, no indurated rock | 60–70 |
| Dolomite sand, buff, limonite-stained; no indurated rock | 70–80 |
| Dolomite, buff, fine- to medium-grained, leached and soft, with sparse limonite staining | 80–95 |
| Dolomite, buff, finely to medium crystalline, hard | 95–128 |
| Dolomite, drab, finely to medium crystalline, slightly leached | 128–149 |
| Cherty unit (drab): | |
| Dolomite as above; gray and brown glassy chert is common to abundant; marked leaching at 185–190 ft; iron sulfide disseminated in both chert and dolomite at 185–215 ft | 149–215 |
| Dolomite as above; chert is generally sparse, but very common at 225–230 ft | 215–245 |
| Dolomite as above; gray chert is common to abundant | 245–260 |
| Dolomite, drab and buff, finely to medium crystalline; chert is sparse | 260–267 |

| | Depth (feet) |
|---|---|
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, gray, mottled, soft | 267–276 |
| Dolomite, dark-gray, mottled; gray shale is abundant | 276–283 |
| Guttenberg limestone member (oil rock): Dolomite, brown, fine- to medium-grained, partly silicified | 283–289 |
| Spechts Ferry shale member (clay bed): Shale, gray, and gray dolomite and dolomitic limestone | 289–296 |
| Platteville formation: McGregor limestone member ("Trenton"): Dolomite, gray, fine-grained | 296–302 |

*Estimated zinc, lead, and iron content, in percent*

| Depth | Zinc | Lead | Iron |
|---|---|---|---|
| 30–40 | | | 1 |
| 40–45 | | Trace | Trace plus |
| 125–135 | | | trace |
| 165–185 | | | Trace plus |
| 185–200 | | | ½ |
| 200–235 | | | Trace plus |
| 235–240 | | | ½ |
| 240–250 | | | Trace plus |
| 250–270 | | | ½ |
| 270–275 | | | 6 |
| 275–285 | Trace | | 8 |
| 285–290 | 1½ | | 6 |
| 290–295 | ½ | | 4 |
| 295–300 | Trace plus | | 2 |
| 300–302 | | | 2 |

*Behnke-Krug area, drill hole 4*

Location: 35 feet east and 470 feet north of the southwest corner of the SE¼ sec. 34, T. 90 N., R. 1 E., Iowa.
Driller: E. Dietz, 1/16/53–1/21/53.

| | |
|---|---|
| Collar elevation | 829.3 ft |
| Total depth | 273 ft |
| Depth of water | 65 ft |

Sample study and logging: A. E. Flint.

| | Depth (feet) |
|---|---|
| Surficial: | |
| Soil and loess | 0–10 |
| Residual brown shale and buff dolomite | 10–15 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff and gray, fine-grained, argillaceous | 15–45 |
| Dolomite, buff, mainly finely to medium crystalline | 45–115 |
| Dolomite, drab, finely to medium crystalline | 115–120 |
| Cherty unit (drab): | |
| Dolomite as above; gray and brown chert is sparse | 120–125 |
| Dolomite as above but chert is abundant | 125–165 |
| Dolomite as above; chert is sparse to common; disseminated iron sulfide in dolomite at 165–175 ft | 165–185 |
| Dolomite as above; chert is abundant at 185–190 ft, sparse to common at 190–220 ft | 185–220 |
| Dolomite as above; chert is common to abundant | 220–235 |
| Dolomite, drab and gray-buff, finely to medium crystalline; chert is sparse | 235–242 |

| | Depth (feet) |
|---|---|
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, gray, mottled, finely to medium crystalline | 242–257 |
| Dolomite, dark-gray, very argillaceous, soft; gray clay is common | 257–261 |
| Guttenberg limestone member (oil rock): Limestone and dolomitic limestone, tan, mainly fine grained, soft; brown shale is common | 261–268 |
| Spechts Ferry shale member (clay bed): Shale, green and gray, and gray fine-grained limestone | 268–273 |

*Zinc and iron content*

| Depth | Estimated percent | | Assayed percent zinc |
|---|---|---|---|
| | Zinc | Iron | |
| 75–90 | | Trace | |
| 100–165 | | Trace | |
| 165–175 | | ½ | |
| 175–220 | | Trace | |
| 220–225 | | ½ | |
| 225–252½ | | Trace plus | |
| 252½–257½ | Trace | 1 | |
| 257½–260 | Trace plus | 5 | |
| 260–262½ | 1 | 12 | |
| 262½–265 | 2-3 | 5 | 1.56 |
| 265–267½ | 1-2 | 4 | 0.78 |
| 267½–270 | ½ | 2 | |
| 270–273 | ¼ | 2 | |

*Behnke-Krug area, drill hole 5*

Location: 80 feet west and 440 feet north of the southwest corner of the SE¼ sec. 34, T. 90 N., R. 1 E., Iowa.
Driller: E. Dietz, 1/22/53–1/26/53.
Collar elevation: 818.5 ft
Total depth: 262.5 ft
Depth to water: 50 to 60 ft
Sample study and logging: C. E. Brown.

| | Depth (feet) |
|---|---|
| Surficial: Soil, loess, and highly decomposed dolomite residuum | 0–20 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff, argillaceous, fine-grained; partly light gray | 20–25 |
| Dolomite, buff, argillaceous, moderately soft | 25–40 |
| Dolomite, buff, medium crystalline, partly recrystallized | 40–100 |
| Dolomite, drab, medium to coarsely crystalline, vuggy; disseminated pyrite specks | 100–121 |
| Cherty unit (drab): | |
| Dolomite, drab to gray, recrystallized, vuggy; gray chert is sparse | 121–125 |
| Dolomite, drab to buff, moderately soft, vuggy; gray-white to drab chert is common | 125–150 |
| Dolomite, drab to gray, medium crystalline, partly vuggy; gray chert is abundant | 150–165 |
| Dolomite as above, very vuggy; chert is sparse | 165–170 |
| Dolomite, drab to buff, medium crystalline, moderately hard; leached white chert is common | 170–185 |
| Dolomite, tan to buff, medium crystalline, moderately hard; drab to buff and leached white chert is common, chert is sparse from 195–205 ft | 185–220 |
| Dolomite as above; drab and leached white chert is common | 220–230 |
| Dolomite as above; chert is sparse | 230–237 |

Decorah formation: *Depth (feet)*

Ion dolomite member (gray beds and blue beds):

Dolomite, light-gray, calcitic, argillaceous with dark-gray flecks, medium crystalline ---- 237–250

Dolomite, medium-gray, mottled, very argillaceous; quartz grains are sparse ---- 250–256

Guttenberg limestone member (oil rock): Dolomite, flesh-colored, medium crystalline, very vuggy; siliceous fossil fragments abundant; brown shale abundant in lower 4 ft ---- 256–262

Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous, and dense gray limestone ---- 262–262½

*Zinc, lead, and iron content*

| Depth | Estimated percent | | | Assayed percent | |
|---|---|---|---|---|---|
| | Zinc | Lead | Iron | Zinc | Iron |
| 125–140 | | | ½–1 | | |
| 165–170 | | | 1 | | |
| 170–195 | Trace–½ | | Trace–½ | | |
| 195–200 | ½ | | Trace | 1.15 | |
| 200–205 | Trace–½ | | Trace | | |
| 205–210 | ½ | | Trace | .77 | |
| 210–235 | Trace | | Trace | | |
| 235–250 | | | ½–1 | | |
| 250–255 | Trace | | 10 | | |
| 255–257½ | ½ | Trace | 6 | | |
| 257½–260 | (1) | Trace | (1) | .72 | 6.08 |
| 260–262½ | (1) | Trace | 2 | .92 | |

1 Samples were studied after these assays were made; therefore, estimates were made by referring to assayed samples.

*Wallis area, drill hole 1*

Location: 1,350 feet west and 200 feet south of the northeast corner of sec. 5, T. 89 N., R. 2 E., Iowa.

Driller: H. Landgraf, 12/1/52–12/11/52.

Collar elevation ---- 801.6 ft

Total depth ---- 210 ft

Depth to water ---- 195 ft

Sample study and logging: C. E. Brown.

*Depth (feet)*

Surficial: Soil, loess, and residuum ---- 0–15

Galena dolomite:

Noncherty unit (yellow-sandy):

Dolomite, yellow-buff, crystalline ---- 15–45

Dolomite, buff, medium crystalline ---- 45–61

Cherty unit (drab):

Dolomite as above; tan chert with red iron-oxide specks is sparse ---- 61–65

Dolomite as above; drab to tan chert is abundant ---- 65–80

Dolomite as above; slight limonite staining; leached white chert is common ---- 80–85

Dolomite, yellow-brown; chert is sparse ---- 85–90

Dolomite, buff; white chert common; clear calcite is sparse ---- 90–105

Dolomite as above; leached white chert is sparse ---- 105–150

Dolomite as above; slight limonite staining; white chert is very abundant; clear calcite is common ---- 150–170

Dolomite, coarsely crystalline; calcite is common ---- 170–175

Decorah formation:

| | Depth (feet) |
|---|---|
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, buff, crystalline, vuggy; green shale partings are common; clear calcite is common | 175–188 |
| Dolomite, blue-gray, mottled, argillaceous; blue-green shale is common; clear calcite is abundant | 188–195 |
| Guttenberg limestone member (oil rock): Dolomite, medium-grained light-brown; brown shale is common; disseminated iron-sulfide | 195–204 |
| Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous; dense fossiliferous gray limestone is abundant; clear calcite is common; pyrite is sparse | 204–210 |

*Estimated iron content in percent*

| Depth | Iron |
|---|---|
| 190–195 | ½ |
| 195–200 | 3 |
| 200–205 | 1 |
| 205–210 | ½ |

*Wallis area, drill hole 2*

Location: 570 feet south and 425 feet west of the northeast corner sec. 5, T. 89 N., R. 2 E., Iowa.
Driller: H. Landgraf, 12/13/52–12/24/52.

| | |
|---|---|
| Collar elevation | 759.5 ft |
| Total depth | 165 ft |
| Depth to water | 130 ft |

Sample study and logging: C. E. Brown.

Galena dolomite:

| | Depth (feet) |
|---|---|
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff, medium crystalline, limonite-stained | 0–10 |
| Dolomite, buff, hard, recrystallized, limonite-stained | 10–17 |
| Cherty unit (drab): | |
| Dolomite, yellow-brown, hard, crystalline; light-tan chert is sparse | 17–23 |
| Dolomite, light-brown, medium crystalline, partly limonite stained; white and drab chert, common | 23–55 |
| Dolomite as above; white chert is sparse | 55–60 |
| Dolomite, buff, fine- to medium-grained; drab chert is common | 60–70 |
| Dolomite, buff, crystalline, partly decomposed; chert fragments are sparse | 70–85 |
| Dolomite, buff, limonite-stained; white chert fragments common; clear calcite common | 85–95 |
| Dolomite, buff, recrystallized, limonite-stained; chert is sparse | 95–110 |
| Dolomite, calcitic, buff, limonite-stained; white and drab chert is abundant | 110–125 |
| Dolomite, calcitic, light-brown, medium crystalline; chert is sparse | 125–134 |

Decorah formation:

| | |
|---|---|
| Ion dolomite member (gray beds and blue beds): | |
| Limestone, dolomitic, argillaceous, buff with black specks; green shale partings are common | 134–147 |
| Limestone, dark- and light-gray, mottled, argillaceous | 147–156 |

| | Depth (feet) |
|---|---|
| Decorah formation—Continued | |
| Guttenberg limestone member (oil rock): Limestone, light-brown, very fine grained, fossiliferous; brown shale is abundant | 156–164 |
| Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous, and dense gray limestone | 164–165 |

*Estimated zinc, lead, and iron content, in percent*

| Depth | Zinc | Lead | Iron |
|---|---|---|---|
| 155–160 | ½–1 | ½–1 | ½–1 |
| 160–164 | ½–1 | Trace–½ | 1 |
| 164–165 | | | ½–1 |

*Wallis area, drill hole 3*

Location: 420 feet south and 880 feet west of the northeast corner sec. 5, T. 89 N., R. 2 E., Iowa.
Driller: H. Landgraf, 1/11/53–1/29/53

| | |
|---|---|
| Collar elevation | 794.9 ft |
| Total depth | 195 ft |
| Depth to water | No water |

Sample study and logging: C. E. Brown.

| | Depth (feet) |
|---|---|
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, buff, medium crystalline; partly decomposed | 0–10 |
| Dolomite, buff, moderatley soft, medium crystalline | 10–53 |
| Cherty unit (drab): | |
| Dolomite, buff, medium crystalline, normally hard; white to pink chert is sparse | 53–60 |
| Dolomite, buff, medium crystalline; pink chert is common | 60–65 |
| Dolomite, buff, moderately soft, partly limonite stained; white to cream-colored chert is common | 65–90 |
| Dolomite, buff, slight limonite stains, fine- to medium-grained; chert is sparse | 90–95 |
| Dolomite as above; pink to white chert is common | 95–115 |
| Dolomite as above; white chert is common to abundant | 115–140 |
| Dolomite as above; white chert is common to abundant | 140–160 |
| Dolomite, buff, recrystallized, vuggy; chert is very sparse | 160–168 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, calcitic, buff, gray-specked; greenish-buff argillaceous partings | 168–181 |
| Limestone, blue-gray, very argillaceous, medium-grained; calcite and pyrite specks | 181–188 |
| Guttenberg limestone member (oil rock): Limestone, dolomitic, flesh-colored, fine-grained; brown carbonaceous shale; brown chert is sparse | 188–193 |
| Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous, and dense gray limestone | 193–195 |

*Estimated iron content, in percent*

| Depth | Iron |
|---|---|
| 190–195 | 1–2 |

*Parker area, drill hole 1*

Location: 375 feet west and 25 feet south of the northeast corner sec. 12, T. 89 N., R. 1 E., Iowa.
Driller: E. Dietz, 12/12/52–12/16/52.

| | |
|---|---|
| Collar elevation | 713.0 ft |
| Total depth | 148 ft |
| Depth to water | 70 ft |

Sample study and logging: A. E. Flint.

| | *Depth (feet)* |
|---|---|
| Surficial: | |
| Soil | 0–5 |
| Loess | 5–27 |
| Residual dolomite, sand, and chert | 27–31 |
| Dolomite, buff, fine- to medium-grained, partly decomposed, probably talus | 31–55 |
| Galena dolomite: | |
| Cherty unit (drab): | |
| Dolomite, buff, finely to medium crystalline, soft; buff clay common | 55–60 |
| Dolomite and clay as above, slight ocher staining; gray-white chert common; angular quartz sand grains and other glacial material is sparse | 60–70 |
| Dolomite and chert as above | 70–85 |
| Dolomite as above but very soft; light-gray and white leached chert is common; slight ocher staining; crevice clay at 85–105 ft | 85–108 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite and dolomitic limestone, gray, mottled; very argillaceous | 108–125 |
| Limestone, gray, mottled, very argillaceous; blue-green shale, common; disseminated iron sulfide in limestone, common | 125–131 |
| Guttenberg limestone member (oil rock): Limestone, light-tan, mainly fine grained; sparse disseminated iron sulfide; calcite is sparse | 131–145 |
| Spechts Ferry shale member (clay bed): Shale, gray and green, and gray mainly fine-grained limestone with disseminated iron sulfide common in both shale and limestone | 145–148 |

*Estimated iron content, in percent*

| *Depth* | *Iron* |
|---|---|
| 125–130 | ½ |
| 130–148 | Trace plus |

*Parker area, drill hole 2*

Location: 300 feet west and 350 feet south of the northeast corner, sec. 12, T. 89 N., R. 1 E., Iowa.
Driller E. Dietz, 12/16/52–12/22/52.

| | |
|---|---|
| Collar elevation | 659.2 ft |
| Total depth | 110 ft |
| Depth to water | 10 ft |

Sample study and logging: A. E. Flint.

| | *Depth (feet)* |
|---|---|
| Surficial: | |
| Soil | 0–4 |
| Stream deposit, mainly glacial sand and pebbles | 4–50 |
| Residual Galena dolomite, glacial sand, and abundant chert | 50–60 |

| | Depth (feet) |
|---|---|
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): Limestone, gray, mottled, partly dolomitic, very argillaceous | 60–78 |
| Guttenberg limestone member (oil rock): Limestone, light-tan, fine-grained, fossiliferous; sparse brown shale | 78–94 |
| Spechts Ferry shale member (clay bed): Shale, green and tan-gray, and gray fine-grained limestone; phosphatic nodules and disseminated iron sulfide common | 94–102 |
| Platteville formation: McGregor limestone member ("Trenton"): Limestone, gray, fine-grained, dolomitic | 102–110 |

*Parker area, drill hole 3*

Location: 205 feet west and 700 feet south of the northeast corner sec. 12, T. 89 N., R. 1 E., Iowa.
Driller: E. Dietz, 12/22/52–1/3/53.

| | |
|---|---|
| Collar elevation | 660.5 ft |
| Total depth | 95 ft. |
| Depth to water | 10 ft |

Sample study and logging, A. E. Flint.

| | Depth (feet) |
|---|---|
| Surficial: | |
| Soil | 0–6 |
| Stream deposits of chert, glacial sand, and pebbles | 6–55 |
| Stream deposits of glacial sand and decomposed buff dolomite | 55–65 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Dolomite, mottled gray, finely to medium crystalline, argillaceous | 62–70 |
| Limestone, dark-gray, mottled, finely to medium crystalline; gray and green shale, common | 70–78 |
| Guttenberg limestone member (oil rock): Limestone, tan, fine-grained, fossiliferous, and sparse brown shale | 78–92 |
| Spechts Ferry shale member (clay bed): | |
| Limestone, gray, fine-grained, and green shale | 92–95 |

*Estimated zinc and iron content, in percent*

| Depth | Zinc | Iron |
|---|---|---|
| 65–70 | Trace | Trace plus |
| 70–75 | Trace plus | 1 |
| 75–80 | Trace plus | ½ |

*Dietz-Schromen area, drill hole 1*

Location: 630 feet west and 380 feet north of the southeast corner sec. 11, T. 89 N., R. 1 E., Iowa.
Driller: E. Burg, 11/3/52–11/14/52.

| | |
|---|---|
| Collar elevation | 804.7 ft |
| Total depth | 255 ft |
| Depth of water | 55 ft |

Sample study and logging: C. E. Brown.

| | Depth (feet) |
|---|---|
| Surficial: Dark-brown soil, loess, and residuum | 0–10 |
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, light-gray, fine-grained, argillaceous; calcite common | 10–20 |
| Dolomite, gray fine-grained, argillaceous, partly crystalline; clear calcite, sparse | 20–38 |
| Dolomite, buff, crystalline, soft, slight limonite stains | 38–70 |

| | Depth (feet) |
|---|---|
| Galena dolomite—Continued | |
| Noncherty unit—Continued | |
| Dolomite, gray-buff, medium crystalline, partly vuggy, hard | 70–110 |
| Dolomite, tan, medium crystalline, vuggy; limonite stains lower 5 ft | 110–120 |
| Cherty unit (drab): | |
| Dolomite as above; sparse, white, leached chert | 120–125 |
| Dolomite, tan, crystalline grains of sand, very soft; chert common, selectively limonite stained, also as gray grains with disseminated pyrite | 125–130 |
| Dolomite as above; chert as above very abundant | 130–140 |
| Dolomite, buff to tan, harder than above; light-gray and white chert, partly limonite stained, very abundant | 140–145 |
| Dolomite, buff to light-brown, soft, crystalline; light-gray and dark-gray chert with very abundant disseminated pyrite | 145–170 |
| Dolomite, tan to buff, hard, specked with disseminated pyrite, slight limonite staining; very abundant chert as above | 170–200 |
| Dolomite, light-gray to buff, vuggy, medium crystalline; abundant chert as above | 200–208 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): Limestone, light-gray to buff, argillaceous, hard; sparse green shale; calcite common | 208–220 |
| Limestone, gray with dark-gray patches, medium-grained, argillaceous, moderately soft; green shales, common | 220–227 |
| Guttenberg limestone member (oil rock): Limestone, whitish-tan, partly fine grained, earthy, argillaceous; brown shale common in lower 7 ft | 227–243 |
| Spechts Ferry shale member (clay bed): Shale, blue-green, fossiliferous; dense gray limestone | 243–251 |
| Platteville formation: McGregor limestone member ("Trenton"): Limestone, gray, granular, argillaceous | 251–255 |

*Estimated zinc and iron content, in percent*

| Depth | Zinc | Iron | Depth | Zinc | Iron |
|---|---|---|---|---|---|
| 10–25 | | Trace | 175–185 | | 1–2 |
| 25–40 | Trace | Trace | 185–190 | | ½–1 |
| 40–145 | | Trace | 190–205 | | 1–2 |
| 145–150 | | 2 | 205–215 | | ½–1 |
| 150–170 | | 4 | 215–220 | | Trace |
| 170–175 | | 3 | | | |

*Dietz-Schromen area, drill hole 2*

Location: 740 feet west and 430 feet north of the southeast corner sec. 11, T. 89 N., R. 1 E., Iowa.
Driller: E. Burg, 11/15/52–12/5/52.

| | |
|---|---|
| Collar elevation | 818.7 ft |
| Total depth | 267 ft |
| Depth to water | 70 ft |

Sample study and logging: C. E. Brown.

| | Depth (feet) |
|---|---|
| Surficial: Soil, loess, and residuum | 0–20 |
| Maquoketa shale ("slate"): Shale, dark-brown, carbonaceous; depauperate fossils common in lower 3 ft; calcite common | 20–26 |

| | Depth (feet) |
|---|---|
| Galena dolomite: | |
| Noncherty unit (yellow-sandy): | |
| Dolomite, gray-buff, fine-grained, argillaceous; calcite common | 26–50 |
| Dolomite, gray and buff, partly crystalline, argillaceous; slight limonite straining lower 5 ft | 50–65 |
| Dolomite, buff, finely to medium crystalline | 65–90 |
| Dolomite, buff and drab, crystalline | 90–100 |
| Dolomite, tan and drab, finely to medium crystalline | 100–140 |
| Cherty unit (drab): | |
| Dolomite, buff to tan, slight limonite staining; sparse gray chert with disseminated pyrite | 140–145 |
| Dolomite, buff to tan; white chert common | 145–155 |
| Dolomite, drab, slight limonite staining; dark-gray and leached white chert abundant; disseminated pyrite common | 155–175 |
| Dolomite, drab, hard; abundant chert as above | 175–185 |
| Dolomite, tan to drab, hard; chert as above | 185–205 |
| Dolomite, gray-drab, hard; sparse chert | 205–220 |
| Dolomite, tan; abundant white chert | 220–228 |
| Decorah formation: | |
| Ion dolomite member (gray beds and blue beds): | |
| Limestone, light-gray, medium crystalline, dark-brown argillaceous partings | 228–242 |
| Limestone, gray, mottled with dark specks, argillaceous; green shale partings | 242–250 |
| Guttenberg limestone member (oil rock): Limestone, light-tan, fossiliferous, fine-grained, hard; brown shale common | 250–265 |
| Spechts Ferry shale member (clay bed): Shale, blue-green; gray, dense limestone | 265–267 |

*Estimated zinc and iron content, in percent*

| Depth | Zinc | Iron | Depth | Zinc | Iron |
|---|---|---|---|---|---|
| 25–30 | ½ | 3 | 145–150 | | 3 |
| 30–35 | Trace | 1 | 150–155 | | 2 |
| 110–120 | | 1 | 155–175 | | 3 |
| 120–125 | | 1–2 | 175–185 | | 1 |
| 125–130 | | 2–3 | 185–220 | | Trace-1 |
| 130–135 | | 3 | 230–235 | | 1 |
| 135–140 | | 1–2 | 235–240 | | 2 |
| 140–145 | | ½ | 250–260 | | 1 |

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