EXPLORATORY DRILLING PROGRAM OF THE U. S. GEOLOGICAL SURVEY FOR EVIDENCES OF ZINC-LEAD MINERALIZATION IN IOWA AND WISCONSIN, 1950-51
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By Allen F. Agnew, Arthur E. Flint, and John W. Allingham

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ABSTRACT

The Upper Mississippi Valley zinc-lead district covers 2,500 square miles of Wisconsin, Illinois, and Iowa. It is one of the oldest mining districts in the United States, as lead mining by settlers began in 1788. Zinc has been mined since 1859, and the present production is more than ten times that of lead.

The Tete des Morts area, Iowa, and the Highland area, Wisconsin, were selected for exploratory drilling to determine the possibility of zinc-lead mineralization that might be economically recoverable. The program described here was carried out in two areas at the margin of the district. Twenty-five holes that totalled 7,466 feet were drilled in 1950-51. In the
Tete des Morts area, Iowa, the drilling showed lithology, structure, and evidences of mineralization that are favorable indications of the possible existence of pitch-type lower-run ore bodies; it showed a lateral extension of the potentially productive part of the district. In the Highland area, Wisconsin, lithology and evidences of mineralization found in strata of the Prairie du Chien group indicate that this unit might warrant further investigation as a potential source of ore at a lower stratigraphic position than that now being prospected in the main part of the zinc-lead district, farther south. Drilling in beds of the Prairie du Chien showed a vertical extension of the potentially productive part of the district.

INTRODUCTION

Purpose and scope of exploration

The exploratory drilling program of the U. S. Geological Survey in Iowa and Wisconsin in 1950 and 1951 was part of a continuing comprehensive geologic investigation of the zinc-lead district (figs. 1 and 2) that began in 1942. The principal purpose of the drilling was to provide geologic data related to the over-all objective of extending laterally (geographically) and vertically (stratigraphically) the favorable indications of and known potentials for zinc and lead ore (Agnew and Heyl, 1947, p. 228.)

The southern limit of current activity in the Wisconsin-Illinois-Iowa mining district is the Black Jack-Bautsch fold, an ore trend (fig. 2) a few miles south of Galena, Ill. Because the currently mined ore bodies are large and rich and were discovered during recent years as a result of new geological ideas regarding the occurrence of ore, it was proposed to explore an area in Iowa, just to the west of the Black Jack-Bautsch mines. Answers to several geologic questions were sought:

1. Is the lithology of the Tete des Morts area similar to that in the Black Jack-Bautsch trend 5 miles to the east?
2. Are structural features (Willman and Reynolds, 1897, pp. 14-15) similar?
3. Are products of mineralization similar?

Thus, the exploration in the Tete des Morts area was primarily an attempt to indicate a geographic, or lateral extension of the main ore-bearing zone of the zinc-lead district.

Lead and zinc minerals in the Lower Ordovician Prairie du Chien group have been found in several localities, particularly in the northern part of the mining district (Heyl, Lyons, and Agnew, 1951). In the Highland area, surface indications of lead mineralization in the Prairie du Chien group are particularly abundant, and a deep shaft had been sunk in this area to mine lead ore. Furthermore, lead was in short supply when the Geological Survey program was being planned. The drilling in the Highland area, therefore, was an attempt to obtain information regarding the (1) stratigraphic occurrence, (2) structural relations, and (3) mineralogic relations of lead in the Prairie du Chien group. It was an attempt to extend vertically the zinc-lead district—the search for a stratigraphically lower-producing zone.

Preliminary geologic studies in the Tete des Morts and Highland areas were made in the summer of 1950 in order to choose the most promising localities for drilling. Five properties were selected, and 28 holes were drilled by cable-tool rigs between September 10, 1950, and May 25, 1951; the holes aggregated 7,466 feet of drilling.

History and mineral production of district

The zinc-lead district in Wisconsin, Illinois, and Iowa is one of the oldest mining areas in the United States. The lead mines in the Dubuque area were among the earliest worked by white men, beginning in 1788 with Dubuque's Concession. The annual production of lead increased rapidly in the late 1820's and reached a maximum of about 27,000 tons of lead metal in the middle 1840's, when the district contributed 85 to 90 percent of the lead produced in the United States. Lead mining in this district declined gradually until 1878, when the annual output was less than 5,000 tons.

Zinc production did not begin until 1859, as before that time no market existed. In 1859 zinc carbonate and in 1867 zinc sulfide were first mined, and by 1873 zinc sulfide had replaced zinc carbonate as the district's major ore. By 1872 zinc production was about twice that of lead. The zinc-lead ratio increased only slightly until World War I when it suddenly became about 20 to 1 in 1917, and the peak of zinc output from this district was more than 64,000 tons of zinc metal. By 1930 most of the large mining companies had left the district, and for the next 10 years zinc-lead production was generally low until the demands of World War II rejuvenated zinc-lead activity in 1941. Several large mining companies entered the district after 1944, and a large program of exploration and mining is now under way. Mines in the district produced about 1,120,000 tons of zinc metal from 1859 to 1947 and about 815,000 tons of lead metal from 1800 to 1947.

Previous geologic work

The mining district was studied intermittently but rather thoroughly by government survey parties from 1836 until about 1916. From 1916 to the late 1920's the geologic investigations were carried out by company geologists. During the 1930's research by faculty and students of universities nearby kept geologic interest alive; however, except for the work of Behre (1939), these studies were directed toward specific phases of geology rather than general investigations of the entire district.

Numerous publications resulted from the previous geologic work, but an adequate resume or bibliography is not within the scope of this brief report.

Acknowledgments

The Wisconsin Geological and Natural History Survey supplied part of the funds for the supervision of the drilling program.

C. W. Tandy, Jr., aided by surveying during the preliminary geologic investigations of the two areas.
Figure 1.—Index map showing the location of the Wisconsin-Illinois-Iowa zinc-lead mineralized district.

Figure 2.—Map showing the location of the Tete des Morts and Highland areas and the Black Jack-Bautsch trend.
GENERAL GEOLOGY OF THE DISTRICT

Much of the bedrock in the Wisconsin-Illinois-Iowa zinc-lead district is covered with a mantle of Pleistocene and Recent loess as much as 35 feet thick. The sedimentary rocks exposed in the district range from Early Ordovician to Middle Silurian in age. A generalized summary of the rocks, compiled from outcrop and drill-hole data, is as follows:

<table>
<thead>
<tr>
<th>System</th>
<th>Formation</th>
<th>Dominant Lithology</th>
<th>Average Thickness (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silurian system</td>
<td>Kankakee limestone of Savage (1916)</td>
<td>Dolomite, chert</td>
<td>150+</td>
</tr>
<tr>
<td></td>
<td>Edgewood limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordovician system</td>
<td>Maquoketa shale</td>
<td>Shale, dolomite</td>
<td>105-200</td>
</tr>
<tr>
<td></td>
<td>Galena dolomite</td>
<td>Dolomite, chert</td>
<td>220-230</td>
</tr>
<tr>
<td></td>
<td>Decorah formation</td>
<td>Limestone, dolomite, chert.</td>
<td>35-45</td>
</tr>
<tr>
<td></td>
<td>Platteville Formation</td>
<td>Limestone, dolomite, shale.</td>
<td>55-75</td>
</tr>
<tr>
<td></td>
<td>St. Peter sandstone</td>
<td>Sandstone</td>
<td>280-320</td>
</tr>
<tr>
<td></td>
<td>Prairie du Chien group</td>
<td>Dolomite, chert, shale, sandstone.</td>
<td></td>
</tr>
<tr>
<td>Cambrian system</td>
<td>Trempealeau formation</td>
<td>Dolomite, sandstone, siltstone.</td>
<td>120-150</td>
</tr>
<tr>
<td></td>
<td>Franconia sandstone</td>
<td>Sandstone, siltstone, sandstone.</td>
<td>110-140</td>
</tr>
<tr>
<td></td>
<td>Dresbach sandstone</td>
<td>Sandstone, siltstone</td>
<td>800-1000</td>
</tr>
</tbody>
</table>

The zinc-lead district lies on the south side of the Wisconsin pre-Cambrian high (Thwaites and Howell, 1935); it is just west of the structural extension southward toward the LaSalle anticline in Illinois (Thwaites, Howell, and Jones, 1935). The strata of the district have been gently flexed and broken. Although the folds are of small amplitude and are generally local, general axial trends can be traced for several miles. These trends are north-eastward and north-westward; eastward folds of similar continuity are less common. Faults are of relatively small magnitude and are of three general types—reverse, normal, and tear. Dip-slip displacement on the reverse faults is less than 6 feet, but strike-slip displacement on the tear faults is known to be at least 35 feet and may be as much as 200 feet or more.

Solution effects that accompanied the zinc-lead mineralization accentuated the tectonic structural features and altered the lithologic features of the rocks. Depositions of zinc-lead are found mainly in the lower part of the Galena dolomite ("drab" of local usage), the Decorah formation ("gray," "blue," "oil rock," and "clay bed" of local usage), and the upper part of the Platteville formation ("glass rock" and "Trenton" of local usage). Lead was recovered from vertical joint crevices in the upper, noncherty part of the Galena dolomite. The galena in these "upper-run" deposits occurred as isolated crystals (dice lead) or clusters (cog lead) in a matrix of dolomite sand, as veins (sheets) less than an inch thick, and as pods several feet wide. Podlike forms of ore were present in "openings" (Whitney, 1858, p. 438) at favorable stratigraphic horizons. At one or more of these horizons, similar podlike enlargements occurred at intervals along a crevice. At intersections of crevices, "chimneys" or pipes of galena were sometimes found. Individual crevices were mined for lengths as much as 1,700 feet.

In the lower, cherty part of the Galena dolomite, in beds of the Decorah formation, and in the upper part of the Platteville formation zinc and some lead ore deposits were mined from reverse faults (pitches) and associated bedding-plane faults (flats) in the limbs of synclines. In one of these "lower-run" ore bodies the minerals replaced the rock and filled vugs, constituting a "brangle" (solution-breccia zones of dolomite blocks cemented by sphalerite and marcasite-pyrite) type of ore in the "core ground," which lies on the footwall side of and extends to within a few feet of the pitch. The ore bodies were as much as 30 feet or more high (in the Black Jack mine more than 120 feet), 100 feet or more wide, and 3,500 feet or more long, although the average length was perhaps 1,000 feet.

The Prairie du Chien group constitutes a lower, potentially ore-bearing zone, as in a few places in the northern part of the district galena has been mined from dolomite beds in the upper part of the unit.

THE TETE DES MORTS AREA, IOWA

The Tete des Morts area is in southeastern Dubuque County and northeastern Jackson County, Iowa (fig. 2). The area in which drilling was done is about 1 square mile and is bounded on the northeast by the Mississippi River. Relief is about 160 feet, and the upland is under cultivation.

Lead ore was mined in this area by the Indians, and its occurrence was briefly described by Owens (1840),
Platteville formation consists of light-brown dolomite, this formation. In this hole the lower part of the penetrates in only one hole, Schenk 1, which cut about 75 feet. The McGregor (Pecatonica dolomite member), overlying thin green shale (Glenwood shale member). The McGregor limestone member is a gray limestone in Schenk holes 1 to 3, which penetrated its entire thickness. The uppermost member of the Platteville, the Quimbys Mill member or "glass rock" of local usage, is limestone except in Kohlenberg hole 2, where part of the rock is dolomitic limestone. A trace of pyrite in the "glass rock" unit in Schenk hole 7 is the only indication that the rocks of the Platteville formation were mineralized. The Decorah formation, which averages 43 feet in thickness, consists of four units. The lowest, or Spechts Ferry shale member, is green shale; the middle, or Gutenberg limestone member, is brown limestone and shale, called "oil rock"; and the upper two, which constitute the I on dolomite member, are gray and dark-gray limestone (dolomite in Schenk holes 4 through 9) and shale.

In the Tete des Morts area the Galena dolomite, 225 feet thick, is dolomite throughout, except on the Kohlenberg property where the lower 25 to 30 feet contain as much as 90 percent limestone and dolomitic limestone. The lack of limestone in the Galena dolomite on the Schenk property shows that the dolomite is due apparently to dolomitization associated with mineralization, for, if it were due to regional dolomitization, these beds on the Kohlenberg land would also have been dolomitized. Several "openings" occur in the Galena dolomite in the Dubuque, Iowa, area 15 miles to the northwest and in the Galena, Ill., area 5 miles northeast of the Tete des Morts area; the stratigraphic positions of these openings are shown in figure 3. Galena is the common mineral in the openings, but in the Dubuque area sphalerite and marcasite-pyrite are reported from openings that lie below the water table. The openings in the upper, noncherty unit of the Galena dolomite are commonly filled with clay and dolomite sand. However, the "upper flint" opening, the "lower flint" opening, and the mineralized zone (here named the lower Receptaculites opening) that lies 20 to 30 feet above the base of the Galena dolomite are commonly brangle zones. Even though it has great length, the opening type of deposit is relatively narrow, and prospecting for this type of ore zone by vertical drilling is likely to be disappointing.

No Maquoketa shale was penetrated in the holes drilled. In Schenk hole 5, however, phosphatic pebbles similar to the material of the depauperate zone occurring at the base of the Maquoketa shale were found below the surficial material; so the basal contact of the Maquoketa was probably within a few feet of the depth at which it was logged. Lithologic information for the Maquoketa (fig. 3) was derived mainly from the study of samples from a well drilled about 2 miles to the south (W. H. Felderman, W 1/2 SE 1/4 sec. 15, T. 87 N., R. 4 E., Iowa). A capping of loess as much as 35 feet thick is present on the uplands.

Structure. —One of the major reasons for the selection of the Tete des Morts area was the occurrence of favorable structures.
Figure 3. — Stratigraphic column of the Tete des Morts area, Dubuque and Jackson Counties, Iowa.
A structure contour map (pl. 1) of the top of the cherty unit of the Galena dolomite, prepared before drilling, showed two synclines that appeared to join near the center of the W½ of sec. 3. Drilling corroborated the presence of both synclines. The northeastward-trending syncline is thought to be the extension of the Galena-Shullsburg syncline and has much more relief than the narrower northwestward-trending one, which is like the Black Jack-Bautsch fold.

Evidence of mineralization

Indications of solution-thinning of the "oil rock" (middle part of Decorah formation) and the "glass rock" (upper part of Platteville formation) were seen in cuttings from one of the holes (Schenk 4), drilled near the pitch zone noted previously.

Although lines of lead shafts and "sucker holes" (diggings) were found, they are thought to be related to mining of the vertical or near-vertical "upper-run" (in the noncherty unit of the Galena dolomite) or crevice deposits and were not given any weight in the planning of the drilling because the purpose of this program was to explore the "lower-run" or pitch-and-flat type of ore body.

Holes 1 through 6 on the Schenk property (sec. 3) were spotted, on 125-foot centers, to cut across the southeastern projection of the pitch zone in the Tete des Morts River. They were drilled on the northeast limb of the northwestward-trending structure. Iron minerals were the only significant evidence of mineralization in Schenk holes 1 through 6. Holes 2, 3, and 5 showed an estimated 3.5 to 4.7 percent iron for a thickness of 16 to 39 feet (pl. 2). All the holes except no. 4 had traces of zinc, and hole 3 had a trace of lead. The iron minerals were found at the stratigraphic position of the upper and lower flint openings. As this position is in the upper part of the pitch-type ore bodies farther north and east, the occurrence of the iron is interpreted as a favorable indication of the possible existence of pitch-type lower-run ore bodies in the Tete des Morts area. Although no pitch-type fractures were found in the drilling, the existence of solution-thinning of the "oil rock" and "glass rock" with associated concentration of shaly material found in Schenk hole 4 is believed to justify further exploration for lower-run zinc-lead deposits.

Holes 7 through 9 on the Schenk property were aligned across the gently dipping southeast limb of the northeastward-trending syncline. In hole 7, iron deposition similar to that in holes 2, 3, and 5 was discovered at the same stratigraphic position as in holes 1 through 6. In addition, a mineral identified as one of the manganese oxides was present at this position of the upper flint opening. This cross section, holes 7 through 9, showed less promise than the one for holes 1-6.

The alignment of holes drilled on Kohlenberg's property crossed the northwestward-trending syncline. Hole 1 showed iron deposition estimated at 3 percent for 15 feet at the position of the lower Receptaculites opening, which is near the base of the Galena dolomite. Hole 2 showed traces of zinc, and hole 4 showed the manganese mineral, noted in Schenk hole 7, in the "gray" beds of the Decorah formation.

The significance of the manganese mineral is not known; however, the iron in Kohlenberg hole 1 is interpreted as a favorable indication of the possible existence of pitch-type lower-run ore bodies in the Tete des Morts area.

All holes drilled in the Tete des Morts area were completed to the desired depth at or near the base of the "glass rock" except Kohlenberg hole 1, which was bottomed in the "gray" beds of the Decorah. In the lower part of this hole, from 215 to its total depth of 244 feet, a joint with a strong flow of water caused such drilling and sampling difficulties that the hole was abandoned.

Recommendations

The exploratory work here described showed structure, lithology, and type and position of mineralized zones that are interpreted as favorable indications of the possible existence of pitch-type lower-run ore bodies. The Tete des Morts and surrounding area thus constitute a potential extension of the mining district and further exploratory work is recommended.

Outcrop mapping is recommended as a means of locating geologic structures along the Mississippi River bluff, the Tete des Morts River, and other areas where exposures are numerous and structural control is good. Where such geologic data are not available, it is recommended that favorable structure be prospected for by means of drilling, preferably using either a grid, or a series of cross sections across syncline trends.

Although the ore bodies are localized along structural trends, not all such trends bear ore bodies, and any one trend can have both ore-bearing and lean or blank areas. Thus, the structural picture must be used only as a guide in finding ore, not as a certain indication of ore.

Furthermore, it is recommended that any exploratory program, in this or similar new areas in the district, be planned to include an adequate number of drill holes. Recent experience by mining companies in the district has shown that limited drilling can give only insufficient information regarding any ore discoveries and often it unjustly condemns an area.

THE HIGHLAND AREA, WISCONSIN

The Highland area (fig. 2) in west-central Iowa County and the adjoining part of Grant County, Wis., includes about 5 square miles. The village of Highland lies in the northeast corner of the area. Maximum topographic relief is approximately 300 feet. The uplands are under cultivation; the valley slopes and narrow stream flood plains are grasslands.

Zinc and lead ores in this area have been mined from Middle Ordovician rocks of the Platteville, Decorah, and Galena formations and lead ore has been taken from Lower Ordovician rocks of the Prairie du Chien group. The formations that contain these two ore-bearing zones are separated by the Middle Ordovician St. Peter sandstone (fig. 4). Because this part of the exploration by the Geological Survey was concerned with the lower ore zone, evidence of mineralization
Limestone, fine- and medium-grained, fossiliferous

Dolomite, gray to buff, medium-grained; phosphatic nodules at base

Shale, green to gray, arenaceous. Phosphatic nodules and iron sulfide common

Sandstone, quartz, rounded, fine-to medium-grained, coarse at top and base

(Deposited in solution channels in underlying rocks)

Dolomite, light-brown, fine-to medium-grained; local glauconite, quartz sand; shale, light-green upper 2-3 feet; chert sparse

Dolomite, as above; chert abundant; oolites and glauconite, quartz sand lenses

Dolomite, as above; sparse chert; local shale and quartz sand

Dolomite, as above; arenaceous and argillaceous; and sandstone, dolomitic

Dolomite, light brownish-gray, mainly medium-grained; local glassy chert

Dolomite, as above; chert glassy and porcellaneous, very abundant. Lead sulfide locally

Dolomite, as above; chert, as above, moderate to sparse

Dolomite, as above; chert, as above, abundant; abundant iron sulfide in middle of zone

Dolomite, as above; chert, sparse to absent. Local shale and quartz sand lenses middle and lower part of zone. Abundant iron sulfide in middle of zone

Dolomite, light-to medium-brown, mainly medium-grained; chert glassy, moderate to abundant; oolites common

Dolomite, light-brown, fine- and medium-grained; lower 15 feet arenaceous, colitic, glauconitic; chert sparse; sandstone, dolomitic, common near base

Sandstone, white, fine-to medium-grained; green shale partings and dolomitic cement locally common

Cryptozoon may occur locally throughout the upper 155-165 feet of the Prairie du Chien formation.

Figure 4.—Stratigraphic column of the Highland area, Grant and Iowa Counties, Wis.
in the Prairie du Chien rocks only is discussed. Most of the lead ore from this unit was mined from about 1850 to 1880, and no records of production are available. Areas of diggings (pl. 3) are relatively extensive, more so in the Highland vicinity than in other places where ore has been mined from the Prairie du Chien strata.

The Ohlerking mine, near the center of the W4SE4 sec. 31, T. 7N., R. 1E., produced only lead ore. It was operated through a shaft about 180 feet deep, from which about 275 feet of drift was driven (Chamberlin, 1882, pp. 516-517). Although the amount of lead ore recovered is not known, this was the largest operation in the lower ore zone.

A preliminary survey of the geology of the area, including the examination of the old mine dumps, was made by Flint before drilling began. A geologic and structural map (pl. 3) based on information gathered during this survey was used for determining the location of the drill holes. The topography was the only other important factor governing the exact location of the holes.

Stratigraphy

Upper Cambrian.—The Upper Cambrian Trempealeau formation is not exposed in the area mapped in the vicinity of Highland but crops out 3 miles north. The upper Trempealeau strata are sandstone. They consist of white fine and medium subangular to subrounded quartz grains. Green shale partings separate the irregular thin sandstone beds.

Lower Ordovician.—The Lower Ordovician Prairie du Chien group, which includes the mineralized zones explored by drilling, conformably overlies the Upper Cambrian Trempealeau formation and crops out in the northern half of the Wisconsin-Illinois-Iowa mining district in the more deeply dissected stream valleys. Where observed in the Highland area, this group is from 50 to 215 feet thick. Farther west a middle sandstone unit separates the dolomite strata of the group and permits its division into three formations. An attempt was made to extend this threefold division into the area covered by this report; however, because of incomplete knowledge of detailed Prairie du Chien stratigraphy throughout the mining district, it was not possible to identify positively the middle formation (fig. 4 and pl. 4), if it is present in the Highland area. From the base upward the three formations have been called the Oneota dolomite, New Richmond sandstone, and Shakopee dolomite. Recent study by-Flint, however, has shown that these members are not mappable units either in the Highland area or generally in the Wisconsin-Illinois-Iowa zinc-lead district.

The Oneota dolomite is mainly a brown-gray medium-grained crystalline dolomite. Chert is common in abundant 30 to 40 feet above the base and in the upper half of the member. Oolitic textures appear near the base in both the chert and dolomite. Glauconite is common as a minor constituent of the rock. Algal (cryptophyta) structures occur locally throughout the formation, and near the base two algal zones are persistent. Lenses of quartz sandstone and arenaceous dolomites occur locally throughout the Oneota, but except in the lower 20 feet, approximately, the quartz represents only a small percentage of the total rock. Banded chalcedony and drusy quartz line vugs in both the dolomite and chert. Shale is present locally throughout the Oneota but does not seem to occupy particular stratigraphic zones. Iron sulfide, mainly pyrite, is a common constituent of the rock.

In the Highland area the unit designated as New Richmond sandstone is an arenaceous shaly bed about 5 feet thick. In the one exposure where this bed is readily identified, a dolomitic sandstone layer about 1 foot thick is present. The sand is medium to coarse in size and very similar to sand grains of the St. Peter sandstone, which is described below.

The Shakopee dolomite is more argillaceous and arenaceous than the Oneota. Algal structures are common. The beds are generally thin and irregular. Shaly and sandy strata are common; locally chert is very abundant, and much of it is oolitic.

Middle Ordovician.—The Prairie du Chien group is overlain by the St. Peter sandstone. Where observed in the Highland area, this formation is from 48 to 221 feet thick. The sandstone is white to buff, mainly medium grained, but coarse at the top and near the base of the formation. The St. Peter is unmineralized except for local iron sulfide concentrations.

Above the St. Peter sandstone, the Platteville formation has the thin Glenwood shale member at its base; the Glenwood is overlain by the Pecatonica dolomite member, which is overlain by the McGregor limestone member, the highest stratigraphic unit penetrated by drilling.

A mantle of residual boulders, sand, clay, and soil, which is as much as 5 feet thick, covers the area.

Results of geologic mapping

Evidences of mineralization.—Considerable float galena in many of the stream beds in the E4 sec. 31 and the NW4 sec. 32, T. 7 N., R. 1 E., and in the SW1/4 NW1/4 sec. 6, T. 6 N., R. 1 E. was found by field investigation of the area before drilling. Much of the galena was not broken up and appeared to be near its source. In a sharp ravine in the northwest corner of sec. 32, T. 7 N., R. 1 E., galena was found in place, where it is associated with a brown-red clay. The dolomite beds are thin and irregular and are warped upward into a small dome, the top of which has been eroded away exposing the mineral.

In the quarry in the NW1/4 SW1/4 sec. 32 some galena was recovered as a byproduct in the quarrying activities. The lead mineral here occurs near and in a honeycombed chert layer 2 to 3 feet thick. Galena filling the voids in large free chert blocks may be seen near the entrance to the quarry. Abundant float galena occurs in the stream valley in the SW1/4 SW1/4 sec. 31, T. 7 N., R. 1 E., and a lesser amount is in the stream valley in the SW1/4 SW1/4 sec. 6, T. 6 N., R. 1 E. Two occurrences of galena seen in outcrops are in a zone 110 to 125 feet below the top of the St. Peter sandstone. A third occurrence also seen in an outcrop is in a zone 140 to 150 feet below the top of the St. Peter.
The pits and caved shafts of mines other than the Ohlerking mine appear to have been no deeper than 30 or 40 feet; in fact, most were very shallow and seem to have been dug to recover only residual galena concentrated at the bedrock surface.

Where galena is seen in outcrops, it is associated with thick chert layers and with solutional thinning of beds.

No zinc mineral was found in any of the exposures.

**Structure.** The upper surface of the St. Peter sandstone was chosen as the datum plane for structure contours because of the exceedingly irregular surface of the Prairie du Chien group. Much of this irregularity is primary and not a reflection of warping and flexing of the strata after deposition of the Prairie du Chien. However, the relief on the upper surface of the St. Peter sandstone is believed to represent adjustment to stresses applied to the strata, and these adjustments account for the fractures that localize mineralization.

As seen on the map of the Highland area (pl. 3), the basic structure is a southward-dipping homoclinal. Superposed on it are northeastward-trending minor corrugations that may be purely superficial because stream dissection has produced moderately steep-walled valleys, and the resulting mass movement of both surficial material and the sandstone bedrock may account for the minor warping. Furthermore, the trend of this minor structure locally tends to parallel the topography. Nevertheless, this structure was prospected because areas of float galena and old lead diggings seem to be located along its trend and because such gentle structures localize mineral deposits in the upper ore zone in the main part of the mining district. Groups of drill holes aligned normal to the trend of the corrugated structure were drilled at three places (pl. 3).

**Results of exploratory drilling**

Twelve exploratory holes were drilled between February 22 and May 17, 1951, five on the Steil property, N ½ sec. 6, T. 6 N., R. 1 E., five on the Williams property, SE ¼ sec. 31, T. 7 N., R. 1 E., and two on the West property, SE ¼ sec. 29, T. 7 N., R. 1 E. (pl. 3). Samples were taken of cuttings recovered from each 5 feet of drilling and were examined through a binocular microscope. (Summary logs are included on pp. 11-36.)

Three holes penetrated zones containing galena, samples of which assayed as high as 1.2 percent lead, and traces of galena were found in samples from other holes (pl. 4 and summary logs, pp. 11-36). Zinc sulfide in present in the samples only as traces. Iron sulfide is a common constituent of Prairie du Chien rocks, and significant amounts are present in samples from all the exploratory holes except Steil 3 which penetrated the very thick St. Peter sandstone and only 46 feet of dolomite beds of the Prairie du Chien group. Concentrations of iron sulfide occur in two general zones, one being 150 to 160 feet below the top of the St. Peter, the other 195 to 205 feet below that surface. Several samples were estimated to contain more than 10 percent iron sulfide, and an estimate that iron sulfide comprised as much as 26 percent of one of the samples was corroborated by assay. The iron sulfide seems to increase slightly in amount from northwest to southeast in each property as is shown in the cross sections prepared from drill-hole data. This trend is significant because in the upper mineralized zone in the main part of the mining district the larger zinc deposits commonly have an iron sulfide halo that extends peripherally for some distance beyond the zinc ore.

At least two periods of chert emplacement are indicated. The earlier chert, which is similar to that common in the Prairie du Chien over a wide area, is glassy and is commonly gray or brown; the later chert is porcelaneous, white or cream, and is seen in the cuttings to have partly or completely replaced the dolomite. In some of the exploratory holes the later chert seems to be associated with the iron deposits. Considerable drusy quartz and banded chalcedony occur locally in the dolomite and chert. Late dolomite is present in the vugs also. No obvious relation was noted between the late dolomite, the quartz, and the zones mineralized with iron sulfide, although one may exist.

The general knowledge of Prairie du Chien stratigraphy has been augmented by data from the drilling. Oolite zones and more poorly defined zones of abundant and sparse chert (pl. 4) were recognized in the study of the samples. Changes in lithology and rock textures were observed, and it was established that the New Richmond sandstone cannot be distinguished with certainty in the Highland area. The drilling indicated that, as in the southern and central parts of the district, the lithology of the Prairie du Chien rocks varies laterally in short distances.

**Recommendations**

Continued district-wide study of Prairie du Chien stratigraphy is desirable. At present not enough data regarding these strata in and near the mining district are available to locate and describe persistent zones and stratigraphic markers. Stratigraphic factors affected emplacement of lead and zinc in the Galena-Decorah-Plateville ore zone, and probably the same is true of mineral zones in the Prairie du Chien. Thus a detailed knowledge of the stratigraphy of the mineral-bearing rocks is an important and necessary consideration for prospecting in this group.

Although some galena-bearing rock was penetrated in the area drilled, no conclusions about the presence or absence of zinc and lead ore in the Prairie du Chien strata, generally, can be drawn from the limited drilling described in this report.

**Future investigation of mineral deposition in the Prairie du Chien in the Highland area should include:**

1. Additional drill holes southeastward along the lines of the exploratory holes drilled in 1950-51. Such drilling may provide data on the increasing concentration of iron sulfide in that direction and on the structural possibilities in these localities.
2. The cleaning out of the shaft and inspection of the old Ohlerking mine workings. The shaft reaches a depth at which it should penetrate the zones of iron deposition recorded in the drill holes on the Williams property. Examination of stopes and drifts in this mine should reveal structural and stratigraphic controls, and the manner of mineral emplacement. Such information can be obtained only partly by drilling.

LITERATURE CITED


Schenk 1

Location: 3,470 ft north, 1,510 ft east of southwest corner, sec. 3, T. 87 N., R. 4 E., Iowa.


Collar elevation: 702.4 ft.

Total depth: 362 ft.

Depth to water: 45,137 1/2 ft.


### Surficial:

- Soil, loess, dark-brown, silty .................. 0 - 35 1/2

### Galena dolomite:

#### Noncherty unit:

- Dolomite, light yellowish-buff, medium-granular, in part crystalline, cinnamon-specked .... 35 - 57 1/2
- Dolomite, orange-brown, coarsely crystalline .... 57 1/2 - 70
- Dolomite, light-brown .... 70 - 92 1/2
- Dolomite, as above, in part medium-granular .... 92 1/2 - 100

#### Cherty unit:

- Dolomite, as above; chert, estimated as 30 percent or less ........ 132 1/2 - 155
- Dolomite, drab to brown, coarsely crystalline; drab chert, estimated as 10 percent or less .......... 155 - 167 1/2

### Decorah formation:

#### Ion dolomite member ("gray" and "blue" beds):

- Dolomite, light-gray, coarsely crystalline, silty, black-specked ........ 236 - 246
- Dolomite, brown, coarsely crystalline, black-specked; dark-gray, medium-crystalline, and coarsely crystalline mottled dark-gray dolomite ...... 246 - 255

#### Ion and Guttenberg members:

- Limestone, gray, dolomitic, very black specked and mottled; sandy with fine to medium quartz and fine phosphate nodules; brownish-gray coarsely crystalline slightly dolomitic sandy limestone; light-brown coarsely crystalline mottled and specked limestone; fossiliferous .......... 255 - 260

#### Guttenberg limestone member ("oil rock"):

- Dolomite, brown, fine- to medium-crystalline, mottled-brown; fossiliferous ..... 260 - 262 1/2
- Limestone, brown to light-brown, finely crystalline, dense, red-specked; fossiliferous .......... 262 1/2 - 275

#### Spechts Ferry shale member ("clay bed"):

- Shale, green, hard, black-specked ................ 275 - 282 1/2

### Platteville formation:

#### Quimbys Mill member ("glass rock"):

- Limestone, brown to dark-brown, fine-grained and crystalline, dense, black-specked; dark-brown hard black-specked shale ........ 282 1/2 - 290

#### McGregor limestone member ("Trenton"):

- Limestone, dolomite, grayish-brown, silty, slightly mottled brown; fossiliferous; trace of gray hard shale .................. 290 - 297 1/2
- Limestone, light-brown, fine-grained, dense; fossiliferous; grayish-olive hard brown-streaked shale ................. 297 1/2 - 302 1/2
- Limestone, grayish, fine-grained, dense, silty .... 302 1/2 - 307 1/2

---

1 Driller's log shows 0-22 feet surficial.
Galena dolomite:

Noncherty unit:
- Dolomite, light-gray, medium-granular; yellowish coarsely granular,innamon speckled dolomite...... 50-60
- Dolomite, buff to brown, fine to medium-granular, crystalline to granular................. 60-155

Cherty unit:
- Dolomite, as above; white to brown chert, estimated as 40 percent or less...... 155-180
- Dolomite, drab, coarsely crystalline; chert, estimated as 25 percent or less...... 180-195
- Dolomite, as above; mottled-gray; chert, estimated as less than 10 percent.............. 195-210
- Dolomite, brown, coarsely crystalline.......................... 210-215
- Dolomite, as above; buff, chert, estimated as 25 percent.................. 215-282

Decorah formation:
- Ion dolomite member ("gray" beds):
  - Dolomite, grayish-brown, coarsely crystalline, black-specked, silty; trace of grayish shale...... 262-276
  - ("blue" beds):
    - Limestone, gray, coarsely crystalline, silty, very fossiliferous............... 276-282

- Ion and Guttenberg members:
  - Limestone, light-brown, fine-grained, fossiliferous, sandy with medium subrounded quartz........ 282-287

- Guttenberg limestone member ("oil rock"):
  - Limestone, brown to light-brown, finely granular to dense, yellow-specked, very fossiliferous...... 287-290
  - Limestone, as above; limestone, dark-brown, granular, argillaceous........ 290-302

- Spechts Ferry shale member ("clay bed"):
  - Shale, bluish-green, flaky, black-specked; gray-brown hard shale. Drab very fine-grained dense very fossiliferous limestone, with phosphate nodules. White limestone............. 302-309

Platteville formation:
- Quimbys Mill member ("glass rock"):
  - Limestone, brown to dark-brown, medium-granular, sugary, fossiliferous; trace of dark-brown hard shale.................. 309-315

Platteville formation--Continued

McGregor limestone member--Con.
- Limestone, as above; grayish argillaceous material abundant........ 307½-312½

Limestone, grayish-drab, fine-grained, very silty, with grayish argillaceous material..... 312½-321

Pecatonica dolomite member:
- Dolomite, brown, finely granular, sugary, brown resinous blebs; trace of brownish-gray organic shale.......................... 321-325
- Dolomite, mottled-gray, medium-granular, black-specked. . 325-330
- Dolomite, caramel, medium-granular, crystalline .... 330-335
- Dolomite, brown, finely granular, sugary, very silty; black phosphate nodules; trace of coarse subrounded quartz sand... 335-342½

Pecatonica and Glenwood members:
- Dolomite, as above, also sandy with coarse subrounded quartz; phosphate nodules; grayish-green sandy shale, with organic specks; coarse subrounded quartz sandstone; argillaceous and pyritic cement 342½-346

St. Peter sandstone:
- Sandstone, quartz, medium to coarse, subrounded; dolomitic and siliceous cement ............... 346-350

- Sandstone, quartz, fine to medium, angular to subangular.................. 350-352½

- Sandstone, quartz, coarse to very coarse.............. 352½-358

- Sandstone, quartz, fine to medium.......................... 358-362

Schenk 2

Location: SE ¼ NW ¼ sec. 3, T. 87 N., R. 4 E., Iowa; 123 feet N. 15° E. from Schenk 1.


Collar elevation: 730.0 ft.

Total depth: 350 ft.

Depth to water: 140 ft.

Sample study and logging: A. F. Agnew, Nov. 1950.

Surficial:
- Loess.......................... 0 - 40
- Loess; trace of buff granular dolomite........ 40 - 50

¹Drillers' log shows 0-40 feet surficial.
### Platteville formation--Continued

**McGregor limestone member**  
("Trenton"):  
Limestone, gray to grayish-brown, fine-grained, silty; trace of grayish-brown brown-specked shale ............ 315-325  
[No sample] ............. [325-330]

Limestone, gray to olive, very fine grained, very dense; very fossiliferous; silty, with greenish argillaceous areas........... 330-347

**Pecatonica dolomite member:**  
Limestone, dolomitic, grayish-brown, finely granular, silty, yellow-specked .... 347-350

### Estimated iron content

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
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<tbody>
<tr>
<td>160-165</td>
<td>2</td>
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<td>165-170</td>
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<td>170-175</td>
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<td>175-180</td>
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<tr>
<td>180-185</td>
<td>4</td>
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<td>190-195</td>
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<tr>
<td>195-200</td>
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<tr>
<td>200-205</td>
<td>1</td>
</tr>
<tr>
<td>205-210</td>
<td>1</td>
</tr>
<tr>
<td>210-215</td>
<td>Tr.</td>
</tr>
<tr>
<td>235-300</td>
<td>Tr.</td>
</tr>
<tr>
<td>300-304</td>
<td>2</td>
</tr>
<tr>
<td>305-306</td>
<td>4</td>
</tr>
</tbody>
</table>

**Schenk 3**

Location: SE1\NW4 sec. 3, T. 87 N., R. 4 E., Iowa; 113 ft S. 20° 45 ft W. from Schenk 1.


Collar elevation: 719.7 ft.

Total depth: 351 ft.

Depth to water: 95,145 ft.


### Surficial:

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-45</td>
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</table>

### Galena dolomite--Continued

**Noncherty unit--Continued**

Dolomite, yellowish-buff, medium-granular to coarsely-granular, crystalline ............ 50-155  
[No sample] ............. [155-160]

Cherty unit:

Dolomite, brown to drab, medium-crystalline; brown-mauve-cream chert ........... 160-265

**Decorah formation:**

**Ion dolomite member**  
("gray"and"blue" beds):  
Dolomite, drab, coarsely crystalline, gray-specked; trace of dark-greenish-gray, silty shale ....... 265-266

**Guttenberg limestone member**  
("oil rock"):  
Limestone, brown to light-brown, finely granular, brown-specked ............. 286-302

**Spechts Ferry shale member**  
("clay bed"):  
Shale, green, fossiliferous; olive hard black-specked shale............ 302-307

**Platteville formation:**

**Quimbys Mill member**  
("glass rock"):  
Limestone, buff to brown, finely granular, crystalline, dense; fossiliferous; trace of dark-brown brown-specked shale............ 307-315

**McGregor limestone member**  
("Trenton"):  
Dolomite, grayish-brown to brown, coarsely granular, mostly crystalline........ 315-325

Limestone, brownish-gray, fine-grained, dense; fossiliferous; trace of dark-brown brown-specked shale............ 325-335

Dolomite, drab, slightly mottled gray, finely granular, silty........... 335-347

**Pecatonica dolomite member:**  
Dolomite, as above, but with brown specks; not silty .............. 347-351

### Estimated iron content

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
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<tbody>
<tr>
<td>165 -170</td>
<td>3</td>
</tr>
<tr>
<td>170 -175</td>
<td>4</td>
</tr>
<tr>
<td>175 -180</td>
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<td>180 -182½</td>
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<td>182½-185</td>
<td>.75</td>
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<td>185 -190</td>
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</tr>
<tr>
<td>190 -195</td>
<td>2</td>
</tr>
<tr>
<td>195 -200</td>
<td>1</td>
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</table>

1 Driller's log shows 0-37 feet surficial.
Schenk 3--Continued

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<th>Percent</th>
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<td>200 - 205</td>
<td>.25</td>
</tr>
<tr>
<td>205 - 210</td>
<td>Tr.</td>
</tr>
<tr>
<td>210 - 215</td>
<td>.75</td>
</tr>
<tr>
<td>215 - 220</td>
<td>---</td>
</tr>
<tr>
<td>220 - 225</td>
<td>1</td>
</tr>
<tr>
<td>225 - 230</td>
<td>Tr.</td>
</tr>
<tr>
<td>230 - 235</td>
<td>.5</td>
</tr>
<tr>
<td>235 - 240</td>
<td>1</td>
</tr>
<tr>
<td>240 - 245</td>
<td>1</td>
</tr>
<tr>
<td>245 - 250</td>
<td>Tr.</td>
</tr>
<tr>
<td>250 - 255</td>
<td>1</td>
</tr>
<tr>
<td>255 - 260</td>
<td>.75</td>
</tr>
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</table>

Decorah formation:

 Ion dolomite member
("gray" beds):
Dolomite, gray to buff, medium-crystalline, black-specked. 285-298
("blue" beds):
Dolomite, light-gray, medium-granular, crystalline, very black specked; in part sandy with medium subrounded quartz and medium black phosphate nodules. 298-306

Guttenberg limestone member
("oil rock"):
Limestone, brown to cream, medium-crystalline, brown-specked; cream to tan very fine dense red-specked limestone. 306-315

Spechts Ferry shale member
("clay bed"):
Shale, green to grayish, soft; orange-buff fine-grained medium-granular, crystalline fossiliferous limestone; trace of phosphate nodules. 312-321

Platteville formation:

Quimbys Mill member
("glass rock"):
Limestone, dark-brown to brown, fine-grained, dense, dark-brown specked; trace of dark-brown shale. 321-328

McGregor limestone member
("Trenton"):
Limestone, buffish-gray, mottled, finely granular, silty. 326-335

Schenk 4
Drillers: John Hauser, R. E. Griffin, Oct. 28 to Nov. 11, 1950.
Collar elevation: 726.0 ft.
Total depth: 335 ft.
Depth to water: 97 ft.

<table>
<thead>
<tr>
<th>Depth (feet)</th>
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<tbody>
<tr>
<td>0 - 35</td>
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<tr>
<td>35 - 52</td>
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<td>52 - 70</td>
<td>Tr.</td>
</tr>
<tr>
<td>70 - 170</td>
<td>0.25</td>
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</table>

Galena dolomite:
Noncherty unit:
Dolomite, light-gray, granular, crystalline; light-brown medium-granular red-specked sandy dolomite; trace of depauperate material. 52-70
Dolomite, buff to brownish, otherwise as above. 70-170
Cherty unit:
Dolomite, as above; gray to light-brown chert. 170-215
Dolomite, grayish or drab, otherwise as above. 215-235
Dolomite, brown to light-brown, mottled. 235-285

Surficial:
Loess, brown. 0-35
Loess; glacial sand, quartz, chert, quartzite, jasper, coarse to very coarse, subangular. 35-52

1 Driller's log shows 0-50 feet surficial.
Schenk 4--Continued

**Estimated iron content--Continued**

<table>
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<th>Depth (feet)</th>
<th>Percent</th>
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<td>220-225</td>
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<tr>
<td>305-315</td>
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<tr>
<td>315-320</td>
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<tr>
<td>320-325</td>
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</table>

**Decorah formation--Continued**

Spechts Ferry shale member ("clay bed"):
Shale, green; limestone, brown, phosphate nodules; trace of light-gray bentonite............ 322-330

Platteville formation:
Quimbys Mill member ("glass rock"):
Limestone, light- to dark-brown, finely granular, crystalline, dark-brown specked...... 330-340

**Estimated iron content**

[No visible zinc except for a trace at the 65- to 70-foot depth]

<table>
<thead>
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<th>Depth (feet)</th>
<th>Percent</th>
</tr>
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<tbody>
<tr>
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<tr>
<td>35-50</td>
<td>3</td>
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<tr>
<td>50-65</td>
<td>Tr.</td>
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<tr>
<td>65-70</td>
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<tr>
<td>770-75</td>
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<tr>
<td>125-130</td>
<td>Tr.</td>
</tr>
<tr>
<td>130-135</td>
<td>1</td>
</tr>
<tr>
<td>135-140</td>
<td>Tr.</td>
</tr>
<tr>
<td>185-190</td>
<td>.25</td>
</tr>
<tr>
<td>190-195</td>
<td>5</td>
</tr>
<tr>
<td>195-200</td>
<td>4</td>
</tr>
<tr>
<td>200-205</td>
<td>5</td>
</tr>
<tr>
<td>205-210</td>
<td>Tr.</td>
</tr>
<tr>
<td>280-285</td>
<td></td>
</tr>
<tr>
<td>285-290</td>
<td>.5</td>
</tr>
<tr>
<td>290-295</td>
<td>.25</td>
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<tr>
<td>295-300</td>
<td>Tr.</td>
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<tr>
<td>315-320</td>
<td>Tr.</td>
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<tr>
<td>320-325</td>
<td>.25</td>
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<tr>
<td>325-330</td>
<td>.75</td>
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<tr>
<td>330-335</td>
<td>.25</td>
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<tr>
<td>335-340</td>
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Schenk 5

Location: SE\NW\ sec. 3, T. 87 N., R. 4 E., Iowa; 318 ft S. 21° W. from Schenk 1.
Drillers: John Hauser, R. E. Griffin, Nov. 14 to Nov. 29, 1950.
Collar elevation: 731.8 ft.
Total depth: 340 ft.
Depth to water: 145 ft.

**Surficial:**

Loess, brown............. .
Loess, as above; glacial sand, estimated as much as 70 percent; gray till................. 35-50
Till, as above; trace of sand, as above; depauperate pebbles, estimated as 25 percent or less........... 50-58

**Galena dolomite:**

Noncherty unit:
Dolomite, brown to light-brown, finely granular to medium-granular, cinnamon-specked........... 58-180

Cherty unit:
Dolomite, light-brown to grayish-brown, medium-crystalline; white to brown chert........... 180-287

**Decorah formation:**

Ion dolomite member ("gray" and "blue" beds):
Dolomite, brown-gray, medium-crystalline, gray-specked; trace of greenish shale.................. 287-308

Ion and Guttenberg members:
Limestone, dolomitic, grayish-brown, medium-crystalline, gray-specked; sandy with medium sub-rounded quartz.......... 308-310

Guttenberg limestone member ("oil rock"):
Limestone, light-brown to tan, fine-grained, dense; fossiliferous; dark-brown argillaceous matter...... 310-323

1Drillers' log shows 0-57 feet surficial.

Schenk 6

Location: SE\NW\ sec. 3, T. 87 N., R. 4 E., Iowa; 252 ft N. 24° E. from Schenk 1.
Collar elevation: 733.7 ft.
Total depth: 315 ft.
Depth to water: 150 ft.

**Surficial:**

Loess, brown; trace of depauperate pebbles at base... 0-35
Galena dolomite:

Noncherty unit:
Dolomite, yellowish-brown to brown, medium-granular, mostly crystalline 35-155

Cherty unit:
Dolomite, grayish-drab to buff, medium-crystalline to coarsely crystalline; brown to flesh-colored chert varying to cotton rock 155-264

Decorah formation:

Ion dolomite member ("gray" beds):
Dolomite, gray to buff, medium-granular, gray-specked 284-277

("blue" beds):
Limestone, dark-gray to brown, mottled; argillaceous; very fossiliferous; subrounded quartz sand and phosphate nodules 277-284

Guttenberg limestone-member ("oil rock"):
Limestone, light-brown, medium-crystalline, mottled; fossiliferous; silty. Light-brown to tan fine-grained dense argillaceous limestone; with brown specks 284-300

Spechts Ferry shale member ("clay bed"):
Shale, green to gray-green, very fossiliferous. White to light grayish-brown fine-grained limestone containing phosphate nodules and fossils 300-306

Platteville formation:

Quimbys Mill member:
Limestone, gray-brown, fine-grained, dense; argillaceous; trace of dark-brown shale 306-315

Estimated iron content

[No visible zinc except for a trace at the 285- to 290-foot depth]

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
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<tbody>
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<tr>
<td>170-175</td>
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<tr>
<td>175-180</td>
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<td>180-185</td>
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<tr>
<td>185-190</td>
<td>.5</td>
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Depth (feet)

Schenk 6--Continued

<table>
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<th>Depth (feet)</th>
<th>Percent</th>
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<tbody>
<tr>
<td>190-195</td>
<td>1</td>
</tr>
<tr>
<td>195-200</td>
<td>.75</td>
</tr>
<tr>
<td>200-205</td>
<td>Tr.</td>
</tr>
<tr>
<td>210-215</td>
<td>.25</td>
</tr>
<tr>
<td>215-220</td>
<td>Tr.</td>
</tr>
<tr>
<td>220-225</td>
<td>.5</td>
</tr>
<tr>
<td>225-230</td>
<td>1</td>
</tr>
<tr>
<td>230-235</td>
<td>Tr.</td>
</tr>
<tr>
<td>235-240</td>
<td>Tr.</td>
</tr>
<tr>
<td>240-245</td>
<td>Tr.</td>
</tr>
<tr>
<td>245-250</td>
<td>Tr.</td>
</tr>
<tr>
<td>250-255</td>
<td>Tr.</td>
</tr>
<tr>
<td>255-260</td>
<td>Tr.</td>
</tr>
<tr>
<td>260-265</td>
<td>Tr.</td>
</tr>
<tr>
<td>265-270</td>
<td>Tr.</td>
</tr>
<tr>
<td>270-275</td>
<td>.5</td>
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<tr>
<td>275-280</td>
<td>.25</td>
</tr>
<tr>
<td>280-285</td>
<td>Tr.</td>
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<tr>
<td>285-290</td>
<td>1</td>
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<tr>
<td>290-295</td>
<td>Tr.</td>
</tr>
<tr>
<td>295-300</td>
<td>1</td>
</tr>
<tr>
<td>300-305</td>
<td>.25</td>
</tr>
<tr>
<td>305-310</td>
<td>1</td>
</tr>
<tr>
<td>310-315</td>
<td>.5</td>
</tr>
</tbody>
</table>

Schenk 7

Location: NE\(^4\)SW\(^4\) sec. 3, T. 87 N., R. 4 E., Iowa; 1,086 ft S. 32° 30 ft E. from Schenk 1.


Collar elevation: 720.0 ft.

Total depth: 312 ft.

Depth to water: --

Sample study and logging: A. F. Agnew, Jan. 16, 1951.

<table>
<thead>
<tr>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surficial:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Loess, brown</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>0-25(^1)</td>
</tr>
</tbody>
</table>

Galena dolomite:

Noncherty unit:
Dolomite, yellowish-buff, medium-granular, crystalline, cinnamon-specked 25-150

Cherty unit:
Dolomite, brownish-drab, medium-crystalline; gray to brown chert 150-258

Decorah formation:

Ion dolomite member ("gray" beds):
Dolomite, light-gray to brown, medium-crystalline, gray-specked; trace of green hard silty shale 258-273

("blue" beds):
Dolomite, calcareous, gray, medium-crystalline, gray-specked; in part sandy; greenish argillaceous areas 273-280

\(^{1}\) Drillers' log shows 0-27 surficial.
Decorah formation--Continued

Guttenberg limestone member ("oil rock"):
Limestone, cream to brown, fossiliferous, brown-specked ........... 280-295

Spechts Ferry shale member ("clay bed"):
Shale, green; bentonite; gray limestone ....................... 295-301

Platteville formation:
Quimbys Mill member ("glass rock"):
Limestone, brown to cream, fine-grained, fossiliferous; brown argillaceous areas; trace of dark-brown shale ...................... 301-311

McGregor limestone member ("Trenton"):
Limestone, light-gray, fine-grained, silty.............. 311-312

Estimated iron and manganese content

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Iron</th>
<th>Manganese</th>
</tr>
</thead>
<tbody>
<tr>
<td>145-150</td>
<td>Tr.</td>
<td>---</td>
</tr>
<tr>
<td>150-155</td>
<td>0.5</td>
<td>---</td>
</tr>
<tr>
<td>155-160</td>
<td>2</td>
<td>Tr.</td>
</tr>
<tr>
<td>160-165</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>165-170</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>170-175</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>175-180</td>
<td>5</td>
<td>.25</td>
</tr>
<tr>
<td>180-185</td>
<td>4</td>
<td>Tr.</td>
</tr>
<tr>
<td>185-190</td>
<td>3</td>
<td>Tr.</td>
</tr>
<tr>
<td>190-195</td>
<td>Tr.</td>
<td>---</td>
</tr>
</tbody>
</table>

Schenk 8

Location: SE\NW\ sec. 3, T. 87 N., R. 4 E., Iowa; 1, 240 ft S. 47° 45 ft E. from Schenk 1.
Collar elevation: 718.4 ft.
Total depth: 301 ft.
Depth to water: 125 ft.
Sample study and logging: A. F. Agnew, Feb. 27, 1951.

Surficial:
Loess, brown ............. 0-25

Galena dolomite:
Noncherty unit:
Dolomite, yellowish-brown, medium-granular, crystalline ................ 25-140
Cherty unit:
Dolomite, grayish-brown; chert.................................. 140-250

\textsuperscript{1}Drillers' log shows 0-30 feet surficial.

Galena dolomite:
Noncherty unit:
Dolomite, light-brown, medium-granular ................................ 38-140
Cherty unit:
Dolomite, grayish-brown; grayish-brown chert ....................... 140-250

\textsuperscript{1}Driller's log shows 0-35 feet surficial.

Schenk 9

Location: SW\NW\ sec. 3, T. 87 N., R. 4 E., Iowa; 1, 634 ft S. 62° E. from Schenk 1.
Collar elevation: 720.4 ft.
Total depth: 305 ft.
Depth to water: 125 ft.
Sample study and logging: A. F. Agnew, Feb. 27, 1951.
Decorah formation:

Ion dolomite member
("gray" beds):
- Dolomite, light-gray to grayish-brown, medium-crystalline, gray-specked;
in part silty .......... 250-265

("blue" beds):
- Limestone, gray, medium-granular, crystalline, gray-specked; fossiliferous;
in part sandy .......... 265-272

Guttenberg limestone member
(oil rock):
- Limestone, brown to buff, fine-grained, dense, mottled; fossiliferous;
  brown shale .......... 272-287

Spechts Ferry shale member:
- Shale, green, very fossiliferous; cream fine-grained dense fossiliferous limestone,
  containing phosphate nodules .......... 287-295

Platteville formation:

Quimbys Mill member
("glass rock"):
- Limestone, brown to dark-brown, fine-grained, dense; trace of dark-brown shale .......... 295-301

McGregor limestone member
("Trenton"):
- Limestone, light-brownish gray, finely granular, sugary, slightly mottled .......... 301-305

Kohlenberg 1

Location: 4,302 ft north, 504 ft west of southeast corner, sec. 4, T. 87 N., R. 4 E., Iowa.
Collar elevation: 732.0 ft.
Total depth: 244 ft.
Depth to water: 215 ft.
Sample study and logging: A. F. Agnew, Jan. 16, 1951.

Surficial:
- Loess, brown; glacial sand ............. 0-16

Galena dolomite:

Noncherty unit--Continued
- Dolomite, brown, mottled, granular, brown-specked .......... 105-125

Cherty unit:
- Dolomite, as above; caramel to brown to pink chert; buff to cream fine- and medium-grained limestone; much calcite .......... 125-155
- Dolomite, as above; grayish-brown medium-crystalline vuggy dolomite; calcite; limonite; chert, as above .......... 155-205
- Dolomite, brown as above; dolomite, calcareous, buff, calcite, 205-210
  [No sample] .......... [210-230]
- Dolomite, brown and buff, as above .......... 230-231

Galena dolomite--Continued

Noncherty unit--Continued
- Dolomite, yellowish-brown, medium-granular; in part silty .......... 16-60
- Dolomite, as above; caramel dull chert (high-level gravel caved) .......... 60-105

1 Drillers' log shows 0-15 feet surficial.

Drillers reported considerable difficulty in the lower part of the hole. At 214 feet a "pitchoff" (fracture that turned the bit away from vertical) was penetrated. The rock was hard drilling until 219 feet, where a second pitchoff was struck. From 219 to 225 feet, soft drilling was accompanied by sanding of the hole. At 225 feet the hole was reamed and casing was set to stop the sanding. From 225 to 230 feet drilling required 2 days (normal footage per day is 30 to 40 feet). The hole was reamed to 230 feet and casing set at that depth. From 215 to 230 feet no cuttings were recovered because flow of water underground washed them away in a fracture. Drilling proceeded in soft rock to 244 feet, where two bits and the bailer were stuck. After these were recovered, rocks and a fence post thrown into the hole were carried away by the underground flow of water, as were the cuttings for the 240- to 244-foot interval. The hole was abandoned.

The cuttings from 230 to 240 feet indicate that the trouble was caused by an "opening" in a crevice zone and not by a slump joint.

Estimated iron content

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-185</td>
<td>Tr.</td>
</tr>
<tr>
<td>185-190</td>
<td>1</td>
</tr>
<tr>
<td>190-195</td>
<td>2</td>
</tr>
</tbody>
</table>
Kohlenberg 1—Continued

Estimated iron content—Continued

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>195-200</td>
<td>5</td>
</tr>
<tr>
<td>200-205</td>
<td>2</td>
</tr>
<tr>
<td>205-210</td>
<td>1</td>
</tr>
<tr>
<td>210-215</td>
<td>1</td>
</tr>
</tbody>
</table>

Kohlenberg 2

Location: NE NE 1/4 sec. 4, T. 87 N., R. 4 E., Iowa; 442 ft N. 44° E. from Kohlenberg 1.
Collar elevation: 689.0 ft.
Total depth: 245 ft.
Depth to water: 110 ft.
Sample study and logging: A. F. Agnew, Jan. 16, 1951.

Galena dolomite:
Noncherty unit:
  Dolomite, yellowish-buff, medium-granular, silty ................... 0-90
Cherty unit:
  Dolomite, as above, mottled; chert .................. 90-165
  Dolomite, calcareous, light-brown, medium-granular, crystalline; white medium-crystal-line limestone; chert .................. 165-192

Decorah formation:
Ion dolomite member
("gray" beds):
  Dolomite, gray to buff, medium-crystalline, mottled; greenish and brownish-olive black-specked shale ...................... 192-207
("blue" beds):
  Limestone, dolomitic, gray, medium-crystalline, argillaceous; mottled, silty; fossiliferous .................. 207-215

Guttenberg limestone member
("oil rock"):
  Limestone, cream to brown, fine-grained, very fossiliferous .......... 215-229

Spechts Ferry shale member
("clay bed"):
  Shale, green, splintery; phosphate nodules; bentonite .......... 229-235

1 Driller’s log shows 0-2½ feet surficial.

Depth (feet)

Platteville formation:
Quimbys Mill member ("glass rock"): Limestone, cream, fine-grained; dolomitic brown fine-grained argillaceous limestone, containing fossils; trace of dark-brown shale .................. 235-245
McGregor limestone member
("Trenton"): Trace of limestone, light-gray, finely granular, sugary ...... 245

Kohlenberg 3

Location: SE NE 1/4 sec. 33, T. 88 N., R. 4 E., Iowa; 986 ft N. 23° E. from Kohlenberg 1.
Driller: John Hauser, Jan. 15 to Jan. 23, 1951.
Collar elevation: 734.7 ft.
Total depth: 291 ft.
Depth to water: 160 ft.

Galena dolomite:
Noncherty unit:
  Dolomite, yellowish-brown, medium-granular .................. 15-125
Cherty unit:
  Dolomite, as above; chert .... 125-210
  Dolomite, as above; in part calcareous .................. 210-233

Decorah formation:
Ion dolomite member
("gray" and "blue" beds):
  Limestone, brown to cream to gray, in part mottled olive; trace of olive shale ...................... 233-250
  Limestone, as above, silty, black-specked, fossiliferous; fine phosphate nodules .................. 250-255

Guttenberg limestone member
("oil rock"):
  Limestone, cream to brown, fine-grained, dense, brown-specked; brown shale .... 255-275

Spechts Ferry shale member
("clay bed"):
  Shale, green, soft; grayish-brown fine-grained fossiliferous limestone, containing phosphate nodules .......... 275-281

Platteville formation:
Quimbys Mill member ("glass rock"): Limestone, light-brown to gray, fine-grained, dense, fossiliferous .......... 281-291

Surficial:
Loess, brown .................. 0-15
Kohlenberg 4

Location: NE\NE sec. 4, T. 87 N., R. 4 E., Iowa; 42 ft N. 44°31 ft W. from Kohlenberg 1.


Collar elevation: 734.5 ft.

Total depth: 287 ft.

Depth to water: ---


<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>235-240</td>
<td>3</td>
</tr>
</tbody>
</table>

Highland area, Iowa and Grant Counties, Wis.

Wiest 1

Location: 1,130 ft north, 1,805 ft east of southeast corner, sec. 29, T. 7 N., R. 1 E., Wis.


Collar elevation: 1,084.8 ft.

Total depth: 275 ft.

Depth to water: 115 ft.

Sample study and logging: Arthur E. Flint, Apr. 20, 1951.

<table>
<thead>
<tr>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0- 20</td>
</tr>
</tbody>
</table>

Soil, residual clay

Platteville formation:

Glenwood shale member:
Shale, gray-green, partly arenaceous

St. Peter sandstone:
Sandstone, quartz, light-gray, buff, medium-coarse; coarse upper 10 feet, 65 to 75 feet, and lower 20 feet. Many grains show crystal overgrowths, local dolomitic cement.

Prairie du Chien group:

Shakopee dolomite:
Dolomite, buff, fine- and medium-grained; green arenaceous shale, very common; chert, sparse; quartz sand (caved), common; iron 1 percent

Dolomite, as above; oolitic chert, abundant; green shale, caving (?) common; quartz sand, caved, common; iron 1 percent

Dolomite, as above, partly arenaceous; chert, as above; quartz sand, common; iron 1 percent

Dolomite, as above; oolitic chert, very common; quartz sand, common; iron % percent

Quimby's Mill member
("glass rock")
Calcereous rock flour, tan; trace of dark-brown shale

McGregor limestone member
("Trenton")
Limestone, gray, finely granular

<table>
<thead>
<tr>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>270-275</td>
</tr>
<tr>
<td>275-286</td>
</tr>
<tr>
<td>286-287</td>
</tr>
</tbody>
</table>
Prairie du Chien group—Continued

New Richmond sandstone(?):  
Dolomite, brown, very arenaceous; green arenaceous shale; chert, sparse; quartz sand, abundant; iron 1 percent............. 130-135

Oneota dolomite:  
Dolomite, brown; fine- and medium-grained; chert, abundant; green shale and quartz sand, common; iron -1 percent............. 135-140

Dolomite, as above; chert, common; green shale and quartz sand, sparse; iron -1/4 percent............. 140-145

Dolomite, as above; chert, very abundant; green shale, common; iron 1 percent............. 145-150

Dolomite, as above; chert, very abundant; green shale, sparse; iron -1 percent............. 150-155

Dolomite, as above; chert, very abundant; shale, as above; iron -1 percent............. 155-160

Dolomite, as above; chert, very abundant; limonite and hematite estimated as 3 percent............. 160-165

Dolomite and chert, as above; green shale, very common; iron -1/4 percent............. 165-170

Dolomite and chert, as above; trace of glauconite............. 170-175

Dolomite, as above; chert estimated as 90 percent of sample; green shale, sparse............. 175-180

Dolomite, as above; chert, very abundant; iron 1 percent............. 180-185

Dolomite, gray, fine- and medium-grained; chert, common; iron -1 percent............. 185-190

Dolomite, as above; medium-grained; chert, common; trace of glauconite............. 190-195

Dolomite, as above; chert, common to sparse; iron -1 percent............. 195-200

Dolomite, brown, medium-grained, granular; chert, as above; iron 1 percent............. 200-205

Dolomite, as above; chert, abundant; iron 4 percent............. 205-210

Prairie du Chien group—Continued

Oneota dolomite—Continued  
Dolomite, as above; chert, sparse; iron 1 percent............. 210-215

Dolomite, as above; brown-green shale, common; iron 1 percent............. 215-220

Dolomite, as above; chert and shale, sparse............. 220-230

Dolomite, as above; green shale, sparse............. 230-235

Dolomite, as above; oolitic chert, abundant............. 235-245

Dolomite, as above, granular; green shale, common............. 245-255

Dolomite, as above, partly oolitic; green shale, oolitic chert, and quartz sand, sparse............. 255-260

Dolomite, as above, arenaceous; chert, as above; green shale and quartz sand, sparse............. 260-265

Dolomite, as above; medium-coarse rounded quartz sandstone, abundant............. 265-270

Dolomite, as above; chert, sparse; sandstone, as above, abundant............. 270-275

Wiest 2

Location: Sec. 29. T. 7N., R. 1 E., Wis.; 315 ft S. 52°E. from Wiest 1.  
Collar elevation: 1,083.4 ft.  
Total depth: 235 ft.  
Depth to water: ----  
Sample study and logging: Arthur E. Flint, May 27, 1951.

Soil, residual clay.................. 0-4

St. Peter sandstone:  
Sandstone, quartz, light-gray and buff, medium and medium-coarse except coarse near top and base............. 4-62

Prairie du Chien group

Shakopee dolomite:  
Shale, buff, very abundant; oolitic chert, abundant; brown-gray dolomite, sparse............. 62-65

Dolomite, brown, fine- and medium-grained; buff shale, very abundant; quartz sand, very common (caving)............. 65-70
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Prairie du Chien group--Continued</th>
<th>Oneota dolomite--Continued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (feet)</td>
<td>Shakopee dolomite--Continued</td>
<td>Dolomite, gray-brown,</td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above,</td>
<td>fine- and medium-grained;</td>
</tr>
<tr>
<td></td>
<td>chert, abundant;</td>
<td>chert, abundant; iron</td>
</tr>
<tr>
<td></td>
<td>quartz sand, sparse; iron -1 percent</td>
<td>5 percent</td>
</tr>
<tr>
<td>70-75</td>
<td>Dolomite, chert, and</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>quartz sand, as</td>
<td>very abundant; iron 6</td>
</tr>
<tr>
<td></td>
<td>above</td>
<td>percent</td>
</tr>
<tr>
<td>75-80</td>
<td>Dolomite, as above; partly</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>collitic chert; quartz sand</td>
<td>abundant; iron 2 percent;</td>
</tr>
<tr>
<td></td>
<td>as above; iron -1 percent</td>
<td>trace of zinc</td>
</tr>
<tr>
<td>80-85</td>
<td>Dolomite and chert,</td>
<td>Dolomite, as above; chert,</td>
</tr>
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<td></td>
<td>as above; quartz sand,</td>
<td>sparse to common; iron</td>
</tr>
<tr>
<td></td>
<td>common; green shale,</td>
<td>iron +1 percent</td>
</tr>
<tr>
<td></td>
<td>sparse; iron -1 percent</td>
<td>180-185</td>
</tr>
<tr>
<td>85-90</td>
<td>Dolomite, as above; chert,</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>as above, abundant;</td>
<td>sparse to common; iron</td>
</tr>
<tr>
<td></td>
<td>red-brown shale, very</td>
<td>iron +1 percent</td>
</tr>
<tr>
<td></td>
<td>common; quartz sand,</td>
<td>195-200</td>
</tr>
<tr>
<td></td>
<td>sparse; iron 1 percent</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>1 percent</td>
<td>sparse to common.</td>
</tr>
<tr>
<td>90-95</td>
<td>Dolomite, as above, partly</td>
<td>Dolomite, gray, medium-</td>
</tr>
<tr>
<td></td>
<td>arenaceous; chert, common;</td>
<td>grained; chert, very</td>
</tr>
<tr>
<td></td>
<td>iron -1 percent</td>
<td>abundant; iron 1 percent;</td>
</tr>
<tr>
<td>95-100</td>
<td>Dolomite, as above; chert,</td>
<td>trace of zinc</td>
</tr>
<tr>
<td></td>
<td>very common; green shale and</td>
<td>Dolomite, as above; iron</td>
</tr>
<tr>
<td></td>
<td>quartz sand, sparse</td>
<td>-1 percent</td>
</tr>
<tr>
<td>100-105</td>
<td>Dolomite, nonarenaceous, and</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>chert, as above; quartz sand,</td>
<td>sparse to common.</td>
</tr>
<tr>
<td></td>
<td>common; iron -1 percent</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td>105-110</td>
<td>Dolomite, brown, fine- and</td>
<td>sparse.</td>
</tr>
<tr>
<td></td>
<td>medium-grained; chert, common;</td>
<td>Dolomite, as above; gray</td>
</tr>
<tr>
<td></td>
<td>iron +1 percent</td>
<td>shale, very common; iron</td>
</tr>
<tr>
<td>110-115</td>
<td>Dolomite and chert,</td>
<td>-1 percent</td>
</tr>
<tr>
<td></td>
<td>as above; quartz sand, common;</td>
<td>Dolomite, as above; gray</td>
</tr>
<tr>
<td></td>
<td>iron -1 percent</td>
<td>shale, abundant.</td>
</tr>
<tr>
<td>115-120</td>
<td>New Richmond sandstone(?)</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above, partly</td>
<td>sparse to common; iron</td>
</tr>
<tr>
<td></td>
<td>arenaceous; chert, common;</td>
<td>iron +1 percent</td>
</tr>
<tr>
<td></td>
<td>iron -1 percent</td>
<td>220-225</td>
</tr>
<tr>
<td>120-125</td>
<td>Dolomite, as above; chert,</td>
<td>Dolomite, as above; chert,</td>
</tr>
<tr>
<td></td>
<td>abundant; iron -1 percent</td>
<td>sparse to common; iron</td>
</tr>
<tr>
<td>125-130</td>
<td>Dolomite, brown, fine- and</td>
<td>iron +1 percent</td>
</tr>
<tr>
<td></td>
<td>medium-grained; chert,</td>
<td>230-235</td>
</tr>
<tr>
<td></td>
<td>common</td>
<td>Williams 1</td>
</tr>
<tr>
<td>130-135</td>
<td>Dolomite, as above; chert,</td>
<td>Location: 1, 465 ft north,</td>
</tr>
<tr>
<td></td>
<td>as above, sparse to common</td>
<td>1, 700 ft west of southeast</td>
</tr>
<tr>
<td></td>
<td>iron -1 percent</td>
<td>corner, sec. 31, T. 7 N.,</td>
</tr>
<tr>
<td>135-140</td>
<td>Dolomite, as above; chert,</td>
<td>Driller: R. Dagenhardt,</td>
</tr>
<tr>
<td></td>
<td>as above; iron -1 percent</td>
<td>Feb. 22 to Mar. 5, 1951.</td>
</tr>
<tr>
<td>140-145</td>
<td>Dolomite, as above; chert,</td>
<td>Collar elevation: 1, 116.6 ft.</td>
</tr>
<tr>
<td></td>
<td>abundant; red-brown shale,</td>
<td>Total depth: 330 ft.</td>
</tr>
<tr>
<td></td>
<td>sparse to common; iron 3 percent</td>
<td>Depth to water: 50 ft.</td>
</tr>
<tr>
<td></td>
<td>limestone fragments</td>
<td>[Percentages estimated]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-5</td>
</tr>
</tbody>
</table>
Platteville formation:

McGregor limestone member:
- Limestone, brown and gray, medium- and fine-grained, fossiliferous .......... 5-32

Pecatonica dolomite member:
- Dolomite, gray and buff, medium-granular, arenaceous in lower 2 feet; phosphatic nodules common near base .......... 32-47

Glenwood shale member:
- Shale, gray-green; a few phosphatic nodules; limonite common .......... 47-50

St. Peter sandstone:
- Sandstone, quartz, light-gray and buff, medium-grained except coarse near base in the 85- to 90-foot sample and near top of formation; limonite common near base .......... 50-123

Prairie du Chien group--Continued

Oneota dolomite:
- Dolomite, as above, some medium-grained; chert, sparse to common; quartz sand, common .......... 155-160
- Chert, light-gray, glassy, estimated as 80 percent of sample; dolomite, as above .......... 160-165
- Dolomite, as above, medium-grained; chert, as above, abundant .......... 165-170
- Dolomite, as above; chert, some oolitic, very abundant .......... 170-175
- Dolomite, as above; chert, some oolitic, very abundant .......... 175-180
- Dolomite, as above; chert, some oolitic, very abundant .......... 180-185
- Dolomite, as above; chert, some oolitic, common .......... 185-190
- Dolomite, as above; chert, some oolitic, common .......... 190-195
- Dolomite, gray, medium-grained; chert, some is oolitic, very abundant; iron, trace .......... 195-200
- Dolomite, as above; chert, some arenaceous, very abundant; green shale, very common; iron +2 percent .......... 200-205
- Dolomite, as above; chert, very abundant; quartz sand, common; iron +2 percent .......... 205-210
- Dolomite, as above; chert, very abundant; iron 2 percent .......... 210-215
- Dolomite, as above; chert, very abundant; quartz sand, common; iron +2 percent .......... 215-220
- Dolomite, as above; chert, very common; quartz sand, as above; iron -1 percent .......... 220-225
- Dolomite, as above; chert, sparse to common; quartz sand, as above; iron -1 percent .......... 225-230
- Dolomite, as above; chert, sparse to common; iron -1 percent .......... 230-235
- Dolomite, as above; chert, sparse; iron -1 percent .......... 235-245
Prairie du Chien group—Continued
Oneota dolomite—Continued

Dolomite, as above; chert, very common; iron 2 percent.......... 245-250
Dolomite, brown, medium-grained; chert, sparse; iron 1 percent........ 250-255
Dolomite, as above; chert, some oolitic, common; green shale, common; iron 1 percent........ 255-260
Dolomite, gray, medium-grained; green shale, very common; chert, sparse; iron 1 percent........ 260-265
Dolomite, as above; chert, sparse; gray arenaceous shale, sparse to common; quartz sand, common .......... 270-275
Dolomite, as above; chert, partly oolitic, abundant ........ 290-295
Dolomite, as above; chert, nonoolitic, very common ........ 295-300
Dolomite, as above; chert, a little is oolitic, common; quartz sand, common .......... 300-305
Dolomite, as above, arenaceous; quartz sand, common ........ 305-310
Dolomite, buff, arenaceous, oolitic, and dolomitic sandstone; chert, sparse to common .......... 310-315
Dolomite and dolomitic sandstone, as above; chert, sparse; quartz sand estimated as 30 percent of sample; trace of green shale ..... 315-320
Sandstone, dolomitic, buff, medium-coarse, rounded, and arenaceous dolomite; quartz sand, abundant; trace of glauconite .......... 320-325

Trempealeau formation (Cambrian):
Jordan sandstone member:
Sandstone, quartz, clear, medium-grained, poorly sorted, some dolomitic cement.................. 325-330

Williams 2
Location: Sec. 31, T. 7 N., R. 1 E., Wis.; 335 ft N. 31°10' W. from Williams 1.
Collar elevation: 1,097.1 ft.
Total depth: 295 ft.
Depth to water: 105 ft.
Sample study and logging: Arthur E. Flint, Mar. 20, 1951.

[Percentages estimated]

Platteville formation:
McGregor limestone member:
Limestone, gray-brown, fine- and medium-grained, fossiliferous .......... 5- 11
Pecatonica dolomite member:
Dolomite, gray and buff, medium-grained, arenaceous in lower 3 feet; phosphatic nodules and limonite common near base .......... 11- 29
Glenwood shale member:
Shale, gray-green, arenaceous in part; phosphatic nodules and marcasite partly oxidized, common .......... 29- 31
St. Peter sandstone:
Sandstone, quartz, light-gray and buff, medium-grained except coarse at top and through lower 20 feet, rounded, some grains frosted, pitted .......... 31- 97

Prairie du Chien group:
Shakopee dolomite:
Shale, gray; brown-gray dolomite, sparse .......... 97-100
Dolomite, brown-gray, fine- and medium-grained, some is arenaceous; oolitic chert, very abundant; some caving sandstone .......... 100-105
Dolomite and chert, as above; gray-green shale, common; trace of glauconite .......... 105-110
Prairie du Chien group—Continued

Shakopee dolomite—Continued

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110-120</td>
<td>190-195</td>
</tr>
<tr>
<td>120-125</td>
<td>195-200</td>
</tr>
<tr>
<td>125-130</td>
<td>200-205</td>
</tr>
<tr>
<td>130-135</td>
<td>205-210</td>
</tr>
<tr>
<td>135-140</td>
<td>210-215</td>
</tr>
<tr>
<td>140-145</td>
<td>215-220</td>
</tr>
<tr>
<td>145-150</td>
<td>220-225</td>
</tr>
<tr>
<td>145-150</td>
<td>225-230</td>
</tr>
<tr>
<td>150-155</td>
<td>230-235</td>
</tr>
<tr>
<td>155-160</td>
<td>235-240</td>
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<tr>
<td>160-165</td>
<td>240-245</td>
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<tr>
<td>165-170</td>
<td>245-250</td>
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<tr>
<td>170-175</td>
<td>250-255</td>
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<tr>
<td>175-180</td>
<td>255-265</td>
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<tr>
<td>180-185</td>
<td>265-275</td>
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<tr>
<td>185-190</td>
<td>275-280</td>
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<tr>
<td>185-190</td>
<td>280-290</td>
</tr>
<tr>
<td>190-195</td>
<td>290-295</td>
</tr>
</tbody>
</table>
Williams 3

Location: Sec. 31, T. 7 N., R. 1 E., Wis.; 265 ft S. 43° E. from Williams 1.
Collar elevation: 1,093.3 ft.
Total depth: 290 ft.
Depth to water: 155 ft.

[Percentages estimated]

<table>
<thead>
<tr>
<th>Soil, residual clay, weathered limestone</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 8</td>
</tr>
</tbody>
</table>

Platteville formation:
McGregor limestone member:
Limestone, brown-gray, fine-grained ....... 8 - 12

Pecatonica dolomite member:
Dolomite, gray and buff, medium-grained, arenaceous near base .............. 12 - 26

Glenwood shale member:
Shale, gray-green, a few phosphatic nodules ............ 26 - 28

St. Peter sandstone:
Sandstone, quartz, light-gray and buff, rounded, medium-grained except coarse in upper 8 feet and lower 10 feet .......... 28 - 72

Prairie du Chien group:
Shakopee dolomite:
Dolomite, buff, fine- and medium-grained; oolitic chert, common; green glauconitic shale, common ............ 72 - 75
Dolomite, as above; chert, sparse .......... 75 - 85
Dolomite, buff, medium-grained .......... 85 - 90
Dolomite, brown, fine- and medium-grained; chert, sparse to common ............ 90 - 95
Dolomite, as above, partly oolitic; chert, sparse ............ 95 - 100
Dolomite, as above, nonoolitic; oolitic chert, very abundant; green arenaceous shale, common ............ 100 - 105
Dolomite, as above; oolitic chert, abundant; gray-green shale and quartz sand, common ............ 105 - 110

Prairie du Chien group--Continued
Shakopee dolomite--Continued
Dolomite, as above; but fine-grained, dense; oolitic chert, very abundant; shale and quartz sand, as above ............ 110 - 115
Dolomite, as above, fine- and medium-grained; chert, common to sparse .......... 115 - 120
Dolomite, as above, fine- and medium-grained .......... 120 - 130

New Richmond sandstone(?):
Dolomite, brown, medium-grained; chert, sparse .......... 130 - 135

Oneota dolomite:
Dolomite, as above; chert, very abundant .......... 135 - 140
Dolomite, as above; chert, very abundant .......... 140 - 145
Dolomite, gray, fine- and medium-grained; chert, abundant .......... 145 - 150
Dolomite, brown, fine- and medium-grained; chert, sparse to common .......... 150 - 165
Dolomite, gray, fine- and medium-grained; chert, common .......... 165 - 170
Dolomite, as above; chert, abundant .......... 170 - 175
Dolomite, as above; chert, abundant; iron 2 percent .......... 175 - 180
Dolomite, as above; chert, common .......... 180 - 185
Dolomite, as above; chert, abundant .......... 185 - 190
Dolomite, gray, medium-grained; chert, abundant .......... 190 - 195
Dolomite, as above; chert, abundant .......... 195 - 200
Dolomite, as above; chert, abundant; iron +1 percent .......... 200 - 205
Dolomite, brown, medium-grained; chert, abundant; iron -1 percent .......... 205 - 210
Dolomite, gray, medium-grained; chert, sparse to common; iron -1/2 percent .......... 210 - 215
Dolomite, as above; chert, sparse .......... 215 - 220
Dolomite, as above; chert, abundant; iron 3 percent .......... 220 - 225
Dolomite, as above; chert, abundant; iron 2 percent .......... 225 - 230
Dolomite, as above; chert, sparse; iron -1/2 percent .......... 230 - 235

27
Prairie du Chien Continued

Oneota dolomite Continued

Dolomite, gray, granular; chert, partly oolitic, sparse .................. 235-240
Dolomite, as above; trace of chert.................................. 240-245
Dolomite, brown, medium-grained, arenaceous; angular quartz sand, very abundant .............. 245-250
Dolomite, as above, nonarenaceous; quartz sand, as above, very abundant. 250-260
Dolomite, as above; chert, abundant................................ 260-265
Dolomite, as above, partly oolitic; oolitic chert, abundant; quartz sand, sparse to common .......... 265-270
Dolomite, as above; partly oolitic chert, abundant; quartz sand, as above. 270-275
Dolomite, as above, partly arenaceous and oolitic; chert and quartz sand, sparse 275-280
Dolomite, as above, arenaceous and oolitic; oolitic chert, common; quartz sand, sparse; iron 1 percent. 280-285
Dolomite, as above, arenaceous, glauconitic; chert and quartz sand, sparse. 285-290

Williams 4

Location: Sec. 31, T. 7 N., R. 1 E., Wis.; 525 ft S. 45°50 ft E. from Williams 1.
Driller: R. Dagenhardt, Apr. 6 to Apr. 17, 1951.
Collar elevation: 1,080.2 ft.
Depth to water: 145 ft.
Sample study and logging: Arthur E. Flint, Apr. 20, 1951.

[Percentages estimated, except where assay values are indicated]

St. Peter sandstone:
Sandstone, quartz, light-gray and buff, rounded, many grains frosted, medium-grained except coarse in upper 10 feet and lower 8 feet, traces of white porcellaneous chert in lower 30 feet (may be caved) ......... 10-56

Prairie du Chien group:
Shakopee dolomite:
Shale, brown-buff; dolomite, buff, sparse ....................... 56-60
Dolomite, brown, fine- and medium-grained; oolitic chert, sparse; quartz sand (caving) .......... 60-65
Dolomite, as above, partly arenaceous; chert, sparse; quartz sand, as above .................. 65-75
Dolomite, as above, fine- and medium-grained .......... 75-80
Dolomite, as above, partly oolitic; partly oolitic chert, very common; brown shale, sparse .... 80-85
Dolomite, as above, nonoolitic; partly oolitic chert, abundant .................. 85-90
Dolomite, as above, partly arenaceous; very oolitic chert, abundant; green arenaceous shale, common ...................... 90-95
Dolomite, as above, some very fine-grained; partly oolitic chert, abundant; quartz sand and green shale, sparse to common .............. 95-100
Dolomite, as above, partly arenaceous; quartz sand, sparse; trace of glauconite .......... 100-105

New Richmond sandstone(?):
Dolomite, brown, partly arenaceous, and dolomitic sandstone; green shale, sparse to common .......... 105-110

Oneota dolomite:
Dolomite, brown, partly arenaceous; and medium-grained .............. 110-115
Dolomite, brown and gray, medium- and fine-grained; chert, abundant ............... 115-120
Dolomite, as above; chert, very common ...................... 120-125

Soil, residual clay and chert................................. 0-8

Platteville formation:
Glenwood shale member:
Shale, gray-green, oxidized in part to red ...................... 8-10
### Prairie du Chien group—Continued

#### Oneota dolomite—Continued

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dolomite, brown, medium-grained; chert, sparse; iron 1 percent</td>
<td>235-240</td>
</tr>
<tr>
<td>Dolomite, as above; partly oolitic chert, very abundant</td>
<td>250-255</td>
</tr>
<tr>
<td>Dolomite, as above; chert and quartz sand, sparse to common</td>
<td>255-260</td>
</tr>
<tr>
<td>Dolomite, as above; partly oolitic chert, common; quartz sand, sparse</td>
<td>260-265</td>
</tr>
<tr>
<td>Dolomite, as above; partly oolitic chert, common to sparse</td>
<td>265-270</td>
</tr>
<tr>
<td>Dolomite, brown, medium-grained, arenaceous, partly glauconitic; quartz sand common; trace of iron</td>
<td>270-275</td>
</tr>
</tbody>
</table>

**Williams 5**

Location: Sec. 31, T. 7 N., R. 1 E., Wis.; 860 ft S. 46°45 ft E. from Williams 1.

Driller: R. Dagenhardt, Apr. 18 to Apr. 28, 1951.

Collar elevation: 1,072.2 ft.

Total depth: 275 ft.

Depth to water: 25 ft.

Sample study and logging: Arthur E. Flint, Apr. 30, 1951.

[Percentages estimated]

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil, alluvium, silt and fine quartz sand</td>
<td>0-5</td>
</tr>
</tbody>
</table>

**St. Peter sandstone:**

Sandstone, quartz, light-gray and buff, medium-grained except coarse in upper 5 feet, 35- to 50-foot sample, and lower 17 feet, rounded, some grains frosted, overgrowths on grains in upper 15 feet common | 5-82 |
Prairie du Chien group:
Shakopee dolomite:
Shale, green; oolitic chert, common; arenaceous fine- and medium-grained dolomite, sparse .................. 82-85
Dolomite, buff, fine- and medium-grained, arenaceous; oolitic chert, abundant; buff arenaceous shale, common; quartz sand (caving), common .......... 85-90
Dolomite, brown, as above; oolitic chert, very common; quartz sand, sparse .......... 90-95
Dolomite, as above; oolitic chert, sparse to common; green shale, common; quartz sand, iron +1 percent ...... 100-105
New Richmond sandstone(?):
Dolomite, as above; green arenaceous shale, very common; quartz sand, sparse; iron 1 percent .......... 105-110
Oneota dolomite:
Dolomite, as above; chert, abundant; green shale, sparse; iron 1 percent ........ 110-115
Dolomite, gray, nonarenaceous; chert, abundant; green shale, common; trace of lead .......... 115-120
Dolomite and chert, as above; shale, as above, sparse; trace of lead .......... 120-125
Dolomite, as above; chert, sparse; quartz sand, sparse .......... 125-130
Dolomite, as above, partly arenaceous; chert and shale, sparse .......... 130-135
Dolomite, as above; chert, common to sparse; trace of lead .......... 135-140
Dolomite, gray, granular, medium-grained; green-brown shale, very common; chert, sparse; trace of glauconite; iron +1 percent. 140-145

Prairie du Chien group--Continued
Oneota dolomite--Continued
Dolomite, brown, gray, fine- and medium-grained; chert, common ................. 145-150
Dolomite, as above; chert, very abundant; green shale, very common .......... 150-155
Dolomite, as above, partly medium-grained; chert, abundant; green shale, common; iron 2 percent .......... 155-160
Dolomite, as above; chert, very abundant; iron +1 percent .......... 160-165
Dolomite, as above, medium-grained; chert, abundant; iron +1/2 percent .......... 165-170
Dolomite and chert, as above .......... 170-175
Dolomite, as above; chert, sparse .......... 175-200
Dolomite, gray, medium-grained; chert, sparse; iron 4 percent .......... 200-205
Dolomite, as above; iron 5 percent .......... 205-210
Dolomite, as above; iron 2 percent .......... 210-215
Dolomite, gray-brown, medium-grained; iron +1 percent .......... 215-220
Dolomite, gray, medium-grained; iron +1/2 percent .......... 220-225
Dolomite, light-buff, medium-grained; white decomposed chert, sparse; iron +1/2 percent .......... 225-230
Dolomite, brown-gray, medium-grained; chert, sparse .......... 230-335
Dolomite, as above .......... 235-245
Dolomite, as above; oolitic chert, very common; green-brown arenaceous glauconitic shale, common; trace of glauconite .......... 245-250
Dolomite, brown, medium-grained, partly arenaceous; green glauconitic arenaceous shale, common .......... 250-255
Dolomite, as above, arenaceous and oolitic; shale, as above, common; chert, sparse; iron +1/2 percent .......... 255-260
Dolomite, as above, very arenaceous and glauconitic; iron 2 percent .......... 260-270
Dolomite, as above, arenaceous and oolitic; oolitic chert, sparse; iron +1/2 percent .......... 270-275
Steil 1

Location: 165 ft south, 1,685 ft east of north-west corner, sec. 6, T. 6 N., R. 1 E., Wis.
Collar elevation: 1,119.8 ft.
Total depth: 350 ft.
Depth to water: 45 ft.
Sample study and logging: Arthur E. Flint, Mar. 8, 1951.

[Percentages estimated]

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Soil, residual clay and weathered limestone (Quimbys Mill?) in lower 8 feet</th>
<th>0-15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Platteville formation:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>McGregor limestone member:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limestone, medium-gray, medium-grained 20 to 33 feet;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>otherwise fine- and very fine grained;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fossiliferous 15-50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pecatonica dolomite member:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, medium-gray, weathered buff;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>quartz sand and phosphatic nodules at base 50-61</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glenwood shale member:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shale, gray-green, arenaceous; limonite, phosphatic nodules, very common 61-84</td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Peter's sandstone:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sandstone, quartz, light-gray, rounded, medium-fine except coarse in upper 10 feet and lower 15 feet 64-151</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prairie du Chien group:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shakopee dolomite:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shale, green, arenaceous 151 to 153 feet; gray-brown fine- and medium-grained dolomite; some arenaceous oolitic chert; glauconite, common 151-155</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above, nonarenaceous; quartz sand (mostly caving), 15 percent of sample; trace of green shale 155-160</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above, some arenaceous; oolitic chert, abundant 160-165</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, as above, partly oolitic, abundant; sparse green shale and quartz sand (caving) 165-170</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prairie du Chien group—Continued</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shakopee dolomite—Continued</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, as above, some oolitic, common; quartz sand, sparse 170-175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New Richmond sandstone(?)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, buff and light brownish-gray, fine- and very fine grained, partly arenaceous; light-gray and light-yellow chert, much is oolitic, abundant; green shale, sparse; quartz sand, common 175-180</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Onega dolomite:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, buff, fine- and medium-grained; partly oolitic chert, common; quartz sand, common (caving from New Richmond?); iron 1 percent 180-185</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, light brown-gray, mainly fine-grained; chert, common 185-195</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chert, light-gray, 80 percent of sample; dolomite, as above 195-200</td>
<td></td>
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<tr>
<td></td>
<td>Dolomite, as above; chert, common 200-205</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, light brownish-gray, medium-grained; chert, abundant; quartz sand, sparse; iron 1 percent 205-210</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, common; trace of glauconite 210-215</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, light brown-gray, fine- and medium-grained; chert, as above 215-220</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, light to medium brown-gray, medium-grained; chert, common; iron -1 percent 220-225</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, abundant; quartz sand, common; iron 225-230</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, as above, abundant; quartz sand, common; iron 3 percent 230-235</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite and chert, as above; quartz sand and green shale, common; iron 3 percent 235-240</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, abundant; iron 240-245</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, common; quartz sand and green shale, sparse; iron -1 percent 245-250</td>
<td></td>
</tr>
</tbody>
</table>

31
Prairie du Chien group—Continued
Oneota dolomite—Continued

Dolomite, as above; chert, very common; yellow-buff shale and quartz sand (caving?), common; iron -1 percent ............ 250-255
Dolomite, as above; chert, as above; quartz sand, as above; iron +2 percent ........... 255-260
Dolomite, as above; chert, common; quartz sand, as above; iron +1 percent........... 260-265
Dolomite, as above; chert and quartz sand, sparse to common; iron 1 percent ........... 265-270
Dolomite, as above; chert and quartz sand, sparse ............... 270-275
Dolomite, as above; green-gray shale, abundant; trace of glauconite................ 275-280
Dolomite, light- and medium-brown, medium-grained; shale, as above, common ............. 280-285
Dolomite, as above ................ 285-290
Dolomite, as above; chert, sparse .......... 290-295
Dolomite, as above; chert, much is oolitic, very common .............. 295-300
Dolomite, as above; chert, very common ................ 300-305
Dolomite, as above; a little greenish-gray siltstone; chert, common ................ 305-310
Dolomite, as above; chert, sparse to common; quartz sand, very common ............. 310-320
Dolomite, as above, much is arenaceous and oolitic; oolitic chert, common; quartz sand, common; trace of glauconite ............ 320-325
Dolomite, as above, most is arenaceous and oolitic; arenaceous and oolitic chert, common; quartz sand, abundant; light-green shale, common ................ 325-330

Prairie du Chien group—Continued
Oneota dolomite—Continued

Dolomite, as above; chert, sparse; quartz sand, abundant; iron 3 percent ............ 330-335

Sandstone, quartz, fine to coarse, poorly sorted; dolomite, arenaceous 20 percent of sample .................. 335-337

Trempealeau formation:

Jordan sandstone member:
Sandstone, quartz, fine to coarse, poorly sorted, in part dolomitic cemented ............... 337-350

Stei 2

Location: Sec. 6, T. 6 N., R. 1 E., Wis., 245 ft N. 63°30 ft W. from Steil 1.
Driller: John Hauser, Mar. 3 to Mar. 16, 1951.
Collar elevation: 1,113.8 ft.
Total depth: 325 ft.
Depth to water: 225 ft.
Sample study and logging: Arthur E. Flint, Mar. 18, 1951.

[Percentages estimated, except where assay values are indicated]

Soil, residual clay, decomposed buff limestone.............. 0-10

Platteville formation:

McGregor limestone member:
Limestone, gray, weathers buff, fine- and medium-grained, fossiliferous .......... 10-37

Pecatonica dolomite member:
Dolomite, medium-gray, medium-grained, arenaceous near base .................. 37-54

Glenwood shale member:
Shale, grayish-green, iron, common .................. 54-56

St. Peter sandstone:
Sandstone, quartz, rounded; many grains frosted, pitted, medium-fine except coarse in upper 10 feet and medium-coarse in lower 12 feet ..... 56-137

Prairie du Chien group:

Shakopee dolomite:
Shale, light-buff; dolomite, buff, arenaceous; chert, sparse; limonite, common ... 137-140
### Prairie du Chien Group—Continued

#### Shakopee Dolomite—Continued

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>140-145</td>
<td>Dolomite, light-buff; some oolitic, very common; light-gray chert, much is oolitic, 70 percent of sample; glauconitic shale and quartz sand, sparse.</td>
</tr>
<tr>
<td>145-150</td>
<td>Dolomite, as above; partly oolitic chert, very common; traces of quartz sand and glauconite.</td>
</tr>
<tr>
<td>150-155</td>
<td>Dolomite, as above, some arenaceous; chert, sparse; trace of glauconite.</td>
</tr>
<tr>
<td>155-160</td>
<td>Dolomite, as above; chert, common; iron -1 percent; lead assayed 0. 45 percent.</td>
</tr>
<tr>
<td>160-165</td>
<td>New Richmond Sandstone(?): Dolomite, as above; chert, common to sparse; shale and quartz sand, common; iron +1 percent; lead assayed 0. 6 percent.</td>
</tr>
<tr>
<td>165-170</td>
<td>Oneota Dolomite: Dolomite, as above; some chert; traces of glauconite; lead assayed 0. 5 percent.</td>
</tr>
<tr>
<td>170-175</td>
<td>Dolomite as above; chert, as above; lead assayed (175 to 177 1/2 feet) 1. 25 percent; (177 1/2-180 feet) 1. 20 percent.</td>
</tr>
<tr>
<td>175-180</td>
<td>Dolomite, as above, medium-grained; chert, much is oolitic, very common; lead assayed (180 to 182 1/2 feet) 0. 5 percent; (182 1/2 to 185 feet) 0. 85 percent.</td>
</tr>
<tr>
<td>180-185</td>
<td>Dolomite, as above; chert, common; lead 0. 25 percent.</td>
</tr>
<tr>
<td>185-190</td>
<td>Dolomite, as above; chert, common; iron -1 percent; trace of lead.</td>
</tr>
<tr>
<td>190-195</td>
<td>Dolomite, as above; chert, abundant.</td>
</tr>
<tr>
<td>195-200</td>
<td>Dolomite, as above; chert, some is oolitic, common; quartz sand, 5 percent of sample; trace of glauconite.</td>
</tr>
</tbody>
</table>

### Prairie du Chien Group—Continued

#### Oneota Dolomite—Continued

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-205</td>
<td>Dolomite, as above, a little is arenaceous; chert, sparse; trace of glauconite.</td>
</tr>
<tr>
<td>205-210</td>
<td>Dolomite, light-brown, medium-grained; chert, abundant; iron 2 percent; trace of glauconite.</td>
</tr>
<tr>
<td>210-215</td>
<td>Dolomite, as above; chert, very abundant; iron 2 percent.</td>
</tr>
<tr>
<td>215-220</td>
<td>Dolomite, as above; chert, common; iron +1 percent.</td>
</tr>
<tr>
<td>220-225</td>
<td>Dolomite, as above; chert, common; iron 1 percent.</td>
</tr>
<tr>
<td>225-230</td>
<td>Dolomite and chert, as above; trace of iron.</td>
</tr>
<tr>
<td>230-235</td>
<td>Dolomite and chert, as above; iron 4 percent.</td>
</tr>
<tr>
<td>235-240</td>
<td>Dolomite and chert, as above; iron 3 percent.</td>
</tr>
<tr>
<td>240-245</td>
<td>Dolomite, light-gray, granular; chert, sparse; iron 2 percent; trace of zinc.</td>
</tr>
<tr>
<td>245-250</td>
<td>Dolomite, as above; chert, sparse; gray shale, sparse; iron 2 percent.</td>
</tr>
<tr>
<td>250-255</td>
<td>Dolomite and chert, as above; iron 3 percent.</td>
</tr>
<tr>
<td>260-265</td>
<td>Dolomite, brown-gray, medium-grained; chert, common.</td>
</tr>
<tr>
<td>265-270</td>
<td>Dolomite, brown, medium-grained; chert, sparse; iron 2 percent.</td>
</tr>
<tr>
<td>270-275</td>
<td>Dolomite, as above; chert, sparse; gray shale, sparse; iron 1 percent.</td>
</tr>
<tr>
<td>275-280</td>
<td>Dolomite, as above; chert, sparse; iron -1 percent; trace of zinc.</td>
</tr>
<tr>
<td>280-285</td>
<td>Dolomite, as above; chert, sparse; some gray-green shale.</td>
</tr>
<tr>
<td>285-290</td>
<td>Dolomite, brown, medium-grained.</td>
</tr>
<tr>
<td>290-300</td>
<td>Dolomite, as above.</td>
</tr>
<tr>
<td>300-305</td>
<td>Dolomite, as above; but partly oolitic and arenaceous; light-brown chert, common.</td>
</tr>
<tr>
<td>305-310</td>
<td>Dolomite, as above; chert, some is oolitic, common; quartz sand, 5 percent of sample; trace of glauconite.</td>
</tr>
</tbody>
</table>
Depth (feet)

Prairie du Chien group--Continued

Oneota dolomite--Continued

Dolomite, as above, much is oolitic, arenaceous, and glauconitic; oolitic and arenaceous chert, very common; quartz sand, 5 percent of sample ............... 310-315

Dolomite, as above; chert, as above, common; quartz sand 10 percent of sample ............... 315-320

Dolomite, brown; arenaceous; chert, as above (caving?), sparse; quartz sand 20 percent of sample ............... 320-325

Note: Bottom of hole is at or very near the Cambrian-Ordovician boundary.

Steil 3

Location: Sec. 6, T. 6 N., R. 1 E., Wis.; 210 ft S. 60° 33 ft E. from Steil 1.
Driller: John Hauser, Mar. 16 to Mar. 21, 1951.
Collar elevation: 1,103.7 ft.
Total depth: 310 ft.
Depth to water: 200 ft.
Sample study and logging: Arthur E. Flint, Mar. 25, 1951.

[Percentages estimated]

Depth (feet)

Soil, residual clay and weathered limestone ..... 0 - 5

Platteville formation:

McGregor limestone member:

Limestone, gray-brown, fine- and medium-grained, fossiliferous ............. 5 - 25

Pecatonica dolomite member:

Dolomite, medium-gray, weathered, buff, medium-grained ............... 25 - 42

Glenwood shale member:

Shale, gray-green; phosphatic nodules and iron, common ............. 42 - 43

St. Peter sandstone:

Sandstone, light-gray and buff, medium-grained, locally medium-coarse; gray-green shale, 150 to 175 feet, abundant, and traces in most samples; bright-red hematite occurs with much of shale; iron common in lowest 3 feet ............... 43-264

Prairie du Chien group:

Oneota(?) dolomite:

Shale, light-gray and green; light-brown and gray chert, common; iron, common ............... 264-266

Dolomite, light-gray and light-brown, granular; light-brown and white chert, sparse to common; iron 4 percent ............... 266-270

Dolomite, as above; iron 3 percent ............... 270-275

Dolomite, as above; chert, sparse; trace of glauconite ............... 275-280

Dolomite, as above; traces of chert and green shale ............... 280-290

Dolomite, as above; oolitic chert, common; glauconite, common in dolomite ............... 290-295

Dolomite, light-brown, arenaceous, oolitic; traces of chert, green shale, and glauconite; quartz sand, sparse ............... 295-305

Dolomite, as above, but very arenaceous and glauconitic; oolitic chert, sparse; quartz sand, common; trace of green shale ............... 305-310

Steil 4

Location: Sec. 6, T. 6 N., R. 1 E., Wis.; 710 ft. S. 67° 30 ft E. from Steil 1.
Collar elevation: 1,073.9 ft.
Total depth: 230 ft.
Depth to water: 155 ft.
Sample study and logging: Arthur E. Flint, May 9, 1951.

[Percentages estimated]

Depth (feet)

Soil and residual clay .......... 0 - 5

Platteville formation:

Pecatonica dolomite member:

Dolomite, medium-gray, weathered, buff, medium-grained, some limonite mottling ............... 5-18

Glenwood shale member:

Shale, green; traces of limonite and pyrite; a few quartz sand grains ............... 18-20
<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Peter sandstone:</td>
<td>Prairie du Chien group--Continued</td>
</tr>
<tr>
<td>Sandstone, quartz, light-gray, rounded, some frosting of grains, medium except coarse in upper 5 feet, lower 7 to 8 feet and in sample 45 to 50 feet</td>
<td>New Richmond sandstone(?):</td>
</tr>
<tr>
<td>Shakopee dolomite:</td>
<td>Dolomite, as above, very arenaceous; shale, as above, common; quartz sand, 10 percent of sample.</td>
</tr>
<tr>
<td>Shale, light-buff and green; chert, brown, arenaceous; sandstone, quartz, common (caving?)</td>
<td>Oneota dolomite:</td>
</tr>
<tr>
<td>Dolomite, light-buff, fine-grained; light-gray oolitic chert, abundant; light-buff shale, common (caving); quartz sand (caving), common</td>
<td>Dolomite, as above; chert, very abundant; trace of iron.</td>
</tr>
<tr>
<td>Dolomite, as above, a little arenaceous; chert, sparse; traces of limonite and glauconite; quartz sand, sparse</td>
<td>Dolomite, as above; chert, as above, sparse; trace of iron.</td>
</tr>
<tr>
<td>Dolomite, light-brown and buff, fine- and medium-grained; chert, sparse; limonite, glauconite, and quartz sand, as above</td>
<td>Dolomite, light-gray, medium-grained; chert, as above, common; iron 2 percent.</td>
</tr>
<tr>
<td>Dolomite, medium-gray-brown, fine- and medium-grained; chert, sparse</td>
<td>Dolomite, as above; chert, very abundant; iron 7 percent.</td>
</tr>
<tr>
<td>Dolomite, as above; light-gray oolitic chert, abundant; quartz sand, common</td>
<td>Dolomite, light-gray, very dense, fine-grained; chert, as above, common; iron 5 percent.</td>
</tr>
<tr>
<td>Dolomite, as above, some arenaceous; chert, as above, some oolitic, abundant; green shale, common; a little quartz sand (partly caving)</td>
<td>Dolomite, brown, medium-grained; chert, abundant; iron 2 percent.</td>
</tr>
<tr>
<td>Dolomite, as above, some arenaceous; chert, as above, very common; shale, as above, common</td>
<td>Dolomite, light- and medium-gray, medium-grained; chert, as above, sparse; iron +1 percent.</td>
</tr>
<tr>
<td>Dolomite, as above, some arenaceous; light-gray chert, much is oolitic, very common</td>
<td>Dolomite, as above, medium-grained; chert, sparse; iron 1 percent.</td>
</tr>
<tr>
<td></td>
<td>Dolomite and chert, as above; iron +1 percent.</td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, sparse; iron + 1 percent.</td>
</tr>
<tr>
<td></td>
<td>Dolomite, as above; chert, sparse.</td>
</tr>
</tbody>
</table>
Prairie du Chien group--Continued
Oneota dolomite--Continued
Dolomite, gray-brown, medium-grained; chert, common; iron ½ percent........ 210-220
Dolomite, as above; chert, sparse to common; green shale, sparse; quartz sand (caving?), common .......... 220-225
Dolomite, as above; chert, common........ 225-230

Stell 5

Location: Sec. 6, T. 6 N., R. 1 E., Wis.; 1,475 ft S. 74°32 ft E. from Stell 1.
Collar elevation: 1,070.7 ft.
Total depth: 235 ft.
Depth to water: 135 ft.

[Percentages estimated]

Depth
(Feet)

Soil, residual clay, dolomite sand ........... 0-5

Platteville formation:
Pecatonica dolomite member:
Dolomite, buff and gray, medium-grained, arenaceous at base .................. 5-24
Glenwood shale member:
Shale, gray-green; phosphatic nodules, limonite and marcasite, common ........... 24-26

St. Peter sandstone:
Sandstone, quartz, light-gray and buff, medium except coarse near top and base .................. 26-106

Prairie du Chien group:
Shakopee dolomite:
Shale, green and light-buff; light-brown chert and light-brown dolomite, sparse ............. 108-110
Dolomite, gray-brown, fine- and medium-grained; quartz sand (caving), very common ............. 110-115

Prairie du Chien group--Continued
Shakopee dolomite--Continued
Dolomite, as above; brown oolitic chert, very abundant; trace of green shale .................. 115-120
Dolomite, as above; chert, as above, partly oolitic, abundant; green shale, common; quartz sand, common .......... 120-125
Dolomite, as above; chert, as above, common; quartz sand, common; iron +1 percent .......... 125-130

New Richmond sandstone(?):
Dolomite, as above, some is arenaceous; dolomitic quartz sandstone, common; chert, as above, oolitic, abundant; quartz sand 30 percent of sample; iron +1 percent .......... 130-135

Oneota dolomite:
Dolomite, as above, a little is arenaceous; chert, as above, a little is oolitic, common; brown and green shale, common; quartz sand 5 percent of sample; trace of glauconite .......... 135-140
Dolomite, as above; chert, as above, common; traces of green shale and quartz sand .............. 140-145
Dolomite, as above; chert, sparse to common; shale and quartz sand, as above .......... 145-150
Dolomite, as above; chert, very abundant .......... 150-155
Dolomite, as above; chert, very abundant .......... 155-160
Dolomite, as above; chert, sparse to common .......... 160-165
Dolomite, as above; chert, very abundant .......... 165-170
Dolomite, as above; chert, sparse to common .......... 170-175
Dolomite, brown, fine- and medium-grained; chert, abundant; iron 1 percent .......... 175-180
Dolomite, as above; chert, very abundant, iron +1 percent .......... 180-185
Dolomite, as above, medium-grained; chert, very abundant, iron 1 percent .......... 185-190
Prairie du Chien--Continued
Oneota dolomite--Continued

| Depth (feet) | Prairie du Chien--Continued
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>190-195</td>
<td>Dolomite, as above;</td>
</tr>
<tr>
<td></td>
<td>chert, very abundant;</td>
</tr>
<tr>
<td></td>
<td>iron 1 percent............</td>
</tr>
<tr>
<td>195-200</td>
<td>Dolomite, fine- and</td>
</tr>
<tr>
<td></td>
<td>medium-grained; chert,</td>
</tr>
<tr>
<td></td>
<td>very abundant; iron 2</td>
</tr>
<tr>
<td></td>
<td>percent....................</td>
</tr>
<tr>
<td>200-205</td>
<td>Dolomite, medium-grained;</td>
</tr>
<tr>
<td></td>
<td>chert, sparse to common</td>
</tr>
<tr>
<td></td>
<td>1 percent................</td>
</tr>
<tr>
<td>205-210</td>
<td>Dolomite, chert, sparse;</td>
</tr>
<tr>
<td></td>
<td>iron 9 percent............</td>
</tr>
<tr>
<td>210-215</td>
<td></td>
</tr>
</tbody>
</table>

Prairie du Chien--Continued
Oneota dolomite--Continued

| Depth (feet) | Prairie du Chien--Continued
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>215-220</td>
<td>Dolomite, gray, medium-</td>
</tr>
<tr>
<td></td>
<td>grained; chert, common;</td>
</tr>
<tr>
<td></td>
<td>quartz sand 25 percent</td>
</tr>
<tr>
<td></td>
<td>of sample; iron 5 percent</td>
</tr>
<tr>
<td>220-225</td>
<td>Dolomite, as above;</td>
</tr>
<tr>
<td></td>
<td>chert, sparse to common;</td>
</tr>
<tr>
<td></td>
<td>quartz sand 25 percent</td>
</tr>
<tr>
<td></td>
<td>of sample; iron 4 percent</td>
</tr>
<tr>
<td>225-230</td>
<td>Dolomite, as above;</td>
</tr>
<tr>
<td></td>
<td>chert, common;</td>
</tr>
<tr>
<td></td>
<td>quartz sand 7 to 8 percent</td>
</tr>
<tr>
<td></td>
<td>of sample; iron 2 percent</td>
</tr>
<tr>
<td>230-235</td>
<td>Dolomite, as above;</td>
</tr>
<tr>
<td></td>
<td>chert, sparse to common;</td>
</tr>
<tr>
<td></td>
<td>iron 3 percent............</td>
</tr>
</tbody>
</table>
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
PREPARED IN COOPERATION WITH THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
CIRCULAR 95, PLATE 1

EXPLANATION

Maquaketa shale
Og
Galena dolomite

Structure contour on top of chert, Galena dolomite
Dashed where approximately located

Strike and dip of beds
Geologic contact, approximately located

Drillhole elevation at top of collar, Galena dolomite

Churn-drill hole
Drilled by U. S. Geological Survey

Tete elevation at top of collar
The elevation at top of collar

COUNTY

Outcrop elevation at top of chert, Galena dolomite

L. H. GHER'S DIGGINGS
PROPERTY

GAYLOR
PROPERTY

INDEX MAP
SHOWING EXTENT
OF PROPERTIES

INDEX MAP
SHOWING LOCATION
OF HOLE

MAP OF THE TETE DES MORTS AREA SHOWING THE LOCATION OF THE HOLES
DRILLED BY THE U. S. GEOLOGICAL SURVEY
DUBUQUE AND JACKSON COUNTIES, IOWA

200
200
500
500
1000
1000
Ft
CROSS SECTIONS OF THE HOLES DRILLED BY THE
U.S. GEOLOGICAL SURVEY IN THE TETE DES MORTS AREA
DUBUQUE AND JACKSON COUNTIES, IOWA
CROSS SECTIONS OF THE HOLES DRILLED BY THE U. S. GEOLOGICAL SURVEY IN THE HIGHLAND AREA GRANT AND IOWA COUNTIES, WISCONSIN

Geology by Arthur E. Flint, 1951