GEOLOGICAL SURVEY CIRCULAR 231

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.

Rocks exposed in the district range from Early Ordovician to Middle Silurian in age, and, except for the St. Peter sandstone and the Maquoketa shale, consist mainly of dolomite. Structural compression has resulted in gentle folds and faults; principal trends are northwestward, northeastward, and eastward.

Galena (lead sulfide) has been mined principally from vertical joints in the upper, noncherty part of the Galena dolomite. On the other hand, sphalerite (zinc sulfide) and a minor amount of smithsonite (zinc carbonate) are found as veins, breccia ore, and disseminations in the lower, cherty part of the Galena dolomite, in strata of the Decorah formation, and in the upper beds of the Platteville formation; these "lower-run" ore bodies are in inclined reverse faults (pitches) and associated bedding-plane faults (flats) that are localized along synclinal trends. Lead and zinc minerals are found in beds of the Prairie du Chien group where they are exposed along the northern edge of the district.

Since 1942 the U. S. Geological Survey has been studying the geology of the zinc-lead district and has been mapping the structure, stratigraphy, and the occurrences of ore bodies. The program here described was centered 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 potentialities 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 lighology 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, 1947, 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 25 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.

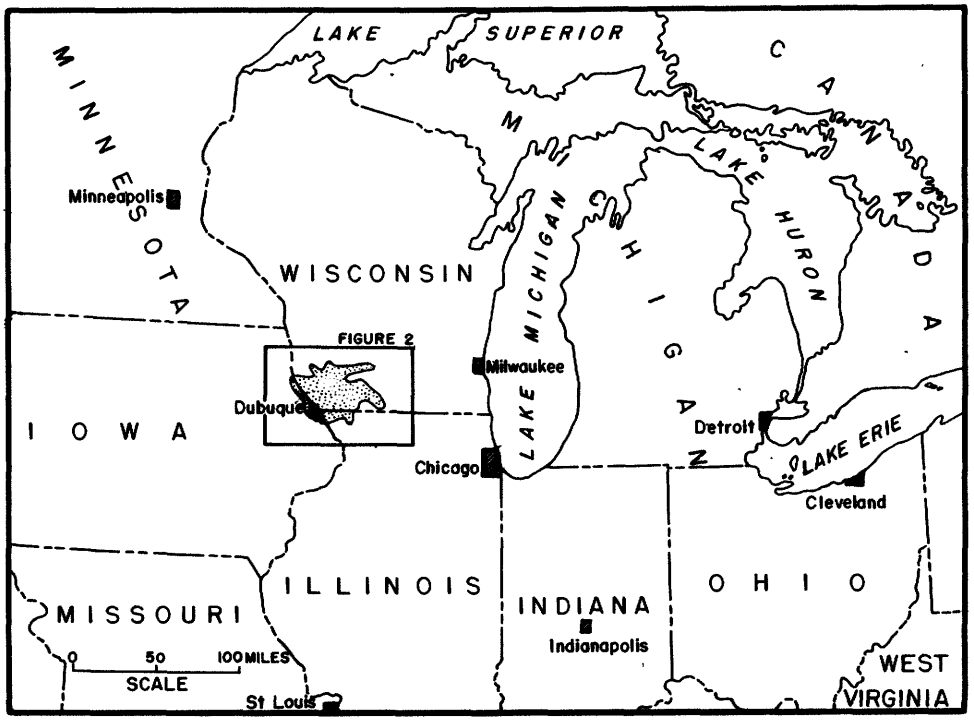

Figure 1.—Index map showing the location of the Wisconsin-Illinois-Iowa zinc-lead mineralized district.

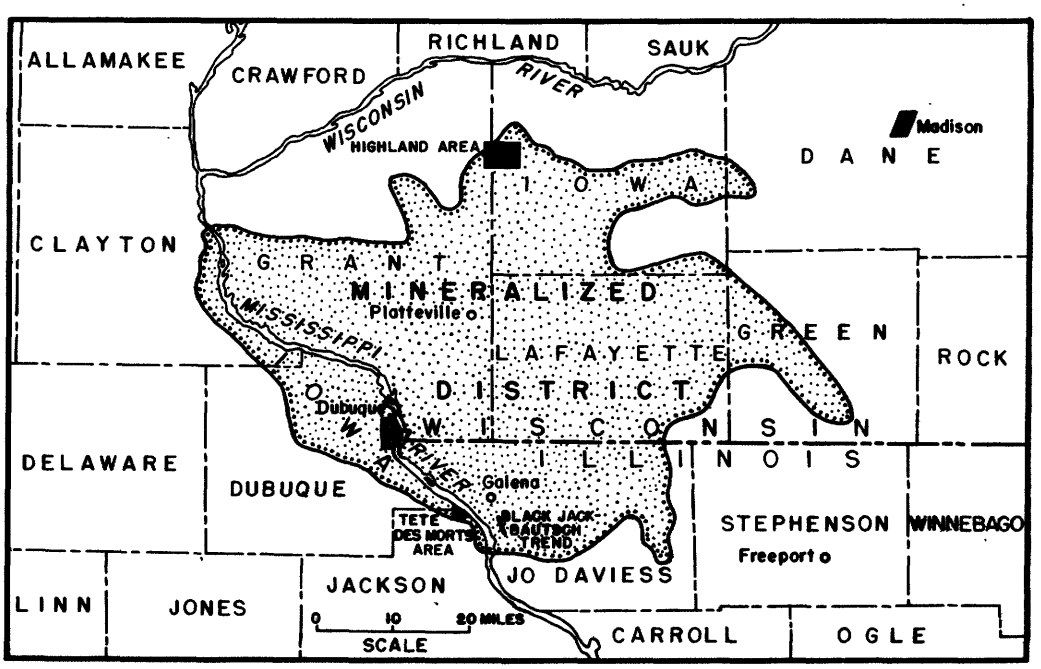

Figure 2.—Map showing the location of the Tete des Morts and Highland areas and the Black Jack-Bautsch trend.

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:

	Dominant lithology	Average thickness (feet)
Silurian system.		
Kankakee limestone of Savage (1916)-- Edgewood limestone----------	Dolomite, chert-----	150+
Ordovician system.		
Maquoketa shale----------	Shale, dolomite-----	105-200
Galena dolomite----------	Dolomite, chert-----	220-230
Decorah formation----------	Limestone, dolomite, chert.	35-45
Platteville formation----------	Limestone, dolomite, shale.	55-75
St. Peter sandstone---------- Prairie du Chien group----------	Sandstone---------- Dolomite, chert, shale, sandstone.	280-320
Cambrian system.		
Trempealeau formation----------	Dolomite, sandstone, siltstone.	120-150
Franconia sandstone----------	Sandstone, shale, siltstone.	110-140
Dresbach sandstone----------	Sandstone, shale, siltstone.	800-1000

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 northeastward and northwestward; 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.

Deposits 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),

who stated that by 1839 at least 15,000 pounds of lead ore had been raised from H. H. Gher's diggings (pl. 1). The Tete des Morts diggings, however, have never been very productive and have long since been abandoned. Lead ore has been mined in recent years from shafts on Kohlenberg's land and from shafts a mile and a half southeast of Gordon's Ferry. Zinc minerals were reported in one of the shafts on the Kohlenberg farm.

Before the drilling exploration, which will be described, a reconnaissance survey of the structural geology was made by Agnew and Flint along the Mississippi River bluff and back from the River, up the tributary valleys. Two synclines were found, one northeastward and the other northwestward in trend (pl. 1). Steep dips, a shattered zone in the rocks, and iron minerals indicative of a pitch zone were seen at the southeast end of the meander in the Tete des Morts River in sec. 3. Joint strikes were mapped, and the pattern showed general northwestward, northeastward, and eastward trends.

The lowest beds exposed in the Tete des Morts area are a few feet of cherty dolomite at the top of the lower, or cherty unit of the Galena dolomite. The upper, or noncherty beds of the Galena are seen along the bluffs of the Mississippi and Tete des Morts Rivers and provided most of the data for mapping the geologic structure. The lower beds of the Maquoketa shale are exposed in the upper reaches of a few small ravines.

Shafts and smaller pits, remnants of lead diggings that are as much as 100 years old, were also located by reconnaissance geologic mapping. The lithology of material on the dump indicated that the productive zone was stratigraphically above the top of the cherty unit of the Galena dolomite. Iron minerals in the exposure of the pitch zone along the Tete des Morts River ranged in stratigraphic position from a few feet below the top of the cherty beds upward for about 75 feet.

Between September 10, 1950, and February 15, 1951, two properties in Iowa were drilled; the drilling totaled 13 holes and 4,036 feet. Cuttings were sacked for every 5 feet of drilling and were examined with a binocular microscope. (Summary logs are included on pp. 11-36.)

Results of geologic mapping and exploratory drilling

Stratigraphy. —The St. Peter sandstone was penetrated in only one hole, Schenk 1, which cut through 18 feet of a quartz sandstone (fig. 3). A pyrite-cemented streak was found in the upper part of the unit; however, such streaks are common in the St. Peter in the upper Mississippi Valley district and have no known significance concerning the proximity of ore bodies.

The Platteville formation is 64 feet thick in Schenk hole 1, the only hole penetrating the base of this formation. In this hole the lower part of the Platteville formation consists of light-brown dolomite (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 Guttenberg limestone member, is brown limestone and shale, called "oil rock"; and the upper two, which constitute the Ion 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, W½NE¼SE¼ 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.

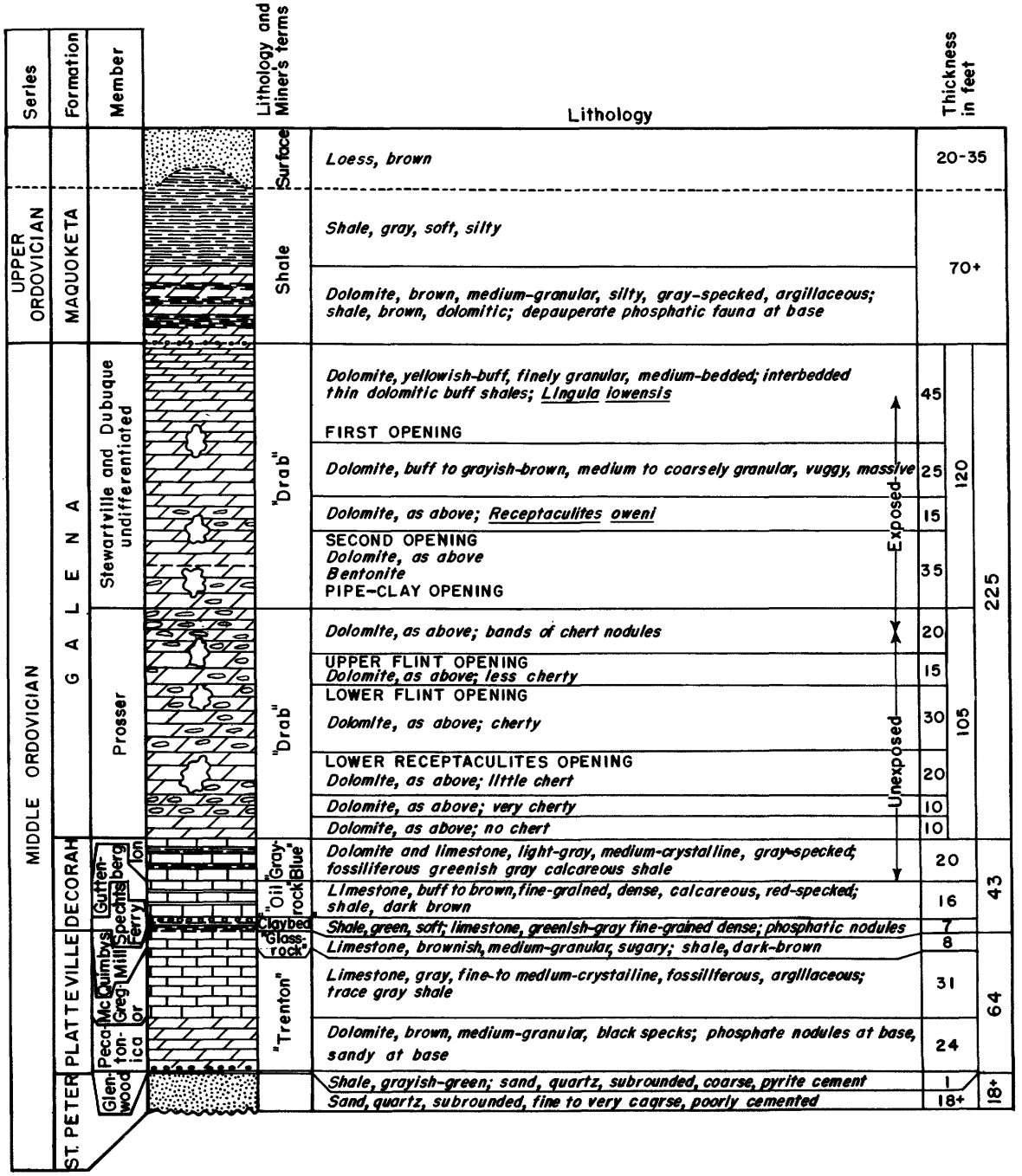

Figure 3.—Stratigraphic column of the Tete des Morts area, Dubuque and Jackson Counties, Iowa.

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 alined 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 alinement 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

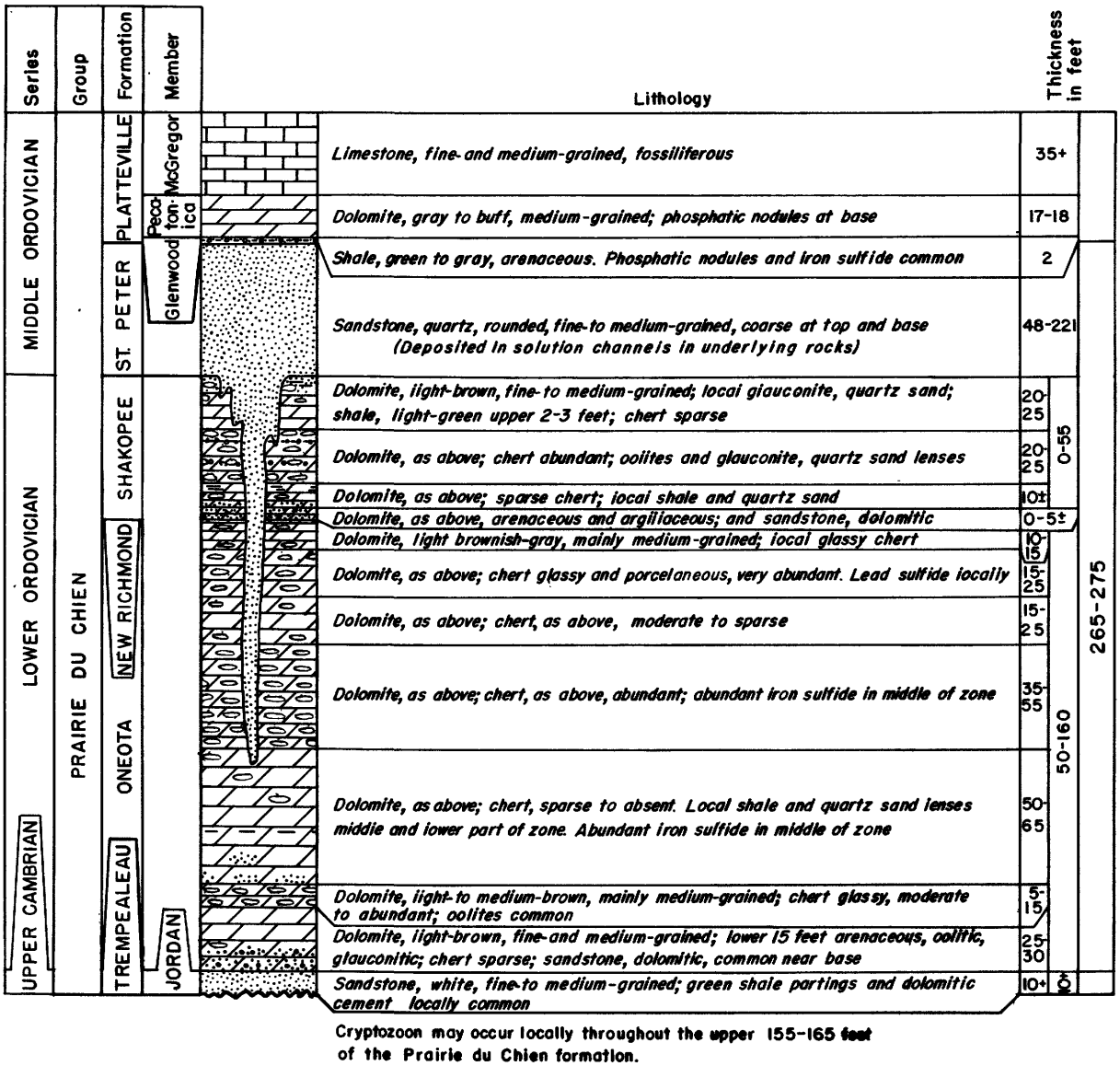

Figure 4. —Stratigraphic column of the Highland area, Grant and Iowa Counties, Wis.

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 W½SE¼ sec. 31, T. 7 N., R. 1 E., 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 was begun. 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 subround 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 nor 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 to 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 (cryptozoon) 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 8 feet thick, covers the area.

Results of geologic mapping

Evidences of mineralization. —Considerable float galena in many of the stream beds in the E½ sec. 31 and the NW¼ sec. 32, T. 7 N., R. 1 E., and in the SW¼NW¼ 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 NW¼NW¼ 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 SW¼SE¼ sec. 31, T. 7 N., R. 1 E., and a lesser amount is in the stream valley in the SW¼NW¼ 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 upper 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 homocline. 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 alined 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, N½ sec. 6, T. 6 N., R. 1 E., five on the Williams property, SE¼ sec. 31, T. 7 N., R. 1 E., and two on the Wiest property, S½ 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 25 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-Platteville 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.

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Tete des Morts area, Jackson and Dubuque Counties, Iowa

Schenk 1

Location: 3,470 ft north, 1,510 ft east of southwest corner, sec. 3, T. 87 N., R. 4 E., Iowa.
Driller: John Hauser, Sept. 21 to Oct. 5, 1950.
Collar elevation: 702.4 ft.
Total depth: 362 ft.
Depth to water: 45, 137½ ft.
Sample study and logging: A. F. Agnew, Oct. 5, 1950.

	Depth (feet)
Surficial:	
Soil, loess, dark-brown, silty	0 - 35[1]
Galena dolomite:	
Noncherty unit:	
Dolomite, light yellowish-buff, medium-granular, in part crystalline, cinnamon-specked	35 - 57½
Dolomite, orange-brown, coarsely crystalline	57½ - 70
Dolomite, light-brown	70 - 92½
Dolomite, as above, in part medium-granular	92½-100
Dolomite, medium-granular, in part crystalline, dense	100 -117½
Dolomite, as above, red-specked	117½-132½
Cherty unit:	
Dolomite, as above; chert, estimated as 30 percent or less	132½-155
Dolomite, drab to brown, coarsely crystalline; drab chert, estimated as 10 percent or less	155 -167½
Dolomite, buff-drab, coarsely crystalline; gray to white chert, estimated as 25 percent or less	167½-175
Dolomite, light-brown to grayish-brown; brown chert, estimated as 20 percent or less	175 -190
Dolomite, brown, coarsely crystalline; white chert, estimated as 25 percent or less	190 -197½
Dolomite, as above; chert, estimated as 5 percent or less	197½-217½
Dolomite, as above; chert, estimated as 40 percent or less	217½-236
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 -262½
Limestone, brown to light-brown, finely crystalline, dense, red-specked; fossiliferous	262½-275
Spechts Ferry shale member ("clay bed"):	
Shale, green, hard, black-specked	275 -282½
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	282½-290
McGregor limestone member ("Trenton"):	
Limestone, dolomite, grayish-brown, silty, slightly mottled brown; fossiliferous; trace of gray hard shale	290 -297½
Limestone, light-brown, fine-grained, dense; fossiliferous; grayish-olive hard brown-streaked shale	297½-302½
Limestone, grayish, fine-grained, dense, silty	302½-307½

[1] Driller's log shows 0-22 feet surficial.

	Depth (feet)
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 cemented	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: SE¼NW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 123 feet N. 15° E. from Schenk 1.
Drillers: John Hauser, Michael Griffin, Oct. 6 to Oct. 17, 1950.
Collar elevation: 730.0 ft.
Total depth: 350 ft.
Depth to water: 140 ft.
Sample study and logging: A. F. Agnew, Nov. 1950.

	Depth (feet)
Surficial:	
Loess	0 - 40
Loess; trace of buff granular dolomite	40 - 50[1]

[1] Drillers' log shows 0-40 feet surficial.

	Depth (feet)
Galena dolomite:	
Noncherty unit:	
Dolomite, light-gray, medium-granular; yellowish coarsely granular cinnamon specked dolomite	50- 60
Dolomite, buff to brown, fine- to medium-grained, 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	215-262
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 mottled, 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

	Depth (feet)
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

Depth (feet)	Percent
160-165	2
165-170	4
170-175	3
175-180	3
180-185	4
185-190	5
190-195	5
195-200	4
200-205	1
205-210	1
210-215	Tr.
295-300	Tr.
300-304	2
304-305	--

Schenk 3

Location: SE¼NW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 113 ft S. 20° 45 ft W. from Schenk 1.
Driller: John Hauser, Oct. 18 to Oct. 27, 1950.
Collar elevation: 719.7 ft.
Total depth: 351 ft.
Depth to water: 95,145 ft.
Sample study and logging: A. F. Agnew, Dec. 1950.

	Depth (feet)
Surficial:	
Loess	0-45[1]
Galena dolomite:	
Noncherty unit:	
Dolomite, gray, medium-granular; yellowish-brown coarsely granular very cinnamon-specked dolomite	45-50
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	265-286
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; argillaceous. Grayish medium-granular silty dolomite	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

Depth (feet)	Percent
165 -170	3
170 -175	4
175 -180	3
180 -182½	4
182½-185	.75
185 -190	2
190 -195	2
195 -200	1

[1] Driller's log shows 0-37 feet surficial.

Schenk 3--Continued

Estimated iron content--Continued

Depth (feet)	Percent
200 -205	.25
205 -210	Tr.
210 -215	.75
215 -220	---
220 -225	1
225 -230	Tr.
295 -300	.5
300 -305	1
305 -307½	1.5
307½-310	1
340 -345	.25
345 -350	Tr.

Schenk 4

Location: SE¼NW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 216 ft S. 22° W. from Schenk 1.
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.
Sample study and logging: A. F. Agnew, Dec. 20, 1950.

	Depth (feet)
Surficial:	
Loess, brown	0- 35
Loess; glacial sand, quartz, chert, quartzite, jasper, coarse to very coarse, subangular	35- 52[1]
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

[1] Driller's log shows 0-50 feet surficial.

	Depth (feet)
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	321-326
McGregor limestone member	
("Trenton"):	
Limestone, buffish-gray, mottled, finely granular, silty	326-335

Estimated iron content

Depth (feet)	Percent
50- 55	0.5
55- 60	2
60- 65	Tr.
170-175	Tr.
175-180	.25
180-185	2
185-190	.75
190-195	Tr.
195-200	.5
200-205	.25
205-210	.75
210-215	.5
215-220	.5

Schenk 4--Continued

Estimated iron content--Continued

Depth (feet)	Percent
220-225	Tr.
305-315	---
315-320	1
320-325	---

Schenk 5

Location: SE¼NW¼ 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.
Sample study and logging: A. F. Agnew, Jan. 1951.

	Depth (feet)
Surficial:	
Loess, brown	0-35
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[1]
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 subrounded quartz	308-310
Guttenberg limestone member ("oil rock"):	
Limestone, light-brown to tan, fine-grained, dense; fossiliferous; dark-brown argillaceous matter	310-323

[1] Drillers' log shows 0-57 feet surficial.

	Depth (feet)
Decorah formation--Continued	
Spechts Ferry shale member ("clay bed"):	
Shale, green; limestone, brown, phosphate nodules; trace of light-gray bentonite	323-330
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]

Depth (feet)	Percent
50-55	---
55-60	3
60-65	Tr.
65-70	1
770-75	---
125-130	Tr.
130-135	1
135-140	Tr.
185-190	.25
190-195	5
195-200	4
200-205	5
205-210	Tr.
280-285	---
285-290	.5
290-295	.25
295-300	Tr.
315-320	Tr.
320-325	.25
325-330	.75
330-335	.25
335-340	Tr.

Schenk 6

Location: SE¼NW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 252 ft N. 24° E. from Schenk 1.
Driller: John Hauser, Nov. 30 to Dec. 14, 1950.
Collar elevation: 733.7 ft.
Total depth: 315 ft.
Depth to water: 150 ft.
Sample study and logging: A. F. Agnew, Dec. 1950.

	Depth (feet)
Surficial:	
Loess, brown; trace of depauperate pebbles at base	0-35

	Depth (feet)
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	264-277
("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]

Depth (feet)	Percent
165-170	0.25
170-175	--
175-180	2
180-185	1
185-190	.5

Schenk 6--Continued

Estimated iron content--Continued

Depth (feet)	Percent
190-195	1
195-200	.75
200-205	Tr.
210-215	.25
215-220	Tr.
220-225	.5
225-230	1
230-235	Tr.
265-270	Tr.
270-275	.5
275-280	.25
280-285	Tr.
285-290	1
290-295	Tr.
300-305	.25
305-310	1
310-315	.5

Schenk 7

Location: NE¼SW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 1,086 ft S. 32° 30 ft E. from Schenk 1.
Drillers: John Hauser, Gilbert Reiter, Dec. 21, 1950, to Jan. 5, 1951.
Collar elevation: 720.0 ft.
Total depth: 312 ft.
Depth to water: - - -
Sample study and logging: A. F. Agnew, Jan. 16, 1951.

	Depth (feet)
Surficial:	
Loess, brown	0- 25[1]
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 feet surficial.

	Depth (feet)
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

Depth (feet)	Percent Iron	Percent Manganese
145-150	Tr.	---
150-155	0.5	---
155-160	2	Tr.
160-165	6	1
165-170	7	1
170-175	6	1
175-180	5	.25
180-185	4	Tr.
185-190	3	Tr.
190-195	Tr.	---

Schenk 8

Location: SE¼NW¼ sec. 3, T. 87 N., R. 4 E., Iowa; 1,240 ft S. 47° 45 ft E. from Schenk 1.
Drillers: John Hauser, Robert Dagenhardt, Jan. 10 to Jan. 18, 1951.
Collar elevation: 718.4 ft.
Total depth: 301 ft.
Depth to water: 125 ft.
Sample study and logging: A. F. Agnew, Feb. 27, 1951.

	Depth (feet)
Surficial:	
Loess, brown	0- 25[1]
Galena dolomite:	
Noncherty unit:	
Dolomite, yellowish-brown, medium-granular, crystalline	25-140
Cherty unit:	
Dolomite, grayish-brown; chert	140-250

[1]Drillers' log shows 0-30 feet surficial.

	Depth (feet)
Decorah formation:	
Ion dolomite member ("gray" beds):	
Dolomite, gray, medium-granular, and buff, medium-crystalline, gray-specked; some greenish argillaceous matter	250-260
("blue" beds):	
Limestone, gray, medium-crystalline, very fossiliferous; in part sandy; greenish argillaceous and shaly material	260-270
Guttenberg limestone member ("oil rock"):	
Limestone, cream to buff, fine-grained, dense, fossiliferous; brown shale	270-285
Spechts Ferry shale member ("clay bed"):	
Shale, green, flaky, soft; very fossiliferous. Light-greenish fine-grained limestone containing phosphate nodules	285-290
Platteville formation:	
Quimbys Mill member ("glass rock"):	
Limestone, tan to dark-brown, fine-grained, dense; brownish argillaceous areas. Dark-brown shale	290-300
McGregor limestone member ("Trenton"):	
Limestone, gray, finely granular, sugary	300-301

Schenk 9

Location: SW¼NE¼ sec. 3, T. 87 N., R. 4 E., Iowa; 1,634 ft S. 62° E. from Schenk 1.
Driller: Robert Dagenhardt, Jan. 20 to Jan. 31, 1951.
Collar elevation: 720.4 ft.
Total depth: 305 ft.
Depth to water: 125 ft.
Sample study and logging: A. F. Agnew, Feb. 27, 1951.

	Depth (feet)
Surficial:	
Loess, brown	0- 38[1]
Galena dolomite:	
Noncherty unit:	
Dolomite, light-brown, medium-granular	38-140
Cherty unit:	
Dolomite, grayish-brown; grayish-brown chert	140-250

[1]Driller's log shows 0-35 feet surficial.

	Depth (feet)
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.
Drillers: John Hauser, Gilbert Reiter, Dec. 6 to Dec. 26, 1950.
Collar elevation: 732.0 ft.
Total depth: 244 ft.
Depth to water: 215 ft.
Sample study and logging: A. F. Agnew, Jan. 16, 1951.

	Depth (feet)
Surficial:	
Loess, brown; glacial sand	0- 16[1]
Galena dolomite:	
Noncherty unit:	
Dolomite, yellowish-brown, medium-granular; in part silty	16- 60
Dolomite, as above; caramel dull chert (high-level gravel caved)	60-105
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
Decorah formation:	
Ion dolomite member	
("gray" beds):	
Limestone, light-brownish, medium-granular; in part gray-specked; much calcite; trace of olive-green black-specked silty shale	[231-240]
[No sample]	[240-244]

[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

Depth (feet)	Percent
180-185	Tr.
185-190	1
190-195	2

Kohlenberg 1--Continued

Estimated iron content--Continued

Depth (feet)	Percent
195-200	5
200-205	2
205-210	1
210-215	1

Kohlenberg 2

Location: NE¼NE¼ sec. 4, T. 87 N., R. 4 E., Iowa; 442 ft N. 44° E. from Kohlenberg 1.
Driller: John Hauser, Dec. 28, 1950, to Jan. 9, 1951.
Collar elevation: 689.0 ft.
Total depth: 245 ft.
Depth to water: 110 ft.
Sample study and logging: A. F. Agnew, Jan. 16, 1951.

	Depth (feet)
Galena dolomite:	
Noncherty unit:	
Dolomite, yellowish-buff, medium-granular, silty	0- 90[1]
Cherty unit:	
Dolomite, as above, mottled; chert	90-165
Dolomite, calcareous, light-brown, medium-granular, crystalline; white medium-crystalline 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
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

[1] Driller's log shows 0-2½ feet surficial.

Kohlenberg 3

Location: SE¼SE¼ sec. 33, T. 88 N., R. 4 E., Iowa; 965 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.
Sample study and logging: A. F. Agnew, Feb. 28, 1951.

	Depth (feet)
Surficial:	
Loess, brown	0- 15
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

Kohlenberg 4

Location: NE¼NE¼ sec. 4, T. 87 N., R. 4 E., Iowa; 42 ft N. 44°31 ft W. from Kohlenberg 1.
Driller: John Hauser, Jan. 25 to Feb. 15, 1951.
Collar elevation: 734.5 ft.
Total depth: 287 ft.
Depth to water: ---
Sample study and logging: A. F. Agnew, Feb. 28, 1951.

	Depth (feet)
Surficial:	
Loess, glacial sand	0- 20
Galena dolomite:	
Noncherty unit:	
Dolomite, buff, medium-granular, cinnamon-specked; trace of Silurian-type chert (caving)	20-130
Cherty unit:	
Dolomite, as above; chert	130-205
Dolomite, as above; white medium-crystalline limestone	205-233
Decorah formation:	
Ion dolomite member ("gray" beds):	
Limestone, light-gray to buff, medium-crystalline, gray-specked; green and olive silty shale	233-248
("blue" beds):	
Limestone, light-gray, finely crystalline, mottled, fossiliferous, sandy	248-253
Guttenberg limestone member ("oil rock"):	
Limestone, cream to tan, finely crystalline, granular, dense, brown-specked, fossiliferous	253-270
Spechts Ferry shale member ("clay bed"):	
Shale, green, fossiliferous, phosphate nodules	270-275
Platteville formation:	
Quimbys Mill member ("glass rock"):	
Calcareous rock flour, tan; trace of dark-brown shale	275-286
McGregor limestone member ("Trenton"):	
Limestone, gray, finely granular	286-287

Estimated manganese content

Depth (feet)	Percent
235-240	3

Highland area, Iowa and Grant Counties, Wis.

Wiest 1

Location: 1,130 ft north, 1,805 ft east of southwest corner, sec. 29, T. 7 N., R. 1 E., Wis.
Drillers: J. Hauser, R. Dagenhardt, Mar. 22 to Apr. 14, 1951.
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.

[Percentages estimated]

	Depth (feet)
Soil, residual clay	0- 3
Platteville formation:	
Glenwood shale member:	
Shale, gray-green, partly arenaceous	3- 5
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	5-107
Prarie du Chien group:	
Shakopee dolomite:	
Dolomite, buff, fine- and medium-grained; green arenaceous shale, very common; chert, sparse; quartz sand (caved), common	107-115
Dolomite, as above; oolitic chert, abundant; green shale, caving(?) common; quartz sand, caved, common; iron 1 percent	115-120
Dolomite, as above, partly arenaceous; chert, as above; quartz sand, common; iron 1 percent	120-125
Dolomite, buff, fine-grained; oolitic chert, very common; quartz sand, common; iron ½ percent	125-130

	Depth (feet)
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 -½ 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 -½ 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.
Drillers: R. Dagenhardt, J. Dagenhardt, May 3 to May 17, 1951.
Collar elevation: 1,083.4 ft.
Total depth: 235 ft.
Depth to water: ----
Sample study and logging: Arthur E. Flint, May 27, 1951.

[Percentages estimated]

	Depth (feet)
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

	Depth (feet)
Prairie du Chien group--Continued	
Shakopee dolomite--Continued	
Dolomite, as above, fine- and medium-grained; oolitic chert, abundant; quartz sand, sparse; iron -1 percent	70-75
Dolomite, chert, and quartz sand, as above	75-80
Dolomite, as above; partly colitic chert; quartz sand as above; iron -1 percent	80-85
Dolomite and chert, as above; quartz sand, common; green shale, sparse; iron -1 percent	85-90
Dolomite, as above; chert, as above, abundant; red-brown shale, very common; quartz sand, sparse; iron 1 percent	90-95
Dolomite, as above, partly arenaceous; chert, common; iron -1 percent	95-100
Dolomite, as above; chert, very common; green shale and quartz sand, sparse	100-105
Dolomite, nonarenaceous, and chert, as above; quartz sand, sparse; iron -1 percent	105-110
Dolomite, brown, fine- and medium-grained; chert, common; iron +1 percent	110-115
Dolomite and chert, as above; quartz sand, common; iron -1 percent	115-120
New Richmond sandstone(?):	
Dolomite, as above, partly arenaceous; green-brown arenaceous shale, common; chert, common; iron -1 percent	120-125
Oneota dolomite:	
Dolomite, as above; chert, abundant; iron -1 percent	125-130
Dolomite, brown, fine- and medium-grained; chert, common	130-135
Dolomite, as above; chert, as above, sparse to common	135-140
Dolomite, as above; chert, as above; iron -1 percent	140-145
Dolomite, as above; chert, abundant; red-brown shale, sparse to common; iron 3 percent	145-150

	Depth (feet)
Prairie du Chien group--Continued	
Oneota dolomite--Continued	
Dolomite, gray-brown, fine- and medium-grained; chert, abundant; iron 5 percent	150-155
Dolomite, as above; chert, very abundant; iron 6 percent	155-160
Dolomite, as above; chert, abundant; iron 2 percent; trace of zinc	160-165
Dolomite, gray, medium-grained; chert, very abundant; iron 1 percent; trace of zinc	165-170
Dolomite and chert, as above; iron 1 percent; trace of zinc	170-175
Dolomite, as above; chert, sparse to common; iron +1 percent	175-180
Dolomite, as above; chert, sparse; iron +1 percent	180-185
Dolomite and chert, as above; iron -1 percent	185-190
Dolomite, as above; iron -1 percent	190-195
Dolomite, as above; chert, sparse to common	195-200
Dolomite, as above; chert, sparse	200-205
Dolomite and chert, as above; iron 1 percent	205-210
Dolomite, as above; gray shale, very common; iron -1 percent	210-215
Dolomite, gray, medium-grained, granular; gray shale, abundant	215-220
Dolomite, as above; chert, sparse	220-225
Dolomite, as above; chert, sparse to common; iron ½ percent	225-230
Dolomite, as above; chert, sparse	230-235

Williams 1

Location: 1,455 ft north, 1,700 ft west of southeast corner, sec. 31, T. 7 N., R. 1 E., Wis.
Driller: R. Dagenhardt, Feb. 22 to Mar. 5, 1951.
Collar elevation: 1,116.6 ft.
Total depth: 330 ft.
Depth to water: 50 ft.
Sample study and logging: Arthur E. Flint, Mar. 10, 1951.

[Percentages estimated]

	Depth (feet)
Soil, residual clay, weathered limestone fragments	0-5

	Depth (feet)
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:	
Shakopee dolomite:	
Shale, light-green and gray; oolitic and arenaceous chert, common; limonite, common	123-125
Dolomite and dolomitic siltstone, buff, fine-grained; oolitic chert, very abundant; green shale, common; quartz sand (caving) and limonite, common; trace of glauconite	125-130
Dolomite, light-brown, some arenaceous, fine- and medium-grained; chert, much is oolitic, abundant; gray and green shale, very common	130-135
Dolomite, as above; chert, some oolitic, very common	135-140
Dolomite, as above; chert, very common; quartz sand cememted with silica, very common	140-145
Dolomite, as above, much is arenaceous, and dolomitic sandstone; chert, sparse; quartz sand, common	145-150
New Richmond sandstone(?):	
Dolomite, as above; chert, sparse; green shale, common; quartz sand cemented with limonite, common	150-155

	Depth (feet)
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; green shale, sparse	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 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 -½ 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

	Depth (feet)
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; iron -1 percent	265-270
Dolomite, brown, medium-grained; chert, some oolitic, sparse to common; quartz sand, common	270-275
Dolomite, as above; chert, sparse; gray arenaceous shale, sparse to common; quartz sand, common	275-280
Dolomite, as above; chert, sparse; quartz sand, very common	280-285
Dolomite, as above; chert, oolitic, very common; quartz sand, sparse	285-290
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 ft W. from Williams 1.
Driller: R. Dagenhardt, Mar. 7 to Mar. 16, 1951.
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]

	Depth (feet)
Soil, residual clay, weathered limestone	0- 5
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

	Depth (feet)
Prairie du Chien group--Continued	
Shakopee dolomite--Continued	
Dolomite, as above, much is arenaceous; chert, some is oolitic, abundant; shale, as above, common to very common	110-120
Dolomite, gray, as above, little is arenaceous; chert, as above, common; trace of glauconite; shale, as above, common	120-125
Dolomite, as above; chert, sparse to common; shale, as above, very common; trace of glauconite	125-130
Dolomite, as above; chert, sparse; shale, as above, common	130-135
New Richmond sandstone(?):	
Dolomite, gray and brown, fine- and medium-grained, much is arenaceous; chert, sparse; green shale, common; a little quartz sand	135-140
Oneota dolomite;	
Dolomite, as above; chert and gray shale, sparse	140-145
Dolomite, as above, partly arenaceous; chert, abundant	145-150
Dolomite, brown and buff, fine- and medium-grained; chert, abundant; gray-green shale, sparse; lead ½ percent	150-155
Dolomite, as above; chert, common; green shale, sparse; trace of lead	155-160
Dolomite, as above, partly arenaceous; gray-green shale, sparse to common; chert, sparse	160-165
Dolomite, as above, non-arenaceous; chert, abundant; trace of green shale; iron 1 percent	165-170
Dolomite, as above; chert, abundant; iron 1 percent	170-175
Dolomite, as above; chert, very common	175-180
Dolomite, gray, fine- and medium-grained; chert, very common; green shale, sparse to common; iron +3 percent	180-185
Dolomite, as above; chert, abundant; iron +3 percent	185-190

	Depth (feet)
Prairie du Chien group--Continued	
Oneota dolomite --Continued	
Dolomite, as above; chert, abundant; iron +2 percent	190-195
Dolomite, as above: chert, sparse to common; iron +2 percent	195-200
Dolomite, as above; chert, common to sparse; iron -1 percent; trace of lead	200-205
Dolomite, as above; chert, sparse; iron ½ percent	205-210
Dolomite, as above; chert, common to sparse	210-215
Dolomite, as above; chert, sparse; iron 1 percent	215-220
Dolomite, as above; chert, sparse; iron -1 percent; trace of lead	220-225
Dolomite, brown, medium-grained; chert, sparse to common; iron -1 percent	225-230
Dolomite and chert, as above; gray-green shale, very common; quartz sand, common; trace of glauconite; iron -1 percent	230-235
Dolomite, as above; chert and shale; sparse	235-240
Dolomite, gray, fine- and medium-grained	240-245
Dolomite, as above; trace of arenaceous green shale; dolomitic sandstone, common to sparse	245-250
Dolomite, brown, medium-grained; green arenaceous shale, common; quartz sand, sparse	250-255
Dolomite, as above; trace of chert and green shale; quartz sand, sparse	255-265
Dolomite, as above; chert, partly oolitic, very common	265-275
Dolomite, as above	275-280
Dolomite, as above, arenaceous	280-290
Dolomite, as above, arenaceous and oolitic; trace of chert, oolitic	290-295

Williams 3

Location: Sec. 31, T. 7 N., R. 1 E., Wis.; 265 ft S. 43° E. from Williams 1.
Driller: R. Dagenhardt, Mar. 17 to Mar. 30, 1951.
Collar elevation: 1,093.3 ft.
Total depth: 290 ft.
Depth to water: 155 ft.
Sample study and logging: Arthur E. Flint, Mar. 3, 1951.

[Percentages estimated]

	Depth (feet)
Soil, residual clay, weathered limestone	0- 8
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 -½ 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 -½ percent	230-235

	Depth (feet)
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.
Total depth: 280 ft.
Depth to water: 145 ft.
Sample study and logging: Arthur E. Flint, Apr. 20, 1951.

[Percentages estimated, except where assay values are indicated]

	Depth (feet)
Soil, residual clay and chert	0- 8
Platteville formation:	
Glenwood shale member:	
Shale, gray-green, oxidized in part to red	8-10
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, fine- 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

	Depth (feet)
Prairie du Chien group--Continued	
Oneota dolomite--Continued	
Dolomite, as above; chert, sparse; trace of lead	125-130
Dolomite, gray, medium-grained; chert, sparse	130-140
Dolomite, as above, fine- and medium-grained; glauconitic chert, abundant	140-150
Dolomite, brown, very fine and medium-grained, partly arenaceous; chert, abundant	150-155
Dolomite, as above; chert, very abundant; iron 2 percent; lead ½ percent	155-165
Dolomite, as above; chert, very abundant; green shale, sparse; iron 2 percent; trace of lead	165-175
Dolomite and chert, as above; iron 1 percent; lead ½ percent	175-180
Dolomite, as above; chert, abundant; iron ½ percent; trace of lead	180-185
Dolomite and chert, as above; iron ½ percent	185-190
Dolomite, as above; chert, very common; iron ½ percent; trace of lead	190-195
Dolomite, gray, fine- and medium-grained; chert, sparse; trace of lead	195-200
Dolomite, as above, medium-grained; chert, sparse	200-205
Dolomite, as above; chert, common to sparse; iron assayed 12.65 percent of sample; zinc assayed trace	205-210
Dolomite and chert, as above; iron 8 percent	210-215
Dolomite and chert, as above; iron 6 percent	215-220
Dolomite, as above; chert, sparse; iron 2 percent	220-225
Dolomite and chert, as above; iron 1 percent	225-230
Dolomite and chert, as above; iron 2 percent	230-235

	Depth (feet)
Prairie du Chien--Continued	
Oneota dolomite--Continued	
Dolomite, brown, medium-grained; chert, sparse; iron 1 percent	235-240
Dolomite, as above	240-250
Dolomite, as above; partly oolitic chert, very abundant	250-255
Dolomite, as above; chert and quartz sand, sparse to common	255-260
Dolomite, as above; partly oolitic chert, common; quartz sand, sparse	260-265
Dolomite, as above; partly oolitic chert, common to sparse	265-270
Dolomite, brown, medium-grained, arenaceous, partly glauconitic; quartz sand common; trace of iron	270-275
Dolomite, as above, arenaceous, and oolitic; partly oolitic chert, sparse; quartz sand, sparse	275-280

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]

	Depth (feet)
Soil, alluvium, silt and fine quartz sand	0- 5
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

	Depth (feet)
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 glauconitic shale, common; quartz sand, sparse	95-100
Dolomite, as above, partly arenaceous; chert and quartz sand, sparse; 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 -½ percent.	140-145

	Depth (feet)
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 ½ 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 -½ percent	220-225
Dolomite, light-buff, medium-grained; white decomposed chert, sparse; iron ½ percent	225-230
Dolomite, brown-gray, medium-grained; chert, sparse	230-235
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 -½ 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 -½ percent	270-275

Steil 1

Location: 165 ft south, 1,685 ft east of northwest corner, sec. 6, T. 6 N., R. 1 E., Wis.
Driller: John Hauser, Feb. 22 to Mar. 1, 1951.
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]

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

	Depth (feet)
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

Steil 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]

	Depth (feet)
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

	Depth (feet)
Prairie du Chien group--Continued	
Shakopee dolomite--Continued	
Dolomite, brown-gray and buff, fine- and medium-grained; chert, much is oolitic, very common; quartz sand (caving), common	140-145
Dolomite, light-buff, some oolitic, very common; light-gray chert, much is oolitic, 70 percent of sample; glauconitic shale and quartz sand, sparse	145-150
Dolomite, as above; partly oolitic chert, very common; traces of quartz sand and glauconite	150-155
Dolomite, as above, some arenaceous; chert, as above, very common; traces of quartz sand and green shale	155-160
Dolomite, as above; chert, common; iron -1 percent; lead assayed 0.45 percent	160-165
New Richmond sandstone(?):	
Dolomite, as above; chert, common to sparse; shale and quartz sand, common; iron +1 percent; lead assayed 0.6 percent	165-170
Oneota dolomite:	
Dolomite, as above; some chert; traces of glauconite; lead assayed 0.5 percent	170-175
Dolomite as above; chert, as above; lead assayed (175 to 177½ feet) 1.25 percent; (177½-180 feet) 1.20 percent	175-180
Dolomite, as above, medium-grained; chert, much is oolitic, very common; lead assayed (180 to 182½ feet) 0.5 percent; (182½ to 185 feet) 0.85 percent	180-185
Dolomite, as above; chert, common; lead 0.25 percent	185-190
Dolomite, as above; chert, common; iron -1 percent; trace of lead	190-195
Dolomite, as above; chert, abundant	195-200

	Depth (feet)
Prairie du Chien group--Continued	
Oneota dolomite--Continued	
Dolomite, as above, a little is arenaceous; chert, sparse; trace of glauconite	200-205
Dolomite, light-brown, medium-grained; chert, abundant; iron 2 percent; trace of glauconite	205-210
Dolomite, as above; chert, very abundant; iron 2 percent	210-215
Dolomite, brown and medium-gray, medium-grained; chert very abundant; light-gray shale, common; iron +1 percent	215-220
Dolomite, as above; chert, common	220-225
Dolomite, gray, medium-grained; chert, common	225-230
Dolomite, as above; chert, sparse; trace of zinc	230-235
Dolomite, as above; chert, sparse; iron +1 percent	235-240
Dolomite, as above; trace of chert; iron 1 percent	240-245
Dolomite and chert, as above; trace of iron	245-250
Dolomite and chert, as above; iron 4 percent	250-255
Dolomite and chert, as above; iron 3 percent	255-260
Dolomite, light-gray, granular; chert, sparse; iron 2 percent; trace of zinc	260-265
Dolomite, brown-gray, medium-grained; chert, sparse; iron 2 percent	265-270
Dolomite, as above; chert, sparse; gray shale, sparse; iron 1 percent	270-275
Dolomite, as above; chert, sparse; iron -1 percent; trace of zinc	275-280
Dolomite, as above; chert, sparse; some gray-green shale	280-285
Dolomite, brown, medium-grained	285-290
Dolomite, as above	290-300
Dolomite, as above; but partly oolitic and arenaceous; light-brown chert, common	300-305
Dolomite, as above; chert, some is oolitic, common; quartz sand, 5 percent of sample; trace of glauconite	305-310

	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.
Driller: R. Dagenhardt, Apr. 28 to May 4, 1951
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

	Depth (feet)
St. Peter sandstone:	
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	20- 72
Prairie du Chien group:	
Shakopee dolomite:	
Shale, light-buff and green; chert, brown, arenaceous; sandstone, quartz, common (caving?)	72- 75
Dolomite, light-buff, fine-grained; light-gray oolitic chert, abundant; light-buff shale, common (caving); quartz sand (caving), common	75- 80
Dolomite, as above, a little arenaceous; chert, sparse; traces of limonite and glauconite; quartz sand, sparse	80- 85
Dolomite, light-brown and buff, fine- and medium-grained; chert, sparse; limonite, glauconite, and quartz sand, as above	85-100
Dolomite, medium-gray-brown, fine- and medium-grained; chert, sparse	100-105
Dolomite, as above; light-gray oolitic chert, abundant; quartz sand, common	105-110
Dolomite, as above, some arenaceous; chert, as above, some oolitic, abundant; green shale, common; a little quartz sand (partly caving)	110-115
Dolomite, as above, some arenaceous; chert, as above, very common; shale, as above, common	115-120
Dolomite, as above, some arenaceous; light-gray chert, much is oolitic, very common	120-125
Prairie du Chien group--Continued	
New Richmond sandstone(?):	
Dolomite, as above, very arenaceous; shale, as above, common; quartz sand, 10 percent of sample	125-130
Oneota dolomite:	
Dolomite, light-buff and light-brown, fine- and medium grained, a little arenaceous; green shale and quartz sard, sparse	130-135
Dolomite, as above, some medium-grained; traces of chert, shale, and quartz sand	135-140
Dolomite, as above; chert, very abundant; trace of iron	140-145
Dolomite, as above, fine- and medium-grained; chert as above, very abundant; trace of iron	145-150
Dolomite, as above; chert, as above, sparse; trace of iron	150-160
Dolomite, light-gray, medium-grained; chert, as above, common; iron 2 percent	160-165
Dolomite, as above; chert, very abundant; iron 7 percent	165-170
Dolomite, light-gray, very dense, fine-grained; chert, as above, common; iron 5 percent	170-175
Dolomite, brown, medium-grained; chert, abundant; iron 2 percent	175-180
Dolomite, light- and medium-gray, medium-grained; chert, as above, sparse; iron +1 percent	180-185
Dolomite, as above, medium-grained; chert, sparse; iron 1 percent	185-190
Dolomite and chert, as above; iron +1 percent	190-200
Dolomite, as above; chert, sparse; iron ½ percent	200-205
Dolomite, as above; chert, sparse	205-210

	Depth (feet)
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

Steil 5

Location: Sec. 6, T. 6 N., R. 1 E., Wis.; 1,475 ft S. 74°32 ft E. from Steil 1.
Driller: R. Dagenhardt, May 4 to May 12, 1951.
Collar elevation: 1,070.7 ft.
Total depth: 235 ft.
Depth to water: 135 ft.
Sample study and logging: Arthur E. Flint, May 14, 1951.

[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	106-110
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

	Depth (feet)
Prairie du Chien--Continued	
Oneota dolomite--Continued	
Dolomite, as above; chert, very abundant; iron 1 percent.....	190-195
Dolomite, as above; fine- and medium-grained; chert, very abundant; iron 2 percent.....	195-200
Dolomite, as above, medium-grained; chert, sparse to common	200-205
Dolomite, as above; chert, sparse; iron 1 percent	205-210
Dolomite, as above; chert, sparse; iron 9 percent	210-215
Prairie du Chien--Continued	
Oneota dolomite--Continued	
Dolomite, gray, medium-grained; chert, common; quartz sand 25 percent of sample; iron 5 percent	215-220
Dolomite, as above; chert, sparse to common; quartz sand 25 percent of sample; iron 4 percent.....	220-225
Dolomite, as above; chert, common; quartz sand 7 to 8 percent of sample; iron 2 percent	225-230
Dolomite, as above; chert, sparse to common; iron 3 percent.....	230-235

INT.-DUP. SEC., WASH., D.C. 38927

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

R.4E.

EXPLANATION

Middle Upper — ORDOVICIAN
- Om — Maquoketa shale
- Og — Galena dolomite

Geologic contact, approximately located

609 — Outcrop elevation at top of chert, Galena dolomite

6 733.6 / 579 — Churn-drill hole
Drilled by U. S. Geological Survey
6: number of hole
733.6: elevation at top of collar
579: elevation at top of chert

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

3 — Strike and dip of beds

Strike and dip of joints and strike of vertical joints

Mine shaft

Lead diggings

True North / Magnetic North

PROPERTY

MISSISSIPPI RIVER

C M St P AND P

DUBUQUE COUNTY / JACKSON COUNTY

T.88N. T.87N.

33 34 3 4 9 10

BERG

L. KOHLENBERG

TETE DES MORTS RIVER

H. H. GHER'S DIGGINGS

QUARRY

M. SCHENK

DONALD GAYLOR PROPERTY

GORDONS FERRY STATION

INDEX MAP SHOWING EXTENT OF PROPERTIES

Geology by Allen F. Agnew and Arthur E. Flint, 1950

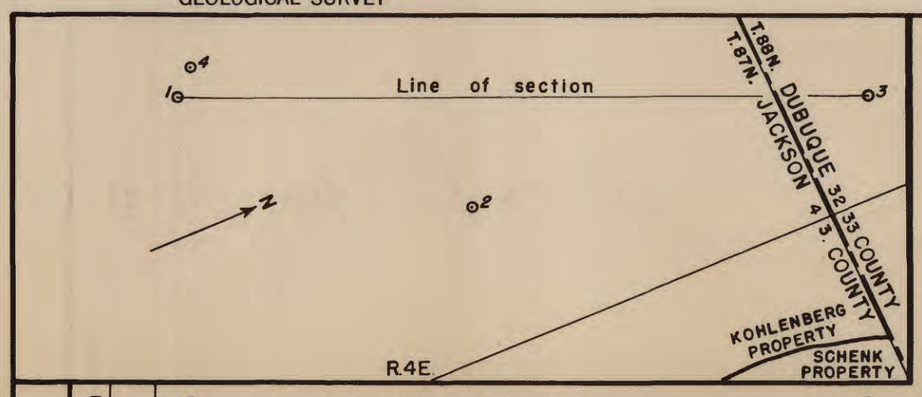
MAP OF THE TETE DES MORTS AREA SHOWING THE LOCATION OF THE HOLES DRILLED BY THE U. S. GEOLOGICAL SURVEY

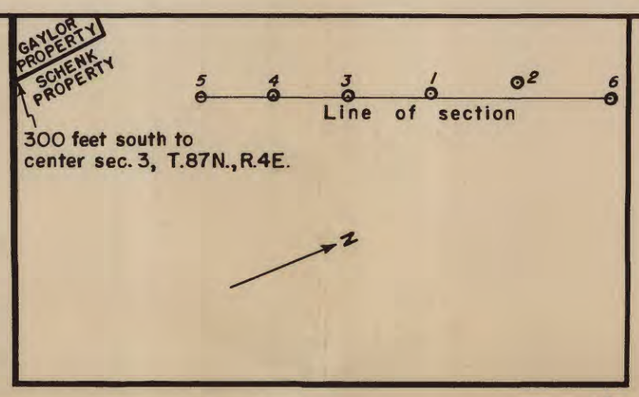
DUBUQUE AND JACKSON COUNTIES, IOWA

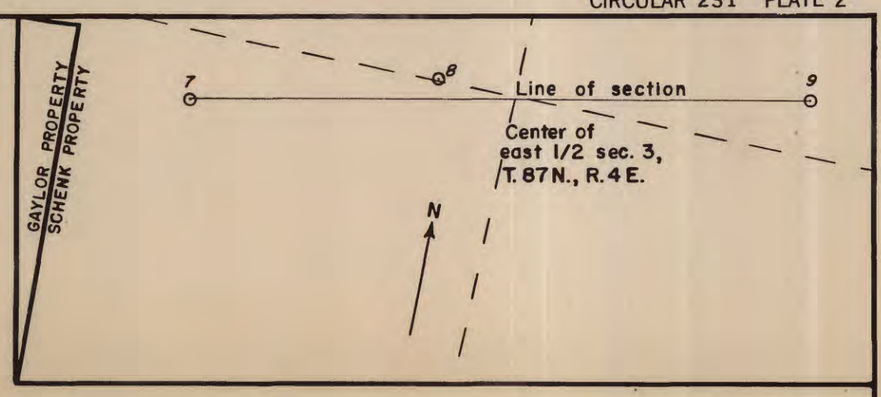
200 0 200 400 600 Feet

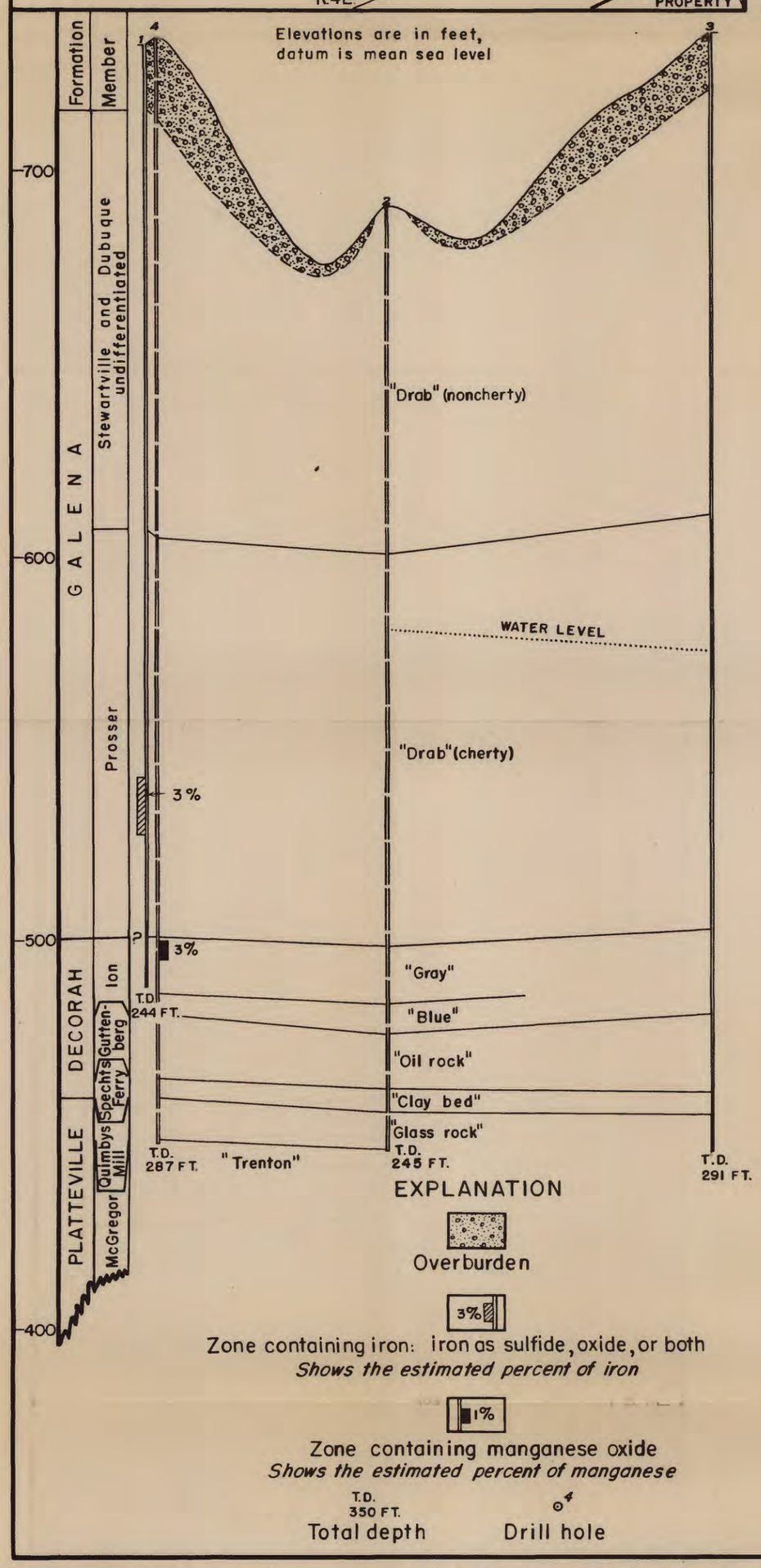
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

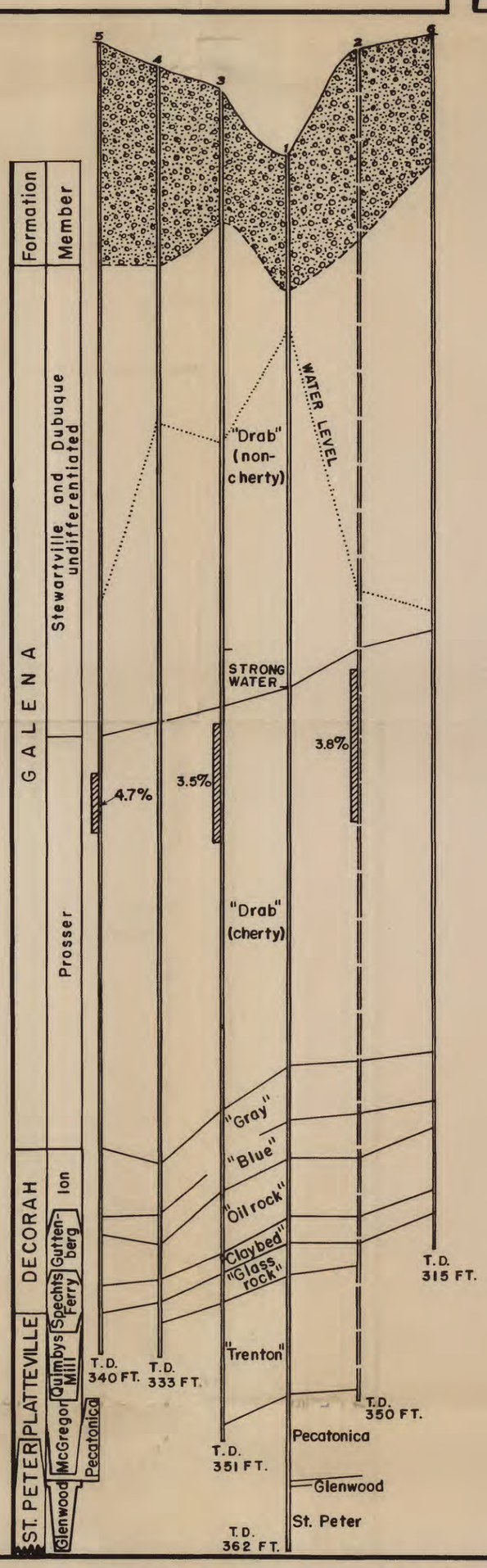
CIRCULAR 231 PLATE 2

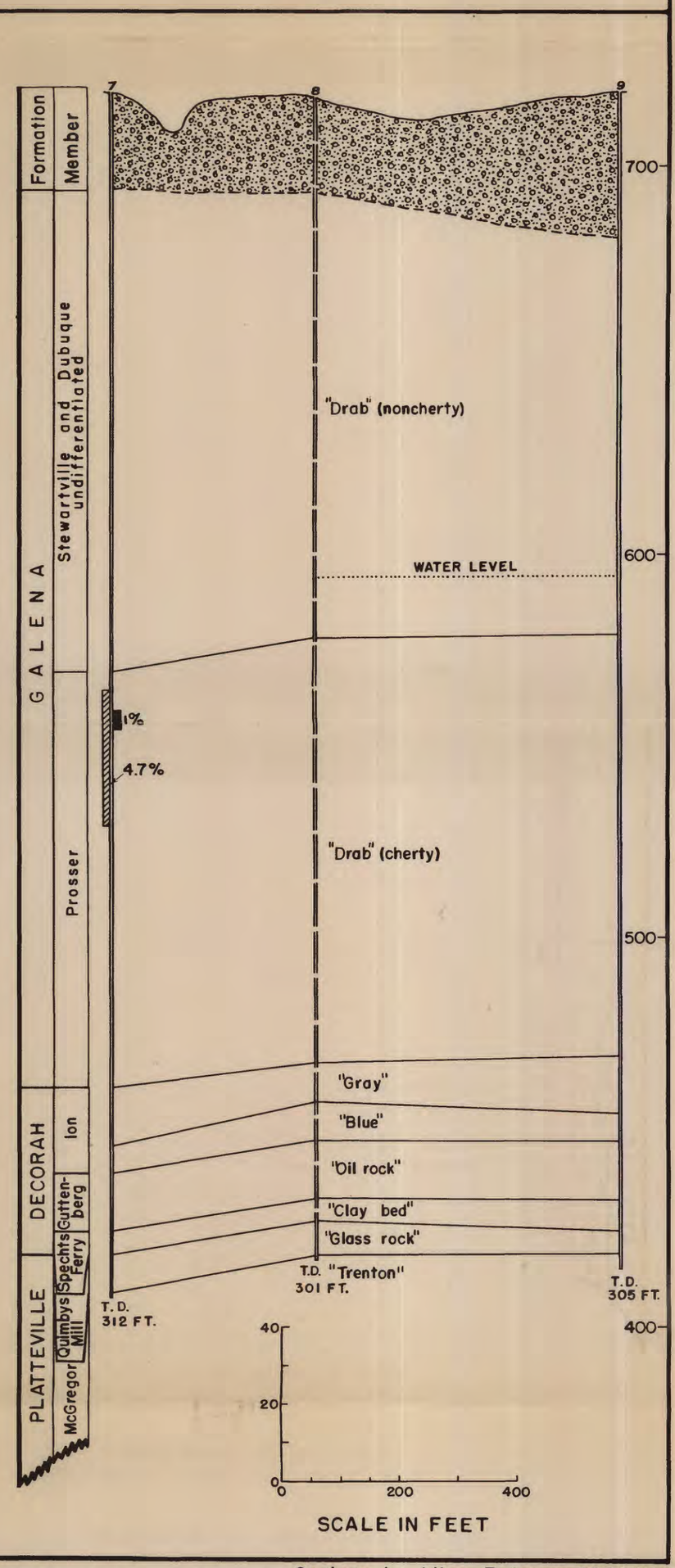












CROSS SECTIONS OF THE HOLES DRILLED BY THE U. S. GEOLOGICAL SURVEY IN THE TETE DES MORTS AREA

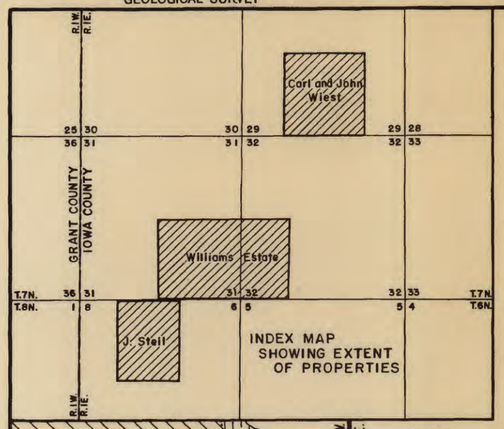
DUBUQUE AND JACKSON COUNTIES, IOWA

Geology by Allen F. Agnew, 1950-1951

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

CIRCULAR 231 PLATE 3



EXPLANATION

Middle Ordovician
- Ogdp — Galena-Decorah and Platteville formations undivided
- Osp — St. Peter sandstone

Lower Ordovician
- Opc — Prairie du Chien group

Geologic contact
Dotted where concealed

×1061
Outcrop elevation at top of St. Peter sandstone
Elevation to the nearest foot

1o1066
Churn-drill hole
Drilled by the U. S. Geological Survey
Shows elevation at top of St. Peter sandstone

—1080—
Structure contour on top of St. Peter sandstone

90 90 90
Strike of vertical joints

×962
Temporary bench mark and elevation
Established by the U. S. Geological Survey

G
Mine shaft
G: *denotes shaft in Galena, Decorah, and Platteville formations*
Zn: *denotes zinc; otherwise lead*

Diggings
Zn: *denotes zinc; otherwise lead*

MAP OF HIGHLAND AREA SHOWING THE LOCATION OF THE HOLES DRILLED BY THE U. S. GEOLOGICAL SURVEY

GRANT AND IOWA COUNTIES, WISCONSIN

1000 0 1000 2000 3000 Feet

Geology by Arthur E. Flint, 1950

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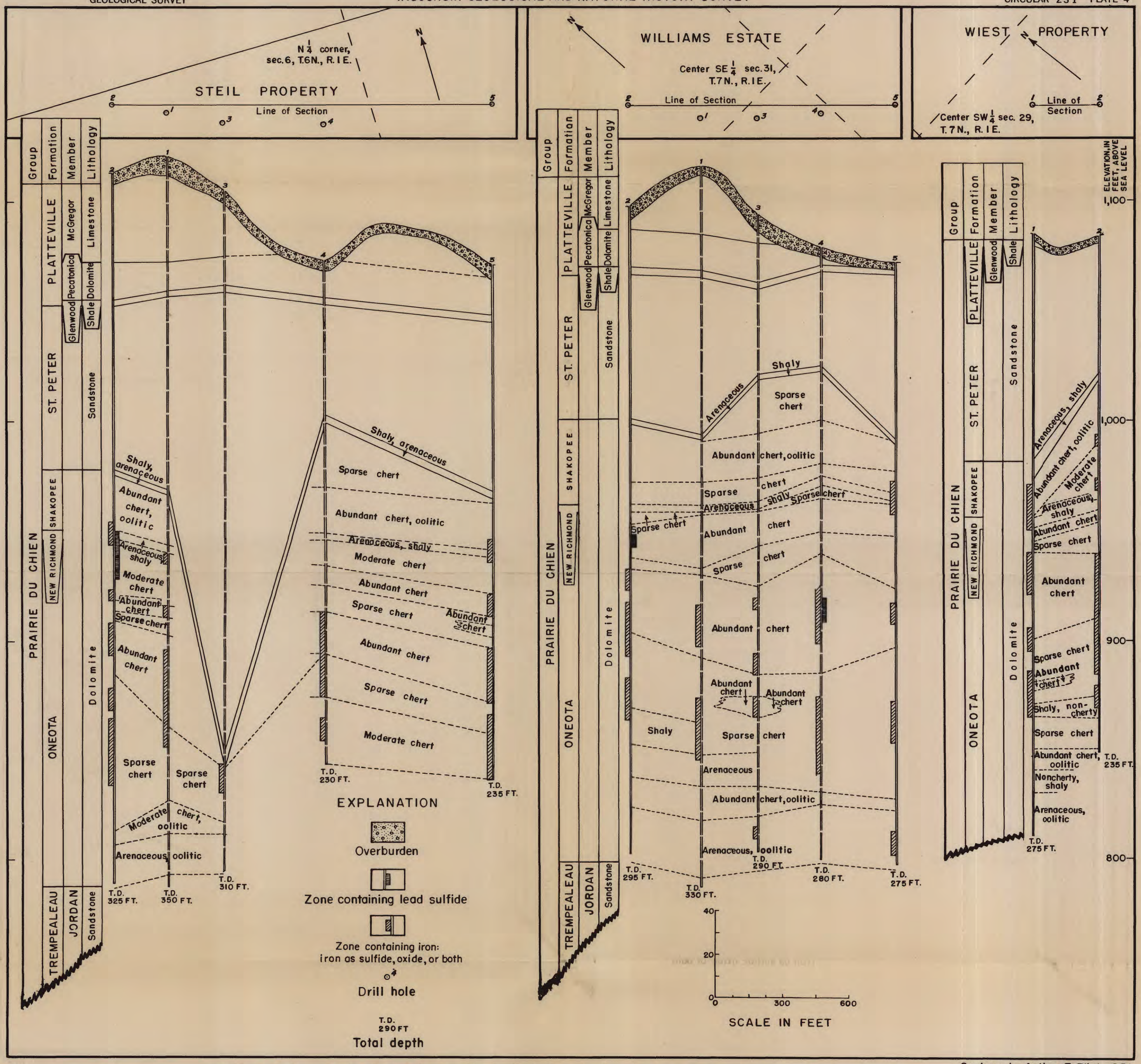
CIRCULAR 231 PLATE 4



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