STATE OF OHIO
MICHAEL V. DISALLE, Governor
DEPARTMENT OF NATURAL RESOURCES
HERBERT B. EAGON, Director
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, Chief

REPORT OF INVESTIGATIONS NO. 42

LOWER AND MIDDLE DEVONIAN LIMESTONES IN NORTHEASTERN OHIO AND ADJACENT AREAS

By

John W. Dow

COLUMBUS
1962

STATE OF OHIO

Michael V. DiSalle
Governor

DEPARTMENT OF NATURAL RESOURCES

Herbert B. Eagon
Director

NATURAL RESOURCES COMMISSION

Herbert B. Eagon
Byron Frederick
Forrest G. Hall
William Hoyne
Joseph E. Hurst
Lawrence Kimble
Roy M. Kottman
Demas L. Sears
Myron T. Sturgeon

DIVISION OF GEOLOGICAL SURVEY

Ralph J. Bernhagen
Chief

The F. J. Heer Printing Company
Columbus 16, Ohio
1962
Bound by the State of Ohio

STATE OF OHIO
MICHAEL V. DISALLE, Governor
DEPARTMENT OF NATURAL RESOURCES
HERBERT B. EAGON, Director
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, Chief

REPORT OF INVESTIGATIONS NO. 42

LOWER AND MIDDLE DEVONIAN LIMESTONES IN NORTHEASTERN OHIO AND ADJACENT AREAS

By

John W. Dow

COLUMBUS
1962

For sale by Ohio Division of Geological Survey, Columbus, Ohio
Price 97 cents plus 3 cents tax in Ohio

BLANK PAGE

CONTENTS

TABLES

ILLUSTRATIONS

FIGURES

PLATE

INTRODUCTION

PURPOSE OF STUDY

The purpose of this project was to study the subsurface lithologic character and stratigraphic relations of the Lower and Middle Devonian limestones in northeastern Ohio. In order to establish their regional relationships it was necessary to extend the study into northwestern Pennsylvania, southern Ontario, and western New York.

Particular attention was paid to C. R. Stauffer's (1957) stratigraphic interpretation of the Middle Devonian limestones in southern Ontario. Stauffer stated that the Detroit River group in that area pinches out eastward, allowing the Columbus limestone to lie unconformably on top of the "Onondaga limestone" (Bois Blanc formation of present usage). An effort was made to determine whether or not these relations occur in Ohio.

PREVIOUS STUDIES

Most of the previous studies of the Middle Devonian limestones in Ohio have been concerned only with the outcrops of these rocks. Relatively little work has been done on these and the Lower Devonian limestones in the subsurface.

Previous subsurface cross sections that include the Lower and Middle Devonian strata have been presented by Pepper, Thomas, and Lockett (1953) and by Shearrow (1957). Several unpublished studies of cores from wells penetrating the Middle Devonian limestones in northern Ohio have been made by Rector (1950), Parker (1950), Rogers (1953), Kerr (1954), Truettner (1954), and Newman and Woodhams (1954).

METHODS OF INVESTIGATION

In this study the writer examined samples from approximately 50 wells located in northeastern Ohio, northwestern Pennsylvania, western New York, and southern Ontario. Twenty-five of the more important wells are listed in table 1. The samples were described in detail with the aid of a binocular microscope, and the percentages of their constituents were estimated and plotted on standard strip logs. Dilute hydrochloric acid (10 percent HCl) was used to determine whether the samples contained limestone or dolomite.

Insoluble residues from 10 of the wells examined were furnished by George G. Shearrow of the Ohio Division of Geological Survey. The method of preparation of the residue samples is described by Shearrow (1957, p. 1) as follows: "A measured volume of each sample was treated in hydrochloric acid. Upon conplete removal of the calcium and magnesium carbonates the samples were washed, dried

TABLE 1. - LIST OF THE MORE IMPORTANT WELLS USED IN THE PRESENT STUDY

Well No.	State	County	Township	Farm	Operator
1[1]	Ohio	Ottawa	Danbury	-	Ohio Minerals Res. Consults.
2	Ohio	Erie	Huron Village	N. Y., Chicago, and St. Louis RR	Nickel Plate Dev. Co.
3[1]	Ohio	Lorain	Sheffield	-	International Salt Co.
4	Ohio	Cuyahoga	Cleveland Harbor	-	International Salt Co.
5	Ohio	Cuyahoga	Highland Heights	Wise	Benedum Trees
6	Ohio	Geauga	Chardon	Crile	East Ohio Gas Co.
7	Ohio	Ashtabula	Harpersfield	Breyley Brothers	Magnolia Pet. Co.
8[1,2]	Ohio	Ashtabula	Ashtabula	Wells	N. J. Pinney
9	Pa.	Erie	Springfield	Childs	Ohio Oil Co.
10	Pa.	Erie	Lake Erie	Pa. Dept. Forest. and Water	N. Y. State Natural Gas Co.
11[1]	Pa.	Erie	Summit	Laskoski	Stephens and Skrabat
12	Pa.	Erie	Venango	Bonney	George Olsen, et al.
13	Pa.	Erie	Greenfield	Pa. State Games Land	Benedum Trees
14	New York	Chataugua	Mina	Stetson	App. Dev. Co.
15	Ohio	Erie	Oxford	Mack	Sentinal Enterprises
16	Ohio	Ashland	Ruggles	Krause	Ohio Oil Co.
17[1,2]	Ohio	Wayne	Chippewa	Hatfield	Chippewa Oil Co.
18	Ohio	Stark	Jackson	Carnes	East Ohio Gas Co.
19[1,2]	Ohio	Stark	Lake	Hyler	C. W. White (Mag. Pet. Co.)
20	Ohio	Portage	Ravenna	Shipley	Gurley, Coen, and Fox
21	Ohio	Trumbull	Hartford	Blaney	Joe E. Dinge, et al.
22[1]	Pa.	Mercer	West Salem	Kyser	Glenn Smith, et al.
23	Pa.	Mercer	Lake	Miller	Bealls and McAndlass
24	Ontario	-	Lake Erie	-	Consolidated West Pet. Ltd.
25[1]	Ontario	Norfolk	Charlotteville	-	United States Steel Co.

1. Description of samples given in appendix A.
2. Description of insoluble residues given in appendix B.

and remeasured." The residues were examined under the binocular microscope, and their lithologic character, as well as the percentage of insoluble material in the samples, was plotted on the strip logs.

Logs from 22 wells examined by the writer and 3 core descriptions were used to construct the stratigraphic sections shown on plate 1. Well 1, Ottawa County, Ohio was described by Kerr (1954), and well 3, Erie County, Ohio by Newman and Woodhams (1954). Well 25 in southern Ontario was described by Sanford of the Geological Survey of Canada.

ACKNOWLEDGMENTS

The writer is indebted to Dr. Robert L. Bates of the Department of Geology, The Ohio State University, for his assistance in this study and to Mr. George G. Shearrow who suggested the problem. He would like to thank Mr. Warren L. Calvert and Mr. Theodore DeBrosse of the Ohio Division of Geological Survey for their cooperation and for supplying the well samples used in this study. The writer expresses his gratitude to Mr. Guy F. Sitler and Mr. R. Russell Paine of the River Gas Company for making their wells available for this project. Finally the writer wishes to express his sincere thanks to Mr. Walter R. Wagner and Mr. Addison S. Cate of the Pennsylvania Topographic and Geologic Survey for their assistance and for furnishing the samples of wells used in this study.

STRATIGRAPHY

GENERAL STATEMENT

The Middle Devonian limestones of Ohio (fig. 1) crop out in three general areas of the State. One area lies east of the Cincinnati anticline in a narrow, north-south belt extending from Kelleys Island in Lake Erie to a point 25 miles south of Columbus, where the beds are overlapped by the Upper Devonian Olentangy and Ohio shales. A second area of outcrop in Ohio occurs in the Bellefontaine outlier, 40 miles northwest of Columbus. This is an elliptical elevated area of about 160 square miles, with Upper Devonian shales in its central part surrounded by a narrow belt of Columbus limestone. The limestone is underlain by the Detroit River group. A third region of outcropping Middle Devonian limestone is in the northwestern part of the State, on the southeastern flank of the Michigan basin. Here a crescent-shaped belt of outcrop extends southward from Michigan into Lucas and Henry Counties, Ohio, and swings westward into Indiana.

The area with which this study is concerned is in northeastern Ohio, where Lower and Middle Devonian rocks are present only as subsurface strata. No work was done on the Bellefontaine outlier or in the northwestern part of the State. Rocks studied in this investigation belong to the Helderberg and Deerpark stages of the Lower Devonian, and to the Onesquethaw and Cazenovian stages of the Middle Devonian.

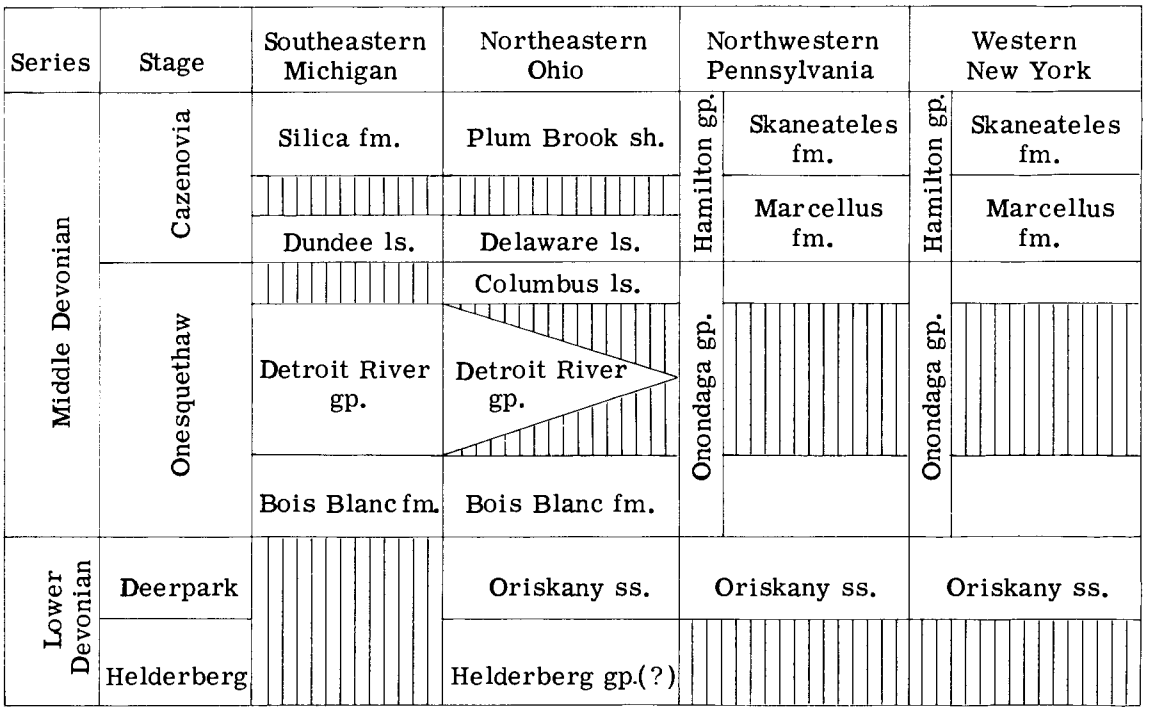


Figure 1. - Correlation chart of Lower and Middle Devonian strata. Size of the spaces does not represent the thickness of the formations. Striped areas represent nondeposition. Abbreviations: fm., formation; gp., group; ls., limestone; sh., shale; and ss., sandstone.

HELDERBERG GROUP (?)

Definition

In 1851 James Hall separated the old Helderberg Division into Upper and Lower units. The Upper Helderberg eventually came to be known as the Onondaga limestone (fig. 5). Hall applied the term "Lower Helderberg" to the strata lying below the Oriskany sandstone and extending downward to the base of the Manlius limestone. In 1899, Clarke and Schuchert restricted the Lower Helderberg, under the name "Helderbergian period" or "group", to the rocks below the Oriskany and above the Manlius. Since that time there has been a controversy on whether or not the restriction of Clarke and Schuchert is correct. Goldring (1931, p. 346) states: "The Lower Helderberg beds in the early days of the [New York] Survey were classed with the Silurian. Later the Siluro-Devonian boundary was changed (Clarke) and the Lower Helderberg limestones with the exception of the Manlius were placed in the Lower Devonian. The Manlius, because of the rather Silurian aspect of its meager fauna was left in the Silurian and since then has been the subject of much discussion as to its age. Some, following Clarke, class the entire Manlius as Silurian, others would place it with the Devonian and a third group place the dividing line within the Manlius."

Rocks of the Helderberg group occur in New York throughout the Appalachian basin (Cooper and others, 1942). According to Shearrow (1957, p. 9) they are present in the subsurface of southeastern Ohio.

A limestone unit occurring below Middle Devonian strata in the subsurface in northeastern Ohio is tentatively identified by the writer as Helderberg(?). This identification is based on the similarity of this limestone and its insoluble residues to the limestone and residues of the Helderberg in southeastern Ohio as described by Shearrow (1957, p. 9-10). The unit is distinctly different from the overlying Middle Devonian strata and quite unlike the Upper Silurian rocks. Due to the lack of paleontological evidence and to the fact that the unit was found in only one well, the identification is not conclusive.

Description

Shearrow (1957, p. 9-10) describes the Helderberg of Ohio as follows: "The upper part of the Helderberg is a brown cherty dense limestone. The residues range from 20 to 90 percent and consist of translucent, dead- or dull-appearing, finely porous chert, with minor amounts of glauconite and very fine-grained sand.... The lower part of the Helderberg is a gray-brown mottled dense limestone with insoluble residues ranging from 5 to 20 percent. The residues consist of gray and brown finely porous shale and traces of very fine-grained sand. Due to the lack of chert, the lower part is easily separated from the upper part and has tentatively been identified as Keyser limestone."

A limestone unit that may represent the Helderberg was found only in well 19 (pl. 1), Stark County, Ohio. This unit consists of dark gray to dark brown finely crystalline limestone containing 20 to 30 percent bluish-gray to bluish-black chert. Insoluble residues range from 25 to 50 percent and consist of brown clay and chert. The Helderberg(?) in this well appears to be the upper part of the group as described by Shearrow. It has a thickness of 75 feet.

The limestone found below the Middle Devonian strata in wells 18, 20, 21, 22, and 23 (pl. 1) may possibly be Helderberg, but it has been tentatively assigned by the writer to the Upper Silurian. The reason is that the color, crystallinity, and insoluble residues of this limestone are very similar to those of the dolomite in the Bass Islands group. Much more work, particularly paleontological examination of well cores, is needed to determine the age relationship of this limestone.

Stratigraphic Relations

The Helderberg(?) of northeastern Ohio is apparently a narrow northern extension of the group from the Appalachian basin, and pinches out north of well 19 (fig. 2). A more detailed study is needed to determine the stratigraphic relationships of the Helderberg group.

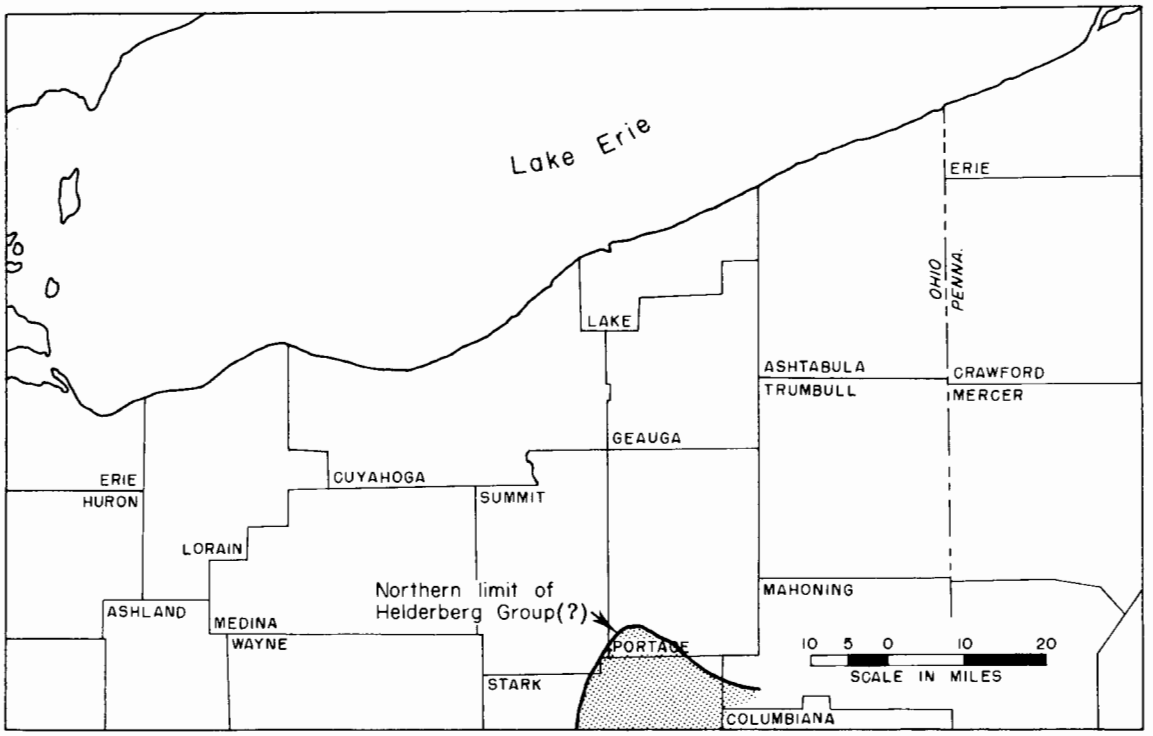


Figure 2. - Northern limit of Helderberg group (?) in northeastern Ohio.

ORISKANY SANDSTONE

Definition

In 1839, both Vanuxem and Hall applied the term "Oriskany" to the sandstone cropping out at Oriskany Falls, Oneida County, New York. Since that time the formation has been traced over a very wide area and separated into several local subdivisions. It occurs throughout the length of the Appalachians and in Ohio, Illinois, Ontario, and the Gaspé Peninsula of Quebec. In central Pennsylvania, western Maryland, northern West Virginia, and parts of Virginia the Oriskany is divided into two members, the Shriver chert below and the Ridgeley sandstone above. In many areas, where deposits of Oriskany age consist chiefly of sandstone and are undifferentiated, the term "Oriskany sandstone" is applied.

The Oriskany is considered to be Early Devonian in age. In Ohio it is found only in the subsurface.

Description

At the type locality the Oriskany is a white to buff loosely cemented fossiliferous sandstone, consisting of medium-sized quartz grains. Its thickness there is 20 feet.

In northeastern Ohio, northwestern Pennsylvania, and western New York the Oriskany is a white medium- to coarse-grained quartzose sandstone. The sand is usually coarser grained in the upper part than in the middle or lower parts. The grains are generally subrounded to rounded and show secondary crystalline overgrowths of silica. Frosted grains, small quartz pebbles, and traces of glauconite occur throughout the formation. The cementing material consists of secondary silica with small amounts of calcite. The upper and lower contacts of the Oriskany appear to be sharp rather than gradational. The thickness of the formation in this area ranges from 10 to 50 feet.

Stratigraphic Relations

The Oriskany sandstone extends westward along the south shore of Lake Erie from the New York-Pennsylvania border into the area of this report as far as Cuyahoga County, Ohio (fig. 3). West of well 4, Cuyahoga County (pl. 1), the formation apparently pinches out. Farther south the Oriskany extends westward from Mercer County, Pa., into Trumbull County, Ohio, where it pinches out.

West of Trumbull County there is some evidence of an extension of the Oriskany from the lake-shore area in Cuyahoga and Geauga Counties southward into Wayne, Summit, Portage, Stark, and possibly Mahoning Counties. In well 17 (pl. 1), Wayne County, a bed of sandstone at the base of the Bois Blanc formation occupies the stratigraphic position of the Oriskany, but no fossils were found and its identity is not certain (see Bois Blanc formation below). In Summit County, approximately 10 miles northeast of well 17, the writer found 110 feet of sandstone in the Diamond Crystal Salt Co. well. Stauffer (1944) reported about 6 feet of sandstone at the Oriskany horizon in the limestone mine at Barberton, in Summit County. In well logs on file with the Ohio Division of Geological Survey, drillers report Oriskany sandstone in wells drilled in west-central and southern Portage County, northern Stark County, and southwestern Mahoning County. However, the validity of the drillers' identification of the Oriskany in some of these wells is in doubt, as is indicated by the dashed section of the Oriskany boundary in figure 3. Several wells in Medina County, northwest of well 17 in Wayne County, penetrated no Oriskany sandstone, thus delineating in a general way the west boundary of this southward extension of the Oriskany. More wells are needed in this area to determine more exactly the westward and southward extent of this sandstone.

The Oriskany sandstone apparently is continuous northward beneath Lake Erie into southern Ontario.

BOIS BLANC FORMATION

Definition

The term "Bois Blanc formation" was introduced by Landes, Ehlers, and Stanley (1945, p. 80-109), for the limestones and dolomites on Bois Blanc Island in the Mackinac Straits region of northern Michigan. The name has been applied by Sanford and Brady (1955) to beds occupying the same stratigraphic position in southwestern Ontario. On the basis of faunal evidence, the formation is considered to be Early Onondagan in age. Its index fossil is the brachiopod Amphigenia elongata.

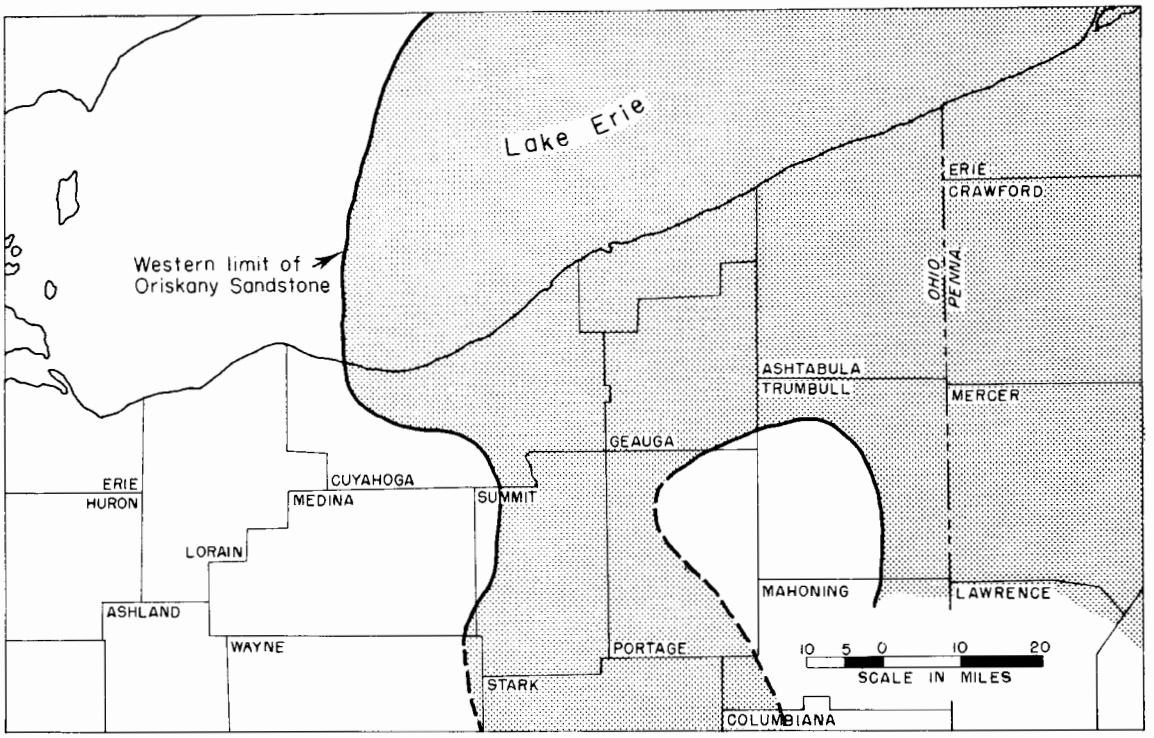


Figure 3. - Western limit of Oriskany sandstone in northeastern Ohio.

Rocks now called Bois Blanc formation were recognized in Ohio by Rogers (1953), although he termed them Onondaga limestone. The next year, Newman and Woodhams (1954) applied the term "Bois Blanc formation" to these beds. This formation does not crop out in Ohio.

Description

The Bois Blanc formation in the type area of northern Michigan consists of three units. The lower is light gray to buff-gray dolomite, interbedded with irregular layers of white to bluish-gray chert. The middle unit consists of light-gray to light-buff limestone or dolomitic limestone with nodules and irregular masses of chert. The upper unit is a gray to buff-gray fossiliferous limestone containing little or no chert. Total thickness of Bois Blanc in this area is approximately 350 feet.

The description by Sanford and Brady (1955, p. 6) of the Bois Blanc in southwestern Ontario could well be applied to these rocks in northeastern Ohio. They describe the Bois Blanc as follows: "The formation consists of brown, grey, and brownish-grey, fine- to medium-grained, dolomitic limestone or calcareous dolomite, with abundant chert. Quartz sand grains, generally associated with glauconite, are common near the base, but become scarce in the upper parts of the formation."

Eastward from Erie County to Cuyahoga and Wayne Counties, the Bois Blanc formation is brown to brownish-gray somewhat sandy finely crystalline dolo-

mite containing 40 to 75 percent white chalky dolomoldic chert and bluish-gray chert. Near the base of the formation the dolomite is usually sandy to very sandy and contains glauconite. Insoluble residues consist mainly of chert with variable amounts of quartz sand and clay. The Bois Blanc is easily distinguished from the Columbus limestone in this area by its dolomitic character, darker color, and much higher proportion of cherty residues. The thickness of the Bois Blanc formation ranges from 60 feet in Erie County to 140 feet in Cuyahoga County.

From Cuyahoga and Wayne Counties to the Pennsylvania border, the Bois Blanc is chiefly brown to brownish-gray finely crystalline limestone or dolomitic limestone, containing 50 to 90 percent grayish-white to gray slightly chalky chert and brown to grayish-brown chert. At the base of the formation there is usually a gray to brownish-gray glauconitic dolomite, in places sandy. Insoluble residues of the rock range from 50 to 90 percent and consist of chert with minor amounts of fine sand and clay. The thickness of the Bois Blanc formation is 155 feet in Geauga County and 130 feet in Ashtabula County.

The writer found that east of Cuyahoga and Wayne Counties it is rather difficult to determine the contact between the Bois Blanc formation and the Columbus limestone. The reason is that the Columbus is a brownish-gray limestone containing a high percentage of chert and is very similar in appearance to the cherty limestone of the Bois Blanc. After examination of several subsurface sections it became evident that a rather definite "chert break" marks the contact. It was also noted that there is a difference in the color of the chert contained in the two formations. The chert in the Columbus is dark brown to brownish-black, whereas that in the Bois Blanc is grayish-white to gray, and brown to grayish-brown. The proportions of insoluble residues in the Bois Blanc are generally much greater than those in the Columbus. In many of the subsurface sections these relationships were very obvious and the contact was easily determined, but in a few sections it was not so clear. In some instances, it was necessary to examine the samples and insoluble residues of several wells in the near vicinity to determine the contact between the Columbus and the Bois Blanc.

Stratigraphic Relations

The Bois Blanc formation covers quite an extensive area. It occurs in all of the Michigan basin except the southeastern part, and in southern Ontario, northeastern Ohio, northwestern Pennsylvania, and western New York.

In northeastern Ohio the Bois Blanc formation pinches out toward the west. In well 2, Erie County (pl. 1), the formation is 60 feet thick, but about 10 miles to the northwest, in well 1, Ottawa County, it is absent. Sanford (Sanford and Brady, 1955) reports that the Bois Blanc does not occur in the wells on Pelee Island, but that it is present northward in the surface and subsurface of southeastern Ontario. It is evident that the formation does not occur on the Cincinnati arch. It either was removed by erosion or was not deposited.

The Bois Blanc formation in northeastern Ohio is underlain by the Oriskany sandstone as far west as well 4, Cuyahoga County. West of well 4 (see Oriskany sandstone, p. 7) the Oriskany is apparently absent. In well 3, Lorain County, Newman and Woodhams (1954, p. 27) found alternating layers of sandstone and dolomite in the basal part of the Bois Blanc formation and labeled this zone "Oriskany (?)". In the same year Truettner (1954, p. 39) found a zone of calcareous sandstone and limestone in a core from a well about 5 miles east of well 3. Truettner reported that this zone is Middle Devonian in age and is the Springvale sandstone,

a basal member of the Bois Blanc formation recognized in Ontario by Stauffer (1915). Parker (1950), in his study of a core from Lorain County, did not find any sandstone at the base of the Bois Blanc. The core examined by Parker was located approximately 3 miles north of Truettner's. It is the writer's opinion that the sandstone reported in Lorain County is very erratic in its distribution and is the Springvale rather than the true Oriskany. Stauffer (1951, p. 7) states: "At Springvale [Ontario] the bottom layers of the Onondaga [Bois Blanc] contain such quantities of coarse sand that they resemble very closely the true Oriskany sandstone except they contain the Onondaga fauna. The supply of sand for these beds undoubtedly came from a nearby deposit of the Oriskany which was worked over by the advancing Onondaga sea and the resulting material incorporated into the basal layers of the deposit from that sea. This local facies of Onondaga limestone [Bois Blanc] is here referred to as the Springvale sandstone..."

DETROIT RIVER GROUP

Definition

In 1895, A. C. Lane used the name "Monroe beds" in describing a geologic section in Michigan. He applied the term to the strata lying below the Dundee limestone and extending downward to the lowest gypsum bed. Later, recognizing that the Sylvania sandstone was part of the Monroe beds, Lane divided them into the Upper and Lower Monroe series separated by the Sylvania.

Lane and others (1909, p. 553-556) further subdivided the Monroe beds and considered them to be Late Silurian in age. The classification of these authors is as follows:

Upper Monroe or Detroit River series	Lucas dolomite (Prosser)[1] Amherstburg dolomite (Sherzer and Grabau) Anderdon limestone (Nattress) Flat Rock dolomite (Sherzer and Grabau)
	- - - - - - disconformity - - - - - - -
Middle Monroe	Sylvania sandstone (Orton)
	- - - - - - disconformity - - - - - - -
Lower Monroe or Bass Islands series	Raisin River dolomite (Lane, Prosser, Sherzer, and Grabau) Put-in-Bay dolomite (Lane, Prosser, Sherzer, and Grabau) Tymochtee beds (Winchell) Greenfield beds (Grabau)

1. The names in parentheses which appear in the classification are of the workers who first defined the formations.

Stauffer (1916) assigned the Sylvania sandstone and the Upper Monroe or Detroit River series to the Devonian system. Three years later Williams (1919) confirmed Stauffer's age assignment and proposed that the term "Monroe" be withdrawn in favor of Grabau's alternate choice, "Detroit River series", for the rocks above the Sylvania sandstone, and the term "Bass Islands series" for the rocks below the Sylvania sandstone. Carman (1927) followed Stauffer and Williams in

stating that in Ohio the Detroit River series and the Sylvania sandstone are definately Devonian.

In 1951 Ehlers, Stumm, and Kesling (1951, p. 10) subdivided the Detroit River group, as follows:

Detroit River group	Anderdon limestone[1] Lucas dolomite Amherstburg dolomite Sylvania sandstone
	- - - - disconformity- - - - -
	Bass Islands group

1. Difference in stratigraphic position of this unit as shown here and the position shown by Lane and others (1909), on preceding page, is due to a newer interpretation based on more recent information.

The type area of the Detroit River group is located along the river of the same name on the Michigan-Ontario border. The group is considered to be Middle Devonian in age.

In the subsurface of northeastern Ohio the writer did not subdivide the limestones and dolomites of the Detroit River group. The only individual formation that was recognized is the Sylvania sandstone.

Description

The Detroit River group in the type area consists of gray to brown, fine to coarsely crystalline limestones and dolomites. At the base of the group there is generally a bed of white medium-grained sandstone, consisting of well-rounded quartz sand grains (Sylvania sandstone). The thickness of the Detroit River group in this area is approximately 120 feet.

In northeastern Ohio the Detroit River group was found only in well 1, Ottawa County, and in wells 2 and 15, Erie County (pl. 1). A core from well 1 on the Marblehead Peninsula was described by Kerr (1954). He described the Detroit River group as a buff or gray compact dolomite grading downward into a tan to brown dolomite with nodules of white chalky fossiliferous chert and thin partings of shale. At the base of the group Kerr reported a 3-inch layer of gray dolomitic sandstone consisting of 95 percent well-rounded quartz sand grains and 5 percent rock fragments. He identified this sandstone as the Sylvania. The total thickness of the Detroit River group in well 1 is 149 feet.

The Detroit River group of well 2 is brown to grayish brown finely crystalline limestone, grading downward into brown finely crystalline dolomitic limestone with 10 to 25 percent white to grayish-white chalky chert. The upper 10 feet of the Detroit River group is gray very finely crystalline limestone containing 5 to 25 percent gray shale and rounded quartz grains of medium size. The upper contact of the group was placed at the top of this gray limestone unit. Insoluble residues of the Detroit River group in this subsurface section range from 5 to 30 percent and consist of shale, asphaltic material, and chert. The proportion of chert in the residues increases toward the base of the group. The Sylvania sandstone does not occur in this section. Total thickness of the Detroit River group in well 2 is 70 feet.

The Detroit River group of well 15 is brown finely crystalline limestone grading downward into brown finely crystalline dolomite. Insoluble residues range from 2 to 15 percent of the rock and consist of medium-sized quartz sand grains with a little shale and white to tan chert. Small quantities of glauconite and traces of pink feldspar occur at the basal contact of the group. The total thickness of the Detroit River group in well 15 is 65 feet.

Stratigraphic Relations

The Detroit River group was not found in the subsurface sections examined by the writer east of Erie County, Ohio. Rogers (1953, p. 34), in his study of a core from Lorain County, states: "The thinning of the Detroit River group to the east must take place very rapidly; the group is 100 feet thick (and more) in the Sandusky region, 40 miles west of this core..." Newman and Woodhams (1954, p. 25), in their study of a core from well 3 in Lorain County, state: "A particular objective of this study was to determine whether the Detroit River group was present at this locality. From the evidence obtained it appears that the formation does not occur. Instead, a total of $63\frac{1}{2}$ feet of the Bois Blanc formation was recorded." It is evident from the preceding remarks that the Detroit River group pinches out toward the east (fig. 4). This is the same stratigraphic relationship that occurs in Ontario (Stauffer, 1957).

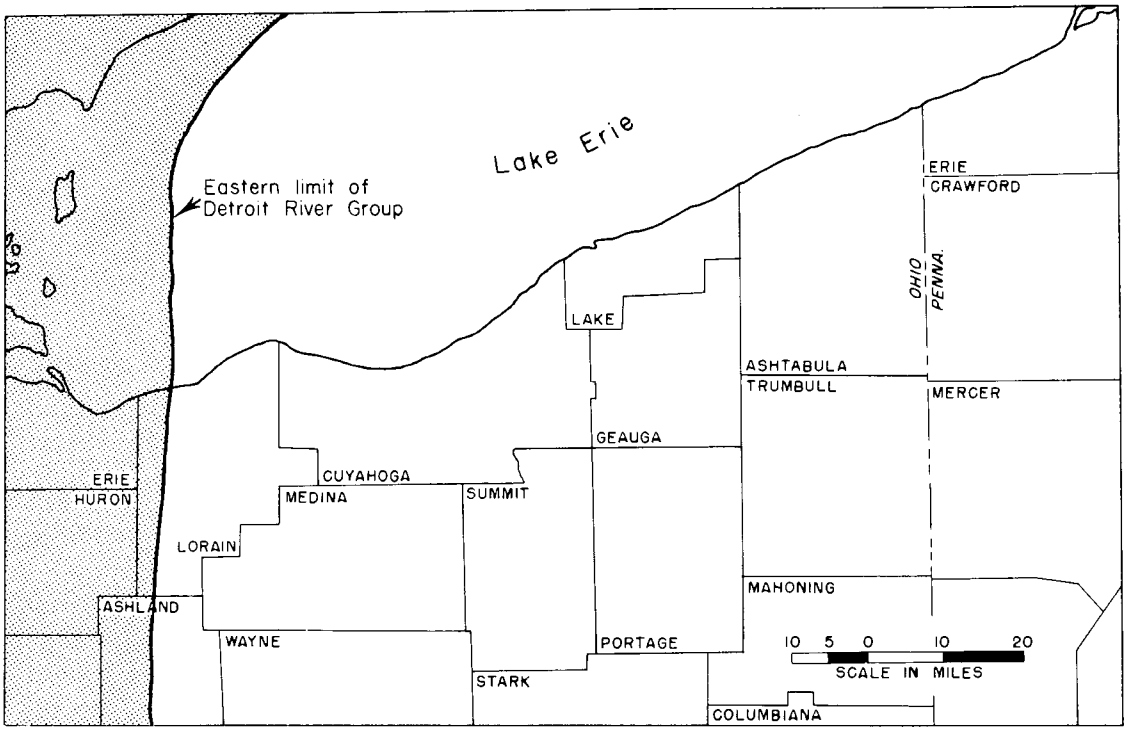


Figure 4. - Eastern limit of Detroit River group in northeastern Ohio.

The Detroit River group extends northwestward into the Michigan basin. Here it is thicker than in Ohio and contains evaporites.

COLUMBUS LIMESTONE

Definition

The name "Columbus" was introduced by Mather in 1859 for the Middle Devonian limestones in the vicinity of Columbus, Ohio. It was used to replace the older term "Corniferous limestone", without any explanation. In 1873, when Newberry subdivided the "Corniferous" into two units, he applied Mather's name to the lower one. Orton in 1878 also used the term for the limestone occurring below the Delaware in Delaware County. Since Newberry's and Orton's time, use of the term "Columbus limestone" has remained unchanged, and it is generally accepted by Ohio geologists.

The Columbus limestone is considered to be Onesquethaw in age and is correlated with the upper part of the Onondaga of New York.

Description

The Columbus limestone in the type area consists of brown magnesian limestone in the lower part, grading upward into gray fossiliferous limestone containing layers of gray to white fossiliferous chert. The beds are massive and contain numerous stylolites. At the base of the formation is a true basal conglomerate a few inches thick, made up of waterworn pebbles from the underlying Silurian dolomite. The Columbus in the type area ranges from 70 to 100 feet in thickness.

The Columbus limestone shows considerable variation in lithologic character across northeastern Ohio. In Erie and Ottawa Counties it is a tan to buff finely crystalline limestone containing a little light gray to white chalky chert. The insoluble residues range from 5 to 10 percent and consist mainly of chert, with occasional minor amounts of fine to very fine sand.

Eastward the formation becomes progressively darker, and the percentages of chert increase. From Geauga and Stark Counties eastward to the Pennsylvania border, the Columbus is a brown to brownish-gray limestone containing 30 to 75 percent dark chert. The chert is brown to brownish-gray in the upper part of the formation and grades downward into a dark brown to brownish black chert in the lower part. The insoluble residues range from 30 to 75 percent, and consist chiefly of chert with minor amounts of fine sand and black carbonaceous material.

The thickness of the Columbus limestone ranges from 30 feet in Ottawa County to 145 feet in Lorain County. East of Lorain County the formation is indistinguishable from the overlying Delaware limestone, and so its thickness cannot be determined.

Stratigraphic Relations

In northern Ohio the Columbus is considered to lie unconformably on the Detroit River group. The contact in well 1, Ottawa County, and in wells 2 and 15, Erie County (pl. 1), is marked by the occurrence of medium-sized, rounded sand grains. The downward change from tan limestone of the Columbus to grayish-brown

limestone of the Detroit River group is quite abrupt. This may indicate that the contact is an unconformity.

East of these wells the Detroit River group pinches out, and the Columbus lies on the Bois Blanc formation. Stauffer (1957, p. 382) reports that this relationship also occurs in Ontario, and that the contact between the Columbus and the "Onondaga" (Bois Blanc) is unconformable. The contact in northeastern Ohio is not marked by a sharp break. Rogers (1953, p. 34), in his study of a core from Lorain County, states: "The contact between the Columbus limestone and the underlying Onondaga [Bois Blanc] is not marked by any sharp unconformity or break in lithology. Similarity of the two formations obscures the break which should be present to mark the hiatus during which the Detroit River rocks were deposited to the west in Sandusky County, and elsewhere in Ohio, Michigan, and Ontario." East of Cuyahoga and Wayne Counties, the contact is marked by a rather definite chert break (see Bois Blanc formation p. 9), which can be traced as far as well 10 in Erie County, Pennsylvania. In wells 11, 12, 13, and 14 (pl. 1) the writer could find no indication of a break or lithologic difference between the Columbus and the Bois Blanc, and he has called the limestone found in these wells the Onondaga group (see p. 17).

It can be seen from the preceding discussion that the Columbus limestone covers quite an extensive area. West of the Cincinnati arch in the Michigan basin the formation apparently does not occur. East of the arch it is the writer's opinion that the Columbus extends across Erie County, Pa., and into western New York. Further work, particularly paleontological examination of well cores, should be done to establish the eastern extent of the formation in New York.

DELAWARE LIMESTONE

Definition

In 1873 J. S. Newberry of Ohio recognized two divisions of the "Corniferous limestone". He called the upper one, which corresponds to the present Delaware, the Sandusky limestone, and the lower one the Columbus limestone. Winchell in 1874 was the first to use the term "Delaware limestone" for the upper part of the "Corniferous", but he did not suggest it as a formational name. In 1878 Orton applied the term "Delaware" as a formational term for the 32 feet of blue limestone exposed near the town of Delaware, Ohio, to replace Newberry's older name "Sandusky limestone" in central Ohio.

The Delaware limestone is considered, on the basis of paleontological evidence, to be the equivalent of the Marcellus shale of New York. It is Early Cazenovian in age.

Description

In the type area the Delaware is 30 to 40 feet thick and is a thin-bedded, blue to brownish-gray limestone with nodules of black unfossiliferous chert. At the base of the formation there is a bed of blue limy soft shale with thin partings of limestone.

The lithologic character of the Delaware limestone varies in the outcrops across the State. Stauffer (1909, p. 27) describes it as "extremely variable in its

appearance, consisting sometimes of thin shaly layers, beds of chert and fairly massive limestone and again almost entirely of rather massive limestone with very little chert and no shale. Usually it has a deep blue to slate color, which becomes brown on weathering. The chert, which it contains, is mostly black and non-fossiliferous, but, in sections where little occurs, it is often a light bluish-white or even pure white and somewhat fossiliferous."

The lithologic character of the Delaware also varies in the subsurface. In Ashland, Erie, and Lorain Counties it is an argillaceous gray to brownish-gray limestone containing 15 to 25 percent brownish-black or mottled blue-gray and brown chert. Insoluble residues range from 25 to 50 percent of the rock and consist of shale, clay, and chert. The formation varies in thickness from 35 to 50 feet. The Delaware is easily distinguished in these counties from the underlying Columbus by its darker color, the presence of brownish-black or mottled blue-gray and brown chert, and a much higher proportion of insoluble material.

In the subsurface east of Ashland and Lorain Counties the Delaware becomes so similar to the Columbus that the writer was unable to separate the two formations. The Delaware is much less argillaceous than in Erie, Ashland, and Lorain Counties, and contains light gray chert instead of the characteristic dark chert. The underlying Columbus in this area is a much darker limestone than in the counties to the west, and contains a higher percentage of insoluble residues.

Stratigraphic Relations

The Delaware is underlain by the Columbus limestone, and overlain unconformably by Upper Devonian black shales. The contact between the Delaware and Columbus is considered to be gradational. Westgate (1926, p. 27) states: "...the essential thing to note is that the transition from the Columbus limestone was gradual. Indeed, it is doubtful if it is more marked than certain transitions within the Columbus and the Delaware." This relationship is particularly true in northeastern Ohio. None of the subsurface sections studied by the writer showed a sharp contact or a definite shale break between the Delaware and the Columbus.

Since the Delaware becomes so lithologically similar to the Columbus, the lateral distribution of the formation east of Ashland and Lorain Counties could not be determined. However, there is some indication of the eastern extent of the Delaware. Stauffer (1944) reported 5 feet of Delaware limestone in the limestone mine at Barberton, Ohio and Rector (1950) reported 107 feet in a core at Ashtabula. In well 25 (pl. 1) Sanford found 34 feet of Delaware. On the basis of the reports and the distribution of the outcrops, it can be seen that in northeastern Ohio the Delaware extends from Erie County along the south shore of Lake Erie into northwestern Pennsylvania and from Ashland County eastward into Summit County.

ONONDAGA GROUP

The terminology of the Onondaga group has undergone various modifications, as shown in figure 5. The type section of the Onondaga was not designated by Hall, who introduced the term, or by any of the early workers who accepted it. Hall evidently took the name from Onondaga County, New York.

<table>
<tr><th>Vanuxem, 1839;
Hall, 1839</th><th>Eaton, 1839; Gebhard, 1840; Mather, 1840</th><th>Hall, in Foster and Whitney, 1851; Lincklaen, 1861</th><th>Hall, in McGee, 1894</th><th colspan="2">Oliver, 1954</th><th colspan="2">This report, 1961</th></tr>
<tr><td rowspan="2">Seneca limestone (Vanuxem)</td><td rowspan="3">Corniferous limestone</td><td rowspan="3">Upper Helderberg limestone</td><td rowspan="3">Onondaga limestone</td><td rowspan="3">Onondaga limestone</td><td>Seneca member</td><td rowspan="3">Onondaga group</td><td rowspan="2">Columbus limestone</td></tr>
<tr><td>Moorehouse member</td></tr>
<tr><td rowspan="2">Onondaga limestone (Hall)</td><td>Nedrow member</td><td rowspan="2">Bois Blanc formation</td></tr>
<tr><td>Edgecliff member</td></tr>
</table>

Figure 5. - Historical review of Onondaga terminology.

The lower Onondaga in the type area consists of massive light gray coarsely crystalline limestone, grading upward into thin-bedded shaly limestone. This shaly unit is overlain by the upper Onondaga, dark gray massive limestone containing a considerable amount of chert. At the base of the formation is a sandy zone, which ranges from 1 inch to several feet in thickness and usually contains phosphate pellets and glauconite.

The Onondaga in this area is underlain by the Oriskany sandstone and overlain conformably by the Marcellus black shale of the Hamilton group.

SUMMARY AND CONCLUSIONS

The Lower Devonian strata in northeastern Ohio include two units, the Helderberg group (?) below and the Oriskany sandstone above. The Middle Devonian limestones consist of four units. In ascending order, these are the Bois Blanc formation, Detroit River group, Columbus limestone, and Delaware limestone.

Seventy-five feet of limestone here termed Helderberg(?) was found in well 19, Stark County, Ohio. This limestone and its insoluble residues are similar to the limestone and residues of the Helderberg in southeastern Ohio, as described by Shearrow (1957, p. 9-10), and are distinctly different from those of the Middle Devonian strata above and the Upper Silurian below. If correctly identified, this limestone apparently represents a narrow northward extension of Helderberg rocks from the Appalachian basin, which lies to the southeast (fig. 2).

The Oriskany sandstone extends westward into the area of this report, from the New York-Pennsylvania border along the southern shore of Lake Erie to at least as far as well 4, Cuyahoga County, Ohio. West of this well the sandstone appears to pinch out. The sandstone occurring in the Oriskany zone in wells of northeastern Wayne, Summit, west-central and southern Portage, northern Stark, and southwestern Mahoning Counties may represent a relatively narrow southern extension of the Oriskany from Geauga and Cuyahoga Counties (fig. 3).

The Detroit River group in northeastern Ohio pinches out east of wells 2 and 15 in Erie County. In the subsurface sections studied by the writer east of these wells, the Columbus limestone lies directly on the Bois Blanc formation. This is the same stratigraphic relationship that occurs in Ontario (Stauffer, 1957).

The contact between the Columbus and the Bois Blanc is not marked by a sharp unconformity. The similarity of the two formations apparently obscures the break that should be present to mark the hiatus during which the Detroit River group was deposited. In describing this stratigraphic relationship in Haldimand and Norfolk Counties, Ontario, Stauffer (1951, p. 379) states, "Although disconformable, the Columbus limestone is so much a part of the top layers of the Onondaga limestone [Bois Blanc formation] in this region, where the two are in contact, that the marked difference in age is obvious only when the horizon is traced from the west, where the wide gap separating the limestones is well filled by the Detroit River group."

The Columbus limestone and the Bois Blanc formation can be separately identified only as far east as well 10 in Erie County, Pa. Equivalent strata beyond this point are here termed the Onondaga group. The writer feels that this usage, at least in northeastern Ohio and northwestern Pennsylvania, is more appropriate than the term "Onondaga limestone" used by geologists of the Pennsylvania Topographic and Geologic Survey in central and western Pennsylvania and by Pepper, Thomas, and Lockett (1953) in northeastern Ohio. The Middle Devonian limestones in this area are not a single formation, but a group consisting of two, the Bois Blanc formation below and the Columbus limestone above. This concept of the Onondaga as a group is becoming accepted by many geologists of Ohio, West Virginia, and Michigan.

REFERENCES CITED

Carman, J. E., 1927, The Monroe division of rocks in Ohio: Jour. Geology, v. 35, p. 481-506.

Clarke, J. M., and Schuchert, Charles, 1899, The nomenclature of the New York series of geological formations: Science, new series, v. 10, p. 874-878.

Cooper, G. A., and others, 1942, Correlation of the Devonian sedimentary formations of North America: Geol. Soc. America Bull., v. 53, p. 1729-1794.

Eaton, Amos, 1839, Cherty lime rock, or corniferous lime rock, proposed as a line of reference....: Am. Jour. Sci., v. 36, p. 61-71.

Ehlers, G. M., Stumm, E. C., and Kesling, R. V., 1951, Devonian rocks of southeastern Michigan and northwestern Ohio: Guide for stratigraphic field trip of Geol. Soc. America Detroit Meeting, November.

Foster, J. W., and Whitney, J. D., 1851, Report on the geology of the Lake Superior land district; pt. 2, The iron region, together with the general geology: U. S. 32nd Cong. spec. session, S. Ex. Doc. 4, xvi, 406 p., illus., maps.

Goldring, W., 1931, Handbook of paleontology for beginners and amateurs; pt. 2, The formations: New York State Mus. Handbook 10.

Hall, James, 1839, Third annual report of the fourth geological district of the State of New York: New York Geol. Survey 3rd Ann. Rept., p. 308-309.

Kerr, J. H., 1954, Stratigraphy and faunas of a core penetrating Middle Devonian and Upper Silurian formations of the Marblehead Peninsula, Ohio: Univ. of Michigan, master's thesis.

Landes, K. K., Ehlers, G. M., and Stanley, G. M., 1945, Geology of the Mackinac Straits region and sub-surface geology of northern southern peninsula: Michigan Geol. Survey Pub. 44, Geol. ser. 37, 204 p., 20 pls., 14 figs.

Lane, A. C., 1895, Geology of lower Michigan: Michigan Geol. Survey Vol. 5, pt. 1, pl. 58.

Lane, A. C., Prosser, C. R., Sherzer, W. H., and Grabau, A. W., 1909, Nomenclature and subdivisions of Upper Silurian strata of Michigan, Ohio, and western New York: Geol. Soc. America Bull., v. 19, p. 553-556.

Lincklaen, Ledyard, 1861, Guide to the geology of New York: New York State Cabinet of Nat. Hist. Ann. Rept. 14, p. 17-84.

McGee, W. J., 1894, Preliminary geologic map of New York: New York Geol. Survey.

Mather, W. W., 1840, Fourth annual report of the first geological district of the State of New York: New York Geol. Survey 4th Ann. Rept., p. 209-258.

_____ 1859, Report on the State House artesian well at Columbus, Ohio: Columbus, 41 p.; (abs.) Am. Jour. Sci., 2nd series, v. 27, p. 276.

Newberry, J. S., 1873, Geological structure of Ohio, Devonian system: Ohio Geol. Survey Vol. 1, pt. 1, p. 140-167.

Newman, K. R., and Woodhams, R. L., 1954, Stratigraphy and paleontology of a core from Lorain County, Ohio: Univ. of Michigan, master's thesis.

Oliver, W. A., Jr., 1954, Stratigraphy of the Onondaga limestone (Devonian) in central New York: Geol. Soc. America Bull., v. 65, p. 621-652.

Orton, Edward, 1878, Report on the geology of Franklin County: Ohio Geol. Survey Vol. 3, p. 596-646.

Parker, J. W., 1950, Paleontology and stratigraphy of a core from Lorain, Ohio: Univ. of Michigan, master's thesis.

Pepper, J. F., Thomas, G. T., and Lockett, J. R., 1953, Geologic cross-section across northern Ohio: Pittsburgh Geological Society.

Rector, G. W., 1950, Paleontology and stratigraphy of a well core from Ashtabula, Ohio: Univ. of Michigan, master's thesis.

Rogers, J. P., 1953, Stratigraphy and paleontology of a core penetrating Upper Silurian and Middle Devonian strata in Lorain County, Ohio: Univ. of Michigan, master's thesis.

Sanford, B. W., and Brady, W. B., 1955, Paleozoic geology of the Windsor-Sarnia area, Ontario: Geol. Survey Canada Mem. 278.

Shearrow, G. G., 1957, Geologic cross section of the Paleozoic rocks from northwestern to southeastern Ohio: Ohio Geol. Survey Rept. Inv. 33.

Stauffer, C. R., 1909, The Middle Devonian of Ohio: Ohio Geol. Survey Bull. 10.

_____ 1915, The Devonian of southwestern Ontario: Geol. Survey Canada Mem. 34.

_____ 1916, Relative age of the Detroit River series: Geol. Soc. America Bull., v. 27, p. 72-77.

_____ 1944, The geological section at the limestone mine, Barberton, Ohio: Am. Jour. Sci., v. 242, p. 251-271.

_____ 1957, The Columbus limestone: Jour. Geology, v. 65, p. 376-383.

Truettner, J. W., Jr., 1954, Stratigraphy and paleontology of a core from Silurian and Devonian strata of Lorain County, Ohio: Univ. of Michigan, master's thesis.

Vanuxem, Lardner, 1839, Third annual report of the geological survey of the third district: New York Geol. Survey 3rd Ann. Rept., p. 273.

Westgate, L. G., 1926, Geology of Delaware County: Ohio Geol. Survey Bull. 30.

Williams, M. Y., 1919, The Silurian geology and faunas of Ontario Peninsula, Manitoulin, and adjacent islands: Geol. Survey Canada Mem. 111, p. 18-22.

Winchell, N. H., 1874, Report on the geology of Delaware County: Ohio Geol. Survey Vol. 2, p. 272-313.

APPENDIX A - DESCRIPTIONS OF SAMPLES FROM SELECTED WELLS

WELL 1
Danbury Twp., Ottawa County, Ohio
Core description by J. E. Kerr (1954)

Depth (ft. and in.) From	To	Descriptions of well samples
		MIDDLE DEVONIAN Columbus Limestone
1-0	1-5	Limestone, buff, medium- to coarse-grained with anhedral calcite crystals with a maximum diameter of 3 mm, few quartz grains present; very fossiliferous, Trochiliscus sp. in large numbers.
1-5	3-7	Limestone, buff, fine- to medium-grained, with a few anhedral calcite crystals having a maximum diameter of 2 mm, few quartz grains present; fossiliferous.
3-7	3-11	Limestone, buff, medium- to coarse-grained, with many coarse anhedral calcite crystals; very fossiliferous, Trochiliscus sp. common.
3-11	6-1	Limestone, buff, fine- to medium-grained; fossiliferous.
6-1	7-1	Limestone, buff, medium- to coarse-grained, with many coarse anhedral calcite crystals; very fossiliferous, Trochiliscus sp. common.
7-1	12-3	Limestone, buff, fine-grained, fossiliferous.
12-3	12-5	Shale, calcareous, dark gray, fine-grained, laminated; unfossiliferous.
12-5	16-0	Limestone, buff, fine-grained; contains white to gray chalky chert nodules; several thin fossiliferous zones.
16-0	27-6	Limestone, buff, fine-grained, very fossiliferous. (18 ft. 9 in. -19 ft. 3 in. missing)
27-6	28-3	Limestone, sandy, gray, fine-grained with few small cavities; contains approximately 5 percent quartz grains with a maximum diameter of 1/2 mm; few fossils.

Depth (ft. and in.) From	To	Descriptions of well samples
28-3	29-7	Limestone, buff, fine-grained except for several anhedral calcite crystals with a maximum diameter of 5 mm; contains a few quartz grains and several small cavities; fossiliferous, Trochiliscus sp. common.
--	29-7	Total thickness of Columbus limestone.
		Detroit River Group Lucas Dolomite
29-7	29-9	Limestone, sandy, brown and black, laminated, fine-grained; contains few small quartz grains; unfossiliferous.
29-9	30-5	Dolomite breccia; dolomite fragments, calcareous, gray, fine-grained, having few anhedral calcite crystals with a maximum diameter of 3 mm; matrix, tan, fine-grained, containing sand grains; many cavities in breccia; unfossiliferous.
30-5	30-8	Dolomite, slightly calcareous, buff, fine-grained, laminated; unfossiliferous.
30-8	31-5	Dolomite breccia; dolomite fragments, calcareous, buff, fine-grained, containing anhedral calcite crystals with a maximum diameter of 1 mm; matrix, gray, fine-grained, with approximately 20 percent sand grains composed of rock fragments and a high percentage of quartz; few cavities in breccia; unfossiliferous.
31-5	33-7	Dolomite, buff and dark gray, laminated, fine-grained, stylolitic, some laminae showing folding, few sandy laminae present, few coarse anhedral calcite grains present, small crystal cavities (negative crystals); unfossiliferous.
33-7	35-8	Dolomite, tan, fine-grained; contains few anhedral calcite crystals with a maximum diameter of 5 mm; unit becomes calcareous near base; unfossiliferous.
35-8	36-3	Limestone, blackish brown, very fine grained, brecciated near base with white limestone fragments with a maximum length of 6 mm; unfossiliferous.
36-3	38-3	Limestone, light tan, fine-grained, sand grains in lower 8 cm, stylolitic contact; fossiliferous.
38-3	39-9	Limestone, slightly dolomitic, sandy, light and dark gray, variegated, fine-grained, brecciated, stylolitic with minute cavities containing pyrite crystals; contains anhedral calcite crystals with a maximum diameter of 3 mm; unfossiliferous.

Depth (ft. and in.) From	To	Descriptions of well samples
39-9	43-10	Dolomite, calcareous, tan, fine-grained, laminated, with small cavities; contains anhedral calcite crystals with a maximum diameter of 1 mm; unfossiliferous.
43-10	44-6	Limestone, dolomitic, gray, fine-grained; contains anhedral calcite crystals with a maximum diameter of 1 mm; unfossiliferous.
44-6	44-9	Dolomite, calcareous, tan, fine-grained, laminated; contains anhedral calcite crystals with a maximum diameter of 1 mm; unfossiliferous.
44-9	46-1	Dolomite breccia; dolomite fragments, brown, fine-grained, with small cavities; white calcite matrix; fossiliferous.
46-1	47-1	Limestone, blackish brown, fine-grained; contains approximately 5 percent sand grains; thin, buff limestone breccia at base; unfossiliferous.
47-1	48-0	Limestone, gray, lithographic to fine-grained, stylolitic; unfossiliferous.
48-0	48-10	Limestone, blackish brown, fine-grained; contains few anhedral calcite crystals with a maximum diameter of 4 mm; unfossiliferous.
48-10	49-4	Limestone breccia; limestone fragments, brownish gray, fine-grained, but contain few anhedral crystals with a maximum diameter of 4 mm; matrix, dark gray, fine-grained; stylolites in breccia; unfossiliferous.
49-4	49-11	Limestone, dark tan, lithographic; contains few small sand grains; unfossiliferous.
49-11	52-0	Limestone, blackish brown and light gray, laminated, fine-grained, stylolitic, some laminae folded; contains anhedral calcite crystals with a maximum diameter of 4 mm; unfossiliferous.
52-0	59-4	Dolomite, slightly calcareous, tan and gray, fine-grained, with cavities, some laminated zones present, few stylolites; contains anhedral calcite crystals with a maximum diameter of 5 mm; poorly preserved fossils.
59-4	60-7	Limestone, sandy, gray, fine-grained, stylolitic; sand grains less than 1 mm in maximum diameter; sand consists of a high percentage of quartz and a few rock fragments, pyrite crystals present; unfossiliferous.
60-7	62-0	Dolomite, calcareous, light buff, fine-grained, small cavities present; contains few anhedral calcite crystals; fossiliferous.

Depth (ft. and in.) From	To	Descriptions of well samples
62-0	70-10	Dolomite, slightly calcareous, buff and gray, laminated, fine-grained; many cavities, lined with euhedral calcite crystals, lowest two being dark buff and unlaminated; fossiliferous.
70-10	72-1	Dolomite, calcareous, buff to brown, fine-grained, small cavities; contains anhedral calcite crystals, uppermost 8 cm contains small sand grains; few fossils.
72-1	73-0	Dolomite, slightly calcareous, brown and gray, laminated, fine-grained; lower part contains cavities; unfossiliferous.
73-0	74-5	Dolomite breccia; dolomite fragments, gray, fine-grained, containing anhedral calcite crystals; dolomite matrix, calcareous, buff, fine-grained, containing sand grains; thin layers of lithographic gray dolomite and also a thin layer of brown and gray laminated limestone at base; unfossiliferous.
74-5	75-11	Limestone, gray and brown, laminated zones present, fine-grained; contains anhedral calcite crystals with a maximum diameter of 4 mm; pyrite crystals present; sandy at top, dolomitic near base; unfossiliferous.
75-11	76-7	Limestone, gray and brown, laminated zones, fine-grained, contains anhedral calcite crystals with a maximum diameter of 4 mm; dolomitic near base; unfossiliferous.
76-7	77-8	Limestone, dark buff, fine-grained, stylolitic, numerous small cavities present; contains anhedral calcite crystals with a maximum diameter of 5 mm; unfossiliferous.
77-8	80-4	Dolomite, slightly calcareous, dark buff, fine-grained, minute cavities present, laminated near top, thin black shale partings near base; few fossils.
		Amherstburg Dolomite
80-4	84-9	Dolomite, tan to gray, fine-grained, granular; has cavities with a maximum diameter of 2 cm; euhedral calcite crystals in cavities; unfossiliferous.
84-9	86-10	Dolomite, light tan, fine-grained, granular; chert nodules at base; unfossiliferous.
86-10	88-2	Dolomite, calcareous, tan and white, irregularly laminated, fine-grained, small cavities present, thin black shale seams at base; unfossiliferous.
88-2	89-10	Dolomite, argillaceous and calcareous, dark brown, fine-grained, granular; contains anhedral calcite crystals in the upper half with irregular light and dark brown laminations; unfossiliferous.

Depth (ft. and in.) From	To	Descriptions of well samples
89-10	90-9	Dolomite, slightly calcareous, buff to tan, fine-grained; unfossiliferous.
90-9	94-3	Dolomite, calcareous, tan, fine-grained, granular, cavities present; contains zones of chert nodules with a maximum thickness of 7 cm; fossiliferous.
94-3	96-9	Dolomite, calcareous, brown, fine-grained, granular, with irregular laminations in upper part; lower part contains cavities with subhedral crystals of calcite with a maximum diameter of 4 cm and a few small euhedral crystals of purple fluorite; stylolite contact at base; few fossils.
96-9	98-6	Limestone, dolomite, light tan and brown, coarsely banded except near top, fine-grained; contains anhedral calcite crystals with a maximum diameter of 8 mm; stylolite contact at base; unfossiliferous.
98-6	102-2	Dolomite, argillaceous and calcareous, brown and tan, irregularly laminated zones, fine-grained with chalky chert nodules; contains anhedral calcite crystals; cavities present with euhedral and subhedral crystals of calcite; fossiliferous.
102-2	102-11	Dolomite, light tan, very fine grained, cavities present with large subhedral crystals of calcite having maximum diameter of 4 cm; fossiliferous.
102-11	103-10	Limestone, dark buff and gray, banded, fine-grained; contains anhedral calcite crystals with a maximum diameter of 6 mm; stylolitic contact; unfossiliferous.
103-10	107-4	Dolomite, slightly calcareous, brown and tan, irregularly laminated, fine-grained, granular, with cavities containing euhedral calcite crystals with a maximum diameter of 3 mm; fossiliferous.
107-4	109-10	Dolomite, slightly calcareous, brown and tan, irregularly laminated zones, fine-grained, granular, few black shale partings, several small cavities present; contains zone of chalky chert nodules; few fossils.
109-10	116-5	Dolomite, calcareous, dark to light tan, irregularly laminated zones, fine-grained, granular, stylolitic; contains cavities, chalky chert nodules near base; unfossiliferous.
116-5	127-10	Dolomite, slightly calcareous, tan and brown, irregularly banded, very fine grained, stylolitic; contains zones of chalky chert nodules; few fossils.
127-10	133-6	Dolomite, slightly calcareous, dark buff, fine-grained; contains zones of gray chalky chert nodules, small cavities present; few fossils.

Depth (ft. and in.) From	To	Descriptions of well samples
133-6	142-3	Dolomite, slightly calcareous, tan and dark buff, irregularly laminated, fine-grained, stylolitic, abundant chalky chert nodules especially in upper part; contains cavities with euhedral celestite crystals and a few chalcedonic aggregates; few fossils. (136 ft. 7 in. -137 ft. missing)
142-3	153-3	Dolomite, slightly calcareous, tan, faintly banded, fine-grained, numerous chalky chert nodules, especially in upper part, cavities partly or completely filled with celestite crystals; few fossils.
153-3	166-9	Dolomite, slightly calcareous, tan and gray, irregularly laminated, fine-grained, stylolitic; contains cavities with euhedral celestite crystals, lower part of dolomite has approximately 2 percent sand consisting of high percentage of quartz and few rock-fragment grains, coloring in lowest part mottled; few fossils.
166-9	170-4	Dolomite, sandy and calcareous, buff and light gray, mottled, fine- to coarse-grained, stylolitic; contains sand and pebbles consisting of quartz, chert, and rock fragments; contains quartz grains with a maximum diameter of 1 mm, few pyrite crystals present; fossiliferous.
170-4	173-9	Dolomite, slightly calcareous, buff, very fine grained, fractured with euhedral celestite crystals in fractures; unfossiliferous.
173-9	177-1	Dolomite, slightly calcareous, buff and gray, banded, few small sand grains present; contains euhedral celestite crystals, stylolite contact at top; unfossiliferous.
177-1	179-6	Dolomite, massive, argillaceous and sandy, fine-grained, interbedded with brecciated gray dolomite containing thin black shale seams; unfossiliferous.
		Sylvania Sandstone
179-6	179-9	Sandstone, dolomite, gray, sand grains with a maximum diameter of 2 mm consisting of approximately 95 percent rounded quartz and 5 percent rock fragments; unfossiliferous.
--	150-2	Total thickness of Detroit River group.
		UPPER SILURIAN Bass Islands Group
179-9	184-11	Dolomite, slightly calcareous, light to medium gray, mottled zones present, very fine grained, stylolitic, fractured and fractures filled with gray dolomitic sandstone; cavities contain euhedral pyrite; dolomite and celestite

Depth (ft. and in.) From	To	Descriptions of well samples
		crystals present in dolomite; thin dolomite conglomerate at top, folded and laminated dolomite at base; unfossiliferous.
184-11	185-10	Dolomite, dark buff, faintly laminated, lithographic, with shale partings at base; unfossiliferous.
185-10	187-0	Dolomite, dark buff, fine-grained with cavities containing euhedral celestite crystals, shaly seams near top, lower half brecciated; fossiliferous.

WELL 3
Sheffield Twp., Lorain County, Ohio
Core description modified from Newman and Woodhams (1954)

Depth (ft. and in.) From	To	Descriptions of well samples
		MIDDLE DEVONIAN Delaware Limestone
857-0	869-0	Limestone, dirty brownish-gray, fine-grained; uniform, massive; contains traces of pyrite; crinoid stems present locally.
869-0	878-6	Limestone, shaly, dark brownish-gray, fine-grained, massive, dense, with scattered black chert nodules.
878-6	879-8	Limestone, grayish buff, fine-grained, uniform massive; unfossiliferous.
879-8	889-6	Shale, very calcareous, brownish-black to black, very fine grained, with black chert nodules; unit uniform, thick bedded, characterized by bituminous odor.
889-6	905-0	Limestone, bluish-gray, fine-grained, massive, dense; 1-inch dark grayish brown coarse-grained layer at base; pyrite traces; fossils prolific.
905-0	907-0	Shale, calcareous, dark chocolate brown, very fine grained, dense; shows subconchoidal fracture.
907-0	910-0	Limestone, light gray, fine-grained, massive, dense; carbonaceous partings..
--	53-0	Total thickness of Delaware limestone.

Depth (ft. and in.) From	To	Descriptions of well samples
		Columbus Limestone
910-0	925-8	Limestone, medium brownish-gray, medium-grained, thick bedded; unit contains abundant white leached chert nodules, black, carbonaceous.
925-8	933-6	Limestone, bluish gray and brownish gray, medium-grained, dense, massive; stylolites and carbonaceous partings; unit contains occasional chert nodules, white, leached, some showing trend toward gray, dense centers.
933-6	936-6	Limestone, grayish buff, fine-grained, thick-bedded, uniform; unit contains white, leached chert nodules.
936-6	941-6	Limestone, bluish gray and brownish gray, fine-grained, massive, stylolitic carbonaceous partings; scattered white chert nodules.
941-6	946-6	Limestone, buff, fine-grained, massive; unit contains white chert nodules with gray and black centers; disseminated calcite crystals in matrix; unfossiliferous.
946-6	947-8	Limestone, bluish-brownish gray, fine-grained, massive, dense with carbonaceous partings.
947-8	954-4	Limestone, buff, locally grading to bluish gray, fine-grained, thick-bedded, containing white, leached chert nodules; fossils few, poorly preserved.
954-4	966-2	Limestone, dark bluish gray, varying locally to light buff gray, fine-grained, dense; unit shows carbonaceous films and pyrite incrustations.
966-2	973-0	Limestone, bluish-brownish gray, medium-grained, massive, uniform, calcite crystals.
973-0	980-0	Limestone, medium gray, fine-grained; contains much white leached chert.
980-0	981-6	Limestone, dark bluish gray, medium-grained, massive, dense, carbonaceous partings.
981-6	1002-0	Limestone, light grayish buff; shows local variation to dark gray, fine grained, thick bedded; many concretions of white leached chert, carbonaceous partings, stylolites; traces of pyrite present.
1002-0	1007-10	Limestone, dark bluish-gray, fine-grained, dense, with interbedded shale.
1007-10	1012-0	Limestone, medium to dark gray, fine-grained, dense with coarsely crystalline interbeds, much white leached chert, carbonaceous partings; unfossiliferous.

Depth (ft. and in.) From	To	Descriptions of well samples
1012-0	1016-10	Limestone, medium gray, fine-grained, much white leached chert, seams of coralline aggregate.
1016-10	1021-0	Limestone, light gray, fine-grained, friable, uniform, thick bedded.
1021-0	1025-0	Limestone, medium brownish-gray, medium-grained with coarse-grained interbeds; strata with brown oil stains, carbonaceous partings.
1025-0	1032-0	Limestone, bluish-grayish brown, medium- to coarse-grained; recrystallized corals make up much of strata.
1032-0	1057-0	Limestone, mottled blue and brown, fine-grained with many black and brown carbonaceous partings; presence of numerous small, dendroid corals gives mottled and vermicular appearance to much of stratum; traces of pyrite present; (unit largely a coralline biostrome).
--	147-0	Total thickness of Columbus limestone.
		Bois Blanc Formation
1057-0	1076-6	Limestone, bluish-gray and brownish-gray, medium-grained, with coarse-grained interbeds, much white leached chert; carbonaceous partings frequent; traces of pyrite present.
1076-6	1095-0	Limestone, medium gray, fine-grained, friable, much white leached chert, some nodular black chert; corals present but poorly preserved undergoing recrystallization to calcite.
1095-0	1119-6	Limestone, medium gray to light gray, fine-grained; chert fraction up to 50 percent of unit, chert generally white, greatly altered, chert black or speckled brown and black on white, locally; brown calcite crystals not uncommon.
1119-6	1120-6	Limestone, dolomitic, buff to dark brown, very fine grained, arenaceous, very cherty; unfossiliferous.
1120-6	1121-0	Sandstone, quartz, calcareous, gray to brownish-gray, very fine grained, grains rounded, cherty, glauconite.
1121-0	1122-6	Dolomite, dark brown, very fine grained, thin-bedded, slightly arenaceous, shaly partings.
1122-6	1124-0	Sandstone, quartz, dolomitic, light gray to brown, very fine grained, grains rounded, minutely porous, glauconitic, chert beds.
1124-0	1128-0	Dolomite, light gray to medium brown, fine-grained, slightly arenaceous, thin chert beds, slightly porous, fossiliferous.

Depth (ft. and in.) From	To	Descriptions of well samples
1128-0	1129-6	Sandstone, quartz, dolomitic, light medium gray, fine-grained, grains rounded, cherty glauconitic, one inclusion of dark dolomite.
1129-6	1133-3	Dolomite, light gray to gray-brown, medium-grained, slightly arenaceous, slightly porous, shaly partings, thin chert beds; fossiliferous.
1133-3	1135-6	Sandstone, quartz, calcareous, light gray to brownish-gray, fine-grained, grains rounded, slightly glauconitic, thin chert beds; fossiliferous.
1135-6	1138-0	Dolomite, medium to dark brown, medium-grained, slightly arenaceous, slightly porous, thin chert beds, shaly partings.
1138-0	1139-9	Sandstone, quartz, dolomitic, light gray to brownish-gray, fine- to medium-grained, grains rounded, porous zones.
1139-9	1141-0	Dolomite, medium brown, medium-grained, thin bedded, slightly arenaceous, shaly partings.
1141-0	1143-6	Sandstone, quartz, dolomitic, light gray to medium brown, fine-grained, grains rounded, slightly porous, thin chert beds, glauconitic, fossiliferous.
--	86-6	Total thickness of Bois Blanc formation.
		UPPER SILURIAN Bass Islands Group
1143-6	1146-6	Dolomite, light gray to light brown, calcilutite texture, pyritic, extremely porous with cavities up to 1 in.; one 2-in. band of crystalline calcite, 1-in. shale parting at bottom.

WELL 8 (fig. 6)
Ashtabula Twp., Ashtabula County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent	Descriptions of well samples
			MIDDLE DEVONIAN Delaware-Columbus Limestone
1325	1333	100	Shale, gray, soft.
1333	1340	50	Shale, gray, soft.
		50	Limestone, tan to brown, fine to medium crystalline.
1340	1347	100	Limestone, tan to brown, fine to medium crystalline, fossiliferous.
1347	1349	90	Limestone, tan to gray, finely crystalline.
		10	Chert, white, ordinary.
1349	1350	90	Limestone, tan, finely crystalline.
		10	Chert, white, chalky, dolomoldic.
1350	1354	90	Limestone, tan, finely crystalline.
		10	Chert, white, chalky, dolomoldic.
1354	1358	90	Limestone, tan, fine to medium crystalline.
		10	Chert, white, chalky, dolomoldic.
1358	1362	80	Limestone, tan, fine to medium crystalline.
		10	Chert, white, chalky, dolomoldic.
		10	Shale, gray, soft.
1362	1366	95	Limestone, tan, fine to medium crystalline.
		5	Shale, gray, soft.
1366	1368	100	Limestone, tan, finely crystalline; chert, white, chalky, dolomoldic.
1368	1371	100	Limestone, tan, finely crystalline; chert, white, chalky, dolomoldic.
1371	1375	85	Limestone, tan, finely crystalline.
		15	Chert, white, chalky, dolomoldic.
1375	1377	100	Limestone, gray to tan, fine to medium crystalline, glauconitic; chert, white, ordinary; chert, white, chalky, dolomoldic.
1377	1381	90	Limestone, tan to brown, fine to medium crystalline.
		10	Chert, white, ordinary.
1381	1387	100	Limestone, tan, fine to medium crystalline, glauconitic; chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.

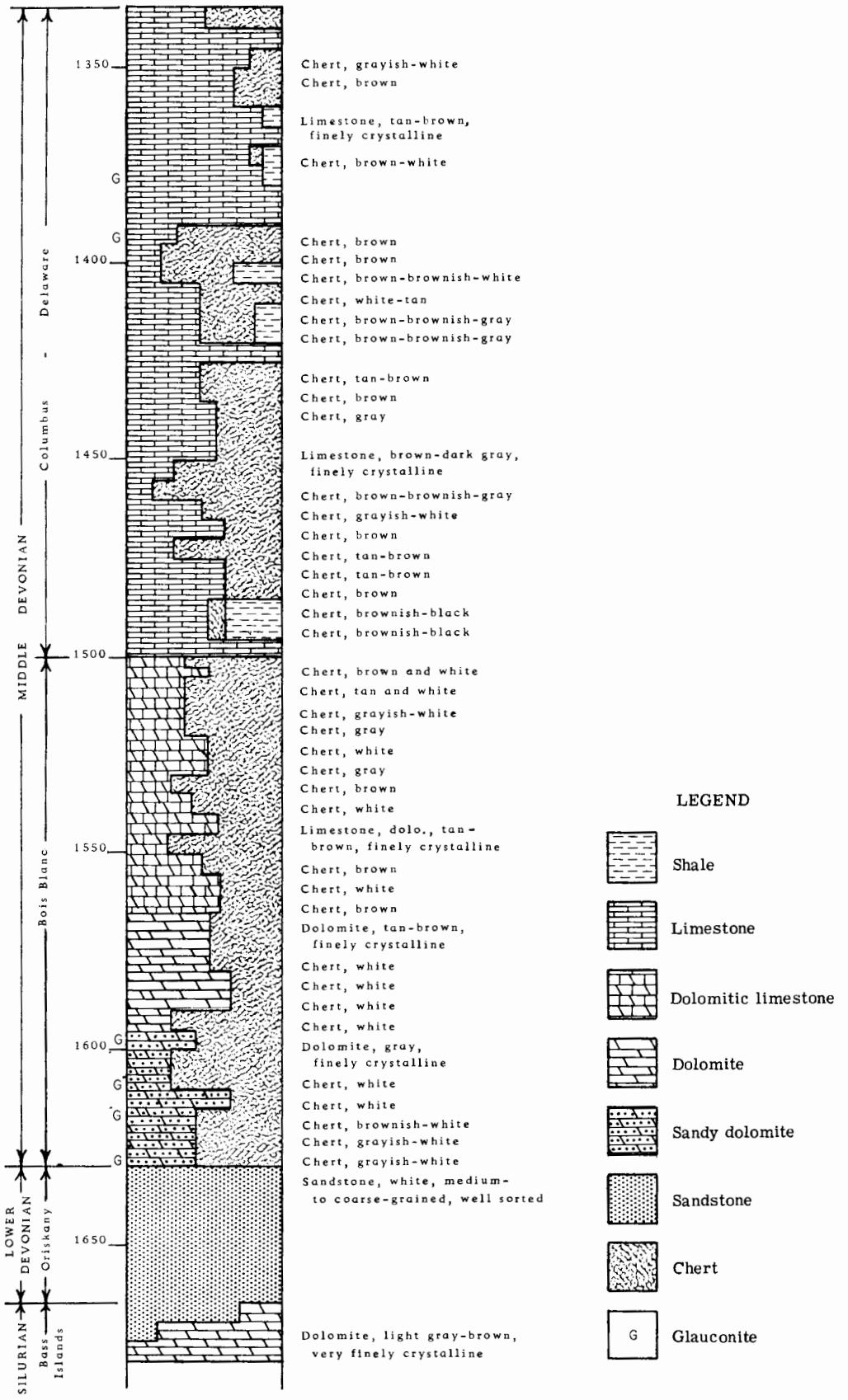


Figure 6. -Lithologic log of well 8, in Ashtabula County.

Depth (ft.) From	To	Percent	Descriptions of well samples
1387	1392	30	Limestone, tan, fine to medium crystalline.
		70	Chert, gray, ordinary; chert, white, chalky, dolomoldic.
1392	1399	10	Limestone, tan, fine to medium crystalline.
		90	Chert, blue-gray, ordinary; chert, gray, ordinary.
1399	1403	40	Limestone, tan, fine to medium crystalline.
		50	Chert, blue-gray, ordinary; chert, gray, ordinary.
		10	Shale, gray, soft.
1403	1406	100	Limestone, tan, finely crystalline; chert, white, ordinary.
1406	1410	50	Limestone, tan, finely crystalline.
		50	Chert, white, ordinary; chert, white, chalky, dolomoldic.
1410	1418	50	Limestone, brown, fine to medium crystalline.
		40	Chert, white, chalky, dolomoldic.
		10	Shale, gray, soft.
1418	1424	100	Limestone, tan, finely crystalline; chert, blue-gray, ordinary.
1424	1425	40	Limestone, tan, finely crystalline.
		60	Chert, tan; ordinary; chert, gray, ordinary.
1425	1429	50	Limestone, tan to brown, finely crystalline.
		50	Chert, blue-gray, ordinary.
1429	1440	70	Limestone, tan to brown, finely crystalline.
		30	Chert, blue-gray, ordinary.
1440	1445	60	Limestone, brown to dark gray, finely crystalline.
		30	Chert, blue-gray, ordinary.
		10	Shale, gray, soft.
1445	1451	70	Limestone, dark gray, finely crystalline.
		30	Chert, blue-gray, ordinary.
1451	1456	20	Limestone, dark gray to brownish black, finely crystalline.
		80	Chert, blue-gray, ordinary; chert, brown, ordinary.
1456	1458	90	Chert, blue-gray, ordinary.
		10	Limestone, brown to dark gray, finely crystalline.
1458	1459	90	Chert, blue-gray, ordinary.
		10	Limestone, brown to dark gray, finely crystalline.
1459	1464	50	Limestone, brownish-gray, finely crystalline.
		50	Chert, blue-gray, ordinary; chert, brownish-gray, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
1464	1467	60	Limestone, brown, finely crystalline.
		40	Chert, brown, ordinary; chert, blue-gray, ordinary.
1467	1471	30	Limestone, tan to brown, finely crystalline.
		70	Chert, white, chalky, dolomoldic; chert, tan, ordinary.
1471	1475	30	Limestone, tan, finely crystalline.
		70	Chert, blue-gray, ordinary; chert, tan, ordinary.
1475	1479	70	Limestone, tan to brown, finely crystalline.
		30	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.
1479	1485	70	Limestone, brown, finely crystalline.
		30	Chert, blue-gray, ordinary; chert, white, ordinary.
1485	1494	70	Limestone, dark gray, finely crystalline.
		10	Chert, blue-black, ordinary; chert, white, chalky, dolomoldic.
		20	Shale, gray, soft.
1494	1499	100	Limestone, tan, finely crystalline.
--	174	--	Total thickness of Delaware-Columbus limestone.
			Bois Blanc Formation
1499	1503	30	Limestone, tan, finely crystalline.
		70	Chert, white, chalky, dolomoldic.
1503	1507	90	Limestone, tan to brownish-black, finely crystalline.
		10	Chert, white, chalky, dolomoldic.
1507	1513	30	Limestone, tan to brownish-black, finely crystalline.
		70	Chert, white, chalky, dolomoldic.
1513	1514	70	Limestone, brown, finely crystalline.
		30	Chert, brown, ordinary.
1514	1517	30	Limestone, dolomitic, tan, finely crystalline.
		60	Chert, blue-gray, ordinary; chert, tan, ordinary.
		10	Shale, gray, soft.
1517	1523	70	Limestone, dolomitic, tan to brown, finely crystalline.
		30	Chert, white, chalky, dolomitic; chert, white, ordinary.
1523	1529	30	Limestone, dolomitic, tan to brownish-black, finely crystalline.
		70	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.

Depth (ft.) From	To	Percent	Descriptions of well samples
1529	1531	90	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.
		10	Limestone, dolomitic, tan to brownish-black, finely crystalline.
1531	1536	30	Limestone, dolomitic, tan to brownish-black, finely crystalline.
		70	Chert, blue-gray, ordinary; chert, white chalky, dolomoldic; chert, brown, ordinary.
1536	1540	40	Limestone, dolomitic, tan to brown, finely crystalline.
		60	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic; chert, brown, ordinary.
1540	1545	60	Limestone, dolomitic, tan to brown, finely crystalline.
		40	Chert, blue-gray, ordinary; chert, white, ordinary, dolomoldic; chert, brown, ordinary.
1545	1551	20	Limestone, dolomitic, tan to brown, finely crystalline.
		80	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic; chert, brown, ordinary.
1551	1555	30	Limestone, dolomitic, tan to brown, finely crystalline.
		70	Chert, blue-gray, ordinary; chert, brown, ordinary; chert, blue-white, ordinary.
1555	1561	80	Limestone, dolomitic, tan to brown, finely crystalline.
		20	Chert, blue-gray, ordinary; chert, brown, ordinary; chert, white, chalky, dolomoldic.
1561	1565	90	Limestone, dolomitic, tan to brown, finely crystalline.
		10	Chert, blue-gray, ordinary; chert, brown, ordinary.
1565	1570	80	Dolomite, tan to brown, finely crystalline.
		20	Chert, blue-gray, ordinary.
1570	1574	80	Dolomite, tan to brown, finely crystalline.
		20	Chert, blue-gray, ordinary.
1574	1580	70	Dolomite, tan to brown, finely crystalline.
		30	Chert, blue-gray, ordinary; chert, brown, ordinary.
1580	1582	80	Dolomite, tan to brown, finely crystalline.
		20	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.

Depth (ft.) From	To	Percent	Descriptions of well samples
1582	1586	80	Dolomite, tan to brown, finely crystalline.
		20	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic.
1586	1593	10	Dolomite, tan, finely crystalline.
		90	Chert, white, ordinary; chert, white, chalky, dolomoldic.
1593	1600	20	Dolomite, tan to gray, finely crystalline, sandy, glauconitic.
		80	Chert, white, ordinary; chert, white, chalky, dolomoldic.
1600	1604	10	Dolomite, gray, finely crystalline, sandy, glauconitic.
		90	Chert, white, ordinary; chert, white, chalky, dolomoldic.
1604	1608	10	Dolomite, gray, finely crystalline, sandy, glauconitic.
		90	Chert, white, ordinary; chert, white, chalky, dolomoldic.
1608	1612	90	Dolomite, gray, finely crystalline, sandy, glauconitic.
		10	Chert, white, chalky, dolomoldic.
1612	1616	70	Dolomite, gray, finely crystalline, sandy, glauconitic.
		30	Chert, white, chalky, dolomoldic.
1616	1620	50	Dolomite, gray, finely crystalline, sandy, glauconitic.
		50	Chert, blue-gray, ordinary; chert, white, ordinary.
1620	1624	15	Dolomite, gray, finely crystalline, sandy, glauconitic.
		85	Chert, blue-gray, ordinary; chert, white, ordinary.
1624	1631	10	Dolomite, gray, finely crystalline, sandy, glauconitic.
		90	Chert, blue-gray, ordinary; chert, white, ordinary.
--	132	--	Total thickness of Bois Blanc formation.
			LOWER DEVONIAN Oriskany Sandstone
1631	1641	100	Sandstone, white, medium- to coarse-grained, subrounded to rounded, well sorted, friable.
1641	1650	100	Sandstone, white, medium- to coarse-grained, subrounded to rounded, well sorted, friable.
1650	1659	100	Sandstone, white, medium- to coarse-grained, subrounded to rounded, well sorted, friable.
1659	1665	100	Sandstone, white, medium- to coarse-grained, subrounded to rounded, well sorted, friable.
--	34	--	Total thickness of Oriskany sandstone.

Depth (ft.) From	To	Percent	Descriptions of well samples
			UPPER SILURIAN Bass Islands Group
1665	1668	80	Sandstone, white, medium- to coarse-grained, sub-rounded to rounded, well sorted, friable.
		20	Dolomite, light gray to brown, finely crystalline.
1668	1672	90	Dolomite, light gray to brown, finely crystalline.
		10	Sandstone, white, medium- to coarse-grained, sub-rounded to rounded, well sorted, friable.

WELL 11
Summit Twp., Erie County, Pa.
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent	Descriptions of well samples
2119	2135	100	Shale, gray, soft.
			MIDDLE DEVONIAN Onondaga Group
2135	2145	40	Limestone, gray to brown; finely crystalline, fossiliferous.
		60	Shale, gray, soft.
2145	2149	90	Limestone, gray to brown, finely crystalline, fossiliferous.
		10	Shale, gray, soft.
2149	2154	95	Limestone, gray to brown, finely crystalline, fossiliferous.
		5	Chert, tan, chalky, fossiliferous.
2154	2160	90	Limestone, tan, finely crystalline.
		10	Chert, white, ordinary; chert, gray, ordinary.
2160	2167	90	Limestone, tan to brown, finely crystalline.
		10	Chert, white, chalky, dolomoldic.
2167	2172	85	Limestone, tan to brown, finely crystalline.
		15	Chert, brown, ordinary.
2172	2179	85	Limestone, tan to brown, finely crystalline.
		15	Chert, brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2179	2182	70	Limestone, tan to brown, finely crystalline.
		30	Chert, brown, ordinary; chert, white, ordinary.
2182	2189	--	Missing.
2189	2195	95	Limestone, tan to brown, finely crystalline.
		5	Chert, gray, white, ordinary.
2195	2204	--	Missing.
2204	2210	75	Limestone, tan to brown, finely crystalline, fossiliferous.
		25	Chert, brown, ordinary.
2210	2217	90	Limestone, tan to brown, finely crystalline.
		10	Chert, gray, ordinary; chert, brown, ordinary.
2217	2224	85	Limestone, gray, finely crystalline.
		15	Chert, gray, ordinary.
2224	2228	70	Limestone, gray, finely crystalline.
		30	Chert, gray, ordinary.
2228	2235	50	Limestone, gray, finely crystalline.
		50	Chert, gray, ordinary.
2235	2242	70	Limestone, brown to brownish-black, finely crystalline.
		30	Chert, brown, ordinary; chert, gray, ordinary.
2242	2251	40	Limestone, brown to brownish-black, finely crystalline.
		60	Chert, brown, ordinary.
2251	2259	40	Limestone, brown to brownish-black, finely crystalline.
		60	Chert, white, ordinary.
2259	2267	--	Missing.
2267	2271	40	Limestone, brown to brownish-black, finely crystalline.
		60	Chert, white, ordinary.
2271	2280	70	Limestone, tan to brown, finely crystalline.
		30	Chert, brown, ordinary; chert, blue-gray, ordinary.
2280	2289	70	Limestone, brown to brownish-black, finely crystalline.
		30	Chert, dark gray, ordinary.
2289	2296	60	Limestone, brown to brownish-black, finely crystalline.
		40	Chert, brownish-black, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2296	2303	75	Limestone, brown to brownish-black, finely crystalline.
		25	Chert, white, ordinary.
2303	2310	50	Limestone, brown to brownish black, finely crystalline.
		50	Chert, white, ordinary.
2310	2315	10	Limestone, tan, finely crystalline.
		90	Chert, white, ordinary.
2315	2319	20	Limestone, tan, finely crystalline.
		80	Chert, white, ordinary.
2319	2324	30	Limestone, tan to brown, finely crystalline.
		70	Chert, brown, ordinary; chert, blue-gray, ordinary.
2324	2327	30	Limestone, tan to brown, finely crystalline.
		70	Chert, brown, ordinary.
2327	2333	35	Limestone, tan to brown, finely crystalline.
		65	Chert, brown, ordinary.
2333	2336	50	Limestone, tan to brown, finely crystalline.
		50	Chert, brown, ordinary.
2336	2339	70	Limestone, tan to brown, finely crystalline.
		30	Chert, brown, ordinary; chert, gray, ordinary.
2339	2346	70	Limestone, tan to brown, finely crystalline.
		30	Chert, brown, ordinary; chert, gray, ordinary.
2346	2353	70	Limestone, tan to brown, finely crystalline.
		30	Chert, gray-white, ordinary.
2353	2360	60	Limestone, tan, finely crystalline.
		40	Chert, white, ordinary; chert, white, chalky dolomoldic.
2360	2365	30	Limestone, tan, finely crystalline
		70	Chert, white, ordinary.
2365	2367	30	Limestone, tan, finely crystalline.
		70	Chert, white, ordinary; chert, brown, ordinary.
2367	2372	30	Limestone, tan to brown, finely crystalline.
		70	Chert, white, ordinary.
2372	2378	50	Dolomite, gray, finely crystalline, glauconitic.
		50	Chert, white, ordinary.
2378	2384	80	Dolomite, gray, finely crystalline, glauconitic.
		20	Chert, white, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2384	2388	30	Dolomite, gray to brown, finely crystalline.
		70	Chert, gray, ordinary.
--	253	--	Total thickness of Onondaga group.
			LOWER DEVONIAN Oriskany Sandstone
2388	2395	10	Sandstone, white, medium- to coarse-grained, well sorted, subrounded to rounded.
		30	Dolomite, gray to brown, finely crystalline.
		60	Chert, brown, ordinary.
2395	2396	100	Sandstone, white, medium- to coarse-grained, well sorted, subrounded to rounded.
2396	2397	100	Sandstone, white, medium- to coarse-grained, well sorted, subrounded to rounded.
--	9	--	Total thickness of Oriskany sandstone.

WELL 17
Chippewa Twp., Wayne County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent	Descriptions of well samples
2100	2120	100	Shale, dark gray, soft.
			MIDDLE DEVONIAN Delaware-Columbus Limestone
2120	2125	50	Shale, dark gray, soft.
		40	Limestone, tan to grayish-brown, finely crystalline, fossiliferous.
		10	Chert, white, chalky, dolomoldic.
2125	2135	90	Limestone, tan to light brown, finely crystalline, stylolitic.
		5	Chert, white, chalky, dolomoldic.
		5	Shale, dark gray, soft.
2135	2150	85	Limestone, tan to light brown, finely crystalline, stylolitic.
		10	Chert, white, chalky, dolomoldic; chert, light gray, ordinary.
		5	Shale, gray, soft.

Depth (ft.) From	To	Percent	Descriptions of well samples
2150	2165	85	Limestone, tan to light brown, fine- to medium-crystalline, stylolitic, fossiliferous.
		10	Chert, white, chalky, dolomoldic; chert, light gray, ordinary.
		5	Shale, gray, soft.
2165	2180	95	Limestone, tan to brownish-gray, fine- to medium-crystalline, dense.
		5	Chert, gray and white, ordinary.
2180	2195	95	Limestone, light brown to brownish-gray, fine- to medium-crystalline.
		5	Chert, white, chalky; chert, gray and white, ordinary.
2195	2210	90	Limestone, light brown to brownish-gray, fine- to medium crystalline.
		10	Chert, gray and white, ordinary; chert, white, chalky, dolomoldic.
2210	2230	95	Limestone, tan to gray-brown, medium crystalline, stylolitic.
		5	Chert, light gray, ordinary.
2230	2245	95	Limestone, gray-brown, fine- to medium-crystalline, argillaceous.
		5	Chert, gray and white, ordinary; chert, white, chalky, dolomoldic.
2245	2265	--	Limestone.
		--	Chert.
2265	2280	95	Limestone, tan to brownish-gray, fine- to medium-crystalline.
		5	Chert, gray, ordinary; chert, brown, ordinary; chert, tan, ordinary.
--	160	--	Total thickness of Delaware-Columbus limestone.
			Bois Blanc Formation
2280	2295	50	Limestone, tan to grayish-brown, finely crystalline, dense, slightly sandy.
		50	Chert, white, chalky, dolomoldic; chert, light gray, ordinary.
2295	2315	10	Sandstone, dolomitic, white, medium- to coarse-grained, well sorted, subrounded.
		40	Dolomite, gray, finely crystalline, dense, sandy, glauconitic.
		50	Chert, white, chalky, dolomoldic; chert, light gray, ordinary; chert, brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2315	2330	30	Dolomite, brown to gray, finely crystalline, sandy, glauconitic.
		40	Chert, white, chalky, dolomoldic; chert, light gray, ordinary.
		30	Limestone, dolomitic, light brown, finely crystalline, dense.
2330	2345	50	Dolomite, light brown to gray, finely crystalline, sandy, glauconitic.
		50	Chert, white, chalky, dolomoldic; chert, white, ordinary.
--	65	--	Total thickness of Bois Blanc formation.
			LOWER DEVONIAN (?) Oriskany Sandstone (?)
2345	2360	10	Sandstone, dolomitic, white, medium- to coarse-crystalline, well-sorted, subrounded.
		50	Dolomite, light brown to gray, finely crystalline, sandy, glauconitic.
		40	Chert, white to gray, chalky, dolomoldic.
--	15	--	Total thickness of Oriskany sandstone.
			UPPER SILURIAN Bass Islands Group
2360	2375	100	Dolomite, light gray, very finely crystalline.

WELL 19
Lake Twp., Stark County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent	Descriptions of well samples
2746	2758	100	Shale, dark gray, soft.
			MIDDLE DEVONIAN Delaware-Columbus Limestone
2758	2766	80	Limestone, brown to brownish-gray, finely crystalline.
		20	Chert, brown and white, ordinary; chert, light brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2766	2774	80	Limestone, light brown, fine- to medium-crystalline, fossiliferous.
		10	Chert, white, ordinary; chert, light brown, ordinary.
		10	Shale, dark gray, soft.
2774	2782	80	Limestone, light brown, fine- to medium-crystalline, fossiliferous.
		20	Chert, light brown, ordinary.
2782	2789	80	Limestone, light brown, fine- to medium-crystalline, fossiliferous.
		20	Chert, light brown, ordinary.
2789	2796	95	Limestone, tan to brown, fine- to medium-crystalline, fossiliferous.
		5	Chert, gray and white, ordinary; chert, brown and white, ordinary.
2796	2804	85	Limestone, tan to grayish-brown, finely crystalline.
		15	Chert, brown and white, ordinary; chert, light brown, ordinary.
2804	2811	85	Limestone, tan to grayish-brown, finely crystalline.
		15	Chert, brown and white, ordinary; chert, gray, ordinary.
2811	2818	70	Limestone, grayish-brown, finely crystalline.
		30	Chert, white, ordinary; chert, light gray, ordinary.
2818	2826	85	Limestone, tan to grayish-brown, finely crystalline.
		15	Chert, light gray, ordinary; chert, white, ordinary; chert, tan, ordinary.
2826	2832	80	Limestone, tan to grayish-brown, finely crystalline.
		20	Chert, gray and white, ordinary; chert, light gray, ordinary; chert, tan, ordinary.
2832	2840	70	Limestone, tan to grayish-brown, finely crystalline.
		30	Chert, gray and white, ordinary; chert, brown and white, ordinary.
2840	2848	60	Limestone, tan to grayish-brown, finely crystalline.
		40	Chert, gray and white, ordinary; chert, brown and white, ordinary; chert, white, ordinary.
2848	2856	50	Limestone, tan to grayish-brown, finely crystalline.
		50	Chert, brownish-gray, ordinary; chert, blue-gray, ordinary.
2856	2863	40	Limestone, tan to grayish-brown, finely crystalline.
		60	Chert, brown, ordinary; chert, blue-gray, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2863	2871	40	Limestone, brown to grayish-brown, finely crystalline.
		60	Chert, light gray, ordinary; chert, blue-gray, ordinary.
2871	2876	30	Limestone, brown to grayish-brown, finely crystalline.
		70	Chert, light gray, ordinary; chert, blue-gray, ordinary.
2876	2884	90	Limestone, brown to brownish-black, fine- to medium-crystalline.
		10	Chert, dark brown, ordinary; chert, black, ordinary.
2884	2891	70	Limestone, brown to brownish-black, fine- to medium-crystalline.
		30	Chert, dark brown, ordinary; chert, brownish-black, ordinary.
2891	2898	70	Limestone, brown to brownish-black, fine- to medium-crystalline.
		30	Chert, dark brown, ordinary; chert, brownish-black, ordinary.
2898	2904	80	Limestone, brown to brownish-black, fine- to medium-crystalline.
		20	Chert, dark brown, ordinary.
2904	2910	55	Limestone, brown to brownish-black, fine- to medium-crystalline.
		40	Chert, blue-gray, ordinary; chert, dark brown, ordinary.
		5	Shale, dark gray, soft.
2910	2918	85	Limestone, tan to brownish-black, finely crystalline.
		15	Chert, brown, ordinary; chert, blue-gray, ordinary; chert, blue-white, ordinary.
2918	2924	70	Limestone, gray to brownish-black, finely crystalline, sandy.
		30	Chert, dark brown, ordinary; chert, blue-white, ordinary.
--	166	--	Total thickness of Delaware-Columbus limestone.
			Bois Blanc Formation
2924	2932	5	Dolomite, grayish-brown, finely crystalline, sandy.
		70	Limestone, tan to grayish-brown, finely crystalline, sandy.
		25	Chert, gray-white, ordinary; chert, dark brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
2932	2940	5	Dolomite, grayish-brown, finely crystalline, sandy.
		70	Limestone, tan to grayish-brown, finely crystalline.
		25	Chert, gray-white, ordinary; chert, brown and white, ordinary.
2940	2947	5	Dolomite, grayish-brown, finely crystalline, sandy.
		65	Limestone, tan to grayish-brown, finely crystalline.
		30	Chert, gray-white, ordinary; chert, white, ordinary; chert, dark brown, ordinary.
2947	2955	5	Dolomite, grayish-brown, finely crystalline, sandy.
		50	Limestone, tan to grayish-brown, finely crystalline.
		45	Chert, white, ordinary; chert, dark brown, ordinary.
2955	2960	15	Dolomite, grayish-brown, finely crystalline, sandy.
		30	Limestone, tan to grayish-brown, finely crystalline.
		55	Chert, white, ordinary; chert, light brown, ordinary.
2960	2966	30	Dolomite, grayish-brown, finely crystalline, sandy.
		30	Limestone, tan to grayish-brown, finely crystalline.
		40	Chert, blue-white, ordinary; chert, light brown, ordinary.
2966	2976	5	Dolomite, grayish-brown, finely crystalline, sandy.
		55	Limestone, tan to brown, finely crystalline.
		40	Chert, blue-white, ordinary; chert, brown, ordinary.
2976	2980	5	Dolomite, grayish-brown, finely crystalline, sandy.
		70	Limestone, brown to grayish-brown, finely crystalline.
		25	Chert, blue-white, ordinary; chert, light brown, ordinary.
2980	2988	60	Limestone, tan to brown, finely crystalline.
		40	Chert, brown and white, ordinary; chert, gray and white, ordinary; chert, brownish-black, ordinary.
2988	2995	50	Dolomite, gray, finely crystalline, dense, sandy, glauconitic.
		50	Chert, gray, ordinary.
2995	3003	10	Dolomite, gray, finely crystalline, sandy, glauconitic.
		40	Limestone, brown to grayish-brown, finely crystalline.
		50	Chert, gray, ordinary; chert, white, chalky, dolomoldic.
3003	3010	20	Dolomite, gray, finely crystalline, sandy, glauconitic.
		20	Limestone, brown to grayish-brown, finely crystalline.
		60	Chert, gray, ordinary; chert, white, chalky, dolomoldic; chert, blue-gray, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
3010	3016	20	Dolomite, gray, finely crystalline, sandy, glauconitic.
		20	Limestone, brown to grayish-brown, finely crystalline.
		55	Chert, blue-gray, ordinary; chert, white, chalky, dolomoldic; chert, brown, ordinary.
		5	Shale, dark gray, soft.
3016	3022	20	Dolomite, gray, finely crystalline, sandy, glauconitic.
		20	Limestone, brown to dark gray, finely crystalline, glauconitic.
		60	Chert, blue-gray, ordinary; chert, white, ordinary.
--	98	--	Total thickness of Bois Blanc formation.
			LOWER DEVONIAN (?) Helderberg (?) Group
3022	3029	55	Limestone, dark gray to dark brown, finely crystalline.
		40	Chert, blue-black, ordinary; chert, blue-gray, ordinary.
		5	Shale, dark gray, soft.
3029	3037	60	Limestone, dark gray to dark brown, finely crystalline.
		40	Chert, blue-black, ordinary; chert, blue-gray, ordinary.
3037	3045	70	Limestone, dark gray to dark brown, finely crystalline.
		30	Chert, blue-black, ordinary; chert, blue-gray, ordinary.
3045	3055	55	Limestone, dark gray to dark brown, finely crystalline.
		40	Chert, blue-black, ordinary; chert, blue-gray, ordinary.
		5	Shale, dark gray, soft.
3055	3063	55	Limestone, dark gray to dark brown, finely crystalline.
		45	Chert, blue-gray, ordinary.
3063	3074	75	Limestone, dark gray to dark brown-gray, finely crystalline.
		20	Chert, blue-gray, ordinary.
		5	Shale, dark gray, soft.
3074	3082	70	Limestone, dark gray to dark brown, finely crystalline.
		30	Chert, blue-gray, ordinary; chert, brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
3082	3092	70	Limestone, dark gray to dark brown, finely crystalline, slightly glauconitic.
		30	Chert, blue-gray, ordinary; chert, brown, ordinary.
3092	3100	80	Limestone, dark gray to dark brown, finely crystalline.
		20	Chert, dark brown, ordinary; chert, blue-gray, ordinary.
--	78	--	Total thickness of Helderberg (?) group.
			UPPER SILURIAN
3100	3110	90	Limestone, dark gray to brownish-gray, finely crystalline.
		10	Chert, brown, ordinary; chert, gray, ordinary.

WELL 22
West Salem Twp., Mercer County, Pa.
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent	Descriptions of well samples
			MIDDLE DEVONIAN Delaware(?)-Columbus Limestone
3095	3100	30	Limestone, tan to brown, finely crystalline.
		70	Chert, white, ordinary.
3100	3105	30	Limestone, tan to brown, finely crystalline.
		70	Chert, white, ordinary.
3105	3114	30	Limestone, tan to brown, finely crystalline.
		70	Chert, white, ordinary.
3114	3119	70	Limestone, tan to brown, finely crystalline.
		30	Chert, white, ordinary; chert, gray, ordinary.
3119	3122	50	Limestone, tan to brown, finely crystalline.
		50	Chert, white, ordinary; chert, brown, ordinary.
3122	3126	50	Limestone, tan to brown, finely crystalline.
		50	Chert, brown, ordinary; chert, gray, ordinary.
3126	3129	70	Limestone, tan to brown, finely crystalline.
		30	Chert, gray, ordinary; chert, light brown, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
3129	3135	20	Limestone, tan to brown, finely crystalline.
		80	Chert, brown, ordinary; chert, gray, ordinary.
3135	3138	60	Limestone, brown to brownish-black, finely crystalline.
		40	Chert, gray, ordinary.
3138	3141	60	Limestone, brown to brownish-black, finely crystalline.
		40	Chert, gray, ordinary.
3141	3146	60	Limestone, brown to brownish-black, finely crystalline.
		40	Chert, gray, ordinary.
3146	3151	85	Limestone, brown to brownish-black, finely crystalline.
		15	Chert, brown, ordinary.
3151	3156	65	Limestone, brown to brownish-black, finely crystalline.
		35	Chert, gray, ordinary.
3156	3158	70	Limestone, brown to brownish-black, finely crystalline.
		30	Chert, gray, ordinary.
3158	3163	60	Limestone, tan to brown, finely crystalline.
		40	Chert, gray, ordinary; chert, brown, ordinary.
3163	3168	30	Limestone, tan to brown, finely crystalline.
		70	Chert, brownish-gray, ordinary.
3168	3175	60	Limestone, tan to brown, finely crystalline.
		40	Chert, brownish-gray, ordinary.
3175	3179	50	Limestone, brown to brownish-black, finely crystalline.
		50	Chert, gray, ordinary.
3179	3183	70	Dolomite, gray to dark gray, finely crystalline, dense, glauconitic.
		30	Chert, brownish-gray, ordinary.
3183	3188	80	Dolomite, brown to dark gray, finely crystalline, dense.
		20	Chert, dark brown, ordinary.
3188	3195	70	Limestone, tan to brown, finely crystalline.
		30	Chert, white, ordinary.
3195	3201	100	Limestone, tan to brown, fine- to medium-crystalline.

Depth (ft.) From	To	Percent	Descriptions of well samples
3201	3206	80	Limestone, brown to brownish-black, finely crystalline.
		20	Chert, brownish-black, ordinary.
3206	3216	70	Limestone, brown to brownish-black, finely crystalline.
		30	Chert, brownish-black, ordinary.
--	121	--	Total thickness of Delaware(?)-Columbus limestone.
			Bois Blanc Formation
3216	3221	30	Limestone, tan to brown, finely crystalline.
		70	Chert, gray-white, ordinary; chert, white, chalky, dolomoldic.
3221	3225	30	Limestone, tan to brown, finely crystalline.
		70	Chert, gray-white, ordinary.
3225	3229	20	Limestone, tan to brown, finely crystalline.
		80	Chert, gray-white, ordinary.
3229	3233	50	Limestone, tan to brown, finely crystalline.
		50	Chert, gray-white, ordinary.
3233	3237	30	Limestone, brown to brownish-black, finely crystalline.
		70	Chert, gray, ordinary; chert, brown, ordinary.
3237	3240	30	Limestone, brown to brownish-black, finely crystalline.
		70	Chert, gray, ordinary; chert, brown, ordinary.
3240	3245	40	Limestone, brown to brownish-black, finely crystalline.
		60	Chert, gray, ordinary; chert, brown, ordinary.
3245	3250	60	Dolomite, gray to dark gray, finely crystalline.
		40	Chert, dark brown, ordinary; chert, gray, ordinary.
3250	3255	30	Dolomite, gray, finely crystalline.
		70	Chert, brown, ordinary; chert, gray, ordinary.
3255	3260	20	Dolomite, tan to brown, finely crystalline.
		80	Chert, white, chalky, dolomoldic.
3260	3264	20	Dolomite, tan to brown, finely crystalline.
		80	Chert, white, chalky, dolomoldic.
3264	3266	20	Dolomite, tan to brown, finely crystalline.
		80	Chert, white, chalky, dolomoldic; chert, white, ordinary.

Depth (ft.) From	To	Percent	Descriptions of well samples
3266	3270	70	Dolomite, tan to brown, finely crystalline.
		30	Chert, white, chalky, dolomoldic.
3270	3276	50	Dolomite, gray to brown, finely crystalline, glauconitic.
		50	Chert, white, chalky, dolomoldic; chert, white, ordinary.
3276	3278	60	Dolomite, tan to brown, finely crystalline, sandy, glauconitic.
		40	Chert, white, chalky, dolomoldic; chert, white, ordinary.
3278	3283	30	Dolomite, gray, finely crystalline, sandy.
		70	Chert, white, chalky, dolomoldic; chert, gray, ordinary.
3283	3285	60	Dolomite, gray, finely crystalline, sandy.
		40	Chert, white, chalky, dolomoldic; chert, gray, ordinary.
3285	3288	50	Dolomite, gray to brown, finely crystalline, sandy.
		50	Chert, white, chalky, dolomoldic; chert, white, ordinary.
3288	3294	50	Dolomite, gray to brown, finely crystalline, sandy, glauconitic.
		50	Chert, gray, ordinary.
3294	3296	20	Dolomite, gray to brown, finely crystalline, glauconitic, sandy.
		80	Chert, gray, ordinary.
3296	3300	50	Dolomite, gray to brown, finely crystalline, sandy.
		50	Chert, gray, ordinary.
3300	3305	70	Dolomite, tan to brown, finely crystalline, sandy.
		30	Chert, gray, ordinary.
3305	3310	40	Dolomite, gray, finely crystalline, sandy, glauconitic.
		60	Chert, gray, ordinary.
3310	3314	60	Dolomite, gray, finely crystalline, sandy.
		40	Chert, gray, ordinary.
3314	3318	60	Dolomite, tan to brown, finely crystalline, sandy.
		40	Chert, gray, ordinary.
--	102	--	Total thickness of Bois Blanc formation.

Depth (ft.) From	To	Percent	Descriptions of well samples
			LOWER DEVONIAN Oriskany Sandstone
3318	3321	20	Sandstone, white, medium-grained, subrounded, well sorted, glauconitic.
		80	Chert, brown, ordinary.
3321	3325	10	Sandstone, white, medium-grained.
		90	Limestone, white and dark gray, finely crystalline.
--	7	--	Total thickness of Oriskany sandstone.
			UPPER SILURIAN
3325	3330	100	Limestone, dark gray, finely crystalline.

WELL 25
Charlotteville Twp., Norfolk County, Ontario
Core Description by B. W. Sanford, Geological Survey of Canada (modified by J. W. Dow, Jr.)

Depth (ft.) From	To	Descriptions of well samples
		MIDDLE DEVONIAN Delaware Limestone
206	210	Limestone, grayish-brown, fine- to medium-crystalline, calcite replacement, stylolites; more finely crystalline toward base, with purity increasing; argillaceous laminae.
210	214	Limestone, grayish-brown, very finely crystalline, dark brown shale partings along bedding planes, argillaceous laminae.
214	216	Limestone, grayish-brown, dense, dark brown bituminous shale partings present in upper part, with abundant resinous type spore cases (typical Delaware lithologic character).
216	217	Limestone, light brownish-gray, quite finely crystalline.
217	221	Limestone, light gray with brown cast, quite finely crystalline, argillaceous, much calcite, limestone grades into medium grayish-brown at base, abundant resinous type spore cases at 220 ft. 9 in., occasional stylolites and shale partings; quite fossiliferous throughout.

Depth (ft.) From	To	Descriptions of well samples
221	225	Limestone, light gray, dense to finely crystalline, abundant spore cases, stylolites; very finely crystalline at base.
225	228	Limestone, medium brown, dense, fossiliferous; abundant spore cases at 227 ft. 3 in.
228	231	Limestone, light brown, very argillaceous along bedding planes, fossiliferous, light gray chert at irregular intervals.
231	235	Limestone, dark brown at top to light brown at bottom, very finely crystalline, occasional dark brown bituminous shale layers, fossiliferous, few spore cases, occasional beds of light gray to brown chert.
235	239	Limestone, light grayish-brown, finely crystalline, very fossiliferous, few spore cases, bands of chert throughout, limestone becomes more dense toward base, stylolitic.
--	33	Total thickness of Delaware limestone.
		Columbus Limestone
239	242	Limestone, grayish-brown, slightly crystalline, very fossiliferous, much calcite.
242	246	Limestone, light brown, finely crystalline, very fossiliferous, much calcite, few nodules of white arenaceous chert.
246	250	Limestone, light brown, medium-crystalline, much calcite; quite fossiliferous, large Favosites at 248 ft.; traces of chert.
250	254	Limestone, light brownish-gray, finely crystalline, fossiliferous, much light gray chert throughout; calcite.
254	273	Limestone, light brown, finely crystalline, light gray nodular chert, chert increases from 258 ft.; dark bituminous streaks are quite common; fossiliferous, corals.
273	278	Limestone, buff brown, finely crystalline; small amounts of white nodular chert, occasional stylolites.
278	286	Limestone, gray-buff, finely crystalline, light gray to brown chert nodules, occasional stylolites.
286	291	Limestone, medium brown, very finely crystalline to dense; at 287 ft. limestone changes to light grayish-brown, finely crystalline, some nodular chert; stylolites.
291	295	Limestone, dark grayish-brown, very finely crystalline, occasional medium gray nodular chert.

Depth (ft.) From	To	Descriptions of well samples
295	298	Limestone, dark grayish-brown, very finely crystalline, occasional medium gray nodular chert; with much calcite replacement, argillaceous laminae.
298	300	Limestone, dolomitic, gray-buff, coarsely crystalline, pyritic, saturated with oil; looks like a calcarenite or clastic limestone.
300	312	Limestone, medium-crystalline, gray with brown cast; from 307 ft. limestone is same as above, but contains much light chert.
312	319	Limestone, light gray, coarsely crystalline, resembles a calcarenite or clastic limestone; this type of limestone grades into a coral zone which has been almost completely dolomitized; heavily oil stained, large assortment of calcite crystals and coral masses; dark brown color due to oil stain; few scattered nodules of chert.
319	339	Limestone, light brown, medium- to fine-crystalline, large assortment of corals, argillaceous laminae, much chert.
--	100	Total thickness of Columbus limestone.
		Bois Blanc Formation
339	361	Limestone, light brown, dense, approximately 50 percent of core consists of gray chert, very fossiliferous, abundant corals, few dark gray shale partings.
361	385	Limestone, light brown, fine- to coarse-crystalline, large assortment of corals, 50 percent chert.
385	387	Limestone, brownish-gray, finely crystalline, chert.
387	389	Limestone, medium brown, finely crystalline, fossiliferous, light gray chert.
389	393	Limestone, grayish-brown, finely crystalline, with 50 percent light gray chert, quite fossiliferous throughout.
393	397	Limestone, light grayish-brown, very finely crystalline, cherty, large amount of medium gray nodular chert.
397	403	Limestone, light brown, medium-crystalline, much calcite; limestone grades into a dense medium grayish-brown; chert varies to a dark gray in places; occasional coral zones.
403	404	Sandstone, light gray, coarse-grained with limestone matrix, angular to rounded; sand grains.
404	405	Sandstone, light gray, quartzose, medium-grained, calcitic, traces of glauconite.

Depth (ft.) From	To	Descriptions of well samples
405	408	Sandstone, white, coarse-grained, quartzose, angular to semirounded, quite friable in parts.
408	432	Sandstone, white, quartzose, coarse-grained, angular to subrounded, traces of glauconite; abundant brachiopods, bryozoans.
432	436	Sandstone, light gray, quartzose, coarse-grained, angular to rounded; light gray chert and thick argillaceous laminae at base.
436	456	Chert, light to dark gray with a minor amount of light grayish-brown, finely crystalline limestone, arenaceous, calcite veining.
456	466	Chert, light to bluish-gray; limestone constitutes very little of core; what is present is light brownish-gray, cherty; few shale laminations.
--	127	Total thickness of Bois Blanc formation.
		LOWER DEVONIAN Oriskany Sandstone
466	468	Sandstone, light gray, coarse-grained, quartzose, angular to subrounded, extremely glauconitic, shales in parts; sandstone becomes coarser toward base, containing large rounded quartz pebbles.
468	470	Sandstone, white, quartzose, coarse-grained, angular to subrounded, fossiliferous.
--	4	Total thickness of Oriskany sandstone.
		UPPER SILURIAN Bass Islands Group
470	472	Limestone, dolomitic, chocolate brown, finely crystalline, calcitic textures, changes to light gray, granular in places.

APPENDIX B - DESCRIPTIONS OF INSOLUBLE RESIDUES FROM SELECTED WELLS

WELL 8
Ashtabula Twp., Ashtabula County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
				MIDDLE DEVONIAN Delaware-Columbus Limestone
1333	1340	65	90	Shale, gray, soft.
			10	Chert, gray, chalky.
1340	1347	20	85	Shale, gray, soft.
			15	Chert, white, chalcedonic.
1347	1349	70	50	Chert, gray, ordinary.
			10	Chert, tan, chalky, dolomoldic (scattered).
			40	Shale, gray, soft.
1349	1350	50	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, white, ordinary.
1350	1354	45	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, white, ordinary.
1354	1358	25	60	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, white, ordinary.
1358	1362	20	5	Chert, white, chalky.
			15	Chert, white, chalky, dolomoldic (abundant).
			20	Chert, tan, chalky.
			50	Chert, brown, ordinary.
			10	Shale.
1362	1366	20	75	Chert, brown, ordinary.
			15	Chert, tan, chalky.
			10	Chert, white, chalcedonic.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1366	1368	20	50	Chert, white, chalky, dolomoldic (abundant).
			30	Chert, light brown, ordinary.
			20	Shale, gray, soft.
1368	1371	25	90	Chert, brown, ordinary.
			10	Shale, gray, soft.
1371	1375	25	30	Chert, brown, ordinary.
			50	Chert, white, chalky, dolomoldic (abundant).
			20	Shale, gray, soft.
1375	1377	25	80	Chert, brown, ordinary.
			20	Chert, white, chalky, dolomoldic (abundant).
1377	1381	25	50	Chert, gray, ordinary.
			50	Chert, white, chalky, dolomoldic (abundant).
1381	1387	20	90	Chert, brown, ordinary.
			10	Brown argillaceous material.
1387	1392	25	70	Chert, white, chalky, dolomoldic (abundant).
			25	Chert, brown, ordinary.
			5	Sand, white, fine-grained, well sorted, subrounded.
1392	1399	60	50	Chert, tan, chalky, dolomoldic (abundant).
			50	Chert, light gray, ordinary.
1399	1403	45	40	Chert, tan, chalky, dolomoldic (abundant).
			60	Chert, brown, ordinary.
1403	1406	60	20	Chert, white, chalcedonic.
			40	Sand, white, fine-grained, well sorted, subrounded.
			20	Chert, tan, chalky, dolomoldic (abundant).
			5	Chert, gray-white, ordinary.
			15	Shale, gray, soft.
1406	1410	50	70	Chert, white, chalky, dolomoldic (abundant).
			30	Chert, grayish-white, ordinary.
1410	1418	75	45	Chert, white, chalky, dolomoldic (abundant).
			45	Chert, brown, ordinary.
			10	Shale, gray, soft.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1418	1424	20	45	Chert, white, chalky, dolomoldic (abundant).
			45	Chert, brown, ordinary.
			10	Shale, gray, soft.
1424	1425	30	20	Chert, tan, chalky, dolomoldic (abundant).
			80	Chert, gray, ordinary.
1425	1429	30	30	Chert, tan, chalky, dolomoldic (abundant).
			70	Chert, gray, ordinary.
1429	1435	25	50	Chert, tan, chalky, dolomoldic (abundant).
			50	Chert, brown, ordinary.
1435	1440	30	30	Chert, tan, chalky, dolomoldic (abundant).
			70	Chert, gray, ordinary.
1440	1445	50	30	Chert, tan, chalky, dolomoldic (abundant).
			30	Chert, gray, ordinary.
			10	Chert, brown, ordinary.
			30	Brown argillaceous material.
1445	1451	30	15	Chert, tan, chalky, dolomoldic (abundant).
			30	Chert, blue-gray, ordinary.
			50	Brown argillaceous material.
			5	Chert, white, chalcedonic.
1451	1456	60	40	Chert, gray, ordinary.
			30	Chert, brown, ordinary.
			15	Chert, tan, chalky, dolomoldic (abundant).
			15	Brown argillaceous material.
1456	1458	60	40	Chert, gray, ordinary.
			30	Chert, brown, ordinary.
			15	Chert, tan, chalky, dolomoldic.
			15	Brown argillaceous material.
1458	1459	50	100	Chert, brown, ordinary.
1459	1464	40	20	Chert, tan, chalky, dolomoldic (abundant).
			80	Chert, gray, ordinary.
1464	1467	40	10	Chert, tan, chalky, dolomoldic (abundant).
			90	Chert, gray, ordinary.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1467	1471	50	10	Chert, tan, chalky, dolomoldic (abundant).
			90	Chert, gray, ordinary.
1471	1475	40	10	Chert, tan, chalky, dolomoldic (abundant).
			90	Chert, gray, ordinary.
1475	1479	25	10	Chert, tan, chalky, dolomoldic (scattered).
			90	Chert, gray, ordinary.
1479	1485	20	15	Chert, white, chalky, dolomoldic (scattered).
			85	Chert, brown, ordinary; chert, gray, ordinary.
1485	1494	20	10	Sand, white, very fine grained, sub-rounded, well sorted.
			45	Chert, brownish-black, ordinary.
			15	Chert, white, chalcedonic.
			30	Shale, gray, soft.
1494	1499	20	90	Chert, dark brown, ordinary.
			10	Shale, gray, soft.
--	166	--	--	Total thickness of Delaware-Columbus limestone.
				Bois Blanc Formation
1499	1503	30	35	Chert, tan, chalky, dolomoldic (abundant).
			55	Chert, dark brown, ordinary.
			10	Shale, gray, soft.
1503	1507	30	30	Chert, tan, chalky, dolomoldic (abundant).
			70	Chert, dark brown, ordinary.
1507	1513	45	20	Chert, tan, chalky, dolomoldic (abundant).
			80	Chert, dark brown, ordinary.
1513	1514	60	60	Chert, white, chalky, dolomoldic (scattered).
			40	Chert, brown, ordinary.
1514	1517	75	60	Chert, white, chalky, dolomoldic (abundant).
			20	Chert, brown, ordinary.
			20	Chert, gray, ordinary.
1517	1523	40	70	Chert, gray-white, ordinary.
			30	Chert, dark brown, ordinary.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1523	1529	55	40	Chert, brown, chalky.
			60	Chert, blue-white, ordinary.
1529	1531	65	35	Chert, brown, chalky.
			65	Chert, blue-white, ordinary.
1531	1536	60	80	Chert, white, ordinary.
			20	Brown argillaceous material.
1536	1540	75	40	Chert, tan, chalky, dolomoldic (abundant).
			60	Chert, gray, ordinary.
1540	1545	60	40	Chert, tan, chalky, dolomoldic (abundant).
			50	Chert, gray, ordinary.
			10	Brown argillaceous material.
1545	1551	85	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, blue-white, ordinary.
1551	1555	85	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, blue-white, ordinary; chert, brown, ordinary.
1555	1561	80	40	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, brown, ordinary.
			20	Brown argillaceous material.
1561	1565	75	40	Chert, brown, chalky, dolomoldic (abundant).
			60	Chert, gray, ordinary.
1565	1570	80	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, gray, ordinary.
1570	1574	75	30	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, gray, ordinary.
1574	1580	80	100	Chert, tan, chalky, dolomoldic (abundant).
1580	1582	65	50	Chert, tan, chalky, dolomoldic (abundant).
			50	Chert, white, ordinary.
1582	1586	65	40	Chert, tan, chalky, dolomoldic (abundant).
			60	Chert, gray, ordinary.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1586	1593	70	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, gray, ordinary.
1593	1600	85	10	Sand, white, very fine grained, subrounded.
			20	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, gray, ordinary.
1600	1604	85	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, white, ordinary.
1604	1608	85	30	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, white, ordinary.
1608	1612	85	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, white, ordinary.
1612	1616	90	60	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, brown, ordinary.
1616	1620	85	60	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, gray-white, ordinary.
1620	1624	85	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, gray-white, ordinary.
1624	1631	85	30	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, gray-white, ordinary.
--	132	--	--	Total thickness of Bois Blanc formation.
				LOWER DEVONIAN
				Oriskany Sandstone
1631	1641	85	100	Sand, white, medium- to coarse-grained, subrounded to rounded, well sorted.
1641	1650	90	100	Sand, white, medium- to coarse-grained, subrounded to rounded, well sorted.
1650	1659	85	100	Sand, white, medium- to coarse-grained, subrounded to rounded, well sorted.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
1659	1665	60	100	Sand, white, medium- to coarse-grained, subrounded to rounded, well sorted.
--	34	--	--	Total thickness of Oriskany sandstone.
				UPPER SILURIAN Bass Islands Group
1665	1668	45	100	Sand, white, fine- to medium-grained, well sorted, subrounded to rounded.
1668	1672	25	80	Sand, white, fine- to medium-grained, well sorted, subrounded to rounded.
			20	Shale, gray, soft.

WELL 17
Chippewa Twp., Wayne County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
				MIDDLE DEVONIAN Delaware-Columbus Limestone
2120	2125	60	5	Chert, white, chalky, dolomoldic.
			75	Shale, black, soft.
			20	Argillaceous material, brown.
2125	2135	25	50	Chert, white to gray-white, chalky, dolomoldic (scattered).
			5	Chert, brown and white, ordinary.
			5	Chert, gray and white, ordinary.
			40	Shale, dark gray, soft.
2135	2150	25	30	Chert, white to gray-white, chalky, dolomoldic.
			10	Chert, gray and white, ordinary.
			60	Shale, gray, soft.
2150	2165	20	35	Chert, white to gray-white, chalky, dolomoldic (abundant).
			5	Chert, brownish-gray.
			60	Shale, dark gray, soft.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
2165	2180	25	50	Chert, white to gray-white, chalky, dolomoldic (abundant).
			40	Chert, gray and white, ordinary.
			10	Shale, dark gray, soft.
2180	2195	20	30	Chert, white to gray-white, chalky, dolomoldic (abundant).
			60	Chert, gray and white, ordinary, dolomoldic (abundant).
			10	Shale, dark gray, soft.
2195	2210	20	40	Chert, white to gray-white, chalky, dolomoldic (abundant).
			60	Chert, gray and white, ordinary, dolomoldic (abundant).
2210	2230	20	60	Chert, white to gray-white, chalky, dolomoldic (abundant).
			40	Chert, gray to brown, ordinary.
2230	2245	20	100	Chert, white to gray-white, chalky, dolomoldic (abundant).
2245	2265	25	50	Chert, white to gray, chalky, dolomoldic (scattered).
			25	Chert, blue-white, ordinary.
			25	Chert, brown, ordinary.
2265	2280	20	30	Chert, white to brownish-white, chalky, dolomoldic (scattered).
			40	Chert, blue-gray, ordinary.
			30	Chert, brown, ordinary.
--	160	--	--	Total thickness of Delaware-Columbus limestone.
		Bois Blanc Formation		
2280	2295	60	60	Chert, white to brownish-white, chalky, dolomoldic (abundant).
			40	Chert, brown and white, chalky, dolomoldic (scattered).
2295	2315	60	50	Chert, white to gray, chalky, dolomoldic (scattered).
			30	Sand, white, medium- to coarse-grained, rounded to subrounded, well sorted.
			20	Chert, white, ordinary.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
2315	2330	80	20	Chert, white to gray, chalky, dolomoldic (abundant).
			30	Chert, brown and white, mottled, ordinary.
			30	Chert, white to gray, ordinary.
			20	Sand, white, medium-grained, rounded, well sorted.
2330	2345	80	50	Chert, white to gray, chalky, dolomoldic (abundant).
			10	Chert, white to gray, ordinary.
			10	Chert, brown and white, mottled, ordinary.
			30	Sand, white, medium-grained, rounded, well sorted.
--	65	--	--	Total thickness of Bois Blanc formation.
		LOWER DEVONIAN		
		Oriskany Sandstone (?)		
2345	2360	80	60	Chert, white to gray, chalky, dolomoldic (scattered).
			40	Sand, white, medium-grained, rounded to subrounded, well sorted.
--	15	--	--	Total thickness of Oriskany sandstone.
		UPPER SILURIAN		
2360	2375	--	--	Missing.

WELL 19
Lake Twp., Stark County, Ohio
Description by J. W. Dow, Jr.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
		MIDDLE DEVONIAN		
		Delaware-Columbus Limestone		
2766	2774	25	45	Chert, gray, chalky, dolomoldic (scattered).
			5	Chert, blue-white, chalcedonic.
			50	Shale, dark gray, soft.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
2774	2782	20	50	Chert, light gray, chalky, dolomoldic (scattered).
			50	Chert, light gray, ordinary.
2782	2789	15	50	Chert, light gray, chalky, dolomoldic (scattered).
			50	Chert, light gray, ordinary.
2789	2796	10	5	Chert, white, chalky, dolomoldic (scattered).
			95	Chert, brownish-gray, ordinary.
2796	2804	15	5	Chert, white, chalky, dolomoldic (scattered).
			95	Chert, brownish-gray, ordinary.
2804	2811	10	100	Chert, gray, ordinary.
2811	2818	20	100	Chert, white, ordinary.
2818	2826	20	10	Chert, gray-white, chalky, dolomoldic (scattered).
			10	Chert, gray, ordinary.
			80	Chert, brownish-white, ordinary.
2826	2832	15	30	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, brownish-white, ordinary.
2832	2840	25	40	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, gray-white, ordinary.
2840	2848	25	100	Chert, gray-white, ordinary.
2848	2856	35	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, gray-white, ordinary.
2856	2863	30	50	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, gray to gray-white, ordinary.
2863	2871	40	50	Chert, white, chalky, dolomoldic (abundant).
			10	Chert, white, ordinary.
			30	Chert, brownish-white, ordinary.
			10	Chert, gray-white, ordinary.
2871	2876	30	30	Chert, white, chalky, dolomoldic (abundant).
			70	Chert, gray-white, ordinary.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
2876	2884	10	20	Chert, white, chalky, dolomoldic (scattered).
			20	Chert, brown, ordinary.
			30	Chert, blue-black, ordinary.
			30	Shale, dark gray, ordinary.
2884	2891	15	100	Chert, brownish-black, ordinary.
2891	2898	15	100	Chert, brownish-black, ordinary.
2898	2904	25	30	Sand, white, medium-grained, rounded, well sorted.
			70	Chert, brownish-black, ordinary.
2904	2910	25	100	Chert, brown to brownish-black, ordinary.
2910	2918	25	10	Brown argillaceous material.
			50	Chert, brown to brownish-black, ordinary.
			20	Chert, white, ordinary.
			20	Chert, gray-white, ordinary.
2918	2924	25	20	Sand, white, very fine grained, subrounded, well sorted.
			60	Chert, brownish-black, ordinary.
			20	Chert, white, ordinary.
--	158	--	--	Total thickness of Delaware-Columbus limestone.
				Bois Blanc Formation
2924	2932	40	40	Sand, white, fine-grained, well sorted, subrounded.
			60	Chert, gray-white, ordinary.
2932	2940	40	40	Sand, white, fine-grained, well sorted, subrounded.
			20	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, gray-white, ordinary.
2940	2947	40	30	Sand, white, fine-grained, subrounded, well sorted.
			30	Chert, white to tan, chalky, dolomoldic (abundant).
			40	Chert, blue-white, ordinary.
2947	2955	40	30	Chert, white, chalky, dolomoldic (abundant).
			40	Chert, blue-white, ordinary.
			30	Sand, white, fine-grained, subrounded, well sorted.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
2955	2960	40	30	Sand, white, fine-grained, subrounded, well sorted.
			70	Chert, blue, ordinary; chert, white, ordinary.
2960	2965	40	20	Chert, white, chalky, dolomoldic (abundant).
			50	Chert, blue-white, ordinary.
			30	Sand, white, fine-grained, subrounded, well sorted.
2965	2972	30	10	Sand, white, fine-grained, subrounded, well sorted.
			80	Chert, light gray, ordinary.
			5	Chert, white, ordinary.
			5	Chert, white, chalky.
2972	2980	30	10	Sand, white, fine-grained, well sorted, subrounded.
			30	Chert, white, chalky, dolomoldic (abundant).
			60	Chert, gray-white, ordinary.
2980	2988	30	10	Sand, white, fine-grained, well sorted, subrounded.
			90	Chert, white, chalky, dolomoldic (scattered).
2988	2995	50	20	Sand, white, very fine grained, well sorted, subrounded, glauconitic.
			80	Chert, brownish-white, ordinary.
2995	3003	50	20	Sand, white, very fine grained, well sorted, glauconitic.
			80	Chert, gray, ordinary.
3003	3010	50	20	Sand, white, very fine grained, well sorted, subrounded.
			80	Chert, gray, ordinary.
3010	3016	40	20	Sand, white, very fine grained, well sorted, subrounded.
			80	Chert, gray, ordinary; chert, brownish-white, ordinary.
3016	3022	45	10	Sand, white, very fine grained, well sorted, subrounded.
			90	Chert, gray, ordinary, chert, brownish-gray, ordinary.
--	98	--	--	Total thickness of Bois Blanc formation.

Depth (ft.) From	To	Percent of Residue	Percent	Descriptions of insoluble residues
				LOWER DEVONIAN (?) Helderberg Group (?)
3022	3029	35	30	Gray argillaceous material.
			70	Chert, blue-gray, ordinary.
3029	3037	40	50	Gray argillaceous material.
			50	Chert, blue-gray to blue-black, ordinary.
3037	3045	35	50	Gray argillaceous material.
			50	Chert, blue-gray, ordinary.
3045	3053	40	30	Gray argillaceous material.
			70	Chert, blue-gray, ordinary; chert, brownish-white, ordinary.
3053	3063	35	50	Gray argillaceous material.
			50	Chert, blue-gray, ordinary.
3063	3074	35	60	Gray argillaceous material.
			40	Chert, blue-gray, ordinary.
3074	3082	20	40	Gray argillaceous material.
			60	Chert, blue-gray, ordinary.
3082	3092	20	50	Gray argillaceous material.
			50	Chert, blue-gray, ordinary.
3092	3100	20	30	Gray argillaceous material.
			70	Chert, blue-gray, ordinary.
--	78	--	--	Total thickness of Helderberg group (?).
				UPPER SILURIAN
3100	3110	10	60	Brown to black argillaceous material.
			40	Chert, tan, chalky.

SCIENTIFIC AND TECHNICAL STAFF OF THE OHIO DIVISION OF GEOLOGICAL SURVEY

RALPH J. BERNHAGEN, Chief
RUSSELL A. BRANT, Asst. Chief
ELEANOR J. HYLE, Secretary

AREAL GEOLOGY SECTION

RUSSELL A. BRANT, Geologist and Head
RICHARD M. DeLONG, Geologist
DON W. FARNSWORTH, Geologist
JANE L. FORSYTH, Geologist
JESSE R. UPPERCO, Geologist

COAL SECTION

HORACE R. COLLINS, Geologist and Head
BRADLEY E. SMITH, Geologist

INDUSTRIAL MINERAL SECTION

KARL V. HOOVER, Geologist and Head
DAVE K. WEBB, Jr., Geologist

LAKE ERIE SECTION

ROBERT P. HARTLEY, Geologist and Head
CHARLES E. HERDENDORF, Geologist
WALTER R. LEMPKE, Engineering Technician
JAMES E. VOEGLE, Engineering Technician
MARLEEN L. MAAG, Secretary

PUBLICATIONS SECTION

HAROLD J. FLINT, Draftsman and Head
FLETCHER W. TWITTY, Jr., Draftsman
DIANA B. PFANNEBECKER, Draftsman
MILDRED M. SHIPLEY, Phototypist

SUBSURFACE GEOLOGY SECTION

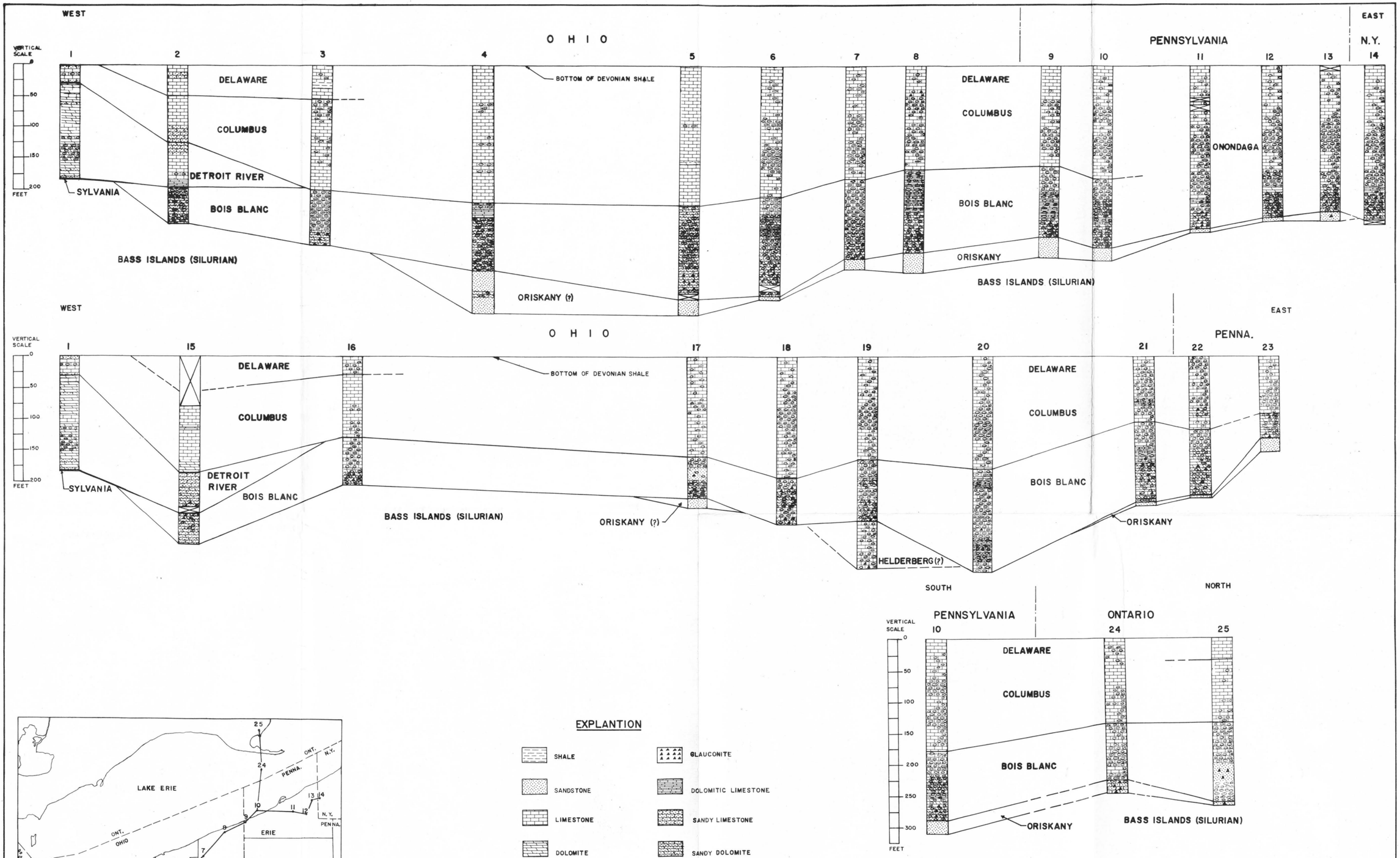
WARREN L. CALVERT, Geologist and Head
THEODORE A. DeBROSSE, Geologist
ROBERT T. ELMORE, Jr., Geologist
W. SCOTT BOWER, Geologist Aide
CAROLE J. JONES, Secretary

TECHNICAL FILES SECTION

PAULINE SMYTH, Geologist and Head
CAROLYN FARNSWORTH, Geologist

RESEARCH AFFILIATES

H. J. PINCUS, Ohio State University
C. H. SUMMERSON, Ohio State University
H. G. MULTER, Wooster College
ROY REINHART, Miami University



STRATIGRAPHIC SECTIONS OF THE MIDDLE AND LOWER DEVONIAN STRATA ACROSS NORTHEASTERN OHIO AND ADJACENT AREAS

BY JOHN DOW

OHIO DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 42