SUBSURFACE STRATIGRAPHY OF THE KINDERHOOK SERIES IN ILLINOIS

BY

L. E. WORKMAN AND TRACEY GILLETTE

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS

1956

by L. E. Workman and Tracey Gillette

ERRATA

Page 9, figure 2: Second parenthesis in figure caption should follow "County."

Page 12, col. 2: Lines 16-17 should read: southeast of the Vandalia arch, and southwest of the LaSalle anticlinal belt,

Page 35, col. 1: Second to last line should read: teau formation of Illinois is considered here

Page 39, col. 2: Reference in line 2 should be to plate 1 only.

Plate 40, map: Line in cross section HI should extend from well 15 to well 82 instead of from 16 to 82.
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**PLATES**  
*(in pocket)*

1. North-south and east-west cross sections of Kinderhook series  
2. Cross section from central Michigan to western Illinois showing correlation of Kinderhook strata
SUBSURFACE STRATIGRAPHY OF THE KINDERHOOK SERIES IN ILLINOIS

BY

L. E. WORKMAN and TRACEY GILLETTE

ABSTRACT

The lowermost series of the Mississippian system, the Kinderhook, underlies approximately the southern half of Illinois. The series in its type region in western Illinois is divided into three groups, the Champ Clark (new) at the base, the Hannibal, and the North Hill.

The Champ Clark consists of Sylamore sandstone, Grassy Creek shale, Saverton shale, and Louisiana limestone. The group is assigned to the Mississippian, but all or part of it may be Devonian. The Hannibal group consists of the Glen Park formation, the Maple Mill shale, including the Nutwood (new) black shale member, and the English River siltstone. In the northern part of the type area the North Hill includes the McCraney limestone, the Prospect Hill siltstone, and the Starrs Cave (new) limestone. To the south the North Hill is represented by the Chouteau limestone. In southeastern Illinois the undifferentiated equivalents of the Champ Clark and Hannibal groups are largely black shale and are included in the New Albany formation.

The subsurface stratigraphy and distribution of the Kinderhook formations in Illinois are shown by isopach maps and cross sections. The Kinderhook is raised to series rank, and Valmeyer series is accepted for the strata that make up the Osage and Meramec groups.

INTRODUCTION

The study of the subsurface stratigraphy of the Kinderhook series was begun in March 1941. Dr. Gillette assumed the major responsibility, and his excellent work on the sample cuttings and interpretations of the data proceeded until his death in November 1942. He had nearly completed a first draft of the report.

To complete the work, it has been necessary to review all the data, including that more recently available, and to prepare certain additional maps and cross sections. However, the important contributions of Dr. Gillette should be emphasized.

This report is based on study of numerous outcrop samples, sample cuttings, and cores of Kinderhook strata on file at the State Geological Survey up to 1951; many additional well samples, cores, and electric logs have since become available. These, and other data that may be obtained through geophysical and geochemical studies of the Kinderhook strata, should provide the basis for advancing our knowledge of these strata.

ACKNOWLEDGMENTS

The investigation was undertaken with the encouragement of M. M. Leighton, then Chief of the Illinois State Geological Survey. G. E. Ekblaw, Head of the Division of Engineering Geology and Topographic Mapping, aided the project by his interest and suggestions. Both criticisms and helpful contributions of knowledge and data by Charles Collinson, D. H. Swann, and H. B. Willman of the Division of Stratigraphy and Areal Geology and other members of the Survey staff are gratefully acknowledged. Able assistance in the study of sample cuttings was given by P. M. Busch and T. C. Buschbach.

GENERAL GEOLOGIC RELATIONS

Kinderhook strata (fig. 1) occur throughout wide areas from New York State to the Rocky Mountains. In Illinois these strata consist mostly of shales but have minor amounts of siltstone, limestone, and sandstone. The term Kinderhook series, named for the village of Kinderhook in western Illinois, is employed herein to designate the
entire sequence of strata from the base of the black shale lying on Devonian limestone or older formations to the base of the Osage limestones, siltstones, and shales which overlie it unconformably. As thus defined, the Kinderhook includes strata at the base that may be Upper Devonian. In southeastern Illinois it includes the middle and upper units of the New Albany shale but excludes at the base the Blocher, which is recognized as Middle Devonian and is not included in the Kinderhook series. However, the Blocher shale has not been differentiated from the overlying black shale in this study.

In the interior of the United States, basal Kinderhook strata overlap formations of many ages. The pre-Kinderhook areal geology in Illinois is shown in figure 2. In the major part of the area underlain by Kinderhook strata, extending from north-central to southern Illinois, the exposed rock is Middle Devonian. Middle Devonian strata exposed in the northwestern half of this area consist principally of the Cedar Valley and minor amounts of Wapsipinicon limestone (Workman, 1944, p. 196); strata in the southeastern half are the Alto, Lingle, and Grand Tower limestones. In the middle of the northwestern half, the Silurian is exposed over a considerable area, though probably there are many thin patches of Cedar Valley and Wapsipinicon. At the northwestern corner of the Silurian area, south of the Colmar-Plymouth oil field, a small patch of Ordovician Maquoketa shale is exposed. In southwestern Illinois the northeastern edge of the Ozark uplift exposes Lower Devonian, Silurian, and Ordovician formations.

The over-all thickness of the Kinderhook series in Illinois is shown in figure 3. Several structural warpings produced the variations in thickness. Two structures, the Ozark uplift and the Vandalia arch, greatly

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**Table:**

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<td>Devonian</td>
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**Fig. 1.—Correlation chart of the Kinderhook series in Illinois.**
Fig. 2.—Distribution of the Kinderhook series and pre-Kinderhook areal geology (excludes thin and discontinuous Kinderhook) in Randolph County.
Fig. 3.—Thickness of the Kinderhook series.
Fig. 4.—Generalized pre-Osage areal geology.
affected the character and place of deposition of the sediments.

The Ozark uplift is a positive area of general and frequent uplift extending from southeastern Missouri into Illinois. Its eastern edge is the DuQuoin monoclinal flexure. In Monroe, Randolph, and Jackson counties,* the uplift produced an area in which Kinderhook strata are thin and discontinuous, although they may once have been thicker. North, east, and south of this area, Kinderhook strata thicken slowly for considerable distances, beyond which the rate of thickening increases rapidly.

The Vandalia arch is a positive area extending northeastward from the Ozark uplift. The structure is named for the city of Vandalia, situated near the junction of the arch with the Ozark uplift (T. 6 N., R. 1 E., Fayette County, Ill.). The arch has the same general location and direction as the “Madison-to-Coles-counties zone” described by Workman (1944, p. 194), where Devonian and Silurian relations change rapidly from northwest to southeast. Kinderhook strata on the crest of the arch are 100 to 125 feet thick. The arch is broad and extends to the northwest as far as the southeastern border of Sangamon County, where thicknesses reach 200 to 225 feet. Its effect is seen as far southeastward as the 175-foot isopach line.

A third major structural uplift is indicated by thinning of Kinderhook strata in east-central Illinois along the LaSalle anticlinal belt. This was not a positive area of relative uplift like the Ozark uplift and Vandalia arch and, therefore, did not influence deposition of Kinderhook sediments. There appears to have been movement of this uplift in post-Kinderhook pre-Osage time (cross section EF, plate 1), which caused thinning of Kinderhook strata over an area from southeastern Champaign County to northern Lawrence County, leaving a saddle in Clark County (shown by the pattern of pre-Osage areal geology, fig. 4).

Northwest of the Vandalia arch and north of the Ozark uplift, the Kinderhook strata are 200 to 225 feet thick over a wide area that will be referred to as the Petersburg basin, named for the town of Petersburg in Menard County. In the basin, Kinderhook strata thin along a northeast-southwest axis through western Schuyler County. Northwest of this axis in Adams, Hancock, and Henderson counties the strata thicken rapidly. This area of thinning will be referred to as the Schuyler arch. The arch was of relatively minor influence until the end of Kinderhook time, prior to which the Petersburg basin opened to the northwest into Iowa.

In the Illinois basin, east of the Ozark uplift, southwest of the Vandalia arch, and southeast of the LaSalle anticlinal belt, Kinderhook strata thicken southward to 400 feet in Hardin and southern Gallatin counties, but the apparent regularity of increase in thickness may result from scarcity of data.

KINDERHOOK SERIES

In previous Illinois Geological Survey reports, Kinderhook strata have been considered a group in the Iowa series. In this report, the Kinderhook is raised to series rank, for reasons discussed by Weller and Sutton (1940, p. 771-775). The name Iowa is dropped, following the usage in the Mississippian correlation chart of Weller et al. (1948). The name Valmeyer (Weller and Sutton, 1940, p. 771) is accepted as a series name to include the Osage and Mermec groups. This classification has the merit of recognizing the threefold differentiation of the Mississippian system in the standard reference area: a lower predominantly clastic series (Kinderhook), a middle limestone series (Valmeyer), and an upper cyclical series (Chester).

The Kinderhook series (fig. 1) in northwestern, western, and central Illinois is divided into three groups: the North Hill (above), the Hannibal (middle), and the Champ Clark (below). In eastern and southern Illinois it is divided into two formations, the Chouteau (above) and the New Albany (below).

*See figure 20 for geographic locations.
Fig. 5.—Distribution of the Sylamore formation.
CHAMP CLARK GROUP

In western Illinois, a succession of conformable formations overlies the unconformity on top of Devonian-Silurian strata and continues upward to the unconformity at the top of the Louisiana limestone. The name Champ Clark group is proposed for this succession, derived from the Champ Clark Bridge at Louisiana, Mo. As thus defined, the group includes strata believed by some to be Mississippian and by others to be Devonian. The group coincides with the Fabius group of Weller et al. (1948), named for outcrops on the Fabius River in northern Marion County. According to T. R. Beveridge, Missouri Geological Survey (personal communication), the formations included in this group are not exposed along the Fabius River. Because the name Fabius has been introduced so recently, and because the exposures at Louisiana are excellent and much better known, the change in name seems desirable.

All the formations in the Champ Clark group are exposed in the Mississippi River bluff at Louisiana, 1000 feet northwest of the bridge, in NE 1/4 sec. 18, T. 54 N., R. 1 W., Pike County, Mo., as indicated below.

Mississippian system
Kinderhook series
Hannibal group
Maple Mill formation (not measured)
Champ Clark group
Louisiana formation
Limestone, dolomitic, buff, thick-bedded above, thin-bedded below . . . 38
Limestone, lithographic, scattered irregular buff dolomitic areas . . . 10
Saverton formation
Shale, silty, brownish gray, blocky, slightly sandy, fossiliferous, glauconitic 1 . . 2
Grassy Creek formation
Shale, bituminous, dark brown, platy, limonitic surface, brittle . . . 4
Sylamore formation
Sandstone, quartz, fine to coarse, pyritic . . . 1
Shale, yellowish gray, weak, crumbly . . . 7

Silurian system
Alexandrian series
Edgewood formation
Bowling Green member—limestone, buff and light gray, very fine . . . 4 6
Noix member—limestone, oolitic, light gray . . . 6 6

Ordovician system
Cincinnati series
Maquoketa formation
Shale, blue, some red marks, weathers buff at top . . . 1

SYLAMORE FORMATION

The Sylamore sandstone (fig. 5) at the base of the Kinderhook series is composed of medium to coarse rounded quartz grains more-or-less cemented with pyrite, calcite, and dolomite. Chert grains are present but are not common. The sandstone is rarely more than 5 feet thick and generally is not more than a few inches thick. It is the initial deposit above the basal unconformity, is irregularly distributed, and grades upward into black shale. It is correlated with the type Sylamore sandstone of Arkansas, the Misener sandstone of Oklahoma, and the Hardin sandstone of Tennessee. The name Sylamore has been widely used for the sandstone in western Illinois and Missouri and is accepted for use throughout Illinois. It has priority over the names “Hardin” and “Misener.”

GRASSY CREEK FORMATION

Keyes (1898, p. 63) introduced the name Grassy Creek for the six feet of black and green shale that lies immediately beneath the Louisiana limestone in the town of Louisiana and thickens to 30 feet along Grassy Creek west of the town. Later Rowley (1907, p. 24-26) included 32 feet of Maquoketa in the formation at the Grassy Creek locality, but it is clear from the thicknesses given by Keyes that no Ordovician strata were included in the original description.

Keyes (1913, p. 160-162) separated the blue or green shale above the black shale from the Grassy Creek formation and named it Saverton shale. Krey (1924, p. 33-34) used “Sweetland Creek (Grassy Creek) shale” to designate all the strata in the interval from Devonian limestone to
Fig. 6.—Thickness of the Grassy Creek and New Albany formations—Grassy Creek to west and New Albany to east of dashed line.
Louisiana limestone and did not recognize the Saverton shale as a distinct formation. Moore (1928, p. 34-42) recognized both the Saverton and Grassy Creek shales. Branson and Mehl (1933, p. 171-184) used Grassy Creek to include both the Saverton and underlying black shale. Weller (1935, p. 191-192) questioned the validity of the term Grassy Creek because of the confusion arising from Rowley's inclusion of the Maquoketa in the Grassy Creek shale at the type locality. He recommended that Grassy Creek be dropped and Saverton used to designate both shales. Weller and Sutton (1940, p. 779) tentatively used "Grassy-Saverton shale." In their Mississippian correlation chart, Weller et al. (1948) accepted Grassy Creek for the black shale and Saverton for the overlying green shale. As stated by Moore (1928, p. 37) and Williams (1943, p. 4), and followed by the present writers, the two shales are distinct formations.

**Lithology.**—The Grassy Creek shale is dominantly tough, brownish black, slightly silty, pyritic, very thinly laminated, and sporangites-bearing. Bluish-gray shale, similar in texture but not as tough, is present in relatively small proportions. In Madison and Clinton counties, dark bluish-gray fossiliferous shale is found at the base of the black shale. In most wells the bluish-gray shale can be observed grading downward or upward through transition zones into the black shale. Northwest of Sangamon County, the Grassy Creek is dominantly black shale, but light-gray flaky dolomitic layers are locally abundant in the basal third of the formation. They increase in relative importance northwestward and are very abundant in northern McDonough and in Warren and Henderson counties. In the latter area, some wells encountered thin light-gray argillaceous limestones in the basal few feet of the formation. In northern Pike County, the upper part grades laterally into a weak brown slightly calcareous shale. Farther to the north and northeast, the relative proportion of brown shale increases and the brown shale is interbedded with greenish-gray shale layers which can be distinguished from the overlying Maple Mill shale only by their lesser silt content.

**Distribution and thickness** (fig. 6).—The name Grassy Creek is applied in western and central Illinois and east as far as the Champ Clark group can be differentiated. Farther east the Grassy Creek is equivalent to part of the New Albany shale. The Grassy Creek is not present on the Ozark uplift in Monroe and Randolph counties nor in the southern tip of Calhoun County. East of the Ozark uplift, it thickens to 75 to 100 feet. Along the Vandalia arch it is 90 to 120 feet thick. In the Petersburg basin the formation increases to about 150 feet over wide areas, and northwestward toward Iowa in Henderson County it thickens to at least 216 feet. Southeastward from the Vandalia arch it increases in thickness to 180 feet.

**Stratigraphic relations.**—The Grassy Creek shale rests conformably on the thin, discontinuous Sylamore sandstone. The two formations together unconformably overlap Ordovician, Silurian, and Middle Devonian strata (fig. 2).

The Grassy Creek is conformably overlain by the Saverton shale. North of the area in which the Saverton has been differentiated, the Grassy Creek seems to be directly overlain by the Maple Mill shale of the Hannibal group. South of the border of the Saverton, the Louisiana limestone lies on the Grassy Creek. Southward and eastward from the Saverton border, the Glen Park formation and the Maple Mill shale successively onlap the Grassy Creek. Southeast of the edge of the Maple Mill shale, the Grassy Creek becomes a major part of the New Albany shale and is not differentiated.

**SAVERTON FORMATION**

The gray shale overlying the black Grassy Creek shale and underlying the Louisiana limestone was named Saverton by Keyes (1913, p. 160-162) for Saverton station, Ralls County, Mo., about seven miles south of Hannibal, near which it is well exposed.

**Lithology.**—The Saverton formation is blue- or green-gray to brownish-gray shale.
SAVERTON FORMATION

It contains some silt but normally is not so silty as the Maple Mill shale. It is noncalcareous to slightly calcareous, which differentiates it generally from the more calcareous Maple Mill shale. Black microscopic flakes of carbonaceous plant material and pyritized cylindrical "stems" a millimeter or more in diameter are common. The Saverton contains scattered rounded very fine to medium grains of quartz sand and rounded to angular granules of black shale. Microscopic whitish tubes or rods are common. Sporangites occur sparsely. In Macoupin County the shale is quite silty and grades to siltstone.

Distribution and thickness (fig. 7).—In outcrops in Pike County (T. 6 S., R. 5 W.), the Saverton shale reaches thicknesses close to 50 feet. In subsurface, south and east of the northwestern edge of the overlying Glen Park formation, it ranges up to 60 feet in thickness. In figure 7 we have attempted to show the northern extent of the shale where it is overlain by Maple Mill shale in the westernmost tier of townships. The isopachs show that the thickness varies

Fig. 7.—Thickness of the Saverton formation. The thickness is shown for only part of the area north of the northwestern edge of the Glen Park formation (dashed line).
from 0 to 75 feet in that area. Farther east, brownish-gray shale overlies greenish-gray shale and appears to make up increasing proportions of the interval between the top of the Grassy Creek and the base of the Osage group; in some wells the brownish-gray shale makes up the entire thickness. Whether or not the brownish-gray shale is actually Saverton or a brownish facies of the Maple Mill is not certain. As the shale is in every way typical of the Saverton, having moderate silt content, sporangi tes, and black shale granules, it is here included in the Saverton.

Stratigraphic relations.—Although the Saverton has generally been considered conformable with the Grassy Creek shale, the shales are distinctly different. The Louisiana limestone conformably overlies the Saverton along the area of thick Saverton in Macoupin and Montgomery counties (fig. 7). Elsewhere the Saverton is unconformably overlain by either the Glen Park or the Maple Mill.

LOUISIANA FORMATION

Keyes (1892, p. 289) introduced the name Louisiana for the “Lithographic limestone” of Swallow (1855, p. 103-106). He described the formation as about 50 feet thick at Louisiana, underlain by six feet of dark-gray clayey shale, and overlain by the Hannibal shale. Moore (1928, p. 40, 48-50 and fig. 2) reported the Louisiana as resting conformably on the Saverton and overlain unconformably in Jersey and Calhoun counties by the Glen Park formation.

In this report the name Louisiana is used to designate the lithographic limestone that in western Illinois normally overlies the Saverton shale or, where the Saverton is absent, the Grassy Creek shale. In Illinois the Louisiana underlies the Glen Park formation of the Hannibal group.

Lithology.—The Louisiana is a light-gray to buff lithographic to sublithographic limestone which contains beds of fine granular buff to light-brown dolomite. The formation contains little insoluble material; it is 90 to 97.5 percent soluble, averaging 95 percent. Residues consist largely of clay.

Coarser portions of the residues average about one-tenth of 1 percent of the limestone, of which siliceous foraminifera make up about one-half. The genera represented are Involutina (Ammodiscus), Lituotuba, Hyperammina, Bathysiphon, Tolyaminina, Aschemonella?, and simpler forms difficult to identify. The other half of the coarser portions of the residues consists of aggregates of argillaceous material and very fine to coarse silt. Beginning 15 feet below the top of the Louisiana limestone at Lovers Leap, near the center of the SE1/4 sec. 38, T. 57 N., R. 4 W., Marion County, Mo., a 5-foot zone yields numerous grains of white rounded and frosted fine to medium sand. An occasional similar grain of sand is found in residue from the Louisiana in Illinois, but these grains are rare.

Distribution and thickness (fig. 8).—Outcrops of the Louisiana limestone in Illinois are confined to the northern and central parts of Calhoun County and the northwestern and midwestern parts of Jersey County. In most outcrops the formation is only three to five feet thick, but in some it is much thicker. It attains a maximum thickness of about 30 feet in Wildcat Hollow, in the NW1/4 SW1/4 SE1/4 sec. 7, T. 8 S., R. 3 W., Calhoun County.

From the area of outcrop the Louisiana extends eastward in the subsurface as far as Bond and Montgomery counties (cross section CD, plate 1 and HI, plate 2). It is a continuous and easily recognized formation. The north-south extent of the formation is roughly the same as in the area of outcrop. The maximum thickness of the Louisiana found in subsurface studies is in the Hughes Petroleum Company Kallall well 1 in sec. 22, T. 8 N., R. 12 W., Jersey County, where about twenty feet was penetrated.

Stratigraphic relations.—The Louisiana limestone is conformably underlain by the Saverton shale, as shown by the core of the Madison Coal Company diamond drill hole 15, in sec. 35, T. 8 N., R. 6 W., Macoupin County. In some outcrops, particularly those around Hannibal, Mo., the shale can be observed grading upward into the Louisiana.
through a thin transition zone. The gradation from Saverton to Louisiana in Missouri was described by Williams (1943, p. 4-5). The Saverton also contains a fauna that Moore (1928, p. 48-49) considered to be closely related to the fauna of the Louisiana. In most of Jersey County and parts of Montgomery and Bond counties the Louisiana lies on the Grassy Creek shale.

In Illinois the Louisiana is everywhere overlain by the Hannibal group. In northeastern Missouri the Louisiana is reported to be overlain unconformably by the Glen Park and Maple Mill (Williams, 1943, p. 5-6). The unconformable relations at Hamburg, Ill., also were described by Williams (1943, fig. 1, pl. 5).

In subsurface, the unconformity at the top of the Louisiana is indicated by an irregular contact and by a sharp and abrupt change in lithology. In outcrop, the most convincing evidence of an unconformity is the presence of pebbles of lithographic limestone in the Glen Park formation, as in Jimtown Hollow in SW1/4 SW1/4 SW1/4 sec. 16, T. 6 S., R 5 W., Pike County. The pebbles have insoluble residues like those from the Louisiana limestone.

**Correlation.**—The Louisiana limestone of Illinois is equivalent to the type Louisiana of Missouri. Stuart Weller (1906, p. 464-467) suggested that the "Hamburg" oolite (in the Glen Park) is the time equivalent of the upper part of the Louisiana. This suggestion was made to explain the relatively thin sections of the Louisiana formation in Illinois as compared with thicker sections in Missouri. However, the presence of pebbles of Louisiana lithographic limestone in the basal Glen Park and the evidence for an unconformity at the top of the Louisiana in Illinois and Missouri seem to rule out this interpretation.

Many writers have discussed the Devonian or Mississippian age of the Louisiana limestone; the arguments will not be reviewed here. In Missouri, Branson and Mehl (1933, p. 179-183) place the Grassy Creek and Louisiana in the Devonian. Several earlier geologists, Keyes and Rowley in Missouri and Udden in Iowa and northwestern Illinois, considered the Grassy Creek as Devonian. On the other hand, many geologists, including Ulrich, Stuart Weller, Krey, Moore, J. M. Weller and Sutton, and Williams, have considered it Mississippian.
In the Mississippian correlation chart (Weller et al., 1948), the Louisiana limestone was included in the Fabius group, the age of which was referred to as Devonian or Mississippian. That practice is followed here, except that the name Champ Clark is proposed as a replacement for Fabius.

**Hannibal Group**

The name *Hannibal* was introduced by Keyes (1892, p. 289-290) for the shales overlying the Louisiana and underlying the Chouteau limestones. It supplanted the descriptive term “Vermicular shales and sandstones,” proposed by Swallow (1955, p. 103). Keyes erroneously identified as Chouteau the basal Burlington beds at Hannibal and Louisiana, but the Chouteau does overlie the shale south of Louisiana. Moore (1928, fig. 2) limited the Hannibal to the shale and siltstone overlying the Glen Park and underlying Chouteau in Jersey and Calhoun counties. Northward in Adams County, where the Glen Park is absent, he included in the Hannibal all the strata from the top of the Louisiana to the base of the Burlington. He considered the Maple Mill shale, English River sandstone, McCraney limestone, and Prospect Hill sandstone to be members of his Hannibal formation. Later (1935, p. 240) he indicated that the Glen Park limestone also should be included. Laudon (1931, p. 366-371) considered the English River siltstone a formation and correlated it with the Hannibal. He stated that the McCraney and Prospect Hill contain prominent Chouteau elements which are not present in the underlying sediments, and he designated the McCraney limestone, Prospect Hill siltstone, and a thin oolitic limestone above the Prospect Hill as comprising the North Hill member of the Hampton formation. Later (1935, p. 246) he removed the North Hill from the Hampton formation.

In this report the name Hannibal is used for the formations that lie above the Louisiana limestone and beneath the Chouteau. Where the Louisiana is absent the Hannibal rests upon the Saverton, and where the Saverton is absent it lies on the Grassy Creek shale. In a small area in westernmost Illinois, the McCraney overlies the Hannibal, and where neither the Chouteau nor the McCraney is present, as in a large area in west-central Illinois, the Hannibal is overlain by Osage strata.

**Divisions of the Hannibal.**—The Hannibal group is composed of three formations; in ascending order they are the Glen Park siltstone, the Maple Mill shale, and the English River siltstone. They are intimately related and in many places it is difficult to draw sharp boundaries between them. A black shale unit in the Maple Mill shale is named the Nutwood member.

**Distribution and thickness.**—The Hannibal group occurs largely northwest of the Vandalia arch and north of the Ozark uplift. In general, the Hannibal thickens northwestward from the Vandalia arch and is 75 to 125 feet in the Petersburg basin. It thins to 50 to 75 feet along the Schuyler arch. Farther to the northwest it thickens to almost 100 feet.

**Glen Park Formation**

Ulrich (1904, p. 110) introduced the name *Sulphur Springs* for a series of strata found in eastern Jefferson County, Mo., at the base of the Kinderhook. He divided these strata into the Bushburg sandstone, about 10 feet thick at the top, the Glen Park oolitic limestone, 1 to 5 feet thick in the middle, and a shale 0 to 15 feet thick at the base. He considered the basal shale a member of the Kinderhook or Devonian. Stuart Weller (1906, p. 464-467) first employed the term *Hamburg* to designate the oolitic limestone at Hamburg, Ill., which he considered slightly younger than the Glen Park limestone and the time equivalent of the upper part of the Louisiana limestone. Later (1914, p. 14) he described the Hamburg oolite as 1 to 15 feet of white or flesh-colored oolitic limestone with interbedded layers of sandy shales, lying under the Hannibal shale and underlain by 1 to 8 feet of brown sandy shale, followed below by the Louisiana limestone. The name Hamburg was pre-empted, however, and Moore (1928, p. 138-140), basing his conclusions on close faunal similarity, stated
that the Hamburg oolite is the equivalent of the Glen Park oolitic limestone and proposed using Glen Park as the name of the formation. He defined the formation as unconformably overlying the Louisiana at Hamburg and underlying the Hannibal shale. Still later (1935, p. 240) Moore stated that the Glen Park “grades upward without evidence of break” into the Hannibal formation and “seems hardly to deserve consideration as a stratigraphic element correlative with other Kinderhook divisions.”

Krey (1924, p. 36) placed the Hamburg oolite of Weller in the Hannibal shale, stating that the basal portion of the Hannibal shale at Hamburg consists of dense siliceous limestone interbedded with sandy shale containing intercalated beds of fossiliferous oolite called the Hamburg oolite. The Glen Park is here considered as a formation of the Hannibal group overlying the Louisiana limestone and underlying the Maple Mill shale. The top of the Glen Park is placed where the formation becomes shale or silty shale. By this definition the brown sandy shale noted below the “Hamburg” oolite by Weller (1914, p. 14) is part of the Glen Park formation.

**Lithology.**—The best exposure of the Glen Park is in Gresham Hollow, about one mile southeast of Hamburg, along the northern edge of the NW¼ sec. 10, T. 6 N., R. 12 W., Calhoun County. In this exposure the formation consists of 17 feet of calcareous blue-gray siltstone overlying 15 feet of light-gray to buff silty dense sublithographic limestone. The limestone contains beds of light-gray to buff silty dense sublithographic limestone. The limestone contains beds of light-gray to brownish-gray compact dolomitic sporangites-bearing siltstone and some lenses of highly fossiliferous white or flesh-colored medium to coarse oolitic limestone. Gray to brownish-gray silty shale layers are abundant. Some of the oolitic beds contain pebbles of Louisiana-like lithographic limestone. Much of the formation is crossbedded. The limestone beds are lenticular. Ripple and wave marks and mud cracks are common. In this exposure the Glen Park overlies 3 feet of Louisiana limestone.

About 20 percent of the dense limestone is insoluble material. Two-thirds of the residue consists of fine-to-coarse silt. Although the dense limestone layers are sublithographic, they differ from similar beds in the underlying Louisiana which average only 5 percent insoluble material and contain less than one-tenth of one percent silt.

Insoluble residues of the oolitic layers show a wide range of composition. Some are composed of as much as 30 percent of medium-sized well-rounded frosted sand grains. In others, sand grains are less common and the residue is largely clay and silt. Residues of the lithographic limestone pebbles reveal that the limestone is remarkably pure, similar in every respect to the Louisiana.

The Glen Park shows similar variability in other outcrops. At its base in Jerseyville Hollow, near Grafton (NE¼ NW¼ sec. 10, T. 6 N., R. 12 W., Jersey County), 6 inches of partly oolitic sandstone or siltstone grades downward into 3 inches of conglomerate composed of sand, oolites, fossil fragments, and pebbles of brownish-black shale. In Jimtown Hollow, in the SW¼ SW¼ SW¼ sec. 16, T. 6 S., R. 5 W., Pike County, the Glen Park contains a conglomeratic oolitic limestone about seven feet thick. Some pebbles and boulders of lithographic limestone in the conglomerate are 6 inches in diameter, although most of them are 1 inch or less. On Brown Branch (east line of NE¼ sec. 26, T. 5 S., R. 5 W., Pike Co.), a slab of conglomerate contains pebbles of lithographic limestone.

In general, the Glen Park appears in subsurface samples to be a very compact gray to brownish-gray siltstone in which carbonate content varies from well to well and from top to bottom of the section. The siltstone contains brown clay that generally increases in abundance toward the east, southeast, and south. Brown to brownish-gray silty calcareous shales are interbedded with the siltstone and increase in abundance as the clay content of the siltstone increases. Limestones are much less prominent in the subsurface sections than in outcrops, though they are well represented. Very fine grained silty dense light-gray to buff limestones are most common. Oolitic limestones are wide-
spread (fig. 9). They occur commonly at the base but sporadically throughout, as in southern Macoupin County and in Logan County. Pyrite and flakes of black carbonaceous material are typical. Some beds locally contain up to 30 percent rounded sand grains.

Distribution and thickness (fig. 9).—The Glen Park formation appears to consist of a number of bar-like silt lenses extending into central Illinois from the southwest. The most prominent lens extends from Pike County to southern Woodford County. It has a maximum thickness of about 80 feet. Other lenses 60 to 70 feet thick extend in an easterly direction and occur as far south as Clinton County. Between the lenses only the basal oolitic limestone is commonly present.

Stratigraphic relations.—The Glen Park is separated from the underlying Louisiana limestone by the erosional unconformity already described. North of the Louisiana lens (fig. 8) the Glen Park siltstone rests with sharp break in lithology on the Saverton or Grassy Creek shale. To the east and southeast, considerable black argillaceous material comes into the siltstone, and the
MAPLE MILL FORMATION

The term Maple Mill was first employed by Bain (1895, p. 322-25) to designate the nonfossiliferous dark-gray to blue argillaceous shale underlying the English River grits or sandstones at Maple Mill, Washington County, Iowa. The following year (1896, p. 137), he proposed correlating the Maple Mill with the lower shaly portion of the Hannibal at Louisiana, Mo.

Laudon (1931, p. 355-60) defined the Maple Mill as including everything below the English River and above "the Devonian formations." He believed that the Sweetland Creek shale was equivalent to part of the Maple Mill and probably to some portion a considerable distance above the base.

Moore (1928, p. 20-24 and fig. 2) made the Maple Mill shale the lowest member of his Hannibal formation. He showed the member as unconformably underlain by the Sweetland Creek and overlain conformably by the English River sandstone member of the Hannibal. A few years later (1935, p. 239, 245) he showed the Maple Mill as conformably underlain by the Sweetland Creek which he thought might be equivalent to his Saverton.

In this report, the name Maple Mill is used for the shale overlying the Glen Park or, where the Glen Park is absent, the Louisiana, Saverton, or older rocks. It is overlain in apparent conformity by the English River or Chouteau, and where these are absent, it is overlain unconformably by the Osage. In this sense, the term Maple Mill follows the usage of Moore (1928, p. 20-24) and Weller et al. (1948, chart 5). Correlation of this unit with the type Maple Mill in central Iowa is uncertain. The type section may well include beds equivalent to the Saverton of this paper, as believed by Laudon (1931, p. 359) and Thomas (1949, p. 413). In view of the uncertainty, it seems better not to change current Illinois usage in this report.

A local black shale facies of the Maple Mill in west-central Illinois is differentiated as the Nutwood member.

Lithology.—The Maple Mill formation, except in the black facies, is a weak bluish-to greenish-gray very silty medium to slightly calcareous shale. In outcrops along the Mississippi Valley in Pike and Calhoun counties, the Maple Mill is distinguished from the overlying English River by its thin bedding and typical shaly texture. The rock consists mainly of quartz silt but contains considerable argillaceous material. The silt grains are generally finer than those in the overlying English River siltstone. They range from very fine to medium silt with occasional coarse grains. The siliceous and calcareous character of the Maple Mill aids greatly in distinguishing it from the underlying Saverton and Grassy Creek shales, which are mostly noncalcareous and more highly argillaceous.

The Maple Mill is noticeably silty throughout most of its extent (figs. 10 and 12), particularly along the western margin of the State. To the east and south, either the silt becomes finer or argillaceous material makes up a greater percentage. For example, in Knox County, below the upper few feet of the Maple Mill, medium-sized silt grains are rare and some samples are more than 50 percent argillaceous material. Toward the northwest, brown shale laminate containing sporangites are found locally. In McDonough County, they are found within 20 feet of the top.

East of the counties along the western margin of the State, the very silty shale appears to thin out irregularly on top of the brownish-gray Saverton shale, there being only a few feet in the logs of wells in Knox County and only 20 feet in some wells in McDonough County. In Henderson, McDonough, and Adams counties, the lower part of the Maple Mill, and less commonly other parts, are characterized by rounded very fine to medium quartz sand grains.

Distribution and thickness (figs. 10, 11, and 12).—The Maple Mill formation is present throughout most of western and
south-central Illinois. Its thickness varies inversely with the ridges and troughs in the Glen Park siltstone over which it was deposited (fig. 9). The thickness of the gray Maple Mill also decreases abruptly where it grades laterally into the black Maple Mill (Nutwood member). In places the interval between the Glen Park and the Osage is entirely black shale. Maximum thicknesses of 64 to 70 feet occur close to the major Glen Park lens. The Maple Mill is generally less than 30 feet thick where it extends over the Vandalia arch to the Illinois basin.

Fig. 10.—Thickness of the Maple Mill formation. The thickness is shown for only part of the area north of the northwestern edge of the Glen Park formation (dashed line).
Near the western edge of the State and northwest of the major Glen Park lens, the thickness of the Maple Mill is irregular (fig. 12). In the Petersburg basin it is difficult to separate the Maple Mill from the Saverton shale. The shales together are 50 to 60 feet thick over the Schuyler arch and thicken to 90 feet northwest and 120 feet southeast of the arch.

*Stratigraphic relations.* — Southeast of the major Glen Park lens the Maple Mill rests conformably on Glen Park siltstone. The contact is gradational and in many places is difficult to determine. Northwest of the Glen Park the Maple Mill rests on the Saverton shale or, where the Saverton is absent, on the Grassy Creek shale.

In a belt along the western border of Illinois from Henderson to Pike counties, English River siltstone conformably overlies the Maple Mill shale (fig. 13). The transition zone is thin and there is little difficulty in separating them either in outcrops or in well cuttings.

South of the region in which the English River siltstone is present, the Chouteau limestone (fig. 17) directly overlies the Maple Mill shale. The two appear conformable. In some places the basal Chouteau limestone appears argillaceous and silty, and the underlying Maple Mill shale contains beds of very calcareous siltstone.

In a wide area northwest of the Vandalia arch where neither the English River nor the Chouteau is present, the Maple Mill is unconformably overlain by limestones of Osage age. The contact is sharp. There is a decided increase in carbonates in the upper few feet of the Maple Mill in most well samples and in all the outcrops studied. This increase may be due to original deposition or it may be the result of secondary downward enrichment of the shale by calcite during or after the deposition of the Osage limestone. No such increase in carbonates was noted where the Maple Mill is immediately overlain by the English River siltstone.

*Correlation.* — Most if not all of the Hannibal shale section in the vicinity of Hannibal and Louisiana, Mo., is equivalent to the Maple Mill of Illinois. The northwestward thinning of the undifferentiated Maple Mill and Saverton shales, as shown in

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**Fig. 11.**—Thickness of the Nutwood member of the Maple Mill formation.
cross sections AB and BG (plates 1 and 2), suggests that the Maple Mill and Saverton shales may be very thin in southeastern Iowa. If so, then the Sweetland Creek shale of Iowa may represent the Grassy Creek shale.

Laudon (1931, p. 346, 355-360) considered the Maple Mill to include the entire 200 to 350 feet of shale between the Devonian limestone and the English River formation and thought the Sweetland Creek to be some part of the Maple Mill. He stated (p. 357) that "lithologically the Maple Mill is more like the Saverton shale than like the Hannibal shale. If the Hannibal shale overlaps onto the Saverton-Maple Mill surface, it may be that the English River is the only portion of the Hannibal represented in Iowa. In this case the Saverton of Missouri would be correlated with some portion of the Maple Mill. In time position the Louisiana limestone would occupy the interval between the deposition of the Maple Mill and the English River." Thomas (1949) concluded that the Maple Mill of Iowa is equivalent to the Grassy Creek shale, in which he included both the Grassy Creek and Saverton of this report.

It is suggested here that in southeastern Iowa there may be a deposit of shale under the English River that is the equivalent of the Maple Mill as used here. The possibility of finding such silty shale on argillaceous Saverton shale in the upper part of the Iowa shale section should be investigated. If the Maple Mill of Illinois is very thin in southeastern Iowa, most of the thick shale section now called Maple Mill in Iowa may be Saverton-Grassy Creek.

![Map of thickness of undifferentiated Maple Mill and Saverton formations](image1.png)

![Map of thickness of English River formation](image2.png)
The name **Nutwood** is proposed for a dark-brown to black facies of the Maple Mill formation. It grades and intertongues into the Maple Mill gray shale. Locally in west-central Illinois it replaces the gray shale entirely and is directly overlain by the Chouteau limestone.

The member is named from exposures along the creek that flows through “The Narrows” just northeast of Nutwood in the SE 1/4 NE 1/4 sec. 33 and SW 1/4 NW 1/4 sec. 34, T. 8 N., R. 13 W., and in the bluff behind Tenneriffe School, NW corner sec. 9, T. 7 N., R. 13 W., Jersey County, Ill.

The section given below is along the creek that flows through “The Narrows,” in the SE 1/4 NW 1/4 sec. 34, T. 8 N., R. 13 W., Jersey County, Ill.

### Thickness feet

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maple Mill formation</td>
<td></td>
</tr>
<tr>
<td>Shale, silty, greenish to buffish gray, poorly laminated</td>
<td>12</td>
</tr>
<tr>
<td>Nutwood member—shale, slightly silty, dark brown to black, fissile, abundant sporangites</td>
<td>13</td>
</tr>
<tr>
<td>Shale, silty, gray, blocky, grades into Glen Park below</td>
<td>10</td>
</tr>
<tr>
<td>Glen Park formation</td>
<td></td>
</tr>
<tr>
<td>Limestone, silty, greenish gray to gray, thin-bedded and slabbby, ripple-marked</td>
<td>4</td>
</tr>
<tr>
<td>Louisiana formation</td>
<td></td>
</tr>
<tr>
<td>Limestone, sublithographic, gray, base concealed</td>
<td>1</td>
</tr>
</tbody>
</table>

A good exposure of the shale is in Mason’s Hollow, a little more than a mile north of Grafton, in the NE 1/4 SE 1/4 sec. 4, T. 6 N., R. 12 W., Jersey County, Ill., where more than 20 feet of the Nutwood member occurs in a cut bank on the eastern side of the creek.

**Lithology.**—The Nutwood member is a silty slightly calcareous to noncalcareous dark-brown to black sporangites-bearing shale. It is generally lighter in color, is less laminated, and contains about twice as much silt as the Grassy Creek.

In northeastern Madison and northern Bond counties, the Nutwood shale is weak to firm, partly calcareous, slightly silty, and medium-to-dark brown with some reddish-brown layers. To the southwest it becomes darker and loses much of its calcareous content. In southwestern Madison County it is a very dark brown to black thinly laminated sporangites-bearing shale that cannot readily be distinguished from the Grassy Creek. It is also very dark along its southeastern border. In Fayette County its lithology is similar to that of the New Albany shale.

**Distribution and thickness** (fig. 11).—The Nutwood shale occupies a limited area on the Ozark uplift and Vandalia arch, extending northeastward from the Mississippi River as far as Christian County. It occurs southeast of the thickest portion of the underlying Glen Park siltstone and its thickness varies from 0 to 40 feet, somewhat inverse to variations in thickness of the Glen Park.

**Stratigraphic relations.**—The Nutwood conformably overlies the Glen Park except where the latter is not present, in which area it directly overlies some unit of the Champ Clark group. It grades laterally and vertically into the Maple Mill shale.

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**ENGLISH RIVER FORMATION**

Bain (1895, p. 322) introduced the name **English River** for the “fine grained, buff to white, sandstone or gritstone” outcropping along English River in northern Washington County, Iowa. He defined it as underlain by the Maple Mill shale and overlain by the Wasonville limestone. Moore (1928, p. 56-59) considered the English River to be a member of the Hannibal formation and described it as the fine sandstone that conformably overlies the Maple Mill shale member and is conformably overlain by the McCraney limestone.

In this report the English River is considered the youngest formation of the Hannibal group. It is typically developed in Adams County where it is conformably underlain by the Maple Mill shale and conformably overlain by the McCraney limestone.
Lithology.—In outcrops in Adams County, the English River siltstone is buff to yellow, calcareous, friable, and massive. The unoxidized rock is light gray to light greenish gray. The buff-to-yellow color of the oxidized rock is probably due to the presence of finely disseminated pyrite. The massive appearance is characteristic; in some localities only two or three bedding planes were discernible. The quartz grains constituting the rock are uncommonly well sorted and remarkably uniform in size. Practically all fall within the coarse silt size.

In subsurface, the English River appears lightly “peppered” with dark grains of silt size. In a few wells it is compact, has an abundance of calcium carbonate cement, and commonly is increasingly calcareous upward. Argillaceous material is rare but a few samples show a slight amount of clay. The uniformity of the silt grains, their coarser size, and the lack of any appreciable amount of argillaceous material make the English River easily distinguishable from siltstone lenses in the Maple Mill shale. It is lighter in color and cleaner in appearance than the Glen Park siltstone.

Distribution and thickness (fig. 13).—The English River siltstone is present in western Illinois in a north-south belt about 25 miles wide extending from Henderson to Pike counties. The formation is 30 to 43 feet thick along the middle of the belt, thins to less than 10 feet along the western border of the State, and wedges out eastward.

Stratigraphic relations.—The English River siltstone lies conformably on the Maple Mill shale. There is no evidence of a stratigraphic break with the overlying McCraney limestone in Illinois, but in Iowa they are reported by Laudon (1931, p. 361) to be separated by an unconformity. East of the edge of the McCraney, the English River is unconformably overlapped by the Burlington formation.

North Hill Group

Laudon (1931, p. 366-371) defined the North Hill member of the Hampton formation as containing all beds above the English River formation and below the brown dolomites of the Wassonville member. Later (1935, p. 246) he excluded the North Hill member from the Hampton formation, apparently making the North Hill a formation.

The North Hill formation in southeastern Iowa was shown by Laudon (1931, p. 367, fig. 49) to consist of the oolitic Schellwienella zone (at the top), thin-bedded yellow sandstone, and mottled gray limestone (at the base). Moore (1928, p. 22) had previously correlated the oolitic limestone at the top with the Chouteau formation and had given the name Prospect Hill to the yellow sandstone and the name McCraney to the gray limestone. The latter two he included in the Hannibal formation. Laudon (1931) indicated that all elements of the succession are equivalent to the Chouteau. Later, Moore (1935, p. 241 and 245) agreed with Laudon’s correlation. The oolitic limestone is here named Starrs Cave.

The name North Hill is used here because the North Hill succession is not continuous with the Chouteau in Illinois and precise correlation has not been established.

In this report the North Hill is considered to be a group and includes the Starrs Cave limestone (at the top), the Prospect Hill siltstone, and the McCraney limestone, which have similar distribution (figs. 14 to 16). These units are so widespread and so distinct in lithology that they are considered formations.

The North Hill group has a maximum thickness in Illinois of 108 feet in a well in sec. 11, T. 4 N., R. 9 W., Hancock County.

McCraney Formation

Moore (1928, p. 58) proposed the name McCraney (“McKerney”)* to designate the bluish-drab limestone that crops out in the Mississippi River bluffs south of McCraney Creek, north of Kinderhook in northwestern Pike County, Ill. He considered it a member of the Hannibal formation. It is underlain by the English River

*In the original definition, McCraney (named from McCraney Creek) was misspelled McKerney.
siltstone and overlain by the Prospect Hill siltstone, except where the latter has been removed by pre-Osage erosion. At its type locality the McCraney is unconformably overlain by the Burlington limestone.

In this report the McCraney is considered the basal formation of the North Hill group.

Lithology.—The McCraney limestone is a light gray to buff slightly silty lithographic limestone with alternating layers of buff-to-brown slightly silty very fine grained dolomite. A zone of coarsely oolitic limestone less than 5 feet thick caps the McCraney where it is thick, in the northern part of the area. There is also a thin oolitic zone in the base of the formation in the Burlington area. In outcrops in northwestern Pike County, the McCraney is thin-bedded; the individual layers are one to two inches thick near the top and two to six inches thick near the base. The alternating dolomite and limestone layers plus a rectangular joint pattern give the outcrops a masonry-like appearance.

Insoluble residues show the McCraney averages over 93 percent soluble in hydrochloric acid, not greatly different from the Louisiana limestone. The average amount of residue decreases from about 8 percent near the base to about 4 percent near the top. The residues consist mostly of clay and very fine to coarse silt. There is a very noticeable decrease in silt content upward.

Arenaceous foraminifera are not so abundant as in the Louisiana but a greater number of genera have been recognized—Involutina (Ammodiscus), Psammosphaera, Lagenammina, Tolypanmina, Bathysiphon, Marsipella (?). A few rounded-to-subangular fine sand grains with dull surfaces were found, especially in samples from the lower part. Numerous microscopic coprolites of various shapes and shades of green, brown, and gray were found in the insoluble residues of a bed 14 feet below the top
of the McCraney in an outcrop in the east bank of the short creek flowing southward toward Seehorn (SE1/4 NW1/4 sec. 31, T. 3 S., R. 7 W., Adams Co.).

Distribution and thickness (fig. 14).—The McCraney limestone is confined to the western half of Hancock and Adams counties and the northeastern part of Pike County. It is 58 feet thick along the western borders of these counties and thins eastward and westward. The eastern edge of the McCraney lies along the line of maximum thickness of the English River, where the basal Osage unconformity bevels the two formations.

Stratigraphic relations.—The McCraney is everywhere underlain conformably by the English River siltstone and seems to be gradational with it. Although the McCraney is overlain conformably by the Prospect Hill siltstone, the contact is marked in outcrops by a sharp change of lithology. Where no Prospect Hill is present (fig. 15), the McCraney is unconformably overlain by the Burlington limestone of Osage age. The unconformity is sharp and easily recognizable in outcrops in northwestern Pike County and in subsurface.

Correlation.—Laudon (1931, p. 366-371) correlated the North Hill group, including the McCraney limestone, with the Chouteau limestone of Missouri. Although the McCraney and Chouteau limestones do not occur in Illinois closer than about 36 miles (figs. 14 and 17), the two limestones appear to have been parts of a single extensive formation. Their present separation may be due to the uplift of the Schuyler arch and the erosion that preceded deposition of the Osage. The beveling of the McCraney can be observed in outcrops in western Illinois.

There is some evidence that the Chouteau and the McCraney are not strictly contemporaneous. The Chouteau nearest the McCraney is an impure limestone with silt, chert, and some clay, whereas the McCraney is a comparatively pure limestone.

The McCraney is considered by Stainbrook (1950) to be equivalent to the Louisianan limestone, but the continuity of inter-vening beds between the two limestones tends to refute this correlation.

PROSPECT HILL FORMATION

The name Prospect Hill was introduced by Moore (1928, p. 23) for the “upper yellow sandstone” of Weller (1900, p. 76-77) at Burlington. Moore considered it the uppermost member of the Hannibal formation. In this report the name is used for the siltstone that in Adams and Hancock counties occupies a stratigraphic position in the North Hill group between the McCraney limestone (below) and the Starrs Cave limestone.

Lithology.—The Prospect Hill siltstone is light gray to buff, calcareous, pyritic, and friable. The silt grains range from medium to coarse. The Prospect Hill is massive where it crops out; in some places not a single bedding plane is visible. It closely resembles the English River siltstone, but the silt is not so well sorted, is lighter colored, and lacks the dark pepper-like grains. In well 24 (cross section AB, plate 1), a thin layer of lithographic-to-coarse buff-to-brown limestone was found in the middle of the siltstone. In some wells a bluish-gray silty shale a few feet thick is found at the top of the Prospect Hill.

Distribution and thickness (fig. 15).—The Prospect Hill is confined in Illinois to a narrow belt along the western edge of Hancock and Adams counties. From its eastern limit it thickens westward and reaches a maximum thickness of 29 feet.

Stratigraphic relations.—The Prospect Hill siltstone conformably overlies the McCraney limestone although the lithologic change is abrupt. It is overlain conformably by the oolitic Starrs Cave limestone except where the latter has been removed by pre-Osage erosion.

Correlation.—The Prospect Hill, with other formations in the North Hill group, is correlated with the Chouteau limestone. It may be a lens of siltstone in the midst of a limestone succession, similar to the Northview siltstone in Missouri (Branson and others, 1938, pt. 2, p. 48).
STARRS CAVE FORMATION

Laudon (1931, p. 367-371) referred to the oolitic limestone overlying the Prospect Hill sandstone as the Schellwienella zone. He did not give it a geographic name. Charles Collinson (personal communication) has proposed that it be designated the Starrs Cave limestone from the stratigraphic section at Starrs Cave on Flint River, a mile north-northwest of Burlington, Des Moines County, Iowa, described below. The section is reached from Burlington by going north on the Irish Ridge road 1 1/2 miles beyond its junction with Sunnyside Avenue. It is west of the road and is reached by a trail which leads over the bluff. A fine photograph of this section was published by Keyes (1895, pl. 36). Weller (1900, p. 61) differentiated this limestone as Unit 6.

Type section of Starrs Cave formation in the Flint River bluff near Starrs Cave, NW1/4 NW1/4 sec. 19, R. 2 W., T. 70 N., Des Moines County, Iowa (described by Charles Collinson).

Lithology.—The Starrs Cave formation is a buff to light brownish gray coarsely oolitic limestone that is locally dolomitic and contains small amounts of silt.

Distribution and thickness (fig. 16).—This limestone ranges from 2 to 12 feet thick in six wells in western Hancock County. Laudon (1931, p. 369 and 371) traced for a long distance across Iowa an oolitic bed which he thought might be this limestone.

Stratigraphic relations.—The Starrs Cave limestone conformably overlies the Prospect Hill siltstone and unconformably underlies the Burlington limestone.

Correlation.—Moore (1928, p. 22) and Laudon (1931, p. 371) agree that this limestone correlates with some part of the Chouteau.
nois but is not used here because the name Chouteau has priority.

Chouteau is used in this report for the limestone that in western and central Illinois rests conformably on the underlying Maple Mill formation and in eastern and southern Illinois on the New Albany formation. It is the uppermost limestone of the Kinderhook series in these areas and is unconformably overlain by the Osage group.

**Lithology.**—The most complete section of Chouteau in Illinois crops out in Jerseyville Hollow, SW 1/4 SE 1/4 SE 1/4 sec. 3 to SE 1/4 NE 1/4 NW 1/4 sec. 10, T. 6 N., R. 12 W., Jersey County, about 1 mile north of Grafton.

**Thickness**

<table>
<thead>
<tr>
<th>Feet</th>
<th>Inches</th>
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<tr>
<td>3</td>
<td>2</td>
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**Mississippian system**

**Valmeyer series**

**Osage group**

Fern Glen formation

Limestone, cherty, grayish to greenish brown, with numerous scattered very fine to coarse crinoid grains, pyritic, having a peculiarly rounded grain texture in the basal 2 inches .

Kinderhook series

Chouteau formation

Limestone, gray, lithographic, unevenly bedded .

Shale, bluish gray, weak .

Limestone, dolomitic, argillaceous, cherty, gray to buff, very fine to sublithographic, scattered bryozoa, crinoids, and brachiopods .

Interval covered .

Limestone, as above .

Mostly covered, some projecting limestone beds .

Limestone, dolomitic, argillaceous, gray, medium to very fine grained, small crinoid fragments, some chert .

Hannibal group

Maple Mill formation

Shale, silty, calcareous, greenish to brownish gray, with brown nodular limestone, thin westward, may be transitional to Chouteau .

Shale, silty, gray and greenish gray to brownish gray, pyrite tubes, firm, blocky, conchoidal fracture, some siltstone .

beds (outcrop in cave at "Paint mine") .

Interval covered .

Nutwood member—shale, gray-brown, nonsilty, dark-brown organic specks (outcrop in west bank of stream 100 feet east of road) .

Interval covered .

Shale, gray-brown, scattered fine-to-medium rounded quartz sand, thin siltstone laminae, scattered spores, few conodonts, trace glauconite .

Glen Park formation

Sandstone, calcareous, cherty, argillaceous, light brownish gray, fine-to-medium rounded quartz grains, tightly cemented; buff, medium to coarse oolites .

Limestone, cherty, silty, sandy, brown, dense, gray to ochre, oolitic, brachiopods, crinoids, grades to siltstone and quartz sandstone .

Conglomerate of shale pebbles, limestone, chert, oolites, sand, and fossil fragments .

Champ Clark group

Grassy Creek formation

Shale, brown, fine, thin-bedded, smooth .

Shale, mottled, brown and blue .

Interval covered .

Shale, dark brown, firm, thin-bedded above, blocky below .

Interval covered .

Shale, dark brown, sandy, thinly laminated .

Sylamore formation

Sandstone, oxidized limonite-orange, medium rounded grains .

Bedding characteristics.—The Chouteau formation in the outcrop area of Calhoun and Jersey counties is composed of irregular beds of limestone which normally range from a few inches to less than a foot in thickness. Thin shale partings are present between the beds of limestone.

Texture.—The texture of the Chouteau limestone is fairly constant throughout Illinois. It ranges from sublithographic to very fine grained with scattered coarse crinoid fragments. The dense limestone breaks with a conchoidal or splintery fracture.
Color.—The Chouteau limestone is generally light brownish gray throughout the southeastern part of Illinois and in the outcrop area of Jersey and Calhoun counties of western Illinois (Buschbach, 1952, fig. 1). In Wayne and Hamilton counties, the deepest part of the Illinois basin, the limestone is dark brown. Between these areas the Chouteau is normally light greenish gray. In a narrow strip extending northeastward from the Ozark region, part or all of the Chouteau is red or pink, primarily in the groundmass. Some crinoid stems also display red and green tints, but others are white. There is a sporadic occurrence of reds and greens in the brownish-gray limestone. Locally some beds of the Chouteau are nearly white. The abundance of ferric oxide in the dolomitic layers causes them to become rusty brown when weathered, whereas the dense limestone retains its original grayish-brown color.

Dolomite.—The Chouteau limestone contains some dolomite in almost all areas, especially in thin bands near the top (Buschbach, 1952, fig. 2). In outcrops, the dolomite is in layers seldom over a few inches thick. Silt-size dolomitic crystals, however, are present throughout the dense limestone and are found in some of the chert nodules. The dolomite layers are buff and mottled on weathered surfaces.

Silt and clay.—In Illinois the silt content of the Chouteau limestone has remarkably even distribution (Buschbach, 1952, fig. 3). Although silt-size particles are present nearly everywhere in the formation, they are not known to exceed 10 percent. The clay content appears to be higher where the deposits are thicker. In Madison, Bond, and Clinton counties, the base of the Chouteau becomes more silty and argillaceous. The increase in clastic content is indicated on electric logs by a marked decrease in resistivity. Insoluble residues of outcrop samples also indicate an increase of silt toward the base of the Chouteau. Sand is generally absent.

Chert nodules.—Nodular chert is found in the Chouteau limestone only in Jersey and Calhoun counties and coincides with the area of greatest thickness (fig. 17). Where the thickness is 20 feet or less, throughout most of Illinois, no chert has been found.

The chert is nodular, black to gray, and flinty. It contains dolomite crystals and numerous small fossils. The nodules occur in beds and discontinuous bands from 3 to 6 inches thick and are concentrated in zones which are generally several feet apart. They are most abundant at the base of the formation. As the Chouteau thins northward in Illinois, the chert loses its zoned characteristics and disappears completely. Some botryoidal chert is present in the insoluble residues.

Geodes.—Geodes 1 to 8 inches in diameter and filled with calcite occur in the Chouteau formation.

Fossils.—Crinoids are abundant in the Chouteau formation but are not large. Brachiopods, bryozoa, pelecypods, and corals are common. Arenaceous foraminifera, Bathysiphon and Involutina (Ammodiscus), are present in the insoluble residues. Moore (1929, p. 67-68) and Branson (1944, p. 209-224) give extensive faunal lists.

Distribution and thickness (fig. 17).—The maximum thickness of the Chouteau formation in Illinois is in southern Calhoun and western Jersey counties where it is 40 to 78 feet thick. It is 20 to 30 feet thick in an area between the Schuyler uplift on the northwest and the Ozark uplift and Vandalia arch on the south and southeast. At its northwestern border the Chouteau thins from the maximum thickness and disappears in less than 15 miles, largely because of pre-Osage erosion following the uplift of the Schuyler arch. The outcrops in Calhoun and Jersey counties and in nearby Missouri show the northward thinning. On the Vandalia arch and southeastward the Chouteau is less than 20 feet thick. It is absent in two areas on top of the LaSalle anticlinal belt in eastern Illinois.

The Chouteau may be represented on the west side of Hicks dome in Hardin County by 4 feet of gray porous blocky shale which contains fossil casts and may be a leached or otherwise-altered argillaceous limestone. An
Fig. 17.—Thickness of the Chouteau formation.
outcrop along Hicks Branch about 1/4 mile south of the center sec. 25, T. 11 S., R. 7 E., Hardin County, exposes the following section.

Mississippian system
Valmeyer series
Osage group
Chert, buff, chalky, dull, dense
Shale, silty, glauconitic, green, grades upward into chert
Shale, silty, olive-gray, micaceous, glauconitic
Shale, silty, buff, micaceous
Interval covered

Kinderhook series
Chouteau formation
Shale, gray, punky, porous, fossil casts in lower 3 feet, blocky
New Albany formation
Shale, green, weak, sticky, weathered
Interval covered
Shale, brownish black, tough

Stratigraphic relations.—The Chouteau limestone overlies with apparent conformity the Maple Mill shale or the New Albany shale (fig. 6). In small areas in southwestern Illinois and eastern Missouri, it unconformably overlies the Grassy Creek shale or some member of the Devonian, Silurian, or Ordovician systems. In Illinois the Chouteau is everywhere overlain unconformably by the Osage group. In central and eastern Illinois the Carper sand or the glauconitic Osage (Borden) siltstone overlies the Chouteau. In western Illinois the massive Burlington limestone takes the place of the siltstone. In southwestern Illinois the Sedalia or Fern Glen formations overlie the Chouteau. In Union County and vicinity the Springville shale overlies the Chouteau.

Correlation.—The Chouteau limestone of Illinois is equivalent, or approximately equivalent, to the Starrs Cave limestone, Prospect Hill siltstone, and McCraney limestone of Iowa and Illinois, the Rockford limestone of Indiana, and the lower part of the Waverly formation of Ohio. The Chouteau. In Union County and vicinity the to be equivalent to the Chouteau of north-

eastern Missouri as restricted by Moore (1928, p. 33), which is the lower part of Swallow’s original Chouteau. The Chouteau of Illinois appears equivalent to the Compton formation of the Chouteau group as defined by Clark and Beveridge (1952) in central Missouri.

Post-Mississippian pre-Pennsylvanian erosion had little effect on the distribution of the Chouteau limestone except in northern Champaign and Vermilion counties, where erosion cut through both the Osage and the Chouteau (fig. 4). Elsewhere in central and western Illinois the Osage limestone extends far north of the Chouteau boundary.

NEW ALBANY FORMATION

The New Albany formation was named by Borden (1874, p. 158-60) from typical exposures of thin-bedded bituminous black “slate” at New Albany, Floyd County, Ind. He described the shale as resting on a blue crinoidal limestone (later named the Sellersburg) and as capped by a ferruginous limestone which he recognized from its position to be equivalent to the “goniatite limestone” at Rockford, Ind., subsequently designated the Rockford limestone.

Campbell (1946, p. 837) redescribed the New Albany at the type section to include everything designated by Borden except 9 inches of soft greenish glauconitic fossiliferous shale, which he called the Jacobs Chapel shale, underlying the Rockford limestone. He divided the New Albany at the type locality as follows:

Mississippian system
Rockford limestone
Jacobs Chapel shale, soft, greenish, glauconitic, fossiliferous
New Albany shale
Upper New Albany
Henryville formation, fissile black shale
( Horizon of Underwood shale, soft, greenish, fossiliferous, absent from vicinity of New Albany)
Sanderson formation, black shale with 0.33-foot Falling Run phosphate concretionary member at top
Devonian system

Upper Devonian series

New Albany shale (cont.)

Blackiston formation, black shale with layers of gray shale and calcareous concretions, few layers of sandstone . . . . 78.00

Middle Devonian series

New Albany shale (cont.)

Blocher formation, black shale with layers and lenses of sandstone, few limestone concretions . . . . 13.00

In this report the term New Albany is applied to the predominantly brownish-black shale that lies between the Devonian (or older) formations below and the Chouteau (Rockford) limestone above. The Jacobs Chapel shale may intervene between the New Albany and Chouteau in Illinois, but it is too thin to be separated in sample cuttings. Thus defined, New Albany is used in southern and eastern Illinois mainly as a subsurface term for the black shale unit,
Fig. 19.—Cross section of the New Albany shale from southwestern Indiana to southeastern Illinois. By Guy Campbell, July 1948.
recognizing that it includes undifferentiated Devonian and Mississippian elements. It is treated here as a formation.

Lithology.—The New Albany is a tough brownish-black to dark-brown shale and contains mica, pyrite, and sporangites. It is in part thinly laminated and in part blocky with conchoidal fracture. Thin very compact dark-gray dolomitic siltstones, silty dolomites, and limestones are present in places, particularly near the base of the formation. Gray shale lenses and beds are locally present.

Distribution and thickness (fig. 6).—The New Albany shale occurs south and east of the area in which the equivalent Hannibal and Champ Clark groups are recognized.

Stuart Weller (1920, p. 8) estimated the thickness of the New Albany (“Chattanooga”) as 400 feet in Hardin County. From this maximum it thins rapidly westward and more gradually northward. The axis of greatest thickness extends northward from Hardin County to southern Champaign County.

Stratigraphic relations.—The New Albany shale overlies Middle Devonian limestones throughout most of its extent. Savage (1920, p. 177) reported, on the basis of field work along the eastern edge of the Ozark uplift in Union County, that the New Albany (Mountain Glen) is separated from the underlying Devonian Alto limestone by an unconformity. J. M. Weller (1940, p. 28) suggested that the Alto and Lingle limestones of Union County may be equivalent to part of the New Albany farther east. The Alto and Lingle limestones, as shown in a cross section through Union and Johnson counties (fig. 18), contain black shales and dark siltstones that are not greatly different from some phases of the brownish-black New Albany shale. However, a conglomerate at the base of the Alto in at least the two westernmost wells, the calcitic beds of the Lingle, and the dolomitic limestone of the Alto, all tend to suggest that these two Devonian formations extend under the New Albany and do not grade laterally into it.

The New Albany in Illinois is overlain conformably by the Chouteau limestone. Locally along the LaSalle anticlinal belt the Chouteau limestone is absent, and the strata overlying the New Albany are Osage siltstones and shales.

Correlation.—The New Albany shale of Illinois is correlated with the type New Albany of southern Indiana on the basis of its stratigraphic position beneath the Chouteau (Rockford of Indiana) and above Middle Devonian limestone. Subdivisions of the New Albany of Indiana (Campbell, 1946) have not been differentiated in this study. However, in 1948 Guy Campbell studied sample cuttings from six wells in Clark, Crawford, and Lawrence counties and made tentative correlations with the type New Albany sequence (fig. 19). In these wells Mr. Campbell identified a zone of abundant sporangites which at New Albany characterizes the lower Blackiston. The basal black shale with limestone beds appears to be equivalent to the Blocher shale. Mr. Campbell noted that clay shale, which is prominent in the Blackiston in Indiana, is absent in this unit in Illinois. He also noted a marked decrease in the quantity of pyrite in the Illinois samples.

REJECTED NAMES

CHATTANOOGA FORMATION

The name Chattanooga was given by Hayes (1891, p. 143) to the 0 to 35 feet of black shale at Chattanooga, Tenn., which he described as occupying the interval between the Fort Payne chert and Granger shale above, both of Mississippian age, and the Helderberg limestone of Devonian age below. Stuart Weller (1920, p. 88-90) used the name to designate the 400 or more feet of black shale below the Osage and above the Devonian limestone in Hardin County, Ill. He stated, however, that these strata must include much more than the equivalent of the Chattanooga of Tennessee. Campbell (1946, p. 881) stated that “All the divisions of the New Albany ... are duplicated in the Chattanooga.” Inasmuch as the New Albany has priority and appears to represent more completely
the succession of the Illinois black shale, the name Chattanooga is rejected.

**Sweetland Creek Formation**

The name **Sweetland Creek** was given by Udden (1899, p. 65-78) to an olive-gray and green shale, 0 to 48 feet thick near Muscatine, Iowa, which underlies the Pennsylvanian system. Later, Udden (1911, p. 101-107) announced the eastward extension of the Sweetland Creek shale into Illinois. He considered it Devonian in age. Inasmuch as the Sweetland Creek beds at their type locality represent only a relatively small portion of the almost 200 feet of similar beds called Grassy Creek in nearby northwestern Illinois, the name Grassy Creek is used in this report, and the term Sweetland Creek is discarded.

**Mountain Glen Formation**

The name **Mountain Glen** was proposed by Savage (1920, p. 177) for the hard laminated black shale of Devonian age in Union County, Ill. He described it as unconformably overlying the Alto limestone of Upper Devonian age and unconformably overlain by the Springville shale of Mississippian age. Savage's definition has been generally accepted in reports dealing with that portion of southern Illinois where the Springville shale and the Alto limestone are recognizable.

The Mountain Glen is similar in character to both the Grassy Creek and New Albany black shales, and it is continuous with both formations. In the region of typical development in southern Illinois, it varies from 0 to 50 feet in thickness and may represent only a portion of the New Albany. However, because the shale is directly overlain by the Chouteau limestone, it has the same relations as the New Albany shale. The name, therefore, is rejected in favor of New Albany.

**DISCUSSION OF CROSS SECTIONS**

The relationships of formations and members and the influence of structural movements during and directly following Kinderhook deposition are shown in seven cross sections (plates 1 and 2), three of which—AB, CD, and EF—are in a general north-south direction, and four—BG, HI, JK, and LE—in a general east-west direction (fig. 20). The top of all sections is the base of the Osage; the bottom is generally Middle Devonian (fig. 2). Wells used in the cross sections are identified in the appendix.

**ILLINOIS CROSS SECTIONS**

**AB**

Cross section AB extends in a southeast-northwest direction along the western border of Illinois from Union to Hancock counties. It crosses the highest portion of the Ozark uplift in Illinois (Randolph, Monroe, and St. Clair counties), and from there northward it crosses the Petersburg basin, in which the Schuyler arch is evident.

Although the southeastern edge of the high portion of the Ozark uplift in Illinois is located at the Randolph-Jackson county line, comparison with figure 3 shows that the effect of the uplift extends as far southeast as central Union County, beyond which the New Albany shale thickens rapidly from less than 25 feet to 175 feet. In the same way, the effect of the uplift extends northward as far as Jersey County, where the black shale begins to thicken into the Petersburg basin and reaches 70 feet thick in a few miles. It then thickens more gradually to a maximum of 190 feet at the northwestern end of the section.

The possible equivalence of the Glen Park formation with at least the lower part of the Maple Mill–Saverton shale is brought out by cross section AB.

The Schuyler arch may have been a barrier between the Chouteau limestone on the south and the McCraney–Prospect Hill–Starrs Cave sequence on the north. If deposited entirely across the Petersburg basin, these strata were removed by pre-Osage erosion.

**CD**

Cross section CD extends in a south-to-north direction through the middle of the State close to the Third Principal Meridian
FIG. 20.—Index map of Illinois showing lines of cross sections.
from Massac to Woodford counties. This section crosses the eastern margin of the Ozark uplift in Illinois (fig. 3), crossing the crest in Washington County.

The Hannibal group occurs on the northern side of the Ozark uplift. The Glen Park siltstone is well developed along this cross section.

The Chouteau limestone overlaps all earlier strata except the Louisiana limestone but apparently was eroded from the uplifted area north of Christian County previous to Osage deposition.

**EF**

Cross section EF extends in a south-to-north direction along the eastern border of the State from Hardin to Champaign counties. The section crosses the LaSalle anticlinal uplift from Lawrence to Champaign counties. Along the uplift the Kinderhook strata were deeply cut by post-Chouteau pre-Osage erosion.

**BG**

Cross section BG extends in a northwest-southeast direction through central Illinois from Hancock to Clark counties. Uplift of the Vandalia arch, which is crossed from Christian to Coles counties, did not influence the thickness of the New Albany shale, although uplift along the arch following Grass Creek time formed the Petersburg basin to the northwest. In Clark County local thinning of the New Albany shale suggests movement along the LaSalle anticlinal belt. This section crosses the Schuyler arch in Schuyler and Cass counties.

**HI**

Cross section HI extends in a west-east direction from Calhoun to Crawford counties. This section goes through Vandalia just east of the Third Principal Meridian and shows the effect of the Vandalia arch on the thickness of the Grass Creek—New Albany shale and on deposition of Kinderhook strata in the Petersburg basin. There is no evidence of movement along the LaSalle anticlinal uplift. This section is along the axis of the lens of Louisiana limestone.

In western Montgomery County the black Nutwood shale grades into the Maple Mill green shale.

The Chouteau limestone is present along the entire section and reaches its greatest thickness at the western end of the section.

**JK**

Cross section JK extends in a west-east line from St. Clair to Lawrence counties. The west half shows the thinning of Kinderhook strata on the Ozark uplift. The Grass Creek wedges out and disappears between the Chouteau limestone and the Silurian limestone at the western edge of St. Clair County. East of the Ozark uplift the New Albany shale thickens to as much as 200 feet. The Chouteau limestone extends along the entire section except where it was uplifted and eroded along the LaSalle anticlinal belt in eastern Lawrence County. Both in this section and in section HI, the Chouteau thickens westward, in contrast to the underlying Hannibal and Champ Clark equivalents.

**LE**

Cross section LE extends in a west-east direction from Union to Hardin counties. The effect of the Ozark uplift disappears in Union County near the Third Principal Meridian, and from there eastward the New Albany shale thickens from about 15 feet to over 400 feet.

**ILLINOIS-MICHIGAN CROSS SECTION**

A cross section from St. Louis northeastward through central Illinois, northwestern Indiana, and central Michigan to Saginaw Bay is shown on plate 2. This section shows the continuity of the Grass Creek, New Albany, and Antrim black shales. The Glen Park siltstone appears contemporaneous with the Berea sandstone. The Nutwood black shale member of the Maple Mill may be the Sunbury black shale. A thin limestone in the Michigan section may be the continuation of the Chouteau-Rockford limestone. Finally, the Fern Glen red rock appears to be the Coldwater red rock.
HISTORICAL INTERPRETATIONS

Only in the southwestern part of the State, where the Alto and Lingle limestones are present, does it appear possible that there was continuous deposition from Devonian limestone to black shale. If the Alto and Lingle limestones are equivalent in whole or in part to the black shale, there may have been an area of continuous deposition during Middle to Upper Devonian times east of the Ozark uplift and southeast of the Vandalia arch. The dark-brown sporangites-bearing shales in the Alto and Lingle limestones are similar in lithology to the New Albany shale, which proves that black shale deposition was established in the Union County area before the end of Devonian limestone deposition.

Following the deposition of Middle Devonian limestone, there was widespread uplift, warping, and erosion. The pre-Kinderhook areal geology (fig. 2) shows the effect of the warping and erosion. The Ozark uplift was active and was truncated down to the Maquoketa shale. A broad area of uplift in the Schuyler arch region brought Silurian strata to the surface. Maquoketa shale was exposed on the Colmar-Plymouth anticline. The character of the Silurian sediments suggests that there was no movement of the Schuyler arch during Silurian time. On the other hand, the Wapsipicon and Cedar Valley limestones are sandy and variable in lithology, which suggests Devonian movements. The Vandalia arch began earlier. Workman (1944, p. 192-196) pointed out the changes of Silurian and Devonian strata along the "Madison-to-Coles-counties" line. Lowenstam (1949, fig. 1) showed that the transition from low-clastic to high-clastic Niagaran carbonate rock occurs along this zone.

The Sylamore sandstone appears to have been derived from erosion of Devonian limestone, the sand being washed into shallow depressions on the eroded surface. In view of the widespread thick cherty limestones and dolomites, which had been subjected to erosion previous to Sylamore time, the lack of chert grains is a problem.

The brownish-black color of the Grassy Creek–New Albany shale is due to the presence of organic material, which is so abundant that a sliver of shale will burn for a short time. Sporangites and pyrite are more-or-less abundant throughout the black shale; their preservation was favored by continued reducing conditions. Oxidizing conditions were established locally and gray shales were deposited. The relative abundance of gray shales northwestward toward Iowa suggests proximity of a land mass in that direction.

The Saverton shale is largely confined to the Petersburg basin. Variations in thickness of the Grassy Creek shale and the presence in the Saverton of granules of hard black shale suggest that at least locally there was pre-Saverton uplift and erosion, possibly in the Ozark uplift and the Vandalia arch. The dark bluish gray shale of the Saverton may indicate a transition from the reducing conditions of black shale deposition to the highly specialized type of environment suitable to the formation of the pure lithographic limestone of the Louisiana.

Williams (1943, p. 49-53, plate 5, figs. 6 and 7) interpreted the Louisiana limestone as a deposit in a basin confined on the north by the Pittsfield-Hadley anticline and on the south by the Cap-au-Gres (Lincoln) anticline. The Louisiana lens extends farther east in Illinois than he supposed (fig. 8). The theory advanced by Williams, that these possible barriers were land masses and that the Louisiana was contained in a narrow sea not far from this land (which necessarily would expose shale sediments), does not seem to fit the fact that the Louisiana is a high-purity limestone. Rather, it appears that local submarine warping produced a basin favorable to lithographic limestone deposition. The conformable relations with the Saverton shale, the possible extent of the Saverton shale in the Petersburg basin, and the lack of clastic material in the Louisiana all suggest that the Louisiana also formerly occupied a wide area in the Petersburg basin. At the end of Louisiana time, uplift and warping of the Schuyler arch caused erosion of the Louisiana to its
present small lenticular extent. The Saverton shale also was affected, but in the area of the Schuyler arch the subsequent overlapping of another shale (Maple Mill) makes the present thickness difficult to determine.

The domal uplift of the Schuyler arch on the north, together with the Ozark uplift and the Vandalia arch on the south and east in early Kinderhook times, formed an embayment in central Illinois opening out to the west, in which basal Glen Park oolite was locally deposited. However, an influx of silt through the western entrance to the bay caused the formation of silt bars, the most important of which was located around the southern border of the dome. These silt bars contain some oolitic limestone all the way to the top.

Following Glen Park deposition, the greenish-gray silty shale and siltstone of the Maple Mill were deposited in the bay, on the uneven surface of the Saverton on the borders of the Schuyler uplift, and probably all over the Schuyler arch. Contemporaneously, in the deeper portions of the bay, the Nutwood black shale was deposited.

Then followed the conformable deposition of the English River, McCraney, Prospect Hill, and Starrs Cave formations west of the Schuyler arch. Probably all of these formerly extended considerable distances to the east of their present limits, and the upper three may have extended southward across the Schuyler arch and graded into the Chouteau limestone, which was formed contemporaneously under somewhat different environmental conditions. However, the Schuyler arch may have been a barrier separating the Chouteau from the sediments on the north.

Deposition of the Kinderhook series was brought to a close by uplift of the Schuyler arch, Ozark uplift, Vandalia arch, and LaSalle anticlinal belt. The uplift caused a widespread erosional unconformity beneath basal Osage sediments.

REFERENCES


MEER, F. B., and WORTHEN, A. H., 1861, Remarks on the age of the goniadite limestone at Rockford, Indiana, and its relations to the "black slate" of the Western states, and to some of the succeeding rocks above the latter: Am. Jour. Sci., 2nd ser., v. 32, p. 167-177.


## APPENDIX

### LIST OF WELLS IN CROSS SECTIONS

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NORTH-SOUTH AND EAST-WEST CROSS SECTIONS OF KINDERHOOK SERIES

KEY

- Limestone
- Dolichic limestone
- Slate
- Silt
- Clay shale
- Sandstone

A B C D E F G H I J K L
CROSS SECTION FROM CENTRAL MICHIGAN TO WESTERN ILLINOIS SHOWING CORRELATION OF KINDERHOOK STRATA